D6

TECHNICAL MANUAL

STRUCTURAL REPAIRS

USAF SERIES

F-106A AND F-106B

AIRCRAFT

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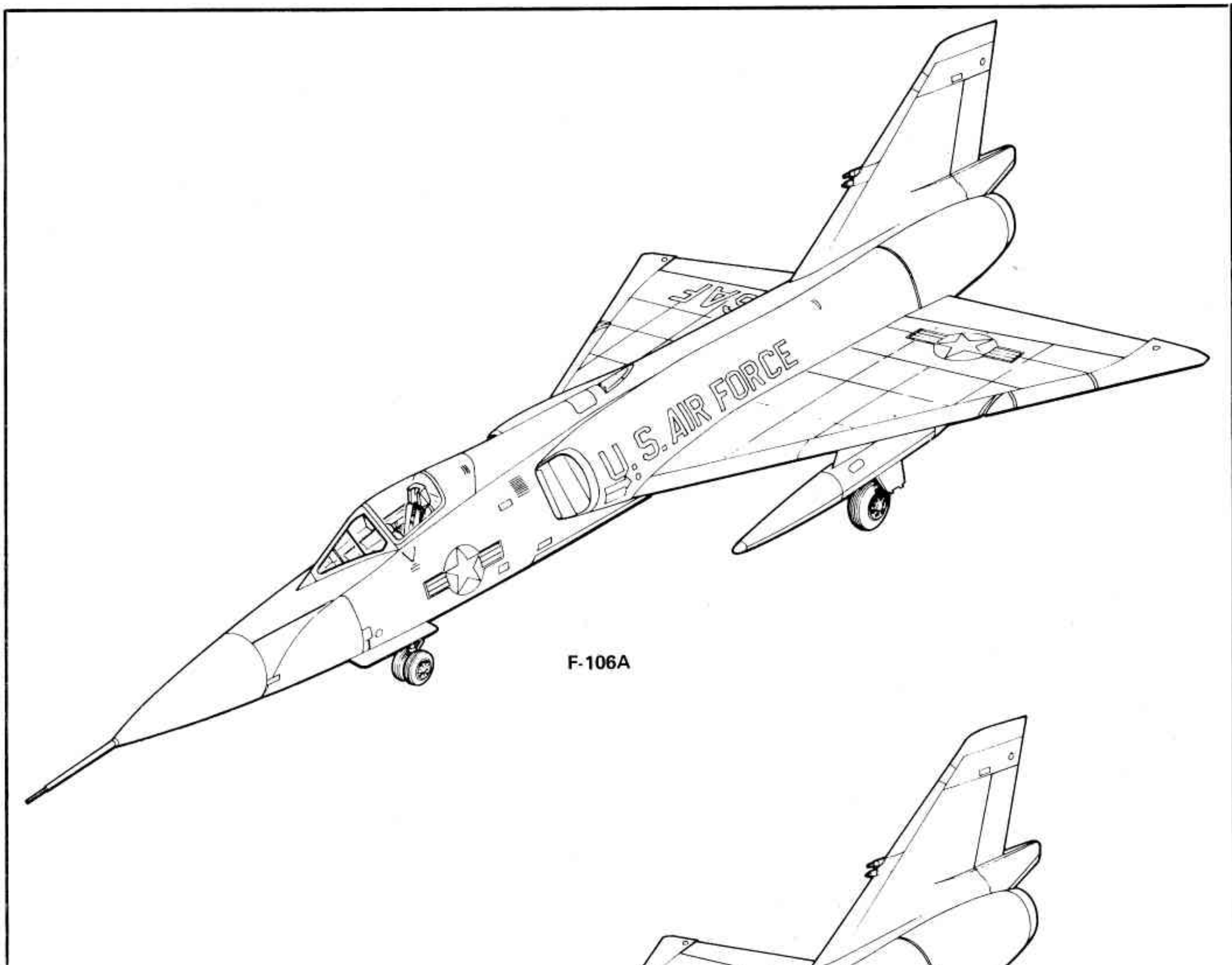


F-106A and F-106B Aircraft

INTRODUCTION

This manual is published to assist Air Force personnel in inspecting and repairing the structure of the F-106A and F-106B airplanes. The repair principles given will enable the airframe repairmen to make repairs that will be satisfactory for most of the damages experienced in normal operation.

In most cases, the repairs shown are within the capabilities of base organization level. Damage to a particular member will usually be accompanied by damage to the attaching parts, such as skin and web. A major repair may be accomplished by combining repairs for skin, webs, and stiffening members. If the possibility of successfully combining repairs seems doubtful, an aeronautical structures engineer should be consulted. A survey of the damage — the type, difficulty, and number of repairs required — and the available facilities will indicate when depot organization level assistance is required. Section I deals with the evaluation of damage, methods of repair, and describes repair materials and fasteners. Procedures for airplane alignment checks and use of optical instruments are also given in Section I. Sections II through VI describe the separate components of the airplane, call attention to points of special importance, and prescribe repairs for the particular types of structure found in each area. Specific repairs of assumed damage are located in the section applicable to the individual component. Typical repairs, which are applicable to elements found in more than one component, are contained in Section X. Section VIII lists the extrusions and roll-formed sections used in the construction of the airplane. Section IX is devoted to repair evaluation and procedures for damage occurring after landing gear failure. Section XI contains a summary of all the repair materials which may be required to fabricate the repair parts described in this manual. Specifications of these items are also contained in this section to avoid calling them out repeatedly in the text of the preceding sections.

The following publications provide supplementary information on the F-106A and F-106B airplanes:

T.O. 1F-106A-1	Flight Manual
T.O. 1F-106B-1	Flight Manual
T.O. 1F-106A-2 series	Maintenance Manuals
T.O. 1F-106A-4	Illustrated Parts Breakdown
T.O. 1F-106B-4	Illustrated Parts Breakdown
T.O. 1F-106A-5	Basic Weight Check List and Loading Data
T.O. 1F-106B-5	Basic Weight Check List and Loading Data
T.O. 1F-106A-6	Inspection Manual
T.O. 1F-106A-10	Power Package Buildup Instructions
T.O. 1F-106A-23	System Peculiar Corrosion Control
T.O. 1F-106A-36	Nondestructive Inspection Procedures
T.O. 1-1-2	Corrosion Control and Treatment for Aircraft
T.O. 1-1A-1	Aircraft Repair — General Manual for Structural Repair
T.O. 1-1-3	Repair of Integral and Removable Metal Fuel and Oil Tanks
T.O. 33B3-1-1	Inspection of Material, Radiography
T.O. 00-85-16	Preparation of Fighter, Trainer, Liaison and Helicopter Aircraft for Shipment
T.O. 1-1-1	Cleaning of Aeronautical Equipment
T.O. 1-1-4	Exterior Finishes, Insignia and Markings applicable to Aircraft and Missiles
T.O. 1-1-24	Maintenance Repair and Electrical Requirements of Fiber Laminate and Sandwich Constructed Airborne Radomes

Section I

GENERAL

1-1. GENERAL DESCRIPTION.

1-2. The F-106A and F-106B airplanes, manufactured by Convair, a Division of General Dynamics Corporation, are high-performance, land-based, delta-wing, all-weather interceptors. The F-106A is a single-place airplane whose primary mission is interception and destruction of attacking hostile airplanes or airborne missiles that operate within the performance capabilities of the airplane. The F-106B interceptor is a two-place, tandem version of the F-106A with pilot training provisions. Both airplanes are equipped with fully retractable tricycle landing gear and are powered by the Pratt and Whitney J75-P-17 continuous flow gas turbine engine. Externally, the F-106A and F-106B are identical in dimensions except for a slight increase in the cross-sectional area of the F-106B cockpit. Figure 1-1 shows the principal dimensions of the two airplanes. The fuselage fuel tank of the F-106B is located farther aft than the tank in the F-106A to accommodate the lengthened cockpit. In addition, the equipment located in the electronic bay of the F-106A is moved aft to the forward missile bay area on the F-106B. The lower halves of the missile bay doors on the F-106B are shortened to conform to this change in equipment location. The access and inspection provisions are shown on figures 1-2 thru 1-5, refer to paragraph 1-335 for structural breakdown of F-106A and F-106B major airplane components.

1-3. TYPE OF CONSTRUCTION.

1-4. Wing Group.

1-5. The F-106A and F-106B wings are of the full cantilever, stressed skin construction with a delta configuration. This configuration has a 60-degree sweepback of the leading edge and a 5-degree sweep forward of the elevon and wing tip trailing edges. The right and left wing panels are attached to the fuselage with special high-strength bolts through the main spars and fuselage bulkhead fittings, and by drag angles riveted to the inboard edge of the wing and attached to the fuselage structure by means of screws. Each wing panel is equipped with removable cambered leading edge sections, a cambered wing tip, an elevon, a main landing gear and gear wing fairing, and provisions for the external mounting of droppable fuel tanks. Refer to Section II for additional information on the wings and for wing repairs.

1-6. Tail Group.

1-7. The tail group consists of a vertical fin and rudder. The fin assembly is an integral part of the fuselage structure and cannot be detached for repair or replacement without extensive separation from the fuselage bulkheads. The fin is equipped with a removable leading edge, a fin tip, and a rudder. The fin loads are carried by four vertical forged spars which are an integral part of the fuselage bulkhead assembly. The rudder is of the aluminum honeycomb core, sandwich-type construction with detachable hinge fittings on the leading edge spar. Refer to Section III for additional tail group information and for repairs to the fin and rudder.

1-8. Body Group.

1-9. The fuselage design is of semi-monocoque construction type with provisions for the radar equipment, the pilot's cockpit, an integral fuel tank, a missile bay, engine air intake ducts, main and nose landing gear wheel wells, electronic and accessory compartments, and the engine compartment. The fuselage structural framework consists basically of a series of semicircular zee and channel spliced beltframes, forged and built-up bulkheads, longerons, gussets, and intercostals. The fuselage framework is enclosed by stressed skins made of aluminum, magnesium, and titanium alloys that are attached with flush-head rivets and other types of fasteners. The fuselage structure depends heavily on the attached wing for longitudinal stiffening; adequate fuselage supports must be provided before a wing may be removed. Refer to Section IV for additional fuselage information and for repairs to the fuselage.

1-10. Landing Gear.

1-11. The F-106A and F-106B airplanes are equipped with electrically controlled, hydraulically operated, fully retractable, tricycle landing gear. The main landing gear retracts inboard and up into the wheel wells in the wing-fuselage area, while the nose landing gear retracts forward and up into the wheel well in the fuselage nose. The dual wheels on the nose gear are steerable during ground operations of the airplane. The nose and main gear assemblies are covered in the retracted position by hydraulically operated doors in the fuselage; wing fairings attached to the main gear struts enclose the main gear wheel well area in the wing

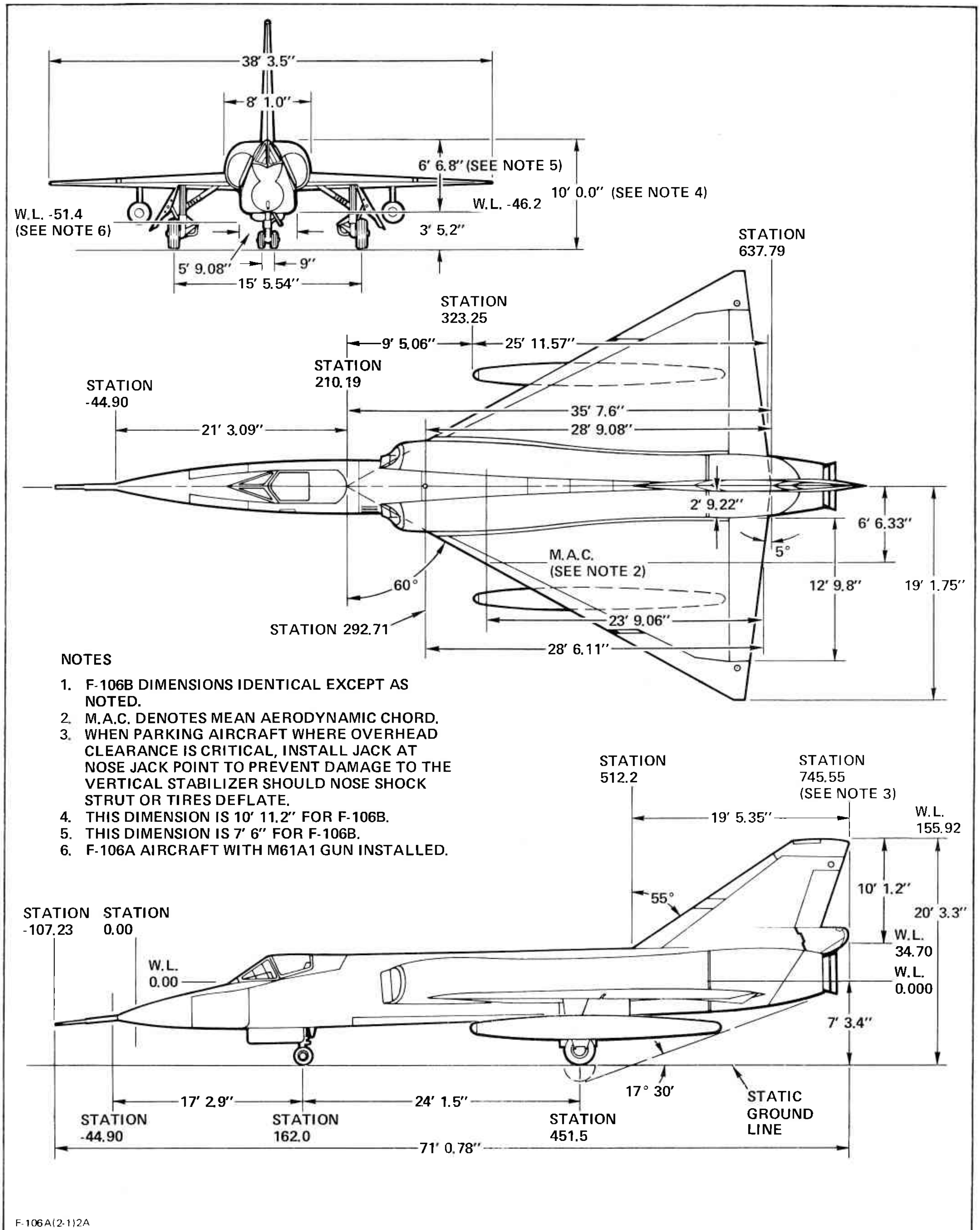
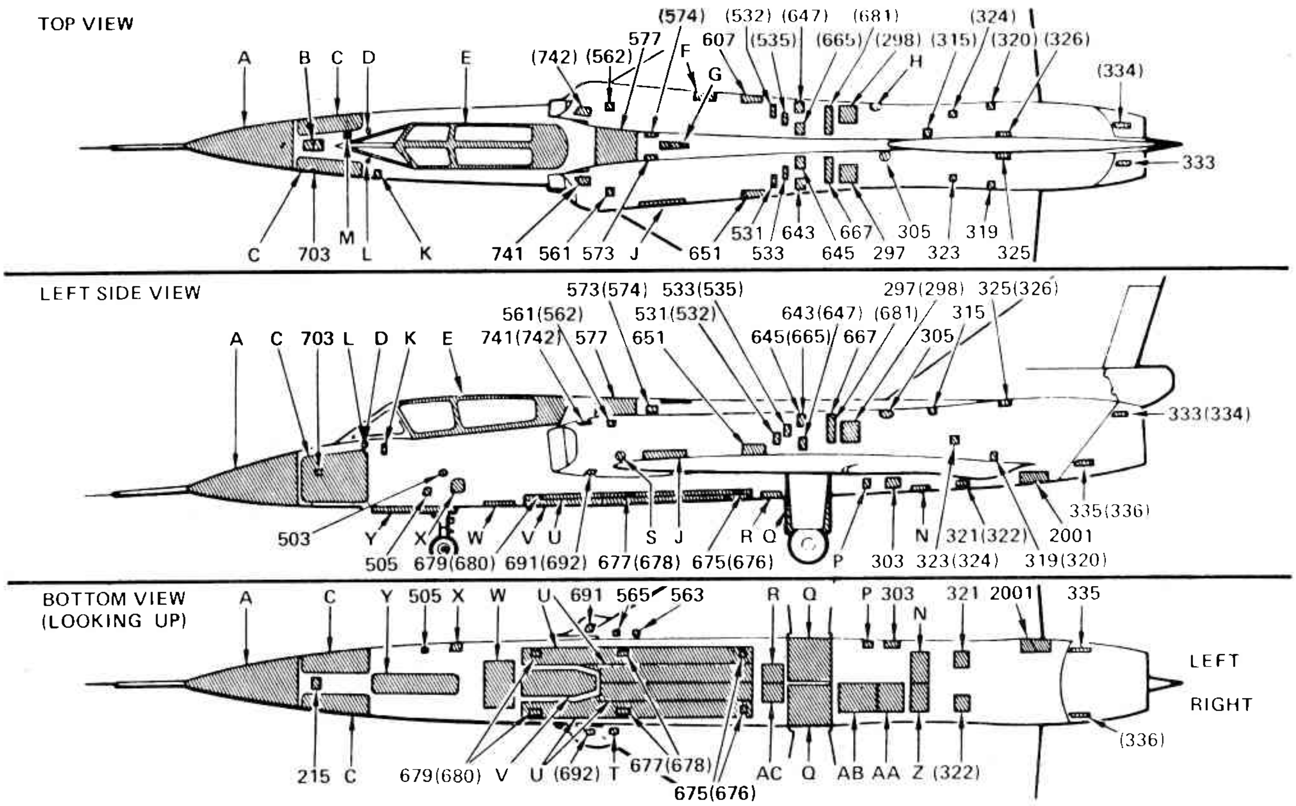


Figure 1-1. Principal Dimensions



ACCESSIBLE EQUIPMENT

TOP VIEW

A	RADAR ANTENNA
B	INFRARED RECEIVER, MECHANISM AND ACTUATING CYLINDER
C	FORWARD ELECTRONIC EQUIPMENT
D	BRAKE SYSTEM COMPONENTS, WINDSHIELD ANTI-ICE TRANSFORMER
E	COCKPIT FURNISHINGS
741(742)	DUCT LIP ANTI-ICING LINES, UPPER
561(562)	VARIABLE RAMP PITOT-STATIC COMPONENTS
577	UPPER-AFT ELECTRONIC EQUIPMENT, AIR CONDITIONING COMPONENTS, ANTI-ICING TANK
573(574)	HEAT EXCHANGER EXHAUST DUCT ANCHOR BOLTS
F	ENGINE HOT SECTION ANALYZER COMPONENTS
G	AERIAL REFUELING RECEPTACLE
(607)	CURRENT TRANSFORMER, MAIN AC CONTACTOR EXTERNAL POWER MONITOR
531(532)	STRUCTURE ACCESS
(535)	CSD OIL COOLER
643(647)	OIL COOLING AIR CONTROL
645(665)	DUCT VALVE BEARING
(681)	CSD OIL COOLER
297(298)	ENGINE MOUNT, FORWARD
H	EQUIPMENT DELETED
(315)	BLEED MANIFOLD
323(324)	ELEVON ACTUATOR, FORWARD END
319(320)	ELEVON ACTUATOR, AFT END
325(326)	ENGINE MOUNT, AFT
333(334)	TAIL CONE LATCH, UPPER
305	ENGINE OIL TANK FILLER CAP
667	ENGINE OIL COOLER
645	TUBING OIL COOLING DUCT BEARING
533	ENGINE AIR-OIL COOLER
651	MA1 POWER TRANSFER RELAY BOX (SEE NOTE 2)
J	HYDRAULIC VALVES
K	CANOPY CONTROLS, EXTERNAL
L	BRAKE SYSTEM COMPONENTS, WINDSHIELD ANTI-ICE TRANSDUCER
M	NITROGEN ACCUMULATOR ADSORBER AND COMPRESSOR. IR COOLING SYSTEM
703	ANGLE OF ATTACK TRANSDUCER

LEFT SIDE VIEW (DOORS SHOWN IN TOP VIEW NOT LISTED)

335(336)	TAIL CONE LATCH, LOWER
321(322)	ELEVON VALVE
N	ENGINE
303	HYDRAULIC PUMP
P	FIRE ACCESS DOOR
Q	MAIN LANDING GEAR WHEEL WELL
R	RAM AIR TURBINE
675(676)	MISSILE BAY DOOR MECHANISM, AFT
S	CANOPY EXTERNAL JETTISON HANDLE
677(678)	MISSILE BAY DOOR MECHANISM, MID
691(692)	DUCT LIP ANTI-ICING, LOWER
V	LOWER-AFT ELECTRONIC EQUIPMENT
679(680)	MISSILE BAY DOOR MECHANISM, FORWARD
W	05 DOOR, LOWER-MID ELECTRONIC EQUIPMENT
X	EXTERNAL POWER RECEPTACLE
505	OXYGEN FILLER CONNECTION
Y	NOSE LANDING GEAR WHEEL WELL
503	CONTROL STICK TORQUE TUBE

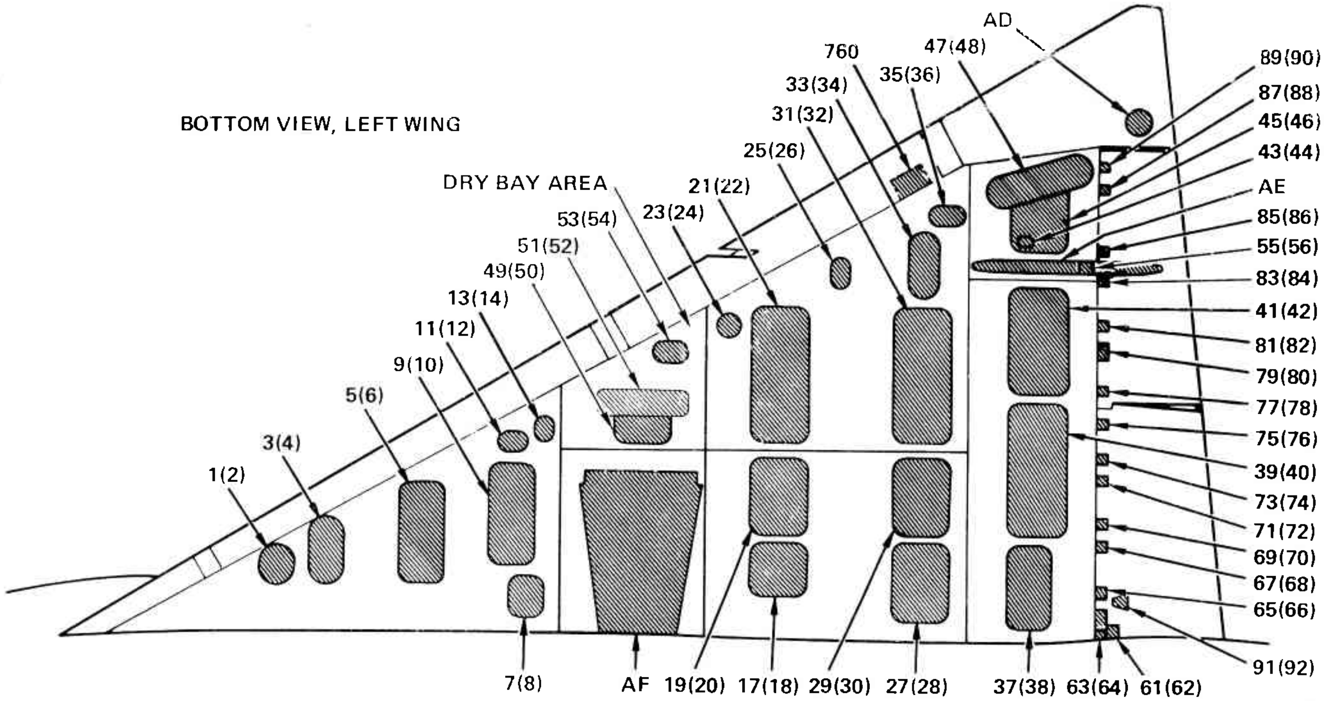
BOTTOM VIEW (DOORS SHOWN IN LEFT SIDE VIEW NOT LISTED)

565	COCKPIT-ELECTRONIC COMPARTMENT GROUND CONDITIONING CONNECTION
563	MISSILE BAY GROUND CONDITIONING CONNECTION
2001	AIR TURBINE GENERATOR
Z	ENGINE AND RAPID TUNE MAGNETRON HYDRAULIC POWER EQUIPMENT
AA	ENGINE ACCESSORIES
AB	CONSTANT SPEED REMOTE GEARBOX
AC	HYDRAULIC SYSTEM COMPONENTS
T	REFUELING ADAPTER
215	ANTENNA

NOTES

1. IDENTIFICATION NUMBERS SHOWN ARE ACCESS DOOR STENCIL NUMBERS. WHERE TWO NUMBERS ARE SHOWN IN DOOR LISTING, THE FIRST NUMBER APPLIES TO THE ACCESS DOOR IN THE LEFT WING, AND THE SECOND NUMBER (IN PARENTHESIS) APPLIES TO THE ACCESS DOOR IN THE RIGHT WING.
2. IDENTIFICATION LETTERS HAVE BEEN ASSIGNED TO THOSE DOORS OR AREAS THAT DO NOT HAVE A STENCILED NUMBER.
3. DOORS ARE LISTED BY VIEW IN CLOCKWISE ORDER.

Figure 1-3. Access and Inspection Provisions; F-106 B Fuselage



ACCESSIBLE EQUIPMENT

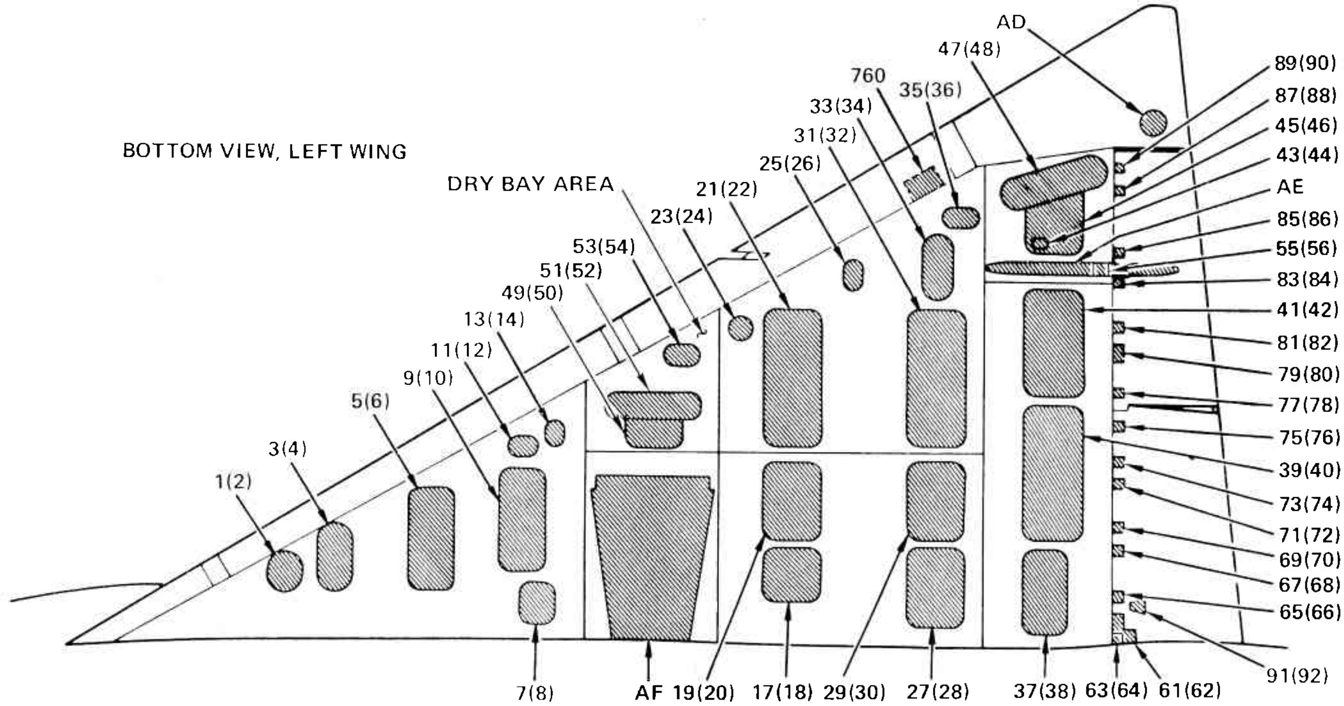
1(2)	FUEL SYSTEM TANK 1.
3(4)	FUEL SYSTEM TANK 1. C.G. TRANSFER LINE
5(6)	FUEL SYSTEM TANK 1. REFUEL SHUTOFF VALVES. REFUEL PILOT VALVES. VENT AND PRESSURE RELIEF VALVES. C.G. TRANSFER LINES, AIR OPERATED SHUTOFF VALVES, REFUEL PRESSURE OPERATED VALVES
9(10)	FUEL SYSTEM TANK 1. TANK PRESSURE CHECK VALVE. REFUEL VENT VALVE. C.G. TRANSFER LINE, REFUEL PILOT VALVE
11(12)	FUEL SYSTEM TANK 1
13(14)	FUEL SYSTEM TANK 1. EXTERNAL TANK SHUTOFF VALVE. TRANSFER LINE
49(50)	TANK PRESSURE SWITCH, BOOST PUMP PRESSURE SWITCH. TRANSFER LINE. EXTERNAL TANK PRESSURE REGULATOR AND FUEL CHECK VALVE
51(52)	PYLON SUPPORT BEAM
53(54)	VENT LINE
23(24)	FUEL SYSTEM TANK 2. VENT LINE
21(22)	ELECTRICAL FUEL QUANTITY RECEPTACLE. FUEL SYSTEM TANK 2. PRESSURE RELIEF VALVE. VENT VALVE. VENT OUTLET FITTING
25(26)	FUEL SYSTEM TANK 2 STRUCTURE ACCESS
31(32)	FUEL SYSTEM TANK 2. FLOAT VALVE. VACUUM RELIEF VALVE. VENT LINE. BELLMOUTH
33(34)	FUEL SYSTEM TANK 2 STRUCTURE ACCESS
760	REMOTE COMPASS TRANSMITTER (UPPER SURFACE OF RH LEADING EDGE ONLY)
35(36)	FUEL SYSTEM TANK 2 STRUCTURE ACCESS
47(48)	STRUCTURE ACCESS
AD	POSITION LIGHT
89(90)	ELEVON HINGE BOLT. BONDING WIRE
87(88)	ELEVON HINGE BOLT. BONDING WIRE
45(46)	STRUCTURE ACCESS. HYDRAULIC LINES
43(44)	ELEVON ACTUATOR BOLT
AE	ELEVON ACTUATOR
85(86)	ELEVON HINGE BOLT. BONDING WIRE
55(56)	ACTUATOR FITTING
83(84)	ELEVON HINGE BOLT. BONDING WIRE
41(42)	FUEL SYSTEM TANSFER TANK. C.G. TRANSFER LINE. FUEL SHUTOFF VALVE. LOW LEVEL PILOT VALVE
81(82)	ELEVON HINGE BOLT. BONDING WIRE
79(80)	ELEVON HINGE BOLT. BONDING WIRE
77(78)	ELEVON HINGE BOLT. BONDING WIRE
75(76)	ELEVON HINGE BOLT. BONDING WIRE
39(40)	FUEL SYSTEM TANSFER TANK. C.G. TRANSFER LINE. VENT VALVE. REFUEL SHUTOFF VALVE. LOW LEVEL PILOT VALVE. VACUUM RELIEF VALVE. ELECTRICAL FUEL QUANTITY RECEPTACLE
73(74)	ELEVON HINGE BOLT. BONDING WIRE
71(72)	ELEVON HINGE BOLT. BONDING WIRE
69(70)	ELEVON HINGE BOLT. BONDING WIRE
67(68)	ELEVON HINGE BOLT. BONDING WIRE
65(66)	ELEVON HINGE BOLT. BONDING WIRE
91(92)	ELEVON FITTING
61(62)	ELEVON HINGE BOLT. BONDING WIRE. (ELEVON LOWER SURFACE)
63(64)	ELEVON HINGE BOLT. BONDING WIRE. (ELEVON UPPER SURFACE)
37(38)	FUEL SYSTEM TRANSFER TANK. REFUEL PILOT VALVE, REFUEL VENT VALVE, PRESSURE RELIEF VALVE, AIR CHECK VALVE, LOW LEVEL PILOT VALVE, FUEL SHUTOFF VALVE, REFUEL PRESSURE OPERATED SHUTOFF VALVE
27(28)	FUEL SYSTEM TANK 3. BOOST PUMP. ENGINE SUPPLY LINE. T-FLAPPER CHECK VALVE
29(30)	FUEL SYSTEM TANK 3. C.G. TRANSFER LINE. SOLENOID OPERATED FUEL SCAVENGE VALVE, AIR CHECK VALVE, REFUEL SHUTOFF VALVE
17(18)	FUEL SYSTEM TANK 3. BELLMOUTH. VENT VALVE.
19(20)	FUEL SYSTEM TANK 3. FUEL BOOST PUMP. C.G. TRANSFER LINE, REFUELING PILOT FLOAT VALVE. TRANSFER LINE
AF	MAIN WHEEL WELL
7(8)	FUEL SYSTEM TANK 1. BELLMOUTH

NOTES

1. IDENTIFICATION NUMBERS SHOWN ARE ACCESS DOOR STENCIL NUMBERS. WHERE TWO NUMBERS ARE SHOWN IN DOOR LISTING, THE FIRST NUMBER APPLIES TO THE ACCESS DOOR IN THE LEFT WING AND THE SECOND NUMBER (IN PARENTHESIS) APPLIES TO THE ACCESS DOOR IN THE RIGHT WING.
2. IDENTIFICATION LETTERS HAVE BEEN ASSIGNED TO THOSE DOORS OR AREAS THAT DO NOT HAVE A STENCILED NUMBER.

F-106A(2-5-2)14B

Figure 1-4. Access and Inspection Provisions, Wing, F-106A



ACCESSIBLE EQUIPMENT

1(2)	FUEL SYSTEM TANK 1.
3(4)	FUEL SYSTEM TANK 1.
5(6)	FUEL SYSTEM TANK 1. AAR VENT VALVE, PRESSURE RELIEF VALVE, REFUEL PILOT FLOAT VALVE, PRESSURE RELIEF VALVE, TRANSFER LINE
9(10)	FUEL SYSTEM TANK 1. TANK PRESSURE CHECK VALVE. REFUEL VENT VALVE. REFUEL PILOT FLOAT VALVE,REFUEL PILOT VALVES EXTERNAL TANK REFUEL VALVE TRANSFER LINE.
11(12)	FUEL SYSTEM TANK 1.
13(14)	FUEL SYSTEM TANK 1. EXTERNAL TANK SHUTOFF VALVE. VACUUM RELIEF VALVE. TRANSFER LINE.
49(50)	TANK PRESSURE SWITCH. BOOST PUMP PRESSURE SWITCH. TRANSFER LINE. EXTERNAL TANK PRESSURE REGULATOR AND AIR SOLENOID VALVE.
51(52)	PYLON SUPPORT BEAM
53(54)	VENT LINE
23(24)	FUEL SYSTEM TANK 2. VENT LINE
21(22)	FUEL SYSTEM TANK 2. ELECTRICAL FUEL QUANTITYRECEPTACLE. PRESSURE RELIEF VALVE. VENT OUTLET FITTING.
25(26)	FUEL SYSTEM TANK 2 STRUCTURE ACCESS.
31(32)	FUEL SYSTEM TANK 2. VENT LINE BELLMOUTH
33(34)	FUEL SYSTEM TANK 2 STRUCTURE ACCESS
760	REMOTE COMPASS TRANSMITTER (UPPER SURFACE OF RH LEADING EDGE ONLY)
35(36)	FUEL SYSTEM TANK 2 STRUCTURE ACCESS
47(48)	STRUCTURE ACCESS
AD	POSITION LIGHT
89(90)	ELEVON HINGE BOLT. BONDING WIRE
87(88)	ELEVON HINGE BOLT. BONDING WIRE
45(46)	STRUCTURE ACCESS. HYDRAULIC LINES
43(44)	ELEVON ACTUATOR BOLT
AE	ELEVON ACTUATOR
85(86)	ELEVON HINGE BOLT. BONDING WIRE
55(56)	ACTUATOR FITTING
83(84)	ELEVON HINGE BOLT. BONDING WIRE
41(42)	FUEL SYSTEM TRANSFER TANK. FUEL SHUTOFF VALVE. LOW LEVEL PILOT VALVE
81(82)	ELEVON HINGE BOLT. BONDING WIRE
79(80)	ELEVON HINGE BOLT. BONDING WIRE
77(78)	ELEVON HINGE BOLT. BONDING WIRE
75(76)	ELEVON HINGE BOLT. BONDING WIRE
39(40)	FUEL SYSTEM TRANSFER TANK. ELECTRICAL FUEL QUANTITY RECEPTACLE. REPLENISH PILOT FLOAT VALVE.
73(74)	ELEVON HINGE BOLT. BONDING WIRE
71(72)	ELEVON HINGE BOLT. BONDING WIRE
69(70)	ELEVON HINGE BOLT. BONDING WIRE
67(68)	ELEVON HINGE BOLT. BONDING WIRE
65(66)	ELEVON HINGE BOLT. BONDING WIRE
91(92)	ELEVON FITTING
61(62)	ELEVON HINGE BOLT. BONDING WIRE. (ELEVON LOWER SURFACE)
63(64)	ELEVON HINGE BOLT. BONDING WIRE. (ELEVON UPPER SURFACE)
37(38)	FUEL SYSTEM TRANSFER TANK. TRANSFER LINE PILOT FLOAT VALVE. ELECTRICAL FUEL QUANTITY RECEPTACLE.
27(28)	FUEL SYSTEM TANK 3. BOOST PUMP ENGINE SUPPLY LINE. DUAL T CHECK VALVE
29(30)	FUEL SYSTEM TANK 3.
17(18)	FUEL SYSTEM TANK 3, BELLMOUTH ANTI-G VENT VALVE.
19(20)	FUEL SYSTEM TANK 3. FUEL BOOST PUMP. REFUEL SHUTOFF VALVE, SOLENOID-OPERATED, SCAVENGE VALVE. TRANSFER LINE
AF	MAIN WHEEL WELL
7(8)	FUEL SYSTEM TANK 1. BELLMOUTH

NOTES

1. IDENTIFICATION NUMBERS SHOWN ARE ACCESS DOOR STENCIL NUMBERS. WHERE TWO NUMBERS ARE SHOWN IN DOOR LISTING, THE FIRST NUMBER APPLIES TO THE ACCESS DOOR IN THE LEFT WING, AND THE SECOND NUMBER (IN PARENTHESIS) APPLIES TO THE ACCESS DOOR IN THE RIGHT WING.
2. IDENTIFICATION LETTERS HAVE BEEN ASSIGNED TO THOSE DOORS OR AREAS THAT DO NOT HAVE A STENCILED NUMBER.

Figure 1-5. Access and Inspection Provisions, Wing, F-106B

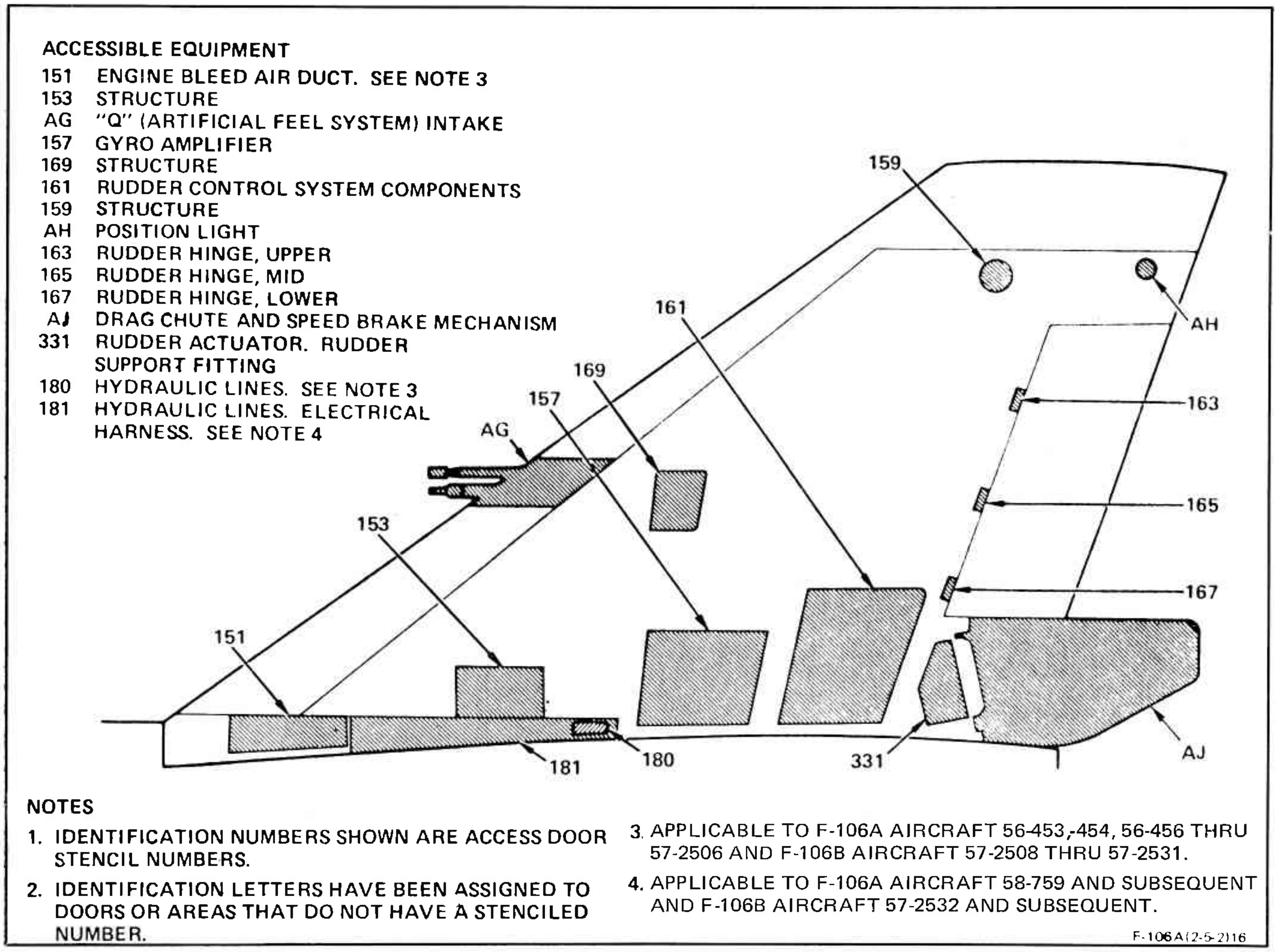


Figure 1-6. Access and Inspection Provisions, Fin.

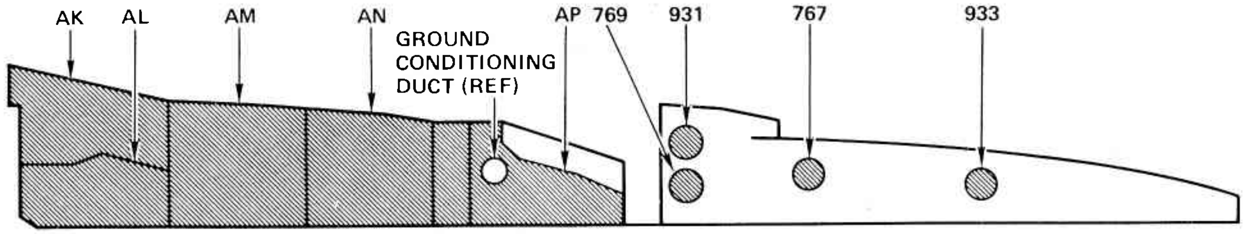
lower surface. Refer to Section V for additional landing gear information and for repairs to the landing gear.

1-12. Engine Compartment.

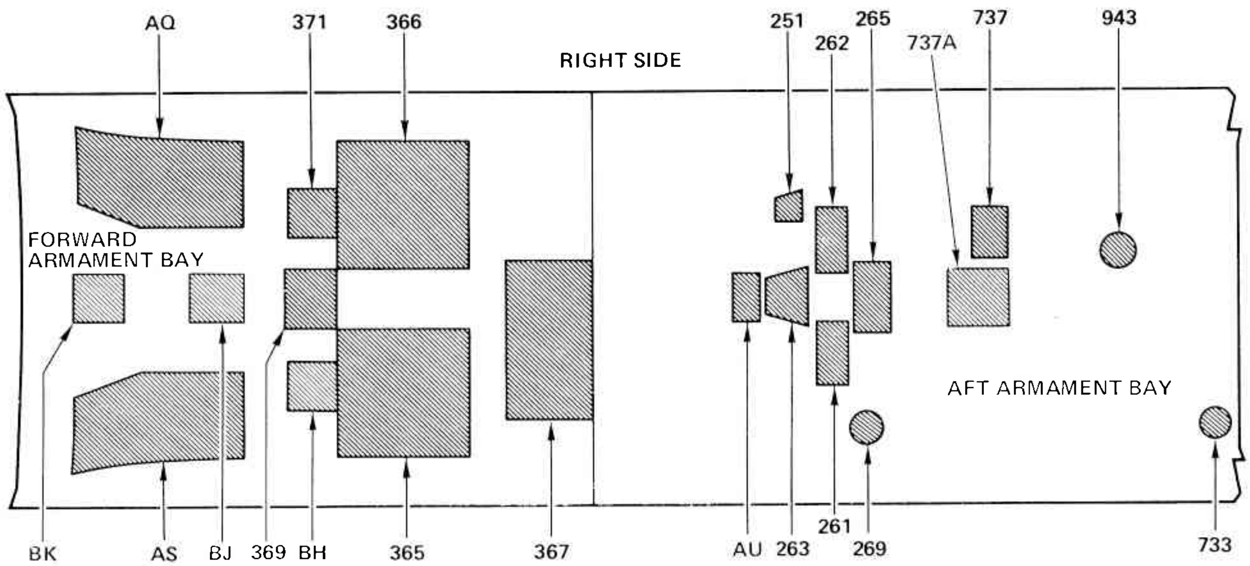
1-13. The aft section of the fuselage from sta 472.00 to the aft end of the tail cone is designed to accommodate the engine. The engine is enclosed by a thin gage titanium shroud containing insulation blankets to provide a fireseal and a barrier to protect the structure from the effects of engine heat. Several access doors are located in the aft section of the fuselage for inspection and maintenance of the engine and engine accessories. The engine is supported within the fuselage by one thrust mount at the forward right-hand side, one rigid link on the forward left-hand side, and by two adjustable links at the aft end. Refer to Section VI for engine section repair information.

1-14. STRESSES.

1-15. A high rate of performance is required of the F-106A and F-106B airplanes, their armament, and their associated electronic equipment in the execution of a mission under all weather and visibility conditions. Because these airplanes must operate at extremes of speed and altitude, it is highly important that the structural integrity be maintained. The airplanes are designed with a predetermined safety margin to provide each .structural component with sufficient strength to withstand the varying loads imposed on it, but not overstrength because of the unnecessary increase in weight. For this reason it is important that any damaged structural component be repaired to fully restore its original strength. The importance of the damage and the type of repair required will require an individual decision for each damaged airplane after a thorough inspection and evaluation of the damaged area. The first inspection and evaluation will usually be conducted by advanced base personnel and a decision made as to whether the damage is negligible, can be repaired by using information found in this manual, or will require the services of an aeronautical structures engineer. The stresses which can be developed safely in a member are usually dependent on three factors: cross-sectional area, shape, and type of material. The shape, cross-sectional area, and type of material of the structural members used in the F-106A and



VIEW LOOKING OUTBOARD, LEFT SIDE



LEFT SIDE

VIEW LOOKING DOWN, ROOF

ACCESSIBLE EQUIPMENT

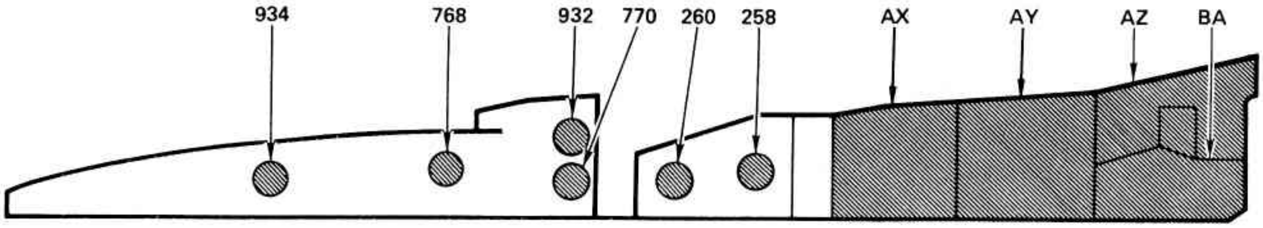
AK	PNEUMATIC LINES. HYDRAULIC LINES
AL	ELEVATOR CONTROL
AM	ELEVATOR CONTROL. PNEUMATIC LINES. HYDRAULIC LINES
AN	ELEVATOR CONTROL. FUEL TRANSFER LINE. PNEUMATIC LINES. HYDRAULIC LINES
AP	ELEVATOR CONTROL. GROUND CONDITIONING DUCT. PNEUMATIC LINES. HYDRAULIC LINES
769	ELEVATOR CONTROL
931	FUEL LINE
767	ELEVATOR CONTROL
933	ELEVATOR CONTROL
AQ	ELECTRICAL HARNESSES
371	ARMAMENT CONTROL RELAY BOX. ELECTRICAL HARNESSES
366	ARMAMENT SYSTEM RELAYS. ELECTRICAL HARNESSES. RUDDER CABLE PULLEY. VARIABLE RAMP JACKS
251	ELECTRICAL HARNESSES
262	FUEL TRANSFER LINE
265	PNEUMATIC SYSTEM AIR FLASK FITTING
737/737A	REFUEL PRESSURE LINE
943	ELECTRICAL HARNESS CONDUIT
733	THROTTLE TELEFLEX CONDUIT
269	THROTTLE TELEFLEX CONDUIT
261	FUEL TRANSFER LINE
263	PNEUMATIC SYSTEM AIR FLASK FITTING
AU	PNEUMATIC SYSTEM AIR FLASK FITTING
367	AIR CONDITIONING SYSTEM COMPONENTS. PNEUMATIC SYSTEM AIR FLASKS. VARIABLE RAMP JACKS
365	AIR CONDITIONING DUCT. RUDDER CABLE PULLEY. VARIABLE RAMP JACKS. MOISTURE SEPARATOR INLET THERMOSTAT
BH	VARIABLE RAMP PITOT STATIC SHUTTLE VALVE
369	MISSILE INTERVALOMETER
BJ	AIR CONDITIONING DUCT
AS	AIR CONDITIONING SYSTEM DUCTING AND MOISTURE SEPARATOR
BK	INTERVALOMETER

NOTES

1. IDENTIFICATION NUMBERS SHOWN ARE ACCESS DOOR STENCIL NUMBERS.
2. IDENTIFICATION LETTERS HAVE BEEN ASSIGNED TO THOSE DOORS OR AREAS THAT DO NOT HAVE A STENCILED NUMBER.

F-106A(2-5-2)17-1C

Figure 1-7. Access and Inspection Provisions, Armament Bay, F-106A (Sheet 1 of 2)



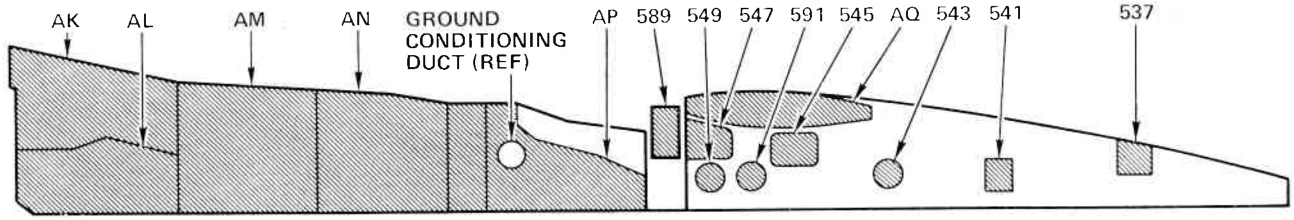
VIEW LOOKING OUTBOARD, RIGHT SIDE

ACCESSIBLE EQUIPMENT

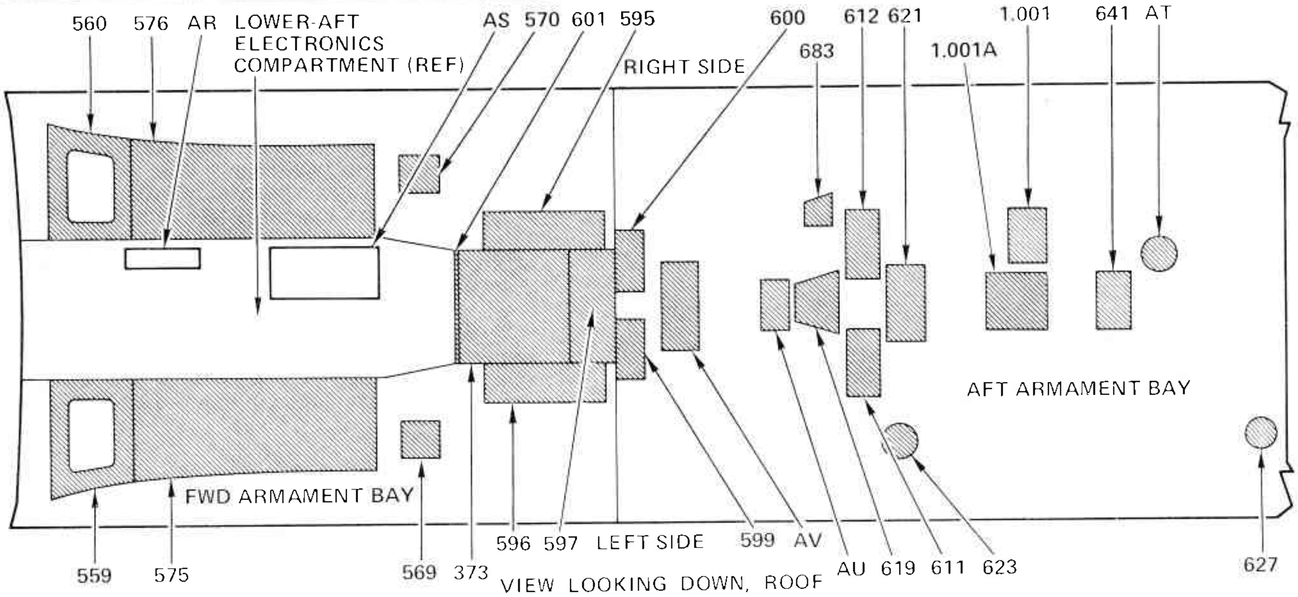
934 AILERON CONTROL
768 AILERON CONTROL
932 FUEL LINE
770 AILERON CONTROL
260 AILERON CONTROL
258 AILERON CONTROL
AX FUEL TRANSFER RELAYS NOS. 1, 2, 3, AND 4. AILERON CONTROL BELL CRANK. FUEL TRANSFER LINE
AY M.W.W. DOOR CLOSE RELAY. IGNITION RELAY. IGNITION ARMING RELAY. ANTI-ICE CONTROL RELAY. EXTERNAL FUEL TANK EJECTION RELAY. HYDRAULIC FLASHER RESET RELAY. DC POWER INTERLOCK RELAY. DC POWER FAILURE WARNING RELAY. AC EMERGENCY CONTROL RELAY. AC EXTERNAL POWER INTERLOCK RELAY.
AZ AC POWER DISCONNECT RELAY. DC POWER DISCONNECT RELAY. OVERHEAT TEST RELAYS, LOOPS 1 AND 2. OVERHEAT FLASHER. HYDRAULIC PRESSURE WARNING FLASHER. PITCH "G" LIMITER INTERLOCK. ELEVATOR CHANNEL RELAY. AILERON CHANNEL RELAY. AC GENERATOR CONTROL PANEL. OVERHEAT DETECTION CONTROL. FIRE DETECTION CONTROL.
BA AILERON CONTROL

F-106A(2-5-2)17-2A

Figure 1-7. Access and Inspection Provisions, Armament Bay, F-106A (Sheet 2 of 2)



VIEW LOOKING OUTBOARD, LEFT SIDE



VIEW LOOKING DOWN, ROOF

ACCESSIBLE EQUIPMENT

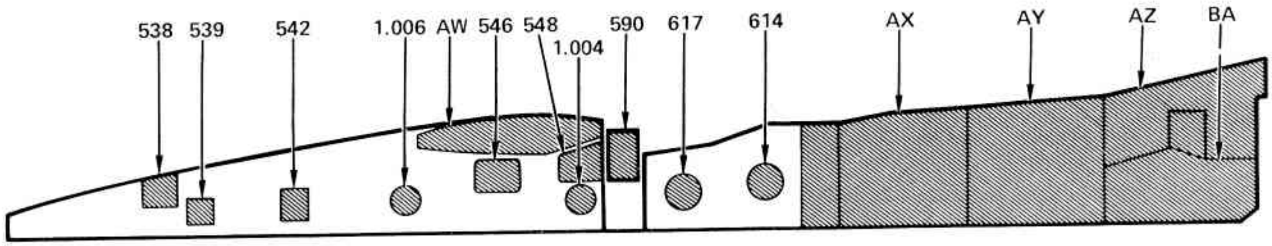
- AK PNEUMATIC LINES, HYDRAULIC LINES
- AL ELEVATOR CONTROL
- AM ELEVATOR CONTROL PNEUMATIC LINES, HYDRAULIC LINES
- AN ELEVATOR CONTROL, FUEL TRANSFER LINE, PNEUMATIC LINES, HYDRAULIC LINES
- AP ELEVATOR CONTROL, GROUND CONDITIONING DUCT, PNEUMATIC LINES, HYDRAULIC LINES
- 589 AIR CONDITIONING DUCTING
- 549 ELEVATOR CONTROL, FUEL VENT LINE
- 547 FUEL VENT LINE
- 591 ELEVATOR CONTROL, VARIABLE RAMP SYSTEM DRAIN VALVE
- 545 FUEL VENT LINE
- AQ VARIABLE RAMP, LOWER-AFT ACTUATOR JACK, RUDDER CABLE PULLEY
- 543 ELEVATOR CONTROL, LUBRICATION
- 541 ELEVATOR CONTROL, FUEL DRAIN VALVE
- 537 ELEVATOR CONTROL, FUEL DRAIN VALVE
- 560 ELECTRICAL HARNESSES, PNEUMATIC LINES, HYDRAULIC LINES, AIR CONDITIONING DUCTING, RUDDER CABLES
- 576 RUDDER CABLES, FUEL SYSTEM DRAIN LINES
- AR AIR CONDITIONING DUCTING
- AS MOISTURE SEPARATOR, MOISTURE SEPARATOR SERVO BYPASS VALVE
- 570 VARIABLE RAMP, LOWER-FORWARD ACTUATOR JACK
- 601 ELECTRICAL HARNESSES, AIR CONDITIONING DUCTING (SEE NOTE 3)
- 595 ELECTRONIC COOLING AIRFLOW CONTROL
- 600 VARIABLE RAMP AIR FLASK, DUCT LIP ANTI-ICE REGULATOR, GROUND COOLING CHECK VALVE
- 683 ELECTRICAL HARNESS
- 612 FUEL TRANSFER LINE
- 621 PNEUMATIC SYSTEM AIR FLASK FITTING
- 1.001/1.001A REFUEL PRESSURE LINE
- 641 COOLING LINE
- AT ELECTRICAL HARNESS CONDUIT
- 627 THROTTLE TELEFLEX CONDUIT
- 623 THROTTLE TELEFLEX CONDUIT
- 611 FUEL TRANSFER LINE
- 619 PNEUMATIC SYSTEM AIR FLASK FITTING
- AU PNEUMATIC SYSTEM AIR FLASK FITTING
- AV TURBINE DISCHARGE, AIR TEMPERATURE CONTROL VALVE
- 599 GROUND COOLING CHECK VALVE, DUCT LIP ANTI-ICE REGULATOR
- 597 HEAT EXCHANGER
- 596 CABIN AIR SENSOR AND SHUTOFF VALVE, CABIN TEMPERATURE CONTROL VALVE
- 373 AIR CONDITIONING SYSTEM COMPONENTS, PNEUMATIC SYSTEM AIR FLASKS, VARIABLE RAMP, UPPER ACTUATOR JACKS
- 569 VARIABLE RAMP, LOWER-FORWARD ACTUATOR JACK
- 575 PNEUMATIC LINES, HYDRAULIC LINES, BALLISTIC HOSES, THROTTLE TELEFLEX CONDUIT
- 559 ELECTRICAL HARNESSES, AIR CONDITIONING DUCTING, RUDDER CABLES, PNEUMATIC LINES, HYDRAULIC LINES, THROTTLE TELEFLEX CONDUIT

NOTES

1. IDENTIFICATION NUMBERS SHOWN ARE ACCESS DOOR STENCIL NUMBERS.
2. IDENTIFICATION LETTERS HAVE BEEN ASSIGNED TO THOSE DOORS OR AREAS THAT DO NOT HAVE A STENCILED NUMBER.
3. DOOR IS LOCATED ADJACENT TO AFT FACE OF ELECTRONICS COMPARTMENT AND ROOF OF MISSILE BAY.

F-106B(2-5-2)5-1B

Figure 1-8. Access and Inspection Provisions, Armament Bay, F-106B (Sheet 1 of 2)



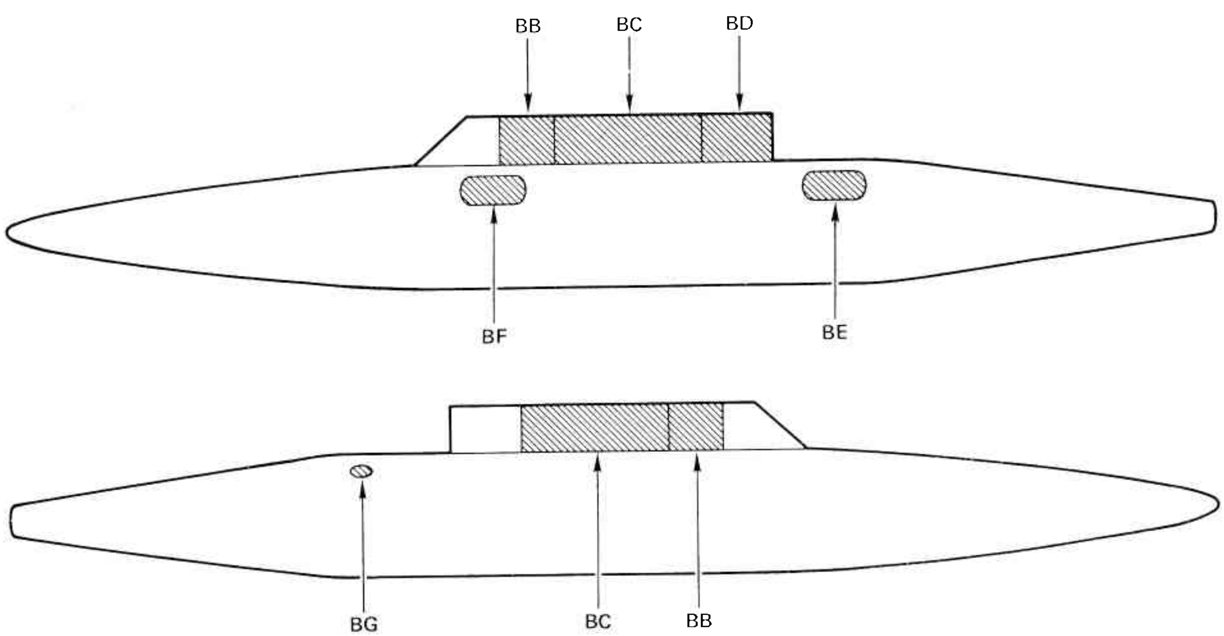
VIEW LOOKING OUTBOARD, RIGHT SIDE

ACCESSIBLE EQUIPMENT

538 AILERON CONTROL
539 AILERON CONTROL. FUEL DRAIN LINE
542 AILERON CONTROL. FUEL DRAIN VALVE
1.006 AILERON CONTROL
AW VARIABLE RAMP, LOWER-AFT ACTUATOR JACK. RUDDER CABLE PULLEY
546 FUEL VENT LINE
548 VENT VALVE SENSE LINE
1.004 AILERON CONTROL
590 AIR CONDITIONING DUCTING, GROUND REFUELING REGULATOR
617 AILERON CONTROL
614 AILERON CONTROL
AX AILERON CONTROL. ELECTRICAL HARNESS
AY AC EMERGENCY CONTROL RELAY. AC EXTERNAL POWER INTERLOCK RELAY. DC EXTERNAL POWER INTERLOCK RELAY. DC POWER FAILURE WARNING RELAY. M.W.W. DOOR CLOSE RELAY. EXTERNAL FUEL TANK EJECTION RELAY. IGNITION RELAY. IGNITION ARMING RELAY. ANTI-ICE CONTROL RELAY. AILERON CONTROL
AZ AIR CONTROL TIMER RELAY CONTROL BOX. FORWARD MISSILES MISFIRE RELAYS. AFT MISSILES MISFIRE RELAYS. MISSILE INTERVALOMETER. AUXILIARY AFT MISFIRE RELAY. SPECIAL WEAPON MISFIRE RELAY. AC GENERATOR CONTROL. AC POWER DISCONNECT RELAY. AC EXTERNAL POWER DISCONNECT RELAY. FIRE DETECTION SYSTEM RELAYS. OVERHEAT FLASHER. OVERHEAT DETECTORS, LOOPS 1 AND 2. HYDRAULIC PRESSURE WARNING FLASHER. HYDRAULIC FLASHER RESET RELAY.
BA AILERON CONTROL

F-106B(2-5-2)5-2A

Figure 1-8. Access and Inspection Provisions, Armament Bay, F-106B (Sheet 2 of 2)



ACCESSIBLE EQUIPMENT

BB FUEL AND AIR LINE DISCONNECT
BC EJECTOR RACK
BD ELECTRICAL DISCONNECT
BE VENT VALVE. REFUELING SHUTOFF VALVE. CHECK VALVE. LOW LEVEL FLOAT SWITCH
BF HIGH LEVEL FLOAT SWITCH. PILOT FLOAT VALVE. VACUUM RELIEF VALVE
BG FUEL FILLER CAP

F-106A(2-5-2)18

Figure 1-9. Access and Inspection Provisions, External Fuel Tank/Pylon

F-106B airplanes have been selected to produce as strong and light a structure as possible, and at the same time meet aerodynamic and production requirements. Consequently, it is very important that any repair return the damaged structural member to its original shape and strength as nearly as possible, and any loss of strength due to change of shape must be compensated for by an increase in cross-sectional area.

Paragraphs 1-16 thru 1-31 and figures 1-10 thru 1-13, deleted.

1-32. Damage Importance Relative to Location.

1-33. Particular attention should be directed to the location of the damage on the member because less damage may be tolerated in certain areas considered critical on each member. When a force is applied which tends to bend a member, stresses are set up in it. The stresses are greatest in the parts of the member which are farthest from its center. For this reason, ribs are built with the greater part of their cross-sectional area at the edges. These reinforced edge sections are called flanges or rails. Because of this concentration of stresses, these flanges or rails are the points where the least damage may be tolerated. Typical rib construction is shown in figure 1-14. Care should be used in the size and location of rivet holes drilled in the flanges, rails and stiffeners. Holes drilled by the manufacturer are the best guide for the mechanic. Remember, a member loses a portion of its cross-sectional area when a hole is drilled in it. If a rivet is properly installed, the strength of the member in compression is largely returned; however, its strength in tension is still reduced. These factors should be considered in evaluating damage and in planning repairs.

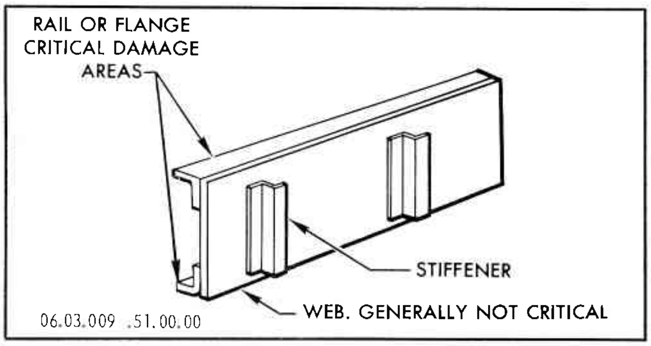


Figure 1-14. Typical Rib Elements

1-34. Weight of Repair.

1-35. To provide maximum operating efficiency, the gross weight of the airplane must be contained within stipulated limits. Therefore, the weight of materials used to repair the existing airplane structure should be held to a minimum consistent with strength requirements. An aircraft structural engineer should be consulted to determine the effect of weight addition through major repairs. In any case, an accurate record must be kept of all weight additions involved in repairs to the aircraft structure. Refer to T.O. 1F-106A-5 and T.O. 1F-106B-5 for airplane center of gravity limits and design gross weights.

1-36. CONTROL SURFACE BALANCING.

1-37. All control surfaces are hydraulically operated and will not require balancing. Repairs to these units shall be designed so as to restore the maximum surface smoothness and trueness of its original contour.

1-38. COCKPIT PRESSURE LEAKAGE, TEST AND REPAIR.

1-39. During normal operation, the cockpit is cooled and pressurized with temperature-regulated engine bleed air that is refrigerated by passing through a refrigeration unit. Cockpit pressure is automatically controlled by a pressure regulator that discharges excess volumes of cockpit air into the nose wheel well. From 31,000 feet to the upper altitude limit of the airplane, cockpit pressure is maintained at a constant differential of 5 psi over ambient atmospheric pressure. It follows that excessive leakage of cockpit air pressure could lower the pilot's maximum altitude limit. Pressurization leakage can also be an important factor in total drag. Even in the low-speed ranges, 300 to 400 miles per hour, pressurization leakage from the outer surface of the fuselage adds to drag. At supersonic speeds, each leak is in effect a subsonic jet projecting from the fuselage, and is as effective as a metallic projection in producing drag. Leaks may be repaired from the inside by stationing a man inside the cockpit while under pressure. Repairing leaks while under pressure is recommended since results may be checked immediately and leaks may be repaired as soon as they are found. After major repairs to the primary structure or replacement of the windshield or canopy panels, the cockpit should be pressure leak tested as outlined in T.O. 1F-106A-2-6. If the flow of air necessary to maintain a constant pressure is excessive and system analysis has isolated the cause to a leak in the structure, check for leaks in accordance with T.O. 1F-106A-2-6-2-1 and as described in the following paragraphs.

1-40. Equipment Requirements.

1-41. The following equipment is required in addition to the equipment listed for the cockpit pressure and leak test in T.O. 1F-106A-2-6-2-1:

a. Stethoscope or rubber tube (listening device to detect leaks.).

b. Bubble fluid (Specification MIL-L-25567).

c. Fillet sealer (MIL-S-8802).

1-42. Deleted.

1-43. Deleted.

1-44. Procedure.

WARNING

Personnel stationed inside the cockpit while it is under pressure should be examined, approved and physiologically indoctrinated (altitude physiology), prior to the test, by medical authority. An experienced operator should be stationed at the test rig control panel at all times while the cabin is under pressure.

a. Station a mechanic, equipped with sealant repair materials and a stethoscope or rubber tube, inside the cockpit. Close and lock canopy.

b. Pressurize cockpit to required leak test pressure, following procedure given in T.O. 1F-106A-2-6-2-1. Rate of pressure change should *never* exceed ½ psi per minute (1000 feet per minute altitude change).

c. With cockpit pressurized, locate leaks on outside of airplane with bubble fluid or castile soap solution. Isolate leaks on inside by running stethoscope or section of rubber tube along seams in floor and bulkhead areas, listening for a whistling sound when tube is moved over a leak.

d. Repair leaks as shown in figures 1-15 and 1-16 until it is no longer possible to detect any change in sound when stethoscope or rubber tube is passed over repair location.

e. Slowly decrease cockpit pressure to zero gage pressure. Maintain rate of pressure change at ½ psi per minute.

f. Open canopy and remove test equipment. Restore air-conditioning and pressurization system to flight condition as directed by procedure in T.O. 1F-106A-2-6-2-1.

1-45. AIRFRAME FABRICATION MATERIALS.

1-46. Titanium.

1-47. The data presented on this relatively new type of material employed in airplane construction provides practical suggestions and limitations to be used in fabricating parts and repairs from titanium sheet. There are three specific reasons for the employment of titanium in structure: High stress and overall strength by weight comparison with other materials, high heat resistance values, and high corrosion resistant properties.

1-48. Types of Titanium.

1-49. The types of titanium most commonly used in the F-106A and F-106B airplanes are:

a. AMS 4901 sheet and strip, replaced by MIL-T-9046, Type I, Comp B.

b. AMS 4908 sheet and strip, replaced by MIL-T-9046, Type III, Comp A.

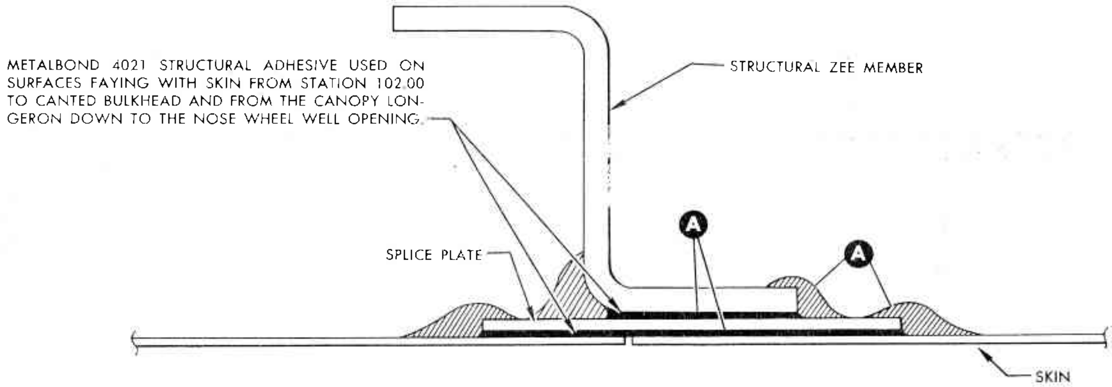
c. Convair Specification 0-01014 sheet and strip, replaced by MIL-T-9046, Type II, Comp A.

d. AMS4925 bar or forging, 4AL-4MN, replace with MIL-T-9047, 6AL-4V.

e. Convair Specification 0-01015 bar or forging, replaced by MIL-T-9047, 5AL-2.5SN.

1-50. Identification of Titanium.

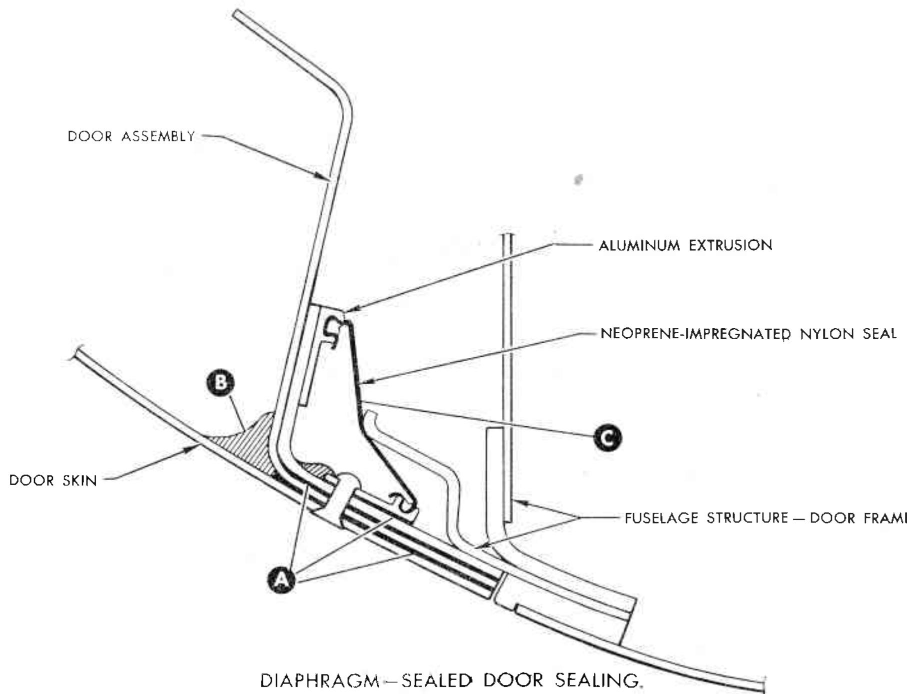
1-51. Titanium can be identified in two ways. Touched on a grinding wheel, it gives off bright white traces ending in brilliant bursts. Titanium may also be identified by applying a drop of 48 percent concentrated hydrofluoric acid. The following procedure should be used when making a chemical test to prevent damage to the titanium part:



COCKPIT SKIN SPLICE SEALING.

A Apply Sealer, Military Specification MIL-S-81733 to faying surfaces of original assembly.

Apply a fillet of sealant, Military Specification MIL-S-8802, along edges of faying surfaces.



DIAPHRAGM—SEALED DOOR SEALING.

A Apply sealer, Militray Specification MIL-S-81733 to faying surfaces of original assembly.

B Repair leaks in original sealant by application of fillet sealer, Military Specification MIL-S-8802.

C Repair leaks in seal as shown on sheet 2 of this illustration.

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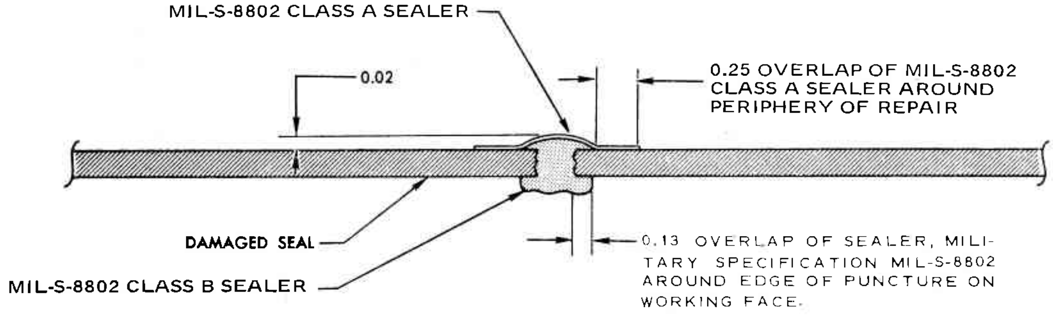
NOTE:
REFER TO PARAGRAPH TITLED "COCKPIT PRESSURE LEAKAGE TEST AND REPAIR" IN THIS SECTION.

