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DEPARTMENT OF COMMERCE
Bureau of Air Commerce

# AIR COMMERCE MANUAL

No. 18

# REPAIR AND ALTERATION OF AIRCRAFT

PROPERTY OF
CIVIL AERONAUTICS AUTHORITY

DEPARTMENT OF COMMERCE
Bureau of Air Commerce

# AIR COMMERCE MANUAL 18

## REPAIR AND ALTERATION OF AIRCRAFT

This manual contains explanatory notes, references and recommendations pertaining to various items of CAR 18 "Repair and Alteration of Aircraft", by numerical reference to such items. It also contains examples of repair methods which are acceptable to the Secretary.

18.701 The heat treatment of aluminum alloy structure is adequately covered in Navy Department, Bureau of Aeronautics Process Specification SR 53a.

18.702 In view of the fact that the exact heat treatment of a member is usually very difficult to determine by tests, it is recommended that this information be obtained from the manufacturer of the aircraft. If the manufacturer is no longer in business, the information may be obtained from the Bureau.

18.704 For more detailed information relative to fabric covering and stitching, reference may be made to Army and Navy Specifications on this subject.

18.7110 In view of the usual poor joint obtained by making scarfs for a spar splice with a saw and plane, it is recommended that a joiner be used.

18.7112 Casein glue is recommended for soft woods such as spruces, and animal glue for hard woods such as plywood and ash.

18.712 When possible, it is recommended that the type of splice shown in Figure 1 herein be used.

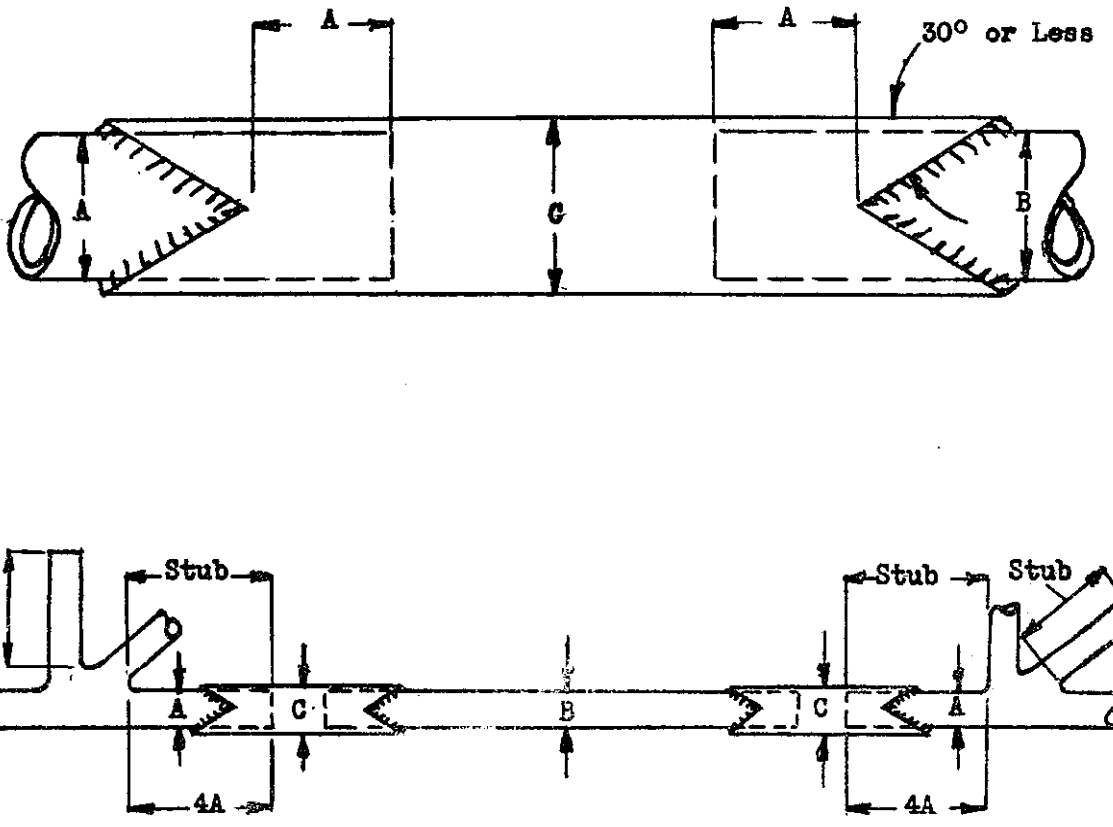
18.7122 It will usually be preferable to make the replacement tube of the same size, gauge, and material as the original, which is shown as Tube A in the figures and tables herein. When is it more convenient to substitute tubes of other gauge and/or material, such substitutions will be acceptable if made in accordance with the tables herein.

18.72002 In many cases it is possible to eliminate a bend by reducing the diameter of the propeller.

18.723 In general, the testing and making of slight repairs to instruments requires extreme accuracy but comparatively simple apparatus. It is recommended, therefore, that before tests and/or repairs are made, the manufacturer of the specific instrument be contacted with regard to obtaining his approval of the testing apparatus and his recommendations as to the test methods to be used.



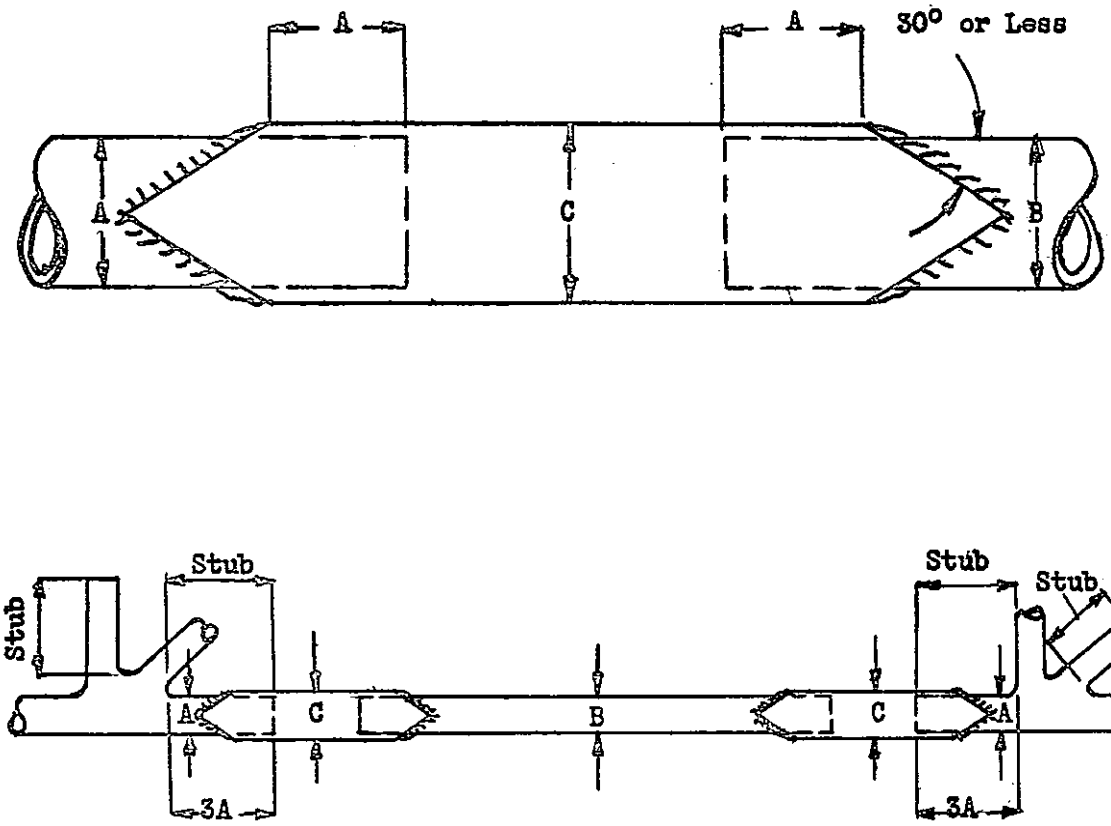
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A = Original Tube
B = Replacement Tube
C = Outside Sleeve

See Table I for diameters, wall thicknesses and materials of tubes A, B and C.

FIGURE 1. TYPE OF SPLICE USING OUTSIDE SLEEVE WITH FISHMOUTHED CUT.

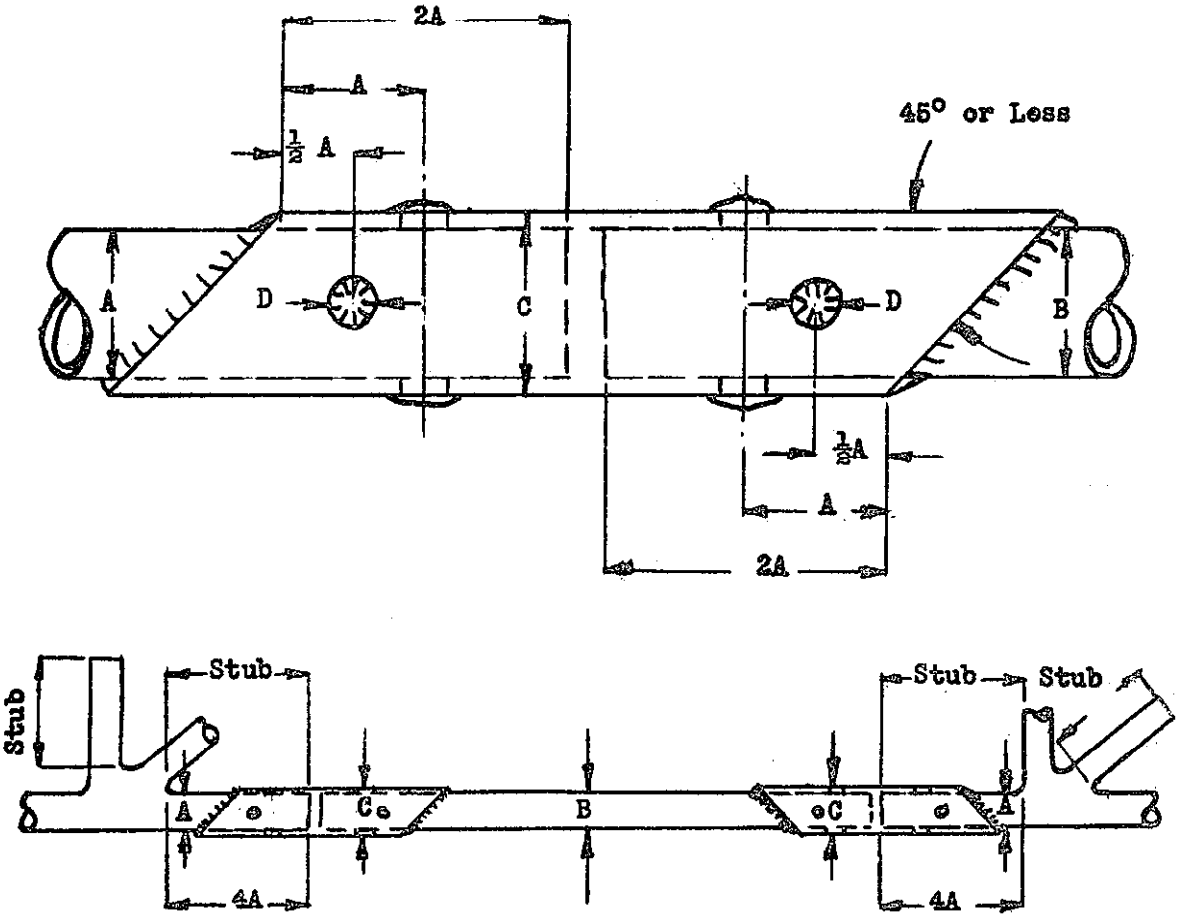



A = Original Tube
B = Replacement Tube
C = Outside Sleeve

See Table I for diameters, wall thicknesses and materials of tubes A, B and C.

FIGURE 2. TYPE OF SPLICE USING OUTSIDE SLEEVE WITH FISHMOUTH CUT.

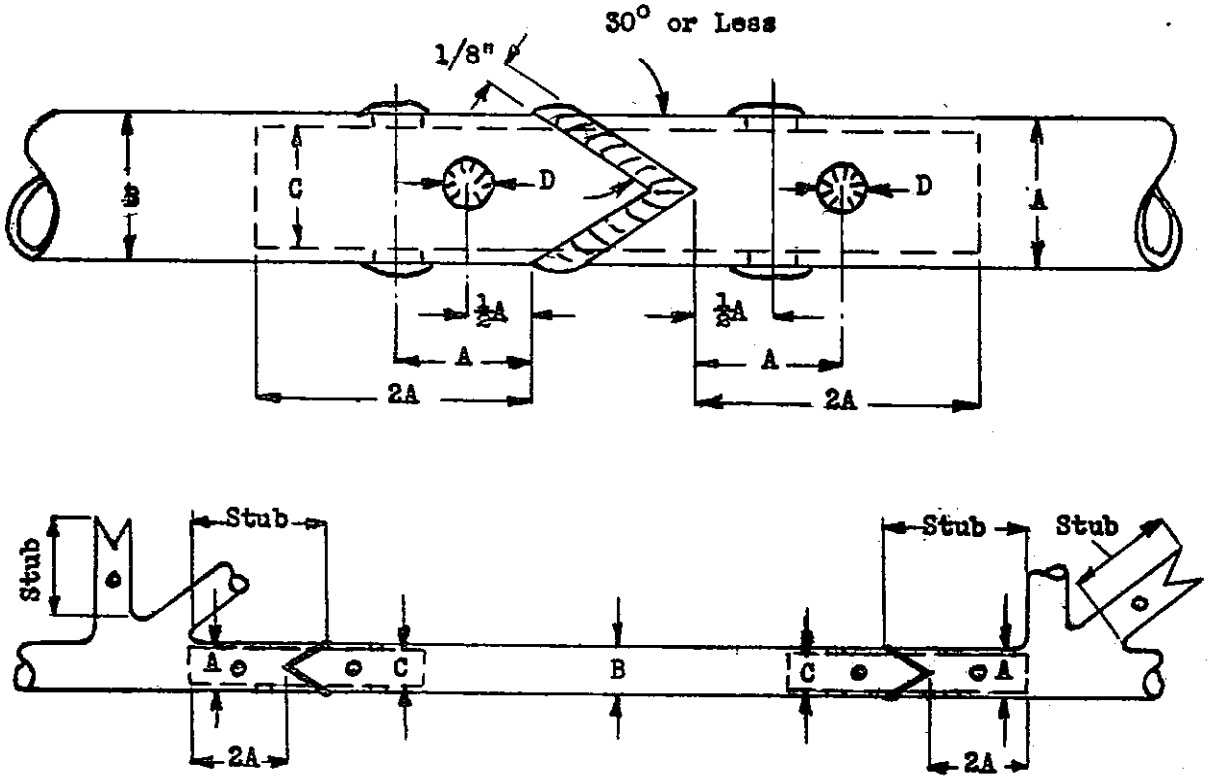
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A = Original Tube
B = Replacement Tube
C = Outside Sleeve
D = 1/4 Diameter of Tube A, but not less than 1/4 inch. (Four rosette welds used for each splice). (Drill outside tube only)

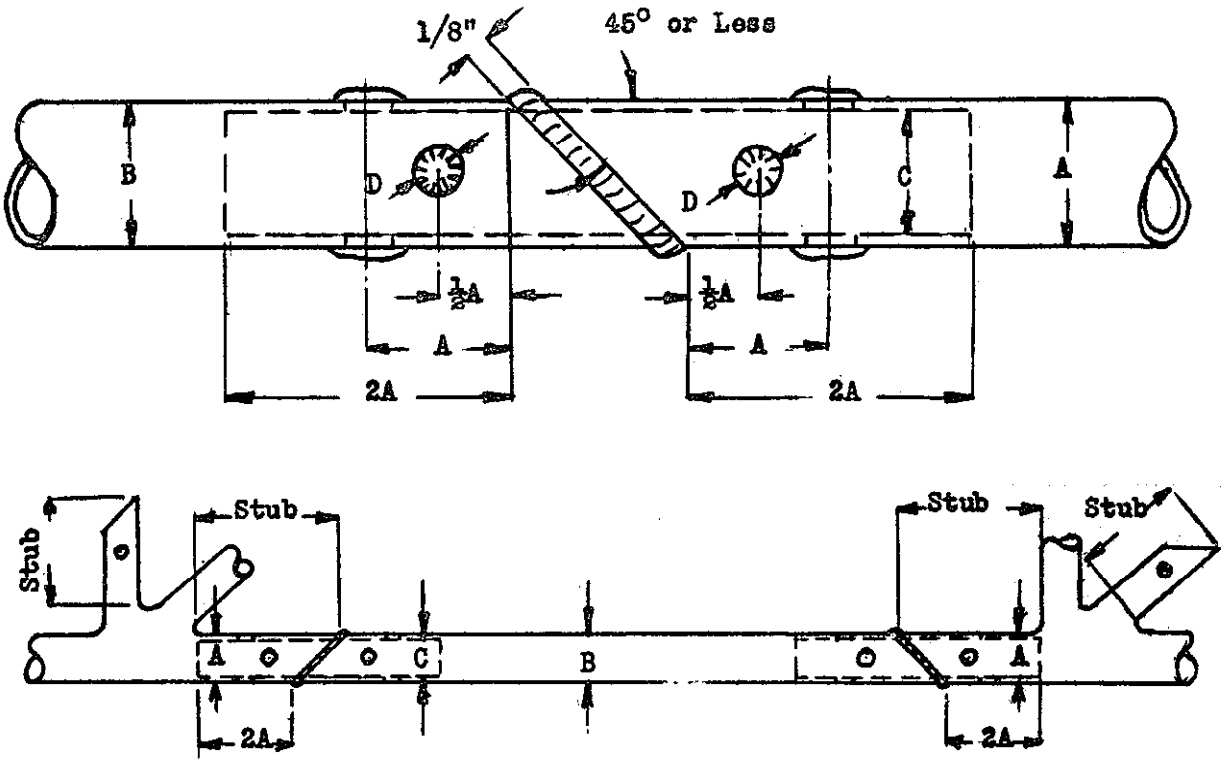
See Table I for diameters, wall thicknesses and materials of Tubes A, B and C.

FIGURE 3. TYPE OF SPLICE USING OUTSIDE SLEEVE CUT AT 45 DEGREES.




A = Original Tube
B = Replacement Tube
C = Inside Sleeve
D = 1/4 Diameter of Tube A, but not less than 1/4 inch
(Four rosette welds used for each splice).
(Drill outside tube only)
See Table II for diameters, wall thicknesses and materials of Tubes A, B and C.

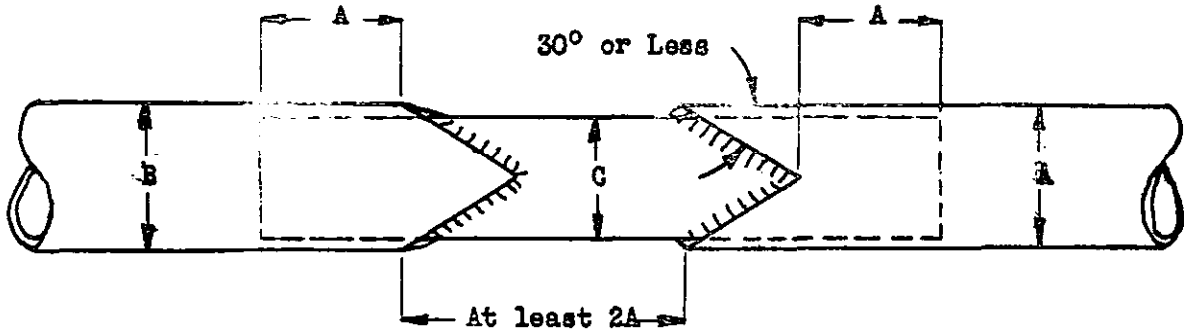
FIGURE 4. TYPE OF SPLICE USING INSIDE SLEEVE, OUTSIDE TUBES FISHMOUTHED AND SINGLE WELDS AT THE SPLICES.

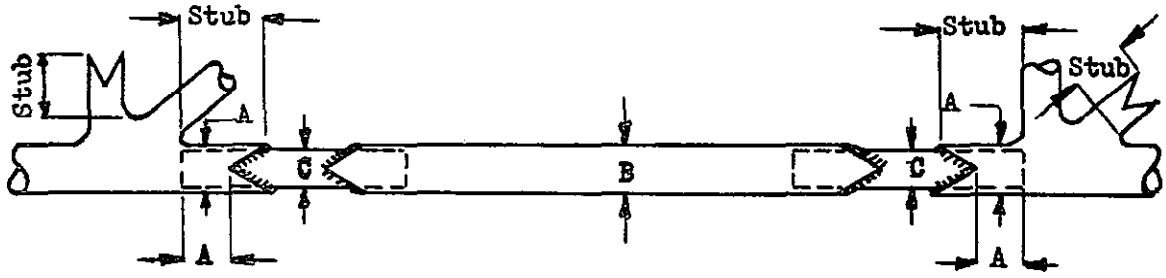



A = Original Tube
B = Replacement Tube
C = Inside Sleeve
D = 1/4 Diameter of Tube A, but not less than 1/4 inch
(Four rosette welds used for each splice).
(Drill outside tube only)

See Table II for diameters, wall thicknesses and materials of Tubes A, B and C.