Figure 1-15. Cockpit and Forward Electronic Compartment Sealing (Sheet 1 of 3)



TYPE I REPAIR OF DAMAGED DIAPHRAGM SEAL

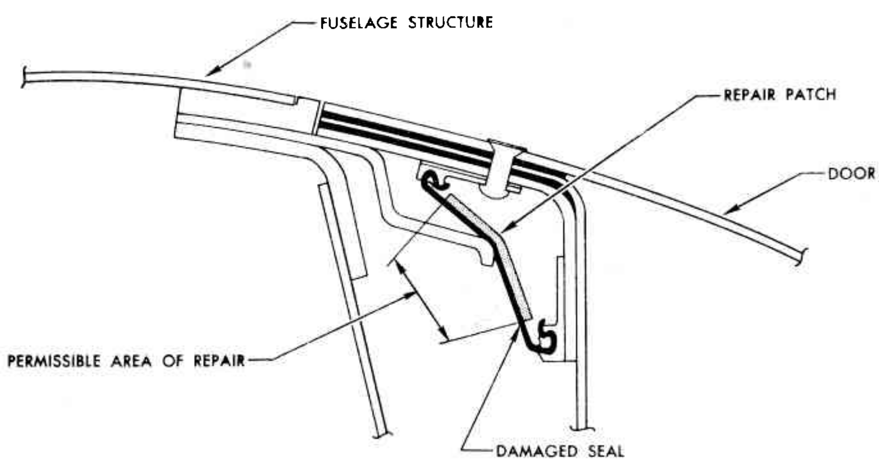
A Measure puncture. If puncture exceeds 3/32 x 3/16-inch, repair as shown for type II repair below.

B Clean surface of seal with methyl ethyl ketone in a ½ inch wide area around edge of puncture.

C Inject puncture with enough sealer, Military Specification MIL-S-8802 Class B to close opening. Smooth and form sealer with spatula on working face as shown above.

D Allow sealer, Military Specification MIL-S-8802 to cure until firm and track free.

E Apply a coating of MIL-S-8802 Class A sealer over working face of repair as shown above.



TYPE II REPAIR OF DAMAGED DIAPHRAGM SEAL

A Measure puncture. If puncture exceeds ½ inch in length or diameter, replace seal.

B Remove seal and apply Camel Vulcanizing Patch or equivalent to inside of seal as shown. Manufactured by H. B. Egan Mfg. Co., Muskogee, Oklahoma. Apply as directed in manufacturer's instructions. Overlap patch ⅜ inch around edge of puncture.

C Re-install seal.

NOTE:
TYPE I AND II REPAIRS ARE LIMITED TO A MAXIMUM OF SIX FOR ENTIRE DOOR WITH A MINIMUM SPACING OF TWELVE INCHES BETWEEN REPAIRS.

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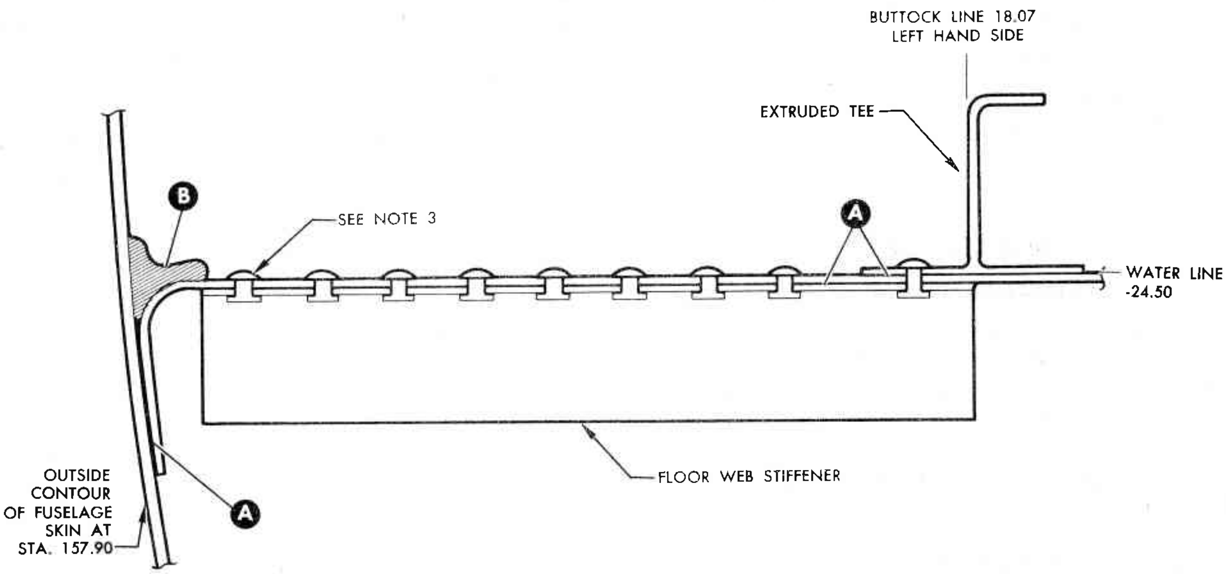
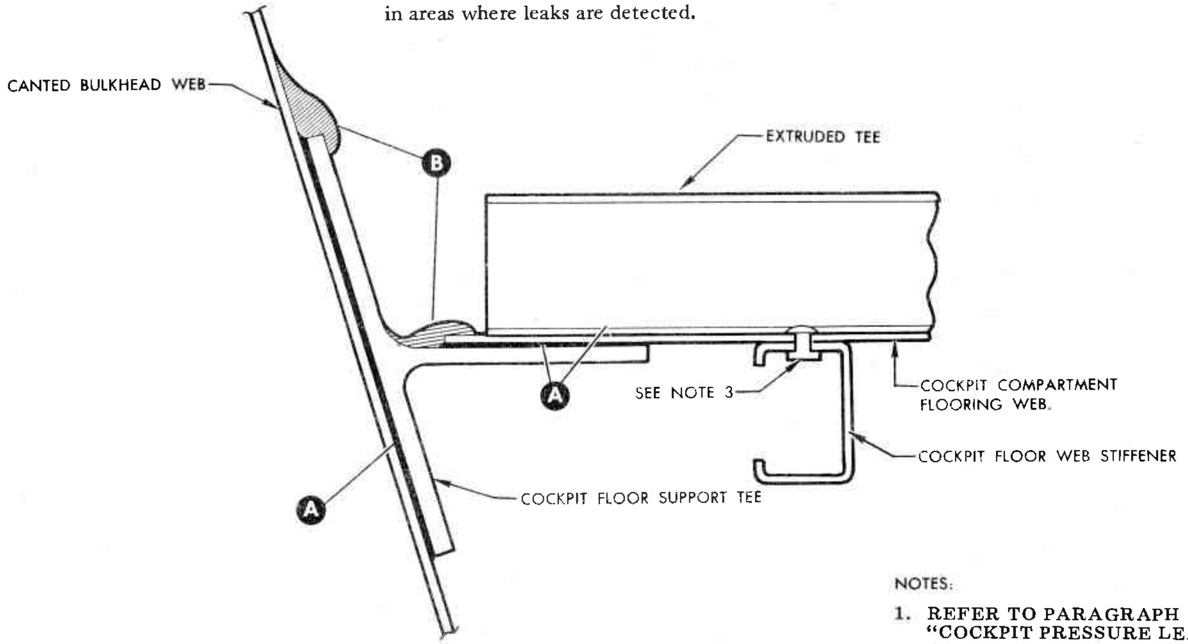
Figure 1-15. Cockpit and Forward Electronic Compartment Sealing (Sheet 2 of 3)



COCKPIT SIDE FLOOR ATTACHMENT

A Apply sealant, Military Specification MIL-S-81733, to all faying surfaces when making repairs. (See note 2.)

B Apply a fillet of sealant, Military Specification MIL-S-8802, along edges of faying surfaces and in areas where leaks are detected.



COCKPIT AFT FLOOR ATTACHMENT

A Apply sealant, Military Specification MIL-S-81733, to faying surfaces when making repairs. (See note 2.)

B Apply a fillet of sealant, Military Specification MIL-S-8802, along edges of faying surfaces and in areas where air pressure leaks are detected.

NOTES:

1. REFER TO PARAGRAPH "COCKPIT PRESSURE LEAKAGE TEST AND REPAIR" IN THIS SECTION.
2. METALBOND 4021 STRUCTURAL ADHESIVE TAPE IS USED ON FAYING SURFACES IN ORIGINAL FABRICATION.
3. ALL RIVETS ARE TO BE COATED WITH SEALER, MILITARY SPECIFICATION MIL-S-81733, PRIOR TO INSTALLATION.

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Figure 1-15. Cockpit and Forward Electronic Compartment Sealing (Sheet 3 of 3)

a. Cut a very small piece from a corner or edge of the part to be tested.

b. Place the test piece on a piece of plate glass.

c. Apply one or two drops of 48 percent concentrated hydrofluoric acid, Specification O-H-795, to the test piece.

WARNING

If hydrofluoric acid comes in contact with the skin, immediately rinse the affected area with cold, clear rinse water. If the burning continues, report to the dispensary immediately.

d. If the test part is titanium, a boiling action will take place immediately.

1-52. Corrosion Resistant Steel.

1-53. Types 301 and 302 corrosion resistant steel are used in the ¼ and ½ hard conditions. Their uses are restricted to structural applications requiring high corrosion resistant properties plus toughness and ductility. High tensile strength may be attained by moderate or severe cold working. These materials are nonmagnetic in the annealed condition but become magnetic when cold worked. Gas or arc welding is not advised in hardened materials due to their tendency to crack. These materials should not be used where temperatures exceed 426°C (800°F).

1-54. Types 321 and 347 Corrosion Resistant Steel.

1-55. Types 321 and 347 corrosion resistant steel are intended for applications requiring high heat resistance values as well as high corrosion resistance. They contain good weldability and are completely resistant to weld decay due to intergranular corrosion. Annealing is not required after welding provided welding is accomplished with rod similar to parent material.

1-56. Magnesium.

1-57. AZ31A magnesium sheet possesses a combination of good physical properties and formability. Forming operations should be confined to moderate contours since cracks are likely to occur. Material may be hot-formed at 148.9°C (300°F) at the expense of a slight drop in physical properties. Considerable annealing takes place at temperatures above 148.9°C (300°F). Fair weldability may be attained with helium arc. Type 5056 countersunk rivets are generally used for attachment of magnesium plating.

1-58. Aluminum Alloys.

1-59. The various aluminum alloys used as repair materials include 2014-T, 2024-T, 6061-T, 7075-T, and 7178-T. The two primary materials which constitute the major part of the airplane structure are 7075-T and 7178-T, both clad and bare. 7178-T is a high-strength aluminum alloy which contains physical properties superior to 7075-T and may be used as a substitute material for 7075-T. In some instances, heavier gages of 7075-T may serve as a substitute material for 7178-T. Refer to material substitutions listed in Table 1-1.

1-60. Plastics, Fiberglass Reinforced.

1-61. Fiberglass reinforced plastics are a new engineering material with specific properties that are unique and cannot be realized by the use of any other available material. Fiberglass reinforced plastics are employed in the F-106A and the F-106B to utilize the following properties: relatively low interference with radio and radar transmission; good electrical insulation; light weight; high strength-weight ratio; high chemical resistance; low cost of fabrication; and formability to complex shapes. Parts such as the radome, radio antenna housings, pneumatic system compressed air storage bottles, rigid plastic air ducts, cockpit trim panels, and a portion of the pilot's glare shield are constructed of fiberglass reinforced plastic. The fabrication of these parts is based upon glass fibers in loosely matted form, or woven fiberglass cloth, combined with a resin, usually belonging to an organic chemical group known as polyesters or alkyds. Certain applications may require use of phenolic, epoxide, or silicone resins, but the polyester resins are most general in use. Prior to use, these resins are relatively thick, syrupy liquids capable of flowing between the glass fibers and forming to the shape of the mold. When properly treated with agents known as catalysts the resins change, through a process called polymerization, from liquids to hard infusible solids. Parts thus formed are then trimmed to the necessary shape and fastened to the airplane with screws, bolts, or rivets passed through holes drilled in the finished part and the attaching structure. Repairs to damaged fiberglass reinforced plastics must be planned with the original design purposes in mind. For example, the pilot's glare shield is designed to be rigid enough to retain its shape when subjected to G loads during airplane turning movements, but it must be flexible enough to bend away from the pilot's knees and feet during an ejection. Consequently, repairs that would tend to stiffen or reduce the flexibility of the glare shield are not advisable. Fiberglass reinforced plastic parts that carry a structural load or have an exposed surface which is a portion of the airplane exterior are classified as structural plastics. Field repairs are not recommended for the compressed air storage bottles. Minor and major repairs may be made to the structural plastic components by following the repair procedures outlined in the applicable sections of this manual. Refer to paragraph 1-197 for repairs to the rain erosion protective coating on plastic exterior surfaces, and to paragraph 1-199 for general information concerning fiberglass laminate skins.

1-62. Material Substitutions.

1-63. When repairs or replacement of parts are required, a duplication of the original materials should be used whenever possible. When duplicate materials are not available, refer to Table 1-I for substitution materials.

1-64. CATEGORIES OF REPAIR CAPABILITIES.

1-65. Repair capabilities are divided into two levels, advanced base level and depot level. In most instances, the repairs shown in this manual are for use by the advanced base level organization. However, these repairs have not been identified as either advanced base or depot level because the repair level requirements can best be determined by surveying all the factors affecting the decision, such as the total damage, the complexity of the required repairs, and the local facilities available for making the repair. If a survey of a damaged airplane indicates the need for special support and alignment tools, a large quantity of machined repair parts, an excessive number of manhours, or the services of structural engineering personnel not available at the advanced base, the repair should be considered in the category of depot level capability. Although the depot level capability is much greater than the advanced base level due to better repair facilities, larger stock of repair materials, and a large pool of skilled personnel, the repair may better be accomplished in some cases by transporting the necessary facilities and personnel to the airplane. The base commander may arrange for depot level assistance, as outlined in Area Support Maintenance Assistance procedures, if the advance base level repair capabilities are not adequate for timely repair of the damaged airplane.

1-66. CLASSIFICATION OF DAMAGE AND TYPES OF REPAIR.

1-67. All damage is divided into five standard classes:

a. Negligible damage.

b. Damage reparable by patching.

c. Damage reparable by insertion.

d. Damage necessitating the replacement of parts.

e. Damage requiring repair exceeding limits specified in this manual shall be designed by an authorized aeronautical structures engineer.

1-68. Negligible Damage.

1-69. The negligible damage classification consists of any minor damage that does not affect the structural requirements of the component involved, or damage that can be corrected by a simple procedure without placing restrictions on flight operations. Listed below are minor damages which may be classified as negligible, depending on location and dimensions. To determine the proper category for each of these damages and the structural members of the airplane, see figures 1-17 thru 1-21 and refer to the negligible damage tables in Sections II, III, IV, V and VI.

a. Dents. Minor dents with no damage to structure and which have no adverse effect on operations may be permitted to remain. Heavier dents that show evidence of stretching or wrinkling of the metal should be treated as a repair.

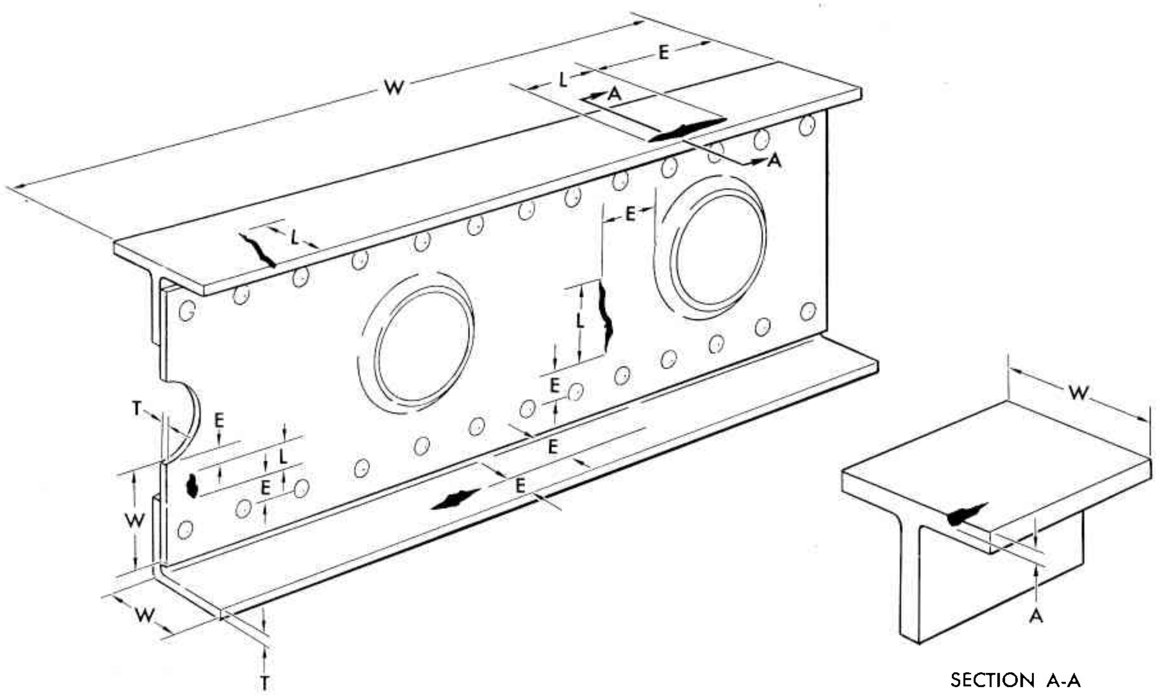
b. Bends. Structural members that have been slightly bent in connection with other more serious damage and which can be fully restored to their original configuration without cracks or wrinkles need not be replaced. 2024-T3 and 2024-T4 materials usually can be bumped out or straightened with good results. In other types of materials, extreme care should be exercised to insure that no cracks remain undetected. Parts which cannot be fully restored must be repaired or replaced.

c. Cracks. This type of damage usually originates at edges, holes, radii, or points where concentrated loads are applied or abrupt changes occur in the cross-sectional area. This type of damage shall not be considered negligible without taking retarding measures. All cracks must be stop-drilled at the ends, and inspection of the area should be made at frequent intervals thereafter to determine the condition of the component involved. See figure 1-20 for information concerning stop-drilling.

d. Holes. Holes which reduce the cross-sectional area of a structural member creating areas of elevated stress, and which interfere with the function of a component, including pressurized or fuel-tight areas, must be repaired. Sharp nicks or cracks projecting into the material from holes must be stop-drilled, rounded or faired into the hole, as shown in figure 1-20. Holes in outer plating of the airplane will be limited to dimensions given in the applicable sections of this manual.

e. Scratches and Nicks. Scratches or nicks which do not exceed the depth of the alclad surface of a part are considered permissible. To determine if alclad has been penetrated, thoroughly clean the surface with methyl-ethyl-ketone, Specification TT-M-261. Apply a 10 percent solution of sodium hydroxide, Specification O-S-60S, to the scratch. If the scratch penetrated the alclad it will be indicated by a black or dark brown discoloration. The solution should not remain longer than two minutes, and due to its corrosive action should be thoroughly washed from the area with water. Scratches and nicks should be burnished and treated with a protective chemical film before priming and painting. Refer to paragraphs 1-188 and 1-190 and figures 1-20 and 1-21 for procedures. Deep scratches may reduce the cross-sectional area of a member and produce localized stress concentrations. This condition can lead to fatigue cracks and possible failure of the component involved.

f. Corrosion. Corrosion damage which does not exceed the prescribed limits for scratches and nicks may be considered as negligible; however, the existing products of corrosion should be removed in accordance with T.O. 1-1-2 and part should be refinished as outlined in paragraphs 1-188 and 1-190.



CODE IDENTIFICATION

A. Depth of nick or scratch.
E. Distance of nick or scratch from an edge, hole, rivet or radius.
C. Cross-sectional area or T x W.
L. Length of nick or scratch.
N. Cross-sectional loss in area due to damage.
T. Gage of part at point of damage.
W. Width of part at point of damage.

NICK DAMAGE CLASSIFICATIONS

KEY	CLASS I	CLASS II	CLASS III
A	0.10 X T OR 0.010 INCH (USE LOWER VALUE)	0.25 X T OR 0.025 INCH (USE LOWER VALUE)	0.50 X T OR 0.050 INCH (USE LOWER VALUE)
E	2 X L OR 0.25 INCH (USE HIGHER VALUE)	2 X L OR 0.25 INCH (USE HIGHER VALUE)	2 X L OR 0.375 INCH (USE HIGHER VALUE)
N	0.02 X C	0.05 X C	0.07 X C

SCRATCH DAMAGE CLASSIFICATIONS

KEY	CLASS I	CLASS II	CLASS III
A	0.05 X T OR 0.005 INCH (USE LOWER VALUE)	0.10 X T OR 0.010 INCH (USE LOWER VALUE)	0.20 X T OR 0.025 INCH (USE LOWER VALUE)
E	0.25 INCH	0.25 INCH	0.375 INCH
L	0.5 X W OR 3.0 INCH (USE LOWER VALUE)	0.5 X W 3.0 INCH (USE LOWER VALUE)	0.25 X W OR 3.0 INCH (USE LOWER VALUE)
N	0.02 X C	0.05 X C	0.07 X C

NOTES:
1. "N" SHALL INCLUDE METAL REMOVED IN RADIUSING OUT NICK.
2. WHEN A NICK OR SCRATCH OCCURS AT AN EDGE, HOLE, OR RADIUS, REDUCE "N" VALUES BY 50 PERCENT.
3. DAMAGES IN EXCESS OF NEGLIGIBLE LIMITS SHOWN MUST BE TREATED AS REPAIRS.
4. WHEN "L" IS GREATER THAN 4 X "A," DAMAGE SHALL BE TREATED AS A SCRATCH.

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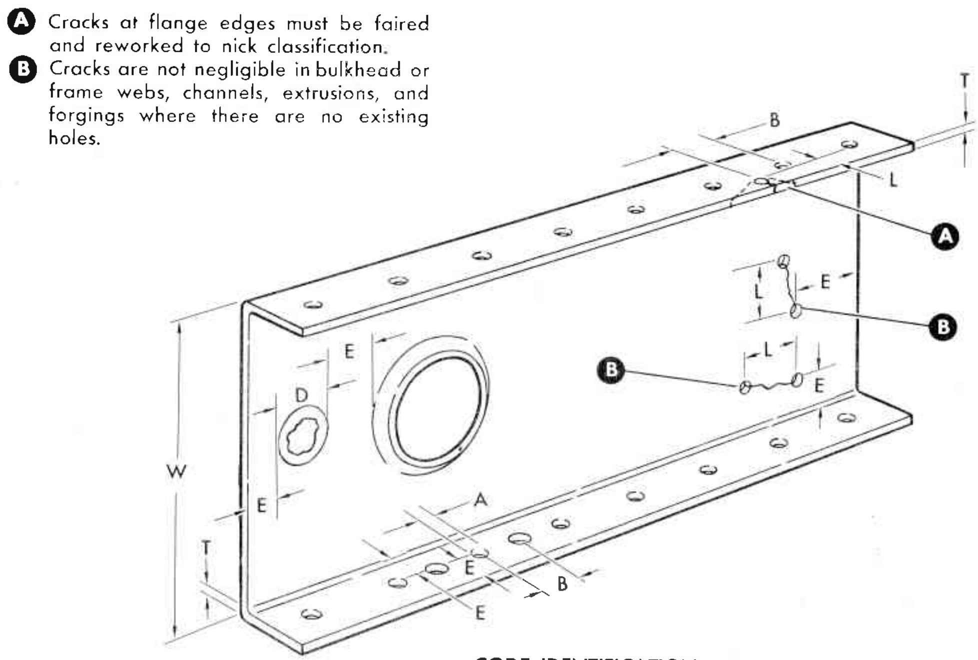
Figure 1-17. Negligible Damage Classification—Nick and Scratch



CODE IDENTIFICATION

A. Diameter of largest existing rivet or bolt hole.
B. Distance of hole or crack from existing hole.
C. Cross-sectional area or T x W.
D. Diameter of hole.
E. Distance of hole or crack from edge, rivet or radius.
L. Length of crack.
N. Cross-sectional loss in area due to damage.
T. Gage of part at point of damage.
W. Width of part at point of damage.

HOLE DAMAGE CLASSIFICATION

KEY	CLASS I	CLASS II	CLASS III
D	1.0 X A OR 0.25 INCH (USE LOWER VALUE)	2.0 X A OR 0.50 INCH (USE LOWER VALUE)	4.0 X A OR 1.00 INCH (USE LOWER VALUE)
B	4.0 X D	4.0 X D	4.0 X D
E	2.0 X D	4.0 X D	4.0 X D
N	0.02 X C	0.04 X C	0.07 X C

CRACK DAMAGE CLASSIFICATION

KEY	CLASS I	CLASS II	CLASS III
L	1.0 X A OR 0.25 INCH (USE LOWER VALUE)	2.0 X A OR 0.50 INCH (USE LOWER VALUE)	4.0 X A OR 1.00 INCH (USE LOWER VALUE)
B	4.0 X L	4.0 X L	4.0 X L
E	2.0 X L	4.0 X L	4.0 X L
N	0.02 X C	0.04 X C	0.07 X C

NOTES:
1. "N" SHALL INCLUDE METAL REMOVED BY STOP-DRILLING CRACKS.
2. WHEN CRACKS OR HOLES OCCUR AT AN EDGE, HOLE OR RADIUS, REDUCE "N" VALUE BY 50 PERCENT.
3. DAMAGES IN EXCESS OF NEGLIGIBLE LIMITS SHOWN MUST BE TREATED AS REPAIRS.

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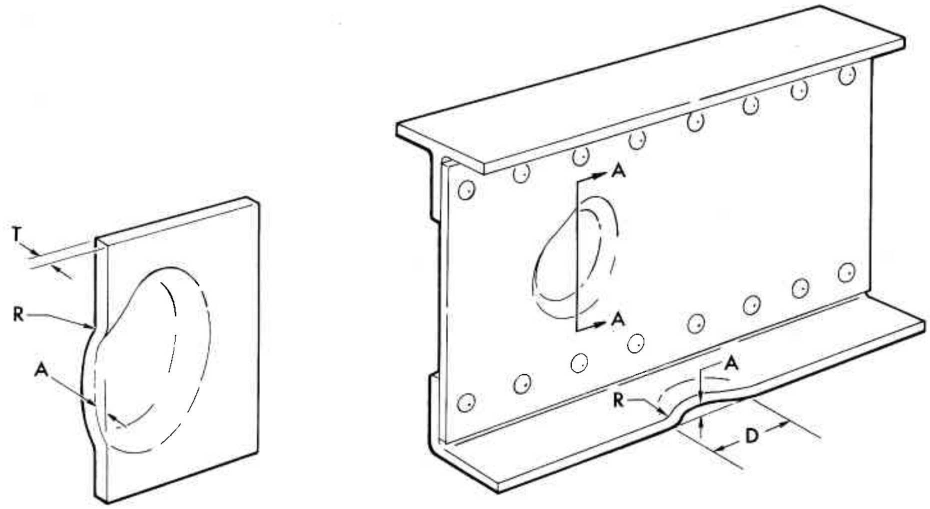
Figure 1-18. Negligible Damage Classification—Hole and Crack



CODE IDENTIFICATION

A. Deflection from contour (maximum).
D. Diameter of dent (smaller direction).
R. Radius of bend at worst point.
T. Gage of part at point of damage.

DENT DAMAGE CLASSIFICATION

KEY	*CLASS I	*CLASS II	**CLASS III
A	2 X T OR 0.050 INCH (USE LOWER VALUE)	4 X T OR 0.10 INCH (USE LOWER VALUE)	10 X T OR 0.25 INCH (USE LOWER VALUE)
D	20 X A MINIMUM	10 X A MINIMUM	5 X A MINIMUM
R	10 X T MINIMUM	5 X T MINIMUM	2 X T MINIMUM

NOTES:
1. * INDICATES DENTS WITH NO VISIBLE STRETCHING OF METAL, AND WHICH CAUSE NO INTERFERENCE WITH OPERATIONS.
   ** INDICATES DENTS WITH SOME EVIDENCE OF METAL STRETCHING, CREASING AND WRINKLING BUT WITHOUT CRACKS OR TEARS AND WHICH CAUSE NO INTERFERENCE WITH OPERATIONS.
2. DENTS IN 2024-T3, T-4, AND T-6 AND TITANIUM SKINS AND WEBS WHICH CAN BE BUMPED OUT TO MEET GIVEN DIMENSIONS MAY BE CLASSIFIED AFTER REWORK.
3. DENTS IN 7075-T6 OR MAGNESIUM ALLOY MATERIAL (FORGINGS AND CASTINGS INCLUDED) SHALL NOT BE BUMPED OUT AND MUST BE TREATED AS REPAIRS WHEN IN EXCESS OF DIMENSIONS GIVEN.

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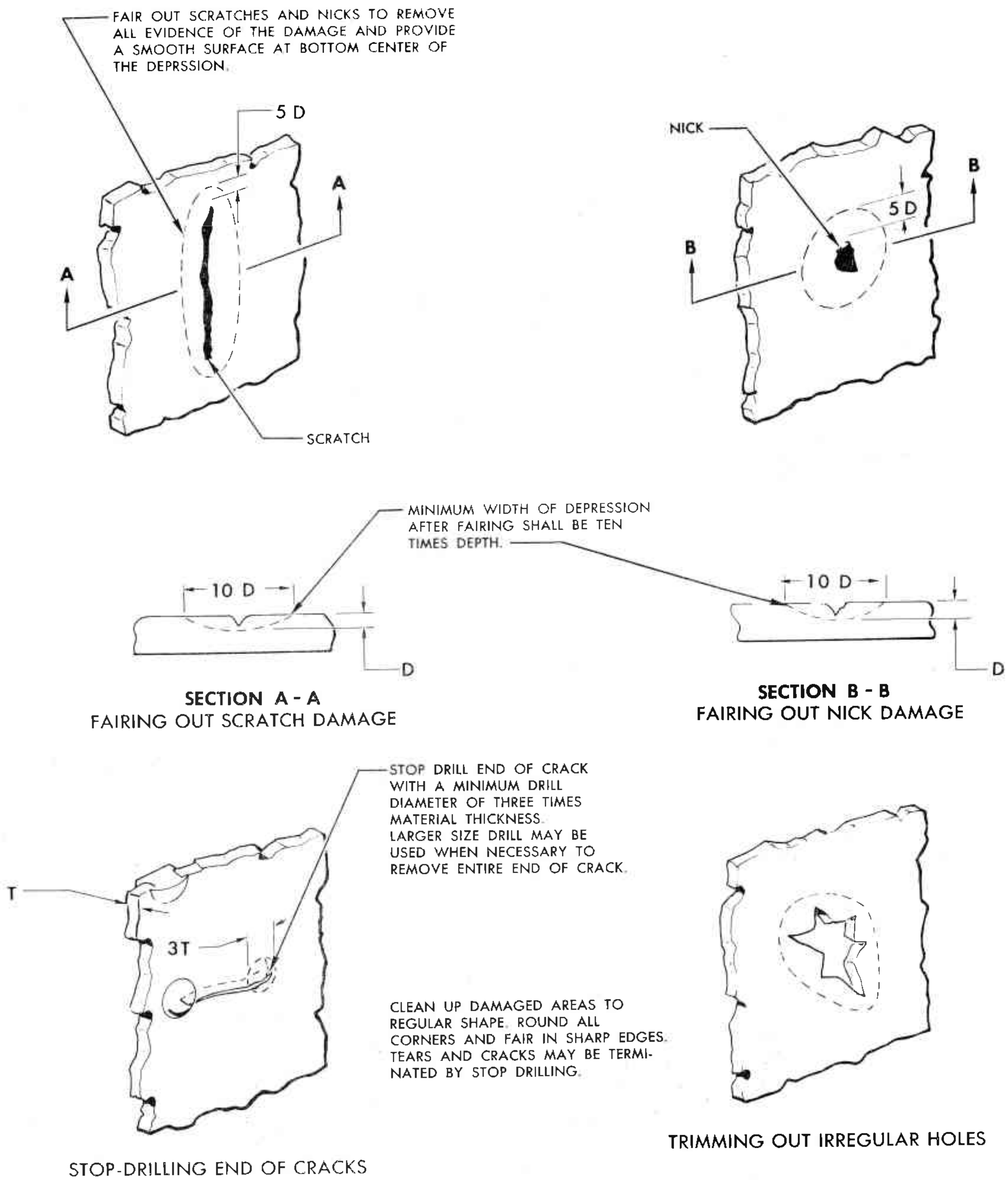
Figure 1-19. Negligible Damage Classification—Dent



NOTE:
MEASUREMENTS OF DAMAGE, AFTER REWORK AS SHOWN, MUST NOT EXCEED NEGLIGIBLE DAMAGE LIMITS GIVEN AT THE END OF EACH HANDBOOK SECTION FOR AIRPLANE COMPONENTS. IF THE NEGLIGIBLE DAMAGE LIMITS ARE EXCEEDED THE PART MUST BE REPAIRED OR REPLACED.

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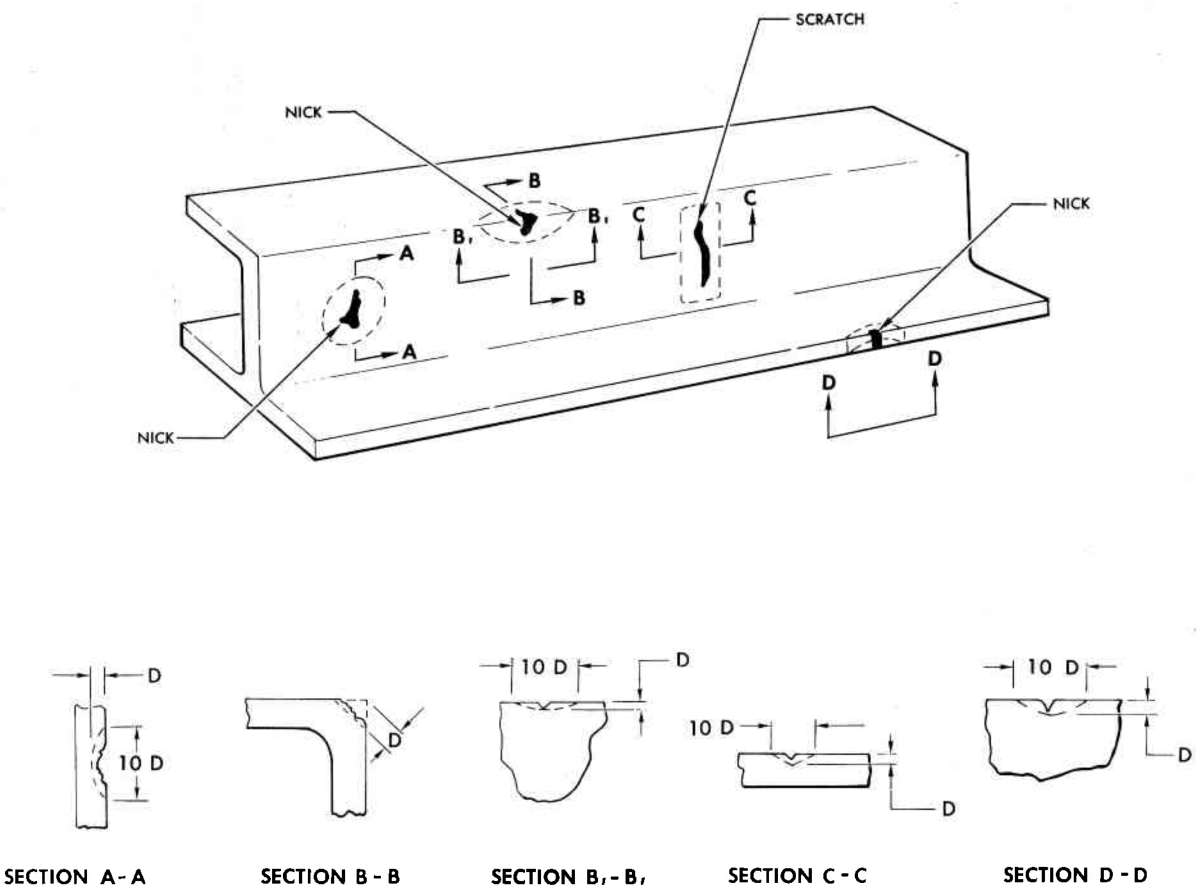
Figure 1-20. Fairing of Minor Damage in Plating



NOTES:
1. FAIR ALL NICKS AND SCRATCHES IN FITTINGS, INCLUDING EXTRUDED AND ROLL-FORMED STRUCTURAL MEMBERS BY REMOVING METAL AS INDICATED BY DOTTED LINES. REMOVE ALL EVIDENCE OF DAMAGE BY FAIRING OUT AN EQUAL AMOUNT AT EACH SIDE OF DEPRESSION (SEE SECTION A-A).
2. DEEP NICKS WHICH PENETRATE MORE THAN 50 PER CENT OF THE THICKNESS OF A STRUCTURAL MEMBER MAY BE FAIRED BY DRILLING A HOLE THROUGH THE MEMBER TO REMOVE SHARP CORNERS. THIS METHOD MAY BE EMPLOYED ONLY WHEN EDGE DISTANCE PERMITS AND HOLE DIAMETER IS CLASSIFIED AS NEGLIGIBLE.
3. MEASUREMENTS OF DAMAGE, AFTER REWORK AS SHOWN, MUST NOT EXCEED NEGLIGIBLE DAMAGE LIMITS GIVEN AT THE END OF EACH HANDBOOK SECTION FOR AIRPLANE COMPONENTS. IF THE NEGLIGIBLE DAMAGE LIMITS ARE EXCEEDED, THE PART MUST BE REPAIRED OR REPLACED.

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Figure 1-21. Fairing of Minor Damage in Fittings

1-70. Damage Repairable by Patching.

1-71. Damage repairable by patching is any damage that can be repaired by bridging the damaged area of a component with splice material of the same type as the original component. Holes and cracks in any of the various structural components that exceed the prescribed limits for negligible damage may be repaired by this method. Filler plates may be used for bearing purposes or for returning the part to its original contour when necessary. See figure 1-22 for formula and method for patch repair. The method of attaching the patch to the undamaged portion of the original structure is very important in developing the strength of the repair, which must be equal to or greater than the strength of the original structure to withstand stresses up to the maximum values for which it was designed.

1-72. Damage Repairable by Insertion.

1-73. Damage repairable by insertion is any damage that can be repaired by splicing in a section of material identical in shape and type to the damaged part. When a portion of a structural component has been severed or otherwise mutilated, not exceeding 50 percent of its total area, the repair requires cutting out the damaged portion and inserting the repair material into the space resulting from the removal of damaged portion. The inserted material is riveted in place by means of splice material of the same type, but of the next heavier gage or a suitable substitute, bridging both sides of the damaged area. The splice connections to the original structure at each end of the insertion provide for load transfer continuity between existing structure and the inserted part. This type of repair is generally used where the damaged part is relatively long or when interference of other structural components can be avoided. See figure 1-23 for formula and method for insertion repair. The method of attaching the inserted part through splice members attached to the undamaged portion of the original structure is highly important since the repair must restore the full load-carrying characteristics of the structure to the maximum values for which it was designed.

1-74. Damage Necessitating Replacement of Parts.

1-75. The type of repair necessitating a replacement of parts is generally made when a component cannot be economically repaired on the airplane or when the "down time" of the airplane can be appreciably reduced by replacing rather than repairing a part. Small nonstructural attaching parts such as clips, angles, gussets, etc., for which no stock level has been established, should be locally manufactured, using the damaged part as a pattern. When a damaged component is to be replaced it should be removed carefully to avoid damage to adjacent or attaching structure. Damage to forged or cast fittings beyond the prescribed limits for negligible damage will require the replacement of the fittings unless otherwise advised by structural engineering authorities. In all cases requiring replacement, it is preferable to use a new part from spare stock; however, when such parts are not available, a new part may be fabricated from the same gage and type of material as the original. Dimensions should be taken from the damaged part, if possible, or from the same part on another airplane of the same series. Extrusions, when not available, may be replaced by equivalent sections fabricated from flat sheet stock or may be machined from bar stock. When the same gage and type of material used in the original design is not available, refer to Table 1-I for a substitute. The original rivet pattern should always be used when possible; however, should the extent of the damage prohibit this procedure, Tables 1-II through 1-XVII and paragraph 1-120 should be consulted. In all damage cases requiring the replacement of parts, the materials and methods of attachment should restore the structure to its original strength.

1-76. Combined Repairs.

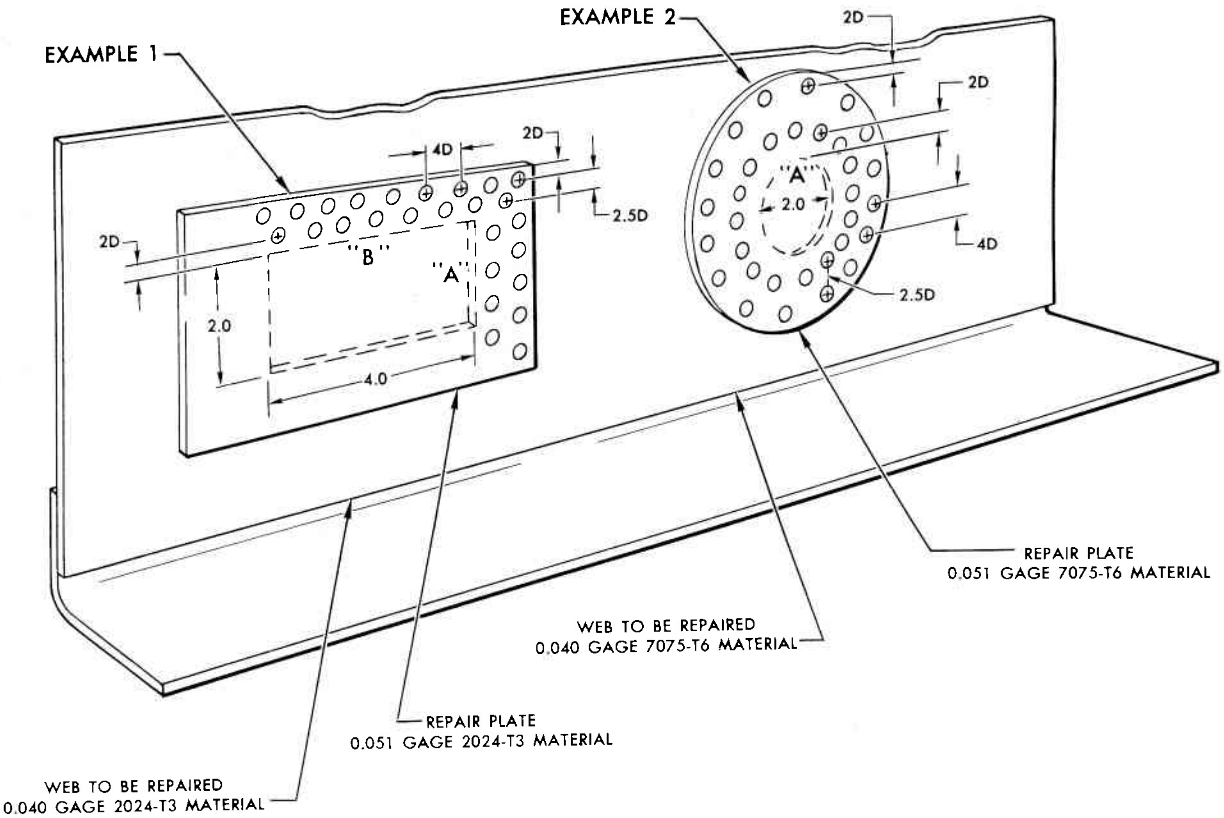
1-77. Since most damage is likely to involve two or more structural components, it follows that most repairs will be combination repairs involving one or more structural components and the skin. In this case the damage may require both the patch and insertion type of repair. See figure 1-24 for the formula and method for a combination repair. Special care must be exercised in making this type of repair since the skin loads and stresses must be transmitted through the internal structure while retaining its structural continuity. The combined repair must be designed to restore the strength of the repaired structure equal to or greater than the original structure.

1-78. AERODYNAMIC SMOOTHNESS.

1-79. Skin Gap and Rivet Protrusion Limitations.

1-80. When making repairs to the exterior surface of the airplane, it is essential that the aerodynamic contour shall be maintained within certain limitations. For data concerning tolerances permissible in skin gaps and the protrusion of rivet heads, see figure 1-25. Surface discontinuities will have an adverse effect on performance; therefore, it is necessary to maintain contours as close to the designed configuration as possible. To maintain aerodynamic smoothness between skin splices and along fairing angles, apply aerodynamic smoothing compound as shown on figure 1-27. In general, the outer surface is most critical aerodynamically in the forward section of the airplane and becomes progressively less critical toward the after section. If large areas of skin are replaced, waviness or bulges must not exceed the following limits:

a. Fuselage area, forward of duct inlet: Contour deviations at points of skin attachment shall not exceed ±0.030 inch. Height of wave between skin attachment points shall not exceed 0.030 inch or 1 percent of wave length, whichever is smaller.



EXAMPLE 1

RECTANGULAR PATCH REPAIR

A. Identify material to be repaired, which in this case is 0.040 gage 2024-T3.
B. Use same material of next heavier gage for repair plate. For suitable substitute see Table 1-I.
C. To select rivets required to make the repair, refer to Table 1-II and note the various sizes of rivets required per inch of seam opposite 0.040 in the gage column applicable to 2024-T3 material.
D. Assuming that AD5 rivets are best suited to the conditions of the repair, multiply the dimensions of one side and one end of the repair by 3.5 (the number of rivets required per inch of seam) to determine the number of rivets required for each end and sides of the damaged area "A" and "B".

"A" $2 \times 3.5 = 7.0$ Use 7 rivets
"B" $4 \times 3.5 = 14.0$ Use 14 rivets

21 rivets required for one side and one end of the repair.

E. For complete repair, multiply above product by 2 and continue same rivet pattern in corners of repair.

EXAMPLE 2

CIRCULAR PATCH REPAIR

A. Identify material to be repaired, which in this case is 0.040 gage 7075-T6.
B. Use same material of next heavier gage for repair plate. For suitable substitute see Table 1-I.
C. To select rivets required to make the repair, refer to Table 1-II and note the various sizes of rivets required per inch of seam opposite 0.040 in gage column applicable to 7075-T6 material.
D. Assuming that AD5 rivets are best suited to the conditions of the repair, multiply the diameter of the repair by 4 and multiply the result of this figure by 4.1 (the number of rivets required per inch of seam) to determine the number of rivets required for the complete repair.

"A" $2 \times 4 = 8 \times 4.1 = 32.8$ or 33 rivets required

NOTES:
1. WHEN NUMBER OF RIVETS REQUIRED EXCEED THE NUMBER ALLOWED IN 2 ROWS, IT WILL BE NECESSARY TO MAKE 3 ROWS.
2. RIVET PATTERNS NOT SHOWN IN THIS ILLUSTRATION THAT EXCEED 2 ROWS SHALL MEET STANDARD MINIMUM RIVET SPACING REQUIREMENTS.
3. SEE RIVET NOMOGRAPH IN THIS SECTION FOR QUICK REFERENCE IN PLANNING REPAIRS.

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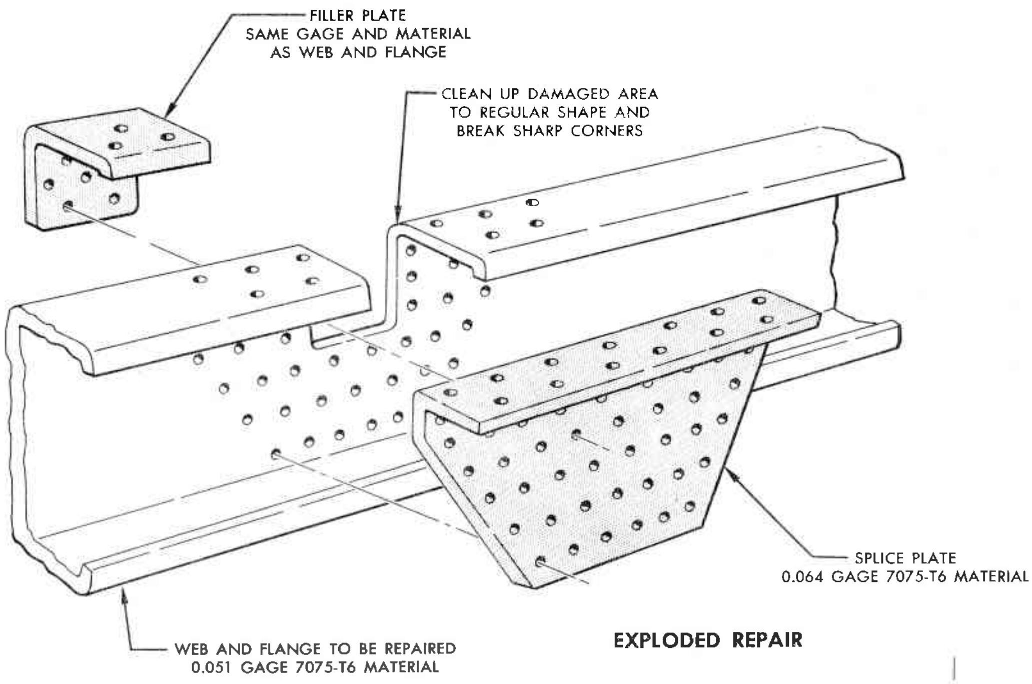
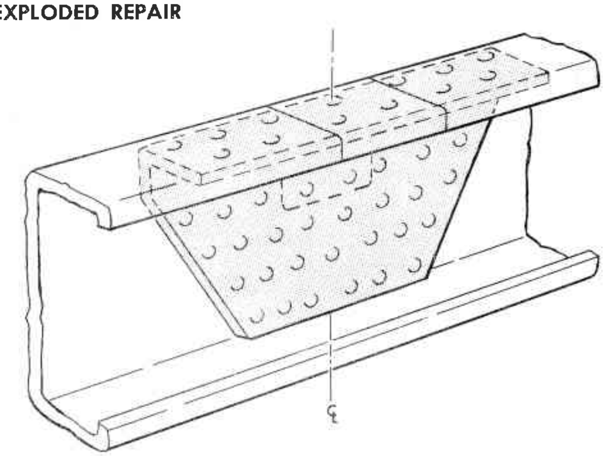
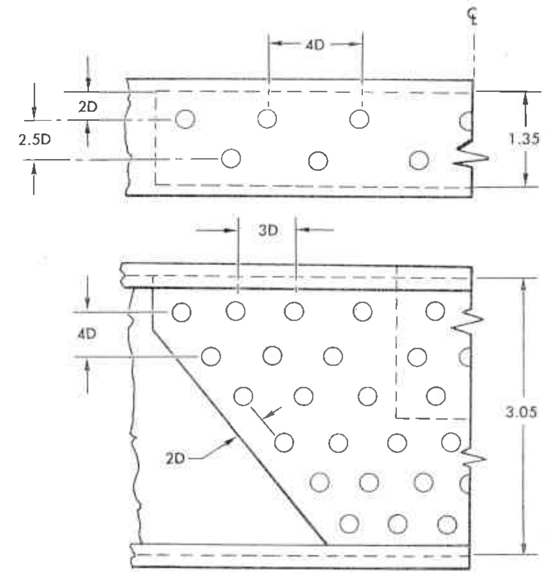
Figure 1-22. Formula and Method for Patch Repair



EXPLODED REPAIR





VIEW A
RIVET PATTERN TO CENTERLINE OF REPAIR – OPPOSITE SIDE IDENTICAL

EXAMPLE

USE FOLLOWING STEPS TO DETERMINE METHOD OF REPAIR.

A. Identify material to be repaired which in this case is 0.051 gage 7075-T6.

B. Use same material and gage for filler plate but next heavier gage for splice plate. For suitable substitute see Table I-I.

C. To select rivets required, refer to Table I-II and note various sizes of rivets required per inch of seam opposite 0.051 in the gage column applicable to 7075-T6 material.

D. Assuming that the AD6 rivets are best suited for the flange repair, multiply the width of the flange by 3.7 (the number of rivets required per inch of seam) to determine the number of rivets required for each side of the damaged area.
$1.35 \times 3.7 = 4.99$ Use 5 rivets each side.

E. For web area use same procedure as for flange repair except assume AD5 rivets best suited for the repair.
$3.05 \times 5.4 = 16.4$ Use 16 rivets each side.

F. Continue same rivet pattern through filler plate. Rivet pattern shall meet standard minimum rivet spacing requirements.

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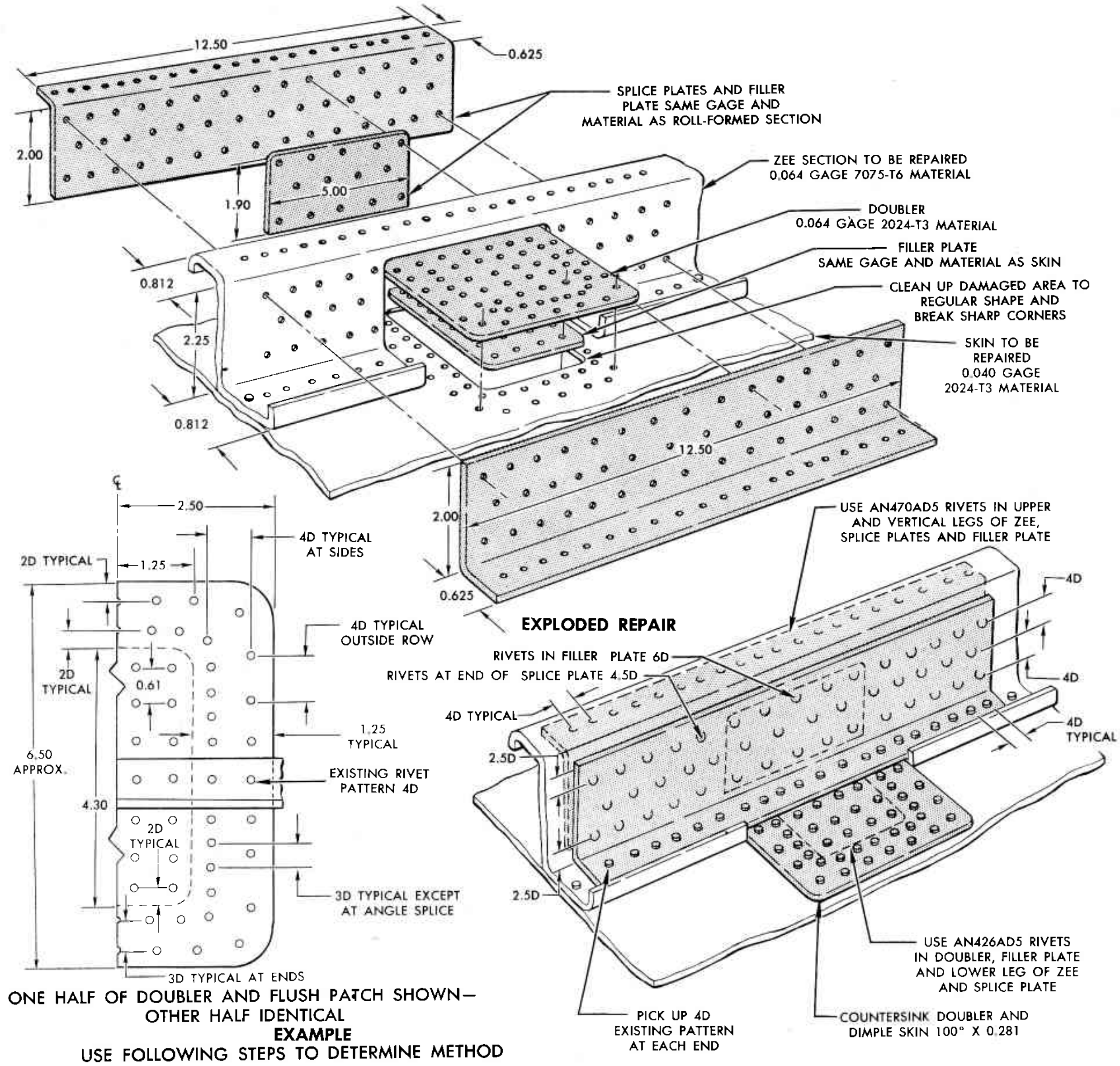
Figure 1-23. Formula and Method for Insertion Repair



ONE HALF OF DOUBLER AND FLUSH PATCH SHOWN—OTHER HALF IDENTICAL

EXAMPLE

USE FOLLOWING STEPS TO DETERMINE METHOD OF REPAIR

A. Identify material to be repaired and select repair materials as shown. For suitable substitute see Table I-I.

B. To select rivets required for skin repair refer to Table I-II and note various sizes of rivets required per inch of seam opposite 0.040 in the gage column applicable to 2024-T3 material using 100° countersunk rivets in dimpled skin.

C. Assuming that AN426AD5 rivets are used in this area, multiply the width and the length of the skin repair by 3.5, to determine the number of rivets required.
2.50 x 3.5 = 8.750 Use 9 rivets on each end.
4.30 x 3.5 = 15.05 Use 15 rivets on each side.
Note that standard minimum rivet spacing, 4D rivet pitch, will not permit this number of rivets and 3D is used on inner row. Minimum row of spacing of 2.50 was not used due to existing rivet pattern of 4D rivet as shown. Flush patch is not a load carrying member and a loose rivet pattern may be used if held within prescribed limits.

D. For zee section use same procedure as for skin except use rivets required for 0.064 gage 7075-T6 material.

E. Assuming that AN470AD5 rivets are best suited for the repair, multiply widths of zee section legs 0.812 x 6.7 = 5.44. Pick up 6 existing AN426AD5 rivets and use same pattern with AN470AD5 rivets in upper leg of zee section. 2.25 x 6.7 = 15.07. Use 15 rivets on each side of repair in vertical leg and use 4.5D rivet pitch to fill out rivet pattern to end of splice as shown. D6 may be used in filler plate as its primary purpose is to serve as filler only.

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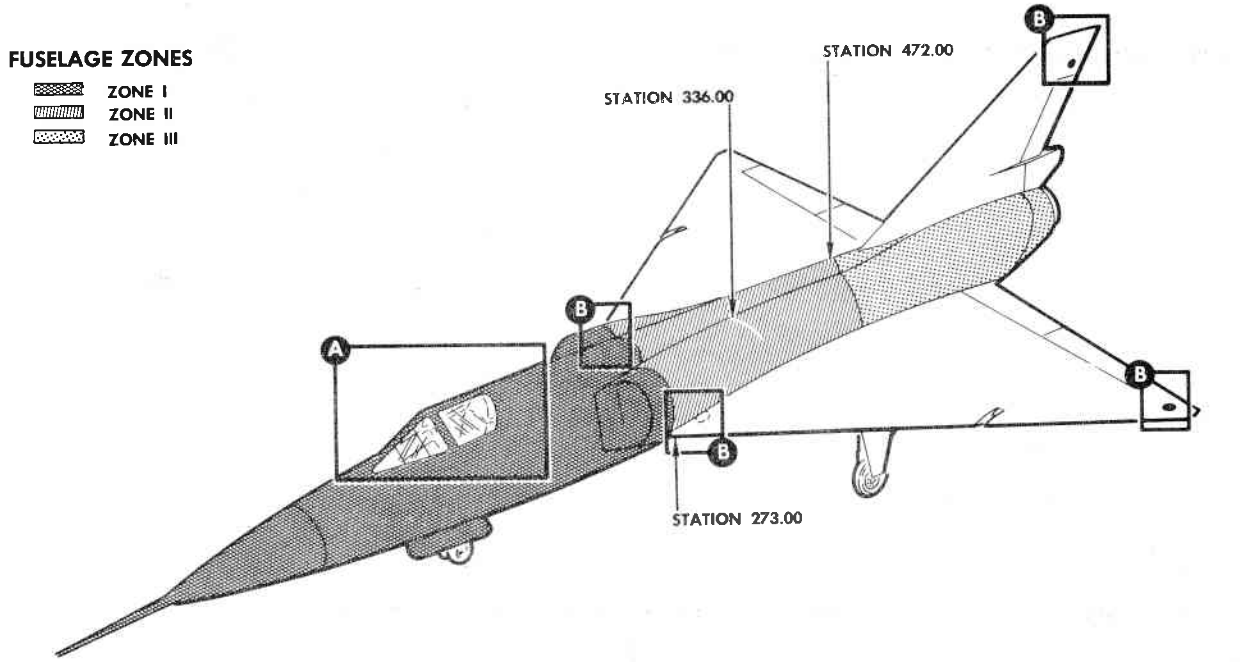
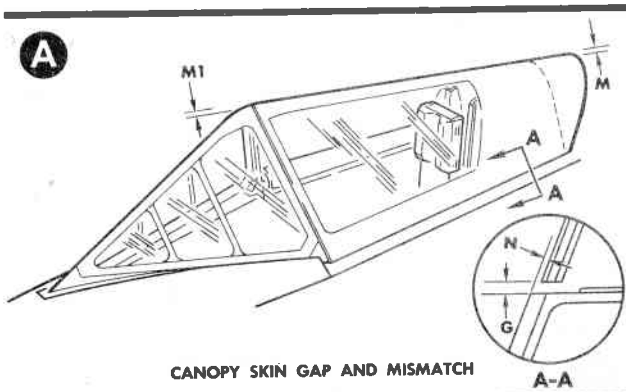
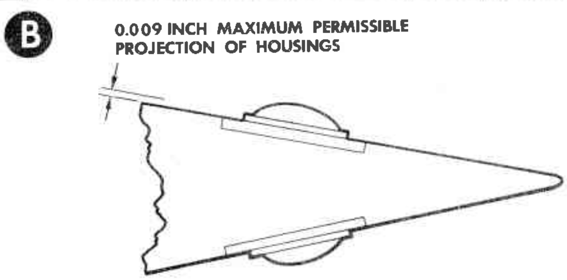
Figure 1-24. Formula and Method for Combination Repair



NOTE
REFER TO SHEET 3 OF THIS ILLUSTRATION FOR SYMBOL DEFINITION AND GAP AND MISMATCH TOLERANCES.



CANOPY SKIN GAP AND MISMATCH



0.009 INCH MAXIMUM PERMISSIBLE PROJECTION OF HOUSINGS

TYPICAL CLEARANCE FOR ALL RECOGNITION LIGHTS

RIVET HEAD PROTRUSION TOLERANCES	
AREA	MAXIMUM HEAD HEIGHT
INSIDE ENGINE AIR INLET DUCT, FROM INLET LIP AFT TO STA 336, FLAT SURFACE, TOP AND BOTTOM.	FLUSH TO 0.004 INCH BELOW SURFACE
FUSELAGE ZONE I.	0.002 INCH
WING LEADING EDGE.	
FIN LEADING EDGE.	
INSIDE ENGINE AIR INLET DUCT, FROM WEDGE LEADING EDGE AFT TO STA 336, FLAT SURFACE, SIDE.	
FUSELAGE ZONE II AND III.	0.004 INCH
FIN AREA, AFT OF LEADING EDGE.	
WING AREA, AFT OF LEADING EDGE.	
INSIDE ENGINE AIR INLET DUCT, AFT OF STA 336, FLAT SURFACE, SIDE.	
INSIDE ENGINE AIR INLET DUCT, FROM INLET LIP AFT TO STA 336, CURVED SURFACE, SIDE, NO MILLING PERMITTED.	
INSIDE ENGINE AIR INLET DUCT, FROM STA 336 AFT TO STA 472, CURVED SURFACE, SIDE, NO MILLING PERMITTED.	0.008 INCH

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Figure 1-25. Aerodynamic Smoothness Requirements (Sheet 1 of 3)

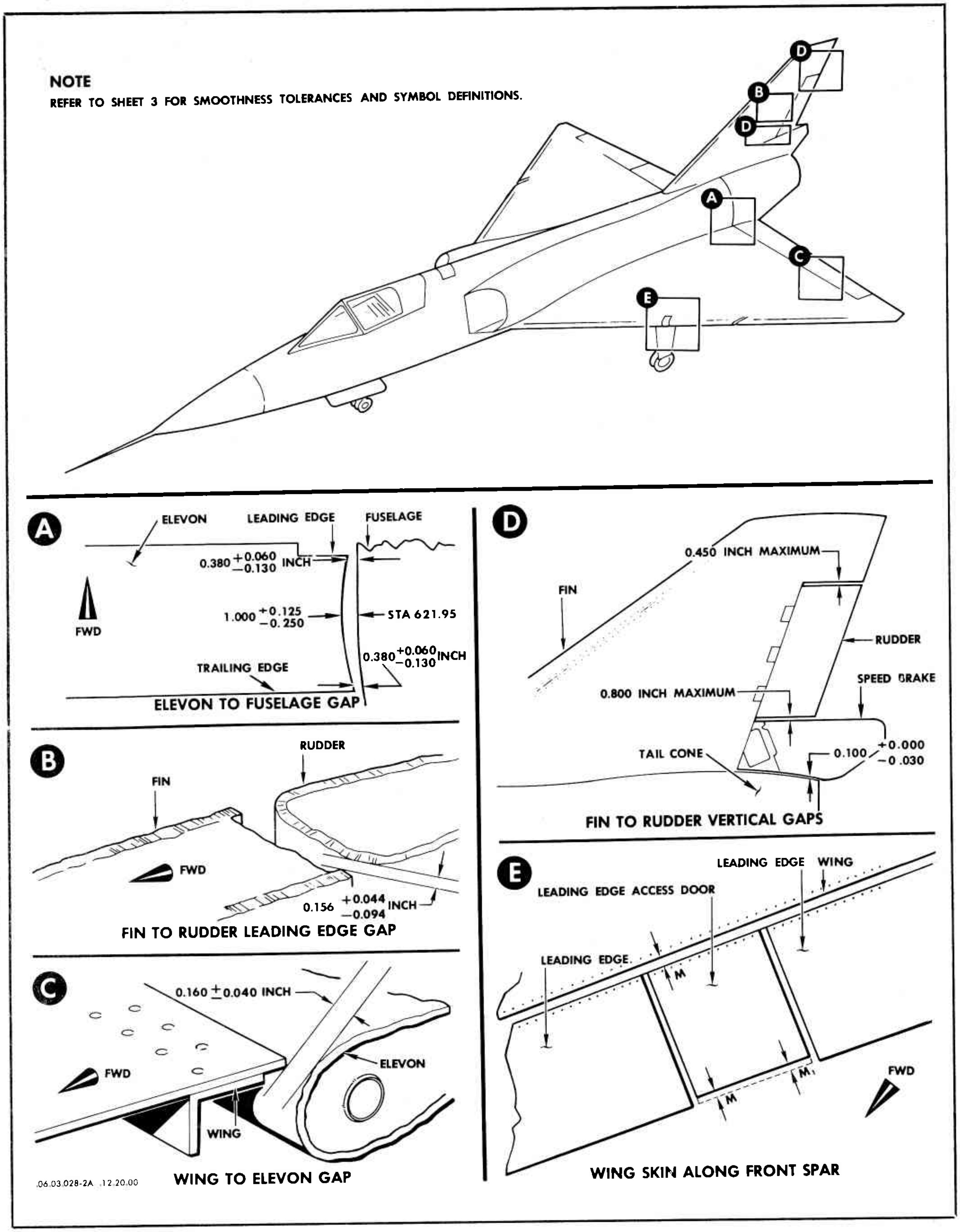
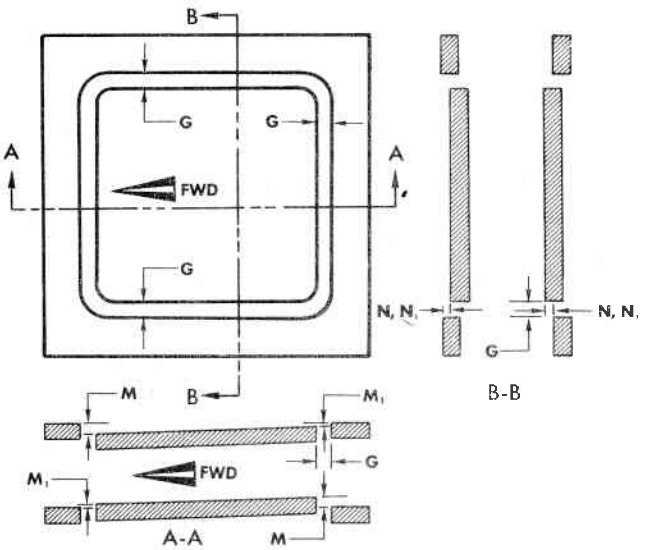
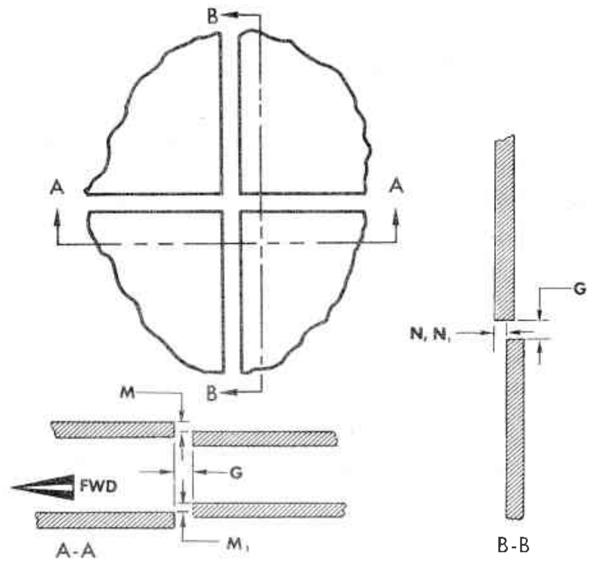


Figure 1-25. Aerodynamic Smoothness Requirements (Sheet 2 of 3)





AREA	SYMBOL	BUTT JOINTS DOOR	BUTT JOINTS SKIN
FUSELAGE ZONE I	G M M_1 N	0.040" MAX 0.008" MAX 0.004" MAX 0.015" MAX	SAME
FUSELAGE ZONE II	G M M_1 N	0.040" MAX 0.012" MAX 0.006" MAX 0.015" MAX	SAME
FUSELAGE ZONE III	G M M N	0.040" MAX 0.015" MAX 0.007" MAX 0.015" MAX	SAME
RADOME	G M M_1	0.040" MAX 0.030" MAX 0.015" MAX	
CANOPY	G M M_1 N	0.030" MIN—0.090" MAX 0.030" MAX 0.015" MAX FLUSH TO 0.060" BELOW FUSELAGE SURFACE	
FORWARD ELECTRONICS COMPARTMENT DOORS AND NOSE GEAR DOORS	G M M_1 N	0.030" MIN—0.090" MAX 0.030" MAX 0.015" MAX 0.030" MAX	
MISSILE BAY DOORS	G G M M_1 N N_1	0.030" MIN—0.090" MAX (LONGITUDINAL GAP) 0.31" MAX FROM BL 0 TO DOOR SPLIT LINE, TAPERING TO 0.06" MAX AT UPPER HINGE LINE (TRANSVERSE GAPS, BOTH ENDS) 0.030" MAX 0.015" MAX 0.030" MAX 0.045" MAX	

AREA	SYMBOL	BUTT JOINTS	
MAIN LANDING GEAR DOOR	G M M_1 N	0.030" MIN—0.090" MAX 0.030" MAX 0.015" MAX 0.030" MAX	
TAIL CONE	G M M_1	0.040" MAX 0.030" MAX 0.030" MAX	
SPEED BRAKES	G M M_1 N	0.030" MIN—0.090" MAX 0.030" MAX 0.015" MAX 0.030" MAX	
		DOOR	SKIN
WING LEADING EDGE (SEE NOTE 2)	G M M M_1	0.020" MAX 0.010" MAX (ALONG FRONT SPAR) 0.004" MAX 0.004" MAX	SAME
WING AFT OF LEADING EDGE	G M M_1 N	0.040" MAX 0.010" MAX 0.010" MAX 0.010" MAX	0.030" MAX 0.010" MAX FLUSH 0.010" MAX
WING LANDING GEAR FAIRING	G M M_1	0.080" MAX 0.010" MAX 0.010" MAX	
FIN	G G M & M_1 N N N	0.020" MAX (LEADING EDGE AND VERTICAL SPLICES) 0.030" MAX (DOORS AND HORIZONTAL SPLICES AFT OF LEADING EDGE) 0.010" MAX (TYPICAL) 0.010" MAX (FWD OF SPAR 5) 0.040" MAX (AFT OF SPAR 5) 0.060" MAX (FINTIP AND TOP OF STREAMLINED RUDDER)	

NOTES:

1. G = GAPS BETWEEN SKINS OR SKINS AND DOORS.

   M = MISMATCH AT TRANSVERSE JOINTS, PROTRUDING SKIN FACING AFT.

   M_1 = MISMATCH AT TRANSVERSE JOINTS, PROTRUDING SKIN FACING FORWARD.

   N = MISMATCH AT LONGITUDINAL JOINTS.

   N_1 = MISMATCH BETWEEN MISSILE BAY DOORS ALONG BL 0.0 EXCEPT AT FORWARD AND AFT END OF DOORS.

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2. A CHAMFER (0.5" WIDE) IS PERMISSIBLE FOR WING LEADING EDGE DOORS WHICH ARE UP TO 0.016" MAXIMUM IN EXCESS OF THE 0.004" MAXIMUM MISMATCH TOLERANCE.
3. LEADING EDGE OF RAM AIR TURBINE DOOR MAY PROTRUDE A MAXIMUM OF 0.020".
4. SCREW HEAD MAXIMUM PROTRUSION IF 0.004" IN ALL AREAS.
5. EXCEPT AS NOTED IN RIVET PROTRUSION TABLE, ALL DRIVEN RIVETS MUST PROTRUDE A MEASURABLE AMOUNT ABOVE THE SKIN SURFACE UP TO 0.008" MAXIMUM BEFORE MILLING.
6. ALL FUSELAGE DOORS WHICH HAVE METAL TO METAL CONTACT REQUIRE "FORMED GASKET" TYPE SEAL.
7. ALL GAPS IN NON-REMOVABLE BUTT JOINTS OF THE AIRPLANE EXTERIOR SURFACE ARE FILLED WITH AERODYNAMIC SMOOTHING COMPOUND. REFER TO SECTION XI. THE INTAKE DUCTS ARE CONSIDERED EXTERIOR SURFACES.

Figure 1-25. Aerodynamic Smoothness Requirements (Sheet 3 of 3)

b. Fuselage area aft of duct inlet: Contour deviation at points of skin attachment shall not exceed ±0.030 inch. Height of wave between skin attachment points shall not exceed 0.050 inch or 2 percent of wave length, whichever is smaller.

c. Wing leading edge area: Height of wave between skin attachment points shall not exceed 0.020 inch or 1 percent of any wave length less than 2.00 inches.

d. Wing area aft of leading edge: Height of wave between skin attachment points shall not exceed 0.050 inch or 1 percent of any wave length less than 5.00 inches.

1-81. Aerodynamic Limitations for One-Time Flight Repairs.

1-82. An airplane damaged beyond "in service" limits may be temporarily repaired for a "one-time" flight to a repair depot, provided the following limitations are observed:

a. All outside patches shall be regarded as temporary repairs which will be replaced with conventional flush repairs. Refer to figure 1-26 for temporary patches.

b. Damage to critical structural components shall be carefully evaluated and if no damage limits are listed in this manual for such components, a qualified aeronautical engineer shall determine airworthiness of the airplane.

c. Flight of the airplane shall be restricted to a maximum of 3 g's.

WARNING

When a "one-time" flight repair is made to an airplane, the cockpit shall be placarded to limit the flight of the airplane, and appropriate entries made in Form 781, Part II.

Under emergency conditions, the aeronautical engineer may approve the use of materials which are not normally approved (not listed in the Material Substitution Tables) or which might be unsuitable for permanent repair. Regardless of the type of material selected, the original strength of the damaged member must be restored; no exceptions may be made. Outside patches must be as smooth as possible with all edges tapered or faired with smoothing compound as shown in figure 1-26. One-time flight repairs should be designed by a qualified aeronautical engineer.

1-83. GENERAL SHOP PRACTICES.

1-84. Fundamental Principles of Repair.

1-85. The fundamental principle of structural repair is to design the strength of the repair equal to or greater than the original structure. Therefore, it is most desirable, though not always necessary, that the repairs have the same configuration as the original structural members. The type of materials, gage, and method of attachment of a structural component must be carefully considered since the weight must be kept to a minimum to permit the maximum load-carrying capacity and operating efficiency consistent with safety. Close observation of the existing structure will indicate the stress-strain ratio of the structural design in each area; for example, a component or group of components made of heavy material and high-tension fasteners indicates a high stress loading in this area and these factors must be considered in designing the repair. Whenever possible the same type material should be used; however, suitable substitutes are listed in Table 1-I. When practicable, pick up existing rivet patterns using the same type and size of rivet as used in the original design. Rivet sizes and patterns may be revised when advisable; for prescribed limits see figure 1-28 and refer to paragraph 1-120. Shop methods for general practice are discussed in the General Manual for Structural Repair, T.O. 1-1A-1.

1-86. Clean Working Practice.

1-87. Establishment of a clean working practice is necessary to eliminate the possibility of damage from corrosion caused by contact of "loose hardware" with unlike metals, damage from loose objects thrown about during flight, and jamming of control mechanisms by foreign objects. This practice will insure that chips, broken parts, and discarded fasteners do not remain in the airplane. Generally, a thorough cleaning of the area at the end of each work period is sufficient to maintain safety standards. During the progress of the repair, broken parts and loose hardware should be picked up before they become lodged between the faying surfaces of repair parts or fall into hard-to-reach recesses. At the completion of a repair, the repair site and surrounding areas of the airplane must be carefully inspected for foreign matter and thoroughly cleaned. Inspect for loose hardware with flashlight and long-handled mirror. The presence of loose hardware in hidden recesses may be detected by lightly tapping lower surfaces of the area with a soft rubber mallet and listening for a rattling sound. Pick up small chips and dirt with a vacuum cleaner, or whisk broom and dust pan. Refer to T. O. 1F-106A-2-2-2-2 for approved airframe cleaning materials and procedures.

1-88. SHEET METAL FORMING.