FIGURE 5. TYPE OF SPLICE USING INSIDE SLEEVE, OUTSIDE TUBES CUT AT 45 DEGREES AND WITH SINGLE WELD AT SPLICES.

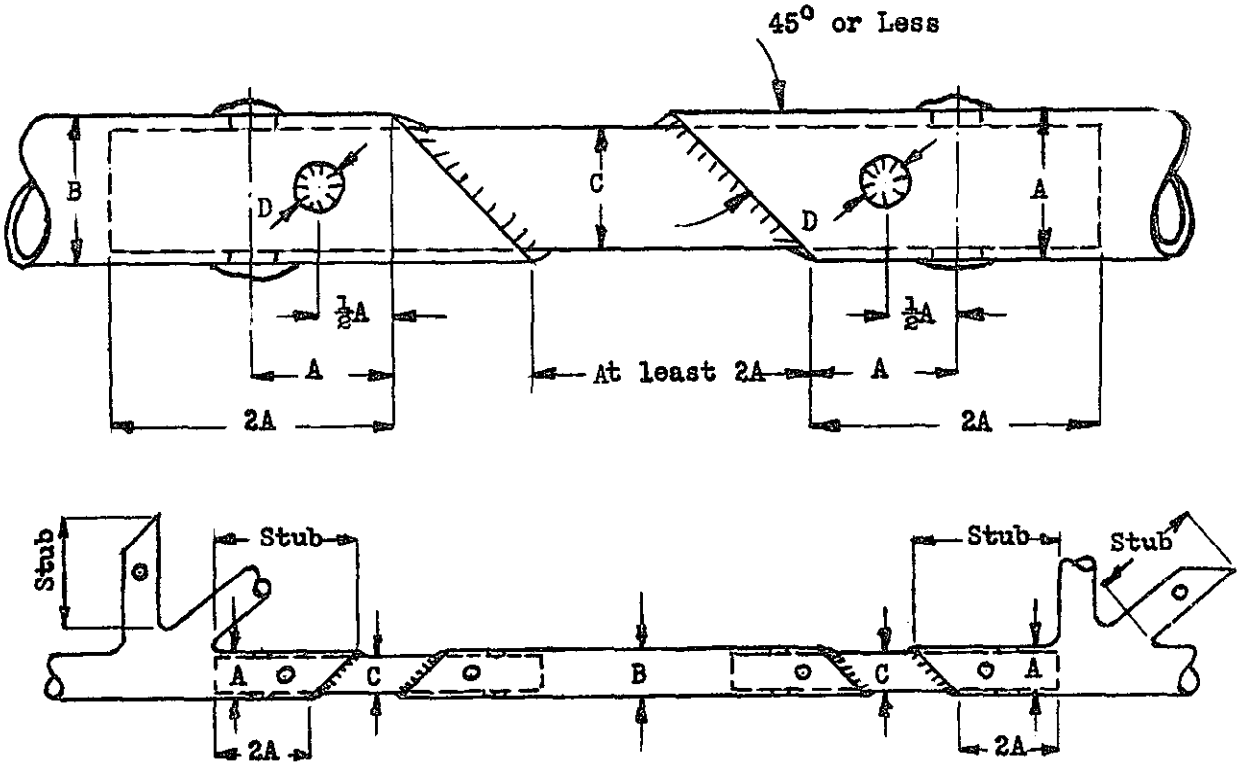



A = Original Tube
B = Replacement Tube
C = Inside Sleeve

See Table III for diameters, wall thicknesses and materials of Tubes A, B and C.

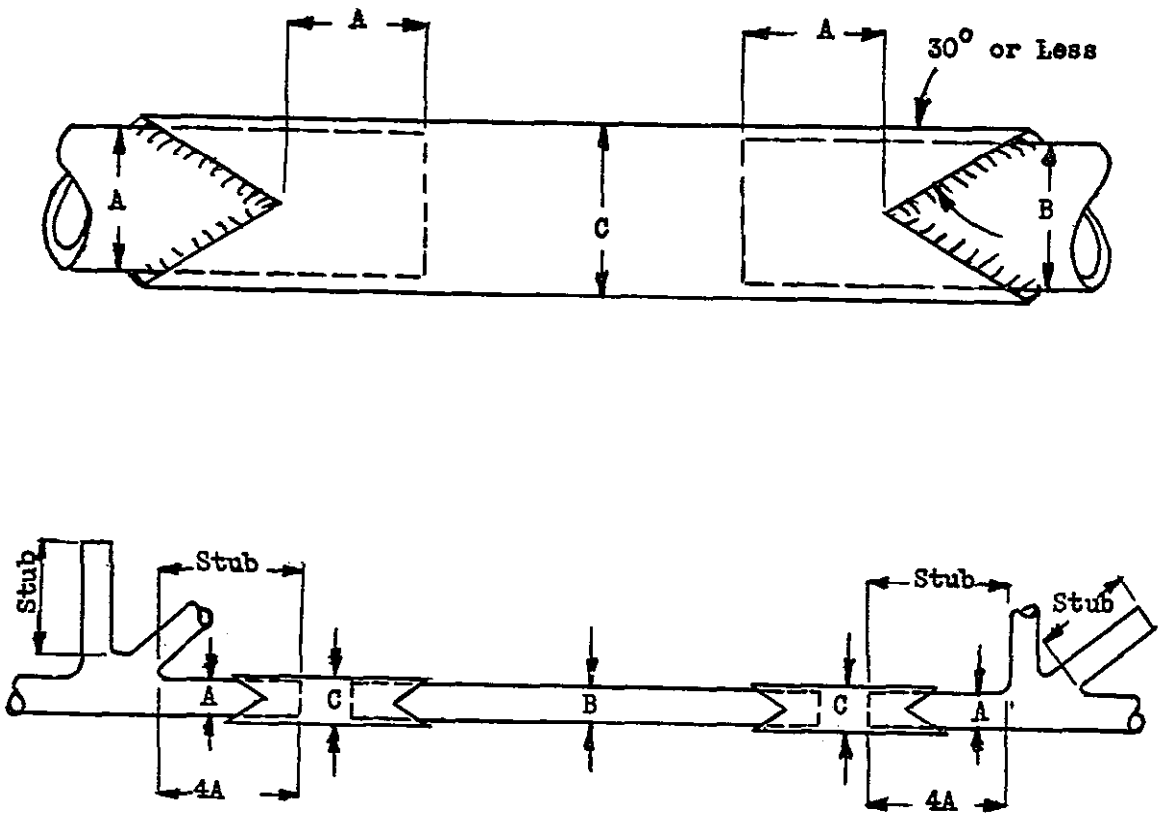
FIGURE 6. TYPE OF SPLICE USING INSIDE SLEEVE, OUTSIDE TUBES FISHMOUTHED AND WITH DOUBLE WELDS AT THE SPLICES.




A = Original Tube
B = Replacement Tube
C = Inside Sleeve
D = 1/4 Diameter of Tube A, but not less than 1/4 inch
(Four rosette welds used for each splice).
(Drill outside tube only)

See Table III for diameters, wall thicknesses and materials of Tubes A, B and C.

FIGURE 7. TYPE OF SPLICE USING INSIDE SLEEVE, OUTSIDE TUBES CUT AT 45 DEGREES AND WITH DOUBLE WELDS AT THE SPLICES.

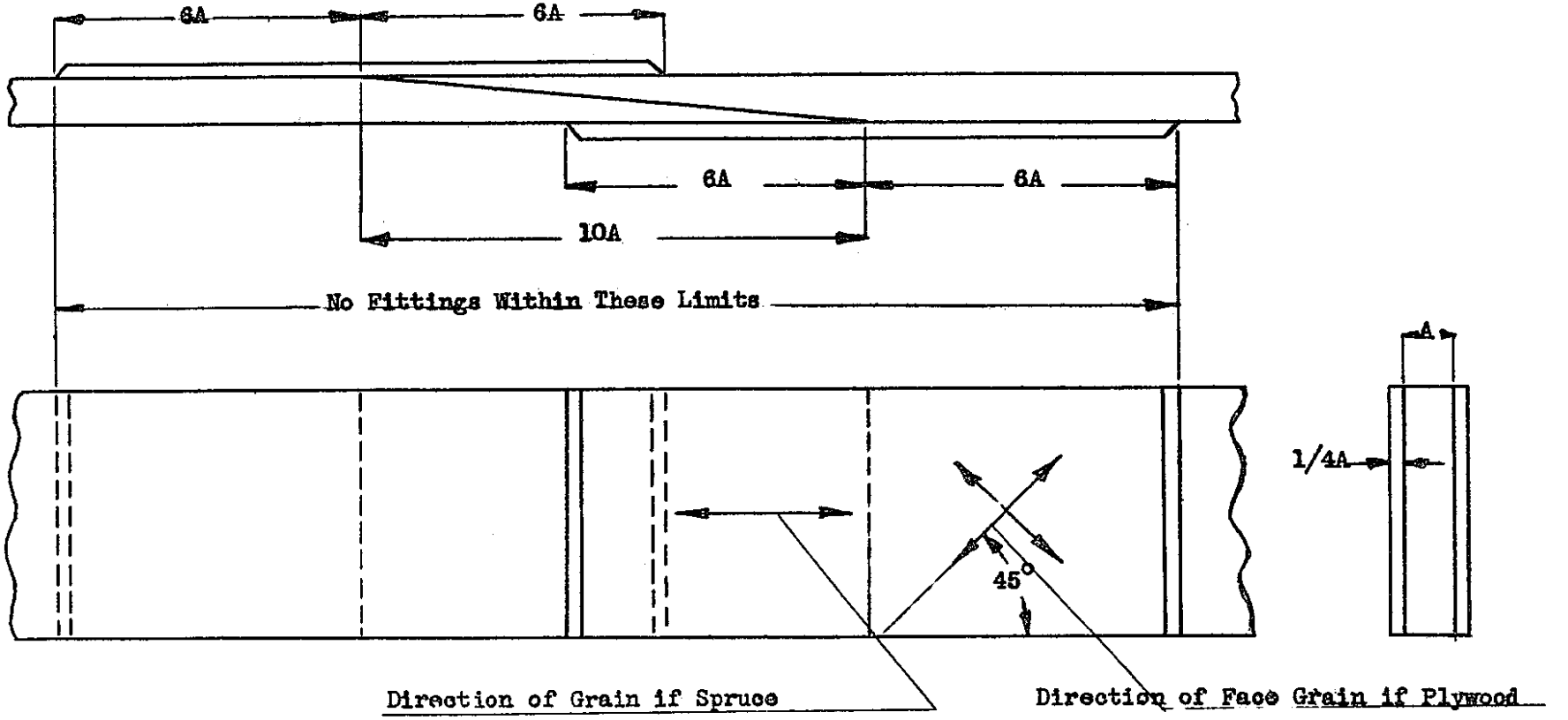



A = Original Tube
B = Replacement Tube
C = Outside Sleeve

See Table IV for diameters, wall thicknesses and materials of Tubes A, B and C.

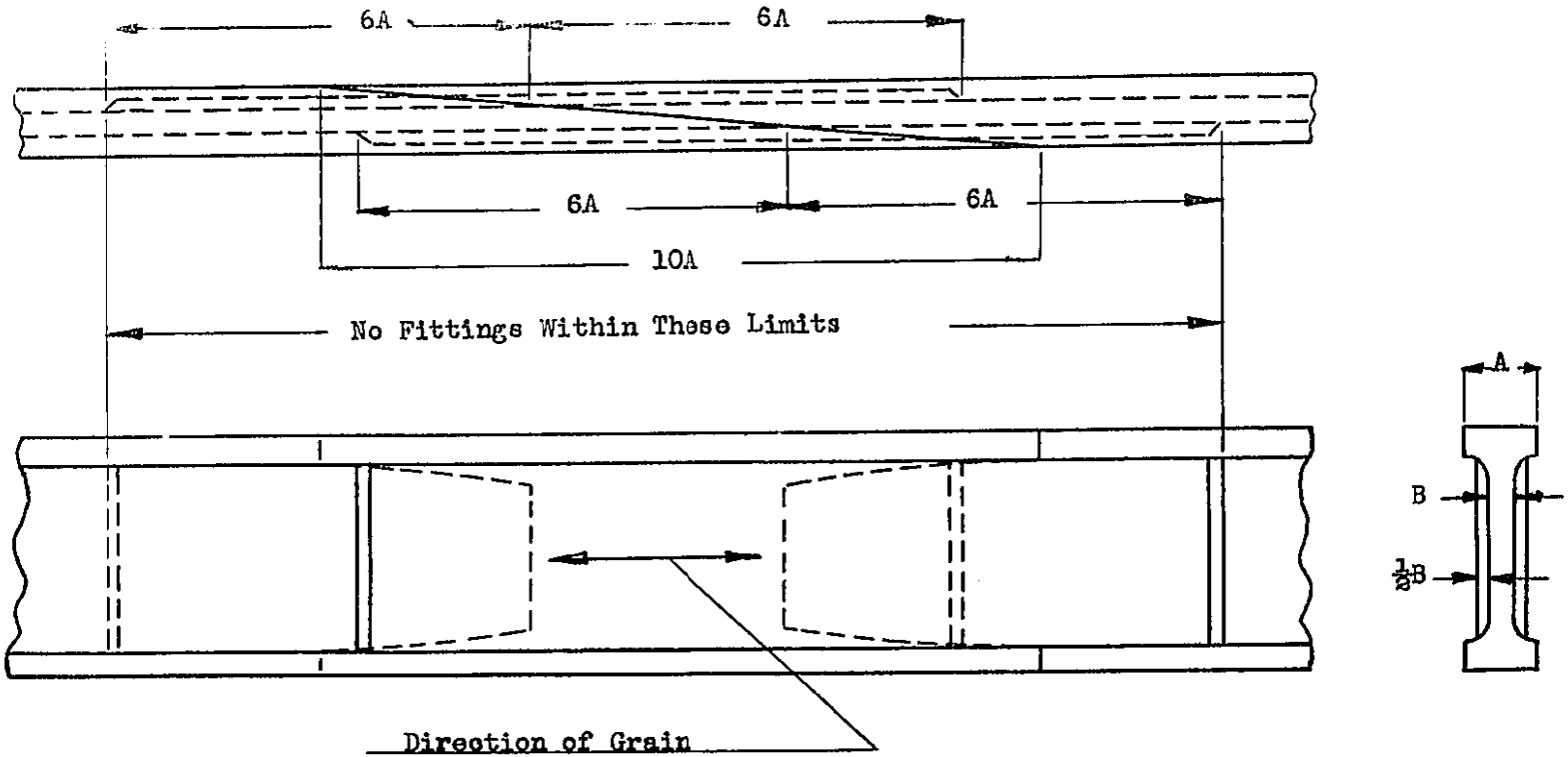
FIGURE 8. TYPE OF SPLICE USING OUTSIDE SLEEVE WITH FISHMOUTHED CUTS FOR CONDITIONS NOT COVERED BY TABLES I, II AND III.

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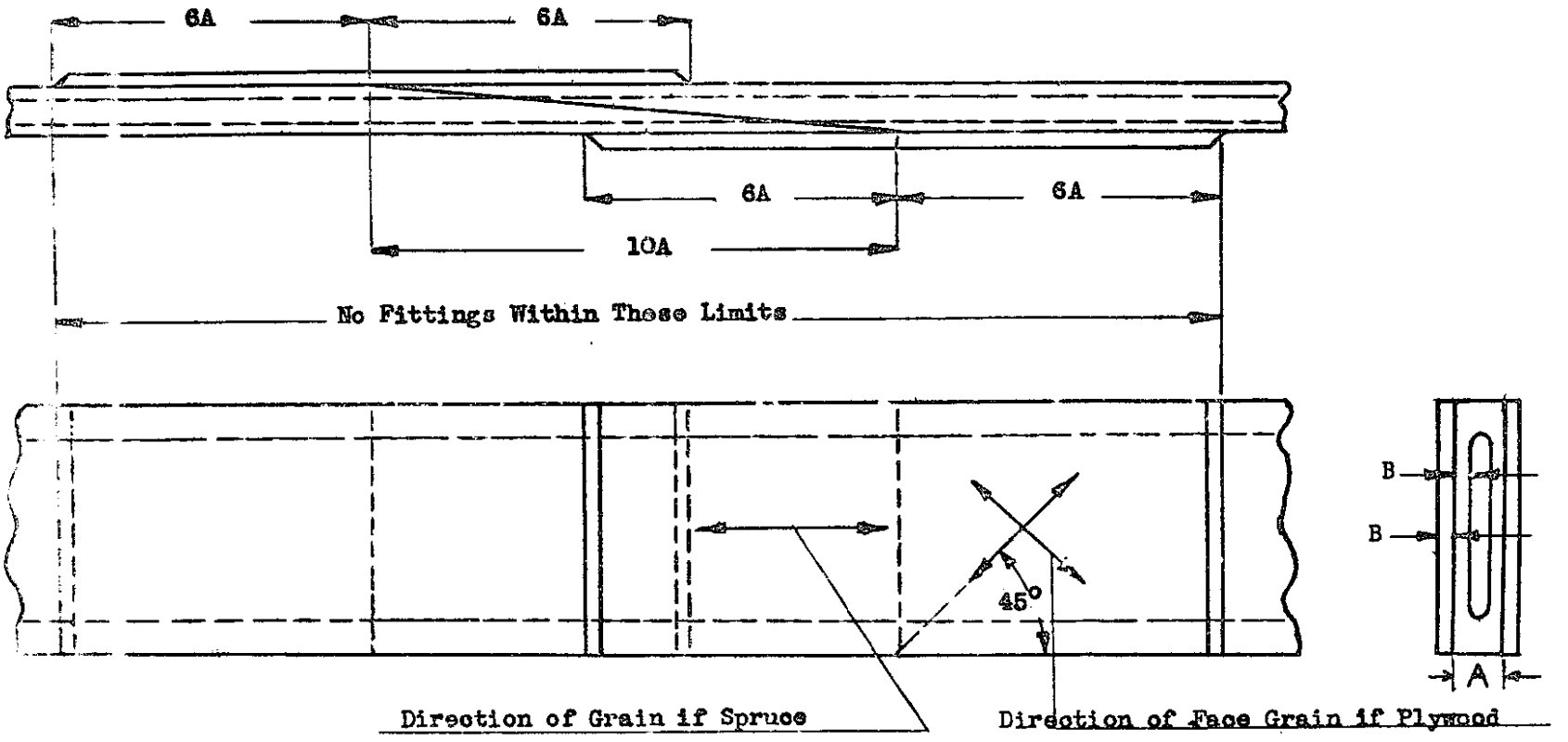

Reinforcing Plates To Be Spruce Or Plywood And Shall Be Glued Only.

FIGURE 9. METHOD OF SPLICING SOLID OR LAMINATED RECTANGULAR SPARS.




Reinforcing Plates To Be Spruce And Shall Be Glued Only.

FIGURE 10. METHOD OF SPLICING SOLID "I" SPARS.




Reinforcing Plates To Be Spruce Or Plywood And Shall Be Glued Only.

FIGURE 11. METHOD OF SPLICING INTERNALLY ROUTED SPARS.