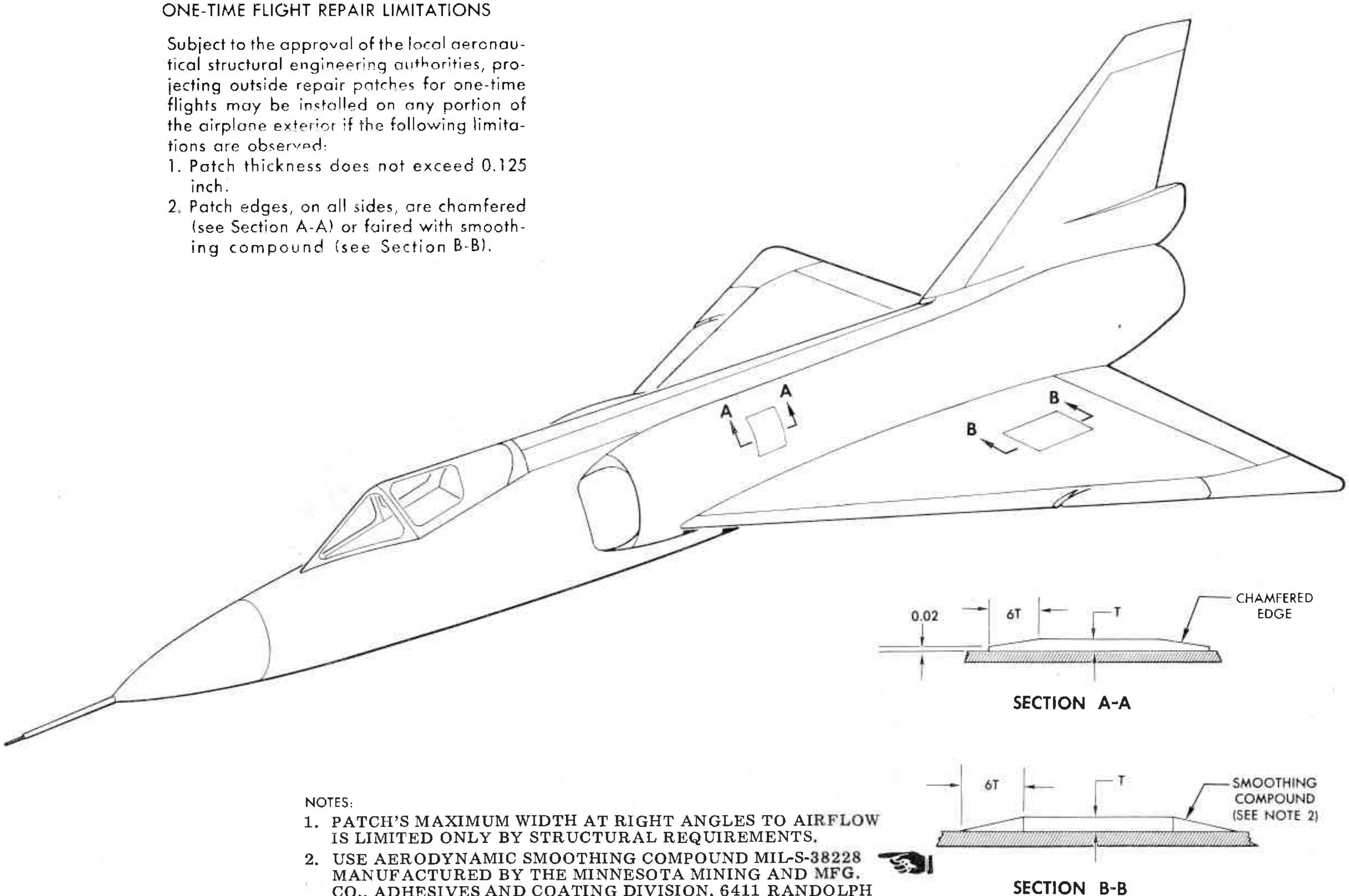
1-89. Materials Used for Fabrication and Repair.

1-90. The basic materials employed in the construction of these airplanes and to be considered for structural repair purposes are: aluminum alloys, titanium alloy, commercially pure titanium, corrosion resistant steels, and magnesium. When fabrication and repair require the employment of these materials, three important factors should be considered. These factors are shape, alloy, and condition or temper designation. In all cases

ONE-TIME FLIGHT REPAIR LIMITATIONS

Subject to the approval of the local aeronautical structural engineering authorities, projecting outside repair patches for one-time flights may be installed on any portion of the airplane exterior if the following limitations are observed:

1. Patch thickness does not exceed 0.125 inch.
2. Patch edges, on all sides, are chamfered (see Section A-A) or faired with smoothing compound (see Section B-B).



NOTES:

1. PATCH'S MAXIMUM WIDTH AT RIGHT ANGLES TO AIRFLOW IS LIMITED ONLY BY STRUCTURAL REQUIREMENTS.
2. USE AERODYNAMIC SMOOTHING COMPOUND MIL-S-38228 MANUFACTURED BY THE MINNESOTA MINING AND MFG. CO., ADHESIVES AND COATING DIVISION, 6411 RANDOLPH STREET, P.O. BOX 3186, TERMINAL ANNEX, LOS ANGELES CALIFORNIA.

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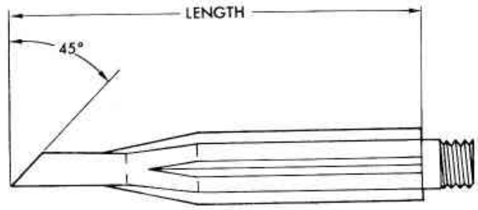
Figure 1-26. Aerodynamic Smoothness Requirements—One-Time Flight



ENLARGED VIEW OF SEALANT NOZZLE

SEALANT APPLICATION PROCEDURE

a. Pump trigger until pressure from ram is exerted against plunger.
b. Relax grip on trigger completely.
c. Place nozzle in position where sealant or fairing compound is to be applied.
d. Squeeze trigger into handle of gun and hold.

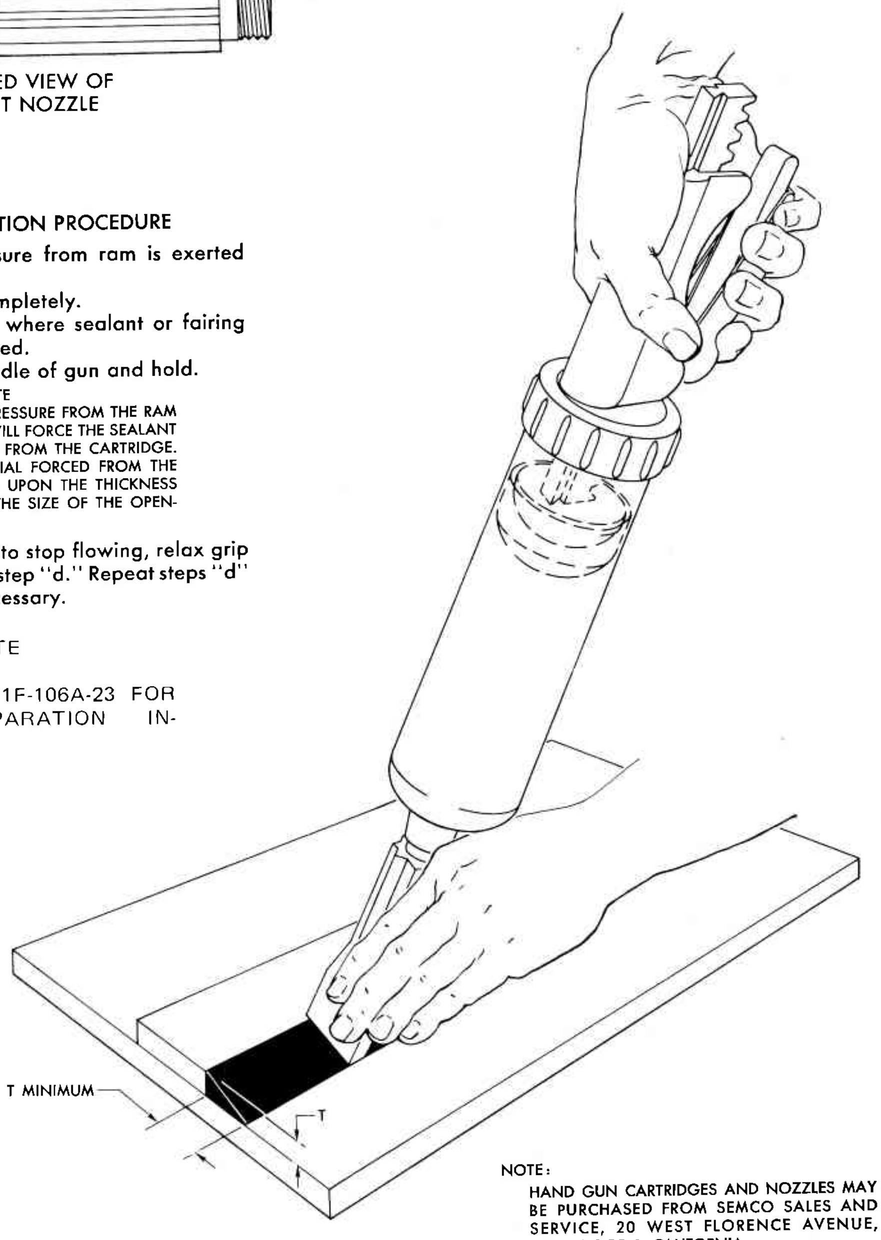
NOTE

IN THIS POSITION, THE PRESSURE FROM THE RAM AGAINST THE PLUNGER WILL FORCE THE SEALANT OR FAIRING COMPOUND FROM THE CARTRIDGE. THE AMOUNT OF MATERIAL FORCED FROM THE CARTRIDGE WILL DEPEND UPON THE THICKNESS OF THE MATERIAL AND THE SIZE OF THE OPENING IN THE NOZZLE.

e. When material is about to stop flowing, relax grip completely, then repeat step "d." Repeat steps "d" and "e" as often as necessary.

NOTE

REFER TO T.O. 1F-106A-23 FOR SURFACE PREPARATION INSTRUCTIONS.



NOTE:
HAND GUN CARTRIDGES AND NOZZLES MAY BE PURCHASED FROM SEMCO SALES AND SERVICE, 20 WEST FLORENCE AVENUE, INGLEWOOD 1, CALIFORNIA.

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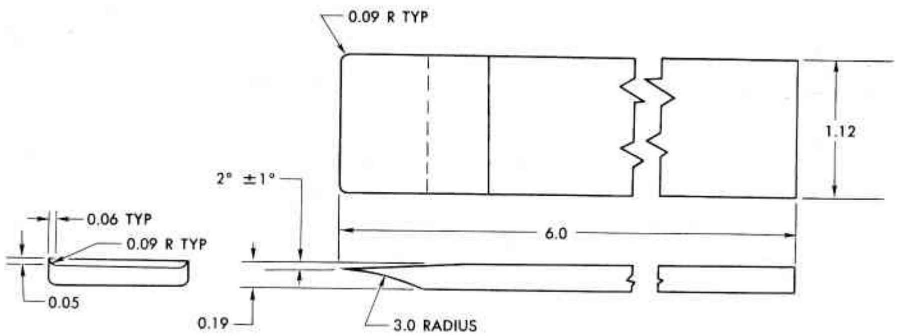
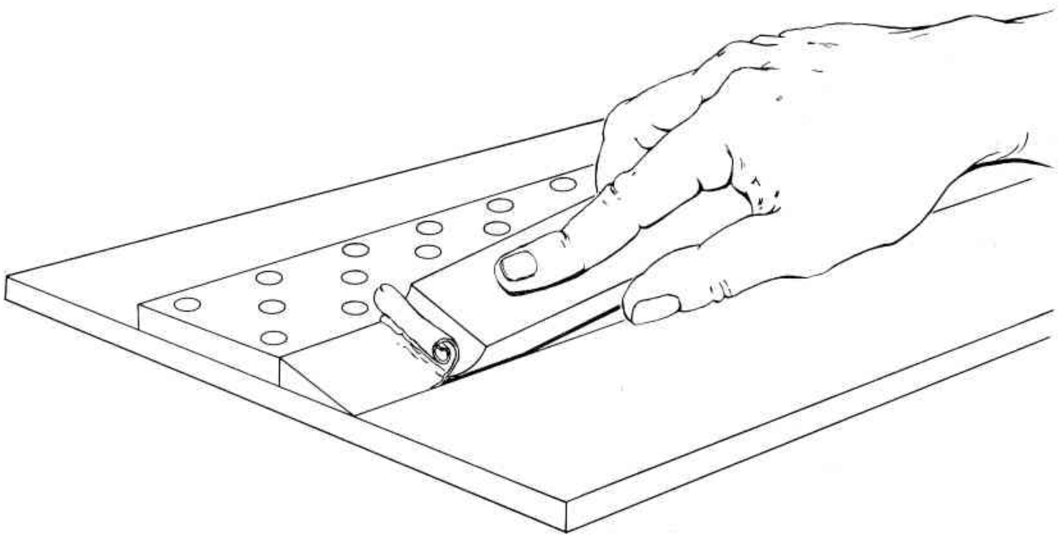
Figure 1-27. Application of Fairing Compound (Sheet 1 of 2)



DETAIL OF
TRIMMING TOOL

TOOL MAY BE MADE FROM 301 TOOL STEEL HEAT TREATED TO ROCKWELL READING OF 60-63, OR FROM A DISCARDED 12-INCH MILL FILE.



TRIMMING PROCEDURE

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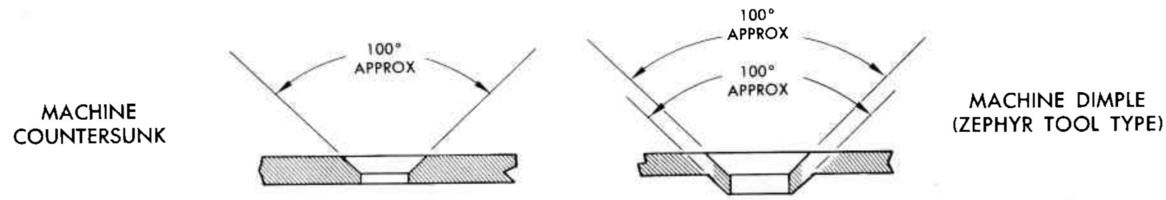
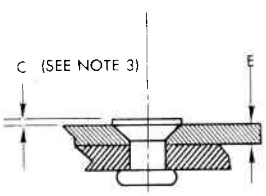
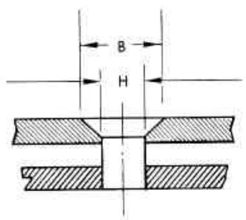
Figure 1-27. Application of Fairing Compound (Sheet 2 of 2)



NOTES:
1. THE FIGURES ABOVE INDICATE THE TYPICAL ANGULAR DIMENSIONS OF TOOLS USED TO INSTALL COUNTERSUNK RIVETS AS REQUIRED BY THIS STANDARD. ALL DIMPLED AND COUNTERSUNK RIVET INSTALLATION DATA ARE BASED ON THE AN426 TYPE (100°) RIVET AND THE TOOLS USED SHALL BE DESIGNED ACCORDINGLY. IN ADDITION, DESIGN AND USE OF THE TOOLS SHALL BE SUCH AS TO ACCOMPLISH THE REQUIREMENTS GIVEN BELOW, SHOWN IN THE FOLLOWING TABLES AND ILLUSTRATIONS.
2. PROVIDED THE INDICATED LIMITATIONS ARE OBSERVED, CHOICE BETWEEN THE VARIOUS METHODS OF INSTALLING COUNTERSUNK RIVETS IS OPTIONAL.
3. TABULATED VALUES FOR DIMENSION "C" IN TABLE 1 ARE APPLICABLE TO INNER STRUCTURE ONLY. FOR VALUES APPLICABLE TO OUTER PLATING, REFER TO AERODYNAMIC SMOOTHNESS REQUIREMENTS IN THIS SECTION.
4. WHEN INSTALLING A HEAVY GAGE PATCH WHICH PICKS UP A MACHINE COUNTERSUNK HOLE IN THE ORIGINAL MEMBER, USE METHOD SHOWN BELOW.



AFTER INSTALLATION



BEFORE INSTALLATION

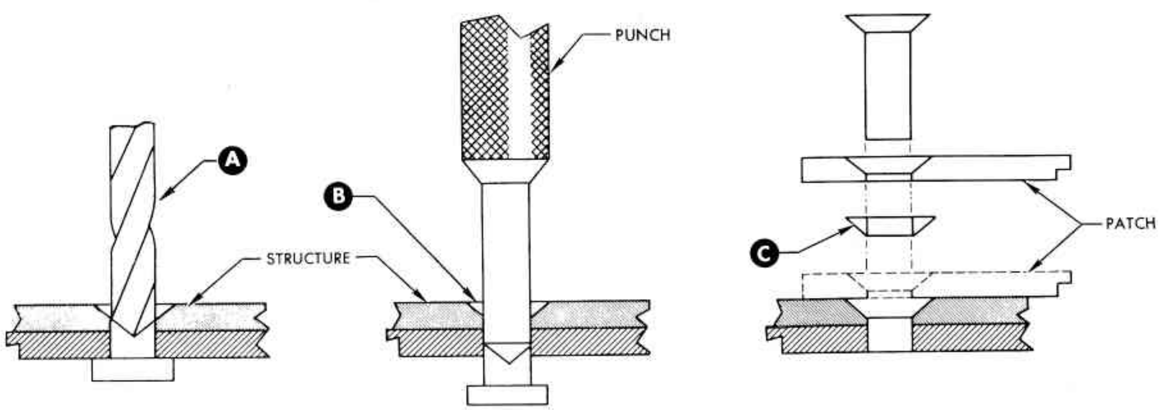
TABLE I

NOMINAL RIVET DIAMETER		1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8
B (NOMINAL)		0.114	0.179	0.225	0.287	0.355	0.478	0.569	0.697
C (SEE NOTE 3)	MAX	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
E	MIN	0.032	0.040	0.051	0.064	0.064	0.064	0.064	0.064
H	MIN	0.067	0.099	0.128	0.161	0.191	0.257	0.323	0.386
	MAX	0.073	0.105	0.134	0.167	0.199	0.265	0.331	0.394

A Remove rivet head using drill of the size prescribed for installation of the rivet to be installed. Use care to center on and not drill beyond the rivet head.

B Remove rivet and save the head.

C Use the rivet head as a tapered filler. Cement in place with sealant, Military Specification MIL-S-8802.



METHOD FOR FILLING DIMPLED OR COUNTERSUNK HOLES

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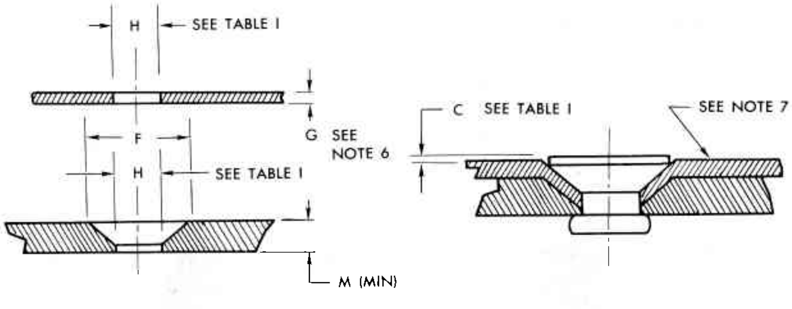
Figure 1–28. Flush Rivet Installation (Sheet 1 of 3)

DIMPLED SKIN



BEFORE INSTALLATION

AFTER INSTALLATION

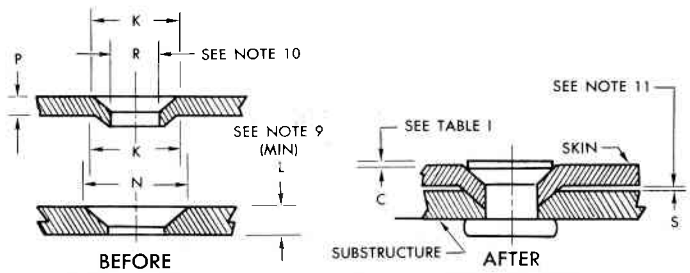
TABLE II

G	NOMINAL RIVET DIAMETER				
	3/32	1/8	5/32	3/16	1/4
(NOMINAL)	F (NOMINAL) SEE NOTE 5				
0.020	0.194	0.240	0.302	0.370	0.493
0.025	0.198	0.244	0.306	0.374	0.497
0.032	0.202	0.248	0.310	0.378	0.501
0.040		0.254	0.316	0.384	0.507
0.051			0.325	0.393	0.516
0.064				0.403	0.526
0.072					0.537
0.081					0.549
M (MIN)	0.051	0.064	0.081	0.102	0.125

MACHINE DIMPLED SKIN

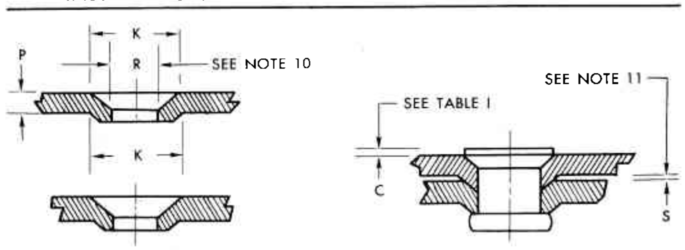
TABLE III

NOMINAL RIVET DIAMETER	3/32	1/8	5/32	3/16	1/4
N NOMINAL DIA OF MACHINE CSINK	0.189	0.235	0.297	0.365	0.488
K NOMINAL DIA OF MACHINE DIMPLE	0.179	0.225	0.287	0.355	0.478
L (MIN)	0.040	0.051	0.064	0.072	0.091
P (MAX)	0.032	0.040	0.051	0.051	0.051
R (MAX)	0.107	0.140	0.175	0.216	0.280
R (MIN)	0.099	0.128	0.161	0.191	0.257



BEFORE INSTALLATION

AFTER INSTALLATION



BEFORE INSTALLATION

AFTER INSTALLATION

NOTES:

5. VALUES IN TABLE II ARE FOR USE ONLY WHEN THE TOP SHEET IS DIMPLED WITH THE RIVET HEAD. WHEN TOP SHEET IS MACHINE DIMPLED, USE TABLE III.
6. TABULATED VALUES FOR DIMENSION "G" ALSO APPLY AS A TOTAL VALUE WHEN MORE THAN ONE SHEET IS DIMPLED SIMULTANEOUSLY INTO A MACHINE COUNTERSINK WITH THE RIVET HEAD.
7. USE OF THIS INSTALLATION METHOD IS RESTRICTED TO APPLICATIONS WHERE THE TOP SHEET HAS FORMING CHARACTERISTICS EQUAL TO OR BETTER THAN 2024-T.
8. VALUES IN TABLE III ARE FOR USE IN THE FOLLOWING APPLICATIONS:
   A. WHEN MACHINE DIMPLED SHEET (OR SHEETS) IS RIVETED TO MACHINE COUNTERSUNK SHEET (OR SHEETS SEE NOTE 7).
   B. WHEN INDIVIDUALLY MACHINE DIMPLED SHEETS ARE RIVETED TOGETHER. (DIMENSION "K" IS APPLICABLE EVEN THOUGH MORE THAN TWO MACHINE DIMPLED SHEETS ARE JOINED.)
9. THE MACHINE COUNTERSUNK SHEET INDICATED BY DIMENSION "L" MAY CONSIST OF MORE THAN ONE SHEET PROVIDED THE TOTAL THICKNESS IS NOT LESS THAN "L."
10. WHEN REQUIRED BY TOOLING LIMITATIONS, VALUES FOR DIMENSION "R" IN MACHINE DIMPLES MAY BE MET AFTER DIMPLES ARE FORMED.
11. TO PROPERLY TRANSMIT SHEAR, DIMPLES SHOULD NEST TIGHTLY IN COUNTERSINKS. THIS MAY RESULT IN GAPS BETWEEN SHEETS WHICH WILL BE ACCEPTABLE SUBJECT TO THE FOLLOWING CONDITIONS:
    A. THE GAP(S) SHALL NOT EXCEED 0.004 INCH ADJACENT TO 3/32 RIVETS, 0.006 INCH ADJACENT TO 1/8 INCH RIVETS, 0.008 INCH ADJACENT TO 5/32 INCH, 3/16 INCH OR 1/4 INCH RIVETS.
    B. THE AREAS AFFECTED ARE NOT INTENDED TO BE LIQUID TIGHT.
    C. THE GAPS DO NOT CAUSE RIPPLES THAT ARE OBJECTIONABLE FROM AN APPEARANCE STANDPOINT.

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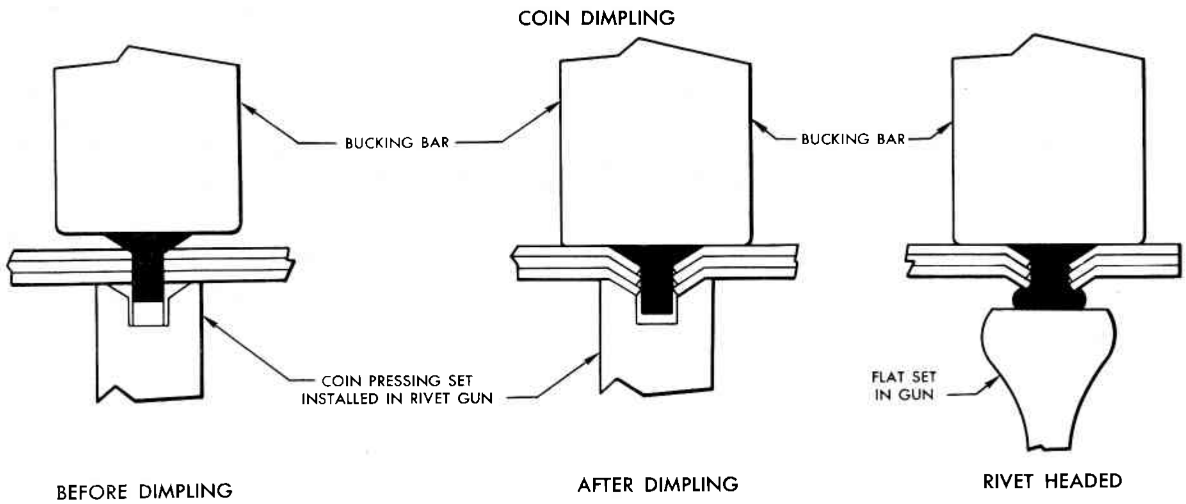
Figure 1-28. Flush Rivet Installation (Sheet 2 of 3)



COIN DIMPLING TOOL NUMBERS

RIVET SIZE	MARTIN TOOL NUMBER	ZEPHYER TOOL NUMBER
3/32	MM-215-1	ZT1851-3/32
1/8	MM-215-2	ZT1851-1/8
5/32	MM-215-3	ZT1851-5/32
3/16	MM-215-4	ZT1851-3/16

TABLE IV

THICKNESS OF COMBINED SHEETS (MAX)	MATERIAL NOTED	PROCESS COIN DIMPLE	
	RIVET DIAMETER		
	1/8	5/32	3/16
0.070			
0.080			7075-T
0.090			
0.100			
0.110			
0.120	2024-T		
0.130			
0.140			

NOTES:

12. TABLE IV IS APPLICABLE ONLY WHEN MORE THAN ONE SHEET IS DIMPLED SIMULTANEOUSLY BY THE COIN DIMPLING PROCESS. WHEN THE SUM OF THE COMPONENT SHEETS FALLS ABOVE THE HEAVY LINE OF THE MATERIAL INDICATED, THE SHEETS MAY BE DIMPLED SIMULTANEOUSLY PROVIDED THE APPLICABLE LIMITS ARE OBSERVED.
13. COIN DIMPLING IS A PROCESS WHERE THE RIVET IS USED AS A TOOL FOR DIMPLING TWO OR MORE SHEETS SIMULTANEOUSLY. THE SHEETS ARE BACKED UP BY A RECESSED TOOL DURING THE DIMPLING OPERATION, THEN A FLAT TOOL FORMS THE SHOP HEAD. THIS METHOD HAS THE ADVANTAGE OF MAKING IT POSSIBLE TO INSTALL 100° COUNTERSUNK RIVETS IN DIMPLED SKIN APPLICATION WHEN DEALING WITH 7075-T WITHOUT HOT DIMPLING EQUIPMENT. IT IS SUBJECT TO THE FOLLOWING LIMITATIONS:
    - A. IT SHALL BE USED ONLY WHEN NECESSARY AS THE RIVET HEAD DEFORMS SO THAT THE REPLACEMENT WITH A STANDARD 100° RIVET IS NOT FEASIBLE.
    - B. IT SHALL NOT BE USED WHERE THE RIVET MATERIAL IS SOFTER THAN 2117.
    - C. THE GAGE OF ANY SINGLE SHEET OR A COMBINATION OF SHEETS SHALL NOT EXCEED 1/2 OF THE MAXIMUM VALUE ALLOWABLE FOR THE COMBINATION AS DETERMINED FROM TABLE IV.
14. TABLE IV IS SUBJECT TO THE FOLLOWING LIMITATIONS:
    - A. WHERE 2024-T IS INDICATED, THE FOLLOWING MATERIALS ARE TO BE INCLUDED: 2024-0, 7075-0, AND 7075-W (WITHIN 2 HOURS AFTER QUENCH).
    - B. WHERE 7075 IS INDICATED, THE FOLLOWING MATERIALS ARE TO BE INCLUDED: 2014, 7075-W, 2024-RT ("Y" SECTIONS), 2024-RT, 2024-T80, 2024-T81, 2024-T84, AND 2024-T86.
    - C. WHERE MORE THAN ONE MATERIAL IS USED SO THAT BOTH 7075-T AND 2024-T LIMITATIONS ARE APPLICABLE, THE 7075-T LIMITATIONS SHALL BE USED.
15. A 3X GUN SHOULD BE USED FOR 1/8, 5/32 AND 3/16 INCH RIVETS WHEN THE COMBINED MATERIAL THICKNESS IS 0.080 INCH OR LESS. A 4X GUN SHOULD BE USED WHERE THE COMBINED THICKNESS IS BETWEEN 0.064 AND 0.150 INCH. WHERE THICKNESS LIMITATIONS OVERLAP, EITHER SIZE GUN MAY BE USED.

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Figure 1-28. Flush Rivet Installation (Sheet 3 of 3) of repair or replacement the original factors should be duplicated; however, should conditions prohibit this procedure, suitable substitutes are listed in Table 1-I.

1-91. Material Shapes.

1-92. There are three basic shapes: sheet stock, extruded shapes, and drawn bar stock.

a. Sheet stock is obtainable in various gages and in clad or bare types. This type of material is used in fabricating patches for skin, panels, rib and bulkhead webs, and may be shaped to produce splice and replacement channels or angles. Refer to "Y" sections listed in Section VIII.

b. Extruded shapes are used extensively throughout the structure, particularly in the heavily stressed areas. When repairs require the replacement of these parts, the same die number extrusion should be used; however, if the same die number is not available, other extrusions of a larger dimension may be machined to the desired dimension. Refer to list of extruded shapes in Section VIII.

c. Drawn bar stock is a material from which parts may be machined. Extruded shapes machined from bar stock are slightly weaker than the original extruded shapes of the same alloy; therefore, the cross-sectional area of the substitute part should be approximately 5 percent greater than the original to compensate for this lower strength factor.

1-93. Bend Radii.

1-94. The standard inside bend radii for the various standard gages of sheet aluminum, magnesium, steel, and titanium are given in Table 1-XIX. See figure 1-29 for the computation of bend reduction and flat pattern layout. The bend radii for aluminum alloy tubing is given in Table 1-XX.

1-95. Temper of Aluminum Alloy.

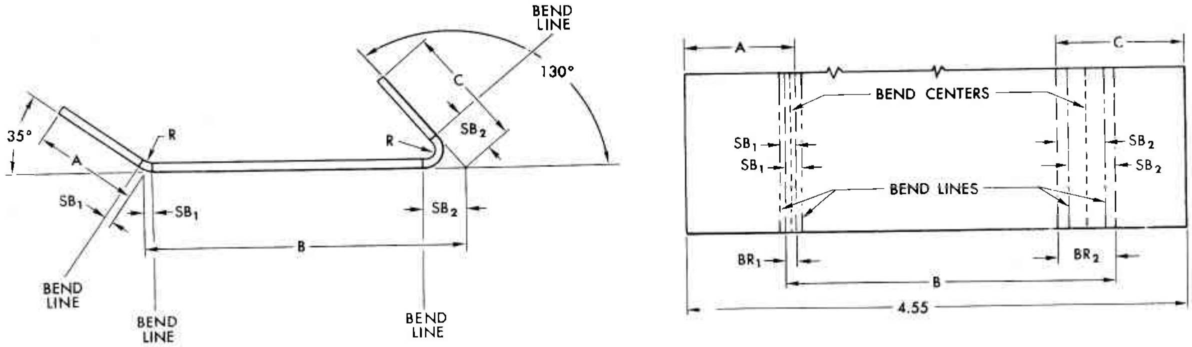
1-96. The aluminum alloys employed in the primary structure are heat-treatable and in a "T" hard condition. It follows, therefore, that materials used in designing and fabricating repairs or making replacements must also be in the "T" hard condition when the repair is completed. All aluminum alloys are heat treated and aged in accordance with Specification MIL-H-6088, except in cases where bare materials have been aged to conditions for clad materials in accordance with Specification AN-A-42.

a. 2014-T4 material is not commonly used; however, structural parts requiring moderately high strength comparable to 2024-T3 or 2024-T4 may be fabricated and employed as a substitute should the necessity arise. This material has good forming qualities in the "O" condition, but is very limited in the "-T4" condition. It possesses good machinability in either the "O" or "-T4" condition.

b. 2024-T sheet stock in the clad and bare condition is used, although not extensively, in the structure in various "-T" or temper designations. Parts fabricated from "-T3" stock without the reheat treatment will retain this rating. If reheat treated and formed in the "W" or unstable condition, they will be designated as 2024-T4. This designation applies when the material is not cold worked or artificially aged after heat treatment. Both 2024-T3 and 2024-T4 materials contain slightly more strength than the 2024-T4 extrusions. A few roll-formed sections are fabricated from 2024-T3. Refer to Section VIII for roll-formed sections and extrusions. Roll-formed sections of 2024-T3 reheat treated to facilitate additional forming will be designated as 2024-T4 after hardening. Extrusions of 2024-T4 will retain their designated rating after being reheat treated. The designation 2024-T6 (formerly known as 24S-T80) indicates material that has been artificially age hardened from the "-T4" condition to increase its mechanical properties. The designation 2024-T81 indicates material that has been artificially age hardened in accordance with Specification AN-A-42 from the "-T3" condition to increase its mechanical properties. These materials are used where a moderate amount of increased strength over the "-T4" and "-T3" materials is required. 2024-T material in increased gages may be used as a substitute material for 7075-T6; however, this practice is not considered advisable except in cases of emergency. When 2024-T is substituted in highly stressed areas it shall be used as a temporary repair only and must be replaced as soon as 7075-T6 material is available. 2024-T36 material that has been solution heat treated and strain hardened becomes 2024-T86 when age hardened. This material is considerably stronger than 2024-T3 or 2024-T4 material. The use of 2024-T36 material should be restricted to plating or machined parts due to its relatively poor forming characteristics.

c. 6061-T6 material may be employed in lower or nonstressed areas. This material contains excellent forming characteristics in the heat treated condition and possesses good machinability and weldability qualities.

d. 7075-T sheet stock in the bare condition is employed extensively in the wing structure, and has a temper designation of "-T6" only. Extrusions, bar stock, and bare roll-formed shapes carry the same temper designation; however, they possess slightly more strength than 7075-T6 clad material, as shown in Table 1-I. When 7075-T6 material is used for repairs and a moderate amount of forming is required, the material should be reheat treated and formed in the "W" or temporarily unstable condition due to the hardness of the material. Following this operation the material must be artificially aged to regain its "-T6" rating or condition. Forming of 7075-T6 material should be confined to moderate or gentle contours, although with care a bend radius of 5T may be obtained (see Table 1-XIX). Ordinary cold dimpling methods are not advisable in 7075-T6 material since cracks are likely to occur. Refer to paragraphs 1-175 through 1-177, and figure 1-28 for information on dimpling.



GIVEN
2024-W CLAD
GAGE=0.125
A=1.00
B=3.00
C=1.50

R =0.25 (SEE NOTE 2)
BR_1 =0.05 (FROM SHEET 2)
BR_2 =0.90 (FROM SHEET 2)
SB_1 =0.14 (FROM SHEET 3)
SB_2 =0.80 (FROM SHEET 3)

$$\text{ACTUAL FLAT LENGTH} = A - BR_1 + B - BR_2 + C$$
$$= 1.00 - 0.05 + 3.00 - 0.90 + 1.50$$
$$= 4.55 \text{ INCHES}$$

FLAT PATTERN LAYOUT

a. Take the dimensions and angles from the damaged or opposite hand part with an accurate hundredths scale and make a cross-section sketch of the part. A piece of wire solder may be bent around the damaged part to obtain shape.
b. Determine bend reduction (BR) value from sheet 2 of this figure for each angle. Bend reduction is subtracted from the sum of the flange lengths to determine the actual flat length. Record values for use in next step.
c. Mark outline of part on a flat sheet of repair material with a sharp pencil. Do not use a metal scribe. Determine actual flat length by subtracting the sum of the BR values from the sum of the side dimensions of the damaged part sketched in step "a."
d. Layout marks for "A" and "C" flanges, using the dimensions shown in sketch of damaged part.
e. Layout marks for "BR_1" and "BR_2" dimensions at ends of pattern as shown. The "B" side dimension is determined by the location of these marks.
f. Determine set-back (SB) value from sheet 3 of this figure for each angle. Bend lines are located by set-back dimensions. Record for use in next step.
g. Layout marks for end lines by marking off "SB_1" and "SB_2" dimensions as shown.
h. Trim part to marked outline and hand form or bend angles on brake.

NOTES:
1. BEND CENTER LINES MAY BE LOCATED BY SUBTRACTING ½ BR FROM EACH BENT-UP FLANGE LENGTH.
2. REFER TO TABLE 1-XIX FOR STANDARD BEND RADIUS.

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Figure 1-29. Flat Pattern Layout (Sheet 1 of 3)

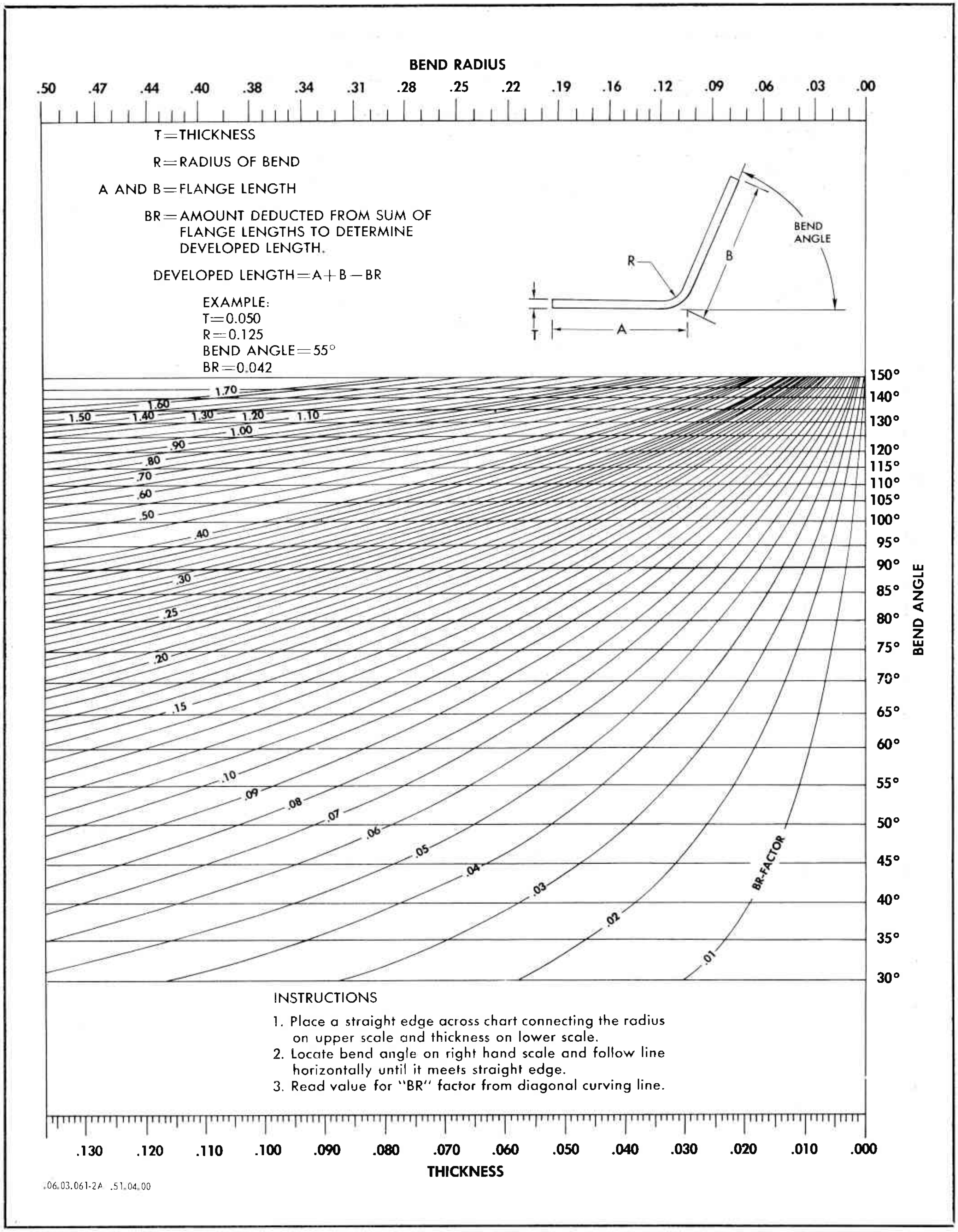

Figure 1-29. Flat Pattern Layout (Sheet 2 of 3)

Table of Bent-Formed Set-Back Values

A°	K	A°	K	A°	K	A°	K
1°	0.00873	46°	0.42447	91°	1.0176	136°	2.4751
2	0.01745	47	0.43481	92	1.0355	137	2.5386
3	0.02618	48	0.44523	93	1.0538	138	2.6051
4	0.03493	49	0.45573	94	1.0724	139	2.6746
5	0.04366	50	0.46631	95	1.0913	140	2.7475
6	0.05241	51	0.47697	96	1.1106	141	2.8239
7	0.06116	52	0.48773	97	1.1303	142	2.9042
8	0.06993	53	0.49858	98	1.1504	143	2.9887
9	0.07870	54	0.50952	99	1.1708	144	3.0777
10	0.08749	55	0.52057	100	1.1917	145	3.1716
11	0.09629	56	0.53171	101	1.2131	146	3.2708
12	0.10510	57	0.54295	102	1.2349	147	3.3759
13	0.11393	58	0.55431	103	1.2572	148	3.4874
14	0.12278	59	0.56577	104	1.2799	149	3.6059
15	0.13165	60	0.57735	105	1.3032	150	3.7320
16	0.14054	61	0.58904	106	1.3270	151	3.8667
17	0.14945	62	0.60086	107	1.3514	152	4.0108
18	0.15838	63	0.61208	108	1.3764	153	4.1653
19	0.16734	64	0.62487	109	1.4019	154	4.3315
20	0.17633	65	0.63707	110	1.4281	155	4.5107
21	0.18534	66	0.64941	111	1.4550	156	4.7046
22	0.19438	67	0.66188	112	1.4826	157	4.9151
23	0.20345	68	0.67451	113	1.5108	158	5.1455
24	0.21256	69	0.68728	114	1.5399	159	5.3995
25	0.22169	70	0.70021	115	1.5697	160	5.6713
26	0.23087	71	0.71329	116	1.6003	161	5.9758
27	0.24008	72	0.72654	117	1.6318	162	6.3137
28	0.24933	73	0.73996	118	1.6643	163	6.6911
29	0.25862	74	0.75355	119	1.6977	164	7.1154
30	0.26795	75	0.76733	120	1.7320	165	7.5957
31	0.27732	76	0.78128	121	1.7675	166	8.1443
32	0.28674	77	0.79543	122	1.8040	167	8.7769
33	0.29621	78	0.80978	123	1.8418	168	9.5144
34	0.30573	79	0.82434	124	1.8807	169	10.385
35	0.31530	80	0.83910	125	1.9210	170	11.430
36	0.32492	81	0.85408	126	1.9626	171	12.706
37	0.33459	82	0.86929	127	2.0057	172	14.301
38	0.34433	83	0.88472	128	2.0503	173	16.350
39	0.35412	84	0.90040	129	2.0965	174	19.081
40	0.36397	85	0.91633	130	2.1445	175	22.904
41	0.37388	86	0.93251	131	2.1943	176	26.636
42	0.38386	87	0.94896	132	2.2460	177	38.188
43	0.39391	88	0.96569	133	2.2998	178	57.290
44	0.40403	89	0.98270	134	2.3558	179	114.590
45	0.41421	90	1.00000	135	2.4142	180	Infinite

Example:

Degrees in Bend (A) = 120°
Gage (T) = 0.032
Radius (R) = 0.125
K (From Table) = 1.732

Set-Back = K (T+R)
Set-Back = 1.732 (0.032+125)
= 1.732 x 0.157
= 0.272

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Figure 1-29. Flat Pattern Layout (Sheet 3 of 3)

e. 7178-T bare sheet stock is employed extensively in the fuselage structure and has a temper designation of "-T6" only. Extrusions, bar stock, and bare roll-formed shapes carry the same temper designation; however, they possess slightly more strength than 7178-T6 clad material, as shown in Table 1-I. When 7178-T6 material is used for repairs and a moderate amount of forming is required, the material should be reheat treated and formed in the "W" or temporarily unstable condition due to the hardness of the material. Following this operation the material must be artificially aged to regain its "-T6" rating or condition. Forming of 7178-T6 material should be confined to large radii of 5T or larger. 7178-T6 material is about 10 percent stronger than 7075-T6 stock and should be carefully inspected for cracks after each forming operation.

1-97. Special Cutting Tool for Aluminum Alloys.

1-98. If standard cutting tools for aluminum alloys are not available, or if the required cutting operation cannot be readily adapted to the standard cutting tools that are available, a special cutting tool similar to the one shown on figure 1-30 may be manufactured locally.

1-99. Forming Characteristics of Titanium.

1-100. Special care in the handling of titanium material to avoid surface and edge imperfections is essential to its successful forming. Higher quality and polish in tools, more effective control of metal flow, higher pressure and slower action in most operations, and the discriminative use of heat for severe forming will aid in overcoming forming difficulties encountered with titanium. Forming operations at room temperatures indicate that this material behaves more like ¼-hard and ½-hard stainless steel than any other metal. In general, parts that can be formed from ¼-hard stainless steel can also be formed from commercially pure titanium, although titanium requires hot forming to accomplish the more severe operations. Titanium alloy will form in straight or very slightly contoured flanges and in curved sections at room temperature.

1-101. Brake Forming of Titanium.

1-102. Titanium sheet and strips may be bent successfully in the power brake, using the same methods and techniques as employed for stainless steel. Bend properties are more favorable if the axis of the bend is perpendicular to the rolling direction of the material. Cold bend tests have determined that a minimum bend radius of 3T may be obtained with all gages of commercially pure titanium. Hot bend tests, heating titanium parts and forming dies to approximately 260°C (500°F), have indicated that a minimum bend radius of 2T may be obtained. Similar results may be obtained with titanium alloy at higher temperatures in gages up to 0.070 inch. Alloys with 8 percent manganese are formed at temperatures up to 565°C (1050°F). Alloys with 5 percent aluminum and 2.5 percent tin are formed at temperatures up to 621°C (1150°F).

CAUTION

Do not apply temperature indicating paint or crayon marks directly on titanium surfaces. Cracks in the titanium may develop from contaminants in these materials. Use a hand pyrometer for temperature measurements.

For gages over 0.070 inch, titanium alloy may be cold formed to bend radii of 3½T and hot formed to 2½T. Refer to Table 1-XIX for bend radii.

1-103. Titanium Acid-Etch Treatment.

1-104. Acid-etch treatment of titanium will remove surface oxides to prevent crack development during forming operations. If a test sample of the material to be used can be formed without cracking at the bend, etching will not be necessary. Mixing of the acids in the correct proportions is important and parts should never be immersed for periods exceeding the time limits given in the following procedure:

a. Prepare etch solution by mixing 1½ to 2½ percent hydrofluoric acid, Specification O-H-795, and 25 percent to 35 percent nitric acid, Specification O-N-350, into tap water at room temperature.

b. Inspect parts for cleanliness before immersion. If parts are oily or soiled, they may be cleaned with an alkaline cleaner solution or vapor degreased.

c. Immerse parts in solution.

WARNING

Operator must wear rubber gloves and face shield during this operation.

Immersing clean, oxide-free titanium in the etch solution for five minutes will remove 0.0005-inch from each surface of the part. Etch only as long as necessary to remove surface scratches. The blue oxide coating, formed by heating part 371° to 426°C (700° to 800°F), will be removed in one to five minutes. The purple oxide coating, formed by heating part 426° to 510°C (800° to 950°F), will be removed in five to ten minutes.

d. Remove part from etch solution and rinse thoroughly in cold running water.

e. Dry part with oil-free air blast or in an oven at 82° to 115°C (180° to 250°F).

1-105. Titanium Drawing Operations.

1-106. Drawn parts of commercially pure titanium may be formed hot or cold, depending on the severity of

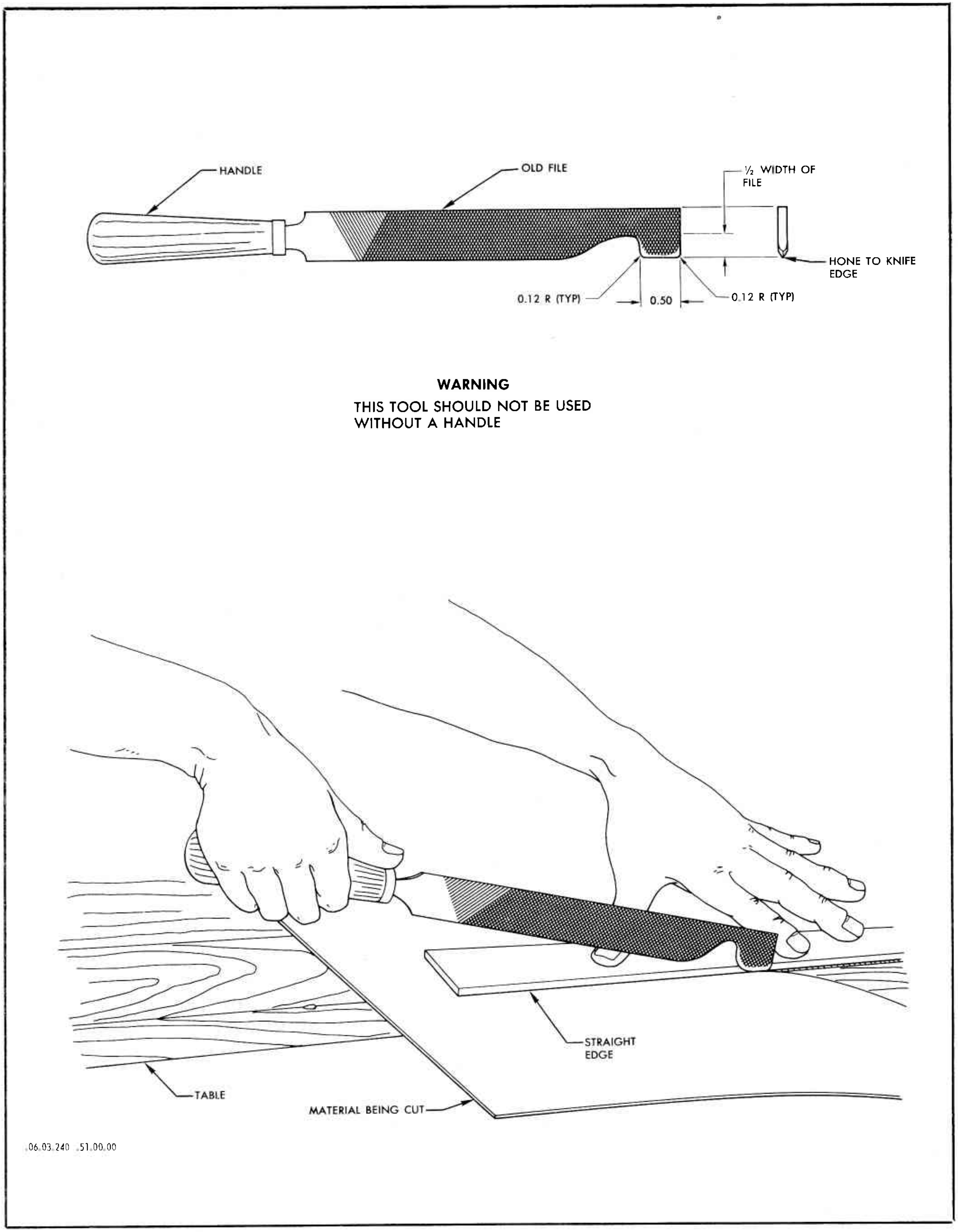


Figure 1-30. Metal Cutting Tool

the operation. In general, most parts can be formed at 260°C (500°F) with dies heated to 135°C (275°F) or higher. Alloy titanium should have an acid-etch treatment prior to the operation and be formed at the temperatures specified for brake forming in paragraph 1-101. Colloidal graphite is a satisfactory lubricant for either hot or cold forming. Tool surfaces require frequent polishing to prevent seizing. Drawing in two stages with an intermediate anneal also gives good results.

1-107. Sawing Titanium.

1-108. Sawing titanium in gages up to 0.250 inch is readily accomplished on a conventional band saw or a friction saw, using sufficient force to keep the saw cutting continuously.

WARNING

The fire precautions used for machining magnesium must be observed when machining titanium. Dry, powder-type fire extinguishing material should be kept available in titanium machining areas. Do not attempt to extinguish titanium fires with carbon dioxide (CO_2). Fine particles of titanium are explosive when suspended in air.

1-109. Blanking and Piercing Titanium.

1-110. Blanking or piercing with a punch press produces results similar to those attained with stainless steel. The force required is greater and the tool life is less when blanking or piercing titanium. Punches and dies should be constructed of the best steel available and should be kept in the best possible condition. Hole punching should not be attempted if the ratio of the hole size to the material thickness is less than one to one.

1-111. Shearing Titanium.

1-112. Commercially pure and alloy titanium in gages of 0.016 to 0.080 inch may be sheared on all types of shears or nibblers. Sharp, closely adjusted steel blades of high quality must be used on all tools and considerably more power is needed. Gages of titanium thicker than 0.080 inch should be sawed, blanked, or cut by square shears.

1-113. Grinding Titanium.

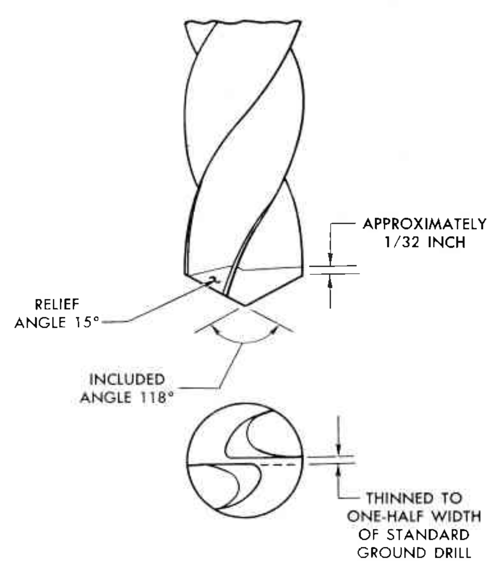
1-114. Grind methods for titanium are similar to those used for stainless steel. An aluminum oxide or silicon carbide abrasive wheel, with open coarse grit, gives the best results. No coolant is necessary for light intermittent grinding. If the grinding wheel is allowed to ride and light pressures are applied, the ground surface will burr heavily and work harden. A water-base, sodium nitrate, amine-type coolant directed on the cut from the bottom side will help prevent formation of heavy burrs. A feed pressure of 3 to 5 pounds against the abrasive wheel will lessen work hardening of the ground surface. The abrasive wheel should be checked periodically and replaced when the peripheral speed becomes appreciably less than 2800 surface feet per minute.

1-115. Routing Titanium.

1-116. Routing of one or two gage thicknesses of 0.016-inch commercially pure titanium is readily accomplished. Stack routing of up to eight thicknesses becomes increasingly difficult due to formation of heavy burrs which may be forced between the stacked sheets. A water-base coolant should be used when routing material with a combined thickness exceeding 0.040 inch. Router rate should be slower than 14,700 rpm when routing heavy gage or stacked material.

1-117. Drilling Titanium.

1-118. Drilling commercially pure titanium is best accomplished with an NAS 907, type C drill or a modified high-speed drill as shown on figure 1-31. Use low drill speeds and maintain a positive feed during entire drilling operation. A conventional chisel-point drill has a short work life and leaves heavy burrs around the edge of the hole. Sufficient pressure must be applied



CAUTION

THINNING DRILL TOO MUCH WILL RESULT IN SHORT DRILL LIFE.

NOTE:
THIS DESIGN FOR 0.250 AND SMALLER HOLES. FOR LARGER HOLE, INCREASE INCLUDED ANGLE FROM 118° TO 135° SPEED SHOULD BE FROM 15 TO 20 SFPM, AND FEED 0.002 TO 0.005 INCH PER REVOLUTION FOR BOTH VERSIONS.

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Figure 1-31. Modified High-Speed Drill for Titanium to keep the drill cutting until the hole is completely drilled. Do not allow the drill to ride in a partially drilled hole. Work hardening will result and further cutting will be extremely difficult. In cases where the titanium will be dimpled after drilling, the work piece should be securely clamped to prevent drill chatter marks which will cause titanium to crack under very small stress. If drill bushings are used, ample chip clearance should be allowed between the drill bushing and the work to reduce the amount of chips carried up through the bushing. If chip clearance is not maintained, choking of the bushing with chips will result in a high rate of drill breakage and excessive marginal wear on the drill.

1-119. FASTENERS.

1-120. All repairs to the outer surfaces of the airplane will require flush rivet installations. Countersinking, machine dimpling, and coin dimpling standards are shown on figure 1-28. Universal-head rivets used on internal structure should have the manufactured head in contact with the thinnest sheet in the joint wherever possible. Hole sizes for protruding head rivets are the same as specified for flush rivets on figure 1-28. Shop-formed rivet heads may be installed at an angle not to exceed 10 degrees from the perpendicular when riveting tapered parts. Protruding-type manufactured rivet heads may also be installed with a 10-degree maximum angular variation. No angular variations are permitted for flush-head rivets. Whenever possible, pick up existing rivet patterns with the same size and type of rivets used in the original construction of the parts involved. If the existing holes in the structure are enlarged past the limits given on figure 1-28, rivets of the next larger size may be installed, provided requirements for minimum rivet edge distance and spacing, as shown on figure 1-32, are met. Oversize fastener holes which indicate a need for a fastener two sizes larger than the original, or create short pitch and edge distance problems, must be submitted to an aeronautical structures engineer for evaluation. Higher strength fasteners may be substituted in the order listed in Table 1-XXII. Strengths of bolts, screws, and rivets are given in Tables 1-XXIV through 1-XXXV for the exclusive use of personnel assigned to design of repairs. Refer to Tables 1-II through 1-XVII for complete data regarding rivets required per inch of seam in various types of materials, and see figure 1-32 for rivet application data. Rivet basic code and numbering is defined in Table 1-XXIII.

1-121. Rivet Patterns.

1-122. Figure 1-32 shows rivet layout patterns. When determining the rivet pattern for a repair, the following terms will be considered:

a. Row: A line of rivets parallel to a seam or splice.

b. Row Spacing: The distance between rows when more than one row of rivets are installed.

c. Stagger: The eccentric or offset location of rivets in adjacent rows.

d. Edge Distance: The distance from the edge of the riveted sheet to the center line of the rivet hole.

e. Pitch: The center-to-center distance between rivets in any row of rivets.

1-123. Rivet Shank Diameter.

1-124. Should the extent of the damage or the required method of repair present some doubt regarding the diameter of a rivet to be used, the accepted rule is to use a rivet diameter approximately three times the thickness of the material to be repaired. See figure 1-32 for rivet pitch and edge distance information.

1-125. Rivet Length.

1-126. The rivet length must provide sufficient material to produce a satisfactory shop-formed head. The shop-formed head should be approximately 1½ times shank diameter in width and one-half times shank diameter in height. To obtain these limits the rivet shank should protrude through the material approximately 1½ times its diameter before driving. See figure 1-33 for rivet nomograph illustration.

1-127. Rivet Pitch.

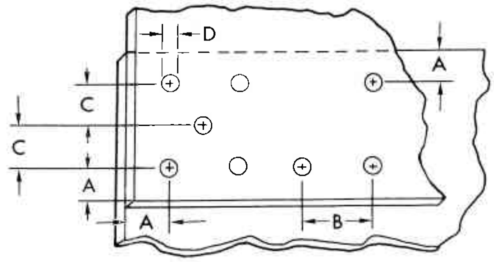
1-128. A minimum rivet pitch of four rivet diameters has been established; however, when a repair requires the next heavier gage of material or where three or more rows of rivets are required, the pitch may be reduced but should never be less than three rivet diameters. Since the pitch of four rivet diameters will reduce the strength of the material to approximately 75 percent along the center line of a row of rivets, care must be exercised at all times to avoid weakening the structure below its original strength. When more than one row of rivets are used they should, whenever possible, be staggered to retain the maximum strength of the repair. See figure 1-32 for rivet pattern layout.

1-129. Aluminum Alloy Rivets.

1-130. Standard solid aluminum alloy rivets are described below. These rivets are manufactured with AN470 universal heads or MS20426, 100-degree countersunk heads. Refer to Table 1-XXII for rivet substitution data and to Table 1-XLIV for standard drill sizes and hole diameter limits.

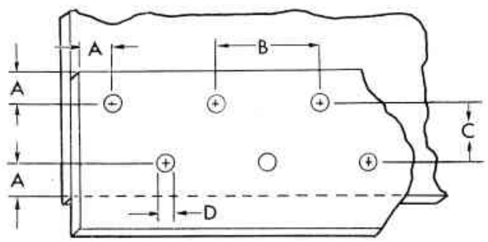
a. "B" Rivets: 5056-F material. Relatively soft, non-heat treatable rivets. These rivets are used only in nonstressed areas or for the purpose of attaching magnesium skins. Refer to Table 1-XV for the number of rivets required per inch of seam.

b. "AD" Rivets: 2117-T3 material. Most commonly used rivet, particularly where flush application is required. Refer to Tables 1-III and 1-IV for rivets required per inch of seam.



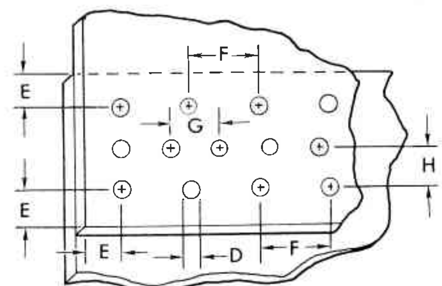
PROTRUDING HEAD OR DIMPLED SKIN

A. Edge distance (2D minimum).
B. Pitch or spacing (4D minimum).
C. Row spacing (2.5D minimum).
D. Rivet diameter.



COUNTERSUNK SKIN

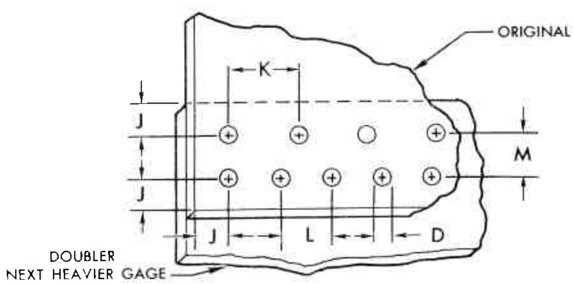
A. Edge distance (2D minimum).
B. Pitch or spacing (6D minimum).
C. Row spacing (3.5D minimum).
D. Rivet diameter.



PROTRUDING HEAD OR DIMPLED SKIN REPAIR

Patch or doubler same gage as original. When 3 or more rows of rivets are used the pitch of the center row may be 3D if the row spacing is 3.5D.

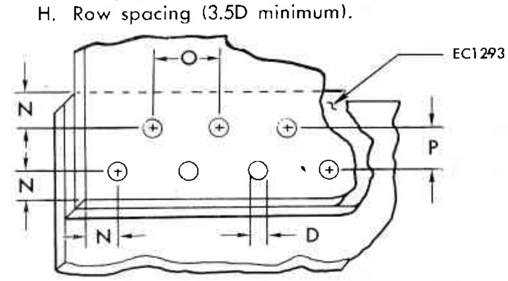
D. Rivet diameter.
E. Edge distance (2D minimum).
F. Pitch, outside rows (4D minimum).
G. Pitch, center rows (3D minimum).
H. Row spacing (3.5D minimum).



PROTRUDING HEAD OR DIMPLED SKIN REPAIR

Patch or doubler one gage heavier than original. When 2 or more rows of rivets are used the pitch of the inner row may be 3D.

D. Rivet diameter.
J. Edge distance (2D minimum).
K. Pitch, outer row (4D minimum).
L. Pitch, inner row (3D minimum).
M. Row spacing (2.5D minimum).



REPAIR OF FUSELAGE SKIN IN PRESSURIZED AREA USING COUNTERSUNK HEAD RIVETS IN DIMPLED SHEET

Repair to be standard except as noted:

D. Rivet diameter.
N. Edge distance (2D minimum).
O. Pitch (4D minimum +10 per cent maximum).
P. Row spacing (2.5D minimum).

Pattern must consist of at least 2 rows with rivets staggered. EC1293 must be applied between all faying surfaces.

NOTE:
THESE MINIMUM VALUES ARE APPLICABLE TO ALL RIVETED REPAIRS UNLESS OTHERWISE NOTED. WIDER SPACING IS GENERALLY DESIRABLE.

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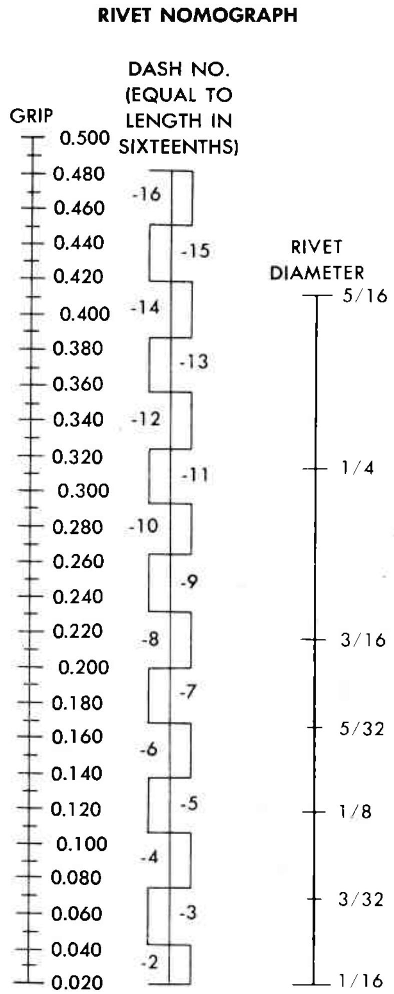
Figure 1-32. Standard Minimum Rivet Spacing



Instructions: Place a straight edge on the Nomograph from the point on the rivet diameter scale indicating the diameter of the rivet to be used, to the point on the grip scale indicating the required grip. The dash number for the correct rivet length will be found at the intersection of the straight edge and the dash number scale. In cases where the straight edge intersects the point between the two dash numbers, use the higher of the two numbers.

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Figure 1-33. Rivet Nomograph — Ratio of Length to Grip

c. "DD" Rivets: 2024-T31 material. Strongest solid aluminum alloy rivet. These rivets harden rapidly after heat treatment; however, the hardening process may be suspended by storing the rivets in a refrigerator at −23°C (−10°F). "DD" rivets must be driven within 30 minutes after removal from refrigerator. Rivets kept out of the refrigerator for more than 30 minutes MUST be reheat treated. DO NOT RETURN HARDENED RIVETS TO REFRIGERATOR. Since fresh, soft rivets form better than reprocessed rivets, do not remove large quantities of rivets from the refrigerator. Rivets shall be moisture-free upon installation. Refer to Tables 1-III and 1-IV for rivets required per inch of seam.

1-131. Straylor Rivets.

1-132. The Straylor rivet is a high-bearing, sealing-head rivet designed primarily to insure a liquid-tight seal at the riveted joint. The manufactured head of the rivet is designed to fit nearly flush within a counter-bored hole in the outer surface of fuel-tight skins and is milled after driving. A soft aluminum foil washer is installed under the head of each rivet to aid in producing a liquid-tight seal. These rivets are made of 2024-T31 aluminum alloy that hardens rapidly after heat treatment; however, the hardening process may be suspended by storing the rivets in a refrigerator at −23°C (−10°F). Straylor rivets must be driven within 30 minutes after removal from refrigerator. Rivets kept out of the refrigerator for more than 30 minutes MUST NOT be reheat treated. DO NOT RETURN HARDENED RIVETS TO REFRIGERATOR. Since fresh, soft rivets seal best, do not remove large quantities of rivets from the refrigerator. Rivets shall be moisture-free upon installation. The manufactured heads of these rivets shall be milled after driving to within the tolernance shown on figure 1-25 for aerodynamic smoothness. Mill with a standard ½-inch mill equipped with a guide and stop. Each rivet head contains a special dimple that is partly cut away after milling, thus indicating the depth of the counterbore in the skin. Specification MIL-C-5541 chemical film or equivalent shall be applied to rivet heads after milling. A piece of scrap should be used to test and adjust the counterbore tool for correct depth before counterboring repair parts. Refer to Tables 1-XVI and 1-XVII for rivets required per inch of seam and see figure 1-34 for installation data.

1-133. Removal of Straylor Rivets.

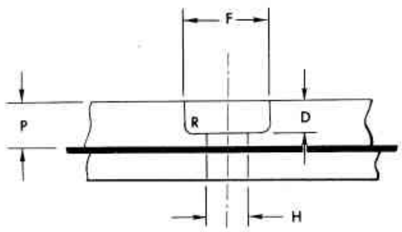
1-134. Use remaining portion of inspection dimple to locate center of manufactured head and proceed as shown on figure 1-35.

1-135. Monel Rivets.

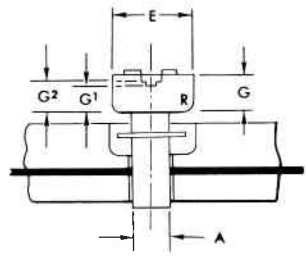
1-136. Monel rivets have excellent corrosion and heat resistant properties. They may be used in high-stressed areas of the structure and are particularly suitable for attaching titanium in areas subjected to high temperatures. Refer to Tables 1-VIII through 1-XIV for rivets required per inch of seam.

1-137. Corrosion Resistant Steel Rivets.

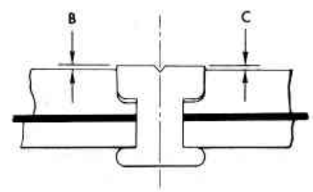
1-138. Corrosion resistant steel rivets are very high-strength rivets with a hollow end in the solid shank to aid in forming the shop head. These rivets are used in areas subjected to high temperatures and are



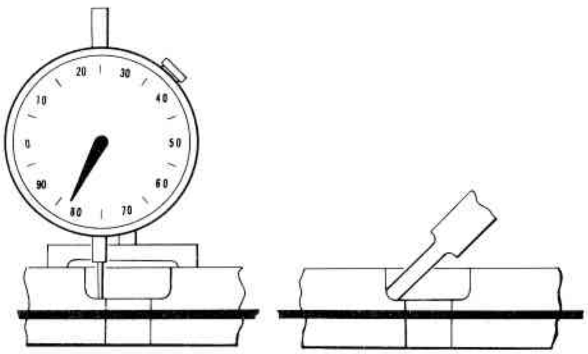
RIVET HOLE DIMENSION
SEE TABLE I



RIVET DIMENSIONS
SEE TABLE II

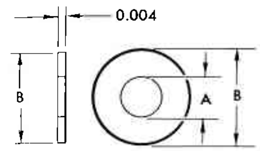


RIVET DIMENSION AFTER DRIVING
SEE TABLE I

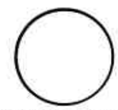


DIAL DEPTH GAGE RADIUS GAGE

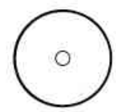
SEE TABLE IV



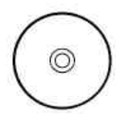
WASHER DIMENSIONS
SEE TABLE III



RIVET NOT SEATED
OR NOT COUNTERBORED
DEEP ENOUGH



RIVET PROPERLY
INSTALLED



COUNTERBORE
TOO DEEP

NOTES:
1. BOTH THE DRILLED HOLE AND THE COUNTERBORE MUST HAVE THE SAME CENTER.
2. USE DIAL DEPTH GAGE AND RADIUS GAGE TO DETERMINE ACCURACY OF COUNTERBORE.
3. USE SPECIAL COUNTERBORE TOOLS LISTED IN TABLE IV.
4. PROTRUSION OF RIVET MUST NOT BE OVER 0.004 AFTER MILLING.
5. TRACE OF DIMPLE TO 0.020 SHOULD BE VISIBLE AFTER MILLING.
6. THE ALUMINUM WASHER IS A MANDATORY SEAL TO INSURE A FUEL TIGHT SEAM.

TABLE I

RIVET DASH NO.		-6	-8
D COUNTERBORE DEPTH	+0.003 −0.003	0.072	0.080
F COUNTERBORE HOLE DIAMETER	+0.005 −0.000	0.330	0.440
H HOLE DIAMETER	+0.005 −0.000	0.190	0.253
P MINIMUM TOP SKIN THICKNESS		0.114	0.125
R COUNTERBORE RADIUS	+0.005 −0.005	0.030	0.040
B MINIMUM HEIGHT AFTER DRIVING		0.015	0.015
BEFORE MILLING		0.015	0.015
C AFTER MILLING		0.004	0.004

TABLE II

RIVET DASH NO.		-6	-8
A SHANK DIAMETER	+0.0025 −0.0005	0.187	0.250
E HEAD DIAMETER	+0.000 −0.005	0.330	0.440
G HEAD DEPTH	+0.011 −0.000	0.105	0.115
R RADIUS	+0.005 −0.005	0.030	0.040
G¹ RIVET DIMPLE	+0.003 −0.003	0.057	0.065
G² RIVET DIMPLE	+0.003 −0.003	0.082	0.090

TABLE III

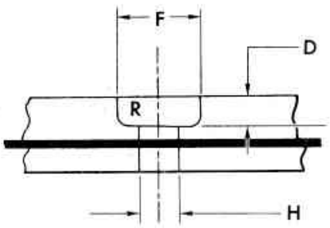
RIVET DIAMETER	WASHER NUMBER	A +0.002 −0.000	B +0.002 −0.000
Q4326-6	Q7106-6	0.189	0.275
Q4326-8	Q7106-8	0.252	0.365

TABLE IV

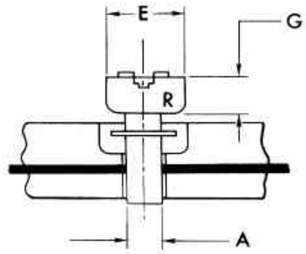
RIVET DIAMETER	COUNTERBORE TOOL
Q4326-6	NO. CBCUM8J-752
Q4326-8	NO. CBCUM8J-753

06.03.025-1A .51.04.00

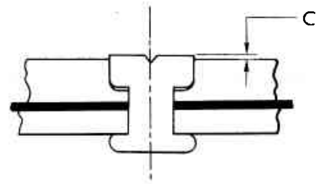
Figure 1-34. Installation of Straylor Rivets (Sheet 1 of 2)



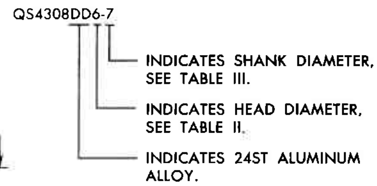
RIVET HOLE DIMENSION
SEE TABLE I



RIVET DIMENSIONS
SEE TABLES II AND III



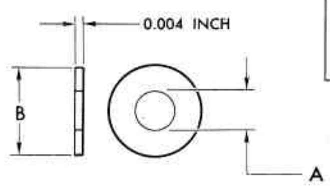
RIVET DIMENSION AFTER DRIVING
SEE TABLE I



RIVET CODE EXAMPLE

NOTES:

1. REPAIR USAGE MUST BE APPROVED BY STRUCTURAL ENGINEERING AUTHORITIES.
2. BOTH DRILLED HOLE AND COUNTERBORE MUST HAVE SAME CENTER.
3. USE DIAL DEPTH GAGE AND RADIUS GAGE TO DETERMINE ACCURACY OF COUNTERBORE, REFER TO SHEET 1.
4. PROTRUSION OF RIVET MUST NOT BE OVER 0.004 INCH AFTER MILLING.
5. TRACE OF DIMPLE TO 0.020 INCH SHOULD BE VISIBLE AFTER MILLING, REFER TO SHEET 1 FOR RIVET DIMPLE IDENTIFICATION.
6. THE ALUMINUM WASHER IS A MANDATORY SEAL TO INSURE A FUEL TIGHT SEAM.



WASHER DIMENSIONS
SEE TABLE IV

CAUTION

QS4308 SERIES, STRAYLOR REPAIR SEAL HEAD RIVETS DEFINITELY SHALL NOT BE USED EXCEPT WITH SPECIFIC APPROVAL OF STRUCTURAL ENGINEERING AUTHORITIES. REFER TO SHEET 1 FOR STANDARD STRAYLOR SEAL HEAD RIVET (Q4326 SERIES) DIMENSIONS AND INSTALLATIONS.

TABLE II

HEAD SIZE DASH NUMBER		DD-6	DD-8
E HEAD DIAMETER	+0.000 −0.005	0.330	0.440
R CORNER RADIUS	+0.005 −0.005	0.030	0.040
G HEAD THICKNESS	+0.003 −0.003	0.111	0.121

TABLE III

SHANK SIZE DASH NUMBER		-7	-9
A SHANK DIAMETER	+0.0025 −0.0005	0.219	0.281

TABLE I
RECOMMENDED DIMENSIONS FOR REPAIR

QS4308 DASH NUMBERS		DD6-7	DD8-9
D COUNTERBORE DEPTH	+0.003 −0.003	0.072	0.080
F COUNTERBORE HOLE DIAMETER	+0.005 −0.000	0.330	0.440
H HOLE DIAMETER	+0.005 −0.000	0.222	0.284
R COUNTERBORE RADIUS	+0.005 −0.005	0.030	0.040
C AFTER MILLING	+0.000 −0.004	0.004	0.004

TABLE IV

RIVET DIAMETER	WASHER NUMBER	A +0.002 −0.000	B +0.002 −0.000
QS4308DD6-7	Q7106-6-7	0.221	0.271
QS4308DD8-9	Q7106-8-9	0.283	0.365

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Figure 1-34. Installation of Straylor Rivets (Sheet 2 of 2)

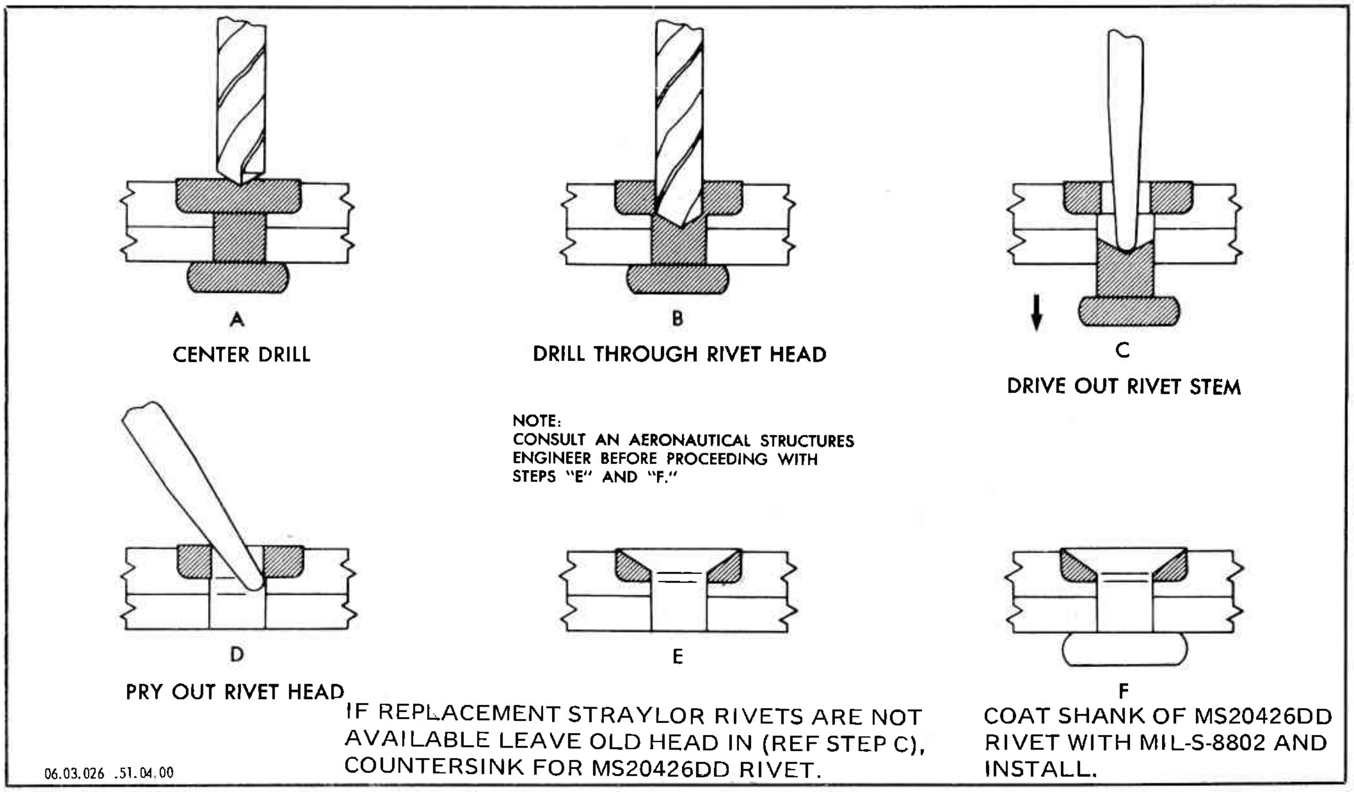


Figure 1-35. Removal of Straylor Rivets

particularly suitable for joining highly stressed parts of the structure. They are driven with ordinary riveting equipment (see figure 1-36). Refer to Tables 1-VII through 1-XIV for rivets required per inch of seam.

1-139. Hi-Shear Rivets.

1-140. Hi-Shear rivets are made of cadmium plated, heat-treated steel. These rivets are used in highly stressed joints in the structure. See figure 1-37 for an illustration of Hi-Shear rivet installation standards. Refer to Tables 1-XXXIV and 1-XXXVII for hole size, countersink, and spotface dimensions. Consult structural engineering authorities before spotfacing material around Hi-Shear rivet holes.

1-141. Huck Lockbolts.

1-141A. Huck Blind Bolts.

1-141B. Huck blind bolts are used in high-stressed areas where the use of a blind fastener is required. The type used is a pull-type, 100-degree countersunk head: serrated steel pin, steel sleeve and steel mechanical lock all of which are cadmium plated. This type of fastener requires the use of a special pulling tool for installation. See figure 1-39A for Huck blind bolt data.

1-142. Huck Lockbolts are used extensively in high-stressed areas where heavier gages of material occur. These lockbolts are notable for their high shear strengths and rigid tightening and locking characteristics. The two types of Huck lockbolts most commonly used are as follows:

a. Pull-type, protruding pan head or 100-degree countersunk head: Cadmium plated steel pin and 2024-T4 aluminum alloy collar. Requires pulling with special lockbolt pulling tool.

b. Stump-type, protruding pan head or 100-degree countersunk head: Cadmium plated steel pin and 2024-T4 aluminum alloy collar. This type is driven with a standard rivet gun and a special set for swaging the collar. It does not have the extended stem with the pull grooves. See figures 1-38 and 1-39 for installation and removal procedures for Huck lockbolts.

1-143. Blind Rivets.

1-144. The use of blind rivets is generally restricted to areas where lack of accessibility prohibits the use of the conventional type of rivet. In most instances, their use is confined to low or nonstressed areas of the structure and, when making repairs, it is recommended that prior structural engineering approval be obtained should their application be contemplated. In all cases of installation of blind rivets, the following rules are most important:

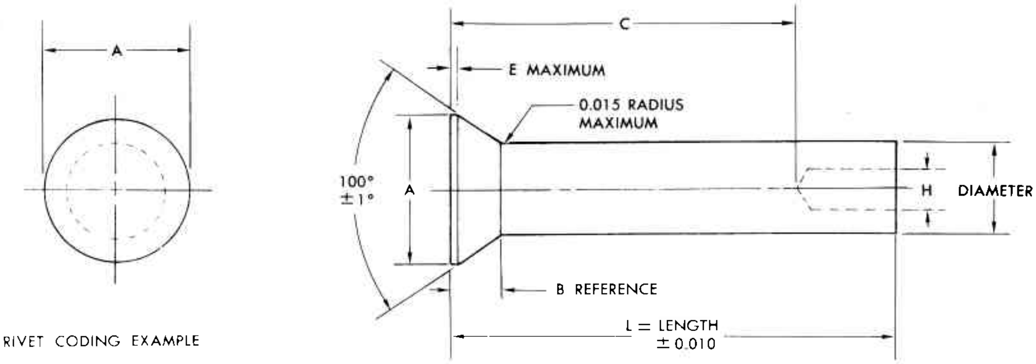
a. Holes must be held to prescribed limits.

b. Burrs and chips must be cleaned from holes.

c. Material to be riveted must be clamped tightly together.

d. When rivet replacement is required, the next larger size shall be used.

e. Proper rivet grip lengths must be selected.



RIVET CODING EXAMPLE

Q4304-C7-12
- 0.75-INCH LONG
- 0.219-INCH DIAMETER
- CORROSION RESISTING STEEL RIVET, 100° COUNTERSUNK HEAD

DIMENSIONS								
DIAMETER +0.003 −0.001	0.094	0.125	0.156	0.187	0.219	0.250	0.312	0.375
A	0.170 +0.002 −0.006	0.216 +0.002 −0.006	0.278 +0.002 −0.006	0.344 +0.003 −0.007	0.403 +0.003 −0.007	0.467 +0.003 −0.007	0.555 +0.003 −0.007	0.685 +0.003 −0.007
B +0.001 −0.003	0.036	0.042	0.055	0.070	0.075	0.095	0.106	0.134
C	—	—	—	(L−0.135)	(L−0.175)	(L−0.205)	(L−0.255)	(L−0.305)
H	—	—	—	0.098 0.083	0.114 0.099	0.130 0.115	0.161 0.146	0.193 0.178
E	0.008	0.008	0.010	0.010	0.010	0.012	0.012	0.012

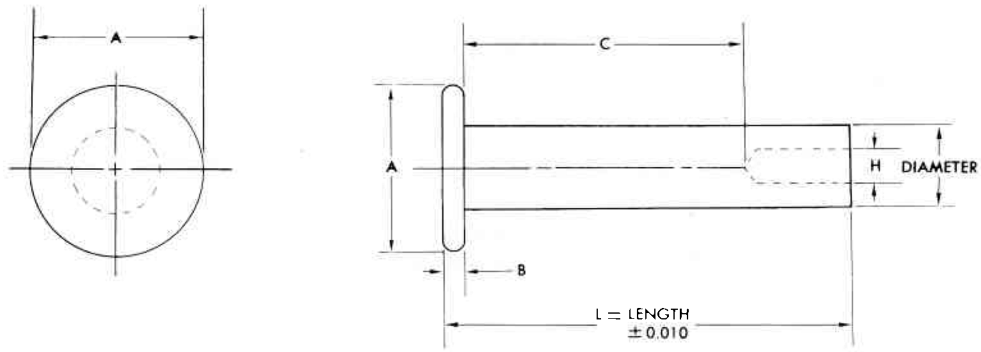
LENGTH	DASH NUMBERS AND DIAMETERS							
	0.094	0.125	0.156	0.187	0.219	0.250	0.312	0.375
0.188	3-3	4-3						
0.250	3-4	4-4	5-4	6-4				
0.312	3-5	4-5	5-5	6-5	7-5			
0.375	3-6	4-6	5-6	6-6	7-6	8-6		
0.438	3-7	4-7	5-7	6-7	7-7	8-7		
0.500	3-8	4-8	5-8	6-8	7-8	8-8	10-8	
0.625	3-10	4-10	5-10	6-10	7-10	8-10	10-10	12-10
0.750	3-12	4-12	5-12	6-12	7-12	8-12	10-12	12-12
0.875	3-14	4-14	5-14	6-14	7-14	8-14	10-14	12-14
1.000	3-16	4-16	5-16	6-16	7-16	8-16	10-16	12-16
1.125	3-18	4-18	5-18	6-18	7-18	8-18	10-18	12-18
1.250	3-20	4-20	5-20	6-20	7-20	8-20	10-20	12-20
1.375	3-22	4-22	5-22	6-22	7-22	8-22	10-22	12-22
1.500	3-24	4-24	5-24	6-24	7-24	8-24	10-24	12-24
1.625	3-26	4-26	5-26	6-26	7-26	8-26	10-26	12-26

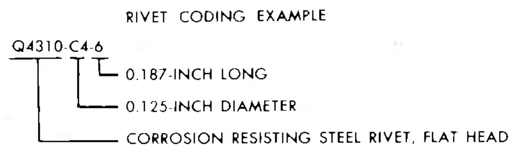
NOTES:

1. USE OF CORROSION RESISTING STEEL RIVETS IS RESTRICTED TO SPECIAL CASES IN CORROSION RESISTANT STEEL WHERE RESISTANCE TO CORROSION IS OF PRIME IMPORTANCE AND IN ALUMINUM ALLOY WHERE CLEARANCES AND OTHER DESIGN CONSIDERATIONS DO NOT PERMIT THE USE OF A SUFFICIENT NUMBER OF ALUMINUM ALLOY RIVETS TO OBTAIN THE DESIRED SHEAR VALUES.
2. USE OF THESE RIVETS IS NOT RECOMMENDED IN GRIP LENGTHS EXCEEDING ONE INCH UNLESS THE PROPOSED APPLICATION IS APPROVED BY AN AERONAUTICAL STRUCTURES ENGINEER.
3. THESE RIVETS HAVE BEEN CADMIUM PLATED IN ACCORDANCE WITH SPECIFICATION QQ-P-416, TYPE 1, CLASS A.
4. Q4304 AND Q4310 RIVETS ARE TO BE DRIVEN IN THE SAME MANNER AS ORDINARY SOLID SHANK RIVETS.

06.03.314-1

Figure 1-36. Q4304 and Q4310 Rivet Installation (Sheet 1 of 2)





DIMENSIONS								
DIAMETER $^{+0.003}_{-0.001}$	0.094	0.125	0.156	0.187	0.219	0.250	0.312	0.375
A	0.187 ±0.009	0.250 ±0.012	0.312 ±0.016	0.375 ±0.019	0.437 ±0.020	0.500 ±0.025	0.625 ±0.031	0.750 ±0.037
B ±0.005	0.032	0.042	0.052	0.062	0.075	0.083	0.104	0.125
C $^{+0.025}_{-0.000}$	—	—	—	(L − 0.135)	(L − 0.175)	(L − 0.205)	(L − 0.255)	(L − 0.305)
H	—	—	—	0.098 0.083	0.114 0.099	0.130 0.115	0.161 0.146	0.193 0.178

LENGTH	DASH NUMBERS AND DIAMETERS							
	0.094	0.125	0.156	0.187	0.219	0.250	0.312	0.375
0.188	3-3	4-3						
0.250	3-4	4-4	5-4	6-4				
0.312	3-5	4-5	5-5	6-5	7-5			
0.375	3-6	4-6	5-6	6-6	7-6	8-6		
0.438	3-7	4-7	5-7	6-7	7-7	8-7		
0.500	3-8	4-8	5-8	6-8	7-8	8-8	10-8	
0.625	3-10	4-10	5-10	6-10	7-10	8-10	10-10	12-10
0.750	3-12	4-12	5-12	6-12	7-12	8-12	10-12	12-12
0.875	3-14	4-14	5-14	6-14	7-14	8-14	10-14	12-14
1.000	3-16	4-16	5-16	6-16	7-16	8-16	10-16	12-16
1.125	3-18	4-18	5-18	6-18	7-18	8-18	10-18	12-18
1.250	3-20	4-20	5-20	6-20	7-20	8-20	10-20	12-20
1.375	3-22	4-22	5-22	6-22	7-22	8-22	10-22	12-22
1.500	3-24	4-24	5-24	6-24	7-24	8-24	10-24	12-24
1.625	3-26	4-26	5-26	6-26	7-26	8-26	10-26	12-26

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Figure 1-36. Q4304 and Q4310 Rivet Installation (Sheet 2 of 2)

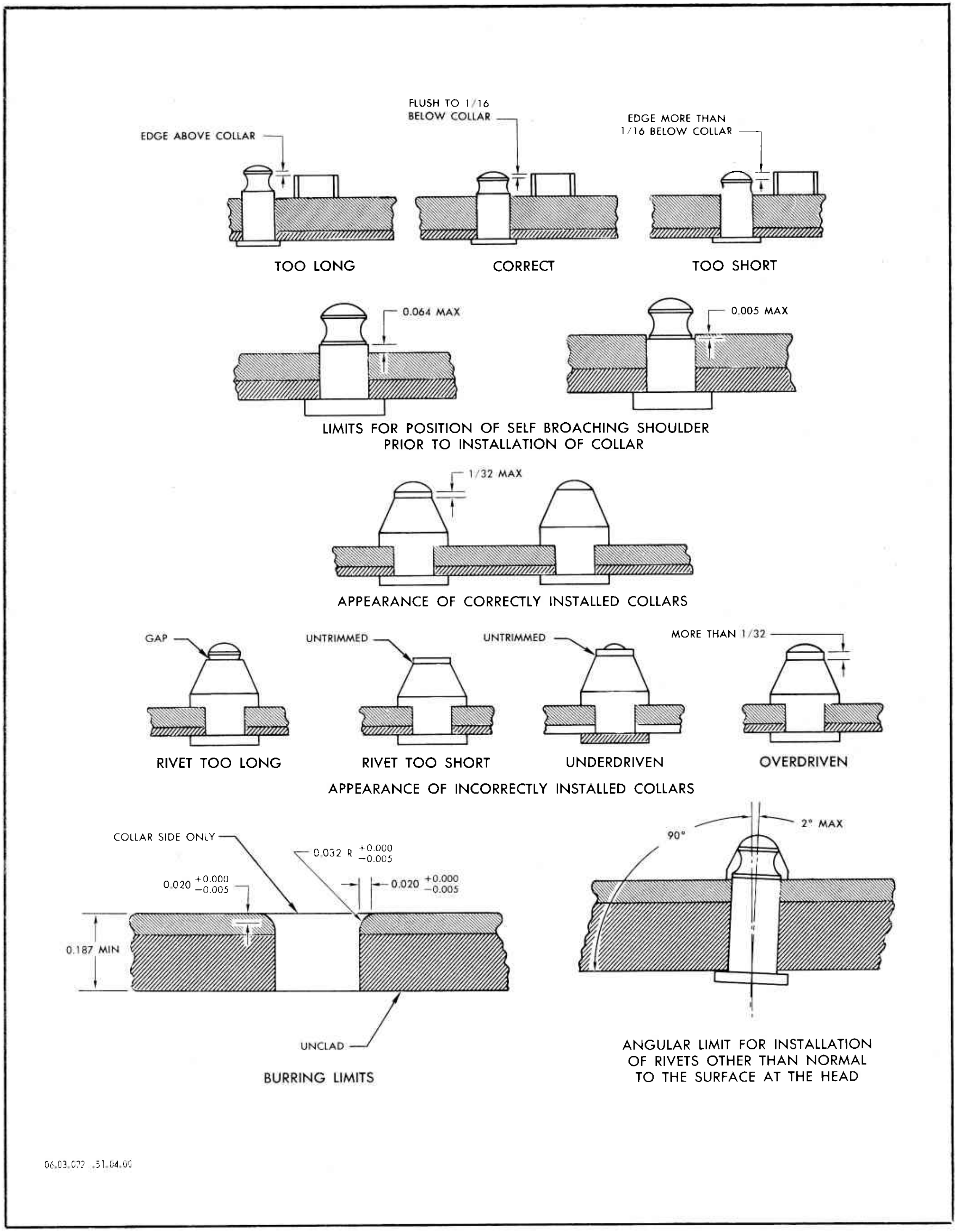
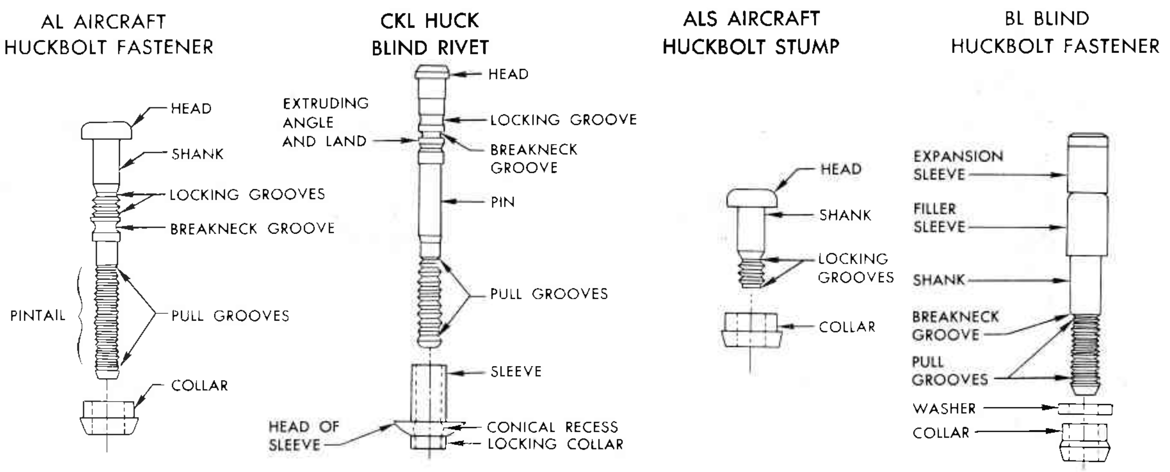
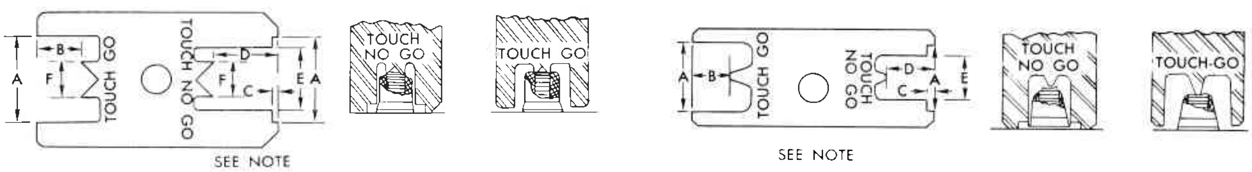


Figure 1-37. Installation of Hi-Shear Rivets





TYPE AL HUCKBOLT INSPECTION GAGE DIMENSIONS							
GAGE	HUCKBOLT	A	B	C	D	E	F
HG85-1	AL-E6 OR T6	3/8	0.190	0.038	0.291	0.303	0.164
HG85-2	AL-E8 OR T8	15/32	0.278	0.038	0.396	0.400	0.224
HG85-3	AL-E10	9/16	0.339	0.083	0.459	0.486	0.268
HG85-4	AL-E12	11/16	0.411	0.062	0.549	0.602	0.339
HG85-5	R1028-29-T10	9/16	0.309	0.136	0.421	0.486	0.268
HG85-6	R1028-29-T12	11/16	0.400	0.124	0.520	0.589	0.339
HG85-7	AL-E5	5/16	0.167	0.030	0.230	0.253	0.136

TYPE ALS HUCKBOLT INSPECTION GAGE DIMENSIONS						
GAGE	HUCKBOLT	A	B	C	D	E
HG34D-1	ALS-E6	3/8	0.238	0.0675	0.322	0.2972
HG34D-2	ALS-T6		0.218	0.0585	0.288	
HG34D-3	ALS-E8	15/32	0.307	0.0735	0.399	0.3942
HG34D-4	ALS-T8		0.301	0.0795	0.371	
HG34D-5	ALS-E10	9/16	0.399	0.0645	0.479	0.4992
HG34D-6	ALS-T10		0.384	0.1065	0.449	0.4862
HG34D-7	ALS-E12	11/32	0.496	0.1195	0.582	0.5892
HG34D-8	ALS-T12		0.480	0.1565	0.545	

TYPE AL HUCKBOLT PART NUMBER IDENTIFICATION

ALP P H — T 6 — 4

- GRIP LENGTH EQUALS SHANK LENGTH IN 16THS OF AN INCH.
- SHANK DIAMETER IN 32NDS OF AN INCH.
- MATERIAL: T EQUALS HEAT TREATED ALLOY STEEL CADMIUM PLATED. E EQUALS 7075-T ALUMINUM ALLOY.
- TYPE: H EQUALS PINTAIL LONGER FOR AUTOMATIC HOLE FILL. N EQUALS PINTAIL SHORTER FOR DRIVE FIT.
- HEAD: P EQUALS PAN HEAD. 426 EQUALS AN426 COUNTERSUNK HEAD. 509 EQUALS CLOSE TOLERANCE HEAD.
- AIRCRAFT HUCKBOLT PIN.

TYPE AL HUCKBOLT IDENTIFICATION			
ALL SIZES	HEAD SHAPE	MATERIAL	IDENTIFICATION
ALPPH-T	PAN	STEEL	⊕ DEPRESSED
ALP426H-T	COUNTERSUNK	STEEL	⊕ RAISED
ALPPH-E	PAN	ALUMINUM	NONE
ALP426H-E	COUNTERSUNK	ALUMINUM	⊙ RAISED
ACT509H-T	COUNTERSUNK	STEEL	⊗ DEPRESSED
ACT509H-E	COUNTERSUNK	ALUMINUM	ⓥ DEPRESSED

TYPE ALS HUCKBOLT PART NUMBER IDENTIFICATION

ALS F — E 6 — 4

- GRIP LENGTH EQUALS SHANK LENGTH IN 16THS OF AN INCH.
- SHANK DIAMETER IN 32NDS OF AN INCH.
- MATERIAL: E EQUALS 7075-T ALUMINUM ALLOY. T EQUALS HEAT TREATED ALLOY STEEL CADMIUM PLATED.
- HEAD: F EQUALS FLAT HEAD. ASCT509 EQUALS CLOSE TOLERANCE AN509 HEAD.
- AIRCRAFT HUCKBOLT STUMP.

TYPE ALS HUCKBOLT IDENTIFICATION			
ALL SIZES	HEAD SHAPE	MATERIAL	IDENTIFICATION
ALSF-T	FLAT	STEEL	⊕ DEPRESSED
ALSF-E	FLAT	ALUMINUM	NONE
ASCT509-T	COUNTERSUNK	STEEL	⊗ DEPRESSED
ASCT509-E	COUNTERSUNK	ALUMINUM	ⓥ DEPRESSED

NOTE:
NORMALLY, A VISUAL INSPECTION IS SUFFICIENT WHEN CHECKING THE INSTALLATION OF HUCKBOLTS. IF THERE IS ANY DOUBT, CHECK THE HUCKBOLT WITH AN INSPECTION GAGE AS SHOWN.

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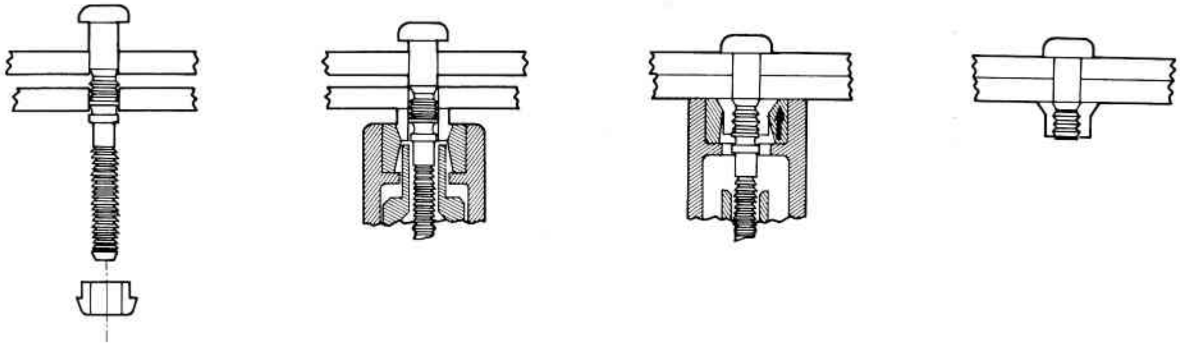
Figure 1-38. Installation of Huck Lockbolts (Sheet 1 of 3)



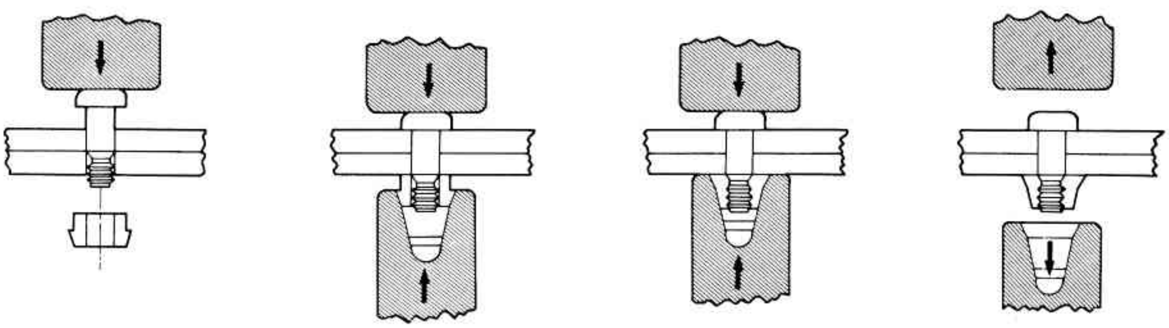
DRILL HOLE ACCORDING TO TABLE BELOW AND INSERT HUCKBOLT.

PLACE COLLAR OVER HUCKBOLT AND PLACE RIVET PULL GUN IN POSITION.

PULL RIVET GUN TRIGGER TO PULL MATERIAL TOGETHER AND TO SQUEEZE COLLAR INTO PLACE.

SQUEEZE TRIGGER UNTIL HUCKBOLT BREAKS. TO INSURE PROPER INSTALLATION, CHECK HUCKBOLT WITH INSPECTION GAGE AS SHOWN ON SHEET 1.

INSTALLATION PROCEDURE FOR TYPE AL HUCKBOLTS



DRILL HOLE ACCORDING TO TABLE BELOW AND INSERT HUCKBOLT.

PLACE COLLAR OVER HUCKBOLT. HOLD A BUCKING BAR AGAINST MANUFACTURED HEAD AND PLACE RIVET GUN NOSE SECTION OVER COLLAR.

HOLDING BUCKING BAR FIRMLY AGAINST MANUFACTURED HEAD, SQUEEZE RIVET GUN TRIGGER UNTIL NOSE SECTION OF RIVET GUN TOUCHES MATERIAL.

CHECK HUCKBOLT FOR PROPER INSTALLATION WITH INSPECTION GAGE AS SHOWN ON SHEET 1.

INSTALLATION FOR TYPE ALS HUCKBOLTS

	SUGGESTED HOLE PREPARATION FOR AL AND ALS HUCKBOLTS				
		DRIVE FIT		LOOSE FIT	
HOLE DIAMETER	PRE DRILL SIZE	DRILL SIZE	HOLE LIMITS	DRILL SIZE	HOLE LIMITS
5/32	NO. 26 (0.147)	NO. 20 (0.161)	0.161 TO 0.164	NO. 19 (0.166)	0.166 TO 0.171
3/16	NO. 18 (0.1695)	NO. 13 (0.185)	0.185 TO 0.188	NO. 11 (0.191)	0.191 TO 0.201
1/4	NO. 1 (0.288)	6.2MM (0.2441)	0.244 TO 0.247	1/4 (0.250)	0.250 TO 0.260
5/16	L (0.290)	7.8MM (0.3071)	0.307 TO 0.372	5/16 (0.3125)	0.3125 TO 0.322
3/8	11/32 (0.343)	U (0.368)	0.369 TO 0.372	3/8 (0.375)	0.375 TO 0.385

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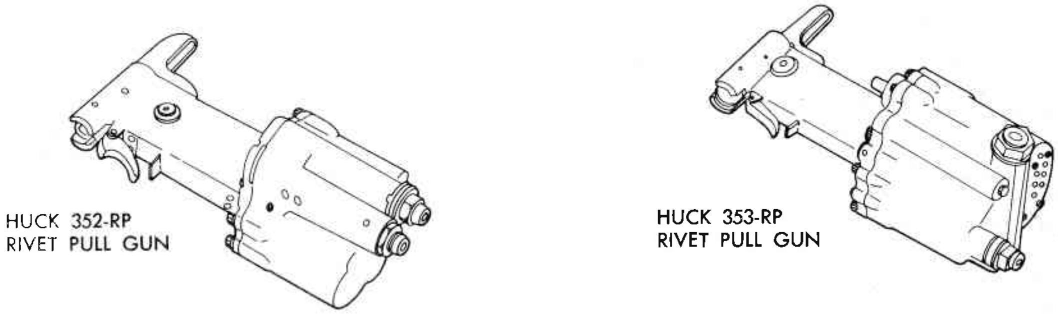
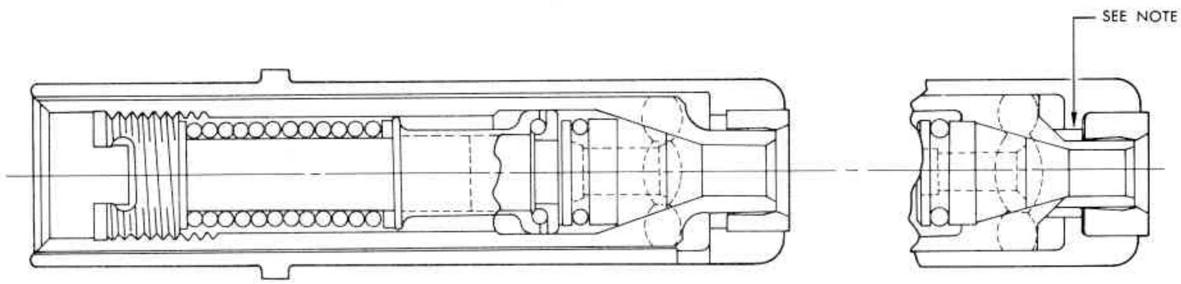
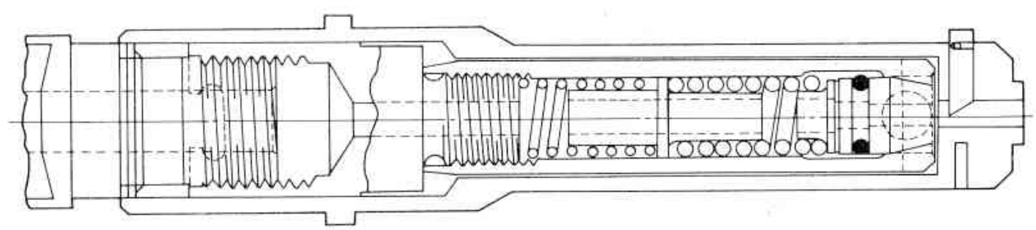
Figure 1-38. Installation of Huck Lockbolts (Sheet 2 of 3)





NOSE ASSEMBLY FOR AL AND ALS TYPE HUCKBOLTS. MAY BE USED WITH EITHER 352-RP OR 353-RP RIVET PULL GUN.



NOSE ASSEMBLY FOR BL TYPE HUCKBOLTS. MAY BE USED WITH EITHER 352-RP OR 353-RP RIVET PULL GUN.

NOTE:
A GUIDE BUSHING IS INSERTED IN THE NOSE SECTION WHEN INSTALLING SAL-6, L6, AND BL-8 TYPE HUCKBOLTS.

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Figure 1-38. Installation of Huck Lockbolts (Sheet 3 of 3)

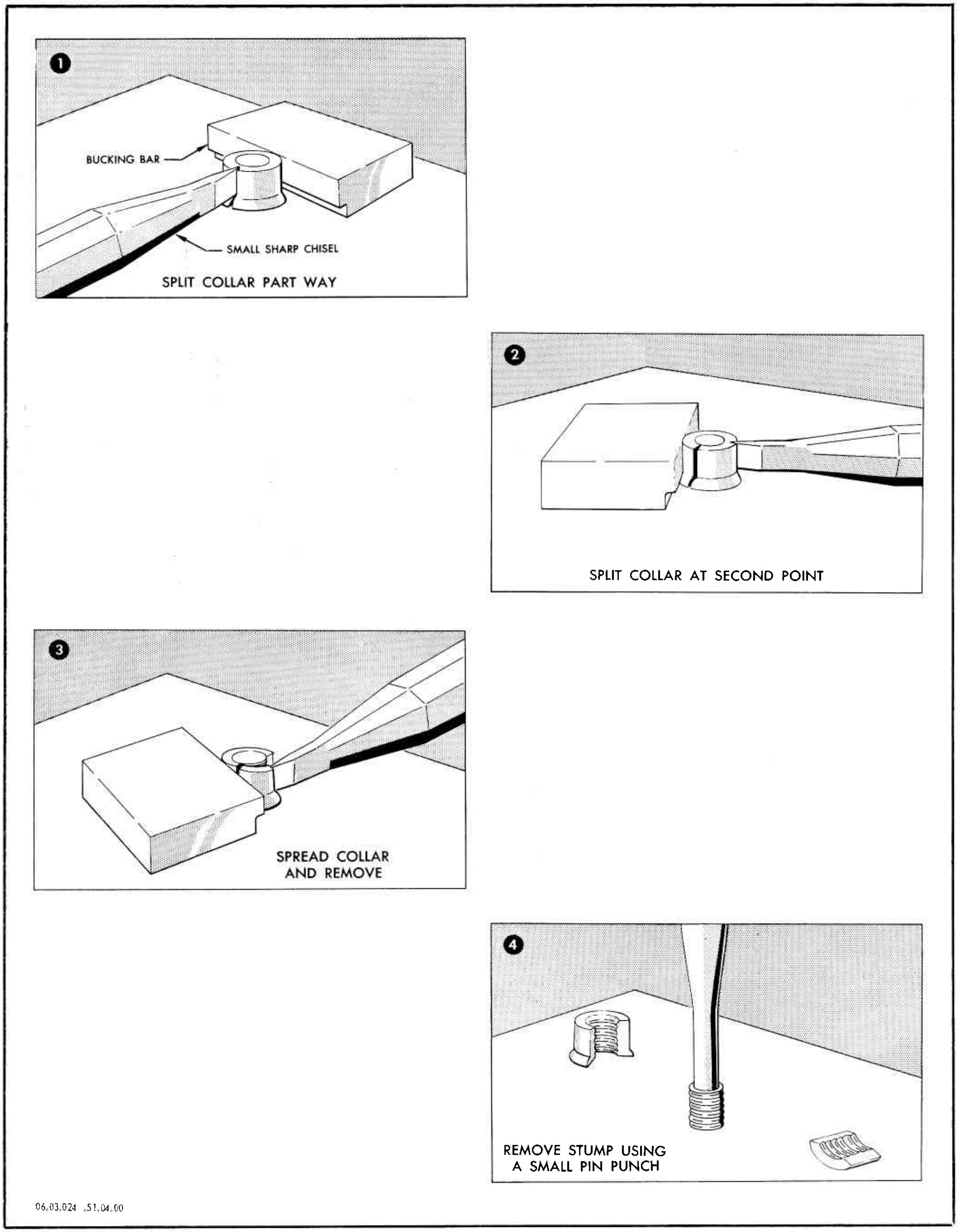
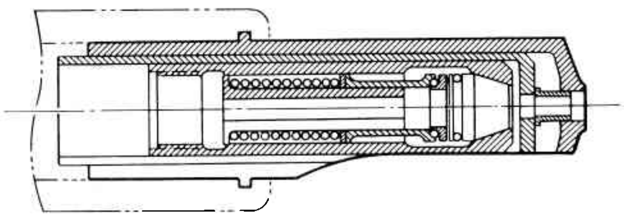


Figure 1-39. Removal of Huck Lockbolts

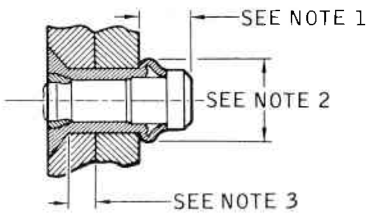


HUCK NOSE ASSEMBLY NO. 99-589 (3/16) OR NO. 99-600 (5/32) USED FOR COUNTERSUNK ALS HUCK BLIND BOLTS. USE WITH MODEL 200 HUCK PULL GUN.

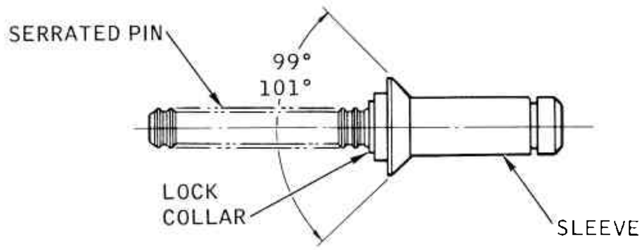
NOTE

HUCK PULL GUN MUST BE ADJUSTED FOR EACH DIAMETER BOLT. FOR 5/32-INCH BOLTS, SET GUN FOR A SHIFT PRESSURE OF 2005 (±100) PSI. FOR 3/16-INCH BOLTS, SET GUN FOR A SHIFT PRESSURE OF 3025 (±150) PSI. USE HUCK PRESSURE SETTING KIT NO. 101300 FOR SETTING SHIFT PRESSURE.

ALS COUNTERSUNK HUCK BLIND BOLT FASTENER



INSTALLED FASTENER



NOTES

1. FOR 5/32-INCH BOLT, 0.120-0.202 INCH. FOR 3/16-INCH BOLT, 0.146-0.231 INCH.
2. MAXIMUM DIAMETER NOT TO EXCEED DIAMETER OF MANUFACTURED HEAD.
3. MINIMUM SHEET BEARING FOR 5/32-INCH BOLT, 0.016 INCH. MINIMUM SHEET BEARING FOR 3/16-INCH BOLT, 0.020 INCH.

MS PART NUMBER:

MS90353-0507 = FASTENER, BLIND, HIGH STRENGTH, PULL TYPE, POSITIVE MECHANICAL LOCK, 100° COUNTERSUNK HEAD, ALLOY STEEL, 112 K.S.I.

- GRIP NUMBER IN 16TH INCHES.
- DIAMETER DASH NUMBER IN 32ND INCHES.
- MS PART NUMBER.

TYPE ALS HUCK BLIND BOLT IDENTIFICATION			
ALL SIZES	HEAD SHAPE	MATERIAL	IDENTIFICATION
MS90353 (B100-T)	COUNTERSUNK	STEEL	DEPRESSED

HUCK PART NUMBER:

B100-T 5-7

- GRIP NUMBER IN 16TH INCHES.
- DIAMETER DASH NUMBER IN 32ND INCHES.
- HUCK FASTENER IDENTIFICATION.

SUGGESTED HOLE PREPARATION FOR HUCK BLIND BOLTS			
HOLE DIAMETER	PRE DRILL SIZE	HOLE FINISH SIZE	HOLE LIMITS
5/32	NO. 26 (0.147)	NO. 19 (0.1660)	0.164 TO 0.167
3/16	NO. 18 (0.1695)	NO. 8 (0.1990)	0.199 TO 0.202

STRENGTH OF HUCK BLIND BOLTS		
PIN MATERIAL	HEAT TREATED ALLOY STEEL	
SLEEVE MATERIAL	HEAT TREATED ALLOY STEEL	
LOCK COLLAR MATERIAL	CRES OR CARBON STEEL	
LOADING / PIN DIAMETER	SHEAR STRENGTH-LBS	TENSILE STRENGTH-LBS
5/32	2340	1350
3/16	3450	2100

65R-986-44

Figure 1-39A. Installation of Huck Blind Bolts

When preparing the holes for rivet installation use a pilot and then a finish drill. Use a sharp drill held at a 90-degree angle to the work. Use prescribed riveting tools, and keep material clamped together at frequent intervals during application. Should a rivet be improperly installed, it should, in all cases, be replaced.

CAUTION

Blind rivets may be used inside of air intake ducts and forward of air induction system only when impossible to use solid rivets. Refer to Section X, paragraph 10-7 for use and substitution of blind rivets/fasteners in these areas.

1-145. DuPont Noiseless Explosive Rivets.

1-146. Two types of DuPont noiseless explosive rivets are used in the structure: the aluminum alloy, 5056 rivet, and the Nickel-L rivet. Refer to Tables 1-VI and 1-VII for rivets required per inch of seam. These rivets are used only where inaccessibility prevents the use of conventional type rivets. They are installed from one side by one operator using a rivet iron or spinning tool on the exposed head to explode the charge of powder in the rivet shank which expands the blind end of the rivet. A DuPont heating iron is recommended, but any iron may be used that is equipped with a temperature control that can be adjusted to cause rivet expansion within 1½ to 6 seconds. See figures 1-41 and 1-42 for operational procedures using heat or spin type explosive rivet tools. Test iron temperature with sample rivets. Holes must be carefully drilled by first using a pilot drill and then redrilling to finish size. Remove burrs and clean chips or shavings from parts. Refer to Table 1-XXXVIII for limits on drill and hole sizes. Rivets are installed as follows:

a. Insert rivet in hole. Be sure it is properly seated. Tap if necessary.

b. Apply heated riveting iron to top of rivet head with sufficient pressure to insure good contact. Keep tip at right angles to, and centered on, the rivet head. Within 1½ to 6 seconds, the charge will fire, expanding the rivet shank to fill the hole and form the upset head.

c. Remove tip of heating iron immediately after rivet expands. Rivet expansion is indicated by the sound of a muffled report.

NOTE

Discard rivets that do not expand within the 6-second time limit. Do not attempt to reheat.

The explosive charge in the DuPont rivet is mixed with a metal powder, and when rivets are driven too close to adjacent structure, particles of the metal powder will be driven into the surface by the explosion and may cause corrosion. In some cases the adjacent material may be protected by the use of a strip of metal or the pitted area can be coated with zinc chromate; however, Table 1-XXXIX, which shows the permissible distances from the ends of the rivets to the adjacent material, should be followed whenever possible. DuPont explosive rivets may be removed by the standard rivet removal procedure outlined in T.O. 1-1A-1, General Manual for Structural Repair.

WARNING

Do not expand explosive rivets in the presence of inflammable vapors, gases, or combustible dusts.

Refer to Tables 1-XL and 1-XLI for grip lengths. Sheets and members must be clamped tightly together while riveting is in process in order to insure a flush contact, as these rivets do not draw the sheets together.

1-147. Storage of Explosive Rivets.

1-148. The following precautions should be exercised in storing explosive rivets:

a. Keep rivets in boxes in which they are received.

b. Store in dry place, preferably in closed cabinet.

c. Avoid temperatures in excess of 48°C (120°F).

d. Keep open fires away from rivets.

1-149. Huck Blind Rivets.

1-150. The Huck blind rivet consists of a sleeve made of 6056 aluminum alloy having a brazier or countersunk head with a conical recess and locking collar at the outer end, and a pin made of 2014-RT aluminum that is pressed into the sleeve. The pin is provided with pull grooves that fit the jaws of the rivet gun. In installation, the pin is pulled through the sleeve to form a head on the blind side. The driven rivet must be expanded to completely fill the hole; therefore, it is important that the drilled holes and grip lengths be held to the limits specified in Tables 1-XLII and 1-XLIII. The installation of Huck blind rivets is illustrated on figure 1-40.

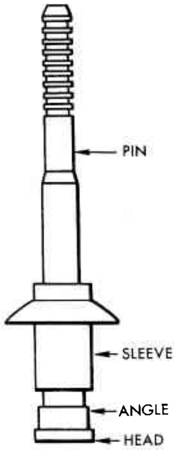
1-151. Cherry Blind Rivets.

1-152. Cherry rivets are the three following types:

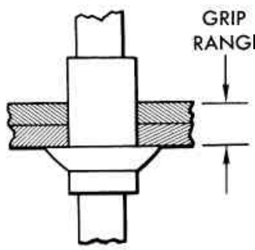
a. The hollow-type rivet in which the stem sets the rivet and is then broken, one portion falling out on the blind side.

b. The self-plugging type rivet, in which the stem remains in the manufactured head of the rivet and must be flush after the stem has been broken.

c. The pull-through type, in which the stem pulls through the rivet and collapses the mandrel on the stem.

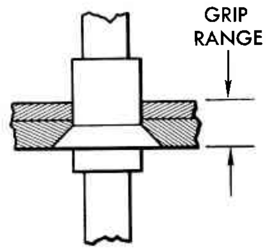


ASSEMBLED
HUCK BLIND RIVET



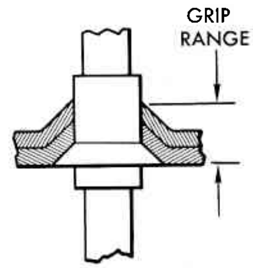
BRAZIER HEAD

Rivets are furnished in various sleeve lengths to accommodate various thicknesses of material. The range of the material thickness is referred to as the grip range.



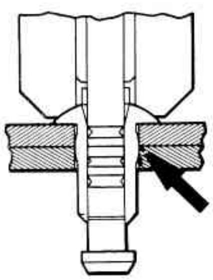
COUNTERSUNK HEAD
(SHEET MACHINE COUNTERSUNK)

To determine the grip range required for rivet application, the total thickness of the material should be measured with a hook scale through the rivet hole. To obtain proper grip range, clamp all parts involved together at point of measurement.



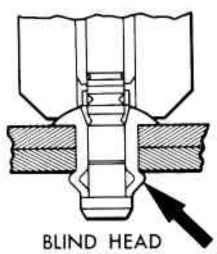
COUNTERSUNK HEAD
(SHEETS DIMPLED)

When rivet holes are to be dimpled the measurement must include the height of the dimple. The type of dimple and degree of bellmouth will affect the grip range.



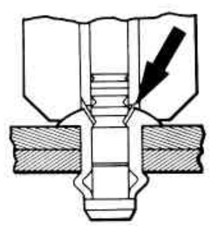
SLEEVE EXPANSION

During the initial part of the driving operation, the rivet gun pulls the extruding angle and land of the pin through the sleeve, expanding the sleeve to fill the hole.



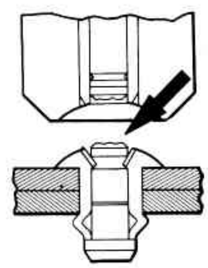
BLIND HEAD
FORMATION

The sleeve is squeezed between the head of the pin and the nose of the rivet gun to form the blind head.



POSITIVE
MECHANICAL LOCK

When blind head has been formed the gun forces the locking collar (at outer end of sleeve) into conical space between the recess in the head and the locking groove in the pin, rigidly locking the parts together.



PIN BREAK

The pin is then broken off in tension at the breakneck groove, flush with the head of the sleeve completing the installation of the rivet.

NOTES:
1. SEE TABLE I-VI FOR RIVETS REQUIRED PER INCH OF SEAM.
2. SEE TABLE I-XLII FOR DRILL SIZES AND HOLE DIAMETER LIMITS.
3. SEE TABLE I-XLIII FOR HUCK BLIND RIVET GRIP LENGTHS.

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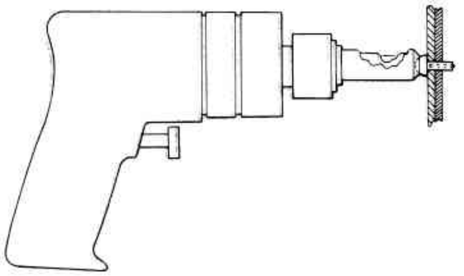
Figure 1-40. Installation of Huck Blind Rivets

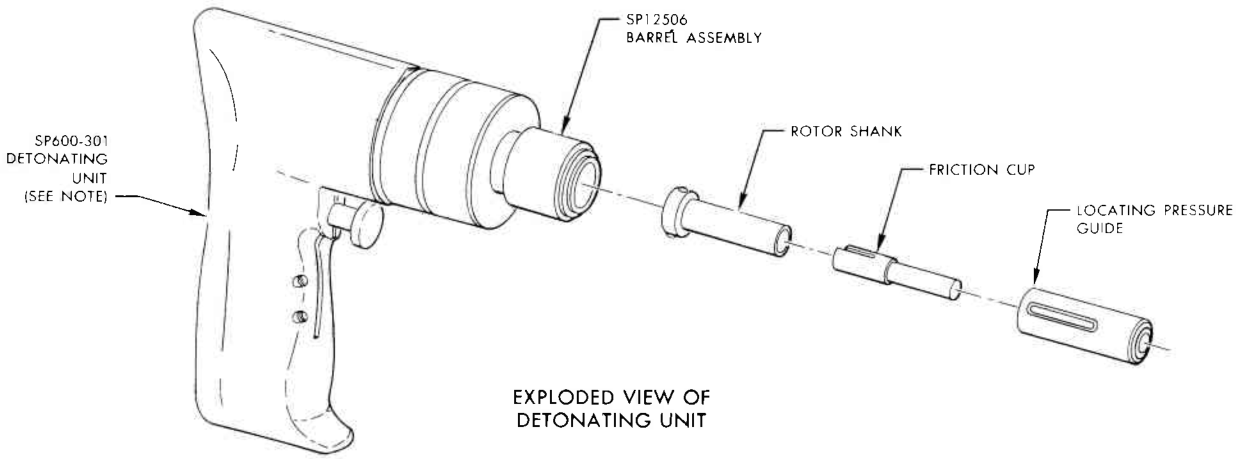


ASSEMBLED VIEW OF DETONATING UNIT

TABLE I

ROTOR SHANK		
PART NO.	LENGTH	LOCATING PRESSURE GUIDES USED
SP601-34	1.828	SP602-1A, -2A, -3A
SP601-35	2.828	SP602-1B, -2B, -3B
SP601-36	3.828	SP602-1C, -2C, -3C
SP601-37	4.828	SP602-1D, -2D, -3D
SP601-38	6.828	SP602-1E, -2E, -3E

NOTE:
IF SP600-301 DETONATING UNIT IS NOT AVAILABLE, ANY AIR MOTOR CAPABLE OF PRODUCING 15,000 TO 18,000 RPMS MAY BE USED BY ATTACHING A DRILL STOP ADAPTER.



EXPLODED VIEW OF DETONATING UNIT

TABLE II

LOCATING PRESSURE GUIDE			
PART NO.	LENGTH	RIVET SIZE	FRICTION CUPS USED
SP602-1A	1.125	1/8	SP603-20
SP602-1B	2.125		
SP602-1C	3.125		
SP602-1D	4.125		
SP602-1E	6.125		
SP602-2A	1.125	5/32	SP603-21
SP602-2B	2.125		
SP602-2C	3.125		
SP602-2D	4.125		
SP602-2E	6.125		
SP602-3A	1.125	3/16	SP603-22
SP602-3B	2.125		
SP602-3C	3.125		
SP602-3D	4.125		
SP602-3E	6.125		

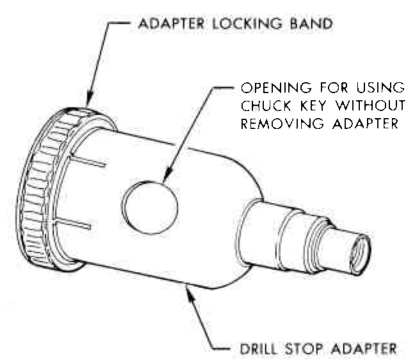


TABLE III

FRICTION CUP	
PART NO.	RIVET SIZE
SP603-20	1/8
SP603-21	5/32
SP603-22	3/16

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Figure 1-41. Explosive Rivet — Friction Detonator Tool

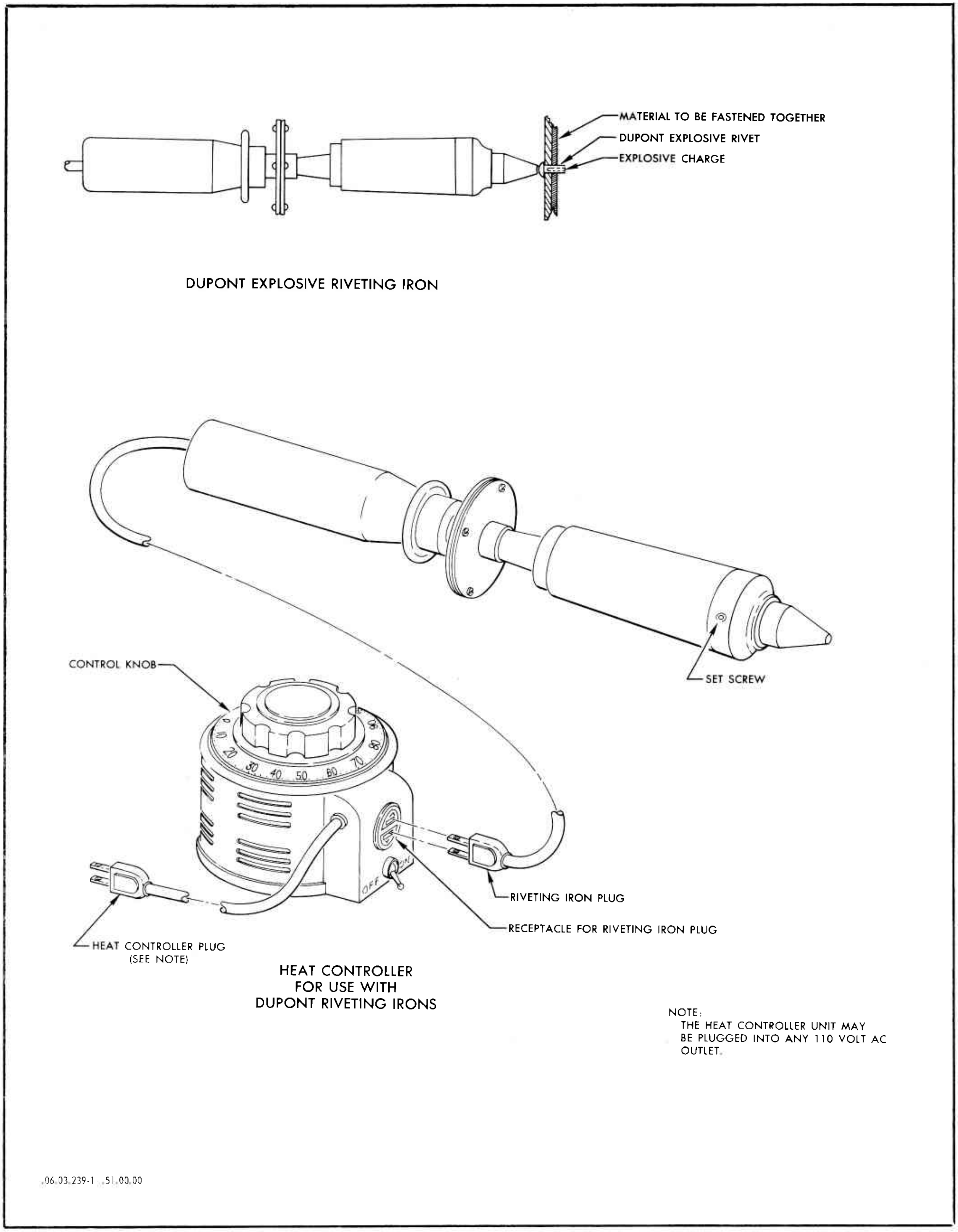


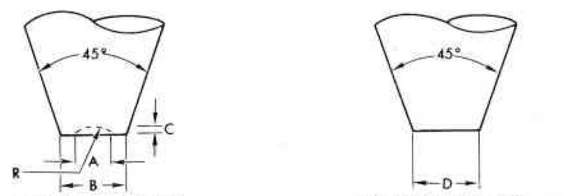
Figure 1-42. Explosive Rivet — Heat Detonator Tool (Sheet 1 of 2)

TABLE I

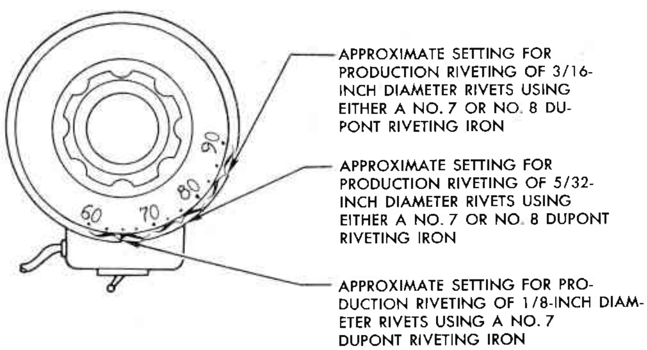
PROPER TIPS AND THEIR POINT DIMENSIONS FOR BRAZIER HEAD RIVETS						
RIVET DIAMETER	TIPS DESIGNATION		POINT DIMENSIONS			
	NO. 7	NO. 8	A	B	C	R(RADIUS)
1/8	7-B4	8-B4	0.170	0.220	0.020	0.181
5/32	7-B5	8-B5	0.210	0.260	0.025	0.226
3/16	7-B6	8-B6	0.250	0.300	0.030	0.272

TABLE II

PROPER TIPS AND THEIR POINT DIMENSIONS FOR COUNTERSUNK HEAD RIVETS			
RIVET DIAMETER	TIP DESIGNATION		POINT DIMENSIONS
	NO. 7	NO. 8	D
1/8	7-C4	8-C4	0.135
5/32	7-C5	8-C5	0.175
3/16	7-C6	8-C5	0.200



BRAZIER TYPE TIP
COUNTERSUNK TYPE TIP
DUPONT RIVETING IRON TIPS



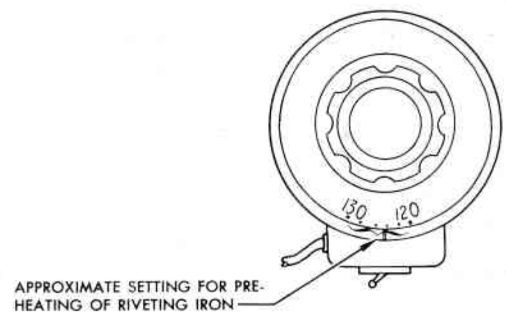
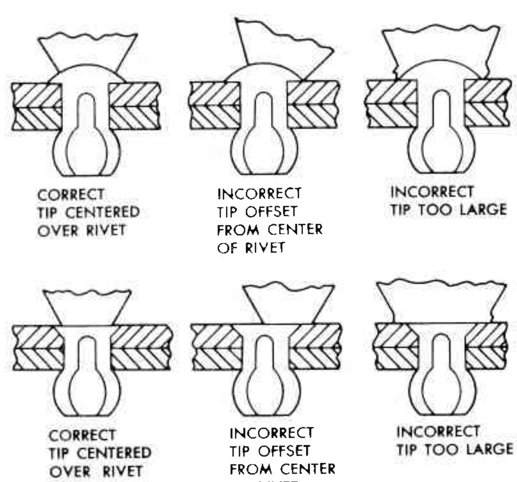


TABLE III

APPROXIMATE HEAT CONTROLLER SETTINGS			
RIVET DIAMETER	RIVET DESIGNATION (EITHER DR OR 56S)	HEAT CONTROL SETTINGS FOR	HEAT CONTROL SETTINGS FOR
		NO. 7 IRON	NO. 8 IRON
1/8	-134A -134-100	63 TO 74 78 TO 88	—
5/32	-173A -173-100	63 TO 71 74 TO 80	70 TO 72 78 TO 80
3/16	-204A -204-100	70 TO 75 83 TO 89	75 TO 77 85 TO 87



CORRECT AND INCORRECT METHOD OF APPLYING TIPS TO RIVETS.

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Figure 1-42. Explosive Rivet—Heat Detonator Tool (Sheet 2 of 2)

The type most commonly used is the self-plugging rivet which consists of a mandrel or stem and a shank of 2117-T4 alloy or monel. A hand or power rivet tool may be used to pull the mandrel into the sleeve to form a head on the blind side. These rivets shall not be used except in cases of emergency, and then only by structural engineering approval.

CAUTION

Cherry blind rivets shall not be employed under any circumstances in pressurized areas or in the engine air induction system structure.

1-153. Jo-Bolts.

1-154. The three types of Jo-Bolts most commonly used are:

a. Blind, protruding hex head, nonmillable, type P; the bolt, nut, and sleeve are made of cadmium plated steel.

b. Blind, countersunk, millable-head, type FA; bolt and sleeve are made of cadmium plated steel, and the nut is made of 7075-T6.

c. Blind, countersunk, flush-head, type F; the bolt, nut, and sleeve are made of cadmium plated steel.

These Jo-Bolts may be installed by one operator inserting the bolt assembly in the rivet hole and using a power or hand tool fitted with a wrench and nose adapter to complete the application. The nose adapter holds the nut in place as the wrench adapter screws the bolt outward to pull the sleeve over the end of the nut, thus forming a head on the blind side. At the time the blind head is formed, the bolt stem is broken off flush with the outer surface of the nut. Bolt stems that do not break off within the limits shown on figure 1-43 indicate that the bolts are not of the proper grip length and should be removed and replaced with correct grip-length bolts. (See figure 1-44 for Jo-Bolt removal information.) Before milling, measure stems for the millable type FA bolts. The countersunk, millable-head type is milled down to the prescribed limits shown on figure 1-25.

CAUTION

These bolts shall not be employed in locations where the bolt or nut components, in the event they become loose, may be drawn into the engine air induction system.

These bolts should be limited to application in which the loads are primarily shear and where the bolts normally may not be subject to replacement. The break-off end of the bolts should be painted with zinc chromate primer after installation as a preventive against corrosion. This type of fastener shall be employed only when approved by an aeronautical structures engineer.

1-155. Blind Bolts (Hi-Shear Core Bolts).

1-156. Blind bolts (Hi-Shear core bolts) may be used instead of Jo-Bolts. Blind bolts should be used where shear loads exist and where only one side is accessible. See figure 1-46 for blind bolt installation procedure and figure 1-47 for bolt identification and usage.

1-156A. Hi-Lok Fasteners.

1-156B. Hi-Lok fasteners, as shown in Figure 1-47A, are used in areas where high-shear strength is required. The fastener consists of a threaded pin and a threaded collar. Hi-Lok pins are available with protruding heads, 100-degree countersunk heads, and 100-degree countersunk sealing heads (used with wet sealant). The pins are made from the following materials: cadmium-plated corrosion resistant steel (CRES), cadmium-plated or nickel cadmium-plated heat-resistant steel, and titanium alloys. Use of Hi-Lok fasteners ranges from attachment of brackets to joining of structural members. The threaded end of the pin is recessed to accommodate use of an allen hex wrench which is used to hold the pin stationary while the collar is being threaded on or off. The threaded collars are automatically tightened to the proper torque when the wrenching portion of the collar shears off during the tightening process. Tightening of the threaded collars is accomplished using an allen wrench and a box end or open end wrench. Re-use of Hi-Lok pins is permissible providing the pins have not been damaged during removal.

1-156C. Removal of Hi-Lok Fasteners.

1-156D. Remove fasteners as follows:

a. Using the proper size allen wrench to hold the pin, unscrew the threaded collar from the pin using pliers.

b. Remove pin from hole. It may be necessary to tap the pin with a nonmetallic hammer for pin removal.

1-156D. Installation of Hi-Lok fasteners.

1-156E. Install Hi-Lok fasteners as follows:

a. Prepare fastener hole in accordance with Figure 1-47B instructions for flush head or protruding head fastener.

b. Measure thickness of structures to be joined and select Hi-Lok pin of proper length.

Note

When material thickness falls between two standard fastener grip lengths; the next longer grip length fastener shall be used.

c. With structures in place and secured, insert pin into hole.

d. If fastener grip length is too long, one washer may be installed under either the nut or the fastener head (protruding type). To minimize dissimilar metal corrosion and to keep added washer weight to a minimum, washer usage shall be as follows:

1. Use AN960PD( ) anodized aluminum washers against aluminum, magnesium, and nonmetallic surfaces.

2. Use AN960-( ) cadmium-plated steel washers against cadmium-plated or painted steel surfaces.

3. Use AN960C( ) CRES washers against CRES or titanium surfaces.

e. Drive pins, installed in interference fit holes, using a rivet gun; check fastener for proper grip length and add washer if necessary.

f. Thread collar on to pin until finger tight.

g. Using and allen wrench and a box end wrench, tighten collar until collar wrenching portion shears off.

h. Check for a slight protrusion of the pin chamfered end beyond the collar. This indicates that the pin is of the proper length. Threads protruding beyond the collar indicates the need of a washer under the collar, or that the pin is of incorrect length.

1-157. Deutsch Drive Pin Blind Rivets.

Deutsch drive pin blind rivets are not used in production of the F-106. If they are used to make emergency repairs, their use should be restricted to nonstructural parts and they should be replaced as soon as approved types of blind fasteners become available. Figure 1-45 illustrates installation procedures for Deutsch drive pin blind rivets.

1-158. Helical Coil Inserts.

1-159. Helical coil inserts are screw-thread bushings coiled from wire, diamond-shaped in cross section, which accommodate both the internal thread of the tapped hole and the external thread of the bolt or screw. Helical coil inserts are made from 18-8 stainless steel, Specification AMS 7245, helically coiled wire. When installed in a heli-coil tapped hole, the insert has a permanent standard internal thread with a class 3B tolerance. The insert is made with a tang (a portion of the bottom coil that has been offset to provide a means of installation). This tang is left on the insert after installation, except when tang removal is necessary for screw or bolt clearance. A V-shaped notch is provided adjacent to the tang to provide a clean break-off point on the tang after installation. See figure 1-48 for identification and installation of helical coil inserts used on this airplane. See figure 1-49 for helical coil removal procedure.

1-160. Ball-Lok Receptacles.

1-161. Ball-Lok receptacles facilitate rapid installation and removal of ground support equipment. See figure 1-50 for replacement of Ball-Lok receptacles.

1-162. Bolt and Screw Attachments.

1-163. AN bolts may be used as substitutes for Hi-Shear rivets with specific structural engineering approval. Refer to Tables 1-VII through 1-XV for fasteners required per inch of seam. NAS bolts are high-tension bolts used only for attaching structural components where high stress loads are imposed on and transmitted through the bolts. Do not replace these bolts with AN bolts. Where practical, all screws and bolts installed in an up-and-down direction shall be installed with the head upward.

NOTE

Where applicable, all screws and bolts shall be installed with the head on the outside of

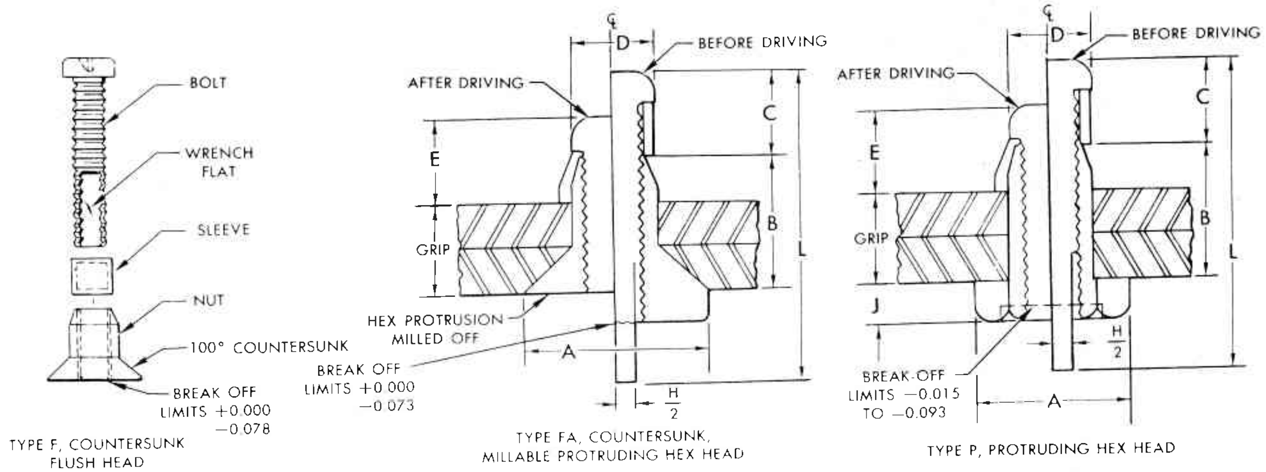


TABLE I

JO-BOLT INSTALLATION DATA											
PART NO.	DRILL SIZE	FINAL DRILL OR REAM DIA	JO-BOLT NOMINAL DIA	A	C	D	E	H	J	100° COUNTERSINK DIAMETER
F200	#15 (0.180)	MAX 0.202	3/16	• 0.385	0.262	0.199	0.209			MAX 0.390
		MIN 0.199		• 0.378	0.242	0.197				MIN 0.375
F260	#D (0.246)	MAX 0.263	1/4	• 0.507	0.315	0.260	0.292			MAX 0.510
		MIN 0.260		• 0.499	0.295	0.258				MIN 0.495
P200	#15 (0.180)	MAX 0.202	3/16	0.312	0.272	0.199	0.235	0.105	0.116	
		MIN 0.199		0.302	0.252	0.197		0.098	0.100	•
FA200	#15 (0.180)	MAX 0.202	3/16	*0.346	0.272	0.199	0.235	0.105		MAX 0.335
		MIN 0.199		*0.332	0.252	0.197		0.098		MIN 0.325
FA260	#D (0.246)	MAX 0.263	1/4	*0.472	0.334	0.260	0.292	0.137		MAX 0.460
		MIN 0.260		*0.458	0.297	0.258		0.129		MIN 0.450

*ACROSS HEX FLATS
• THEORETICALLY SHARP — (MAXIMUM LAND 0.20)

TABLE II

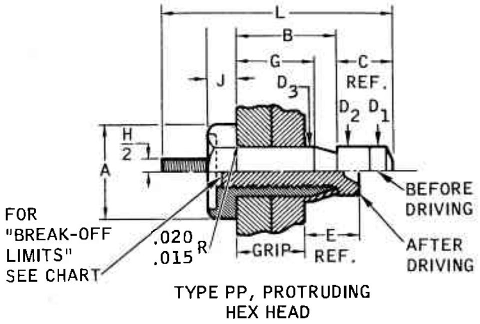
GRIP LENGTHS DATA												
DASH NO.	GRIP RANGE		F200		F260		P200		FA200		FA260	
	MIN	MAX	B ±0.015	L ±0.015	B ±0.015	L ±0.015	B ±0.015	L ±0.015	B ±0.015	L ±0.015	B ±0.015	L ±0.015
2	0.094	0.156	0.228	0.853	0.246	0.880	0.228	0.936	0.308	0.936	0.336	0.960
3	0.156	0.219	0.291	0.916	0.309	0.994	0.291	0.999	0.371	0.999	0.399	1.023
4	0.219	0.281	0.353	0.978	0.371	1.006	0.353	1.061	0.433	1.061	0.461	1.085
5	0.281	0.344	0.416	1.041	0.434	1.069	0.416	1.124	0.496	1.124	0.524	1.148
6	0.344	0.406	0.478	1.103	0.496	1.131	0.478	1.186	0.558	1.186	0.586	1.210
7	0.406	0.469	0.541	1.166	0.559	1.194	0.541	1.249	0.621	1.249	0.649	1.273
8	0.469	0.531	0.603	1.228	0.621	1.256	0.603	1.311	0.683	1.311	0.711	1.335
9	0.531	0.594	0.666	1.291	0.684	1.319	0.666	1.374	0.746	1.374	0.774	1.398
10	0.594	0.656	0.728	1.353	0.745	1.381	0.728	1.436	0.808	1.436	0.836	1.460

TABLE III

JO-BOLT DRIVING TOOL DATA					
JO-BOLT PART NO.	POWER TOOL	ADAPTER ASSEMBLY	NOSE ADAPTER	WRENCH ADAPTER	RATCHET HAND TOOL
F200	LOK-FAST MODEL 30200	PW300	PW3002	PW3001	HWF200
F260	LOK-FAST MODEL 30260	PW360	PW3602	PW3601	HWF260
P200	LOK-FAST MODEL 30200P	PW300P	PW3002P	PW3001	HWP200
FA200	LOK-FAST MODEL 30200A	PW300A	PW3002A	PW3001	HWA200
FA260	LOK-FAST MODEL 30260A	PW360A	PW3602A	PW3601	HWA260

06.03.030-1A

Figure 1-43. Installation of Jo-Bolts (Sheet 1 of 3)



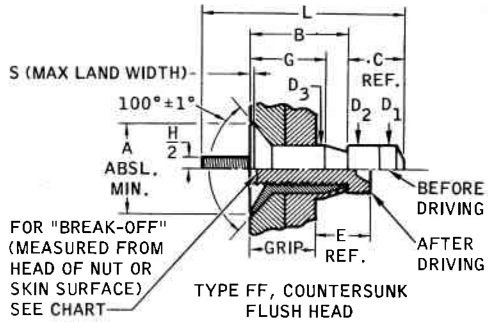


TABLE I

JO-BOLT INSTALLATION DATA

PART NO.	DRILL SIZE	FINAL DRILL OR REAM DATA	JO-BOLT NOMINAL DIA	A	C	D_1	D_2	D_3	E	H	J	100° COUNTERSINK DIAMETER
NAS1669-08 (PP164)	#25	MAX 0.168	0.164	0.250	0.248	0.161	0.163	0.1645	0.215	0.086	0.096	-
		MIN 0.165		0.244	-	0.156	0.158	0.1625	-	0.081	0.086	-
NAS1669-3 (PP200)	#15	MAX 0.202	3/16	0.312	0.276	0.199	0.199	0.1990	0.245	0.104	0.113	-
		MIN 0.199		0.305	-	0.195	0.197	0.1970	-	0.099	0.103	-
NAS1670-3 (FF200)	#15	MAX 0.202	3/16	·0.385	0.276	0.199	0.199	0.1990	0.245	0.104	-	MAX 0.390
		MIN 0.199		·0.378	-	0.195	0.197	0.1970	-	0.099	-	MIN 0.375
NAS1670-6 (FF375)	#S	MAX 0.378	3/8	:0.762	0.488	0.3745	0.3745	0.3745	0.429	0.185	-	MAX 0.765
		MIN 0.375		:0.752	-	0.3660	0.3720	0.3725	-	0.180	-	MIN 0.750

· THEORETICALLY SHARP – (MAXIMUM LAND 0.015)
: THEORETICALLY SHARP – (MAXIMUM LAND 0.023)

TABLE II

GRIP LENGTHS DATA

DASH NO.	GRIP RANGE MIN.	GRIP RANGE MAX(G)	NAS1669-08 (PP164) B ±0.015	NAS1669-08 (PP164) L ±0.015	NAS1669-3 (PP200) B ±0.015	NAS1669-3 (PP200) L ±0.015	NAS1670-3 (FF200) B ±0.015	NAS1670-3 (FF200) L ±0.015	NAS1670-6 (FF375) B ±0.015	NAS1670-6 (FF375) L ±0.015
2	0.094	0.156	0.230	0.795	0.228	0.936	0.228	0.853		
3	0.156	0.219	0.293	0.858	0.291	0.999	0.291	9.916		
4	0.219	0.281	0.355	0.920	0.353	1.061	0.353	0.978	0.479	1.242
5	0.281	0.344	0.418	0.983	0.416	1.124	0.416	1.041	0.542	1.304
6	0.344	0.406	0.480	1.045	0.478	1.186	0.478	1.103	0.604	1.367
7	0.406	0.469	0.543	1.108	0.541	1.249	0.541	1.166	0.667	1.429
8	0.469	0.531	0.605	1.170	0.603	1.311	0.603	1.228	0.729	1.492
9	0.531	0.594	0.668	1.233	0.666	1.374	0.666	1.291	0.792	1.554
10	0.594	0.656	0.730	1.295	0.728	1.436	0.728	1.353	0.854	1.617
11	0.656	0.719	0.793	1.358	0.791	1.499	0.791	1.416	0.917	1.679
12	0.719	0.781	0.855	1.420	0.853	1.561	0.853	1.478	0.979	1.742

TABLE III

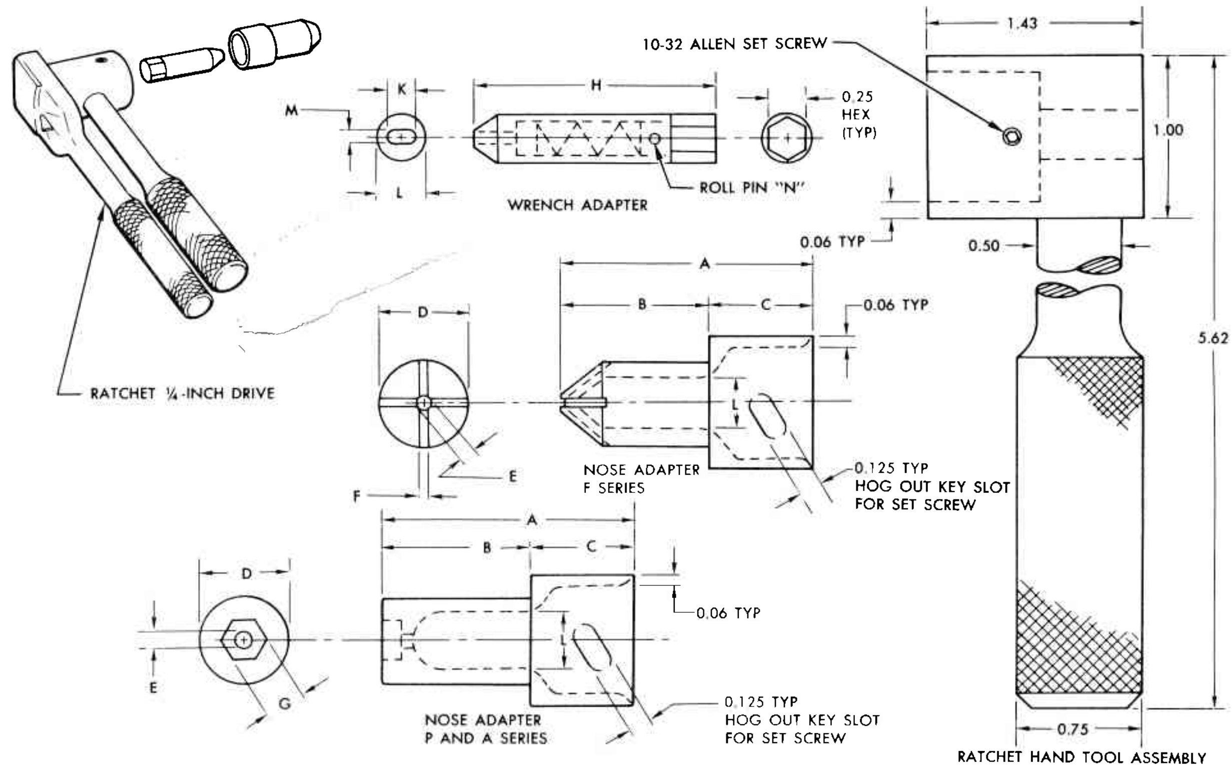
JO-BOLT DRIVING TOOL DATA

JO-BOLT PART NO.	POWER TOOL	ADAPTER ASSEMBLY	WRENCH ADAPTER	RACHET HAND TOOL
NAS1669-08 (PP164)	*LOK-FAST MODEL 302M WITH MASTER TORQUE DRIVER MTD302	TD165P	HW1650P	HW200
NAS1660-3 (PP200)	*LOK-FAST MODEL 302M WITH MASTER TORQUE DRIVER MTD302	TD200P	HW2000P	HW200
NAS1670-3 (FF200)	*LOK-FAST MODEL 302M WITH MASTER TORQUE DRIVER MTD302	TD200	HW2000	HW200
NAS1670-6 (FF375)	*LOK-FAST MODEL 302M WITH MASTER TORQUE DRIVER MTD302	PT375	HW3740	HW300

*LOK-FAST INC.
NEWPORT BEACH, CALIF.