See Figure 14 For Method of Splicing Plywood Webs

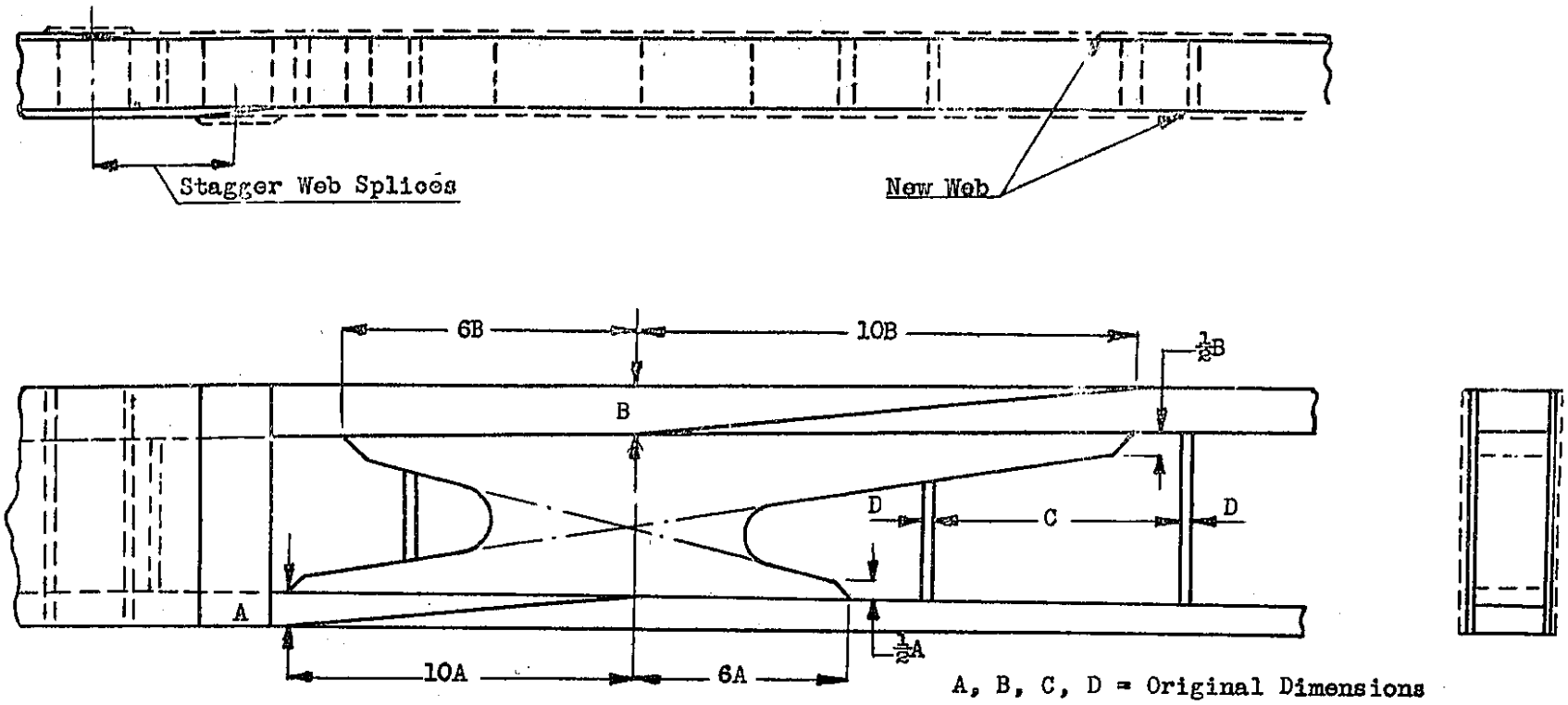
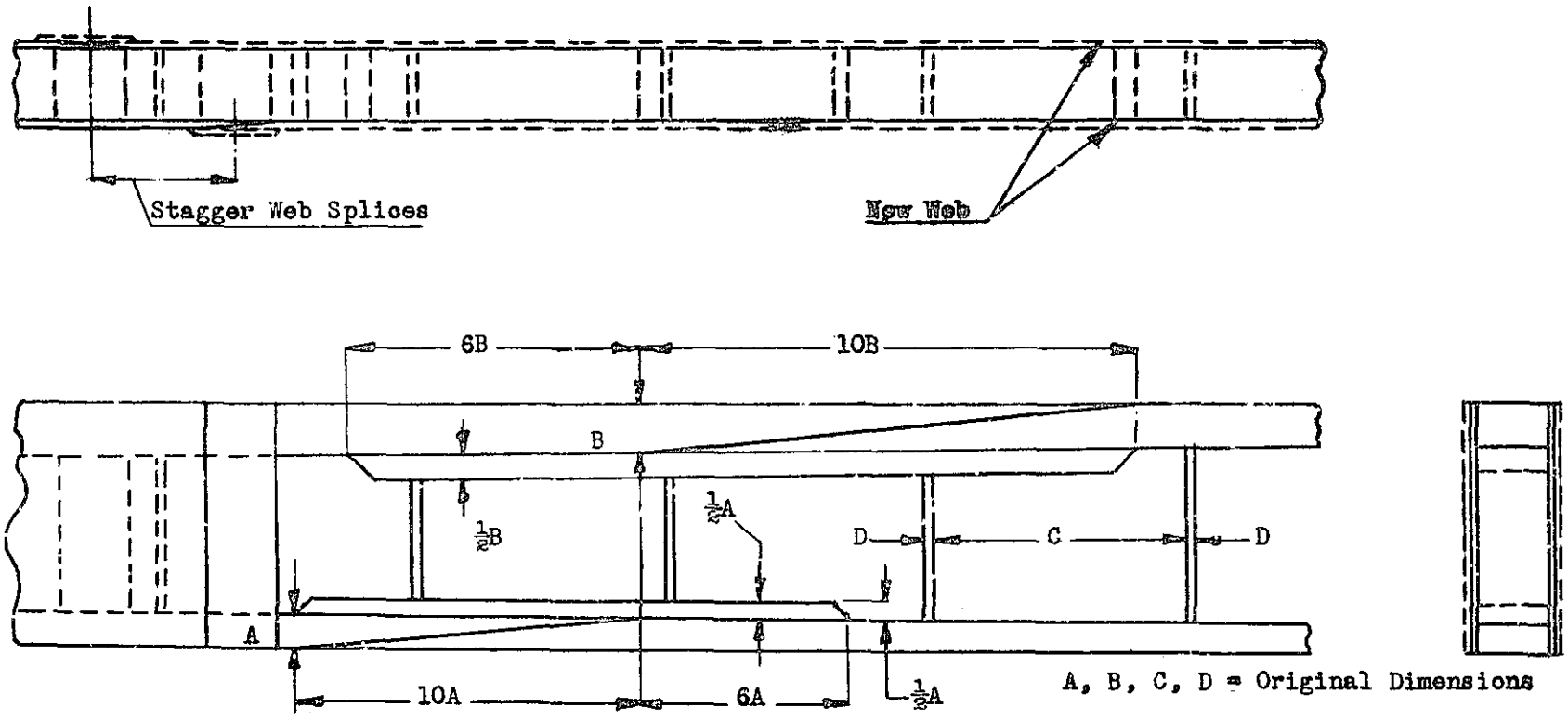


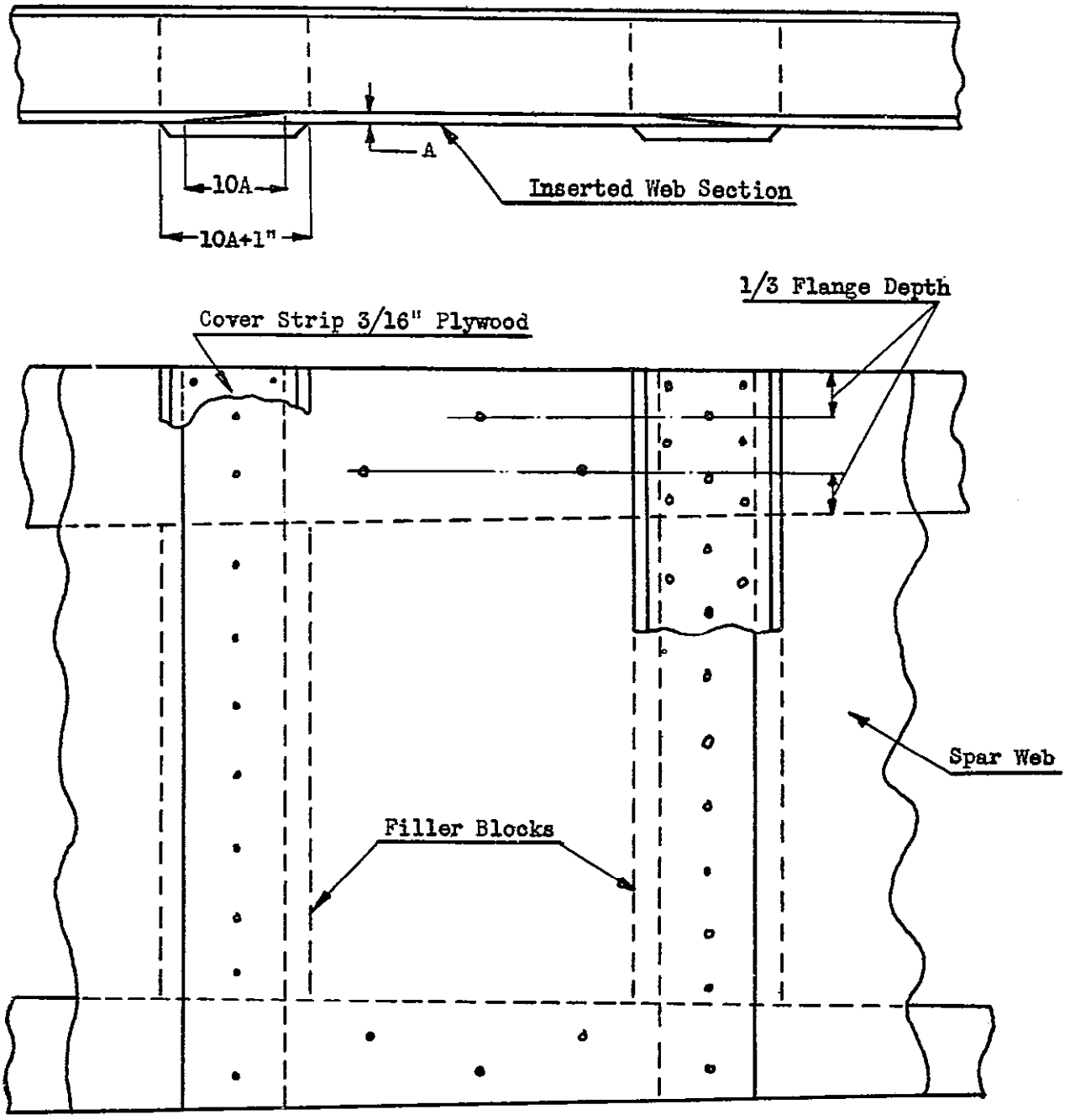

FIGURE 12 - METHOD OF SPLICING BOX SPAR FLANGES

See Figure 14 for Method of Splicing Plywood Webs.




Reinforcing Plates To Be Spruce

FIGURE 13 - METHOD OF SPLICING BOX SPAR FLANGES




NOTE:

1. After Inserted Web Has Been Glued And Nailed In Place, Glue Cover Strip Over Entire Length of Splice Joints.
2. Sectional Shape Of Filler Blocks Must Conform Exactly To Taper Of Spar. They Must Not Be Too Tightly Fitted Or Wedging Action Will Loosen Existing Glue Joints Of Webs To Flanges. If Too Loosely Fitted Crushing of Web Will Occur When Clamping.