65R-986-45

Figure 1-43. Installation of Jo-Bolts (Sheet 2 of 3)



JO-BOLT ADAPTER ASSEMBLY

JO-BOLT SERIES	RATCHET HAND TOOL ASSEMBLY	ADAPTER ASSEMBLY	NOSE ADAPTER	A ±.015	B ±.015	C ±.015	D ±.010	E ±.005	F ±.005	G ±.005	WRENCH ADAPTER	H ±.015	K ±.005	L ±.010	M ±.005	N
F200	HWF200	HW2000	HW2002	1.531	.906	.625	.500	.151	.037		NW2001	1.437	.142	.365	.107	.094
P200	HWP200	HW2000P	HW2002P	1.562	.937	.625	.500	.151		.316						
FA200	HWA200	HW2000A	HW2002A	1.542	.917	.625	.500	.151		.348						
PA200	HWA200	HW2000A	HW2002A	1.542	.917	.625	.500	.151		.348						
F260	HWF260	HW2600	HW2602	1.531	.906	.625	.500	.201	.046		HW2601	1.437	.193	.365	.138	.094
P260	HWP260	HW2600P	HW2602P	1.562	.937	.625	.500	.201		.382						
FA260	HWA260	HW2600A	HW2602A	1.565	.940	.625	.625	.201		.472						
PA260	HWA260	HW2600A	HW2602A	1.565	.940	.625	.625	.201		.472						
F312	HWF312	HW3120	HW3122	1.531	.906	.625	.555	.231	.065		HW3121	1.437	.193	.365	.155	.094
F312	HWP312	HW3120P	HW3122P	1.625	1.000	.625	.575	.231		.439						
F375	HWF375	HW3750	HW3752	1.555	.930	.625	.625	.270	.072 .070		HW3751	2.215	.260	.365	.181	.125
P375	HWP375	HW3750P	HW3752P	1.555	.930	.625	.670	.270	.070	.502						

NOTES:
1. RATCHET HAND TOOL ASSEMBLY AND JO-BOLT ADAPTER ASSEMBLY MAY BE MANUFACTURED LOCALLY OR PURCHASED FROM LOK-FAST INC., 2313 WEST OLIVE, BURBANK, CALIF.
2. TO MANUFACTURE TOOLS LOCALLY MAKE THE RATCHET HAND TOOL ASSEMBLY FROM 7075-T6 BAR STOCK. MAKE THE NOSE AND WRENCH ADAPTERS FROM ALLOY STEEL.

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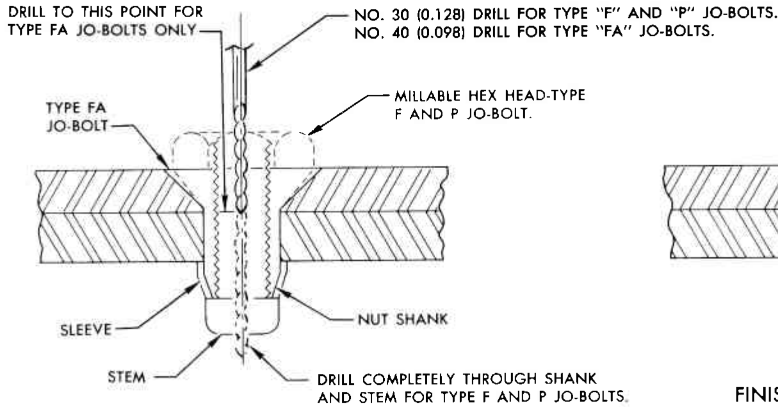
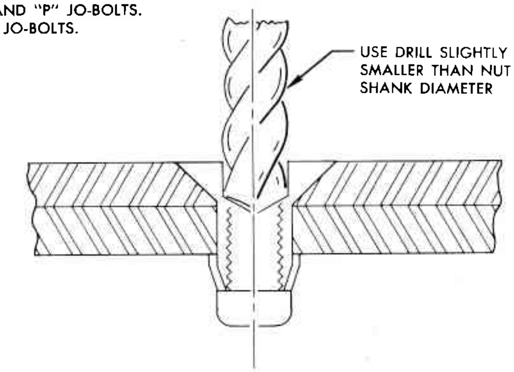
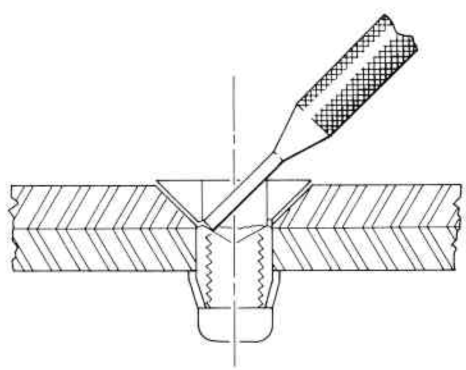
Figure 1-43. Installation of Jo-Bolts (Sheet 3 of 3)



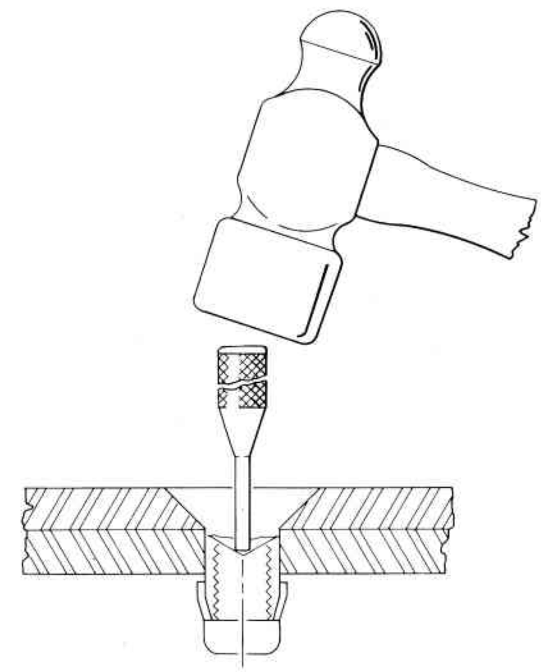
DRILLING OF JO-BOLTS



FINISH DRILLING OF TYPE FA JO-BOLTS



REMOVING DRILLED HEAD OF TYPE FA JO-BOLTS



REMOVING SHANK AND COLLAR OF JO-BOLTS

REMOVAL PROCEDURE OF TYPE FA JO-BOLTS

a. Drill center of stem with a No. 40 (0.098) drill to a point slightly below the intersection of the nut head and shank.
b. Using a drill slightly smaller than nut shank, drill to intersection of nut head and shank. Use a No. 8 (0.199) drill or smaller for 3/16-inch diameter jo-bolts, and a G size (0.261) drill or smaller for 1/4-inch diameter jo-bolts.
c. Pry out nut head with punch.
d. Drive shank from hole using a punch and tapping slightly with a hammer.

REMOVAL OF TYPE F AND P JO-BOLTS

a. Drill center of stem, with a No. 30 (0.028) drill for 3/16-inch bolts or a No. 13 (0.185) drill for 1/4-inch bolts, completely through end of bolt shank and stem.
b. Punch sleeve and end of bolt into blind area.
c. Remove nut from hole with punch or hook.

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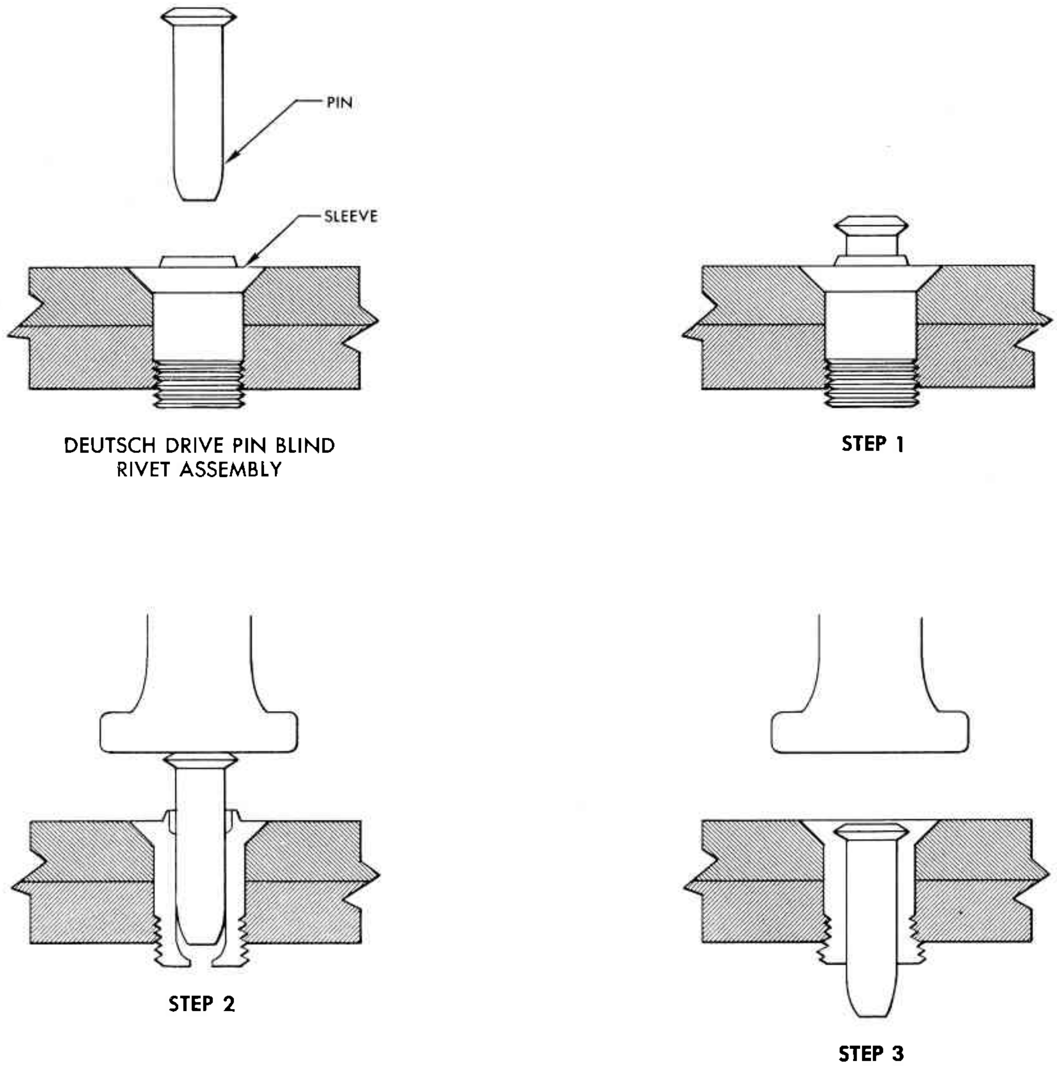
Figure 1-44. Removal of Jo-Bolts



PART NUMBER IDENTIFICATION

6950 – S – C10 – 6 SP

- SP = SHORT PIN; OMIT FOR STANDARD PINS
- 6 — GRIP LENGTH (IN 1/16")
- C10 — DIAMETER: C = CLOSE TOL., 10 = 5/16"
- S — MATERIAL: S = 303 STAINLESS STEEL, H = 17-4 PH STAINLESS STEEL
- 6950 — TYPE (COUNTERSUNK HEAD)

NOTE:
SEE TABLE 1-XLV AND TABLE 1-XLVI FOR FURTHER IDENTIFICATION OF DEUTSCH DRIVE PIN RIVETS. SEE TABLES 1-XLVII AND 1-XLVIII FOR HOLE SIZES AND GRIP RANGES.

INSTALLATION PROCEDURE

a. Place the proper length rivet for the material thickness into the hole. The rivet must fit firmly and snugly in its seat (**STEP 1**).
b. Use a light air hammer with a flat set or a hand hammer and drive the pin into its seat (**STEP 2**).
c. The pin expands the sleeve to form a blind head. The locking lip is pinned to lock the pin in the sleeve.

CAUTION

IF THE RIVET IS DRIVEN THROUGH TIGHT HOLES BY THE PIN, PREMATURE EXPANSION OF THE RIVET WILL RESULT. FOR TIGHT INSTALLATIONS, USE A HOLLOW DRIFT WHICH WILL CLEAR THE PIN WHILE SEATING THE SLEEVE.

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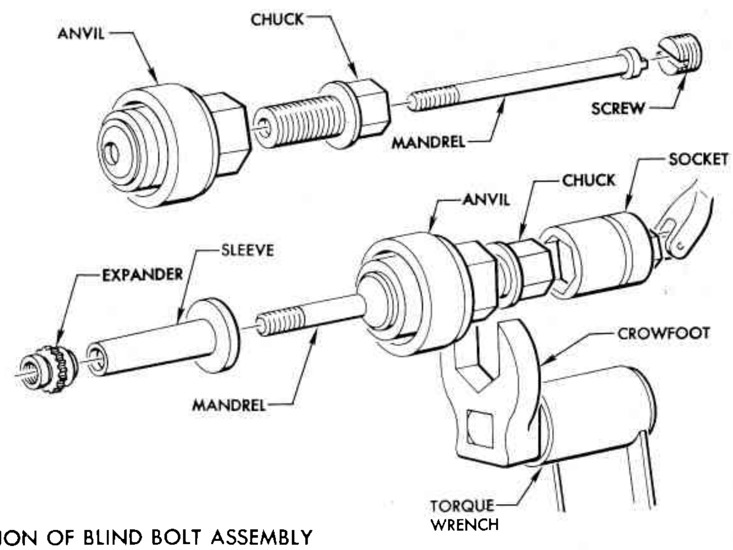
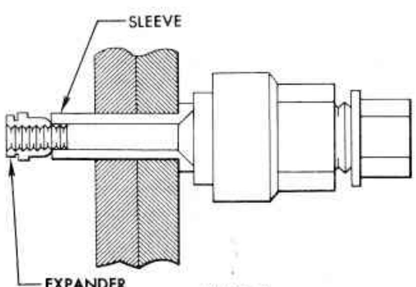
Figure 1-45. Deutsch Drive Pin Blind Rivet — Identification and Installation

INSTALLATION OF BLIND BOLT SLEEVE AND EXPANDER ON TOOL

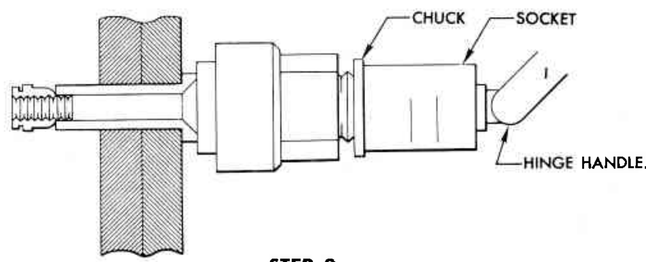
1. Install the mandrel in the chuck.
2. Screw the chuck counterclockwise until it is seated in the anvil.
3. Slip the sleeve over the mandrel.
4. Turn the chuck clockwise until sleeve is firmly seated.



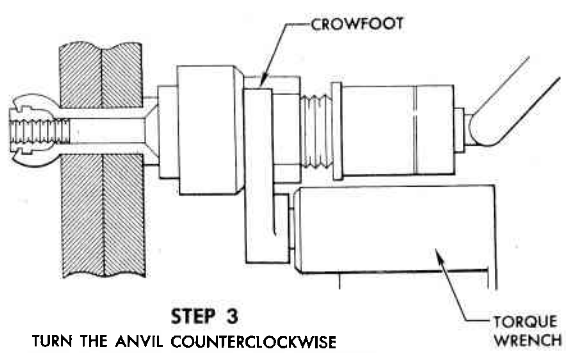
INSTALLATION OF BLIND BOLT ASSEMBLY



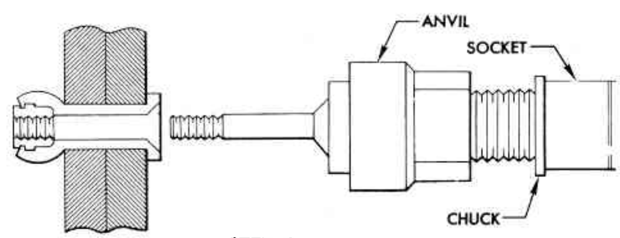
STEP 1
INSERT SLEEVE AND EXPANDER THROUGH WORK.



STEP 2
HOLD CHUCK WITH A SOCKET AND HINGE HANDLE.



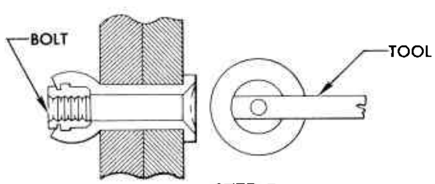
STEP 3
TURN THE ANVIL COUNTERCLOCKWISE WITH A TORQUE WRENCH AND CROWFOOT UNTIL EXPANDER FLARES SLEEVE. TORQUE EXPANDER TO VALUES SHOWN IN TABLE 1.



STEP 4
TO REMOVE TOOL, TURN ANVIL ONE-HALF TURN CLOCKWISE; UNSCREW CHUCK FROM EXPANDER THREADS.

TABLE I

BLIND BOLT SIZE (DASH NO.)	TORQUE INCH POUNDS
-5	65-75
-6	85-95
-8 -832	190-215
-1032	270-295
-10	295-320
-12 -428	465-495



STEP 5
INSTALL BOLT AND TIGHTEN WITH APPLICABLE TOOL.

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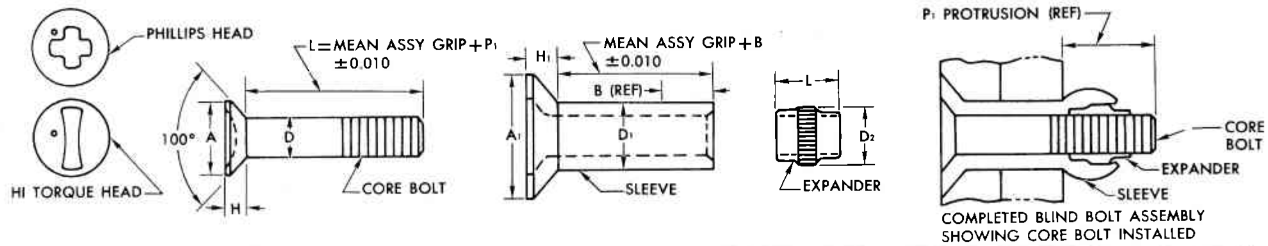
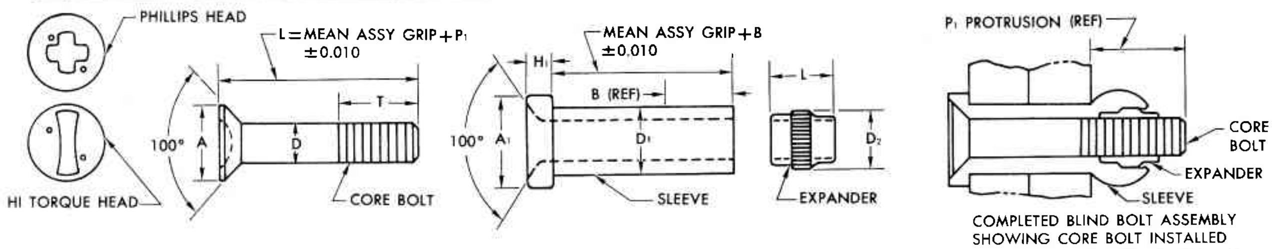
Figure 1-46. Installation of Blind Bolts (Hi-Shear Core Bolts)



BB351 BOLT ASSEMBLY		BB301 CORE BOLT						BB321 SLEEVE				BB341 EXPANDER	
DASH NO.	NOMINAL DIAMETER	HEAD STYLE	A	T	D	H	P_1	A_1	B (GRIP RANGE)	D_1	H_1	D_2	L
— 5	5/32	PHILLIPS	0.227 0.223		0.112 0.110	0.048 0.046	0.208	0.331 0.326	0.210 TO 0.225	0.169 0.166	0.068 0.066	0.167	0.153
— 6	3/16	PHILLIPS	0.251 0.247		0.124 01.22	0.053 0.051	0.239	0.381 0.377	0.250 TO 0.330	0.196 0.193	0.078 0.076	0.194	0.184
— 8	1/4	PHILLIPS	0.330 0.326		0.165 0.163	0.069 0.067	0.316	0.507 0.502	0.315 TO 0.370	0.257 0.254	0.105 0.103	0.255	0.245
—10	5/16	HI TORQUE	0.445 0.441		0.218 0.216	0.095 0.093	0.414	0.634 0.629	0.380 TO 0.420	0.338 0.335	0.124 0.122	0.328	
—12	3/8	HI TORQUE	0.507 0.502		0.249 0.247	0.108 0.106	0.485	0.760 0.756	0.450	0.390 0.387	0.155 0.153	0.383	0.368
—14	7/16	HI TORQUE	0.634 0.629		0.311 0.309	0.135 0.133	0.543	0.888 0.881	0.500	0.468 0.465	0.176 0.173	0.458	
—16	1/2	HI TORQUE	0.760 0.756		0.374 0.372	0.162 0.160	0.600	1.014 1.007	0.550	0.530 0.527	0.203 0.200	0.251	



BB352 BOLT ASSEMBLY		BB302 CORE BOLT						BB322 SLEEVE				BB341 EXPANDER	
DASH NUMBER	NOMINAL DIAMETER	HEAD STYLE	A	T	D	H	P_1	A_1	B (GRIP RANGE)	D_1	H_1	D_2	L
— 5	5/32	PHILLIPS	0.227 0.223	0.274	0.112 0.110	0.048 0.046	0.208	0.294 0.274	0.210 TO 0.225	0.169 0.166	0.055 0.045	0.167	0.153
— 6	3/16	PHILLIPS	0.251 0.247	0.304	0.124 0.122	0.053 0.051	0.239	0.315 0.295	0.250 TO 0.330	0.196 0.193	0.065 0.055	0.194	0.184
— 8	1/4	PHILLIPS	0.330 0.326	0.397	0.165 0.163	0.069 0.067	0.316	0.412 0.387	0.315 TO 0.370	0.257 0.254	0.090 0.080	0.255	0.245
—10	5/16	HI TORQUE	0.445 0.441	0.498	0.218 0.216	0.095 0.093	0.414	0.530 0.500	0.380 TO 0.420	0.338 0.335	0.110 0.100	0.328	0.307
—12	3/8	HI TORQUE	0.507 0.502	0.567	0.249 0.247	0.108 0.106	0.485	0.615 0.580	0.450	0.390 0.387	0.155 0.145	0.383	0.368
—14	7/16	HI TORQUE	0.634 0.629	0.628	0.311 0.309	0.135 0.113	0.543	0.803 0.768	0.500	0.468 0.465	0.160 0.150	0.458	0.429
—16	1/2	HI TORQUE	0.760 0.756	0.685	0.374 0.372	0.162 0.160	0.600	0.896 0.861	0.550	0.530 0.527	0.185 0.175	0.521	0.491

PART NUMBER BREAKDOWN

BB351-8-12

- 12 — 2ND DASH NUMBER INDICATES MEAN ASSEMBLY (THICKNESS OF WORK) GRIP LENGTH IN 1/16 INCH = ¾ INCH.
- 8 — DIAMETER OF BLIND BOLT IN 1/32 INCH = ¼ INCH
- BB351 — BLIND BOLT ASSEMBLY 100° COUNTERSUNK WHICH INCLUDES: BB301 CORE BOLT, BB321 SLEEVE, BB341 EXPANDER.

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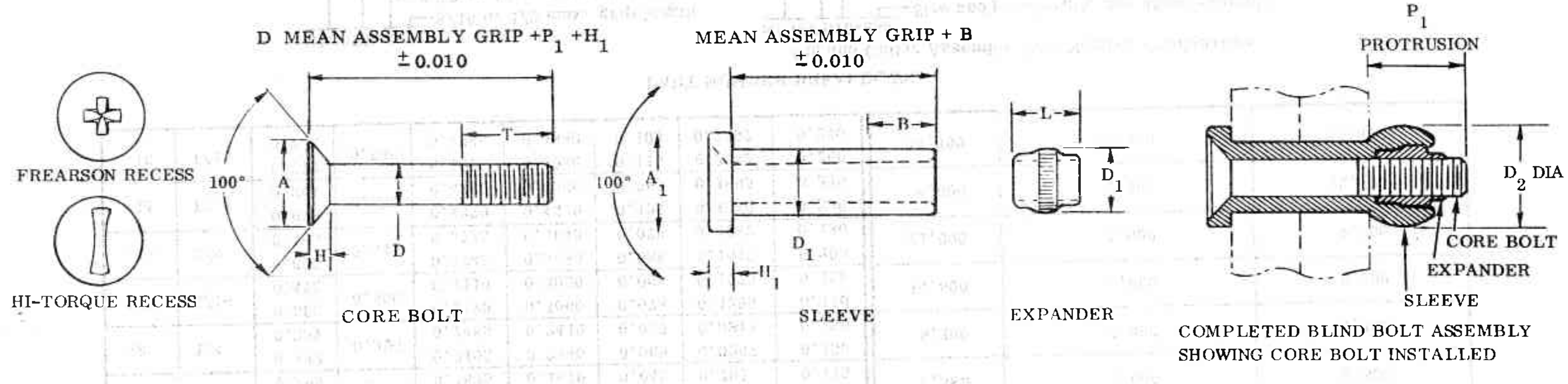
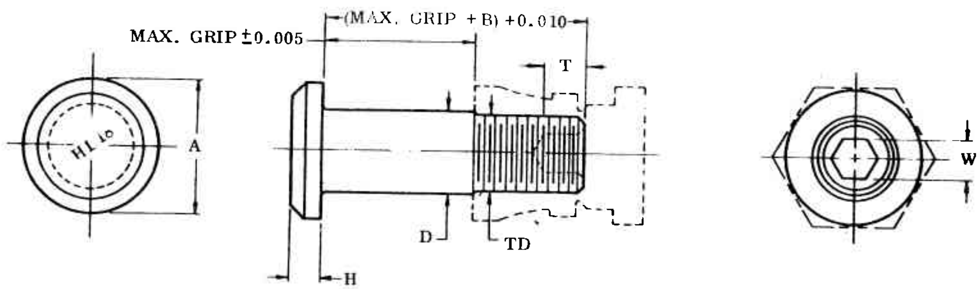
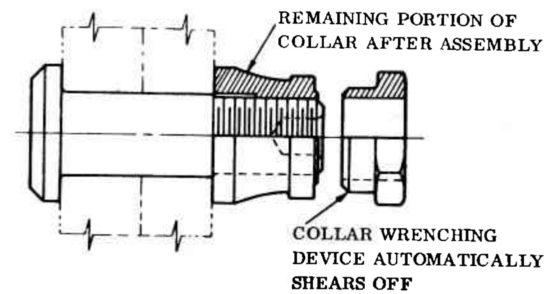
Figure 1-47. Blind Bolt Assembly — Identification (Sheet 1 of 2)



BB366 BOLT ASSEMBLY		BB316 CORE BOLT						BB336 SLEEVE						BB341G EXPANDER	
DASH NUMBER	NOMINAL DIAMETER	RECESS	A	T	D	H	P_1	A_1	B GRIP RANGE 0 - 3/4	B GRIP RANGE 13/16 - 1 1/16	B GRIP RANGE 1 1/8 - 1 5/8	D_1	H_1	D_2	L
-5	5/32	FREARSON	0.2274 0.2226	0.274	0.1120 0.1100	0.048 0.048	0.208	0.294 0.274	0.210	0.225		0.169 0.166	0.055 0.045	0.167	0.153
-6	3/16	FREARSON	0.2514 0.2466	0.304	0.1240 0.1220	0.053 0.051	0.239	0.315 0.295	0.250	0.265	0.330	0.196 0.193	0.065 0.055	0.194	0.184
-8	1/4	FREARSON	0.3304 0.3256	0.397	0.1650 0.1650	0.069 0.067	0.316	0.412 0.387	0.315	0.330	0.370	0.257 0.254	0.090 0.080	0.255	0.245
-10	5/16	HI-TORQUE #3	0.4454 0.4406	0.498	0.2180 0.2160	0.095 0.093	0.414	0.530 0.500	0.380	0.400	0.420	0.338 0.335	0.110 0.100	0.328	0.307
-12	3/8	HI-TORQUE #4	0.5066 0.5018	0.567	0.2490 0.2470	0.108 0.106	0.485	0.615 0.580	0.450	0.450	0.450	0.390 0.387	0.155 0.145	0.383	0.368

Figure 1-47. Blind Bolt Assembly — Identification (Sheet 2 of 2)





PIN AND COLLAR AFTER ASSEMBLY

FIRST DASH NO.	NOM. DIA.	A	B	D	THD	H	SOCKET W HEX	SOCKET T DEPTH
-5	5/32	0.262 0.242	0.312	0.1635 0.1625	0.1595 0.1570	0.047 0.037	0.0801 0.0791	0.135 0.115
-6	3/16	0.315 0.295	0.325	0.1895 0.1835	0.1840 0.1810	0.055 0.045	0.0806 0.791	0.135 0.115
-8	1/4	0.412 0.387	0.395	0.2495 0.2485	0.2440 0.2410	0.069 0.059	0.0967 0.0947	0.150 0.130
-10	5/16	0.505 0.475	0.500	0.3120 0.3110	0.3060 0.3020	0.078 0.068	0.1295 0.1270	0.170 0.150
-12	3/8	0.600 0.565	0.545	0.3745 0.3735	0.3680 0.3640	0.088 0.078	0.1617 0.1582	0.200 0.180
-14	7/16	0.676 0.641	0.635	0.4370 0.4360	0.4310 0.4260	0.105 0.093	0.1930 0.1895	0.230 0.210
-16	1/2	0.770 0.735	0.685	0.4995 0.4985	0.4930 0.4880	0.115 0.103	0.2242 0.2207	0.260 0.240

MECHANICAL PROPERTIES OF PIN AND COLLAR ASSEMBLY

DOUBLE SHEAR POUNDS MINIMUM	ALUMINUM COLLARS HL70 HL79 HL82 TENSION LBS MIN.	STEEL COLLARS HL94 HL97 HL175 TENSION LBS MIN.
4,010	1,400	1,940
5,380	1,600	2,500
9,300	3,000	4,300
14,600	5,000	6,300
21,000	7,000	8,700
28,600	9,500	12,100
37,300	12,500	15,300

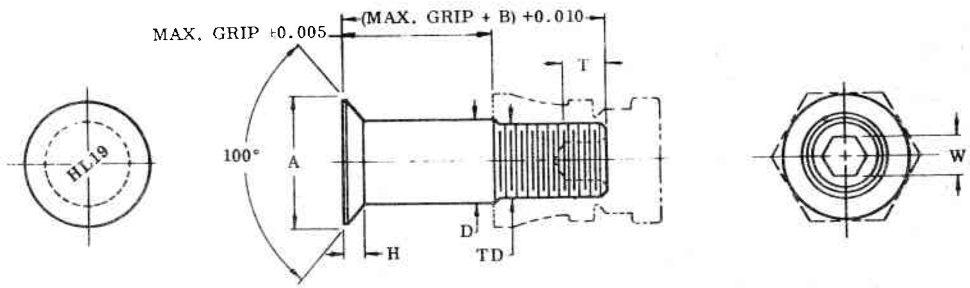
PART NUMBER BREAKDOWN

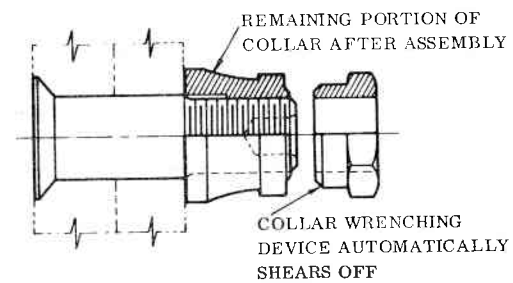
HL18PB-8-8
- 8/16 or 1/2 max. grip length
- 8/32 or 1/4 nominal dia. pin
- Type II cadmium plate, color bronze
- Pin part number

Pin and Collar Assembly Part Number Combination

HL18PB70-8-8
- Size and grip length, see above example
- Collar part number
- Pin finish
- Pin part number

Figure 1-47A. Hi-Lok Fasteners — Identification (Sheet 1 of 4)





PIN AND COLLAR AFTER ASSEMBLY

FIRST DASH NO.	NOM. DIA.	A	B	D	THD	F	H	SOCKET W HEX	SOCKET T DEPTH
-5	5/32	0.2612 0.2564	0.312	0.1635 0.1625	0.1595 0.1570	0.004	0.0410 0.0390	0.0801 0.0791	0.135 0.115
-6	3/16	0.3016 0.2966	0.325	0.1895 0.1885	0.1840 0.1810	0.005	0.0470 0.0450	0.0806 0.0791	0.135 0.115
-8	1/4	0.3948 0.3898	0.395	0.2495 0.2485	0.2440 0.2410	0.006	0.610 0.0590	0.0967 0.0947	0.150 0.130
-10	5/16	0.4739 0.4689	0.500	0.3120 0.3110	0.3060 0.3020	0.007	0.0680 0.0660	0.1295 0.1270	0.170 0.150
-12	3/8	0.5604 0.5554	0.545	0.3745 0.3735	0.3680 0.3640	0.008	0.0780 0.0760	0.1617 0.1582	0.200 0.180
-14	7/16	0.6680 0.6620	0.635	0.4370 0.4360	0.4310 0.4260	0.009	0.0969 0.0944	0.1930 0.1895	0.230 0.210
-16	1/2	0.7540 0.7480	0.685	0.4995 0.4985	0.4930 0.4880	0.010	0.1068 0.1043	0.2242 0.2207	0.260 0.240

MECHANICAL PROPERTIES OF PIN AND COLLAR ASSEMBLY		
DOUBLE SHEAR POUNDS MINIMUM	ALUMINUM COLLARS HL70 HL79 HL82 TENSION LBS MIN.	STEEL COLLARS HL94 HL97 HL175 TENSION LBS MIN.
4,010	1,290	1,290
5,380	1,600	2,000
9,300	3,000	3,700
14,600	5,000	5,000
21,000	7,000	7,200
28,600	9,500	10,000
37,300	12,500	13,500

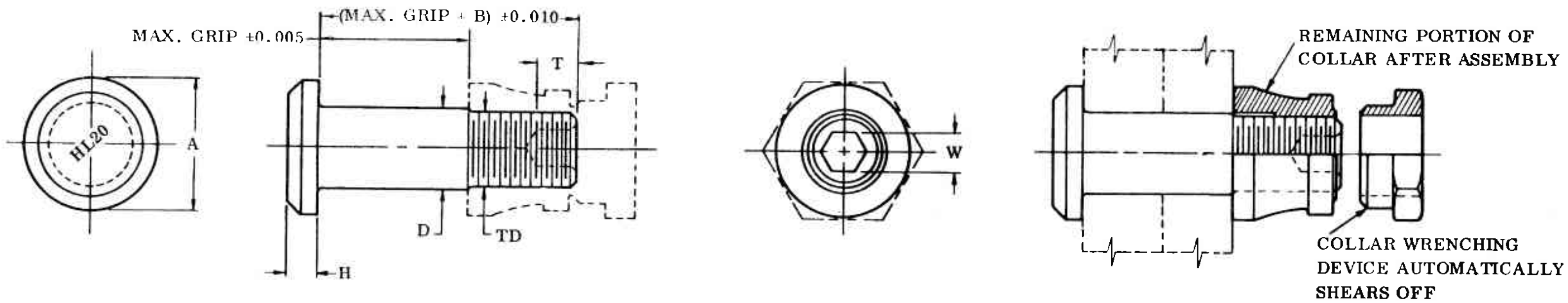
PART NUMBER BREAKDOWN

HL19PB-8-8
- 8/16 or 1/2 max. grip length
- 8/32 or 1/4 nominal dia. pin
- Type II cadmium plate, color bronze
- Pin part number

Pin and Collar Assembly Part Number Combination

HL19PB70-8-8
- Size and grip length, see above example
- Collar part number
- Pin finish
- Pin part number

Figure 1-47A. Hi-Lok Fasteners — Identification (Sheet 2 of 4)



PIN AND COLLAR AFTER ASSEMBLY

FIRST DASH NO.	NOM. DIA.	A	B	D	THD	H	SOCKET W HEX	SOCKET T DEPTH	MECHANICAL PROPERTIES OF PIN AND COLLAR ASSEMBLY: DOUBLE SHEAR POUNDS MINIMUM	STEEL COLLARS HL75 HL86 HL87 TENSION LBS MIN.
-5	5/32	0.322 0.306	0.312	0.1635 0.1625	0.1595 0.1570	0.060 0.055	0.0801 0.0791	0.135 0.115	4,010	2,180
-6	3/16	0.377 0.357	0.325	0.1895 0.1885	0.1840 0.180	0.074 0.064	0.0806 0.0791	0.135 0.115	5,380	2,750
-8	1/4	0.440 0.415	0.395	0.2459 0.2485	0.2440 0.2410	0.090 0.077	0.0967 0.0947	0.150 0.130	9,300	5,000
-10	5/16	0.502 0.472	0.500	0.3120 0.3110	0.3060 0.3020	0.112 0.098	0.1295 0.1270	0.170 0.150	14,600	8,300
-12	3/8	0.565 0.530	0.545	0.3745 0.3735	0.3680 0.3640	0.140 0.130	0.1617 0.1582	0.200 0.180	21,000	12,700
-14	7/16	0.627 0.592	0.635	0.4370 0.4360	0.4310 0.4260	0.160 0.150	0.1930 0.1895	0.230 0,210	28,600	18,900
-16	1/2	0.752 0.717	0.685	0.4995 0.4985	0.4930 0.4880	0.188 0.178	0.2242 0.2207	0.260 0.240	37,300	25,500

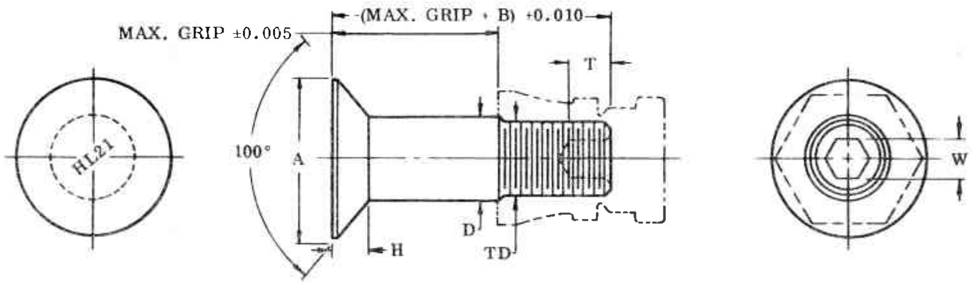
PART NUMBER BREAKDOWN

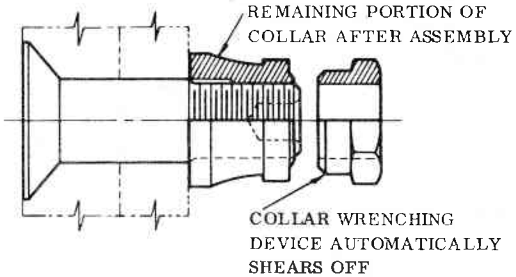
HL20PB-8-8
- 8/16 or 1/2 max. grip length
- 8/32 or 1/4 nominal dia. pin
- Type II cadmium finish
- Pin part number

Pin and Collar Assembly Part Number Combination

HL20PB86-8-8
- Size and grip length, see above example
- Collar part number
- Pin finish
- Pin part number

Figure 1-47A. Hi-Lok Fasteners —Identification (Sheet 3 of 4)





PIN AND COLLAR AFTER ASSEMBLY

FIRST DASH NO.	NOM. DIA.	A	B	D	THD	F	H	SOCKET W HEX	SOCKET T DEPTH	MECHANICAL PROPERTIES OF PIN AND COLLAR ASSEMBLY: DOUBLE SHEAR POUNDS MINIMUM	STEEL COLLARS HL75 HL86 HL87 TENSION LBS MIN.
-5	5/32	0.3304 0.3256	0.312	0.1635 0.1625	0.1595 0.1570	0.004	0.0700 0.0680	0.0801 0.0791	0.135 0.115	4,010	2,180
-6	3/16	0.3813 0.3765	0.325	0.1895 0.1885	0.1840 0.1810	0.005	0.0805 0.0785	0.0806 0.0791	0.135 0.115	5,380	2,750
-8	1/4	0.5066 0.5018	0.395	0.2495 0.2485	0.2440 0.2410	0.006	0.1080 0.1060	0.0967 0.0947	0.150 0.130	9,300	5,000
-10	5/16	0.6335 0.6287	0.500	0.3120 0.3110	0.3060 0.3020	0.007	0.1350 0.1330	0.1295 0.1270	0.170 0.150	14,600	8,300
-12	3/8	0.7604 0.7556	0.545	0.3745 0.3735	0.3680 0.3640	0.008	0.1620 0.1600	0.1617 0.1582	0.200 0.180	21,000	12,700
-14	7/16	0.8884 0.8812	0.635	0.4370 0.4360	0.4310 0.4260	0.009	0.1895 0.1865	0.1930 0.1895	0.230 0.210	28,600	18,900
-16	1/2	1.0139 1.0068	0.685	0.4995 0.4985	0.4930 0.4880	0.010	0.2160 0.2130	0.2242 0.2207	0.260 0.240	37,300	25,500

PART NUMBER BREAKDOWN

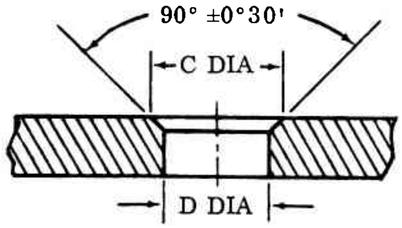
HL21PB-8-8
- 8/16 or 1/2 max. grip length
- 8/32 or 1/4 nominal dia. pin
- Type II cadmium plate
- Pin part number

Pin and Collar Assembly Part Number Combination

HL21PB86-8-8
- Size and grip length, see above example
- Collar part number
- Pin finish
- Pin part number

Figure 1-47A. Hi-Lok Fasteners — Identification (Sheet 4 of 4)

HOLE PREPARATION-PROTRUDING HEAD

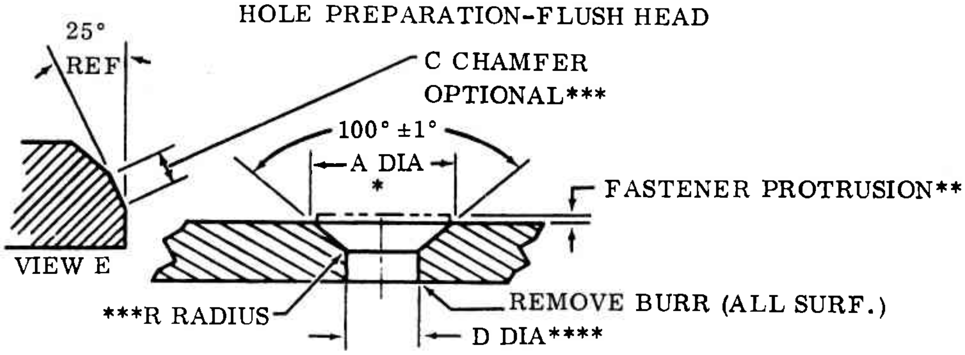


FASTENER (REF)		C ±0.010	HI-LOK PINS**	
SIZE	MAX DIA	DIA*	D MAX	D MIN
5/32	0.1635	0.204	0.1630	0.1615
3/16	0.1895	0.240	0.1890	0.1875
1/4	0.2495	0.300	0.2490	0.2470
5/16	0.3120	0.372	0.3115	0.3095
3/8	0.3745	0.435	0.3740	0.3720
7/16	0.4370	0.497	0.4365	0.4345

*COUNTERSINK IS REQUIRED TO CLEAR THE FILLET RADIUS EXISTING BETWEEN FASTENER HEAD AND SHANK. WHERE WASHERS ARE REQUIRED UNDER FASTENER HEADS, DO NOT COUNTERSINK.

**HOLE SIZES TABULATED RESULT IN INTERFERENCE FITS.

HOLE PREPARATION-FLUSH HEAD



FASTENER (REF)		HI-LOK PINS			R ±0.005	C ±0.010
		A DIA	D DIA****			
SIZE	MAX DIA	*	MAX	MIN	***	***
5/32	0.1635	0.258	0.1630	0.1615	0.025	0.020
3/16	0.1895	0.305	0.1890	0.1875	0.035	0.030
1/4	0.2495	0.399	0.2490	0.2470	0.040	0.035
5/16	0.3120	0.479	0.3115	0.3095	0.045	0.040
3/8	0.3745	0.566	0.3740	0.3720	0.055	0.050
7/16	0.4370	0.674	0.4365	0.4345	0.060	0.050

*COUNTERSINK DIAMETERS ARE STANDARD ONLY AND MUST BE ADJUSTED TO MEET THE FOLLOWING REQUIREMENTS.

**UNLESS OTHERWISE NOTED IN REPAIR OR INSTALLATION PROCEDURES, COUNTERSINKS SHALL ENSURE FASTENER HEAD FLUSHNESS.

***THESE RADII OR CHAMFERS ARE PRIMARILY NEEDED WHEN FASTENERS ARE INSTALLED IN STEEL OR TITANIUM STRUCTURE. OPTIONAL FOR OTHER MATERIALS.

****HOLE SIZE SHOWN IN TABLE RESULT IN INTERFERENCE FITS.

Figure 1-47B. Hi-Lok Fastener Hole Preparation

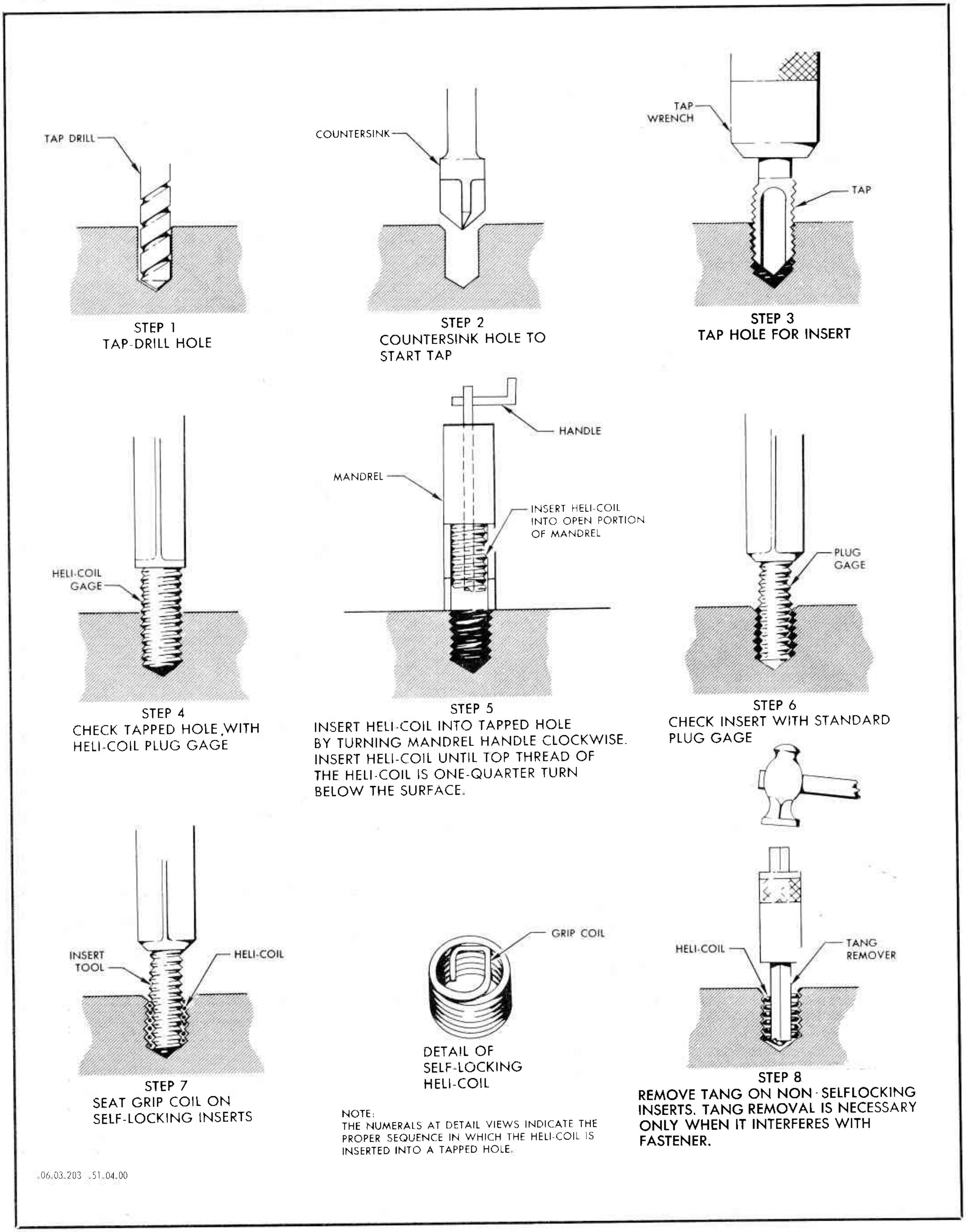
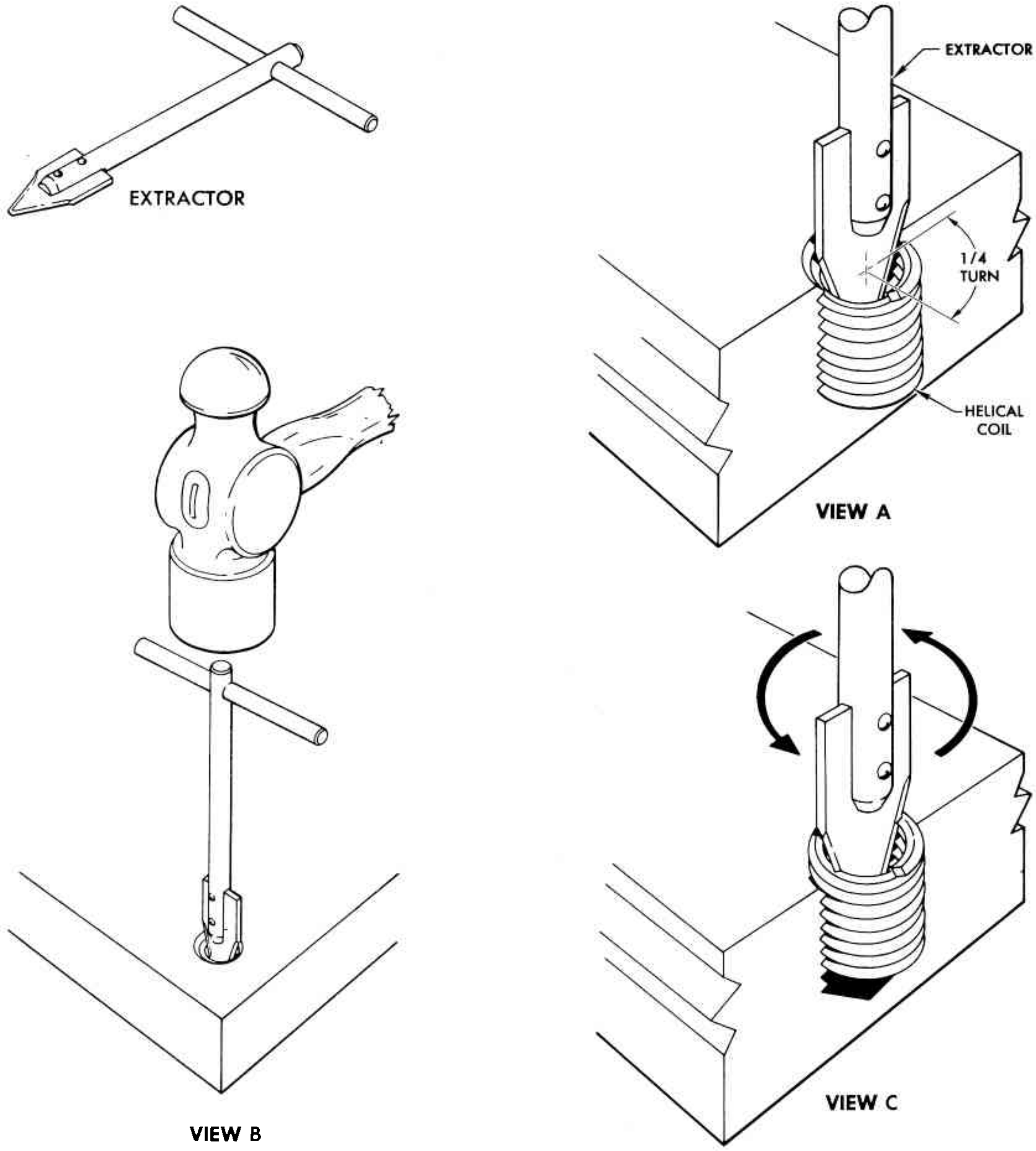


Figure 1-48. Installation of Helical Coils



DAMAGED HELICAL COIL REMOVAL

a. Select proper extractor from Table 1.
b. Place the blade of the extractor on first turn of helical coil insert. The edge of blade should be 1/4 turn away from end of coil. See View A.
c. Rap extractor lightly with hammer to seat blade firmly against coil. See View B.
d. Apply heavy downward pressure and rotate extractor counterclockwise until helical coil is removed. See View C.

TABLE I

HOLE AND THREAD SIZE	EXTRACTOR PART NO.
10-32	1227-6
¼-28	1227-6
5/16-24	1227-6
⅜-24	1227-16
7/16-20	1227-16
½-20	1227-16
9/16-18	1227-16
¾-16	1227-16
⅞-14	1227-16
1-14	1227-16
1¼-12	1227-24

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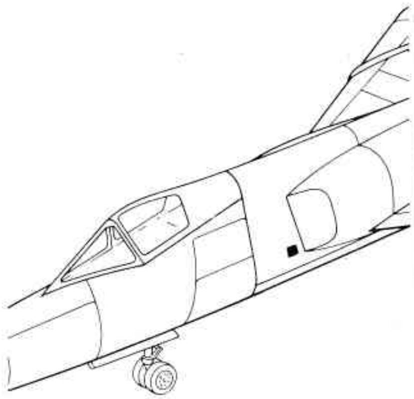
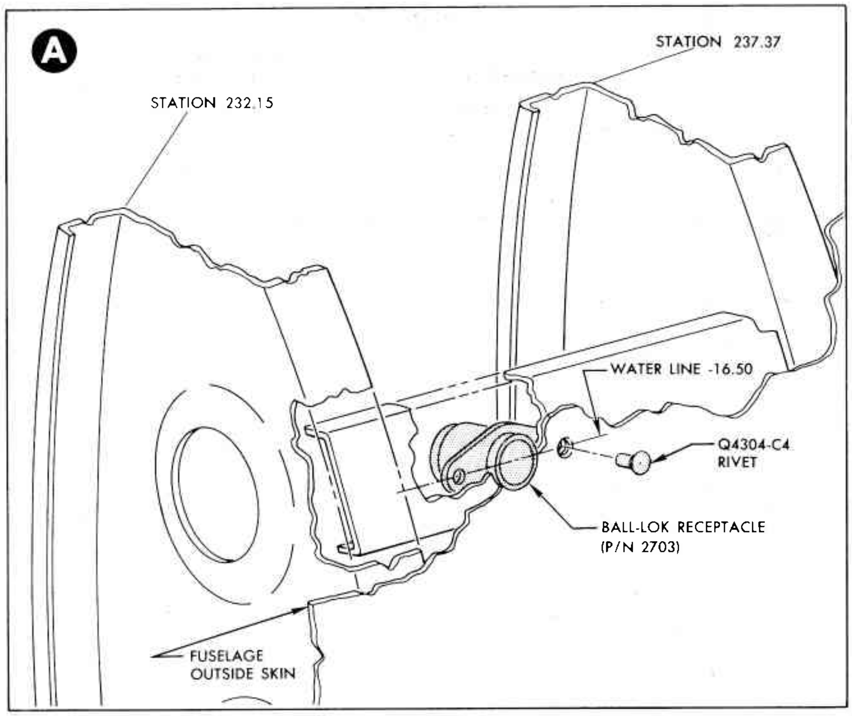
Figure 1-49. Helical Coil Removal





VIEW LOOKING INBOARD (LEFT-HAND SIDE)

REMOVAL AND INSTALLATION PROCEDURE

a. Remove access panel between Stations 226.92 and 247.81 inside forward missile bay compartment.
b. Using a No. 30 (0.128) drill, remove two rivets holding receptacle in place.

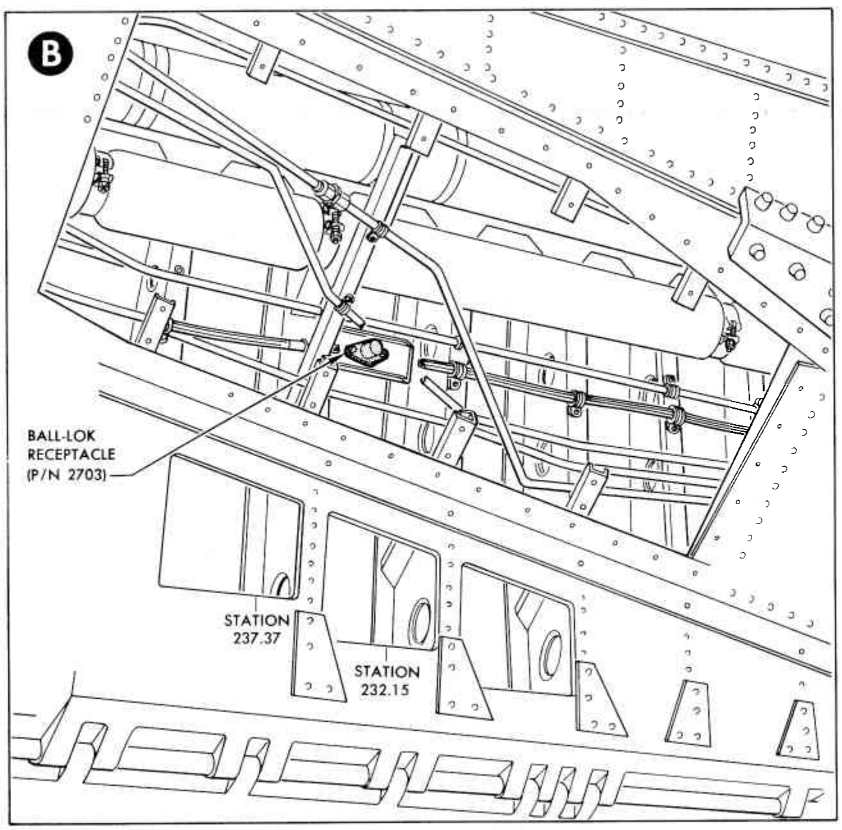
CAUTION

DO NOT ALLOW DRILL TO PENETRATE SKIN MORE THAN NECESSARY, AS UNDERLYING EQUIPMENT MAY BE DAMAGED.

c. Remove damaged Ball-Lok receptacle.
d. Insert new receptacle through access door and fasten in place with a 1/8-inch cleco.
e. Rivet new receptacle in place with two Q4304-C4 rivets. Refer to Table I-XXII for correct rivet substitution if Q4304 rivets are not available.
f. Replace access door inside forward missile bay compartment.

NOTE

BALL-LOCK RECEPTACLES (P/N 2703) ARE MANUFACTURED BY AVDELL INC., 210 SO. VICTORY BLVD., BURBANK, CALIF.



VIEW LOOKING OUTBOARD (LEFT-HAND SIDE)

06.03.242B

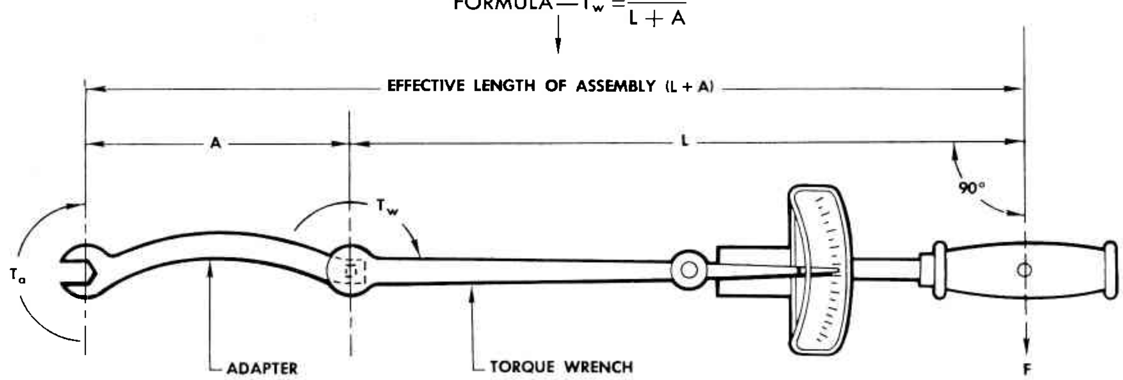
Figure 1-50. Replacement of Ball-Lok Receptacles

BOLT SIZE	STEEL BOLTS — NUT TYPES AN365 AND AN310 — INCH LBS	FOOT LBS	STEEL BOLTS — NUT TYPES AN364 AND AN320 — INCH LBS	FOOT LBS	ALUMINUM ALLOY BOLTS (AN365D NUTS) — BOLT SIZE	INCH LBS	FOOT LBS
10-32	20-25	—	12-15	—	3/16	10-14	—
1/4-28	50-70	—	30-40	—	1/4	20-35	—
5/16-24	100-140	9-12	60-85	5-7	5/16	50-75	4-6
3/8-24	160-190	13-16	95-110	8-9	3/8	80-110	7-9
7/16-20	450-500	38-42	270-300	23-25	7/16	100-140	8-12
1/2-20	480-690	40-57	290-410	24-34	1/2	170-220	14-18
9/16-18	800-1000	67-83	480-600	40-50	5/8	400-460	34-38
5/8-18	1100-1300	92-108	660-780	55-65			
3/4-16	2300-2500	192-208	1300-1500	109-125			
7/8-14	2500-3000	209-250	1500-1800	125-150			
1-14	3700-5500	308-458	2200-3300	184-275			
1-1/8-12	5000-7000	417-583	3000-4200	250-350			
1-1/4-12	9000-11000	750-916	5400-6600	450-550			

When using torque wrench adapters, if the desired torque is known, the torque wrench dial reading may be found as follows:

T_w = Wrench dial reading.
T_a = Desired torque at end of adapter.
L = Lever length of torque wrench.
A = Length of adapter (center distance).

FORMULA — $T_w = \frac{T_a \times L}{L + A}$



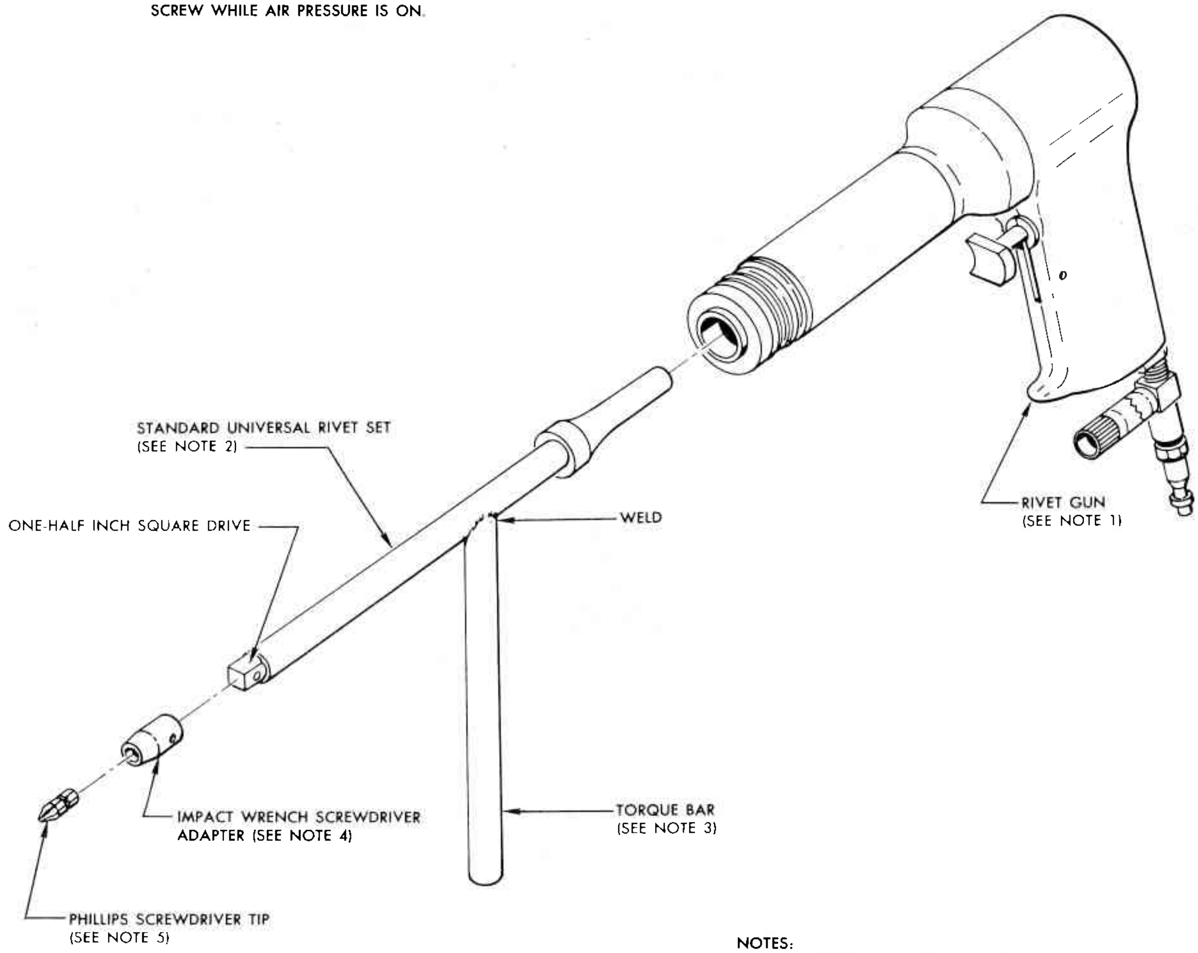
06 02 026A 12 09 00

Figure 1-51. Standard Bolt Torque Values

FROZEN SCREW REMOVAL PROCEDURE

a. Insert machined rivet set with attached torque bar into rivet gun.
b. Place screwdriver adapter over machined end of rivet set.
c. Insert Phillips screwdriver tip into screwdriver adapter.
d. Connect air supply.
e. Engage Phillips screwdriver tip with frozen screw.
f. Press trigger on rivet gun and torque bar to remove frozen screw.

NOTE:
KEEP PHILLIPS SCREWDRIVER TIP PRESSED FIRMLY AGAINST SCREW WHILE AIR PRESSURE IS ON.



NOTES:
1. CP-4X RIVET GUN OR A RIVET GUN OF EQUAL STRENGTH.
2. STANDARD UNIVERSAL RIVET SET 7 INCHES LONG. WITH DRIVEN END MACHINED TO ½-INCH SQUARE TO FIT IMPACT WRENCH ADAPTER.
3. TORQUE BAR. PREFERABLY MADE FROM ½-INCH STEEL TUBE FOR WELDING AND STRENGTH PURPOSES.
4. SCREWDRIVER ADAPTER FROM INGERSOL-RAND 504 IMPACT WRENCH.
5. STANDARD PHILLIPS SCREWDRIVER TIP.

FROZEN SCREW REMOVAL

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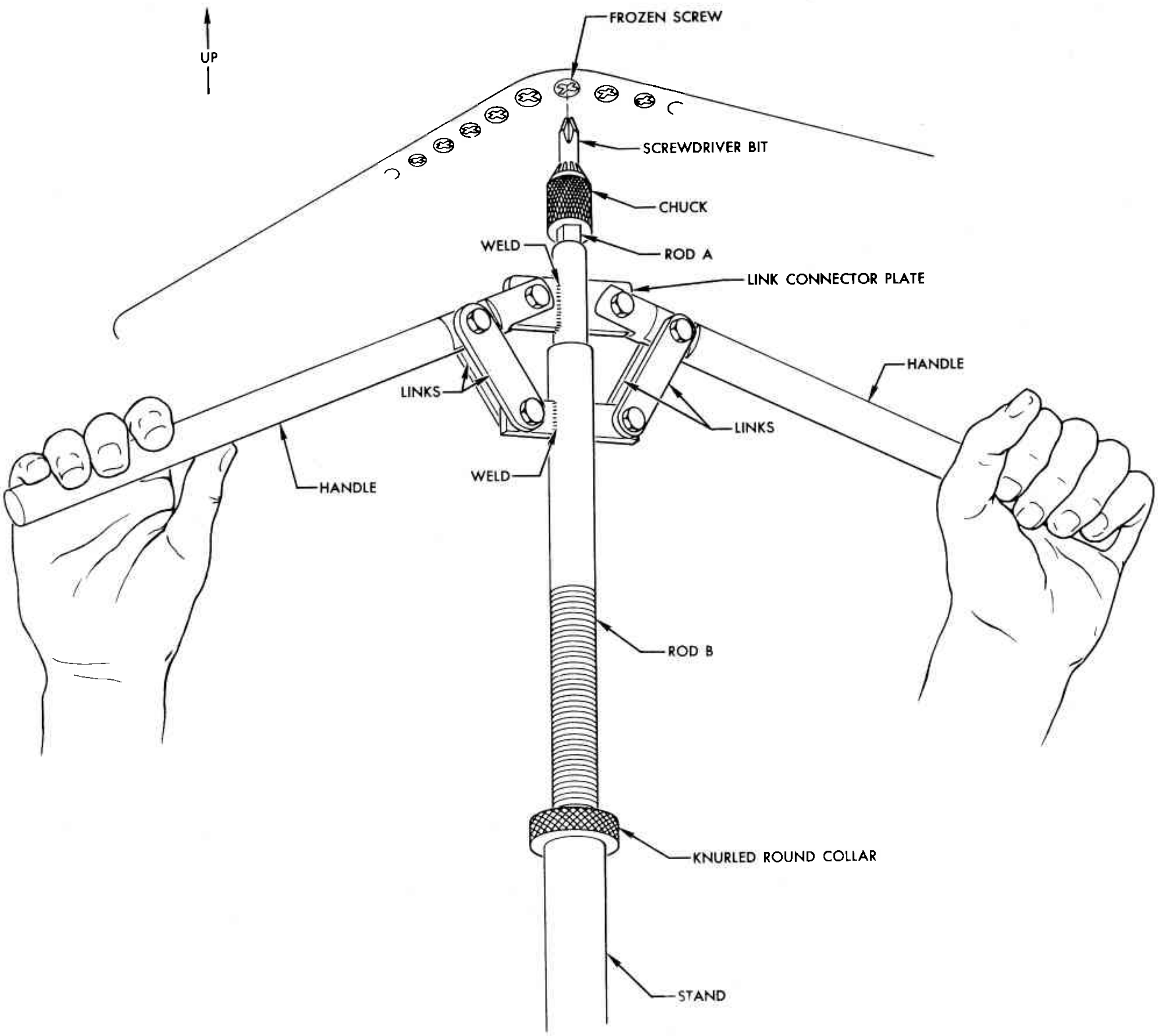
Figure 1-52. Frozen Screw Removal (Sheet 1 of 3)



SCREW REMOVAL PROCEDURE

a. Place stand directly beneath frozen screw.
b. Push handles to up position.
c. Adjust height of stand by turning knurled round collar.

NOTE
ADJUST HEIGHT OF STAND SO THAT TIP OF SCREW-DRIVER BIT IS APPROXIMATELY TWO INCHES FROM HEAD OF FROZEN SCREW.

d. Grasp handles and pull down until screwdriver bit is firmly seated in head of screw.
e. To remove frozen screw, rotate screwdriver bit while pulling down on handles.

NOTE
MAINTAIN CONSTANT DOWNWARD PRESSURE ON HANDLES WHILE TURNING.

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Figure 1-52. Frozen Screw Removal (Sheet 2 of 3)

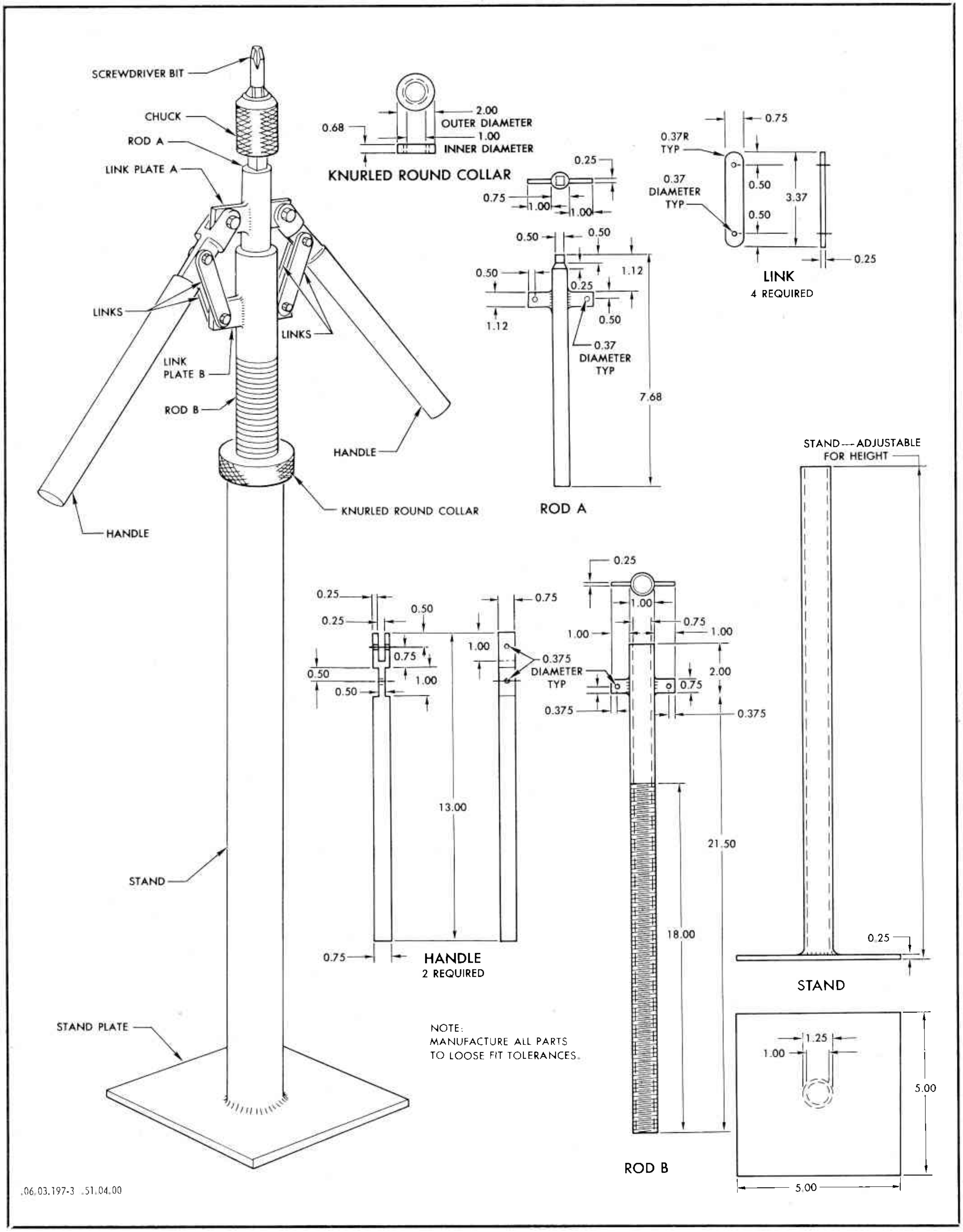


Figure 1-52. Frozen Screw Removal (Sheet 3 of 3)

junction box covers and on the airplane exterior. Where screws or bolts are used to mount junction boxes to the structure, they shall be installed with the head inside the junction box, to eliminate the possibility of loose nuts and washers shorting across electrical terminals.

Where practical, screws and bolts installed in a forward-and-aft direction shall be installed with head forward. Screws and bolts installed in an inboard-and-outboard direction shall be installed with the head inboard. Self-locking nuts, 3/16 and 1/4-inch diameter, shall be used only on fasteners that have not been drilled for cotter pins. Self-locking nuts, 5/16-inch diameter and larger, may be used on fasteners that are drilled for cotter pins if, after the nut is installed, the drilled hole is located beyond the load zone (the flat portion of the nut at the point of wrench contact). Sharp burrs around the cotter pin hole must be removed if fiber insert, self-locking nuts are used. See figure 1-51 for bolt torque values. Methods of removing frozen screws are shown on figure 1-52.

1-164. MS FLARELESS TUBE AND FITTING ASSEMBLY.

1-165. Nylon tubing is used in the airspeed indicating system and the radome anti-ice system. This tubing is installed in the radome section of the airplane. Flareless type MS fittings are used on the airspeed system tubing (see figure 1-53). Standard procedure for installation of MS fittings on aluminum alloy tubing also applies to the installation of MS fittings on nylon tubing, except for torque procedure. Nylon tubing used in the anti-ice system is equipped with flare fittings. The procedure used for flaring and installation of aluminum alloy tubing, as outlined in Air Force Navy Aeronautical Design Standards AND10064, also applies for flaring and installation of nylon tubing, except that the end of the tube must not be chamfered, and for torquing procedures. When installing flared nylon tubing, use the following torque values:

1/4 inch tube — 20 to 30 inch-pounds.

3/8 inch tube — 40 to 60 inch-pounds.

NOTE

The flared ends of nylon tubing have a tendency to return to the tube original shape when the tubing nuts are loosened. Prior to tightening of flared nylon tubing nuts, ascertain that the proper flare shape and size is present at the tube end.

When installing flareless nylon tubing use the following procedure:

a. Ascertain that the tube end is cut smooth and square.

b. Insert tubing into assembled MC fitting, making sure that the tube end seats firmly on shoulder of the fitting.

c. Using thumb and forefinger, tighten nut until the tube cannot be turned in the fitting; then tighten nut 1/3 of a turn, using a wrench; this completes the installation.

1-166. Stressed Panel Camloc Fasteners.

1-167. Electronic and engine access doors are secured with shear-load carrying, stressed-panel Camloc fasteners. Under normal flight conditions these fasteners carry shear loads of considerable magnitude. The airplane should not be flown with any of these fasteners unlocked or with any studs missing. Stud assemblies are of the captive type in all instances, but are retained in the door panel by two different methods. One type of stud is secured in the panel by flaring out the end of the stud bushing, as shown on figure 1-54. The flared end of the bushing serves to hold both the stud and the shear ring in place. The other type of stud is secured in the panel by forcing a spring steel ring with internal nodes over the bushing and engaging the nodes in grooves provided for that purpose in the bushing, as shown on figure 1-55. See figure 1-58 for stud length and grip. See figure 1-59 for installation data on Camloc rings and figure 1-60 for use of shear and buffer plates.

1-168. Standard Camloc Fasteners.

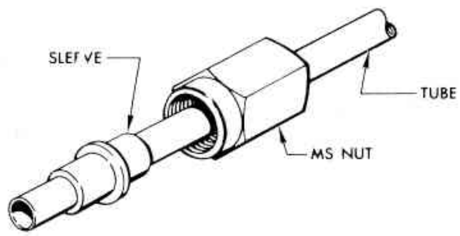
1-169. Standard Camloc panel fasteners are employed to secure the fuselage access doors to the fuselage basic structure. The airplane shall not be flown unless all Camloc fasteners are installed and properly secured. See figure 1-56 for installation procedure, and refer to T.O. 1F-106A-2-2-2-2 for Camloc operational data. See figure 1-57 for stud length and grip.

1-170. Standard Camloc Stud Assembly Removal.

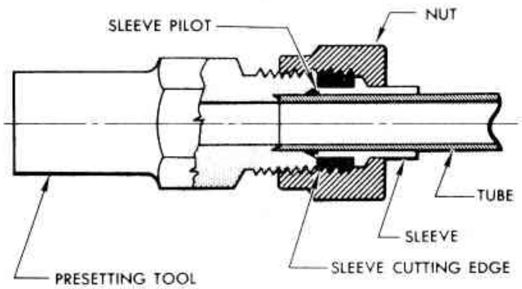
1-171. For quick removal of standard Camloc stud assemblies a tool may be manufactured locally (see figure 1-61). To remove stud assembly, remove lockpin and release stud. Remove grommet as shown on figure 1-61.

1-172. LOCATING BLIND HOLES.

1-173. For many repairs, holes in repair parts or patches must be drilled to match existing holes in the original structure while the repair part or patch is in contact with the original structure. In accessible areas, holes may be properly located by back-drilling through the existing holes into the repair part. In blind areas, the holes must be drilled through the repair part, from the outside, into the existing hole in the underlying structure. Existing holes may be located by using a hole finder similar to that shown on figure 1-62. Burrs and drill chips may be removed from between the faying surfaces without removing the repair parts or patches by using a chip chaser similar to the one shown on figure 1-63. Hole finders can be made locally or purchased in standard sizes for use with common diameter rivet holes. A separate hole finder must be used for each diameter of rivet



STEP 1



STEP 2

ASSEMBLY PROCEDURE

a. Select correct size presetting tool by part number from Table I. If tool is not available, an MS steel or aluminum connector fitting may be used.

CAUTION

IF ALUMINUM CONNECTOR IS USED, USE CONNECTOR ONLY ONCE.

b. Lubricate presetting tool and MS nut threads, sleeve pilot, and tool seat. Refer to Table II for the correct lubricant.

c. Cut tube end square to receive fitting. Burr tube end inside and outside. Chamfer inside and outside edges slightly.

d. Slide MS nut and then sleeve on tube as shown in Step I.

e. Insure that presetting tool is lubricated sufficiently.

f. Bottom tube firmly on presetting tool set and slide sleeve and nut in position. See Step 2.

TABLE I	
TUBE O.D.	*PARKER AIRCRAFT CO. PRESETTING TOOL PART NUMBER
1/8"	1149-565702
3/16"	1149-565703
1/4"	1149-565704
5/16"	1149-565705
3/8"	1149-565706
1/2"	1149-565708
5/8"	1149-565710
3/4"	1149-565712
1"	1149-565716
1-1/4"	1149-565720
1-1/2"	1149-565724
1-3/4"	1149-565728
2"	1149-565732

NOTE:
*PARKER AIRCRAFT COMPANY IS LOCATED AT 5827 WEST CENTURY BLVD., LOS ANGELES 45, CALIF.

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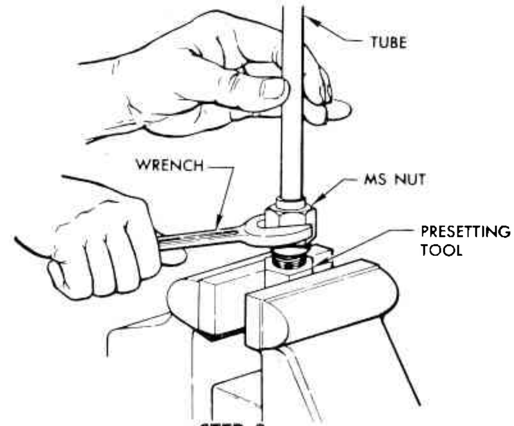
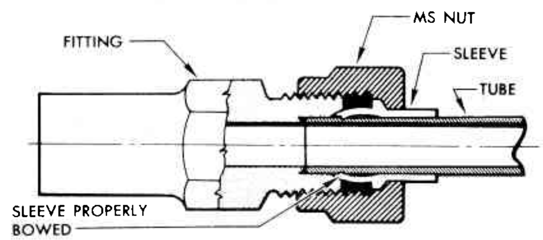


STEP 3

g. Tighten nut until sleeve cutting edge grips tube. Determine proper sleeve cutting edge grip by turning tube slowly but firmly by hand while tightening nut with a wrench. When the tube can no longer be turned between the thumb and fingers, the fitting is ready for presetting or final assembly. See Step 3.

h. Tighten nut an additional 1 to 1⅙ turns for preset or final assembly. Tube material, hardness, wall-thickness and size effect the exact number of presetting turns needed. 1⅙ turns are recommended for ⅛ and ¼-inch hard stainless tubes.



FLARELESS TUBE ASSEMBLY AND FITTING PROPERLY PRESET OR ASSEMBLED

POST ASSEMBLY INSPECTION

a. Remove presetting tool from fitting and tube. Insure that the requirements following in steps "b" through "d" are met.

b. Sleeve pilot shall contact or be within 0.010 inch of tube outside diameter.

c. Sleeve shall be slightly bowed and have a permissible maximum longitudinal 1/64-inch movement. The sleeve may be stationary or have the ability to rotate.

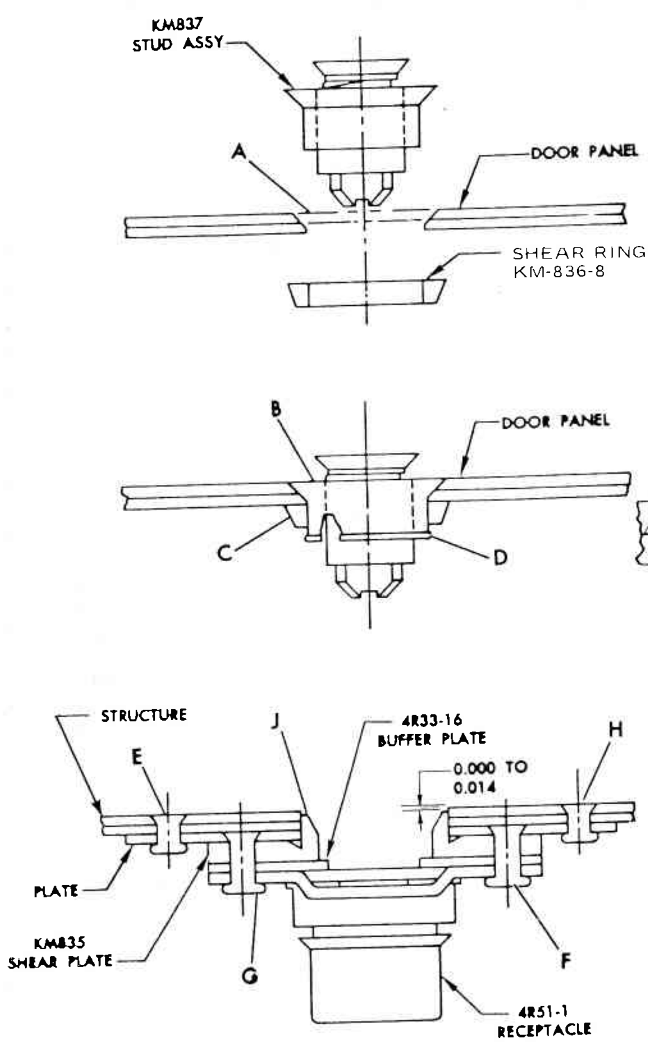
d. Sleeve sealing surface must be smooth, free from scores, nicks and longitudinal cracks or tool marks.

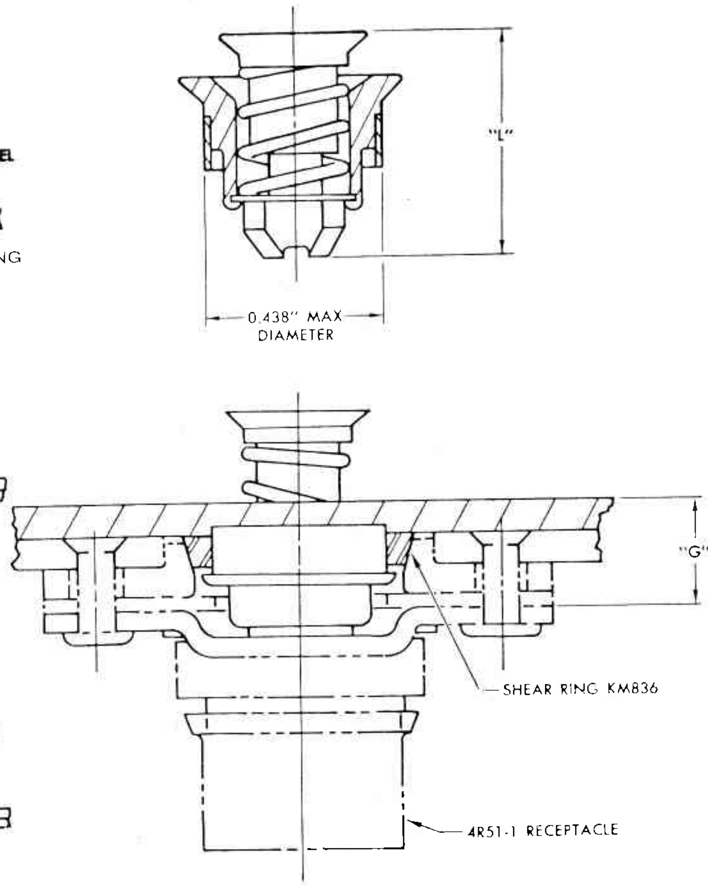
CAUTION

PRESSURE TEST TUBE ASSEMBLY IN ACCORDANCE WITH SPECIFICATION MIL-H-5440 BEFORE AIRPLANE INSTALLATION.

TABLE II	
TUBE SYSTEM	LUBRICANT
HYDRAULIC	MIL-H-5606
FUEL	MIL-H-5606
OIL	SYSTEM OIL
PNEUMATIC	MIL-L-4343
OXYGEN	MIL-T-5542

Figure 1-53. MS Flareless Tube and Fitting Assembly





BASIC	DASH	GRIP "G"		LENGTH "L"	
PART NUMBER	NUMBER	MIN.	MAX.	MAX.	MIN.
KM 837	-6	.258	.357	.654	.639
KM 837	-8	.358	.457	.754	.739
KM 837	-10	.458	.557	.854	.839
KM 837	-12	.558	.657	.954	.939

NOTES:

1. SELECTION OF STUD DASH NUMBER DEPENDS ON TOTAL GRIP THICKNESS.
2. GRIP=TOTAL GRIP THICKNESS FROM PANEL SURFACE TO RECEPTACLE SURFACE. (INCLUDES OUTER PANEL, INNER FRAME, SHEAR PLATE, BUFFER PLATE, PAINT, ETC).

A. Drill 0.438 to 0.440 dia. hole (7/16 drill size) and countersink 100° x 0.571 max. diameter.
B. Install Camloc stud (KM837) through outer surface panel.
C. Slip Camloc shear ring (KM836-8) over inner end of stud housing.
D. Flare end of stud housing to secure stud assy in panel. Use installation tool shown in figure 1-56. Grind off flare for removal of stud.
E. Remove damaged receptacle assembly by drilling out (4) 1/8-inch diameter rivets (30 drill size) securing receptacle to structure.
F. Drill out (2) 3/32-inch diameter rivets (39 drill size) securing plate to receptacle. Save plate, shear plate, and buffer plate for reinstallation.
G. Assemble and rivet receptacle to buffer plate, shear plate, and plate. Coat all faying surfaces of parts with sealer, Military Specification MIL-S-8802. Secure with MS20426AD3 rivets.
H. Rivet receptacle assembly to structure with same type rivets as removed (either MS20426AD4 or Q4304 rivets).
J. If new shear plate is installed, any lip projection past the outer surface of the of the structure must be milled off flush.

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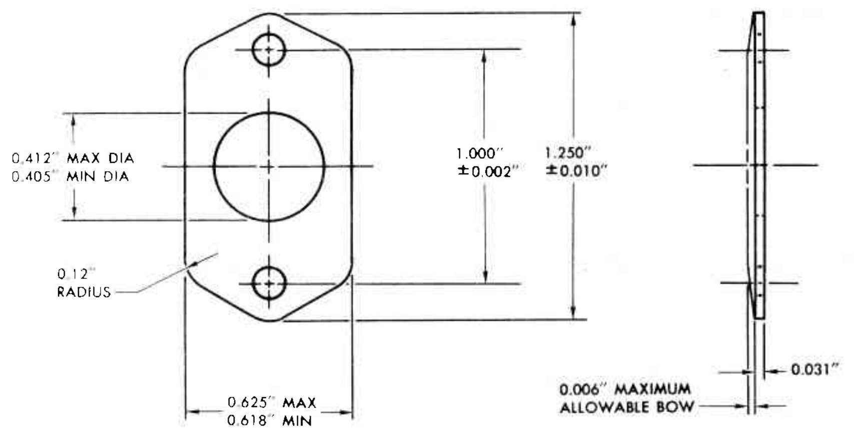
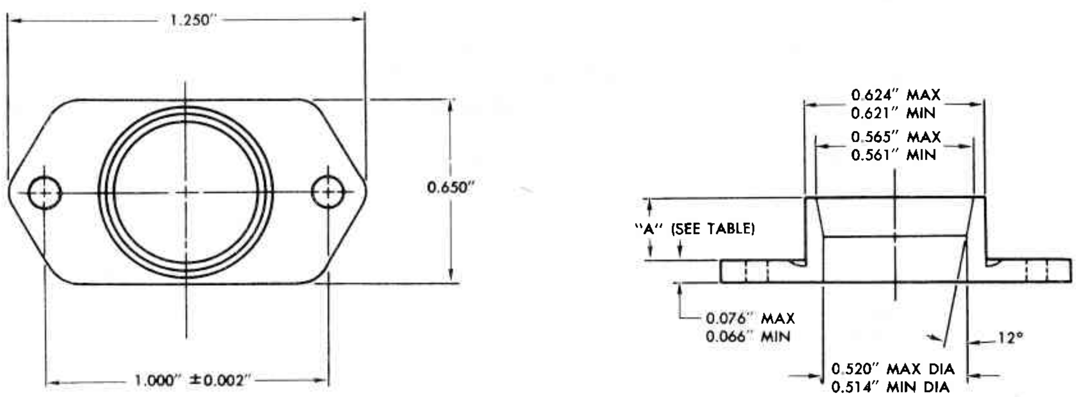
Figure 1–54. Stressed Panel Camloc Fastener–KM837 Stud and 4R51-1 Receptacle



NOTE:
USE WITH KM837 STUD
AND 4R51-1 RECEPTACLE

CAMLOC BUFFER PLATE YR33-16



PART NUMBER	"A" DIMENSION	
	MAXIMUM	MINIMUM
KM 835-8	.080	.075
-12	.120	.115
-13	.130	.125
-15	.150	.145
-16	.160	.155
-17	.170	.165
-18	.180	.175
-20	.200	.195
-21	.210	.205
-25	.250	.245
-27	.270	.265
-29	.290	.285
-42	.420	.415

NOTE:
USE WITH KM837 STUD
AND 4R51-1 RECEPTACLE

CAMLOC SHEAR PLATE KM835

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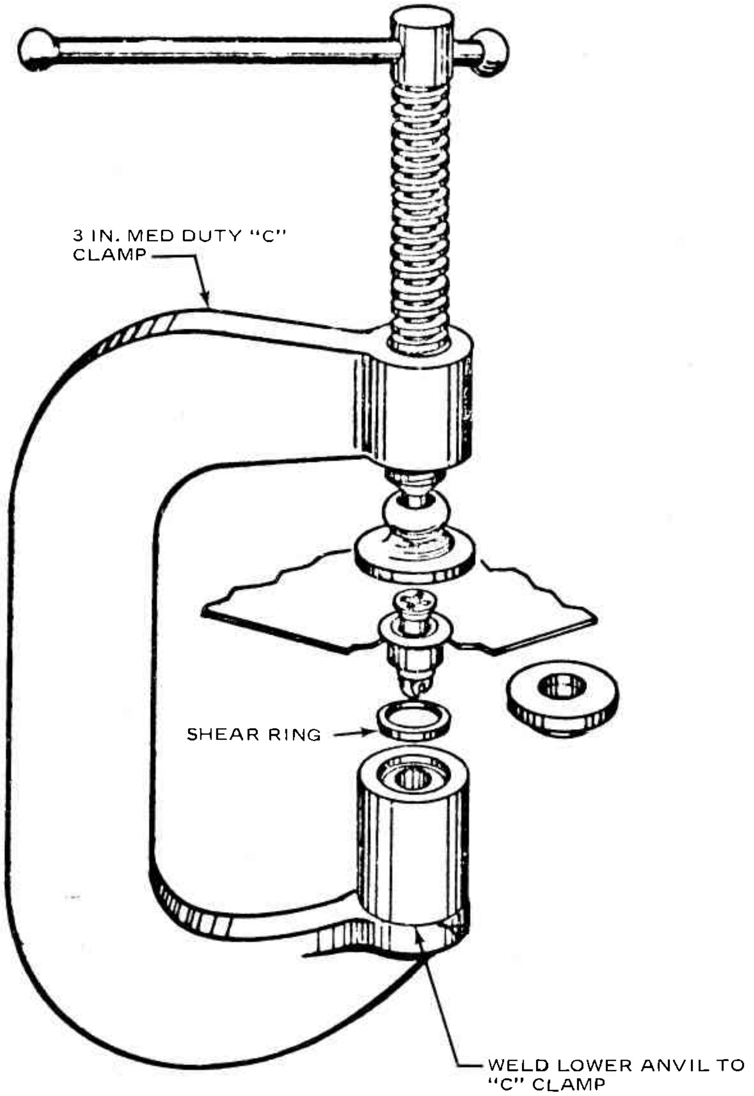
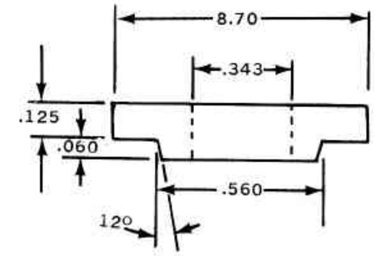
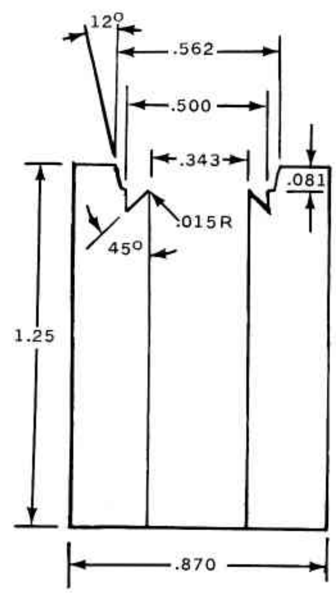
Figure 1-55. Camloc Buffer and Shear Plates





90° ANVIL



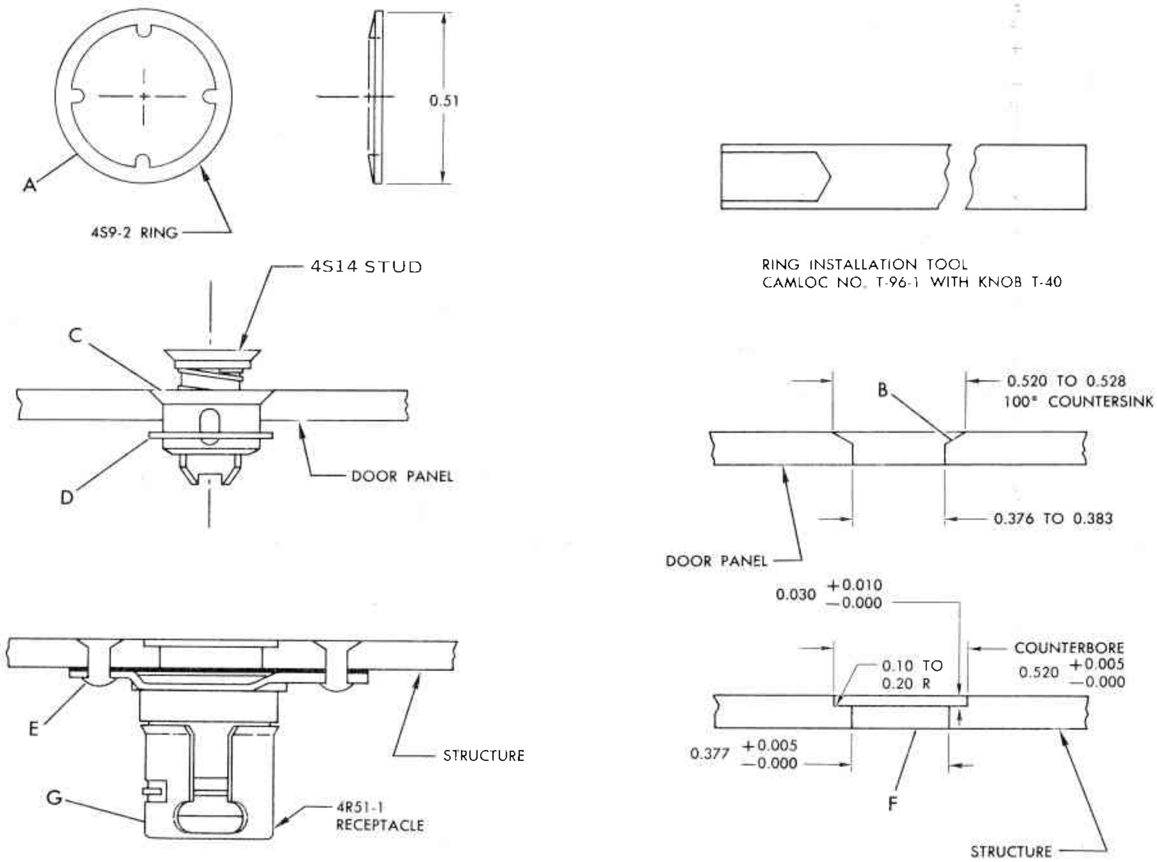
LOWER ANVIL

INSTALLATION PROCEDURE:

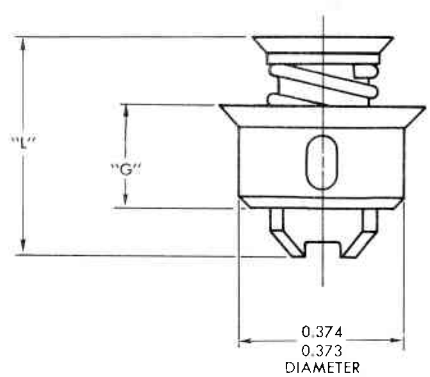
A. INSERT KM837 STUD IN DOOR PANEL.
B. REMOVE THE 90° FLARE ANVIL FROM "C" CLAMP.
C. PLACE KM836-8 SHEAR RING IN THE 45° FLARE ANVIL.
D. POSITION "C" CLAMP OVER STUD IN DOOR AND TIGHTEN TO FORM 45° FLARE.
E. REMOVE "C" CLAMP AND INSTALL 90° FLARE ANVIL.
F. POSITION "C" CLAMP OVER STUD AND TIGHTEN TO FORM 90° FLARE, SECURING STUD IN DOOR.

MAKE ANVILS FROM 4130 STEEL
MIL-S-6758
HEAT TREAT TO 125.000 PSI

Figure 1-56. Stressed Panel Camloc Fastener—KM837 Installation Tool



	GRIP "G"		LENGTH "L"	
PART NUMBER	MAXIMUM	MINIMUM	MAXIMUM	MINIMUM
4S14-4	.286	.274	.554	.539
4S14-6	.386	.374	.654	.639
4S14-8	.486	.474	.754	.739
4S14-10	.586	.574	.854	.839
4S14-12	.686	.674	.934	.939



Remove and replace damaged stud assy as follows:

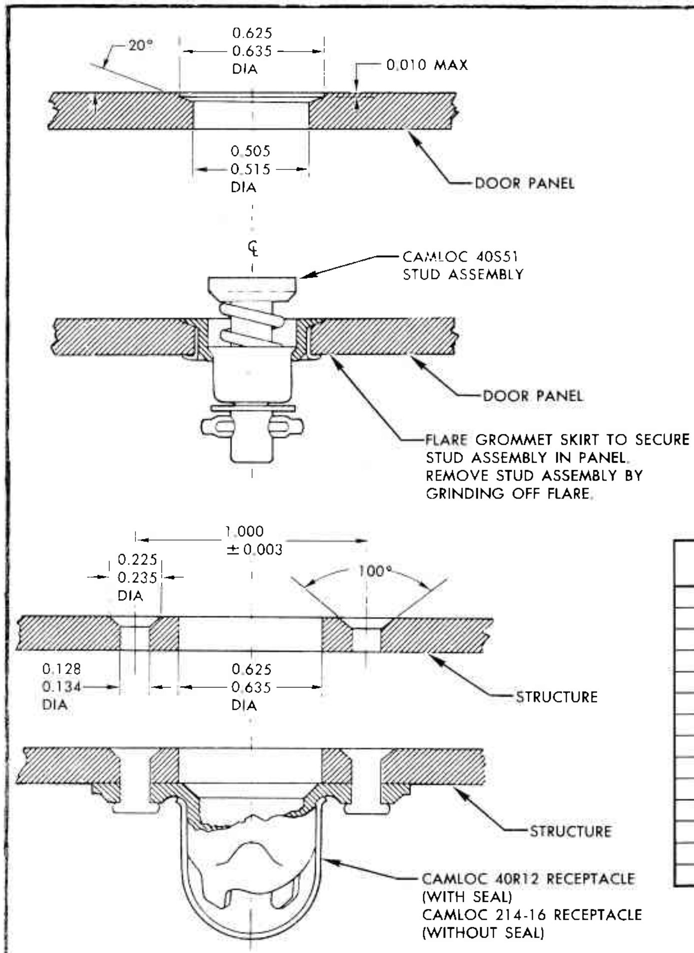
A. Cut or break stud retainer ring and remove stud assembly from panel.
B. Measure hole and countersink dimensions in panel. If panel is damaged, refer to structural engineering authorities.
C. Select camloc stud (4S14) with same grip length as old and insert in door panel.
D. Install spring steel retainer ring (Camloc 4S9-2) over inner end of stud housing. Engage the (4) inner teeth of the ring with (4) grooves in the stud housing, a tool may be manufactured as shown from a length of steel bar. Magnetize bar to hold ring in place during installation.

Remove and replace damaged receptacle as follows:

E. Drill out (2) 3/32-inch diameter rivets (#39 drill size) and remove receptacle.
F. Measure hole and counterbore dimensions in structure. If structure is damaged, refer to structural engineering.
G. Install Camloc receptacle (4R51-1) with applicable sealer applied to faying surfaces. Refer to paragraph on "Repairs to Sealing" in this section. Use **MS20426D3 rivets.**

NOTES:
1. SELECTION OF STUD DASH NUMBER DEPENDS ON TOTAL GRIP THICKNESS.
2. GRIP=TOTAL GRIP THICKNESS FROM PANEL SURFACE TO RECEPTACLE SURFACE.

Figure 1-57. Stressed Panel Camloc Fastener—4S14 Stud and 4R51-1 Receptacle



PART NUMBER BREAKDOWN

40S51 — A 040 — 10 A

- "A" SUFFIX = SLOTTED HEAD STUD / NO SUFFIX = #2 PHILLIPS CROSS RECESS
- 2ND DASH NUMBER INDICATES "L" DIMENSION (STUD GRIP LENGTH).
- 1ST DASH NUMBER INDICATES GROMMET SKIRT LENGTH.
- "A" = FLUSH TYPE GROMMET / "B" = PLUS FLUSH TYPE GROMMET
- BASIC PART NUMBER

BASIC PART NUMBER	FIRST DASH NUMBER	"C" DIM.	PANEL THICKNESS
40S51	-A040	.155	.040 - .069
40S51	-A070	.145	.070 - .099
40S51	-A100	.165	.100 - .129
40S51	-A130	.193	.130 - .159
40S51	-A160	.220	.160 - .189
40S51	-A190	.250	.190 - .219

BASIC PART NO.	SECOND DASH NO.	"L" DIMENSION MIN.	"L" DIMENSION MAX.	"S" DIMENSION SLOTTED	"S" DIMENSION CROSS
40S51	-2	.413	.423	.69	.68
40S51	-3	.443	.453	.72	.71
40S51	-4	.473	.483	.73	.74
40S51	-5	.503	.513	.78	.77
40S51	-6	.533	.543	.81	.80
40S51	-7	.563	.573	.84	.83
40S51	-8	.593	.603	.87	.86
40S51	-9	.623	.633	.98	.89
40S51	-10	.653	.663	.93	.92
40S51	-11	.683	.693	.96	.95
40S51	-12	.713	.723	.99	.98
40S51	-13	.743	.753	1.02	1.01
40S51	-14	.773	.783	1.05	1.04
40S51	-15 NOTE 1	.803	.813	1.08	1.07

USE OF THE FLARING TOOLS

Remove and replace damaged stud assembly as follows:

a. Remove lock pin and release stud. Refer to figure 1-61 for grommet removal.

CAUTION

DO NOT ATTEMPT USE OF CAMLOC PLIERS

b. Measure hole and countersink in door panel to dimensions shown. If panel is damaged, replace it.

c. Select Camloc 40S51 stud with same grip length as old stud and insert it in panel.

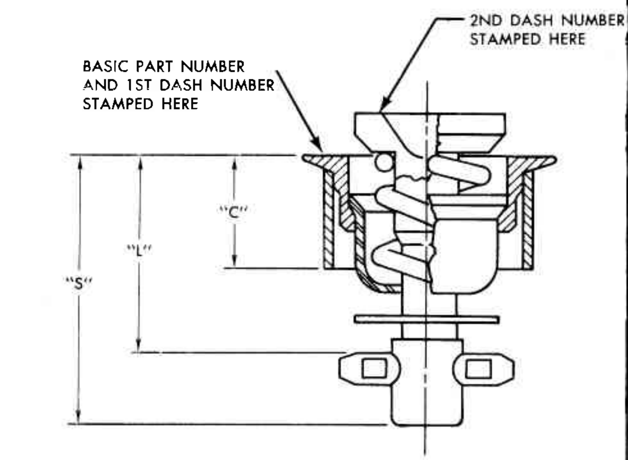
d. Install stud assy using installation tool shown in figure 1-59.

Remove and replace damaged receptacle as follows:

a. Drill out two 1/8-inch diameter rivets (No. 30 drill size) and remove receptacle.

b. Measure hole in structure to dimensions shown. If structure is damaged, refer to an aeronautical structures engineer.

c. Install Camloc receptacle with two MS20426AD4 rivets.

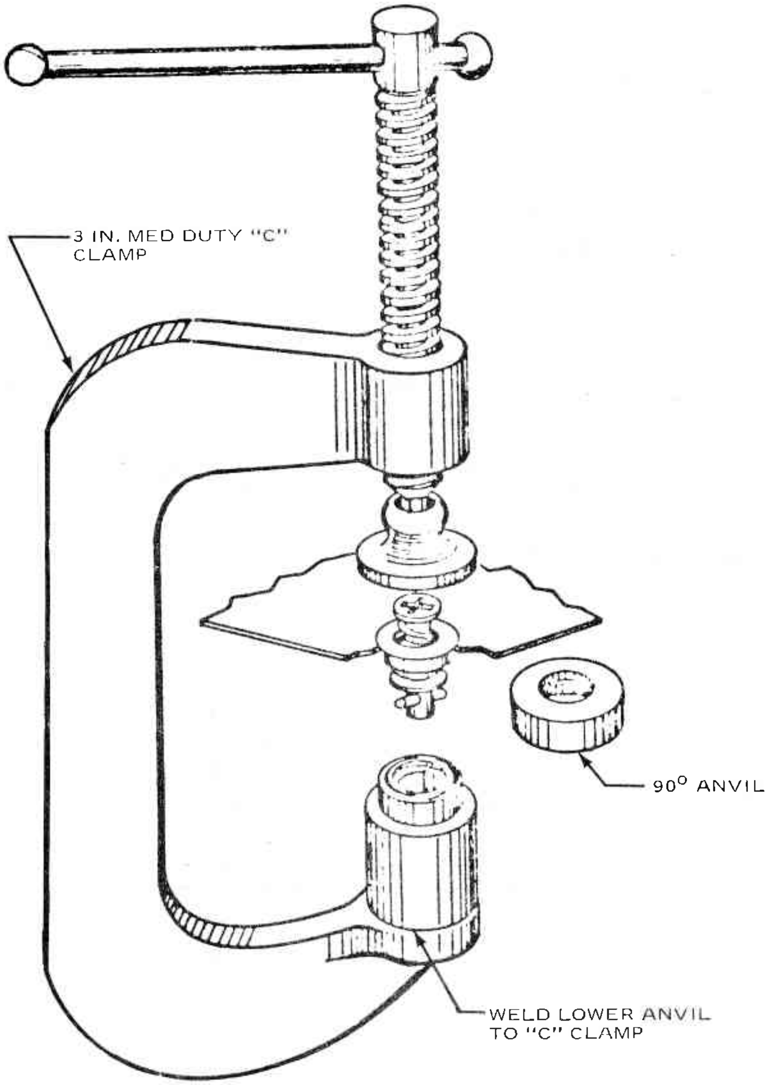


FLUSH GROMMET STUD

NOTES:

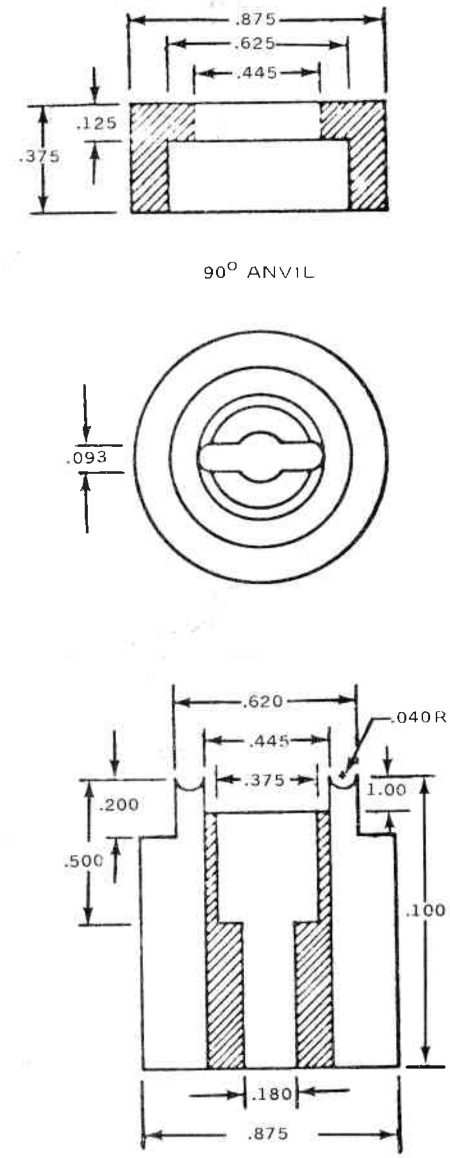
1. FOR DASH NUMBER GREATER THAN −15:
   "L" = (0.030" 2ND DASH NO.) + 353.
   "L" MAXIMUM = "L" MINIMUM + 0.010".
   "S" = SLOTTED HEAD — 0.068 + (0.03" × 2ND DASH NO.)
   CROSS HEAD — 0.062" + (0.03" × 2ND DASH NO.)
2. STUD SELECTION DEPENDS ON TOTAL GRIP ("C") THICKNESS.
3. GRIP = TOTAL GRIP THICKNESS FROM THE OUTER PANEL SURFACE TO THE RECEPTACLE MOUNTING SURFACE (INCLUDES OUTER PANEL, INNER FRAME, PAINT, GASKETS, SHIM, ETC.).
4. USE WITH 40R12 RECEPTACLE FOR SEALED INSTALLATION.
5. USE WITH 214-16 RECEPTACLE FOR UNSEALED INSTALLATION.

Figure 1-58. Removal and Replacement of Standard and Sealed Type Camloc Fasteners



INSTALLATION PROCEDURE:

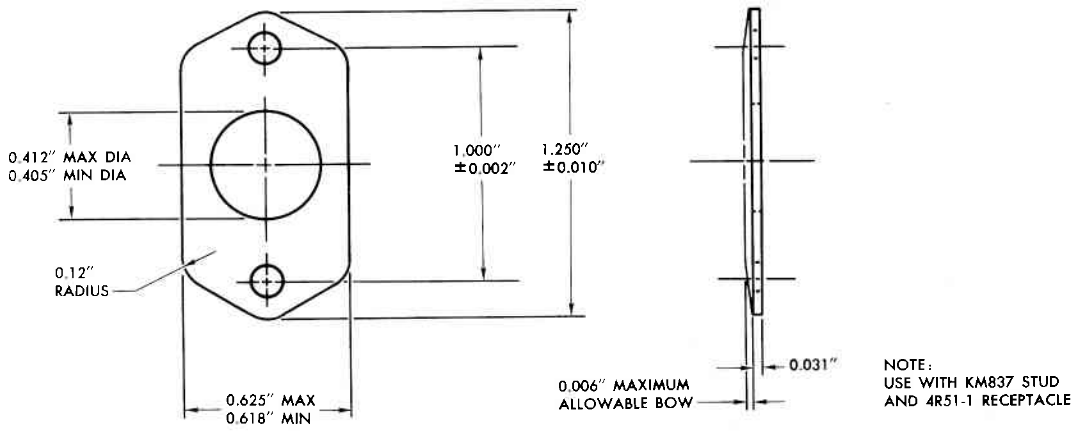
A. INSERT 40S51 STUD IN DOOR PANEL.
B. REMOVE THE 90° FLARE ANVIL FROM "C" CLAMP.
C. POSITION "C" CLAMP OVER STUD, ALIGNING CROSSPIN WITH SLOT IN ANVIL.
D. TIGHTEN "C" CLAMP TO FORM 45° FLARE.
E. REMOVE "C" CLAMP AND INSTALL 90° FLARE ANVIL.
F. POSITION "C" CLAMP OVER STUD AND TIGHTEN TO FORM 90° FLARE, SECURING STUD IN DOOR.]



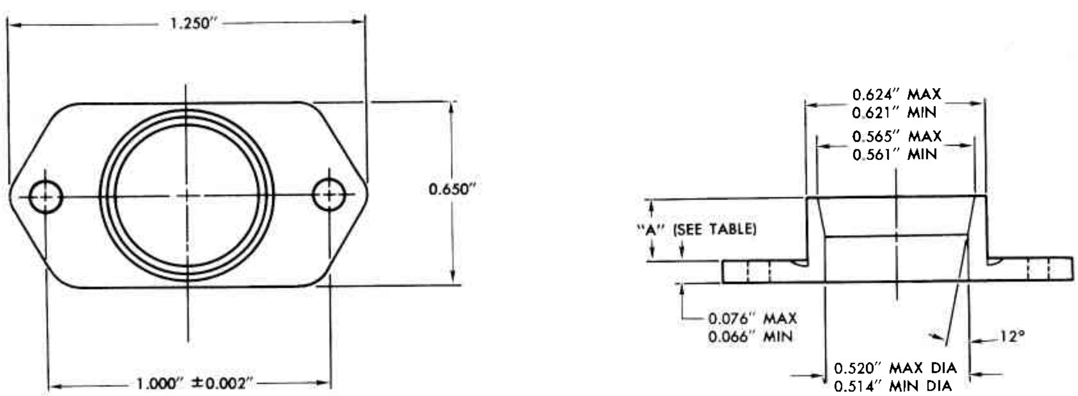
LOWER ANVIL

MAKE ANVILS FROM 4130 STEEL
MIL-S-6758
HEAT TREAT TO 125.000 PSI

Figure 1-59. Camloc Stud, 40S51 Installation Tool



CAMLOC BUFFER PLATE YR33-16



PART NUMBER	"A" DIMENSION	
	MAXIMUM	MINIMUM
KM 835-8	.080	.075
-12	.120	.115
-13	.130	.125
-15	.150	.145
-16	.160	.155
-17	.170	.165
-18	.180	.175
-20	.200	.195
-21	.210	.205
-25	.250	.245
-27	.270	.265
-29	.290	.285
-42	.420	.415

NOTE:
USE WITH KM837 STUD
AND 4R51-1 RECEPTACLE

CAMLOC SHEAR PLATE KM835

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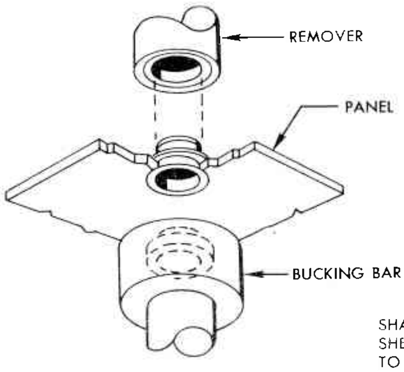
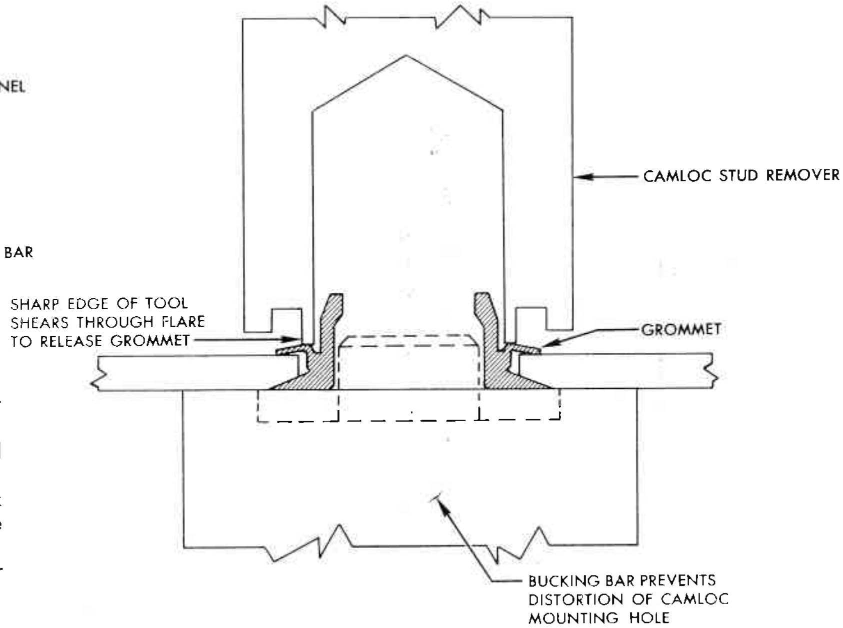
Figure 1-60. Camloc Buffer and Shear Plates



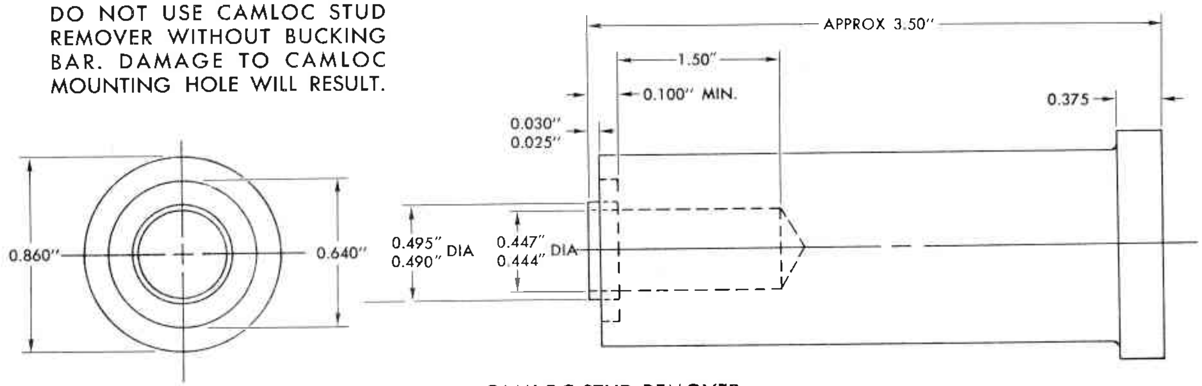


PROCEDURE

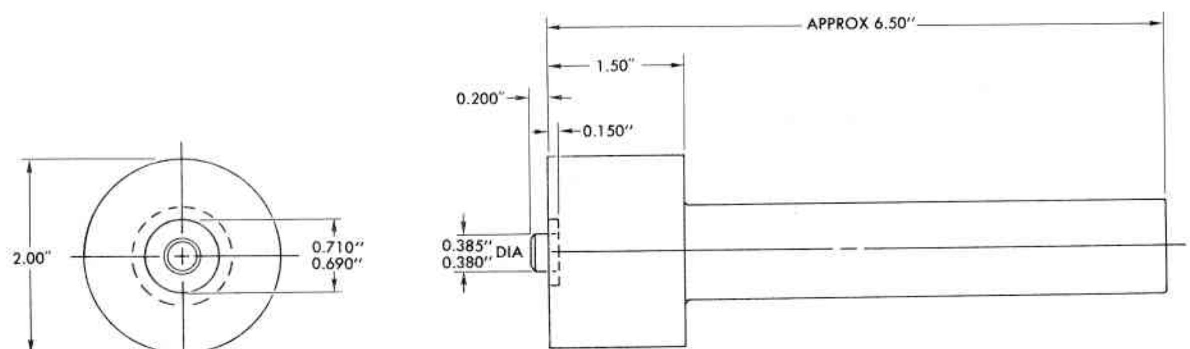
a. Locally manufacture stud remover and bucking bar, as shown.
b. Remove lock pin from camloc stud and remove stud.
c. Insert bucking bar in countersunk side of grommet and remover in flare side.
d. Rap remover with a hammer to shear grommet skirt.

CAUTION

DO NOT USE CAMLOC STUD REMOVER WITHOUT BUCKING BAR. DAMAGE TO CAMLOC MOUNTING HOLE WILL RESULT.



CAMLOC STUD REMOVER



CAMLOC BUCKING BAR

NOTE:
MANUFACTURE CAMLOC STUD REMOVER FROM TOOL STEEL S.A.E. S5 OR EQUAL. HEAT TREAT TO TOUGHEN.

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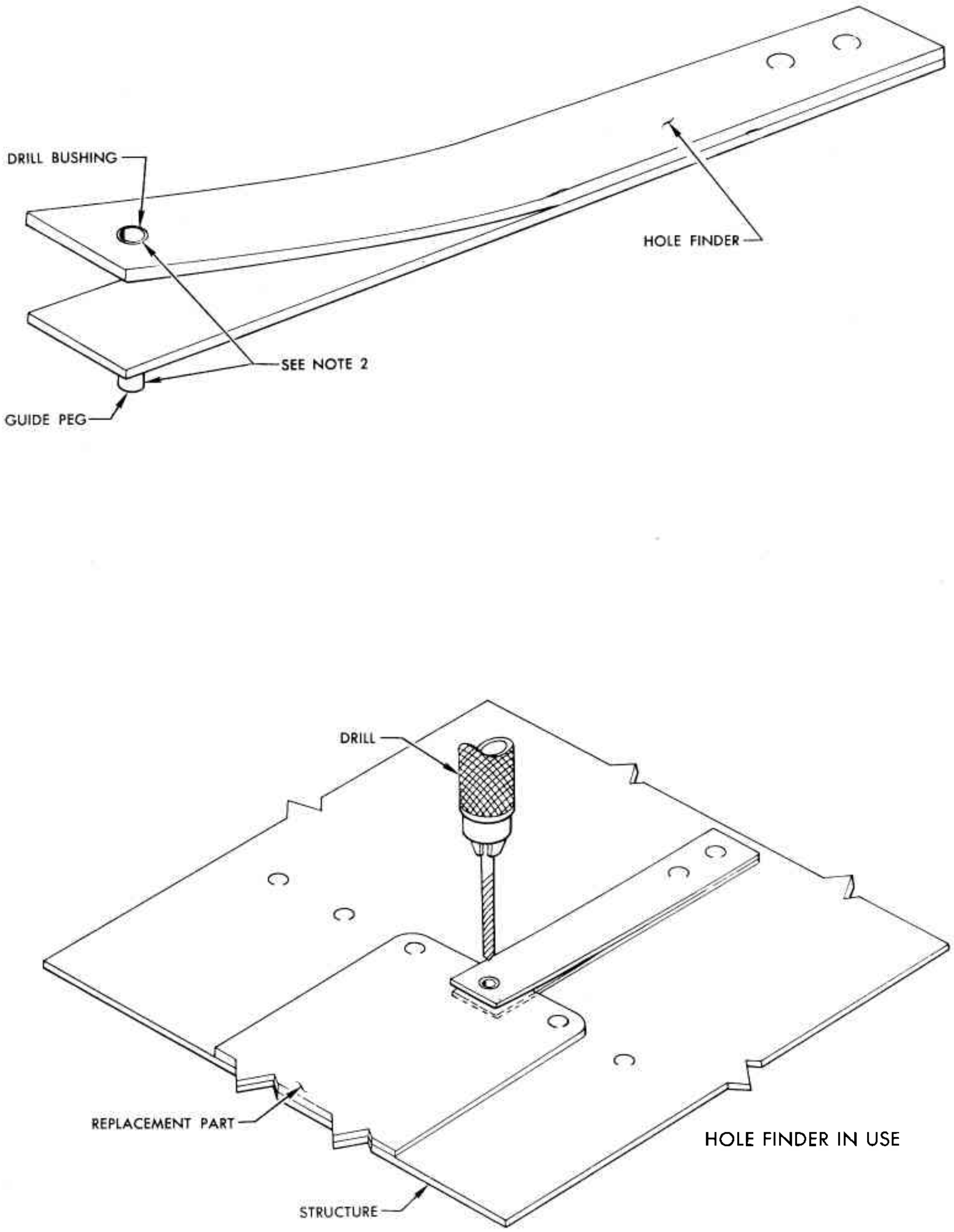
Figure 1-61. Camloc 40S51 Stud Removal Tool



NOTE:
1. REFER TO PARAGRAPH ON "LOCATING BLIND HOLES" IN SECTION I FOR INFORMATION PERTAINING TO HOLE FINDER.
2. DIAMETER OF GUIDE PEG MUST BE SAME AS INNER DIAMETER OF DRILL BUSHING.

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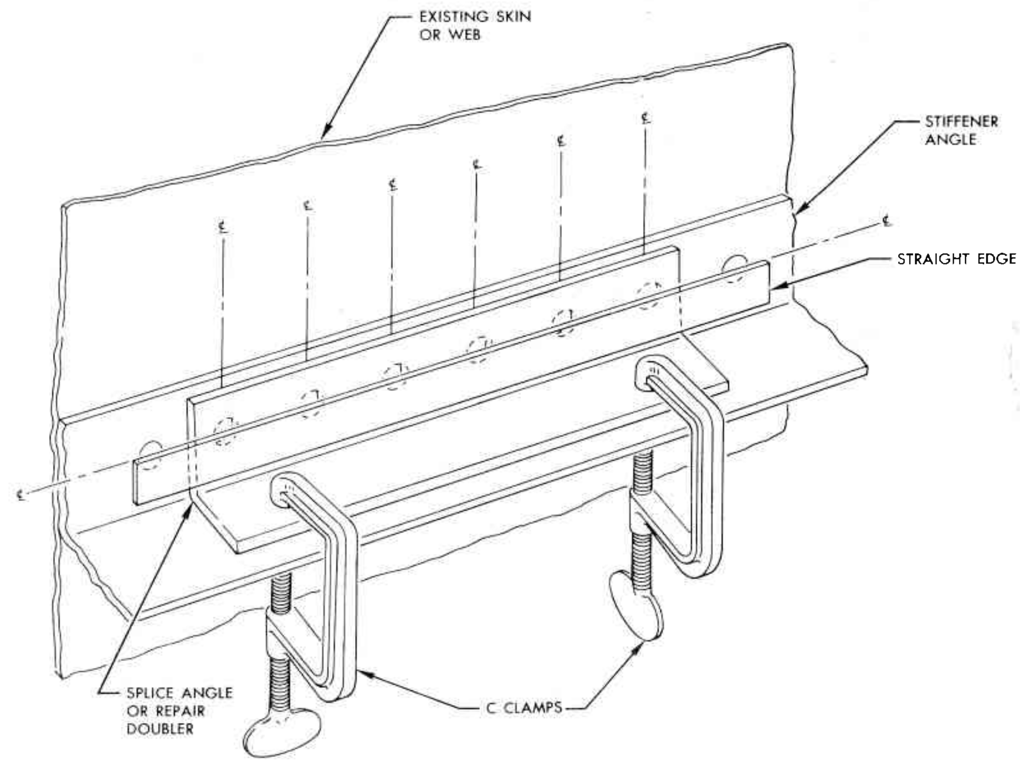
Figure 1-62. Locating Blind Holes (Sheet 1 of 2)



LOCATING BLIND HOLES BY
LINES LAYOUT METHOD

PROCEDURE

a. Remove fasteners from existing structure.
b. Using a straight edge and pencil, draw a vertical and horizontal centerline across each hole.
c. Extend horizontal and vertical centerlines beyond damaged area so that centerlines may be seen when repair part is installed.
d. Remove straight edge.
e. Install repair part.
f. Lay a straight edge across repair part and existing structure and in line with centerlines drawn in step B.
g. Drill holes through intersection of vertical and horizontal centerlines on repair parts.

NOTE

DRILL USED IN STEP G SHOULD BE AT LEAST TWO SIZES SMALLER THAN EXISTING HOLES TO ALLOW FOR ANY ERROR IN LAYING OUT CENTER LINES.

h. Complete drilling operation with final drill size.

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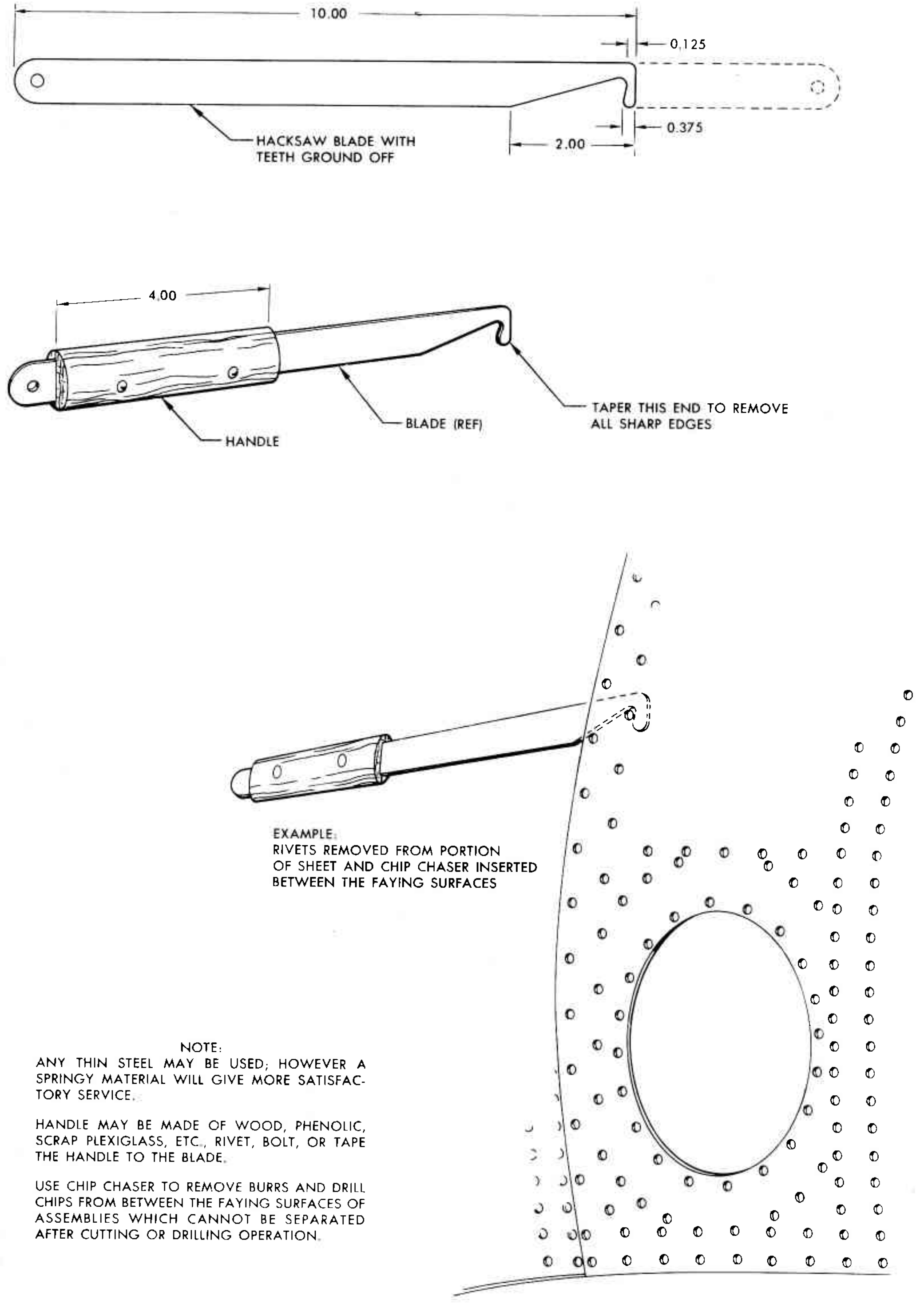
Figure 1-62. Locating Blind Holes (Sheet 2 of 2)



NOTE:
ANY THIN STEEL MAY BE USED; HOWEVER A SPRINGY MATERIAL WILL GIVE MORE SATISFACTORY SERVICE.

HANDLE MAY BE MADE OF WOOD, PHENOLIC, SCRAP PLEXIGLASS, ETC., RIVET, BOLT, OR TAPE THE HANDLE TO THE BLADE.

USE CHIP CHASER TO REMOVE BURRS AND DRILL CHIPS FROM BETWEEN THE FAYING SURFACES OF ASSEMBLIES WHICH CANNOT BE SEPARATED AFTER CUTTING OR DRILLING OPERATION.

Figure 1-63. Chip Chaser

used. The inner diameter of the drill bushing in the top leg and the outer diameter of the guide peg in the lower leg of the hole finder both match the diameter of the existing hole in the structure.

1-174. DIMPLING.

1-175. Hot Dimpling.

1-176. The hot dimpling method consists of locally elevating the temperature of the material to 162.7°C to 176.7°C (325°F to 350°F) by the use of a heated die before dimpling to reduce the possibility of cracks developing in the material. When dimpling light gage 7075-T6 or 2024-T6 is required, this method should be used. The temperature may be determined by the use of Tempilaq applied to the metal adjacent to the hole to be dimpled. Tempilaq is manufactured by Tempil Corporation, 132 W. 22nd Street, New York 11, N.Y. It is a special lacquer that melts at a predetermined temperature, and for this purpose must be rated to melt at 162.7°C (325°F). The temperature of the die should never exceed 332.2°C (650°F), and the dwell time required to melt Tempilaq should never exceed 30 seconds. Tests may be made on scrap material to determine if the die is functioning satisfactorily. See figure 1-28 for dimpling tolerances.

1-177. Equipment for Hot Dimpling.

1-178. The hot dimpling equipment may be either heavy units that are automatically timed to an operating dwell time and controlled by the operator, or simple portable equipment using a 332.2°C (650°F) soldering iron and depending entirely on the use of Tempilaq to determine the correct temperature. With the former, Tempilaq should be applied at intervals to check the accuracy of settings, while with portable equipment it should be applied at each dimple.

NOTE

Emphasis must be placed on the importance of temperature control in hot dimpling operations. Too low temperatures may result in cracked dimples while temperatures that are too high may destroy the hardness of the material.

1-179. Coin Dimpling.

1-180. See figure 1-28 (sheet 3) for the installation of rivets using the coin dimpling procedure.

1-181. PROCEDURES FOR APPLICATION OF STRUCTURAL ADHESIVE BONDS.

1-182. The structural adhesive bonding process is most commonly employed when making repairs to honeycomb structures. This process provides a strong repair without the use of rivets; however, rivets are recommended in addition to the bond when practical. When a repair of this nature is contemplated, all parts to be fabricated and other materials required to accomplish the repair shall be immediately available prior to assembly. Refer to Section X for general honeycomb repairs.

1-183. Procedure for Cleaning Faying Surfaces.

a. All painted surfaces to be repaired shall be stripped.

b. Sandpaper faying surfaces lightly with a very fine sandpaper. Do not use wet-dry type or emery paper which contain oils or abrasives that will contaminate the surfaces to be bonded.

c. Clean area to be bonded with an approved solvent, such as naphtha, toluene, or methyl-ethyl ketone. See figure 10-13 for cleaning procedure. Wipe dry with clean, soft, white, lint-free cloth. Area is clean when drying cloth does not discolor.

1-184. Procedure for Mixing and Applying Bond.

Most adhesives and accelerators are furnished in kit form (under one stock number but in separate containers) in proper proportions for mixing. When using kit form adhesives, always follow the manufacturer's mixing instructions shown on the containers. Standard mixing procedures are explained in Section XI; however, these procedures are to be used only if adhesives and accelerators are not received in kit form. See Table 10-I for honeycomb repair adhesives.

1-185. FINISH REQUIREMENTS.

1-186. Dissimilar Metals.

1-187. Contacts between certain metals tend to create corrosive action; therefore, dissimilar metals shall be defined and grouped as follows:

Group I	Magnesium alloys.
Group II	Aluminum alloys.
Group III	Zinc, cadmium, lead, tin, and steel except corrosion resistant steel.
Group IV	Copper, nickel and their alloys, chromium, corrosion resistant steel, and titanium.

The metals within each group are not dissimilar in reaction, and all metals not grouped together shall be considered dissimilar in reaction with respect to each other. The more widely spaced groups are considered the most dissimilar.

1-188. Corrosion Preventive Measures.

1-189. To reduce the possibility of corrosive action in dissimilar metals, the following precautions should be employed when making repairs:

a. Steel bolts, screws, nuts, washers, steel rivets, and repair parts in contact with dissimilar metals, after surface treatment per item "e," shall receive a coat of zinc chromate primer which may be wet or dry at the time of installation.

b. Aluminum alloy repair parts which are to be treated with primer should be cleaned with methyl, Specification TT-M-261, and treated with chemical film. Do not use iron oxide rouge, steel wool, or other similar abrasives which tend to accelerate corrosion.

c. Close tolerance bolts or press fits may be assembled with an oil bearing material that will not induce corrosion.

d. The faying surfaces or seams of all dissimilar metals, except in fuel tight or pressurized areas where a sealing compound is required, shall be treated with a total of four coats of primer. Any dissimilar metal part may have coats of primer as long as the corresponding faying surface of the dissimilar metal part has enough coats to give a total of four between the faying surfaces. As an alternate method, apply one coat of sealer, Military Specification MIL-S-81733 over prescribed detail finish to a thickness of approximately 15 mils on one of the two faying surfaces. Apply sealer in such a manner as to be squeezed out at all boundaries of joint, leaving a complete fillet all around the boundary when the excess is removed. Contact surfaces of dissimilar metals, where relative motion is involved, shall require insulation only where the end surfaces of bushings do not rotate against the dissimilar metal with which they are in contact. Special precautions shall be taken to insure that in all cases where only one of two adjacent surfaces of dissimilar metal joint requires paint coats, such coats shall be extended past the joint onto unpainted surface by at least one inch wherever possible.

e. All noncorrosion resistant steel repair parts subjected to operating temperatures below 260°C (500°F) shall be cadmium plated in accordance with Specification QQ-P-416, type II, class B. Parts subjected to operating temperatures exceeding 260°C (500°F) shall be nickel plated in accordance with Specification QQ-N-290, class II. After plating, all noncorrosive resistant steel parts shall be painted as required by the applicable portion of paragraph 1-196. Corrosion resistant steel repair parts need not be plated and shall be cleaned (passivated) by a five-minute immersion of the part in a 10 to 15 percent solution of nitric acid, followed by a thorough water rinse. For further information concerning prevention and repair of corrosion refer to T. O. 1-1-2.

1-190. Protective Coatings.

1-191. All exterior surfaces of the airplane require a protective coating, with the exception of the windshield and canopy transparencies, and a portion of the tail cone. When repair work involves the inner and outer surfaces, it is essential that all damaged paint and any existing products of corrosion be throughly removed. For corrosion removal and treatment procedures, refer to T.O. 1-1-2. Prior to and after completion of repairs, refer to T.O. 1F-106A-23 for data concerning application of new protective coating to interior and exterior surfaces, and for repairs to damaged exterior finish.

CAUTION

Aromatic hydrocarbon cleaning solvents shall not be used on this airplane because of possible detrimental effects on paint finishes and some sealant and cement materials. Do not use gasoline, alcohol, kerosene, benzene, xylene, ketones including acetone, carbon tetrachloride, fire extinguisher or de-icing fluids, lacquer thinners, aromatic hydrocarbons, ethers, glass cleaning compounds or any solvent not approved by T.O. 1F-106A-2-2-2-2 for removal of foreign matter from canopy plexiglass panels. During touchup repairs to damaged finish, or cleaning of the airplane with solvents that evaporate at a high rate, paint and solvent fumes must be carried away from the canopy to prevent any possibility of their coming in contact with unprotected plexiglass panels. This is mandatory as acrylic plastic absorbs solvent fumes which destroy its structural strength and optical quality. During repainting of the entire airplane or a major portion of the airplane, such as the wing, fin or fuselage, the canopy should be removed for storage in a cool, dry location away from solvent fumes such as may exist near paint spray or paint storage areas.

1-192. If it is impractical to remove the canopy, refer to paragraph 1-193 for method of protecting plexiglass by masking panels to prevent paint fumes from contacting acrylic plastic sections of canopy. Refer to T. O. 1-1A-12 for additional information concerning repair and maintenance of transparent plastics. Refer to T.O. 1F-106A-2-2-2-2 for approved airframe cleaning materials and procedures.

1-193. Painting Precautions in Area of Canopy Plexiglass Windows.

1-194. When touchup repair painting of a nick or scratch on the airplane finish is to be accomplished within approximately ten feet of the canopy, the transparent area of the canopy window shall be completely masked off as outlined below. If the touchup painting is done in a hangar or enclosed area, the paint fumes must be carried off by forced ventilation. If practical, the airplane should be positioned so that the forced ventilation carries the paint fumes in a direction away from the canopy. During repainting of the entire airplane or major portion of the airplane, the canopy should be removed from the airplane and stored in an area affording protection from all the injurious substances mentioned in paragraph 1-191.

a. Clean both sides of each canopy panel. Refer to T.O. 1F-106A-2-2-2-2 for complete canopy cleaning procedure.

b. Cut one thickness of flannel cloth, Specification CCC-F-456A, or two thicknesses of flannel cloth, Specification CCC-F-466, to fit both the exterior and interior surface of each canopy panel.

c. Secure the flannel cloth in place with tape, Federal Specification PPP-T-60.

NOTE

If flannel cloth is not available, cover both the exterior and interior surfaces of each canopy panel with Protex #20V adhesive paper, manufactured by Maskoff Company, Monrovia, Calif., and proceed with step "d."

d. Cut one sheet of barrier material, Specification MIL-B-131B, to fit both the exterior and interior surfaces of each canopy panel.

e. Secure the barrier material in place with tape, Federal Specification PPP-T-60.

CAUTION

Do not remove the protective covering from the canopy panels until the drying time for the paint has been completed.

f. Remove the protective covering from the canopy panels.

NOTE

If Protext #20V adhesive paper was used in this procedure, peel the adhesive paper slowly from the canopy panels to prevent an excessive buildup of an electrostatic charge in the canopy panels.

g. Upon completion of removing the protective covering from the canopy panels, refer to T.O. 1F-106A-2-2-2-2 for canopy cleaning and polishing procedures.

1-195. and 1-196. Deleted.

All data on pages 1-90, 1-90A and 1-90B, including figure 1-64, deleted.

k. Deleted.

1-197. Repairs to Rain Erosion Protective Coating on Plastic Exterior Surfaces.

a. The plastic laminated exterior surfaces (radome, vertical fin (upper) are coated with rain erosion protective coatings, either MIL-C-7439A, Class I (black) or MIL-C-83231, Class A, Type I, to prevent severe damage to the fiberglass surface when flying through rain.

NOTE

MIL-C-83231 coatings shall be applied, repaired, and removed in accordance with T.O. 1-1-24.

b. These materials will protect the fiberglass surface indefinitely, providing the coating is replaced or repaired when inspection indicates such work is necessary. No other coatings or top coats such as epoxy paint, shoe polish, or wax to enhance the appearance of plastic laminated surfaces is authorized. Polyurethane rain erosion resistant coating, Specification MIL-C-83231, is the preferred coating for general application since it provides more service life than the MIL-C-7439 neoprene. MIL-C-7439 neoprene coating should be used when conditions are such that a proper cure of the polyurethane coating cannot be obtained or when other circumstances warrant its use.

1-198. Repairs to Plastic Exterior Surfaces With MIL-C-7439A.

a. Remove loose, blistered, or erosion damaged sections of coating by sanding with emery cloth (180 grit), or equivalent, to a smooth tapered or feathered edge. Extend feather edge about one-half inch beyond the damaged area. Avoid sanding into the surface of the underlying plastic.

NOTE

The entire coating may be removed, if complete replacement is determined necessary, by application of cloths saturated with toluene to the coating for about two-minute intervals. Between applications of the cloths, vigorously agitate the coating surface with a stiff fiber bristle brush. Continue alternate cloth applications and brushing until coating is entirely removed. Care must be taken to prevent unnecessary exposure of the underlying plastic to the solvent effect of the toluene. If entire coat is removed delete steps "a" and "j" and continue with the remaining steps of the procedure.

b. Wipe surface to be coated until dust free. Use a cloth moistened with toluene.

c. Mask around area to be coated to protect adjacent areas from overspray.

d. Prepare Bostick primer, No. 1007, for spray application by thinning with three volumes of methyl ethyl ketone.

e. Spray on first coat of Bostick primer, No. 1007. Allow to dry for five minues and continue spraying until approximately four coats of primer have been applied with a five-minute drying period between each coat. Total thickness buildup of primer shall be 0.001 to 0.002 inch.

f. Allow final coat of Bostik primer to dry for 20 to 30 minutes.

NOTE

Application of the neoprene protective coating may be applied by brush when repairing an area of four square inches or less. Applications should be made by spraying when repairing an area larger than four square inches.

g. Prepare neoprene coating (Goodyear kit No. 23-56-S) for spraying by mixing Goodyear accelerator, No. 983-C, with Goodyear diluting thinner, No. 1803-C, and adding Goodyear cement, No. 1801-C, in the proportions recommended by the manufacturer. Stir thoroughly. Mix only the amount to be used within the following eight hours.

CAUTION

If 1801-C neoprene coating is not available, use any protective coating which conforms to Specification MIL-C-7439A, Class 1. In any event, the use of a protective coating which contains an anti-static compound will not be allowed for use on the radome.

h. Spray on a 0.0007 to 0.001-inch thick coating of neoprene and allow to dry for 10 to 15 minutes. Continue spraying with a 10 to 15-minute drying period between coats until a sufficient number of layers (approximately 12) have been applied to produce a total primer and coating buildup thickness of 0.007 to 0.012 inch.

i. Remove masking tape and feather edges of the applied coating by sanding with emery cloth (180 grit).

j Spray one additional coating over entire area of repair and the original coating.

k. Allow to cure for 72 hours at 21°C (70°F) or for two to three hours at 66°C (150°F) before use.

1-199. STRUCTURAL FIBERGLASS LAMINATES — MINOR SURFACE REPAIRS.

1-200. Scratch and abrasion damage to the outer surface of fiberglass laminate skins may be repaired at the advanced base level, as directed in the following procedure, if the damage limits are not exceeded for the particular laminate. Refer to applicable component section in this handbook for damage limits.

1-201. Procedure for Minor Surface Repairs.

1-202. Minor surface repairs shall consist of filling in the damaged area with a mixture of catalyzed resin and chopped glass fibers or the laying in of several layers of catalyzed resin-impregnated glass cloth. If the damage has occurred in an area covered by rain-erosion coating, refer to paragraph 1-197 for procedure on removal and replacement of the rain-erosion coating. Generally, a wide abrasion will require patching with sections of glass cloth, while narrow scratches may be loaded with a thick mixture of chopped glass fibers and resin.

a. Remove rough edges of laminate at edges of scratch or abraded area by hand sanding with number 40 to 60 abrasive grit.

b. Remove abrasive particles and dirt from repair area with a cloth moistened with toluene.

c. Catalyze required quantity of resin for filling damaged area by mixing the following weights of resin and catalyst:

100 parts of resin, Epon 815 or 828, Shell Chemical Corp.	and	25 parts of catalyst, Curing Agent T-1, Shell Chemical Corp.

For an alternate, use:

100 parts of resin, Epon 828, Shell Chemical Corp.	and	10 parts of catalyst, Hardener 951, Furane Plastics, Inc.

Measure by weight and mix thoroughly in a clean container. Avoid unnecessary breathing of gases emanating from mixture. Leave container open to prevent possible mild explosion of container due to gas formation.

NOTE

For narrow scratches, proceed with step "d" and delete step "e." For wide abrasions, delete step "d" and continue with step "e."

d. Prepare a thick paste of catalyzed resin mixed with glass fibers chopped from glass cloth. Work paste into scratch with a flat blade or spatula until repair extends slightly beyond flush.

e. Carefully sand the skin in a roughly circular area around the abrasion to produce a neatly feathered or tapered edge. Do not deepen sanded area below first three layers. Taper edge about 0.5 inch wide around damage. Cut filler patches from a section of clean number 181 glass cloth conforming to Specification MIL-F-9084. Cut patches large enough to overlap edges of sanded area. Coat damaged area and one filler patch with brush application of catalyzed resin. Apply resin-impregnated patch to damaged area and brush out air bubbles and excess resin. Continue application of resin-impregnated filler patches until repair is built up slightly above the surface of surrounding area. Remove excess resin that may have been worked out around edges of repair with a cloth moistened with toluene.

f. Cure repair at 150° to 200°F for two to four hours. Use portable infrared heat lamps or heating pads for heat application.

g. After curing, remove excess material and smooth surface of the repair by hand sanding to proper contour. Use number 80 to 120 abrasive grit for finish cut.

h. Mix a small amount of resin and catalyst as specified in step "c." Brush on a thin finish coating of resin over entire area of repair. Extend finish coat a minimum of 0.5 inch beyond edges of repair. Allow to dry at room temperature. Do not sand after cure is completed.

1-202A. DRAG CHUTE CANISTER REPAIR.

1-202B. General canister repair will be accomplished in accordance with existing instructions for non-structural fiberglass. Repair procedure for cracks and damaged rivet holes in canister lower aft body will be accomplished as follows (refer to figure 1-64A):

NOTE

Steps preceded by an asterisk shall apply only when a repair is required for damaged rivet holes.

a. Remove rough edges of laminate at edges of crack by hand-sanding with No. 40 to 60 abrasive grit.

*b. If spacing permits, relocate rivet holes a minimum of 1/4 inch from the damaged holes. Repair damaged holes by tapering from the inner surface and filling the tapered holes with as many plies of No. 181 cloth as required.

*c. If step "b" cannot be accomplished, sand the inner surface aft edge 0.030 inch deep, 0.6 inch wide, and 2.2 inches long, as shown in figure 1-64C, Views B-B and D-D. Note the 0.7 inch taper in View B-B. Sand the outer surface to smooth out all rough edges.

d. Remove abrasive particles and dirt from repair area with a cloth moistened with toluene.

e. Cut repair patches from a section of clean No. 181 cloth, conforming to Specification MIL-F-9084, large enough to extend 1/2 inch beyond the crack in all directions. Cut these patches to have two legs, as shown in figure 1-64B, View A-A, to serve as fillers for the reinforcement patches.