FIGURE 14 - METHOD OF SPLICING
BOX SPAR WEBS

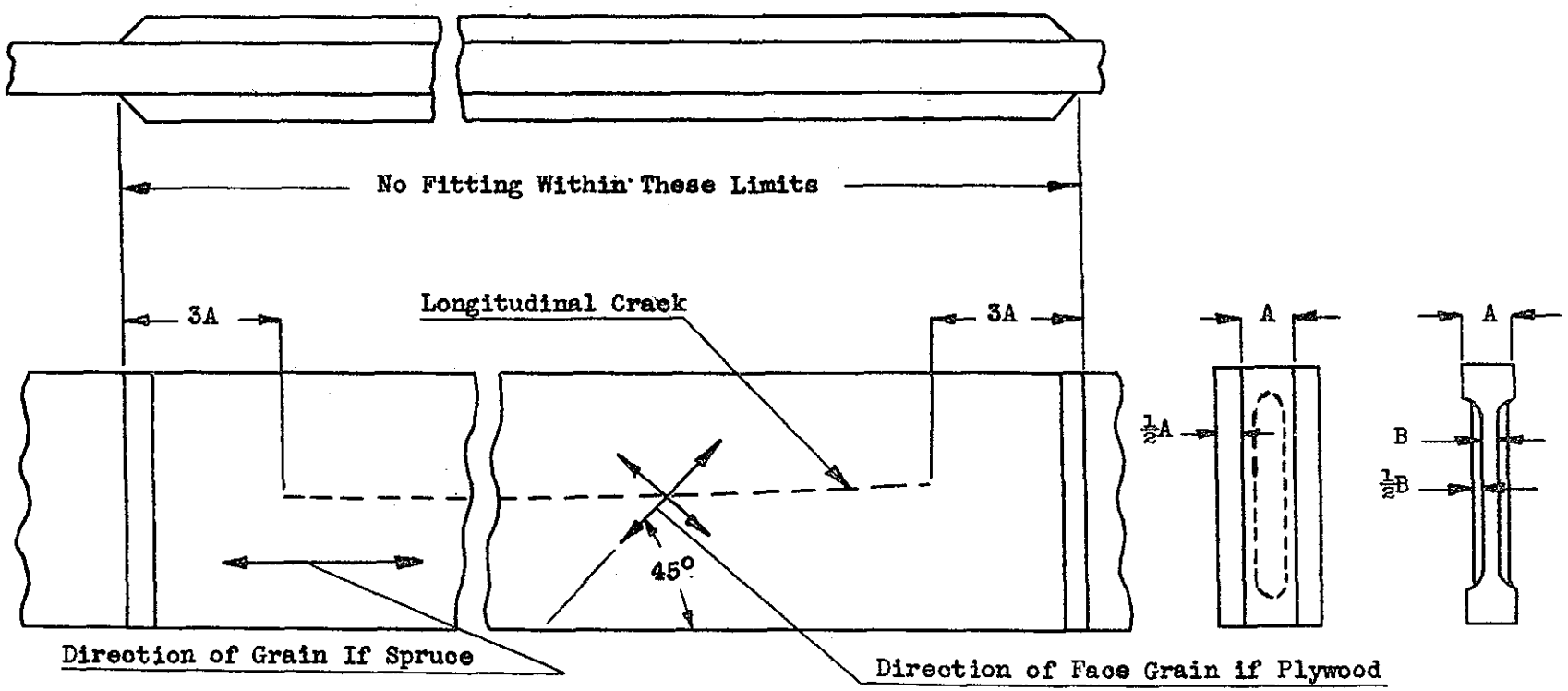



Plate Thicknesses Are For Spruce. If Plywood Plates Are Used Their Thickness May Be One Half The Thickness Specified For Spruce.

FIGURE 16. METHOD OF REINFORCING A LONGITUDINAL CRACK IN A SPAR.

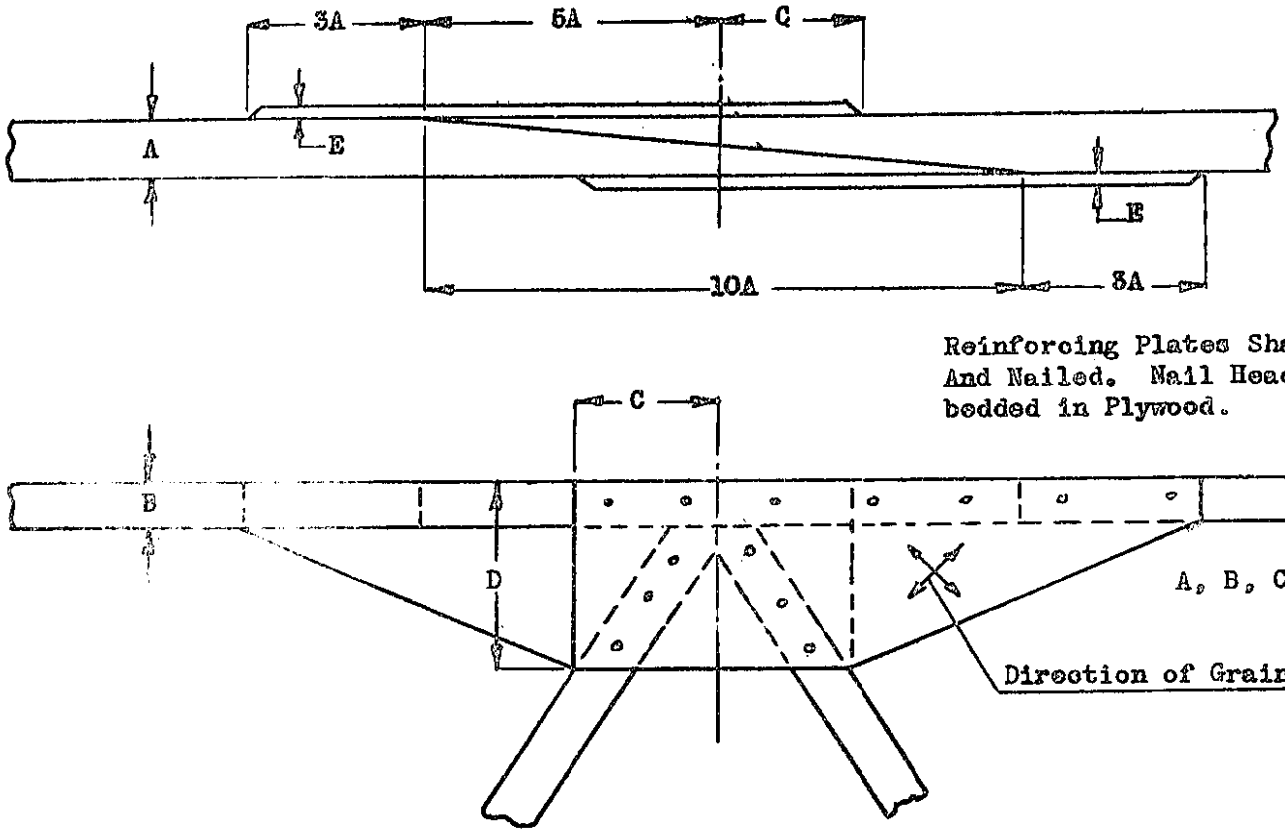
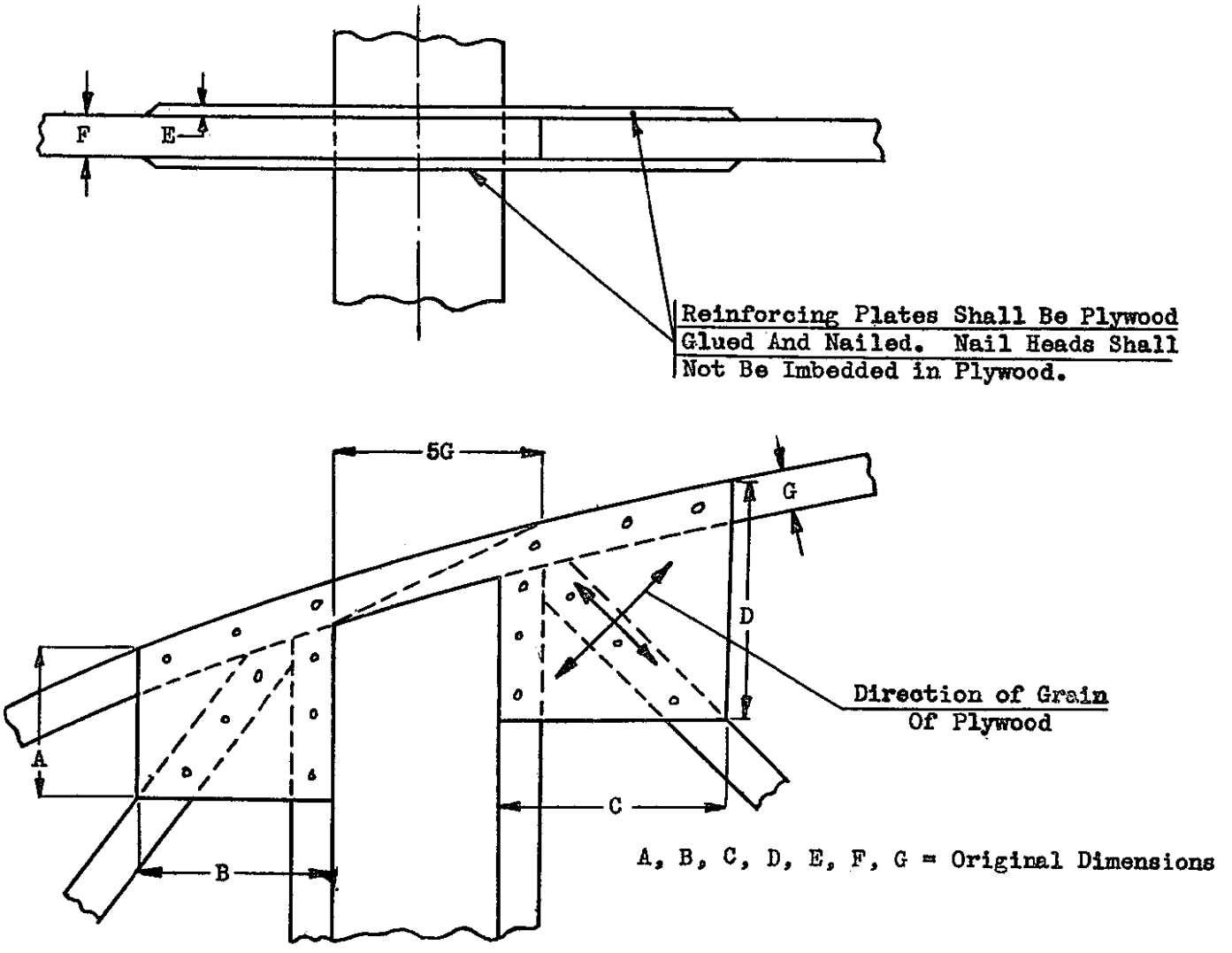



FIGURE 16 - TYPICAL RIB SPLICE AT A JOINT




Damaged Web Members Shall Be Replaced Entirely

FIGURE 17 - TYPICAL RIB SPLICE AT A SPAR.

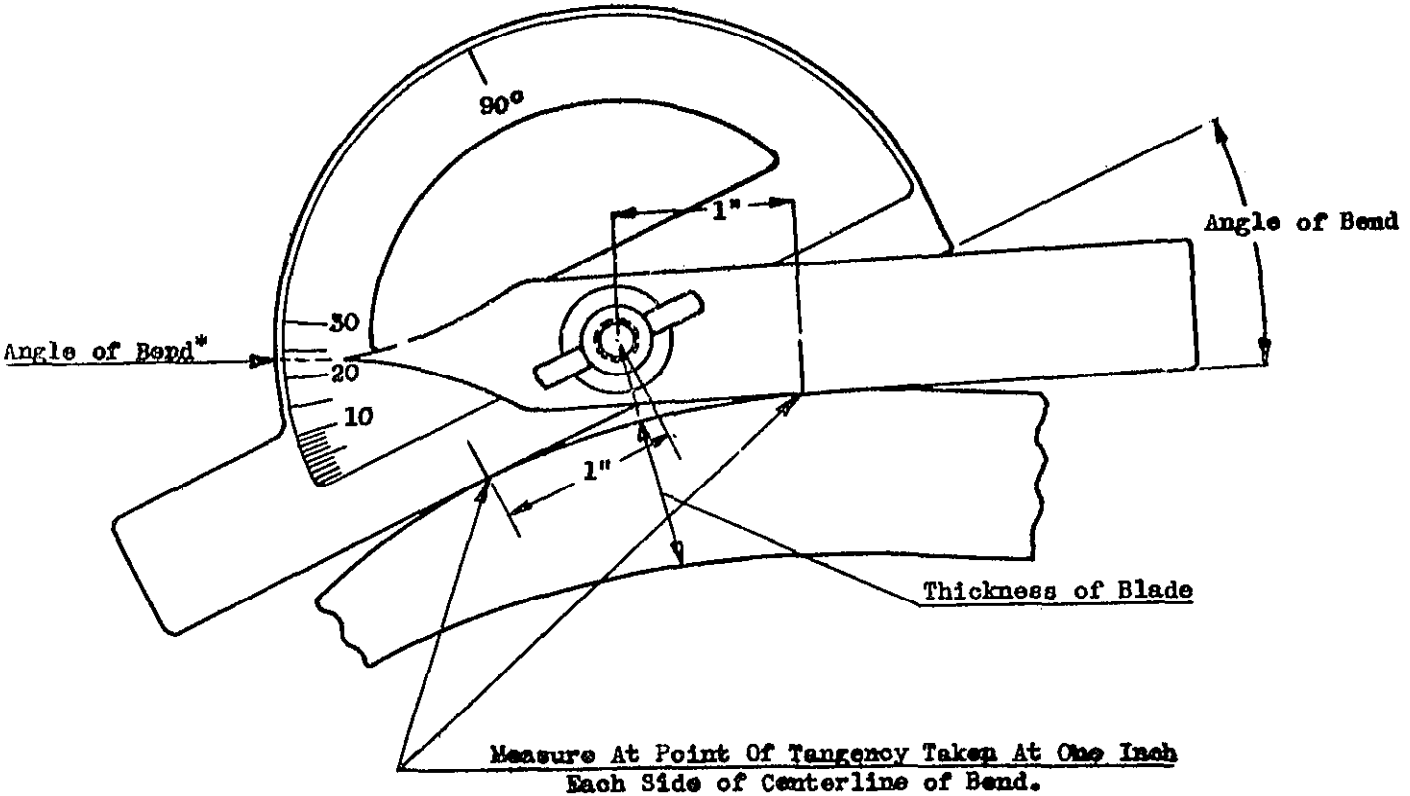



FIGURE 18. PROTRACTOR AND METHOD OF MEASURING ANGLE OF BEND IN ALUMINUM ALLOY PROPELLERS

* See Section 25 (a)(2) for permissible angle of bend before cold straightening

| Material A | Diameter Inches | | Wall Thickness - Inches | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A = .028 | | | | A = .035 | | | | A = .049 | | | | A = .058 | | | | A = .065 | | | |
| | | | 1025 | | 4130 | | 1025 | | 4130 | | 1025 | | 4130 | | 1025 | | 4130 | | 1025 | | 4130 | |
| | A. B | C | B | C | B | C | B | C | B | C | B | C | B | C | B | C | B | C | B | C | B | C |
| 1025 | 1/2 | 5/8 | .028 | .028 | .028 | .028 | .035 | .028 | .035 | .028 | .049 | .049 | .049 | .028 | .058 | .049 | .058 | .028 | .065 | .058 | .065 | .028 |
| 4130 | | | .058 | .049 | .028 | .028 | .065 | .049 | .035 | .028 | .095 | | .049 | .049 | .120 | | .058 | .049 | | | .065 | .058 |
| 1025 | 5/8 | 3/4 | .028 | .028 | .028 | .028 | .035 | .035 | .035 | .028 | .049 | .049 | .049 | .028 | .058 | .049 | .058 | .035 | .065 | .058 | .065 | .035 |
| 4130 | | | .058 | .049 | .028 | .028 | .065 | .058 | .035 | .035 | .095 | | .049 | .049 | .120 | | .058 | .049 | | | .065 | .058 |
| 1025 | 3/4 | 7/8 | .028 | .028 | .028 | .028 | .035 | .035 | .035 | .028 | .049 | .049 | .049 | .028 | .058 | .049 | .058 | .035 | .065 | .058 | .065 | .049 |
| 4130 | | | .058 | .049 | .028 | .028 | .065 | .058 | .035 | .035 | .095 | | .049 | .049 | .120 | | .058 | .049 | | | .065 | .058 |
| 1025 | 7/8 | 1 | .028 | .028 | .028 | .028 | .035 | .035 | .035 | .028 | .049 | .049 | .049 | .035 | .058 | .058 | .058 | .035 | .065 | .058 | .065 | .049 |
| 4130 | | | .058 | .049 | .028 | .028 | .065 | .058 | .035 | .035 | .095 | | .049 | .049 | .120 | | .058 | .058 | | | .065 | .058 |
| 1025 | 1 | 1-1/8 | .028 | .028 | .028 | .028 | .035 | .035 | .035 | .028 | .049 | .049 | .049 | .035 | .058 | .058 | .058 | .049 | .065 | .058 | .065 | .049 |
| 4130 | | | .058 | .049 | .028 | .028 | .065 | .058 | .035 | .035 | .095 | | .049 | .049 | .120 | | .058 | .058 | .120 | | .065 | .058 |
| 1025 | 1-1/8 | 1-1/4 | .028 | .028 | .028 | .028 | .035 | .035 | .035 | .028 | .049 | .049 | .049 | .035 | .058 | .058 | .058 | .049 | .065 | .058 | .065 | .049 |
| 4130 | | | .058 | .049 | .028 | .028 | .065 | .058 | .035 | .035 | .095 | | .049 | .049 | .120 | | .058 | .058 | .120 | | .065 | .058 |
| 1025 | 1-1/4 | 1-3/8 | .028 | .028 | .028 | .028 | .035 | .035 | .035 | .028 | .049 | .049 | .049 | .035 | .058 | .058 | .058 | .049 | .065 | | .065 | .049 |
| 4130 | | | .049 | .049 | .028 | .028 | .065 | .058 | .035 | .035 | .095 | | .049 | .049 | .120 | | .058 | .058 | .120 | | .065 | |
| 1025 | 1-3/8 | 1-1/2 | .028 | .028 | .028 | .028 | .035 | .035 | .035 | .028 | .049 | .049 | .049 | .049 | .058 | .058 | .058 | .049 | .065 | | .065 | .049 |
| 4130 | | | .049 | .049 | .028 | .028 | .065 | .058 | .035 | .035 | .095 | | .049 | .049 | .120 | | .058 | .058 | .120 | | .065 | |
| 1025 | 1-1/2 | 1-5/8 | .028 | .028 | .028 | .028 | .035 | .035 | .035 | .028 | .049 | .049 | .049 | .049 | .058 | .058 | .058 | .049 | .065 | | .065 | .049 |
| 4130 | | | .049 | .049 | .028 | .028 | .065 | .058 | .035 | .035 | .095 | | .049 | .049 | .120 | | .058 | .058 | .120 | | .065 | |
| 1025 | 1-5/8 | 1-3/4 | .028 | .028 | .028 | .028 | .035 | .035 | | .028 | .049 | .049 | .049 | .049 | .058 | .058 | .058 | .049 | .065 | | .065 | .058 |
| 4130 | | | .049 | .049 | .028 | .028 | .065 | .058 | .035 | .035 | .095 | | .049 | .049 | .120 | | .058 | .058 | .120 | | .065 | |
| 1025 | 1-3/4 | 1-7/8 | .028 | .028 | .028 | .028 | .035 | .035 | | .028 | .049 | .049 | .049 | .049 | .058 | .058 | .058 | .049 | .065 | | .065 | .058 |
| 4130 | | | .049 | .049 | .028 | .028 | .065 | .058 | .035 | .035 | .095 | | .049 | .049 | .120 | | .058 | .058 | .120 | | .065 | |
| 1025 | 1-7/8 | 2 | .028 | .028 | .028 | .028 | .035 | .035 | | .028 | .049 | .049 | .049 | .049 | .058 | .058 | .058 | .049 | .065 | | .065 | .058 |
| 4130 | | | .049 | .049 | .028 | .028 | .065 | .058 | .035 | .035 | .095 | | .049 | .049 | .120 | | .058 | .058 | .120 | | .065 | |