*f. Cut inner and extended reinforcement patches from clean No. 181 cloth to the shapes shown in figure 1-64C, Views B-B and D-D.

g. Coat damaged area and one repair patch with brush application of resin, conforming to Specification MIL-R-9499A, Type 1, or MIL-R-7575B, Grade A or B.

h. Apply resin impregnated repair patch to damaged area, as shown in figure 1-64B, View A-A, and brush out air bubbles and excess resin.

i. Apply at least two more resin impregnated repair patches, in accordance with steps "g" and "h" *j. Coat sanded area on inner patch and on extended reinforcement patch with brush application of resin.

*k. Apply the resin impregnated inner and extended reinforcement patches, as shown in figure 1-64C, Views B-B and D-D.

*l. Apply resin impregnated inner patches, as required, to build up the repaired area, flush with the inner surface.

*m. Apply a second resin impregnated extended reinforcement patch on the outer surface.

n. Apply three reinforcement patches, 0.5 x 4.8 inches, cut from clean No. 181 cloth, on each side of enclosure centerline, as shown in figure 1-64B, Views A-A and C-C. (Only one such patch will be applied when step "m" has been accomplished.)

o. Fill all crack voids on inside of enclosure with resin. Small strips of No. 181 cloth may be used, as required, provided the original surface smoothness and flushness can be restored after curing.

p. Cure the repaired area(s) as specified in the resin vendor's instructions.

q. After curing, remove excess material and smooth surface of the repair(s) by hand-sanding to proper contour. Use No. 80 to 120 abrasive grit to accomplish final sanding.

r. Brush on a thin finish coating of resin over entire area(s) of repair. Extend finish coat a minimum of 0.5 inch beyond edges of repair. Allow to dry at room temperature. Do not sand after cure is complete.

1-203. CRASH HANDLING AND SHIPPING.

1-204. Crash handling and shipping covers general information on the handling of the airplane and various removable components after an incident involving damage to the airplane.

1-205. CRASH LANDING.

1-206. If at all possible, standard maintenance procedures should be followed; however, firm procedures cannot be established since each situation must be evaluated individually. Factors such as extent of damage, damage to primary structure, repair allowances, topography, accessibility of crash site, distance to repair site, road clearances, and weight limitations of available roads must be considered in determining practicality of reclamation and salvage operations. Refer to T.O. 1F-106A-2-2-2-2 for standard ground handling procedures. A successful touchdown on level terrain with all gear retracted and the airplane landed in a level attitude will result in major damage to the following aircraft structural components: pitot static boom and fiberglass radome; nose and main landing gear and their attach point supporting structure; lower longerons; lower portion of fuselage bulkheads; beltframes and skin panels; missile bay doors; and the wings and control surfaces. The engine may incur damage from flying debris. Refer to Section IX for a complete fuselage damage survey applicable to nose and main landing gear failure.

1-207. Hoisting Equipment.

1-208. Special equipment required for hoisting the airframe and various removable components is illustrated on figures 1-65 and 1-66.

1-209. Removal of Airplane Components.

1-210. All electronic equipment should be removed from the airplane prior to any hoisting or lifting operation.

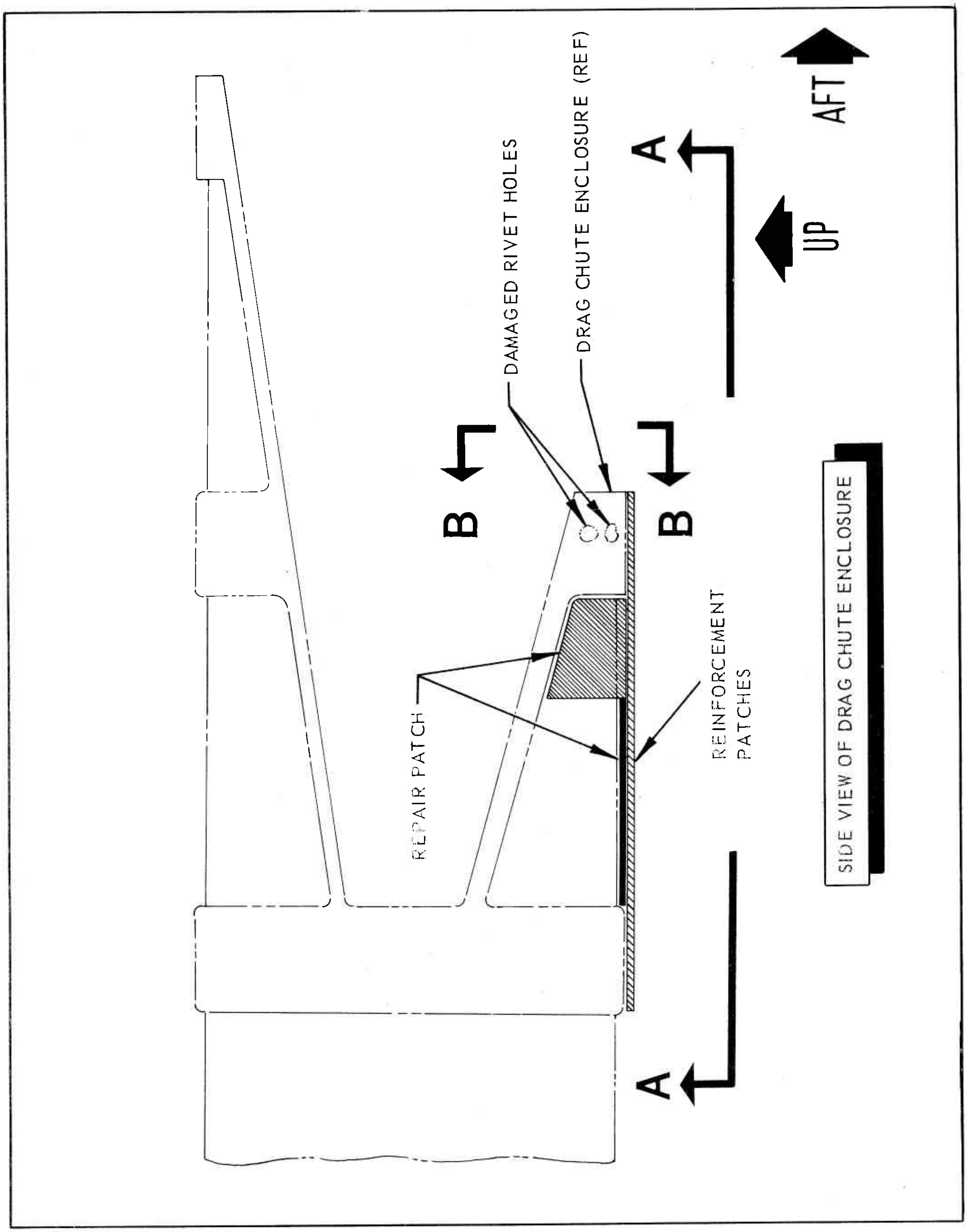


Figure 1-64A. Canister Repair Procedure

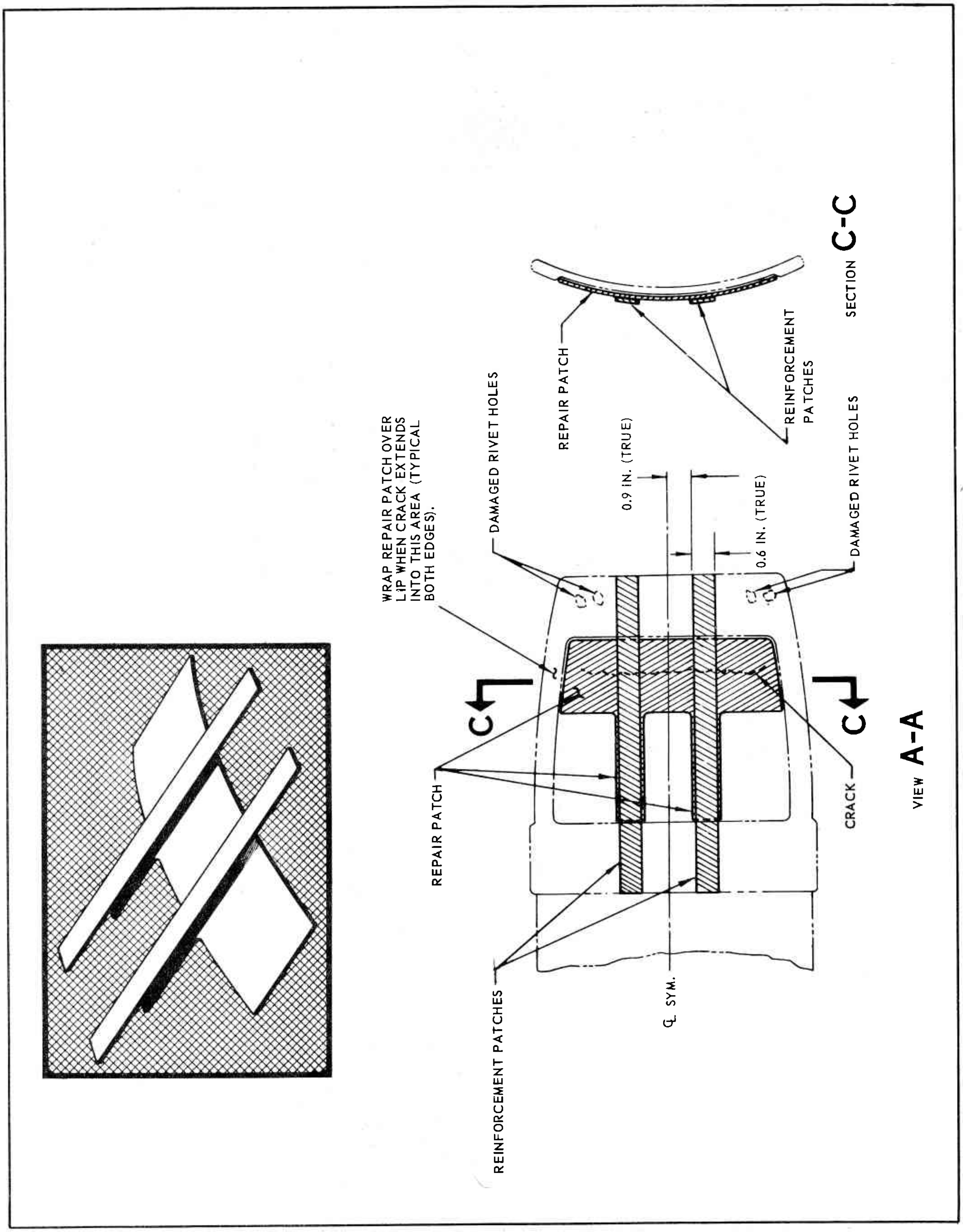


Figure 1-64B. Canister Repair Procedure

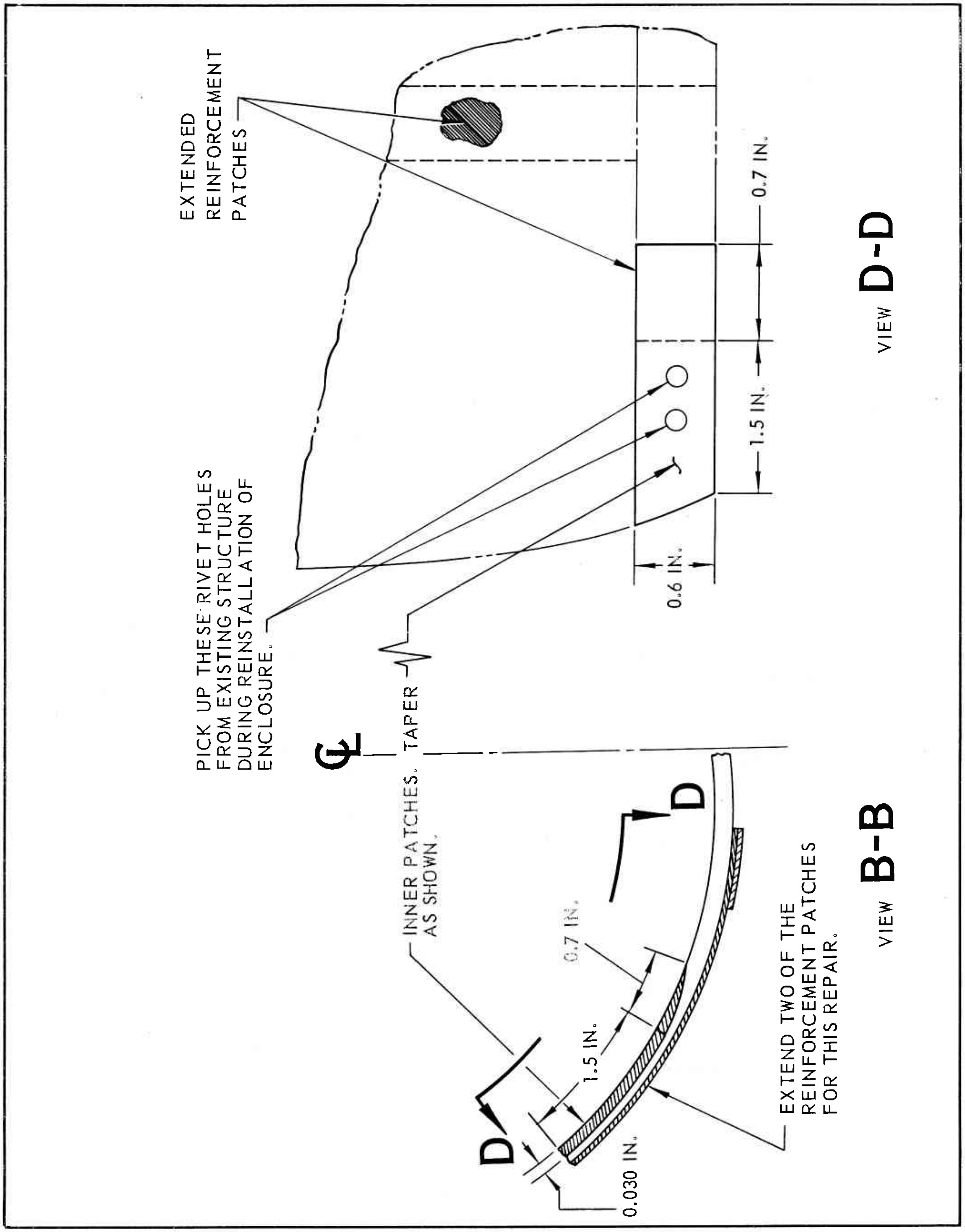
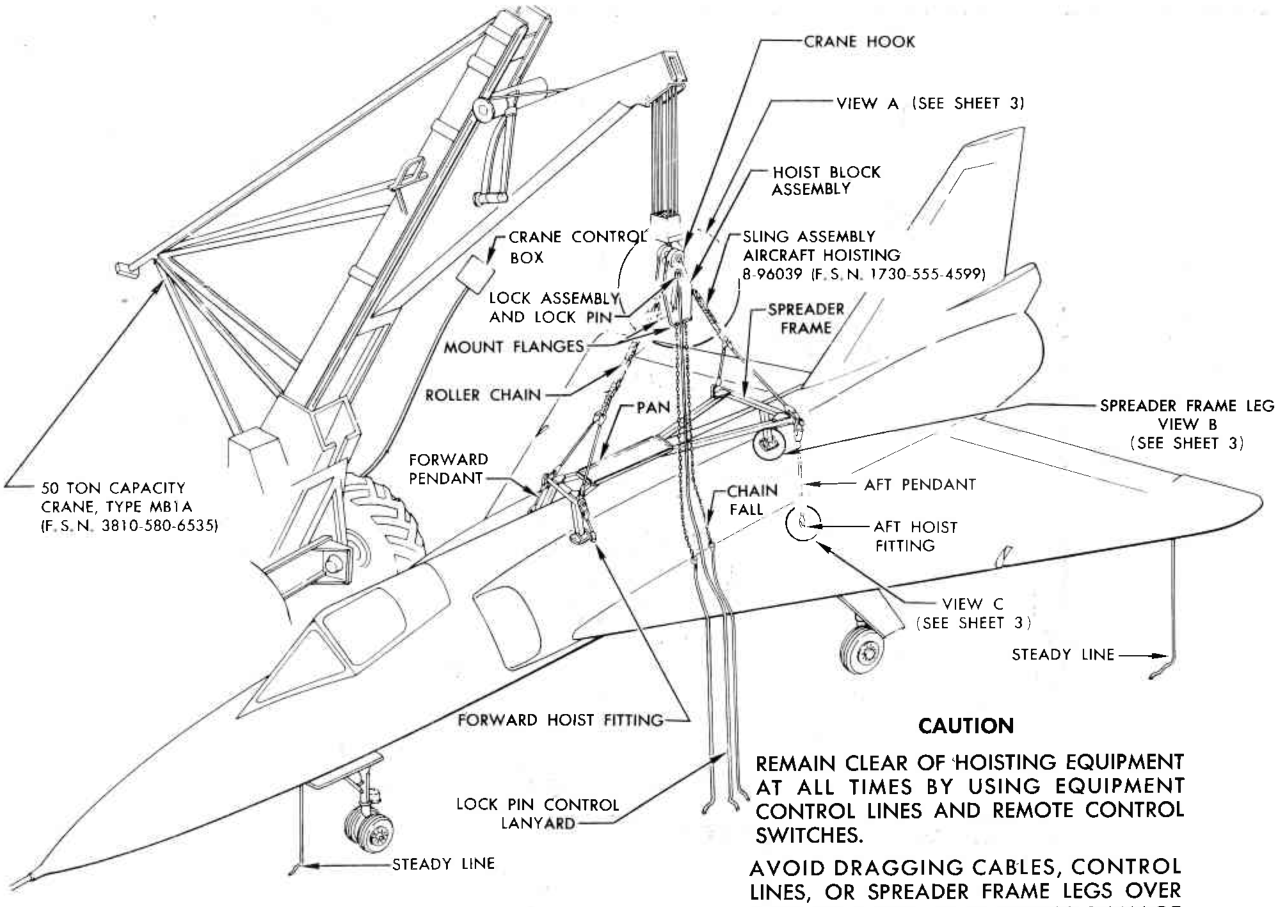


Figure 1-64C. Canister Repair Procedure



CAUTION

REMAIN CLEAR OF HOISTING EQUIPMENT AT ALL TIMES BY USING EQUIPMENT CONTROL LINES AND REMOTE CONTROL SWITCHES.

AVOID DRAGGING CABLES, CONTROL LINES, OR SPREADER FRAME LEGS OVER AIRPLANE SURFACES TO PREVENT DAMAGE TO AIRPLANE SKIN.

HOISTING ENTIRE AIRPLANE

a. Disconnect hoist block from 8-96039 (F.S.N. 1730-555-4599) hoisting sling assembly spreader frame mount pan by removing four attachment bolts from mount flanges. Arrange all pendant cables and fittings on spreader frame to function freely.
b. Pickup hoist sling assembly with 50-ton capacity crane, Type MB1A (F.S.N. 3810-580-6535).
c. Slowly raise hoist sling assembly until roller chain is properly seated over sprocket wheel.
d. Pull lock pin release lanyard and continue raising hoist sling assembly, allowing sprocket wheel to turn freely and hunt balanced position as weight of spreader frame is imposed. Utilize chainfall control as required, to assist in balancing spreader frame.
e. When proper balance has been attained, release lock pin control lanyard to allow engagement of lock pin through sprocket wheel; then raise sling assembly to desired level.

CAUTION

BE SURE THAT LOCK PIN IS IN FULLY LOCKED POSITION (NO RED VISIBLE ON LOCK PIN) PRIOR TO BEGINNING HOISTING OPERATION.

f. Position sling assembly over airplane with crane and carefully lower it into position for attaching hoist fittings, then seat padded legs on fuselage.
g. Remove screw plugs at forward and aft airplane hoist points.
h. Detach hoist fittings from pendant cables of sling assembly by removing shackle pins, then screw hoist fitting firmly into threaded hoist pins on the airplane.
i. Attach pendant cables to airplane hoist fittings and insert shackle pins. Safety shackle pins with cotter key.
j. Ascertain that airplane parking brakes are released.
k. Attach a steady line to either wing tie down fitting and a second line to nose gear. Station a man at each line to hold taut to prevent airplane from turning while it is being hoisted.
l. Station a man to hold tension on lock pin control lanyard, one to operate crane lift control box and one in crane cab. Raise crane lift to apply sufficient tension on hoist sling assembly to observe airplane balance. The angle at which the airplane tips will indicate which way to move crane boom and/or to operate chain fall control to obtain desired balance. Engage lock (by releasing lock pin control lanyard) and make necessary trial lifts and re-adjustments until true balance is obtained. Fully engage lock pin (no red visible) for each trial lift.
m. When true balance point has been reached, raise airplane to desired height.

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Figure 1-65. Airplane Hoisting (Figure 1 of 3)

HOISTING PROCEDURE WITH WINGS AND POWER PLANT REMOVED.

a. Accomplish steps "a" through "f" as shown on sheet 1.

b. Remove screw plugs at forward airplane hoist points.

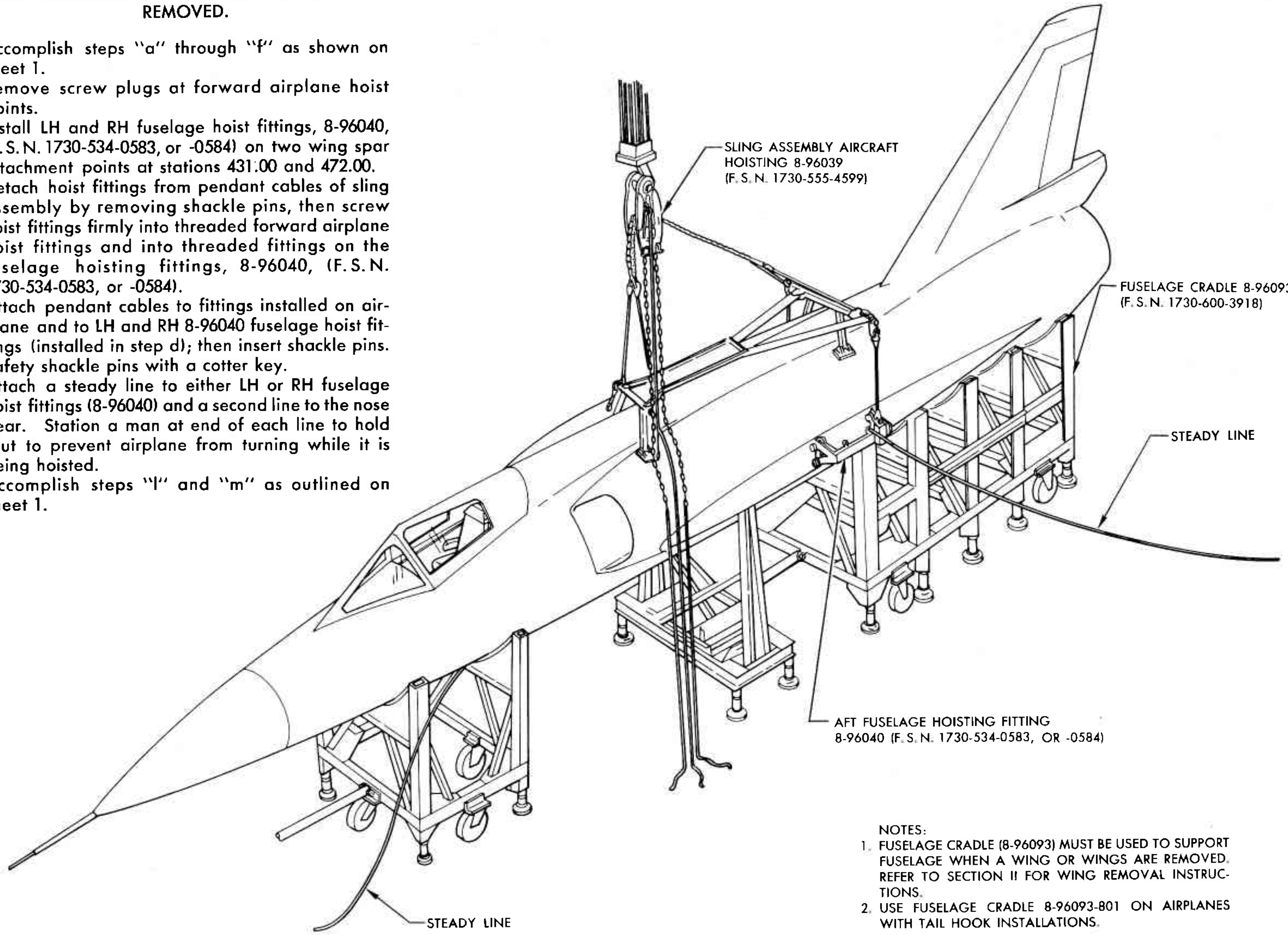
c. Install LH and RH fuselage hoist fittings, 8-96040, (F. S. N. 1730-534-0583, or -0584) on two wing spar attachment points at stations 431.00 and 472.00.

d. Detach hoist fittings from pendant cables of sling assembly by removing shackle pins, then screw hoist fittings firmly into threaded forward airplane hoist fittings and into threaded fittings on the fuselage hoisting fittings, 8-96040, (F. S. N. 1730-534-0583, or -0584).

e. Attach pendant cables to fittings installed on airplane and to LH and RH 8-96040 fuselage hoist fittings (installed in step d); then insert shackle pins. Safety shackle pins with a cotter key.

f. Attach a steady line to either LH or RH fuselage hoist fittings (8-96040) and a second line to the nose gear. Station a man at end of each line to hold taut to prevent airplane from turning while it is being hoisted.

g. Accomplish steps "l" and "m" as outlined on sheet 1.



NOTES:

1. FUSELAGE CRADLE (8-96093) MUST BE USED TO SUPPORT FUSELAGE WHEN A WING OR WINGS ARE REMOVED. REFER TO SECTION II FOR WING REMOVAL INSTRUCTIONS.
2. USE FUSELAGE CRADLE 8-96093-801 ON AIRPLANES WITH TAIL HOOK INSTALLATIONS.

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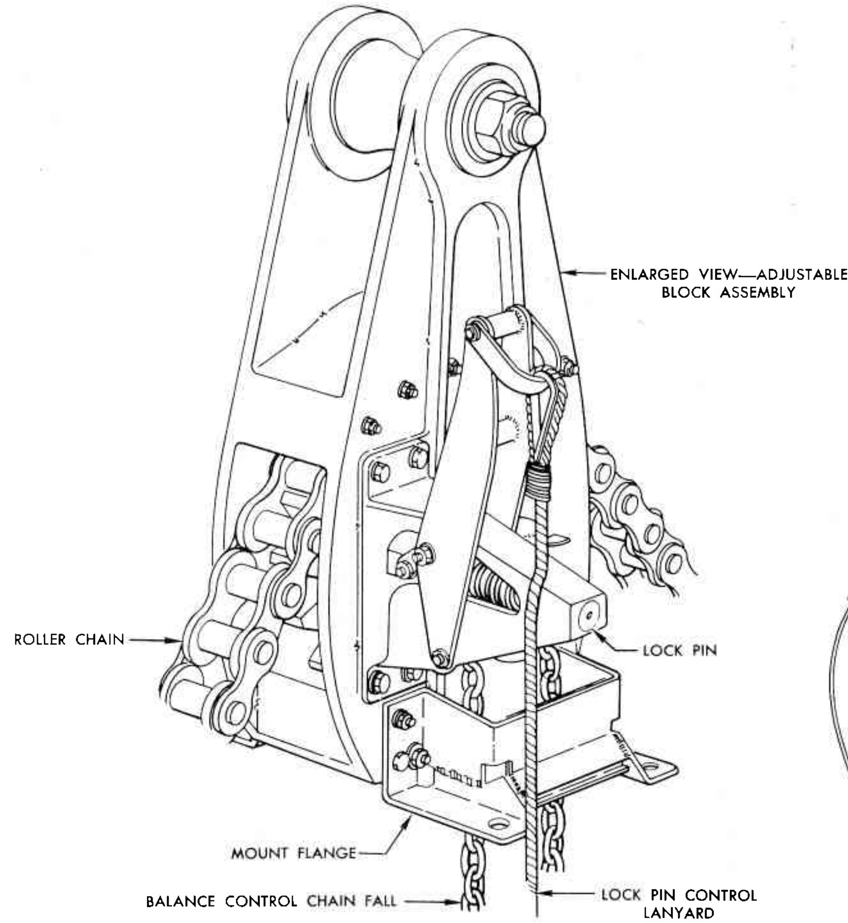
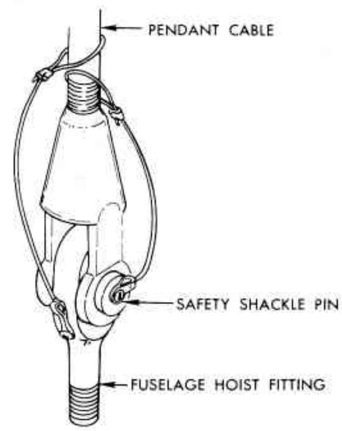
Figure 1-65. Airplane Hoisting (Sheet 2 of 3)





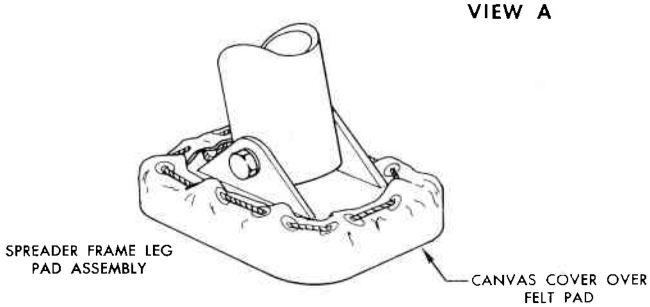


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Figure 1-65. Airplane Hoisting (Sheet 3 of 3)

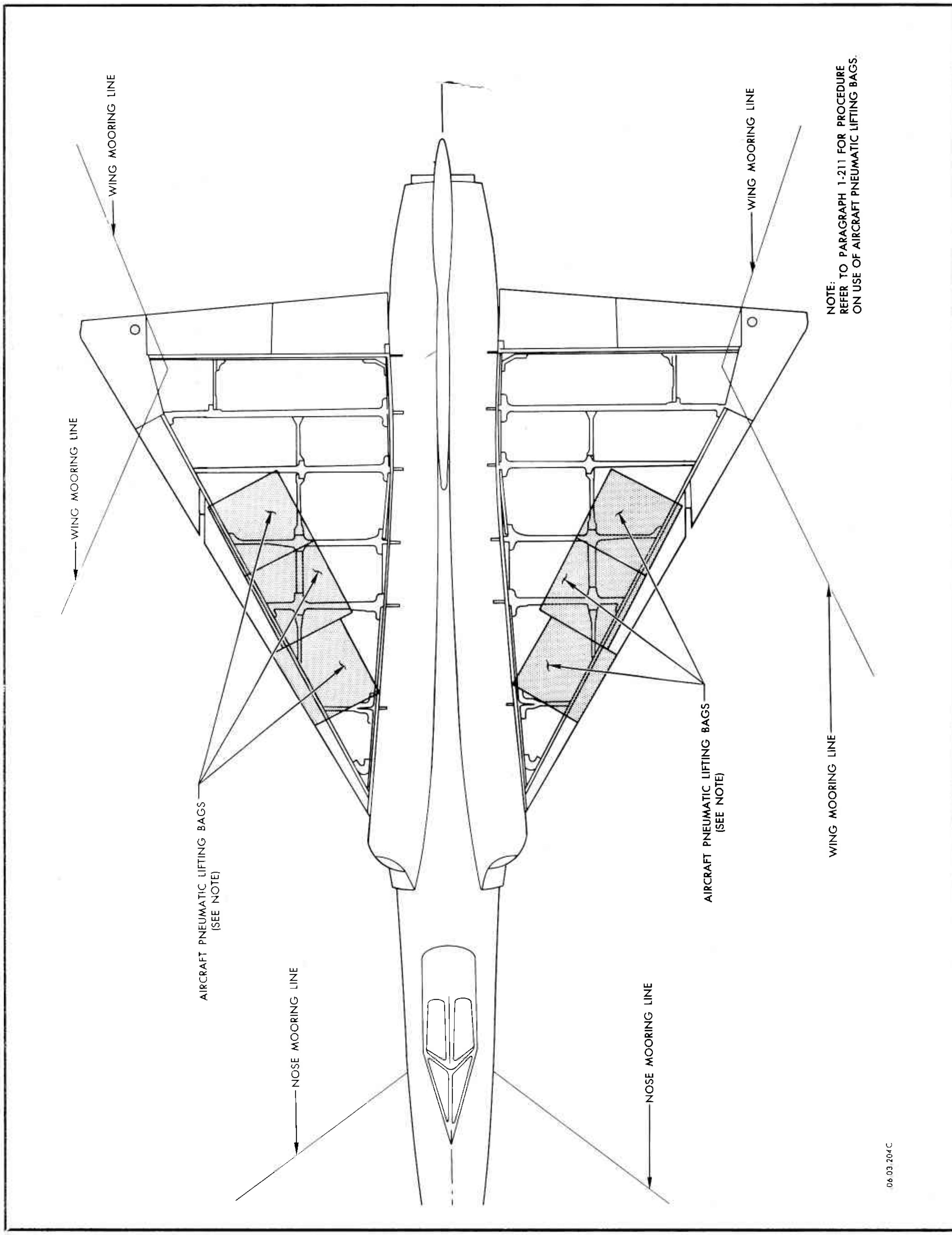


Figure 1-66. Emergency Airplane Lifting

1-211. Lifting Airframe.

1-212. Airplane pneumatic lifting bags (1730-263-2962), type F2, provide a means of raising the airplane from a gear-up landing position to a position which will allow jacks to be inserted when other methods of lifting are impractical. Refer to paragraph 1-215 for jacking provisions. Each lifting bag is designed to lift a total of 24,000 pounds to a maximum height of six feet. Lacing bands are provided to permit the lacing together of two bags when more than six feet of lift is required. Bags are not to be used as supports when other methods of support are available. Each bag is provided with a tarpaulin cover which serves as protection for the bag in shipping or while in storage, and also serves as a ground cover on which to place the bag during the lifting operation. The procedure for lifting an airplane using pneumatic lifting bags is as follows:

a. Moor or tie down the airplane to restrict its side-to-side and forward or backward movement. Mooring tie down points are shown on figure 1-66.

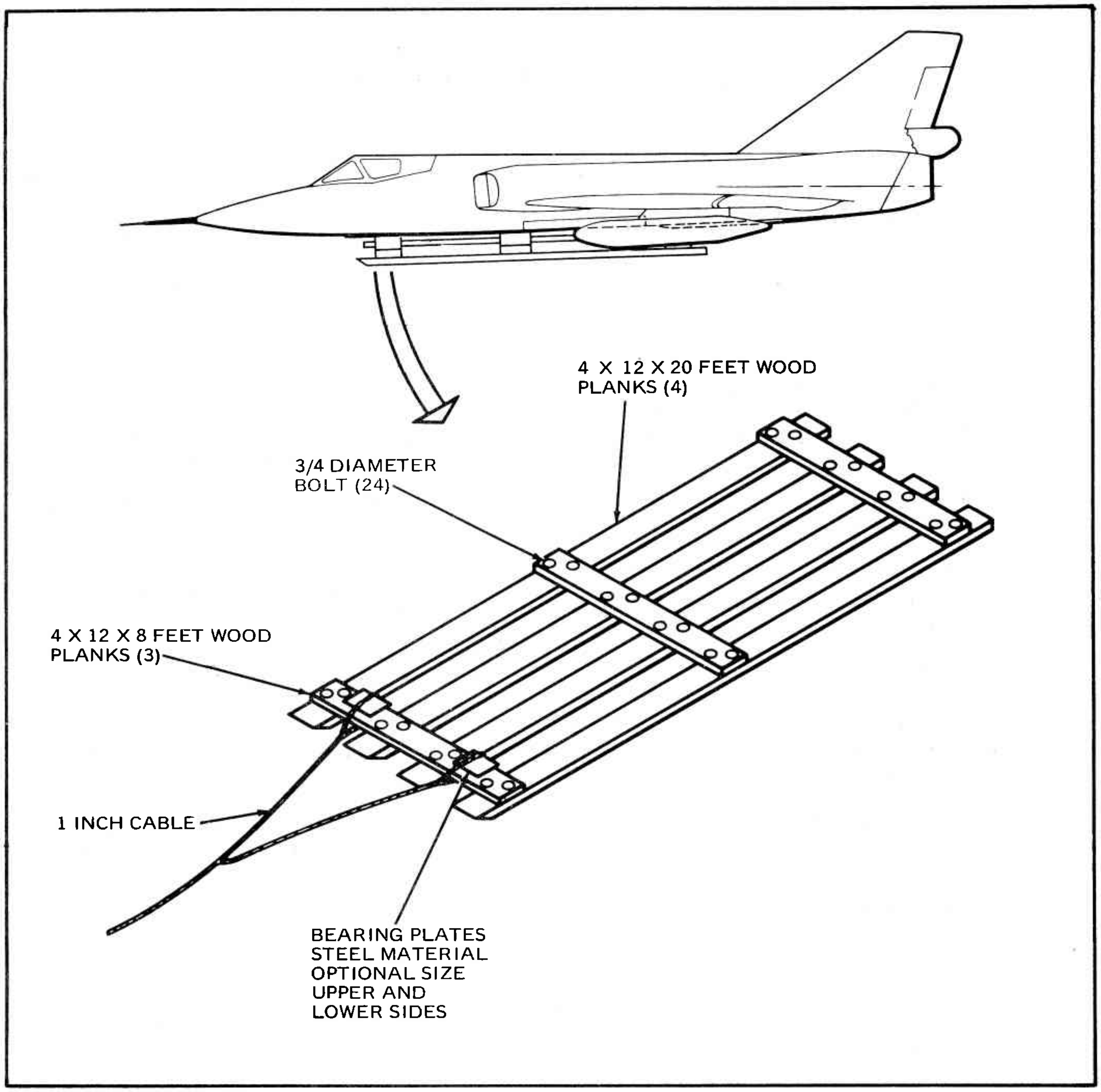
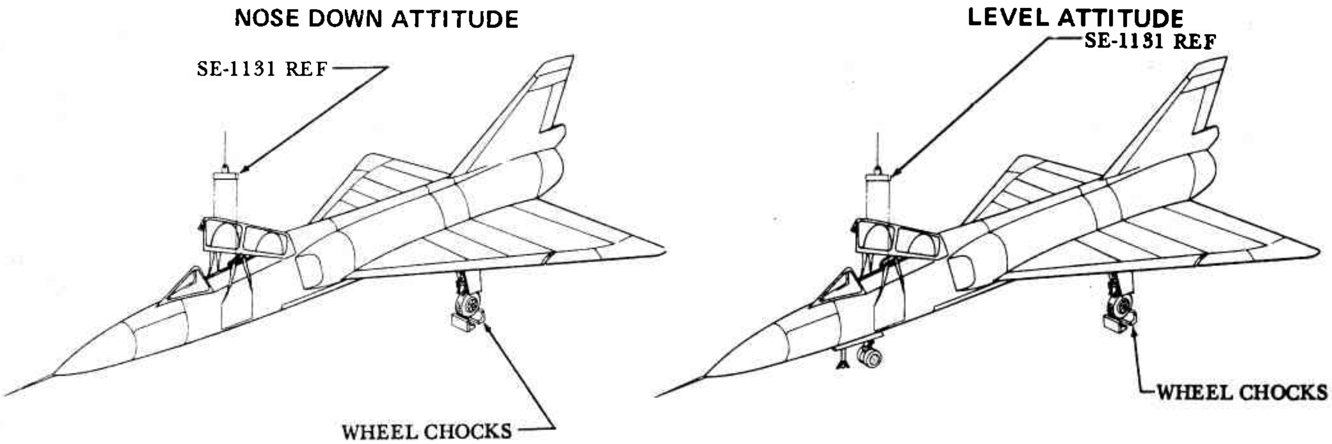


Figure 1-66A. Sled Type Transport Rig-crash Damaged Aircraft Removal



A. DESCRIPTION

The tool is a sling which is made up of spreader bar and two cable assemblies, the ends of which are attached to a 36.0 inch wide belt assembly.

B. FUNCTION

The sling is a tool, used in conjunction with a lift crane, with which the nose of the airplane can be raised to a level attitude in the event of a nose landing gear failure.

C. ADDITIONAL EQUIPMENT REQUIRED

1. Canopy Hold Open Support Assembly Part No. 7140102 or equivalent
2. A lift crane with a minimum capacity of five tons (10,000 pounds)
3. One A/F-B-6 Nose Jack
4. Wheel chocks for main landing gear.

D. INSTALLATION AND OPERATING INSTRUCTIONS:

1. Aircraft Preparation:

   a. Use wheel chocks at main landing gear to prevent fore and aft movement of the aircraft during the lift operation.
   b. Release the main landing gear brakes.
   c. Sling can be used with the canopy open or closed. If open, use upoort assy part no. 7140102.

2. SLING PREPARATION:

   a. Attach 8-96446 (2) cable assemblies to 8-96445 spreader assembly.
   b. Attach lifting eye of 8-96445 spreader assy to crane hook and raise spreader assy (with cables attached) above the cockpit.
   c. Lower spreader assy until the ends of the cable assys can be reached by a man standing on the ground.
   d. Slide 8-96444 belt assy under the airplane and attach one end to each cable assy.
   e. Slowly raise sling until the black stripe on the belt assy matches the centerline of the A/P on the lower surface and the belt lies between the two sta lines indicated on the fuselage. Sta 163.0 and sta 199.0
   f. Raise nose of the A/P to a level attitude and use an A/F-B-6 jack to support the nose while working on the nose landing gear.

Figure 1-66B. Sling Assembly Emergency Nose Lifting

b. Check the under side of the airplane for sharp or rough projections before locating bags under the wings. Cover the top of the lifting bags with felt pads to prevent puncture or damage to the bag while it is being inflated. Place the lifting bag protective tarpaulin covers on the ground under the bags for protection against sharp objects on the ground.

c. Position the inflatable bags to take advantage of the structural strength of the airplane. See figure 1-66 for points that will provide sufficient strength to sustain the weight of the airplane during lifting operations.

d. Connect the blower unit (1730-506-8986) to the inflatable bags and inflate all bags simultaneously.

CAUTION

Do not exceed 2 psi maximum bag pressure. Higher pressure may result in damage to the lifting bag and to the airplane.

e. When the plane has been raised to a sufficient height, install USAF type B-6 jacks (1730-516-2019) with SE-0580-7 jack pads (1730-640-7155), as shown on figure 1-67; then deflate and remove lifting bags as soon as possible.

CAUTION

Airplane jacks must rest on level ground with the jack ram in a vertical position to avoid imposing side loads on the jack and jack pad. If necessary, use steel or wood plates of sufficient thickness and bearing area to distribute high loads over a large area so that the jacks will not sink into the supporting surface or allow the airplane to slip from side to side.

f. If the airplane has been damaged sufficiently to necessitate the removal of major components for packing and shipping, place the airplane on an appropriate cradle, as shown in figure 2-7.

1-212A. REMOVAL-DAMAGED AIRCRAFT FROM RUNWAY.

1-212B. A sled type transport rig, reference figure 1-66A, provides a means to rapidly remove crash damaged aircraft from the runway on a one runway base. Use of this method as outlined below will keep the additional recovery damage to an absolute minimum. This method is effective and can be fabricated locally and made readily available at all bases. Lifting the aircraft to a height to clear sled can be accomplished using pneumatic lifting bags or hydraulic jacks, reference paragraph 1-211. Mooring the aircraft during lifting can be done using heavy vehicles. After cribbing the aircraft with sand bags or cotton matresses, the aircraft can then be moved off the runway using a bed of foam provided by a crash truck. The foam supplies a wetting and smothering agent to minimize the possibility of fire and to reduce sled friction. This method should be used to clear runway for emergency flight operations only. Subsequent moving should be accomplished by conventional methods, reference paragraphs 1-212, 1-214, and 1-216.

1-213. Preparation for Towing.

1-214. If it is possible to manually lower the landing gear, the following procedure may be used for removing the airplane from the crash site:

a. Survey the available routes from the crash site to the repair area for road weight limitations and clearances. See figure 1-1 for aircraft dimensions.

b. Emergency towing should be performed in accordance with procedures outlined in T.O. 1F-106A-2-2-2-2.

c. When towing over earthen roadways, steel landing mats or pierced planking may be used to distribute the weight of the airplane over a larger area.

CAUTION

Defuel airplane before attempting any removal operations. Refer to T.O. 1F-106A-2-5-2-1 for defueling procedure.

1-215. Jacking Airplane.

1-216. Three jack pads, SE-0580-7 (1730-640-7155), provide a bearing surface for the USAF B-6 type jacks (1730-516-2019) used in jacking the airplane. Provisions to receive the jack pads are incorporated in each wing at the spar immediately aft of the main landing gear and at the center line of the fuselage forward of the nose wheel well. Jacking provisions are illustrated on figure 1-67. When jacking at any gear, the landing gear and external tank ground lock safety pins must be installed. The steer-damp unit ground lock pin must also be installed when jacking at the nose gear. Landing gear strut restraining clamps are used in conjunction with the respective nose and/or wing jacks for all jacking operations that do not require gear strut extension. Restraining clamp 8-96175 (1730-631-6467) is for the nose gear and restraining clamps 8-96296 (1730-657-9638) are for the main gears. These clamps prevent the gear struts from extending, thus the main landing gear safety switches are effective and a minimum jacking of the airplane will provide wheel clearance.

NOTE

In special cases, such as electronic weighing, the airplane may be jacked using only the strut pads. The airplane should be raised only enough to clear main wheels from ground, with nose wheel at the minimum height necessary for ground clearance and leveling.

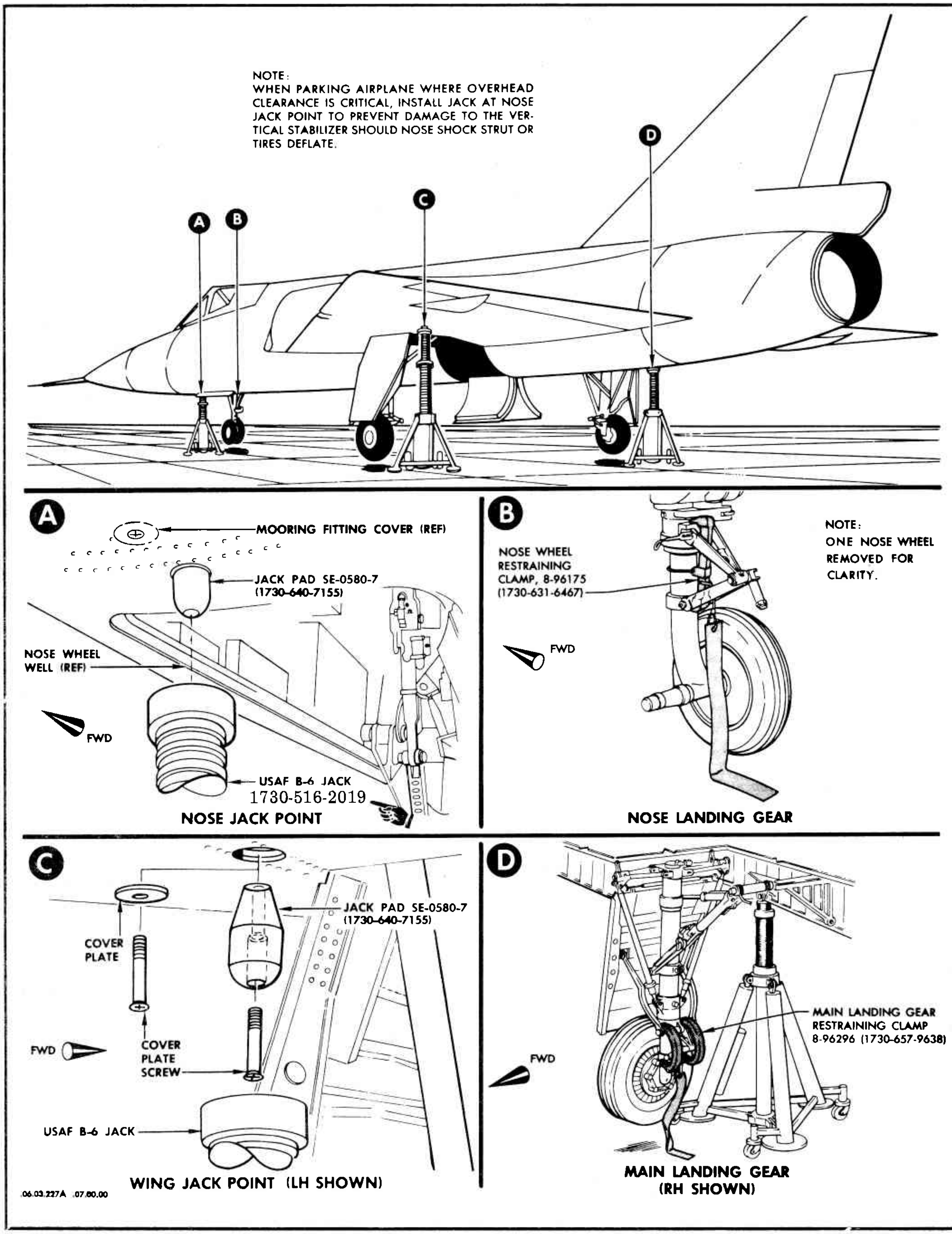


Figure 1-67. Jacking Provisions

All normal precautions, such as removal of unncessary and obstructing equipment and checking of overhead clearances, should be observed prior to performing jacking operations. Jacking operations should be performed in a hangar whenever possible. If operation in a sheltered area or hangar is impractical, jacking may be accomplished outside except during gusty or high wind conditions. The maximum wind velocity in which jacking may be performed safely, in an emergency, is considered to be 30 knots. For specific jacking instructions refer to T.O. 1F-106A-2-2-2-2.

WARNING

Jacking the airplane with the main landing gear struts extended deactuates the main landing gear ground safety switches. This readies the landing-gear-up circuit and other circuits for airborne type operation; exercise care to prevent inadvertent operation.

1-217. Leveling Airplane.

1-218. Leveling lugs are incorporated in the F-106A and F-106B airplanes and are shown on figures 1-68 through 1-70. To level the airplane perform the following operations:

a. Install landing gear and external tank ground safety pins.

b. Jack the airplane; refer to paragraph 1-215.

c. Place a spirit level on the lateral leveling lugs.

d. Place a spirit level on the longitudinal leveling lugs.

e. Adjust jacks to level the airplane laterally and longitudinally.

1-219. Hoisting Airplane.

1-220. Hoisting provisions are incorporated on the airplane to accommodate a four-point hoisting sling as shown in figure 1-65. This sling, 8-96039 (1730-555-4599), permits the hoisting of the airplane in a level attitude, with wings installed or removed. With the wings installed, the sling is attached to fittings on each side of the fuselage and in the upper surface of each wing. With the wings removed the sling is attached to fittings on each side of the fuselage, and to the hoisting adapter which is attached to the wing fittings on each side of the fuselage. Fuselage cradle assembly, 8-96093 (1730-600-3918), is used to support the fuselage when the wings are removed.

NOTE

It is desirable, but not essential, that the airplane be defueled and the engine removed when hoisting the airplane with the wings installed.

1-221. DAMAGE EVALUATION AND INSPECTION CRITERIA.

1-222. Preliminary External Preparation.

1-223. The entire external surface shall be thoroughly examined after an airplane has been damaged. Look for buckled or wrinkled skin, holes, dents, and scratches in the outer surface. Skin wrinkles are a common indication of damage to the internal structural members. Whenever buckles and wrinkles appear, the rows of rivets within the surrounding wrinkled area should be closely inspected. Wrinkles that extend across the substructure indicate failure of attachment. Look for rivets that are sheared, loose, or have tilted heads. Check closely for skin cracks radiating from rivet holes to skin edges. Small skin cracks of this nature frequently occur around door openings. If several discrepancies are found, mark each item with a short strip of masking tape. Using a grease pencil, briefly flag the type of damage by writing on the tape. Do not apply the grease pencil marks directly to the skin surface. When the exterior surface inspection has been completed, enter the airplane and inspect the substructure as indicated in the following paragraphs.

1-224. Access Provisions.

1-225. See figures 1-2 through 1-5 for access to the internal structure for inspection and repair.

1-226. Detailed Visual Inspection of Substructure.

1-227. When a component of the airplane has been damaged, a complete investigation must be made both of the damaged structure and the adjacent or attaching structure to determine if the damaging force has been transmitted over the intervening structure to cause secondary damage. To determine the full extent of the damage, proceed as follows:

a. Remove all dirt and grease so that the surface of each part, rivet, bolt, or weld may be inspected.

b. Look for web or skin wrinkles which indicate distortion. A flashlight and long-handled mirror are useful inspection tools.

c. Look for dents, abrasions, scratches, cracks, tears, and holes. Examine suspected cracks closely with a flashlight and pocket magnifying glass.

d. Look for rivets that are sheared, loose, or have tilted heads. The rivets still may be in position, but may be loose or sheared. An 0.003-inch feeler gage may be used to probe between faying surfaces and under rivet heads to reveal loose or sheared rivets. If bolt heads are found tilted or loose, remove and check for a bent bolt or elongated bolt hole.

e. Look for cracks in paint coatings which may reveal loose rivets or buckled skins or webs.

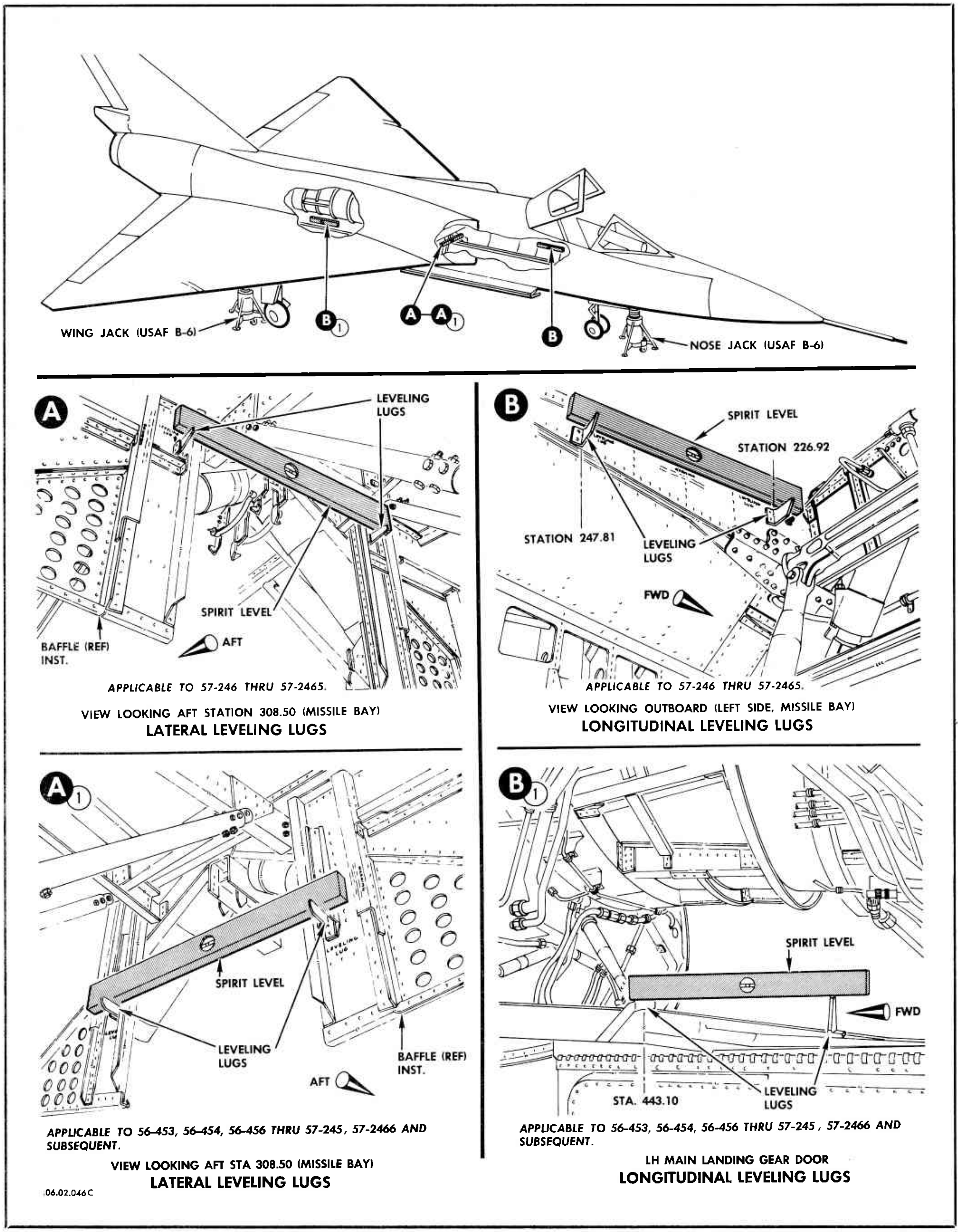


Figure 1-68. Leveling Provisions, F-106A

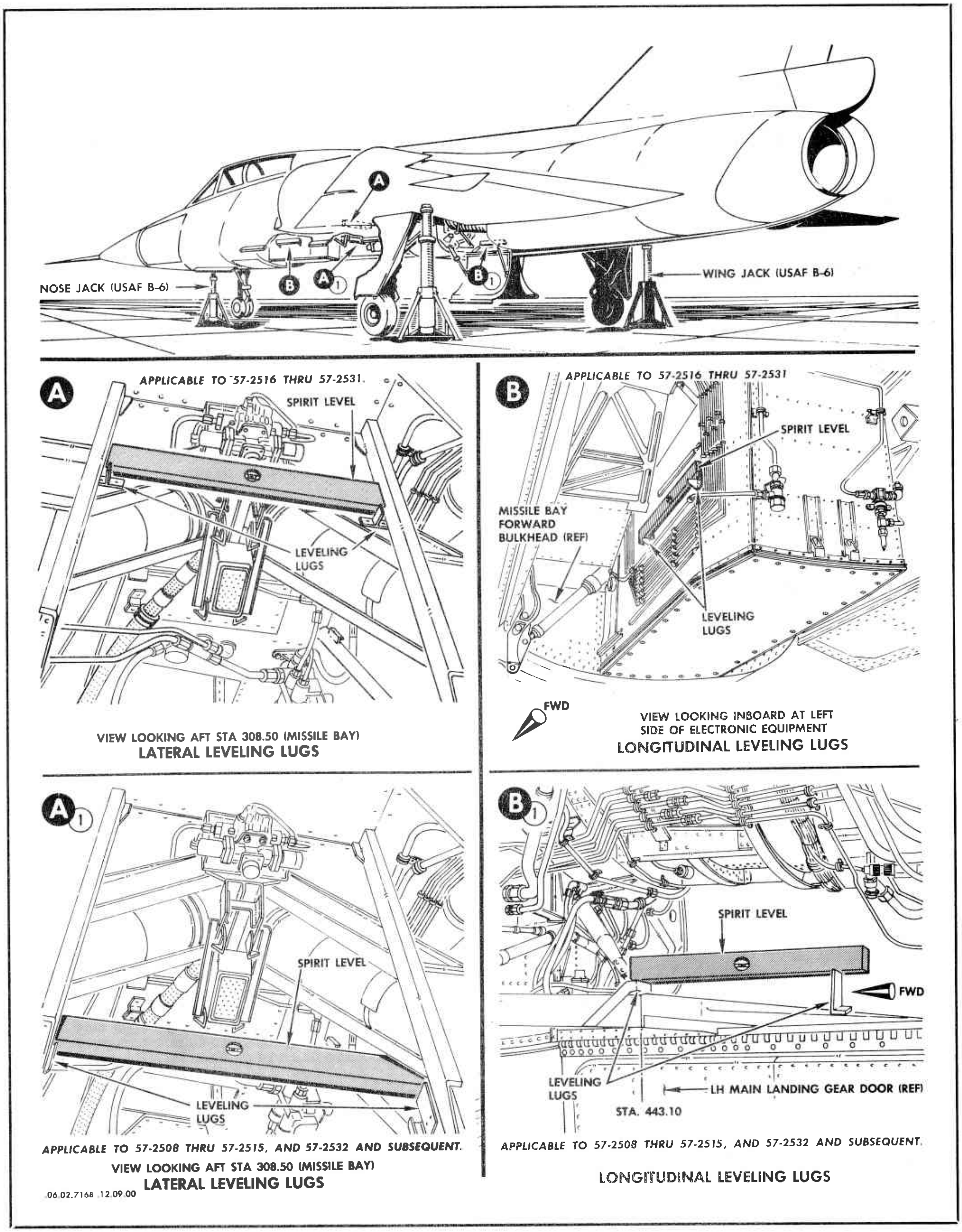
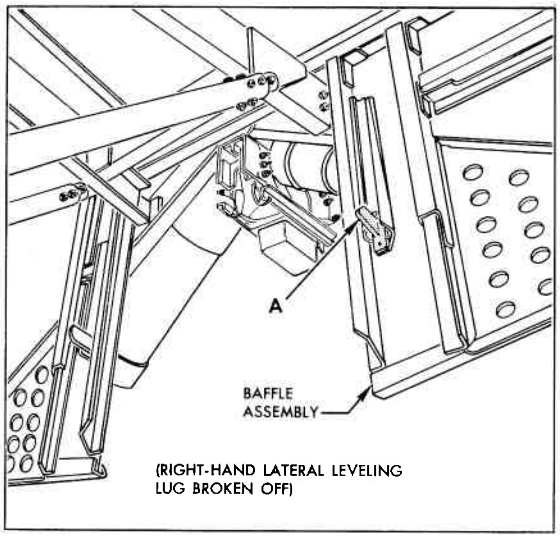
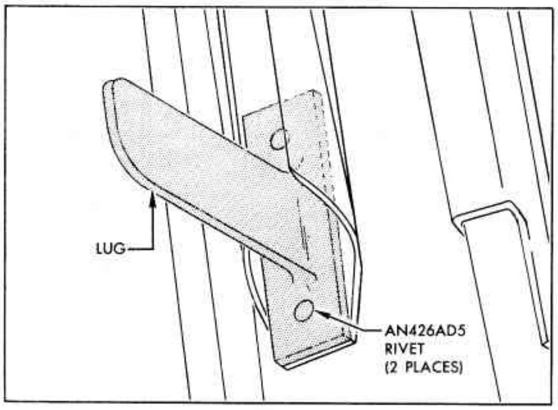
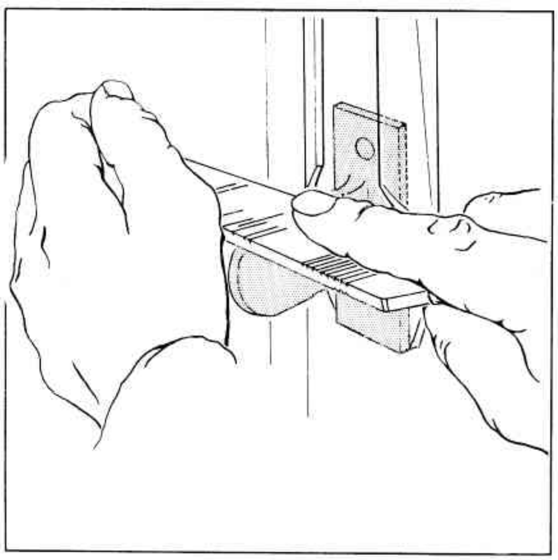


Figure 1-69. Leveling Provisions, F-106B

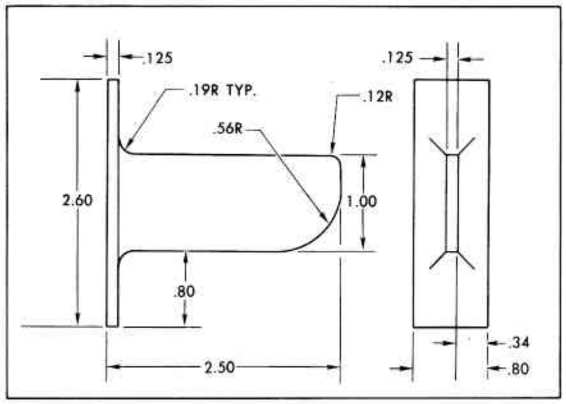




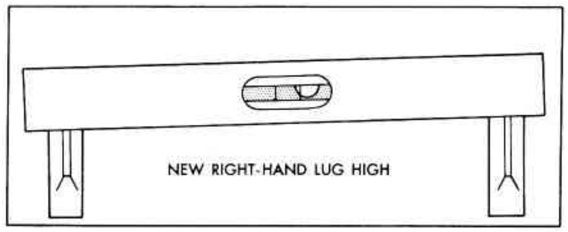
VIEW A



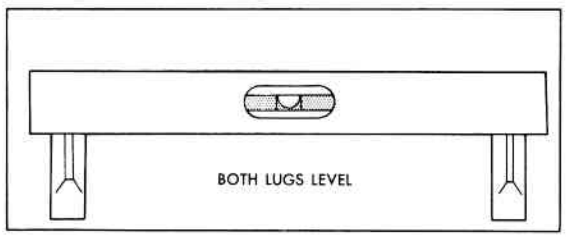
VIEW B



VIEW C



VIEW D



VIEW E

REPLACEMENT PROCEDURE

a. Using a No. 20 (0.161) drill, remove two rivets securing broken leveling lug. Remove and discard broken lug.
b. Fabricate new lug to dimensions shown in view C. Make lug from 2024-T4 extrusion, Alcoa Die No. 13630 or equivalent. If extrusion stock is not available, make temporary lug from 0.125-inch thick aluminum sheet. Bend sheet to provide 0.80-inch flange for attachment and trim lug as shown in side view of view C.
c. Install new lug in approximate location of old lug with two AN426AD5 rivets, as shown in view A.
d. Establish lateral level of airplane with sight level or water hose as shown on sheet 2 of this illustration.
e. Place spirit level across lateral lugs as shown in view D.
f. Remove spirit level and file top of high lug as shown in view B. File evenly across top of lug, removing small amounts of metal and checking at periods with level until a level attitude is observed as shown in view E.

NOTE:
USE REPLACEMENT PROCEDURE GIVEN ON THIS SHEET FOR REPLACEMENT OF LONGITUDINAL LEVELING LUGS.

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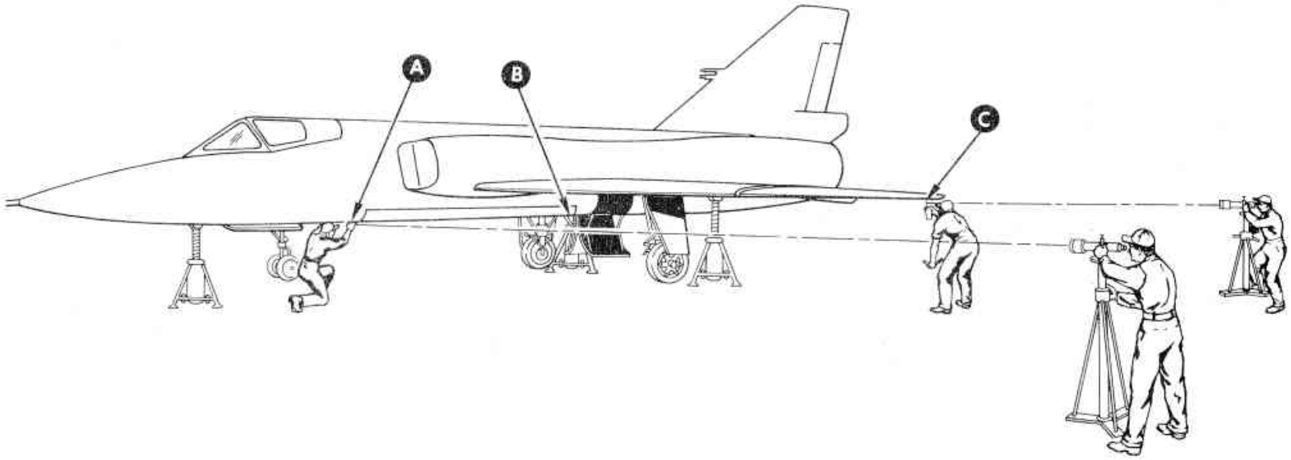
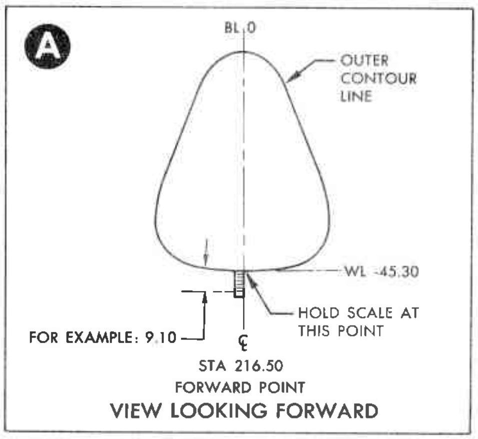
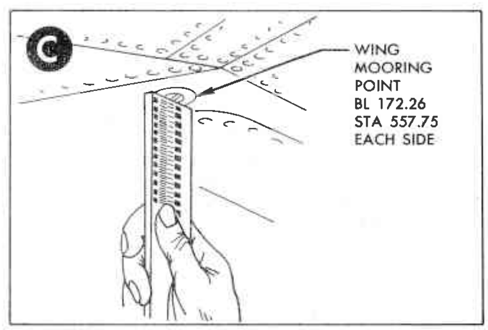
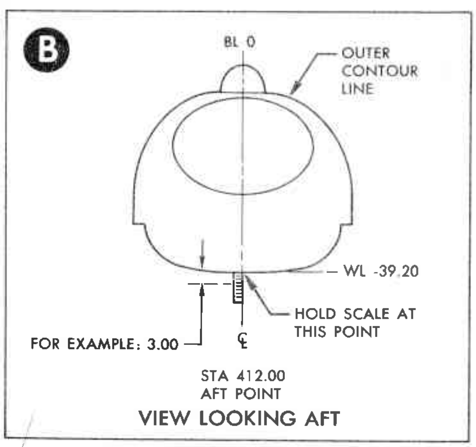
Figure 1-70. Replacement of Damaged Leveling Lugs (Sheet 1 of 3)









LEVELING PROCEDURE WITH SIGHT LEVEL

a. With airplane suitably jacked, level airplane longitudinally by using a sight level to sight on a scale held alternately at points indicated in details A and B.
b. Adjust nose jack until forward point is 6.10 inches below aft point as indicated on scale.
c. Level airplane laterally, by sighting on scale held alternately at point indicated in detail C and same point under opposite wing.
d. Adjust wing jack until left- and right-hand scale readings are identical.

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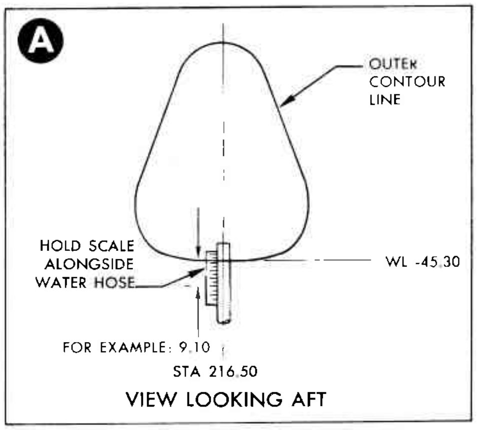
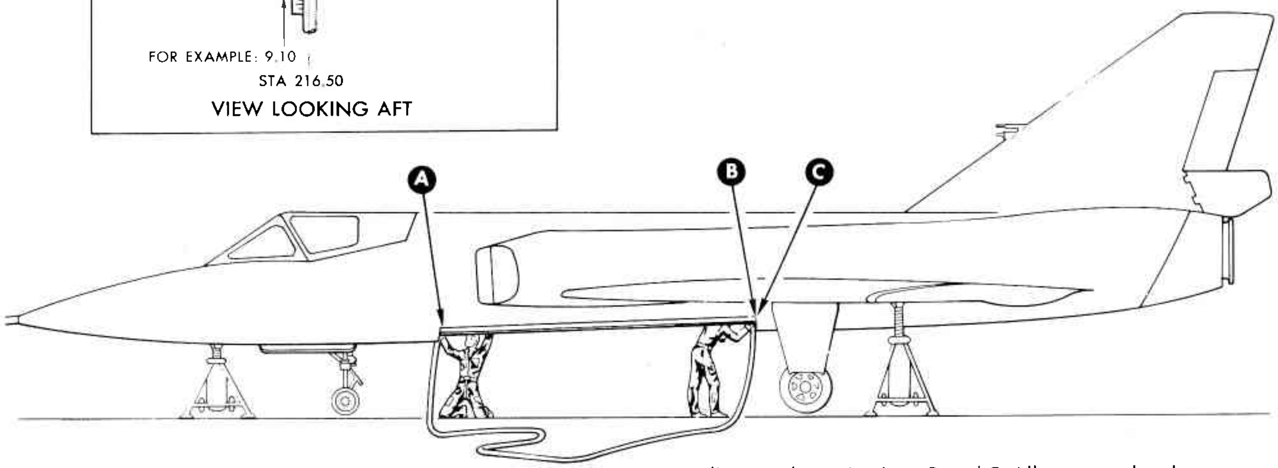
Figure 1-70. Replacement of Damaged Leveling Lugs (Sheet 2 of 3)





LEVELING PROCEDURE WITH WATER LEVEL

An emergency level may be improvised by filling a section of transparent water hose or large diameter transparent plastic electrical sheathing with water. The hose should be 20 feet long or longer. Eliminate all air bubbles from the entire length of the hose by forcing the water through under pressure until bubbles are not visible.

a. With airplane suitably jacked, hold both ends of tubing upright and tape one end of the tubing in a vertical position, as shown in detail A, in such a manner that the water level line viewed through the tubing nearly coincides with the outer surface or skin contour line of the fuselage skin at bottom center line.

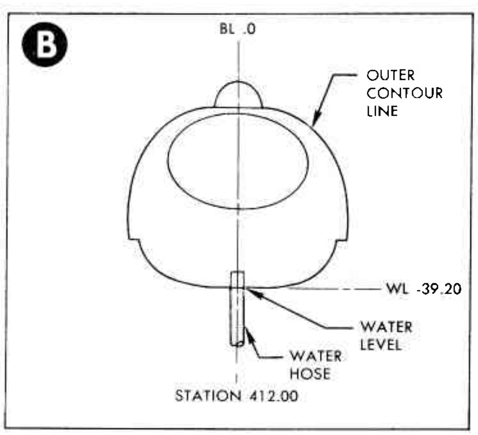
b. Move forward, holding the free end of the hose at about the same height as the opposite end, laying out the center section of the hose on the ground alongside the airplane. Attach the forward end of the tubing inside the missile bay at the forward end.

c. As water will seek its own level, raise or lower the nose of the airplane at the nose jack to establish a longitudinal level condition when the aft hose water level matches with the fuselage skin at bottom center line, and forward water level is 6.10 inches below fuselage skin at bottom center line, as shown in views B and C. Allow water level to stabilize in hose for a few minutes after each adjustment of the hose or change in airplane attitude.

NOTE

TO ELIMINATE UNNECESSARY ADJUSTMENT OF HOSE, WATER LEVELS MAY BE MEASURED WITH SCALES TO ESTABLISH RELATIONSHIP FROM OUTER CONTOUR LINE AT EACH END OF AND BETWEEN ENDS OF MISSILE BAY.

d. The lateral level may be established by repeating the procedure with the vertical ends of the hose attached inside the missile door hinge longerons on each side of the airplane at the same fuselage station.



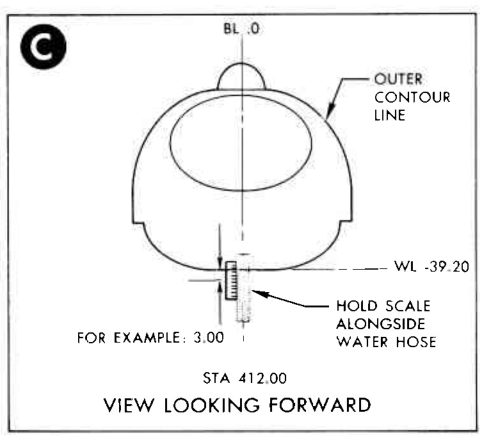


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Figure 1-70. Replacement of Damaged Leveling Lugs (Sheet 3 of 3)

f. Look for stress damage transmitted through structural members to the surrounding area and check all parts for possible misalignment.

g. Operate all functional parts such as hinges and door locks to determine if the damage has caused binding or distortion.

1-228. FLUORESCENT PENETRANT AND X-RAY INSPECTIONS.

1-229. Accomplish fluorescent penetrant and x-ray inspections in accordance with procedures/instructions outlined in T.O. 1F-106A-36 and T.O. 33B-1-1.

Paragraphs 1-230. thru 1-236. Deleted.

All data on page 1-106, including figure 1-71 deleted.

Paragraphs 1-237. thru 1-241. Deleted.

1-242. Description of Damage Causes.

1-243. The causes and degree of damage are variable and may be divided into the following categories:

a. Collision or Gunfire Damage. This type of damage may consist of such minor damage as a small hole or dent, up to very severe damage such as torn, crushed, or burned skin and structural numbers, plus misalignment of the airplane. Inspect the area immediately surrounding the obvious damage to which loads may have been transmitted.

b. Stress Damage. This type of damage usually consists of tilted or loosened rivets, wrinkled skin or webs, and cracked or distorted structural members incurred by resistance to abnormal stresses imposed on the main structural members. Stress damage is usually the result of extra hard landings or violent air maneuvers.

c. Fatigue Damage. This type of damage usually consists of small cracks slowly developed by vibration, oil canning, and repeated application of loads on the structure. Fatigue damage appears more frequently as the operation time on the airplane accumulates. Fatigue cracks appear most frequently on skins in pressurized areas and around door openings, on fittings, and on load-bearing members adjacent to fitting attachments.

d. Corrosion Damage. Corrosion damage may be observed by the presence of white or reddish powdery deposits on the metal accompanied by a roughened, pitted surface. Blistering or scaling of the paint coating when pressed is also evidence of underlying corroded metal. This type of damage may develop in areas where dissimilar metals are near each other, the paint coating is broken, or areas are exposed to moisture. Inspections for corrosion damage should be made at regular intervals and steps taken to arrest further action of any corrosion found before serious damage, which may require replacement of the part, has developed.

1-244. Evaluation of Damage.