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TABLE I - PROPERTIES OF TUBES FOR SPLICES USING OUTSIDE SLEEVES.
(TO BE USED WITH FIGURES 1, 2, 3)

| Material A | Diameter Inches | | Wall Thickness - Inches | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A = .028 | | | | A = .035 | | | | A = .049 | | | | A = .058 | | | |
| | | | 1025 | | 4130 | | 1025 | | 4130 | | 1025 | | 4130 | | 1025 | | 4130 | |
| | A, B | C | B | C | B | C | B | C | B | C | B | C | B | C | B | C | B | C |
| 1025 | 5/8 | 1/2 | .028 | .049 | .028 | .028 | .035 | .049 | .028 | .035 | .049 | .065 | .035 | .049 | .058 | .083 | .049 | .058 |
| 4130 | | | .058 | .083 | .028 | .049 | | .095 | .035 | .049 | | | .049 | .065 | | | .058 | .083 |
| 1025 | 3/4 | 5/8 | .028 | .035 | .028 | .028 | .035 | .049 | .028 | .035 | .049 | .065 | .035 | .049 | .058 | .083 | .049 | .058 |
| 4130 | | | .058 | .065 | .028 | .035 | | .083 | .035 | .049 | | .120 | .049 | .065 | | | .058 | .083 |
| 1025 | 7/8 | 3/4 | .028 | .035 | .028 | .028 | .035 | .049 | .028 | .035 | .049 | .065 | .035 | .049 | .058 | .083 | .049 | .058 |
| 4130 | | | .058 | .065 | .028 | .035 | | .083 | .035 | .049 | | .120 | .049 | .065 | | | .058 | .083 |
| 1025 | 1 | 7/8 | .028 | .035 | .028 | .028 | .035 | .049 | .028 | .035 | .049 | .058 | .035 | .049 | .058 | .083 | .049 | .058 |
| 4130 | | | .058 | .058 | .028 | .035 | | .083 | .035 | .049 | | .120 | .049 | .058 | | | .058 | .083 |
| 1025 | 1-1/8 | 1 | .028 | .035 | .028 | .028 | .035 | .049 | .028 | .035 | .049 | .058 | .035 | .049 | .058 | .083 | .049 | .058 |
| 4130 | | | .058 | .058 | .028 | .035 | | .083 | .035 | .049 | | .120 | .049 | .058 | | | .058 | .083 |
| 1025 | 1-1/4 | 1-1/8 | .028 | .035 | .028 | .028 | .035 | .049 | .028 | .035 | .049 | .058 | .035 | .049 | .058 | .083 | .049 | .058 |
| 4130 | | | .049 | .058 | .028 | .035 | | .083 | .035 | .049 | | .120 | .049 | .058 | | .120 | .058 | .083 |
| 1025 | 1-3/8 | 1-1/4 | .028 | .035 | .028 | .028 | .035 | .049 | .028 | .035 | .049 | .058 | .035 | .049 | .058 | .065 | .049 | .058 |
| 4130 | | | .049 | .058 | .028 | .035 | | .083 | .035 | .049 | | .120 | .049 | .058 | | .120 | .058 | .065 |
| 1025 | 1-1/2 | 1-3/8 | .028 | .035 | .028 | .028 | .035 | .049 | .028 | .035 | .049 | .058 | .035 | .049 | .058 | .065 | .049 | .058 |
| 4130 | | | .049 | .058 | .028 | .035 | | .083 | .035 | .049 | | .120 | .049 | .058 | | .120 | .058 | .065 |
| 1025 | 1-5/8 | 1-1/2 | .028 | .035 | .028 | .028 | .035 | .049 | .028 | .035 | .049 | .058 | .035 | .049 | .058 | .065 | .049 | .058 |
| 4130 | | | .049 | .058 | .028 | .035 | | .083 | .035 | .049 | | .095 | .049 | .058 | | .120 | .058 | .065 |
| 1025 | 1-3/4 | 1-5/8 | .028 | .035 | .028 | .028 | .035 | .049 | .028 | .035 | .049 | .058 | .035 | .049 | .058 | .065 | .049 | .058 |
| 4130 | | | .049 | .058 | .028 | .035 | | .083 | .035 | .049 | | .095 | .049 | .058 | | .120 | .058 | .065 |
| 1025 | 1-7/8 | 1-3/4 | .028 | .035 | .028 | .028 | .035 | .049 | .028 | .035 | .049 | .058 | .035 | .049 | .058 | .065 | .049 | .058 |
| 4130 | | | .049 | .058 | .028 | .035 | | .083 | .035 | .049 | | .095 | .049 | .058 | | .120 | .058 | .065 |
| 1025 | 2 | 1-7/8 | .028 | .035 | .028 | .028 | .035 | .049 | .028 | .035 | .049 | .058 | .035 | .049 | .058 | .065 | .049 | .058 |
| 4130 | | | .049 | .058 | .028 | .035 | | .083 | .035 | .049 | | .095 | .049 | .058 | | .120 | .058 | .065 |

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TABLE II - PROPERTIES OF TUBES FOR SPLICES USING INSIDE SLEEVES WITH SINGLE WELDS AT THE SPLICES (TO BE USED WITH FIGURES 4 AND 5)

| Material A | Diameter Inches | | Wall Thickness - Inches | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A = .028 | | | | A = .035 | | | | A = .049 | | | | A = .058 | | | |
| | | | 1025 | | 4130 | | 1025 | | 4130 | | 1025 | | 4130 | | 1025 | | 4130 | |
| | A, B | C | B | C | B | C | B | C | B | C | B | C | B | C | B | C | B | C |
| 1025<br>4130 | 5/8 | 1/2 | .028<br>.058 | .065<br>.065 | .028<br>.028 | .065<br>.065 | .035 | .120<br>.120 | .035<br>.035 | .120<br>.120 | | | | | | | | |
| 1025<br>4130 | 3/4 | 5/8 | .028<br>.058 | .058<br>.065 | .028<br>.028 | .058<br>.058 | .035 | .083<br>.095 | .035<br>.035 | .083<br>.083 | | | | | | | | |
| 1025<br>4130 | 7/8 | 3/4 | .028<br>.058 | .049<br>.065 | .028<br>.028 | .049<br>.049 | .035 | .065<br>.083 | .035<br>.035 | .065<br>.065 | .049 | .095<br>.120 | .049<br>.049 | .095<br>.095 | .058 | .120 | .058<br>.058 | .120<br>.120 |
| 1025<br>4130 | 1 | 7/8 | .028<br>.058 | .049<br>.058 | .028<br>.028 | .049<br>.049 | .035 | .058<br>.083 | .035<br>.035 | .058<br>.058 | .049 | .083<br>.120 | .049<br>.049 | .083<br>.083 | .058 | .120 | .058<br>.058 | .120<br>.120 |
| 1025<br>4130 | 1-1/8 | 1 | .028<br>.058 | .049<br>.058 | .028<br>.028 | .049<br>.049 | .035 | .058<br>.083 | .035<br>.035 | .058<br>.058 | .049 | .083<br>.120 | .049<br>.049 | .083<br>.083 | .058 | .095 | .058<br>.058 | .095<br>.095 |
| 1025<br>4130 | 1-1/4 | 1-1/8 | .028<br>.049 | .049<br>.058 | .028<br>.028 | .049<br>.049 | .035 | .058<br>.083 | .035<br>.035 | .058<br>.058 | .049 | .083<br>.120 | .049<br>.049 | .083<br>.083 | .058 | .095<br>.120 | .058<br>.058 | .095<br>.095 |
| 1025<br>4130 | 1-3/8 | 1-1/4 | .028<br>.049 | .049<br>.058 | .028<br>.028 | .049<br>.049 | .035 | .049<br>.083 | .035<br>.035 | .049<br>.049 | .049 | .083<br>.120 | .049<br>.049 | .083<br>.083 | .058 | .083<br>.120 | .058<br>.058 | .083<br>.083 |
| 1025<br>4130 | 1-1/2 | 1-3/8 | .028<br>.049 | .049<br>.058 | .028<br>.028 | .049<br>.049 | .035 | .049<br>.083 | .035<br>.035 | .049<br>.049 | .049 | .083<br>.120 | .049<br>.049 | .083<br>.083 | .058 | .083<br>.120 | .058<br>.058 | .083<br>.083 |
| 1025<br>4130 | 1-5/8 | 1-1/2 | .028<br>.049 | .049<br>.058 | .028<br>.028 | .049<br>.049 | .035 | .049<br>.083 | .035<br>.035 | .049<br>.049 | .049 | .065<br>.095 | .049<br>.049 | .083<br>.065 | .058 | .083<br>.120 | .058<br>.058 | .083<br>.083 |
| 1025<br>4130 | 1-3/4 | 1-5/8 | .028<br>.049 | .049<br>.058 | .028<br>.028 | .049<br>.049 | .035 | .049<br>.083 | .035<br>.035 | .049<br>.049 | .049 | .065<br>.095 | .049<br>.049 | .065<br>.065 | .058 | .083<br>.120 | .058<br>.058 | .083<br>.083 |
| 1025<br>4130 | 1-7/8 | 1-3/4 | .028<br>.049 | .049<br>.058 | .028<br>.028 | .049<br>.049 | .035 | .049<br>.083 | .035<br>.035 | .049<br>.049 | .049 | .065<br>.095 | .049<br>.049 | .065<br>.065 | .058 | .083<br>.120 | .058<br>.058 | .083<br>.083 |
| 1025<br>4130 | 2 | 1-7/8 | .028<br>.049 | .049<br>.058 | .028<br>.028 | .049<br>.049 | .035 | .049<br>.083 | .035<br>.035 | .049<br>.049 | .049 | .065<br>.095 | .049<br>.049 | .065<br>.065 | .058 | .083<br>.120 | .058<br>.058 | .083<br>.083 |

TABLE III - PROPERTIES OF TUBES FOR SPLICES USING INSIDE SLEEVES WITH DOUBLE WELDS AT THE SPLICES

(TO BE USED WITH FIGURES 6 AND 7)

TABLE IV - PROPERTIES OF TUBES FOR SPLICES USING OUTSIDE SLEEVES FOR CONDITIONS NOT COVERED BY TABLES I, II AND III. (To Be Used With Figure 8).

A, B and C Either 1025 or 4130

| Diameter | | Wall Thickness | |
|---|---|---|---|
| A and B | C | A and B | C |
| 1-7/8" Or Less | Diameter A + 1/4" | .095" or Less | .095" |
| | | .120" | .120" |
| | Diameter A + 3/8" | 5/32" | 5/32" |
| | Diameter A + 3/8" | 3/16" | 3/16" * |
| | Diameter A + 1/4" | 1/4" | 1/4" * |
| 2" Or More | Diameter A + 1/4" | .095" or Less | .095" |
| | | .120" | .120" |
| | Diameter A + 1/2" | 5/32" | 1/4" * |
| | | 3/16" | |
| | | 1/4" | |

* SLEEVE C MUST BE REAMED TO SLIDING FIT.

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