1-245. When the full extent of the damage has been resolved, prepare an analysis of the materials, work, time, and cost factors required to complete the repair. To prepare this analysis the following requirements shall be observed:

a. The repaired structure must perform its special function, such as restoring pressurization and fuel-tightness.

b. External structure must conform to the original aerodynamic contour unless otherwise approved by structural engineering authorities.

c. Repair must not restrict the functioning of any moving parts.

d. Precautions against corrosion must be observed, such as priming faying surfaces and insulating dissimilar metals.

e. In cases where cost of repair is prohibitive, the damaged member should be replaced.

1-246. DELETED.

1-247. DELETED.

All data on pages 1-108 thru 1-110, including figure 1-72 deleted.

1-254. IDENTIFICATION OF MATERIALS.

1-255. Steel, aluminum, and magnesium are readily identified by the difference in weight and color of the metal. The various aluminum and magnesium alloys are identified by chemical tests. Chemical test methods for aluminum and magnesium alloys are described in paragraphs 1-256 through 1-259. Methods for identifying titanium alloys are described in paragraph 1-50.

1-256. Chemical Test, Aluminum Alloy Identification.

1-257. The primary airframe structure contains strong heat treatable aluminum alloys, such as 2024, 6061, 7075, and 7178. The nonheat treatable aluminum alloys, such as 1100, 3003, 5052, and 5056, are used in nonstructural components of the airplane.

CAUTION

Nonheat treatable alloys shall not be used for repair or replacement of parts made of heat treatable alloys.

Nonheat treatable and heat treatable alloys may be identified by immersing a sample of the material in a 10 percent solution of sodium hydroxide (caustic soda) for a few minutes. The nonheat treatable alloys will remain brightly unaffected and will not darken, but the heat treatable alloys will turn black due to their copper content. Clad surfaces of heat treatable alloys will remain bright, but may be identified by a dark core area when viewed from the edge. Heat treatable 2024 may be further distinguished from other heat treatable alloys, such as 7075 or 7178, by treating a clean area of the material with a 10 percent solution of cadmium chloride or cadmium sulfate. A dark gray deposit will appear on 7075 or 7178 within two minutes, but will not appear for 15 to 20 minutes on 2024 material.

1-258. Chemical Test, Magnesium Alloy Identification.

1-259. Magnesium alloy parts may be separated from those made of aluminum alloy by using the following spot-test procedure: Remove paint, if present, from an area about the size of a dime. Wipe the area clean with solvent. If methyl ethyl ketone is not available, lacquer thinner may be substituted. Dissolve a few silver nitrate crystals in a small amount of distilled water. Place one or two drops of the silver nitrate solution on the test area. If the material is magnesium, the clear liquid will immediately turn black. If the material is an aluminum alloy there will be no reaction. If the material tested is an aluminum alloy, refinish as directed on figure 1-64. If material is a magnesium alloy:

a. Wash the test area thoroughly with clean water.

b. Remove the black stain with Bon Ami or fine abrasive emery cloth.

c. Swab with a 20 percent solution of chromic acid. Allow to stand two minutes.

d. Rinse with clean water and dry thoroughly.

e. Apply protective coating and paint as directed on figure 1-64.

1-260. FIRE OR HEAT DAMAGE EVALUATION.

1-261. Primer and Paint Discoloration.

1-262. Discoloration or blistering of primer or paint on structural parts indicates fire or heat damage which may have affected the temper of the metals and reduced the strength of the parts below safe levels. To determine fire or heat damage to structural parts, use the sample color plate comparison method as directed in paragraph 1-263. Do not use standard hardness testers to evaluate heat damage to structural parts.

1-263. Hardness Testing of Fire or Heat Damaged Parts.

1-264. Most aluminum alloys used in F-106A and F-106B airplanes are heat-treated and age-hardened under controlled conditions. When these materials are later subjected to temperature exceeding 260°C (500°F), the hardness may increase and indicate acceptable readings if standard hardness testers are used. Upon reheating to normal operating temperatures, however, the strength of the material will fall off rapidly to the point where structural integrity is lost. To evaluate heat damage to "T" condition aluminum alloy structural parts, use the following color comparison method with sample color plates:

a. Make up six sample plates of aluminum alloy sheet stock. The plates should be approximately 1" x 1" x 0.032".

b. Paint all plates with wash primer, Specification MIL-C-8514, and zinc chromate primer, Specification MIL-P-8585, of the color used in the airplane interior. Finish three of the plates with exterior gray acrylic lacquer or polyurethane. Applicable steps of paragraph 1-196 may be used for painting procedures. Air-dry the sample plates for at least 48 hours at normal room temperatures.

c. Place one zinc chromate plate and one gray plate in an oven, and heat to a temperature of 176.7°C (350°F) for 15 minutes. The sample plates will just start to discolor at this temperature. Remove the plates from the oven and mark "350°F."

d. Place one zinc chromate plate and one gray plate in the oven and heat to a temperature of 260°C (500°F) for 15 minutes. Both plates will turn brown at this temperature. Remove plates from the oven and mark "500°F."

e. Place one zinc chromate plate and one gray plate in the oven and heat to a temperature of 315°C (600°F) for 15 minutes. The plates will turn black-green and dark brown, respectively, at this temperature. Remove plates from the oven and mark "600°F."

f. Use the marked sample plates to compare with colors in interior and exterior damaged areas on the airplane.

NOTE

Any heat-damaged member, which indicates by color that 260°C (500°F) has been reached, must be replaced or repaired.

GENERAL COLOR INDICATIONS DUE TO TEMPERATURE

Finish Color (approximate)	Temperature	Action
Zinc Chromate (Aircraft Interior Color)		
Starting to discolor.	148.9°C (300°F) to 204.4°C (400°F)	Continue in service.
Brown.	260.0°C (500°F)	Replace/Repair
Black-green.	315.6°C (600°F)	Replace/Repair
Exterior Gray acrylic lacquer or polyurethane		
Light brown.	148.9°C (300°F) to 204.4°C (400°F)	Continue in service.
Brown.	260.0°C (500°F)	Replace/Repair
Dark brown to black.	315.6°C (600°F)	Replace/Repair

1-265. HARDNESS TESTS.

CAUTION

Do not use the Barcol or Ernst portable hardness testers to evaluate heat damage to structural parts.

1-266. Hardness tests may be made on structural parts with either a Barcol portable hardness tester, Barber-Coleman Co., Rockford, Ill., or an Ernst portable hardness tester, Models RAR and RBR, Newage International, Inc., 235 East 42 Street, New York 17, N.Y., which reads directly for Rockwell A and B scales, to aid in identifying unknown materials. Material hardness is determined by measuring the depth of penetration of a spring-loaded diamond indenter on the Ernst tester and a steel ball indenter on the Barcol tester. The Ernst Model RAR is used for testing hardened steel and hard alloys. The Ernst Model RBR and the Barcol testers are used for checking unhardened steel and most nonferrous metals. The hardness values obtained from clad aluminum alloys will vary considerably because of the coating of pure aluminum on the core alloy. This coating may be removed from areas to be tested and the hardness of the core material determined. The parts tested must be thick enough to prevent bulging on the reverse side. The following procedure describes the use of the Barcol and Ernst testers (see figure 1-73):

a. Remove paint coat from surface of test area. Select a smooth, scratch-free area on an accessible surface of the part.

b. Check calibration of tester on test plate provided with instrument. If the reading varies more than one point from the nominal reading marked on the test plate, the instrument should be recalibrated in accordance with manufacturer's instructions.

c. The instrument must be held so that the penetrator is at a right angle to the surface being tested.

1-267. Structural parts may be accurately tested for hardness with a Riehle portable hardness tester as follows (see figure 1-74):

CAUTION

Do not use the Riehle portable hardness tester to evaluate heat damage to structural parts.

a. Place the part to be tested on a work bench or table.

b. Remove the paint and/or primer coating from surface of test area. Select a smooth, scratch-free area or an accessible surface of the part.

c. Remove the Riehle tester from the carrying case provided and calibrate according to the manufacturer's instructions.

d. Select proper anvil to suit the shape of the material being tested.

e. Select penetrator to be used. Use a diamond penetrator for hardened or heat-treated steel. Use a ball penetrator for nonferrous material, or materials harder than C-20 on the Rockwell scale.

f. Make sure loading screw is backed off sufficiently so that penetrator does not project beyond upper clamp.

g. Clamp material being tested firmly between upper clamp and anvil by means of adjusting knob on lower clamp.

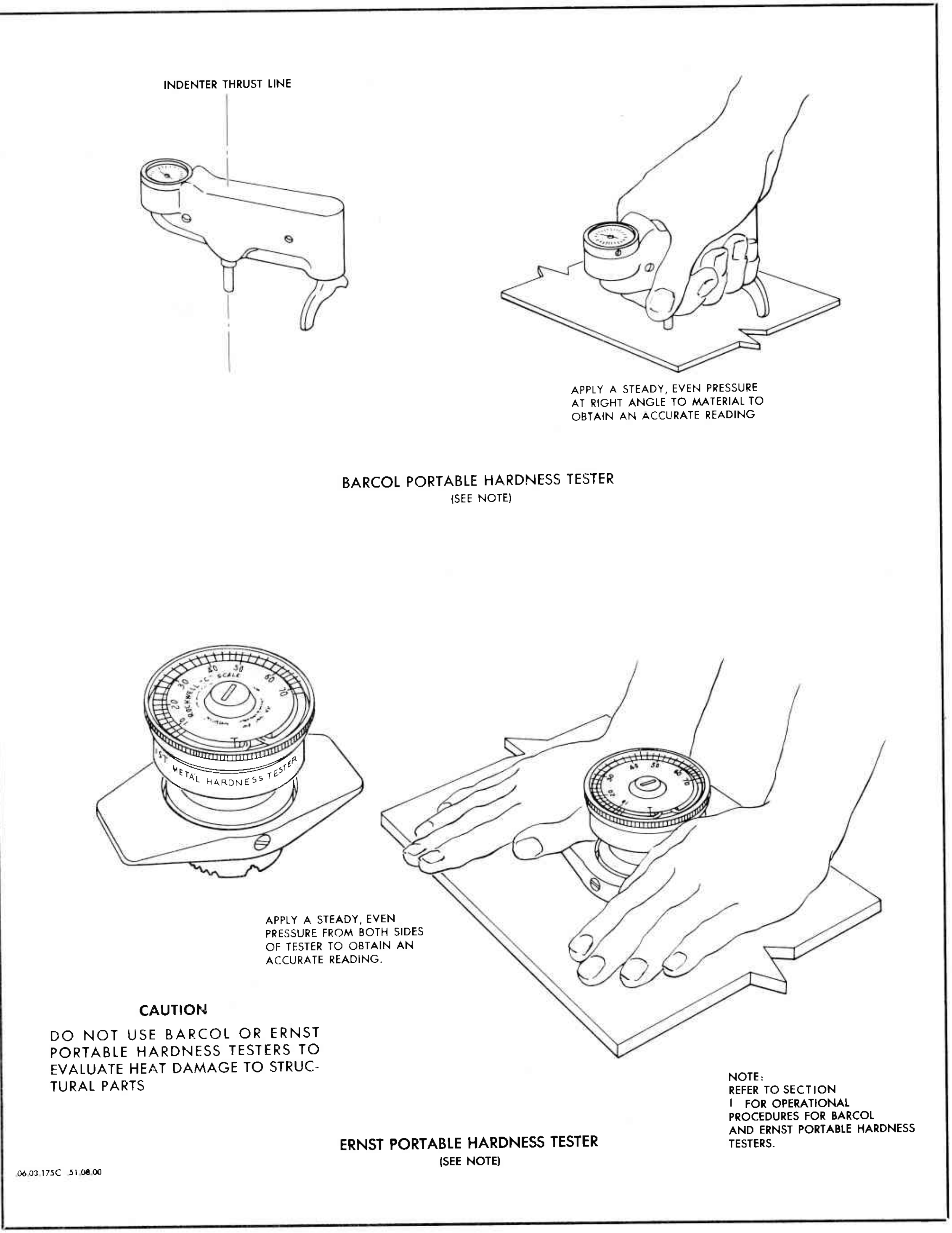
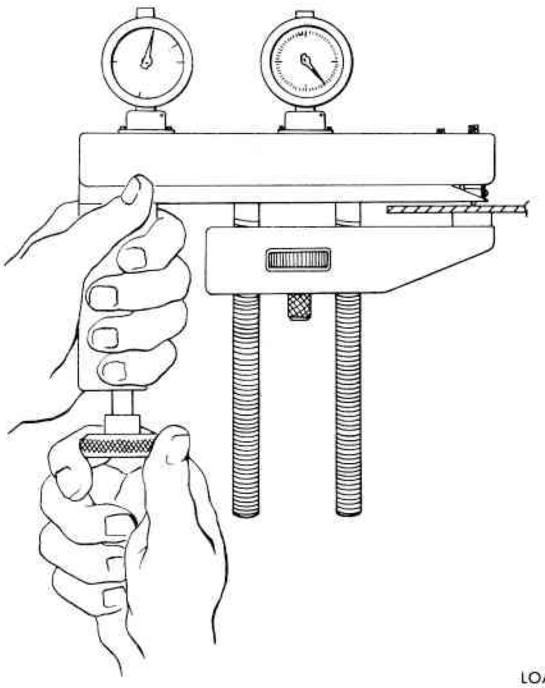
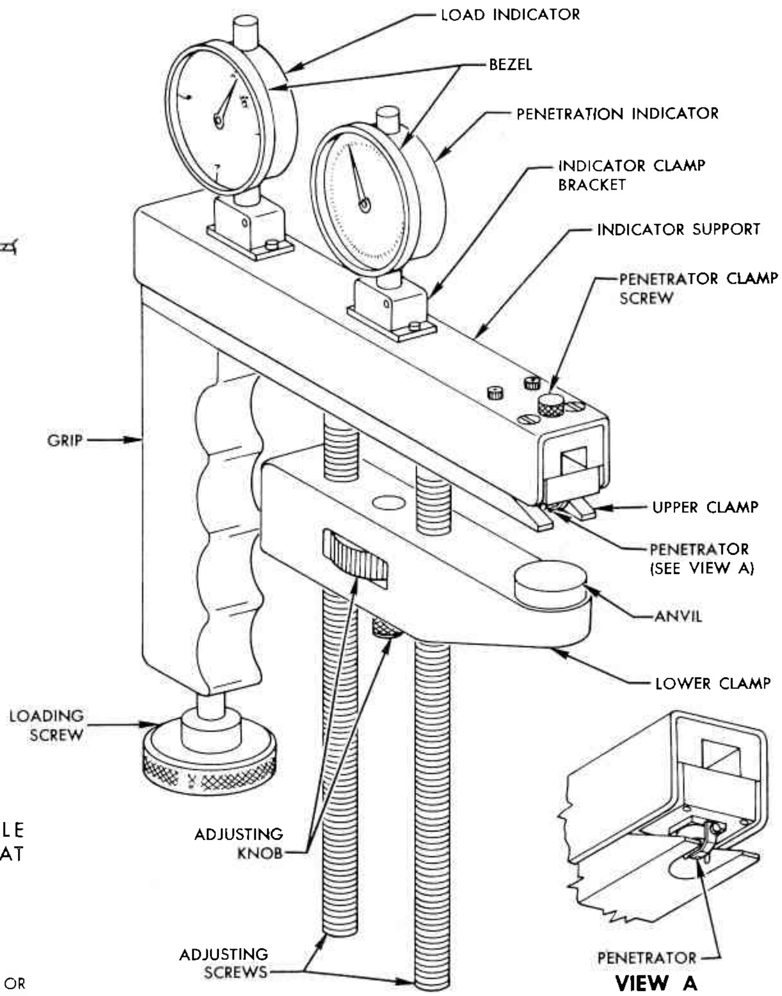


Figure 1-73. Barcol and Ernst Portable Hardness Testers





OPERATING PROCEDURE

CAUTION

DO NOT USE RIEHLE PORTABLE HARDNESS TESTER TO EVALUATE HEAT DAMAGE TO STRUCTURAL PARTS

a. Select penetrator to be used.

NOTE

USE A DIAMOND PENETRATOR FOR HARDENED OR HEAT TREATED STEEL. USE A BALL PENETRATOR FOR NONFERROUS OR MATERIALS SOFTER THAN A ROCKWELL READING OF C-20.

b. Select proper anvil to suit shape of part to be tested.
c. Turn loading screw counterclockwise until penetrator does not project beyond upper clamp.
d. Place material to be tested between upper clamp and anvil.

NOTE

PLACE THE MATERIAL TO BE TESTED BETWEEN UPPER CLAMP AND ANVIL SO THAT TEST MAY BE MADE AS FAR FROM THE EDGE AS POSSIBLE.

e. Clamp material to be tested between upper clamp and anvil by turning adjusting knob on lower clamp clockwise.

CAUTION

DO NOT FORCE

f. Set load indicator dial for zero setting by rotating bezel until pointer is over small black dot.
g. Apply a 10 kg minor load by turning loading screw clockwise until pointer of load indicator dial is over SET.

CAUTION

INSTRUMENT MUST BE HELD STEADY TO OBTAIN AN ACCURATE READING

h. Rotate bezel on penetration indicator dial until pointer is on "0" of the black scale.
i. Apply major load by turning screw clockwise.

NOTE

NORMAL SETTINGS FOR MAJOR LOADS AS INDICATED ON LOAD INDICATOR DIAL ARE AS FOLLOWS: "C" SCALE (150 kg) OR "A" SCALE (60 kg) FOR DIAMOND PENETRATOR AND "B" SCALE (100 kg) FOR BALL PENETRATOR.

j. Remove major load and reduce to minor load by turning loading screw counterclockwise until pointer of load indicator dial moves back to SET.
k. Hardness of material being tested will be indicated on penetration indicator dial.

NOTE

READ BLACK FIGURES WHEN USING DIAMOND PENETRATOR. READ RED FIGURES WHEN USING BALL PENETRATOR.

l. Remove instrument by turning adjusting knob counterclockwise.

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Figure 1-74. Riehle Portable Hardness Tester

h. Press the material to be tested through the throat of the Riehle tester.

i. Check zero setting of load indicator. Rotate bezel (setting ring) to bring pointer over small black dot for zero load.

j. Apply a 10 kg minor load by turning loading screw clockwise until pointer of load indicator dial is directly over the word SET.

CAUTION

To obtain an accurate reading, the instrument must be held steady to avoid twisting motion of penetrator on work.

k. Check zero setting of penetration indicator. Rotate bezel to bring pointer to zero on the black scale.

l. Apply major load, normally "C" scale (150 kg) or "A" scale (60 kg), for diamond penetrator, or "B" scale (100 kg) for ball penetrator.

m. Take off major load by turning loading screw counterclockwise until pointer on load indicator returns to SET.

n. Hardness is indicated on penetration indicator. Read black figures when using diamond penetrator and red figures when using ball penetrator.

o. Release load completely by backing off loading screw.

p. Turn adjusting knob to left to loosen lower clamp.

1-268. ALIGNMENT CHECK.

1-269. An alignment check of various components of the airplane may be made to determine the cause of reported unsatisfactory operation, to check for conformance to original dimensions after major repairs, as an aid in evaluation of damage, or to position components correctly during repair. The airplane alignment may be checked by direct measurement. This is done with the airplane in the "flight-line" condition with a full load of fuel and oil and with the shock struts inflated. An alignment check by direct measurements, as shown in figures 1-75 and 1-76, is an approximate method which permits a rapid appraisal after an accident or after a major repair. For more precise measurements, a jig transit should be used as shown in figure 1-77. Because of the critical structure and close tolerance built into the F-106A and F-106B airplanes, special optical tooling and equipment are required to check alignment of components and to effect satisfactory major structural repairs.

1-270. Landing Gear Alignment.

1-271. The alignment check for the nose and main landing gear shall consist of an operational check as specified in T.O. 1F-106A-2-8-2-1. During this check, all gear assemblies shall be checked for proper operation throughout a complete extension and retraction cycle. If the operational check is not satisfactory or all clearances are not as specified in T.O. 1F-106A-2-8-2-1, carefully inspect the landing gear assembly and its attachment to the structure for damage, and for further disposition consult an aeronautical structures engineer.

1-272. Wing and Fin Alignment Check Procedure.

1-273. By using the following procedure, alignment of the wing and fin may be checked in the field (see figure 1-77):

a. Place the airplane on jacks, and level airplane by means of the leveling lugs in the armament bay. Refer to paragraph 1-215 for jacking provisions and to paragraph 1-217 for leveling provisions.

b. Position an instrument stand at a point approximately in line with the centerline of the airplane and about 25 feet aft of the tail cone.

c. Mount a sight level on the instrument stand. Crank up or adjust height of stand to position the sight level slightly below the lower surface of the wing. Carefully level the instrument to maintain a level line of sight when the scope is rotated to left or right. Refer to paragraph 1-280 for the procedure of leveling the sight level.

d. Raise and hold up the left elevon to provide access through the lower openings in the elevon leading edge at the hinge fittings.

e. Position and hold an accurate scale (graduated in hundredths of an inch or less) against the shoulder of the flanged bushing in the rear spar elevon hinge fittings at BL 175.44. Do not hold end of scale against the tapered cone in the hinge assembly. Refer to paragraph 1-280 for technique of holding scale in vertical position. See figure 2-2 for BL locations.

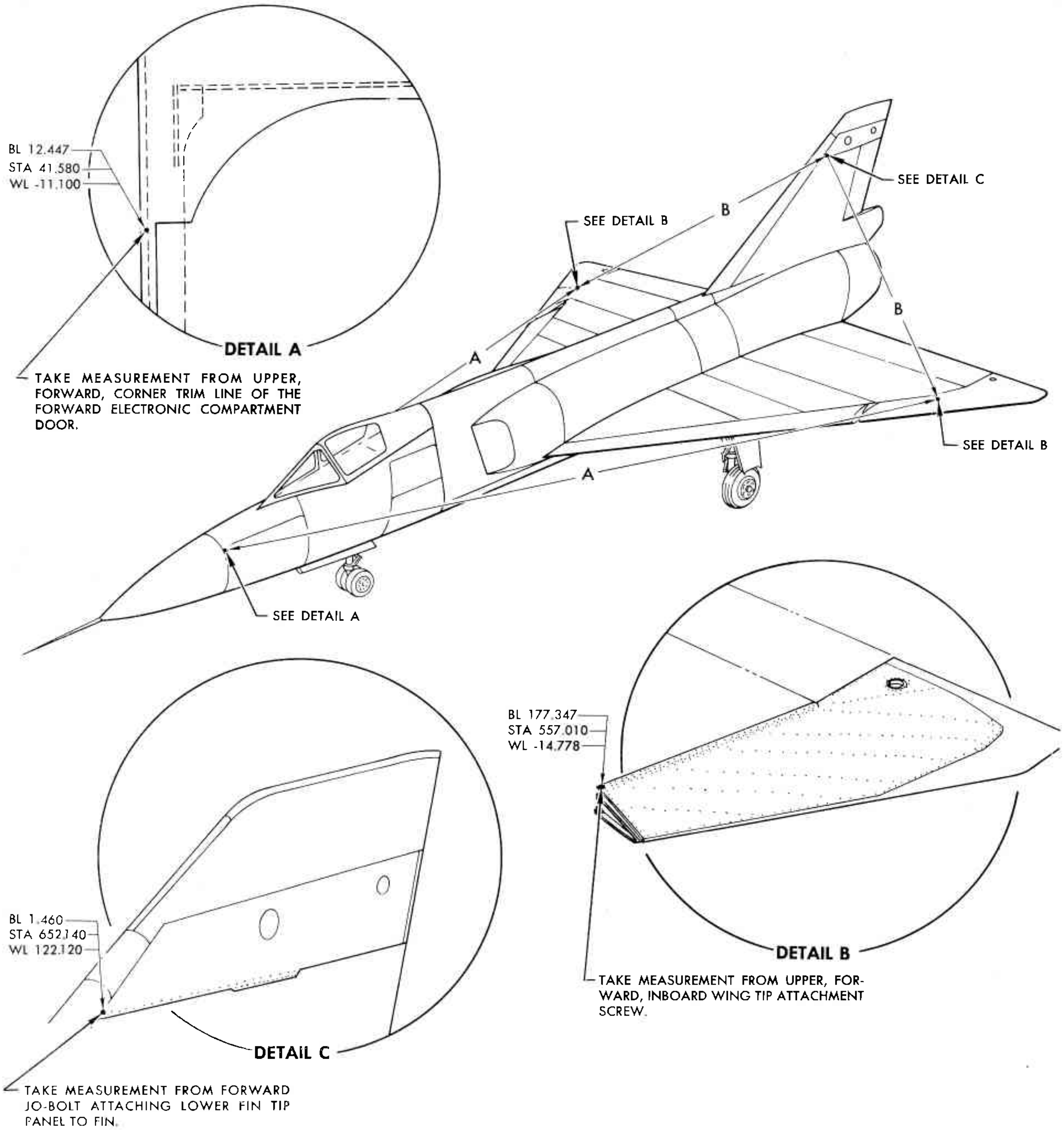
f. Aim and focus instrument on scale. Record scale graduation viewed at intersection by the scope horizontal cross hair. This location is the fix or reference point on the scale.

g. Move to opposite wing, raise the right elevon, and repeat step "e."

h. Swing scope; aim and focus on scale. Record scale graduation viewed at intersection by the scope horizontal cross hair. If this reading is identical with the reading recorded in step "f," the wing is in lateral level. If the readings differ, adjust either wing jack until the same reading is observed at BL 175.44 as called out in steps "e" and "g."

i. Verify alignment of wings by checking all remaining (7) elevon hinge fittings inboard of BL 175.44 on both wing rear spars as follows:

1. Check reading at left-hand elevon hinge fitting at BL 130.44 and right-hand elevon hinge fitting at BL 130.44; the readings should agree.



NOTES:

1. USE STEEL TAPE MEASURE FOR MEASURING BETWEEN WING TIP POINT AND POINTS ON THE FIN AND NOSE. TAKE MEASUREMENT WITH AIRPLANE RESTING ON LANDING GEAR AND IN SHADED AREA PROTECTED FROM WIND GUSTS.
2. THE ABOVE MEASUREMENTS ARE FOR A FIELD ALIGNMENT CHECK. IF THE TOLERANCES ARE EXCEEDED, USE THE WING AND FIN ALIGNMENT CHECK PROCEDURE IN THIS SECTION FOR A MORE PRECISE OPTICAL MEASURING SYSTEM.

REFERENCE LETTER	CONFIGURATION	NOMINAL DIMENSION	TOLERANCE EACH SIDE	TOLERANCE BETWEEN SIDES
A	FUSELAGE NOSE TO WING TIP	45′ 1¼″	±1″	±½″
B	WING TIP TO FIN TIP	20′ 1½″	±½″	±½″

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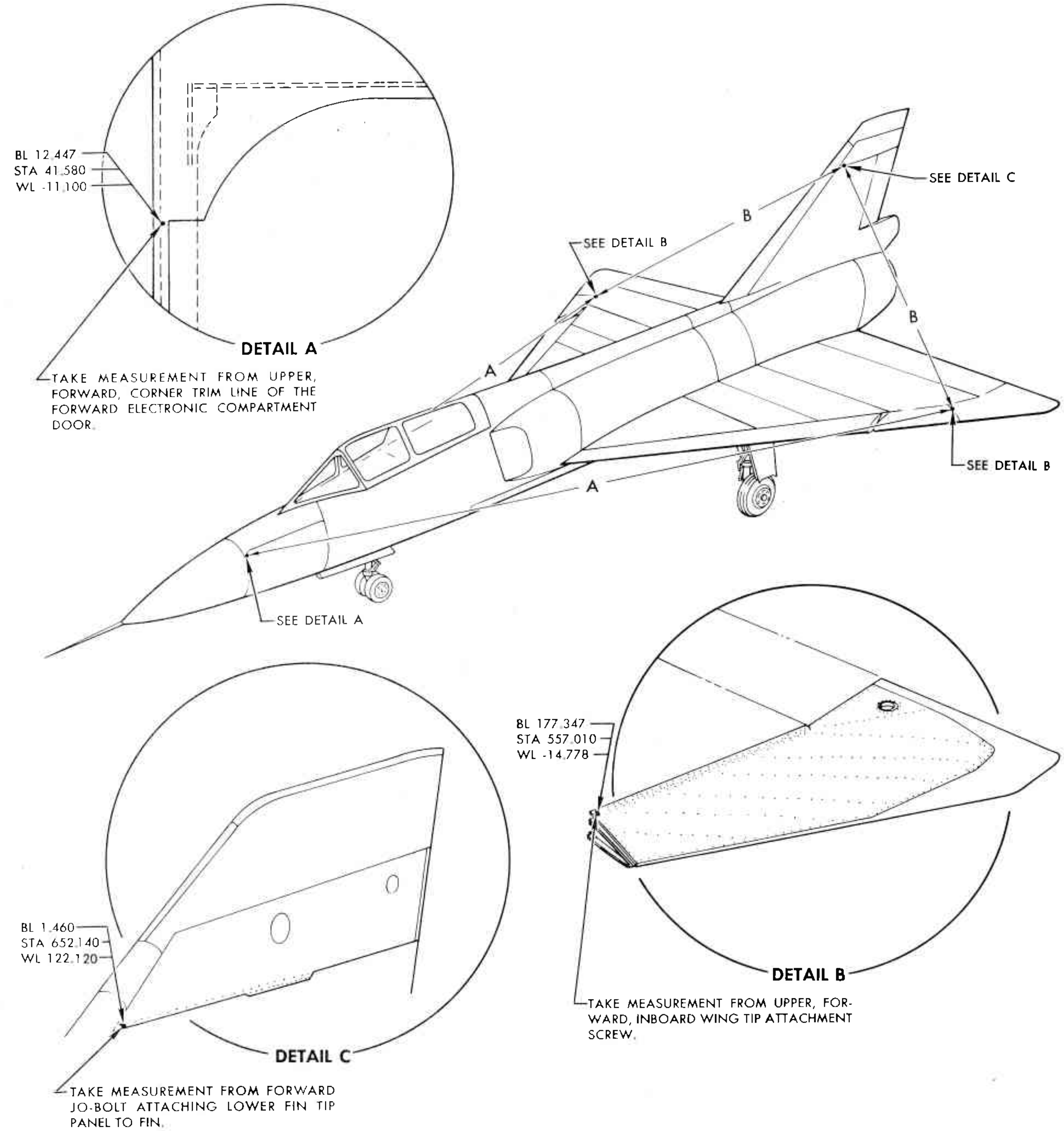
Figure 1-75. Rigging Check Diagram — F-106A



NOTES:
1. USE STEEL TAPE MEASURE FOR MEASURING BETWEEN WING TIP POINT AND POINTS ON THE FIN AND NOSE. TAKE MEASUREMENT WITH AIRPLANE RESTING ON LANDING GEAR AND IN SHADED AREA PROTECTED FROM WIND GUSTS.
2. THE ABOVE MEASUREMENTS ARE FOR A FIELD ALIGNMENT CHECK. IF THE TOLERANCES ARE EXCEEDED, USE THE WING AND FIN ALIGNMENT CHECK PROCEDURE IN THIS SECTION FOR A MORE PRECISE OPTICAL MEASURING SYSTEM.

REFERENCE LETTER	CONFIGURATION	NOMINAL DIMENSION	TOLERANCE EACH SIDE	TOLERANCE BETWEEN SIDES
A	FUSELAGE NOSE TO WING TIP	45′ 1¼″	±1″	±½″
B	WING TIP TO FIN TIP	20′ 1½″	±½″	±½″

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Figure 1-76. Rigging Check Diagram — F-106B

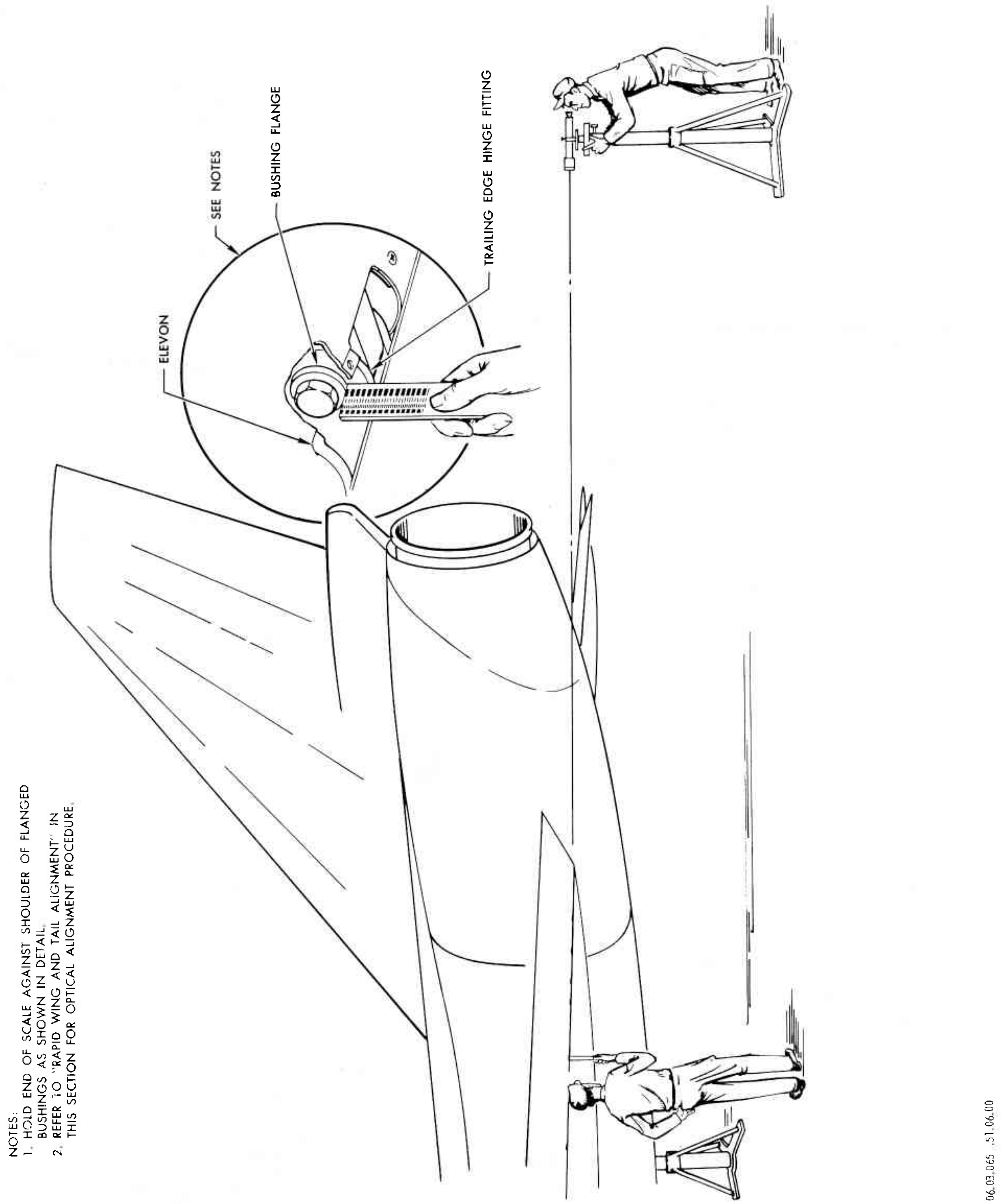


Figure 1-77. Wing and Fin Alignment Method

2. Repeat measurements at each elevon hinge fitting as indicated in step 1. If reading between like BL fittings indicate a misalignment in excess of ± 0.20 inch, check the wing structure for damage and refer to structural engineering authorities.

j. Remove sight level and mount a jig transit on the instrument stand. Carefully level the jig transit by using the procedure outlined in steps "l" through "q" in paragraph 1-293.

k. Adjust rudder to streamline position by aligning rudder trailing edge as shown in T.O. 1F-106A-2-7-2-1.

l. Loosen transit vertical and horizontal axis clamps, and swing the instrument around and up to aim on the centerline of the rudder trailing edge at the lowest point visible. Tighten the vertical axis clamp on the transit snug enough to prevent horizontal motion.

m. Elevate transit line-of-sight to tip of fin. Centerline of fin tip trailing edge should be in line with centerline point observed in step "1." Sweep transit up and down along fin and rudder trailing edge and measure any deviations with a scale held horizontally across trailing edge. If the misalignment exceeds ± 0.25 inch at top of fin, check for damage to fin structure and refer to structural engineering authorities.

1-274. ARMAMENT BORESIGHT PLATE ALIGNMENT.

1-275. Boresight mounting plates are provided for alignment of missile launchers as described in T.O. 1F-106A-2-12. These boresight plates are located inside the missile bay at BL 8.15 on the right-hand side. See figure 1-78 for an illustration of the boresight plate locations and alignment data. The forward plates are secured to the aft side of the bulkhead at station 216.50 and the aft plates are secured to the forward side of the bulkhead at station 412.00. The boresight mounting plates are adjustable to provide for readjustment in the field. They are jig located at time of manufacture and fixed in place with two MS 20600B4-4 blind rivets. If the boresight is readjusted in the field, the blind rivets must be drilled out to free the mounting plate and two new holes must be drilled for two AN173-5A close tolerance bolts to permanently lock the mounting in place. Broken or damaged boresight plates may be realigned after replacement by the following procedure:

a. Place the airplane on jacks, and level airplane by means of the leveling lugs in the armament bay. Refer to paragraphs 1-215 and 1-217 for procedures.

b. Drop two plumb lines, with fairly heavy bobs or weights attached, from the lower surface of the fuselage at flush screws installed through skin. These screws are located at stations 102.00 and 431.00 and BL 8.15 on the right-hand side. Secure plumb line by replacing existing screws with like screws which have been drilled through recess in head, creating a hollow shank for plumb line.

c. Position an instrument stand, equipped with cross slide or lateral adjuster, at a point approximately in line with the plumb lines and about 25 feet forward of the nose of the airplane. Refer to paragraph 1-292 for tools and accessories required.

d. Carefully remove the jig transit from its carrying case and mount it on the instrument stand.

e. Rough level the instrument with the bullseye level in transit frame by adjusting the four leveling screws at the bottom plate of the instrument.

f. Set optical micrometer at "0" reading and focus the eyepiece until the telescope cross hairs are seen clearly. Adjust height of stand to allow sighting under airplane.

g. With near plumb line held to one side, aim the telescope at the far plumb line (station 431.00) and adjust the telescope focusing knob until the line appears sharp and clear. See figure 1-79 for an illustration of the telescope focusing procedure.

h. Tighten clamp on the instrument vertical axis snug enough to prevent horizontal movement and adjust the horizontal motion tangent screw until the telescope vertical cross hair is superimposed on the estimated center of the plumb line.

i. Readjust the telescope focusing knob until the near plumb line (station 102.00) is clearly visible.

j. Adjust the instrument stand cross slide or lateral adjuster to move the transit left or right until the vertical cross hair is superimposed on the estimated center of the near plumb line. The transit telescope line-of-sight will be aligned with both plumb lines when estimated centers of the lines are visible, each in turn, without moving the telescope.

NOTE

Do not readjust the horizontal motion tangent screw during this step.

k. Repeat steps "g" through "j" until telescope vertical cross hair remains superimposed on estimated centers when focused to each plumb line.

l. At forward boresight mounting plate inside missile bay at station 216.50, move upper mounting plate until center of 5/16-inch bolt hole in upper plate is aligned with two 0.250-inch diameter tooling holes in web of bulkhead at WL −32.00 and BL 20.00 (one each side, left-hand and right-hand), as determined by an accurate straight edge. Tighten adjustment bolts.

m. Suspend third plumb line with heavy weight attached from a 5/16-inch bolt installed in upper mounting plate.

n. Sight through transit on third plumb line and move slightly loosened mounting plate to left or right until estimated center of plumb lines established in steps "g" through "k" is in line with transit vertical cross hair. Lock plate in place with two AN3 bolts in mounting plate assembly.

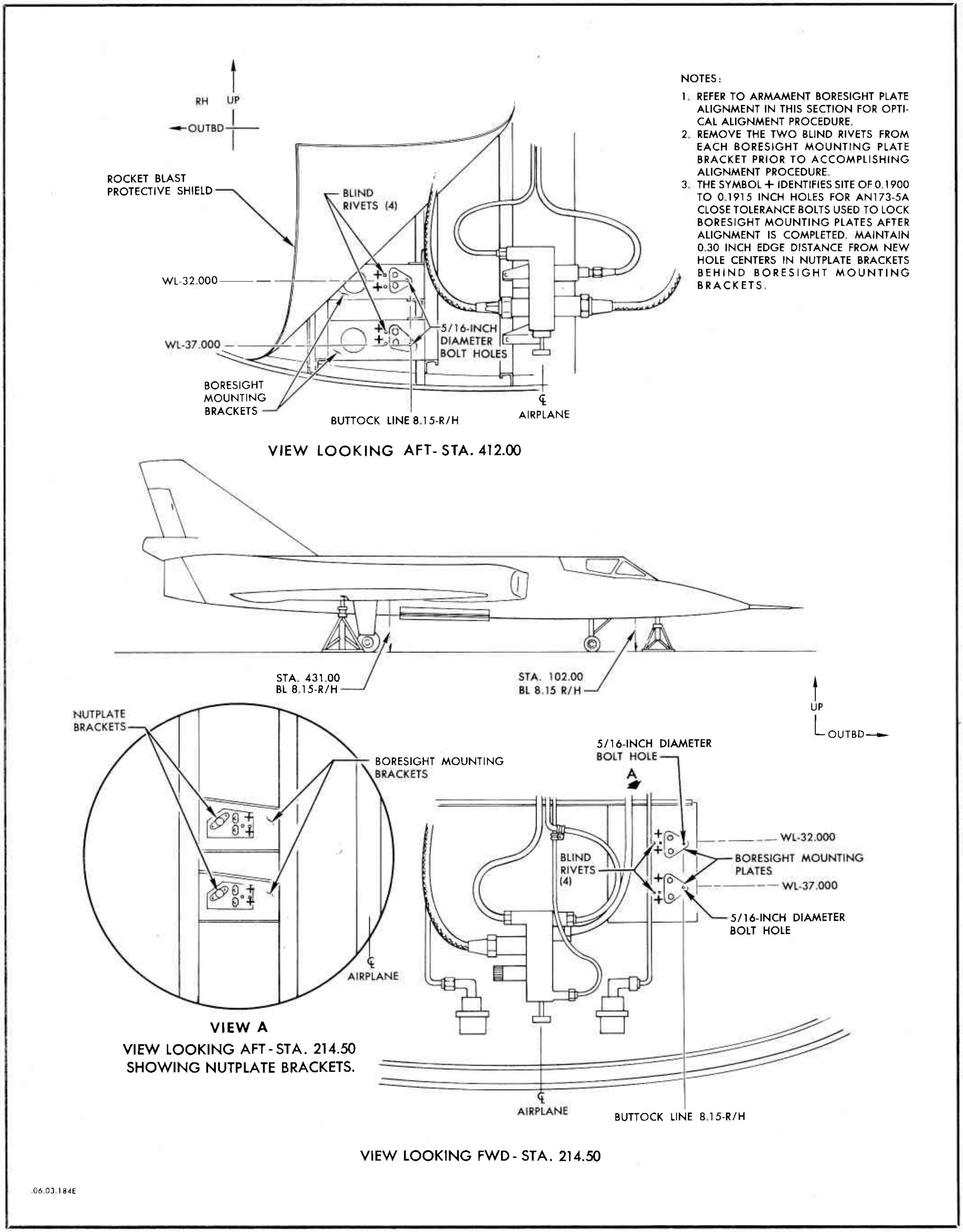
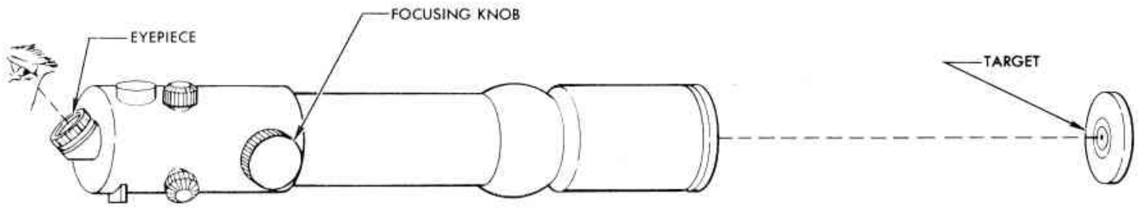
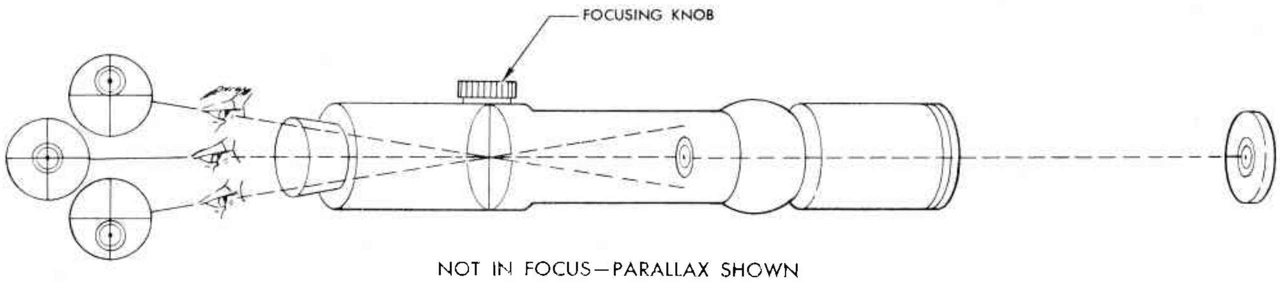


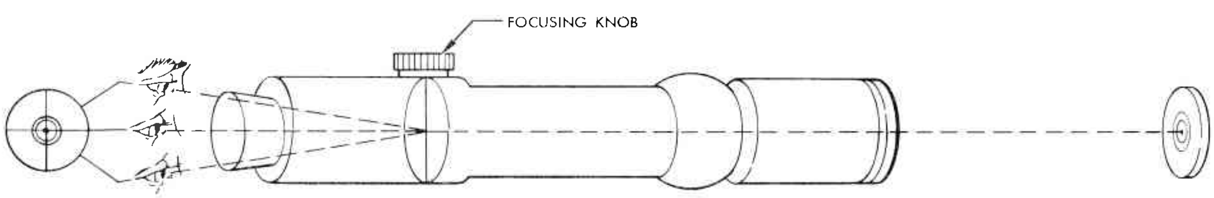
Figure 1-78. Boresight Mounting and Plumbline Locations



A. Focus eyepiece on telescope cross hairs by turning eyepiece until cross hairs appear sharp and clear.
B. Focus telescope on target by turning telescope focusing knob until target image appears to be superimposed on the telescope cross hairs.
C. Adjust focusing knob slightly, until target image remains stationary when head is moved.



NOT IN FOCUS—PARALLAX SHOWN



FOCUSED—PARALLAX ELIMINATED

NOTE:
LOOK THROUGH TELESCOPE WITH BOTH EYES OPEN AND ASSUME A RELAXED POSITION AS WHEN VIEWING A DISTANT OBJECT. IF CORRECTIVE LENS GLASSES ARE NORMALLY WORN BY THE OPERATOR THEY SHOULD NOT BE REMOVED.

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Figure 1-79. Telescope Focusing Procedure

o. Drill two 0.1900 to 0.1915-inch holes for two AN173-5A close tolerance bolts in each plate near old blind rivet holes. Maintain 0.30-inch edge distance from hole centers in nutplate brackets behind boresight mounting brackets.

p. Install two AN173-5A close tolerance bolts in plate. Permanently lock in place with two AN365-1032 nuts.

q. Align lower mounting plate at station 216.50 in same manner as in preceding steps, except locate 5/16-inch bolt hole in lower plate at a distance of 5.00 inches below 5/16-inch bolt hole in upper plate. Swing plumb line from lower plate to align and lock as in steps "m" through "p."

r. Align aft mounting plates at station 412.00 in same manner as in preceding steps, except locate 5/16-inch bolt hole in upper plate at a distance of 7.00 inches below two 0.25-inch tooling holes in bulkhead web at BL 10.00 and WL −25.00, left and right sides. Locate lower mounting plate at a distance of 5.00 inches below upper plate. Align and lock both plates as in steps "m" through "q."

1-276. Optical Tooling.

1-277. Optical tooling applies the principles of surveying and precision optics to the task of erecting or rechecking assembly jigs and fixtures required in aircraft construction. Aircraft component alignment and reference points are established by using line-of-sight instruments. Line-of-sight instruments are also used to establish true lines and planes in space, to determine precise right angles, and to measure horizontal and vertical distances. Heavy mechanical tools, used in previous methods, are lightened and simplified by use of the optical tooling system, since lines-of-sight are established as reference lines instead of mechanical devices. Use of optical instruments also eliminates some errors that are commonly found in the larger mechanical measuring devices. Errors in mechanical measurements may be caused by wear, dirt, corrosion, obstructions, distance, sag of long scales or bars, inaccessibility of points to be located, and distortion from unequal coefficients of expansion. The following four instruments are the basic optical tools used in erecting F-106A and F-106B jigs and fixtures:

1. The sight level.
2. The jig transit.
3. The alignment telescope.
4. The optical square.

These four optical instruments and complementary accessories cut jig and fixture construction time by as much as 20 percent and, at the same time, attain equal if not greater accuracy than previous methods. The instruments and accessories listed in the procedures that follow are typical of the optical tools used in the construction of the F-106A and the F-106B. Other instruments and accessories may be used in these procedures by making allowances for the variations in design of the instruments. A glossary of optical tooling terms is listed in paragraph 1-333.

1-278. THE SIGHT LEVEL.

1-279. The sight level is the optical counterpart of the master or precision level. A sensitive prismatic viewing type spirit level is attached parallel to the optical axis of a telescope tube. The prismatic level provides a split image of a bubble. By matching the halves of each end of the split bubble, an accurate level can be established. Most sight levels are equipped with a bullseye bubble or circular level for roughing in the level of the instrument. The sight level is illustrated on figure 1-80. When the level of the scope is established, any point sighted through the telescope can be adjusted to the same horizontal plane with every other point.

1-280. Setting Level Points on a Horizontal Plane.

1-281. By using the following procedure, two or more points may be established on a surface in a horizontal plane to very close tolerances by means of the sight level.

1-282. Tools and Accessories Required.

FIGURE	QUANTITY	NAME	PART NUMBER
1-90	1	Instrument stand, standard height.	Keuffel & Esser No. 9092-20 or Brunson Model 230-2 or equivalent
1-90	1	Wyteface scale, 10.0 inches or more.	Keuffel & Esser No. 9099-30 or equivalent
1-80	1	Tilting (Dumpy) sight level, equipped with	Keuffel & Esser No. P-5022 or equivalent
	1	Prismatic viewing level, and	Keuffel & Esser No. 5097-46A or equivalent
	1	Optical micrometer.	Keuffel & Esser No. 9092-7 or equivalent

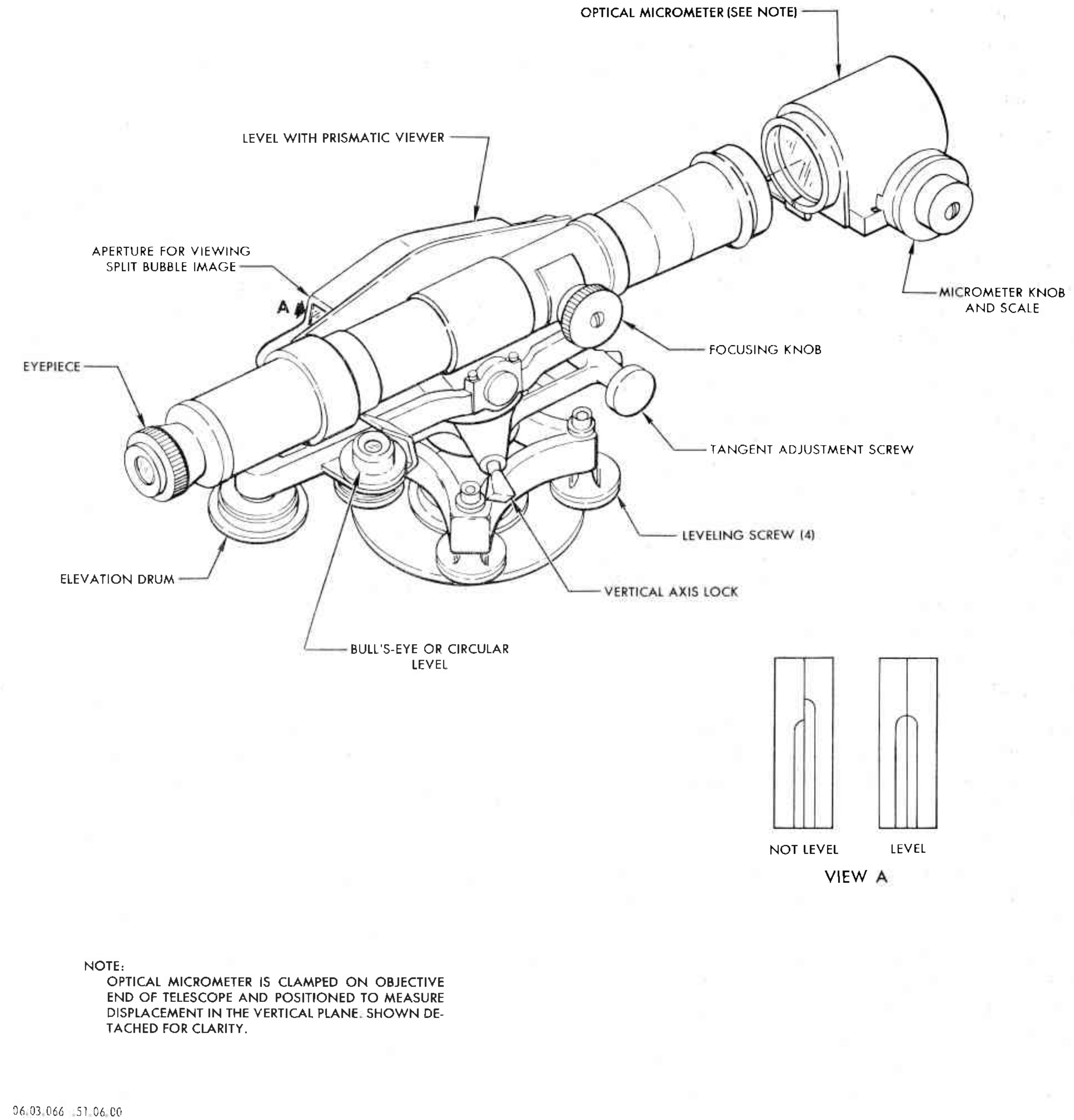


Figure 1-80. The Sight Level

1-283. Procedure.

a. Position stand near a point midway between ends of object to be leveled, taking care that a minimum distance of about six feet is maintained between the stand and the object.

b. Crank up or adjust height of stand to allow the sight level to be slightly above the surface to be leveled.

c. Carefully remove the sight level from the carrying case and mount it on the stand.

d. Level the instrument roughly by adjusting the four leveling screws until the bullseye or circular level indicates a leveled setting.

e. Swing telescope barrel in a horizontal plane until it is in line with a scale held vertically on any point of the surface.

NOTE

Move the scale forward and aft and observe the minimum scale dimension reading. Hold scale at the position where the minimum reading intersects the line-of-sight.

f. Observe the split bubble through the prismatic level viewing aperture to the left of the eyepiece. Adjust elevating drum under telescope eyepiece until the two halves of the split bubble are aligned. See figure 1-80 for an illustration of the split bubble.

g. With micrometer dial on sight level set at zero, focus on scale. See figure 1-79 for an illustration of telescope focusing procedure. Then rotate micrometer dial until the horizontal cross hair is located on an even decimal point on the scale. This location becomes the fix or reference point on the scale.

h. Record micrometer dial setting.

i. Swing instrument to aim at second point to be set. Reset split bubble by turning elevation drum under eyepiece to bring telescope portion of the instrument back on a level plane.

j. Focus telescope on the scale.

k. Rotate micrometer dial up or down until horizontal cross hair is located at same point on the scale as in step "g."

l. Compute the difference between the two micrometer readings. The resulting figure is the difference or error in level between the two points checked. To check a number of points repeat steps "i" thru "l," remembering to realign the split bubble by adjusting the elevating drum at each position before adjusting the micrometer.

1-284. Measuring or Setting Vertical Distance Between Two Horizontal Planes or Points With a Sight Level.

1-285. By using the following procedures, the vertical distance between two horizontal planes may be accurately measured with any reliable sight level.

1-286. Tools and Accessories Required.

Refer to paragraph 1-282 for list of equipment required:

1-287. Procedure.

a. Adjust stand height until sight level is located at any elevation between the two surfaces on which measurements are to be taken.

b. Adjust the leveling screws until the spirit level or split bubble level indicates a level setting.

c. Suspend a scale from upper point or horizontal plane so that a portion of the scale intersects the telescope line-of-sight.

d. Read and record the dimension viewed on the scale at the telescope horizontal cross hair.

e. Stand a scale from lower point or horizontal plane. Telescope may be swung to the right or left to allow scale to intersect the line-of-sight.

NOTE

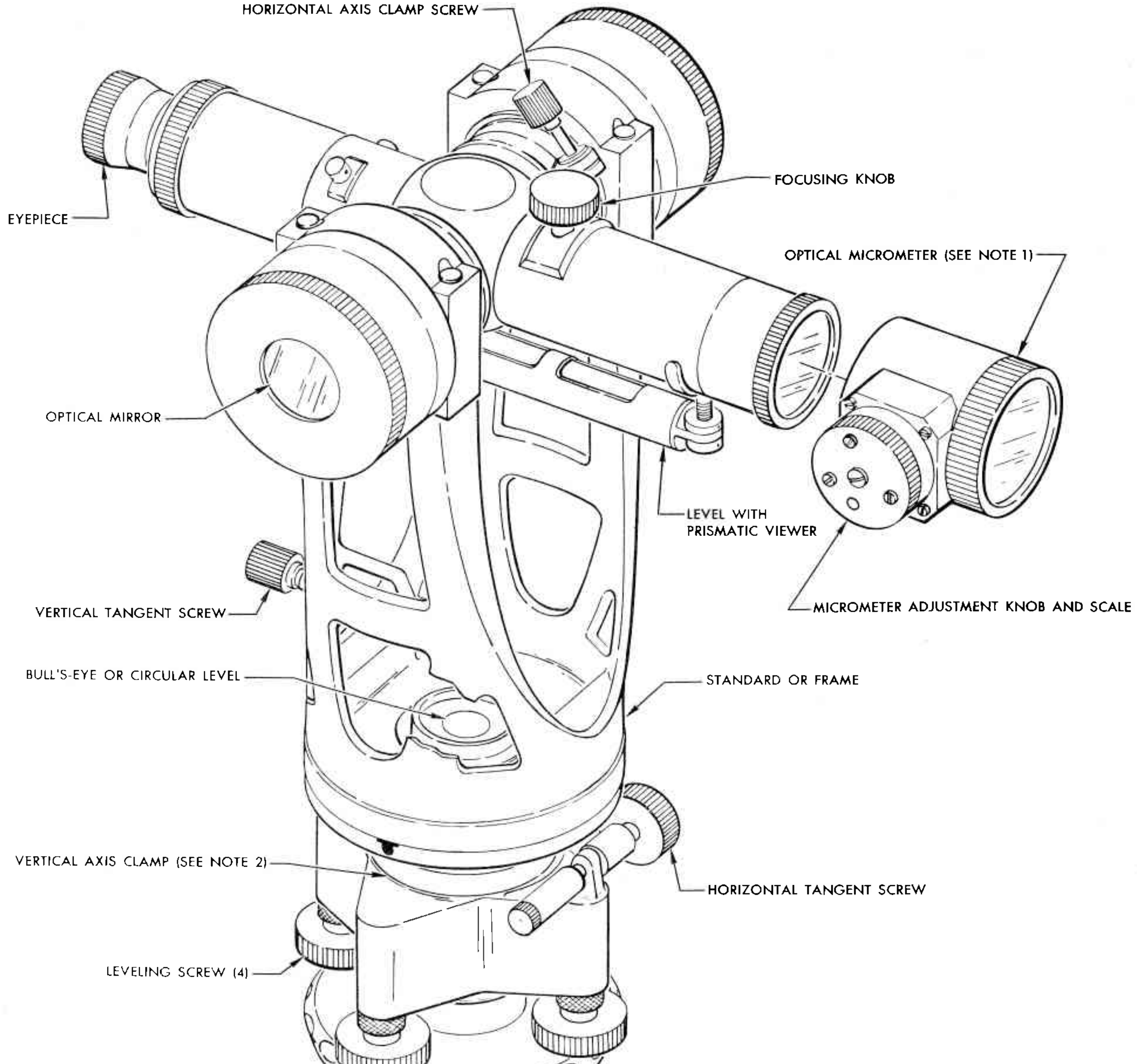
If the telescope is moved in a horizontal plane, the level indication must be checked and reset if any change has occurred.

f. Read and record the dimension viewed on the scale at the telescope horizontal cross hair.

g. Add the dimensions recorded in steps "d" and "f." The resulting total is the vertical distance between the points measured.

1-288. THE JIG TRANSIT.

1-289. The jig transit is similar to the surveyor's transit, an optical instrument commonly used for measuring land, except that the jig transit does not incorporate the 360-degree horizontal and vertical circle plates used for angular measurements. The major components of a jig transit are: a telescope, a heavy frame or standard, a spider, and a bottom plate. The telescope is mounted near its center of balance in the frame or standard to allow the scope to be easily rotated or plunged through a 360-degree vertical arc. The frame in turn is mounted on a spider and bottom plate with bushings or bearings which allow the telescope to be swung through 360 degrees in the horizontal plane. See figure 1-81 for an illustration of the jig transit. A bullseye, or circular level is mounted in the base of the standard or frame for rough leveling of the instrument. A more precise level, with a prismatic viewer which provides a split bubble image (see figure 1-80), is mounted on the tube of the telescope. An optical micrometer is mounted on the objective end of the telescope. Both horizontal axes of the telescope mount an axis mirror parallel to the sighting axis of the telescope. These mirrors are ground optically flat to within 0.000004-inch tolerance. Precise right angles to a line-of-sight can be determined by autoreflection or autocollimation with the optical axis mirror. This instrument has a lock clamp on the vertical



NOTES:

1. THE OPTICAL MICROMETER IS CLAMP MOUNTED ON THE OBJECTIVE END OF THE TELESCOPE AND MAY BE ROTATED TO MEASURE DISPLACEMENT IN THE VERTICAL OR HORIZONTAL PLANE, WHICHEVER APPLIES. IN THIS ILLUSTRATION THE OPTICAL MICROMETER IS SHOWN DETACHED FROM THE TELESCOPE FOR CLARITY.
2. TIGHTENING THE VERTICAL AXIS CLAMP SCREW, NOT VISIBLE IN THIS ILLUSTRATION, PREVENTS TRAVERSING OR HORIZONTAL MOVEMENT OF THE TRANSIT.

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Figure 1-81. The Jig Transit

and horizontal axes and fine adjustment screws for both these movements. These are known as tangent screws. The tangent screws permit rapid close tolerance settings when aligning or "bucking in" the jig transit. The primary use of the jig transit is to erect vertical planes or to establish lines perpendicular to a horizontal plane.

1-290. Erection of a Vertical Plane from a Horizontal Plane Using the Jig Transit.

1-291. A vertical plane or line may be erected from a horizontal plane or level surface by utilizing the following procedure. Refer to paragraph 1-280 for the procedure for leveling a horizontal plane.

1-292. Tools and Accessories Required.

FIGURE	QUANTITY	NAME	PART NUMBER		
1-90	1	Instrument stand, standard height, with cross slide.	Brunson Mod. 230-2	or	Keuffel & Esser No. 9092-20 or equivalent
	1	Lateral adjuster, for Keuffel & Esser stand.	Keuffel & Esser		No. 9099-71
1-81	1	Jig transit, equipped with	Brunson Model 71	or	equivalent
	1	Optical micrometer	Brunson No. 190	or	equivalent
	2	Mirrors, horizontal axis, auto-reflecting, and	Brunson No. 189	or	equivalent
	1	Prismatic viewing level.	Brunson No. 194	or	equivalent
1-90	1	Wyteface scale, 10.0-inches long.	Keuffel & Esser No. 9099-30	or	equivalent

1-293. Procedure.

a. Lay out a line or two points on the leveled horizontal surface of the fixture or object from which the vertical plane will be erected. This line will represent the lower edge of the vertical plane to be erected. If this procedure is used to check an existing vertical member, locate the line or points at an arbitrary distance of 1.00 to 3.00 inches to one side. Use a scale held against the vertical surface for a reference dimension from the vertical plane. This procedure prevents reflected light from interfering with the telescope line-of-sight.

b. Set up the instrument stand in line with the reference points or the line on the horizontal surface. Maintain a minimum distance of four feet from the nearest point on the reference line.

c. Carefully remove the jig transit from its carrying case and mount it on the instrument stand.

d. Rough level the instrument with the bullseye level by adjusting the four leveling screws at the bottom plate of the instrument.

e. Set optical micrometer at "0" reading and focus the eyepiece until the telescope cross hairs are seen clearly.

f. Aim the telescope at the far end of the reference line and adjust the telescope focusing knob until the line appears sharp and clear. See figure 1-79 for illustration of telescope focusing procedure.

g. Tighten clamp on the instrument vertical axis snug enough to prevent horizontal movement and adjust the horizontal motion tangent screw until the telescope vertical cross hair is superimposed on the far end of the line.

h. Rotate the telescope downward on its horizontal axis, aiming for the near end of the reference line. Readjust the telescope focusing knob until the line is clearly visible.

i. Adjust the instrument stand cross slide or lateral adjuster to move the telescope left or right until the vertical cross hair is again superimposed on the line or point.

NOTE

Do not readjust the horizontal motion tangent screw during this step.

j. Repeat steps "f" through "i" until telescope vertical cross hair remains superimposed on the line when swung to either end point.

k. Rotate transit on vertical axis to 90 degrees from the sighting position called out in step "g."

l. Plunge the telescope so that the prismatic leveling device is on the top of the scope tube. Plunging is a rotation of the telescope on its horizontal axis by an up-and-over movement of the eyepiece through 180 degrees of arc in a vertical plane.

m. With the sighting axis of the telescope in a horizontal position, tighten clamp on instrument horizontal axis snug enough to prevent vertical movement and adjust the vertical motion tangent screw until the split bubble (viewed through aperture in prismatic level) indicates a precise level position. See figure 1-80 for an illustration of the split bubble.

n. Loosen the vertical axis clamp and swing the telescope to left or right through 180 degrees of arc in a horizontal plane and note error indicated by split bubble. Remove one-half of the error by adjusting the two base leveling screws that are in line with the telescope sighting axis. The remaining error is removed by adjusting the vertical motion tangent screw.

o. Swing telescope back 180 degrees to original position and repeat the process of removing one-half the level error with the two base leveling screws and the remaining error with the vertical motion tangent screw as done in step "m."

p. Repeat steps "m" and "n" until the split bubble indicates a precise level at both positions.

q. Rotate telescope to left or right through 90 degrees of arc in a horizontal plane and remove *all* the remaining level error with the two base leveling screws that are in line with the telescope sighting axis.

r. Recheck level at all positions when swinging telescope in a horizontal plane. If a precise level indication is not maintained, repeat steps "m" through "p."

s. Swing telescope until the telescope vertical cross hair is superimposed once more on the near end of the reference line on the level surface or horizontal plane.

t. Tighten the vertical axis clamp snug enough to prevent horizontal motion and loosen the horizontal axis clamp.

u. Rotate telescope by depressing eyepiece end until the far end of the reference line is visible. If the telescope vertical cross hair does not remain superimposed on the reference line when moved to either end point, correct by repeating steps "f" through "i."

v. Elevate the telescope line-of-sight to the desired height for locating the upper points of the vertical plane above the horizontal surface. An existing vertical member, as mentioned in step "a," may be checked for deviations from the lower reference line by sighting the 1.00 to 3.00-inch arbitrary dimension point on a scale held against the vertical surface. Measure the deviation by turning the optical micrometer adjustment knob until the vertical cross hair has moved into line with the reference points, and reading the error on the micrometer scale.

1-294. THE ALIGNMENT TELESCOPE.

1-295. The modern optical tooling system for aircraft is founded upon the alignment telescope. This is the primary tool for the construction and checking of jigs and fixtures by establishment of optical reference lines in relationship to basic aircraft reference lines. The use of bulky master gages is falling rapidly into discard as tool engineers find that new optical methods bring previously unattainable precision and simplification into their tasks. An alignment telescope is an optical instrument of sturdy, rigid construction, containing cross hairs in the optical axis. The telescope optical axis is identical with the mechanical axis. The telescope is capable of providing and maintaining an accurate optical reference line or line-of-sight. The outer surface of the telescope tube is ground concentrically to the center line-of-sight of the telescope to provide for mounting the telescope within a standard spherical mount. See figure 1-82 for an illustration of the alignment telescope. Telescope magnification usually ranges from 30 to 60 power, depending on the make or model. Vertical or horizontal displacement from the telescope line-of-sight may be measured by integral or built-in optical micrometers. See figure 1-83 for an illustration of the principle of operation of the optical micrometer. Micrometer measurements, in a range of plus or minus 0.100 inch, are accomplished by a system of internal glass optical flats, mechanically linked to external adjustment knobs. Increments of 0.001 inch are read on a graduated scale at the external micrometer adjustment knob. An exception, the Farrand alignment telescope, provides a view of internal scales through the telescope eyepiece. See figure 1-84 for an illustration of the conditions to be avoided in establishment of the telescope line-of-sight.

1-296. Establishment of an Optical Reference Line or Line-of-Sight on the Fixture Using the Alignment Telescope.

1-297. The following procedure will provide one or more stable optical reference lines from which contour plates or facility gages may be set or fixed. Where more than one optical reference line is established, one line is designated as the basic line-of-sight and the other lines-of-sight are known as auxiliary or secondary lines-of-sight. This procedure employs an alignment telescope equipped with an adjustable focus eyepiece, adjustable objective focus, integral optical micrometers for measuring in two planes, and a spherical mount or adapter for mounting the telescope in the cup mounting base. The spherical mount is a steel sphere bored through the center to a diameter large enough to permit mounting a target or alignment telescope on the axis of the sphere. The cup mounting bases are permanently fixed by screws and dowel pins to a steel plate welded to the fixture. The spherical mount is not required for the Farrand alignment telescope which incorporates an integral spherical mount.

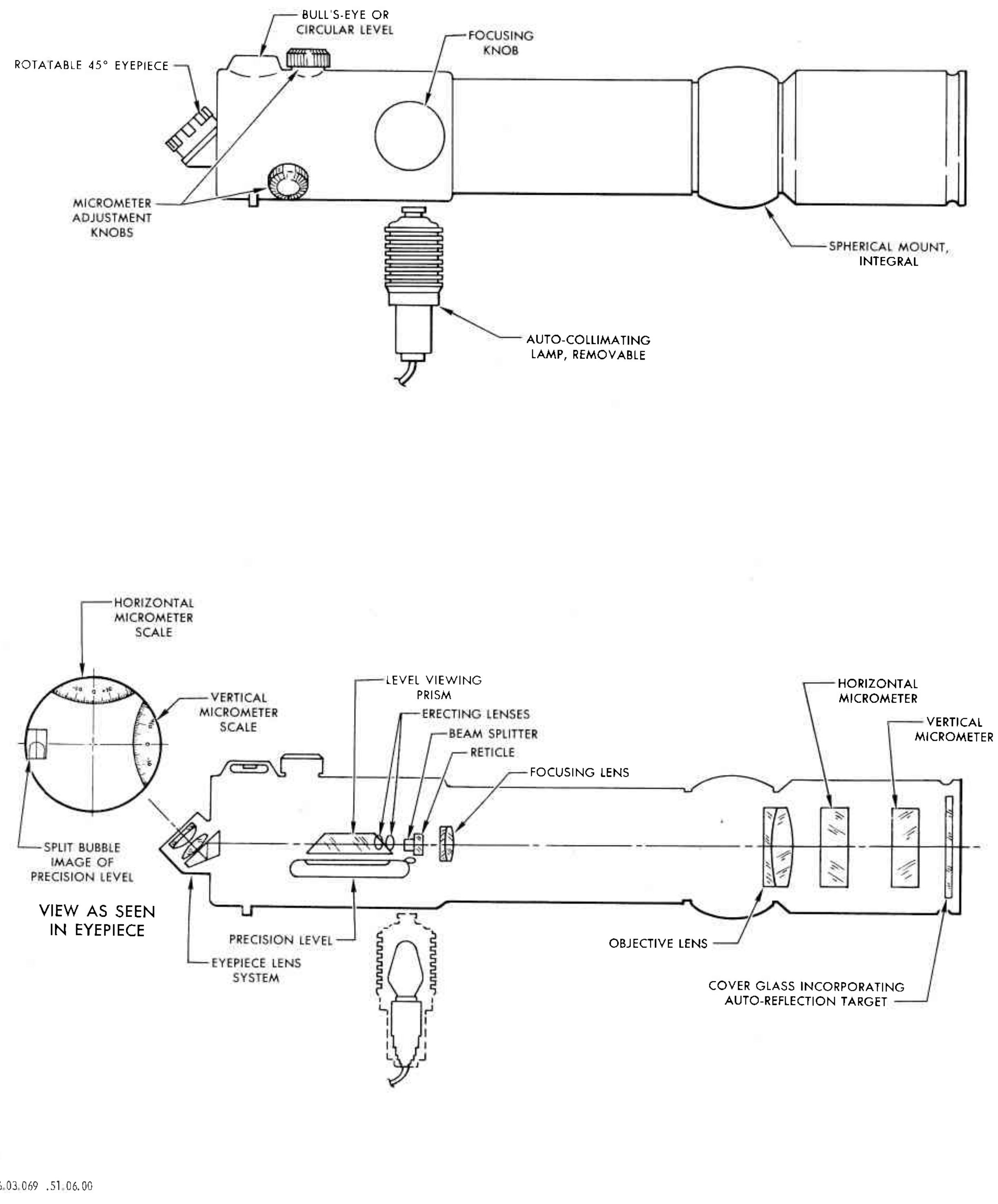


Figure 1-82. The Alignment Telescope

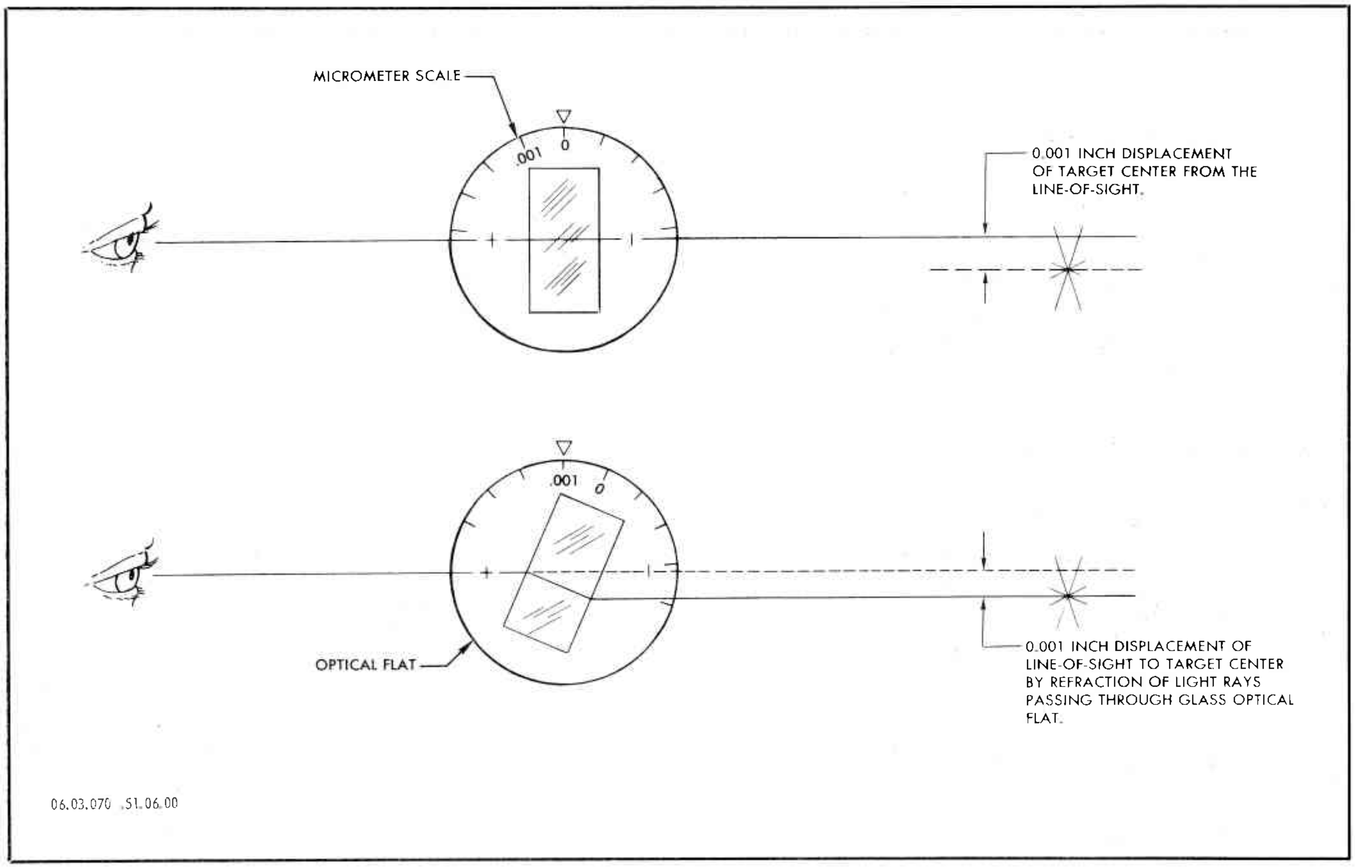


Figure 1-83. Principle of the Optical Micrometer

1-298. Tools and Accessories Required.

FIGURE	QUANTITY	NAME	PART NUMBER
1-85	2	Adjustable cup mounting base.	Farrand No. 87955 or Keuffel & Esser No. 9099-54, or equivalent
1-85	2	Cup mount clamp.	Farrand No. 31354 or Keuffel & Esser No. 9099-54½, or equivalent
1-85	2	Spherical mount or adapter.	Farrand No. 88291 or Keuffel & Esser No. 9099-53
1-85	1	Adjustable telescope mounting bracket.	Farrand No. 91671 or Keuffel & Esser 9099-57
1-85	1	Plastic target, 2¼-inch diameter.	Farrand No. 88342 or equivalent
1-90	1	Plastic target positioning tool.	Farrand No. 24391 or equivalent
1-85	1	Target illuminator.	Farrand No. 88292 or Any portable drop light
1-82	1	Alignment telescope.	Farrand No. 95360 or Taylor-Hobson No. TTH 112/365 or equivalent

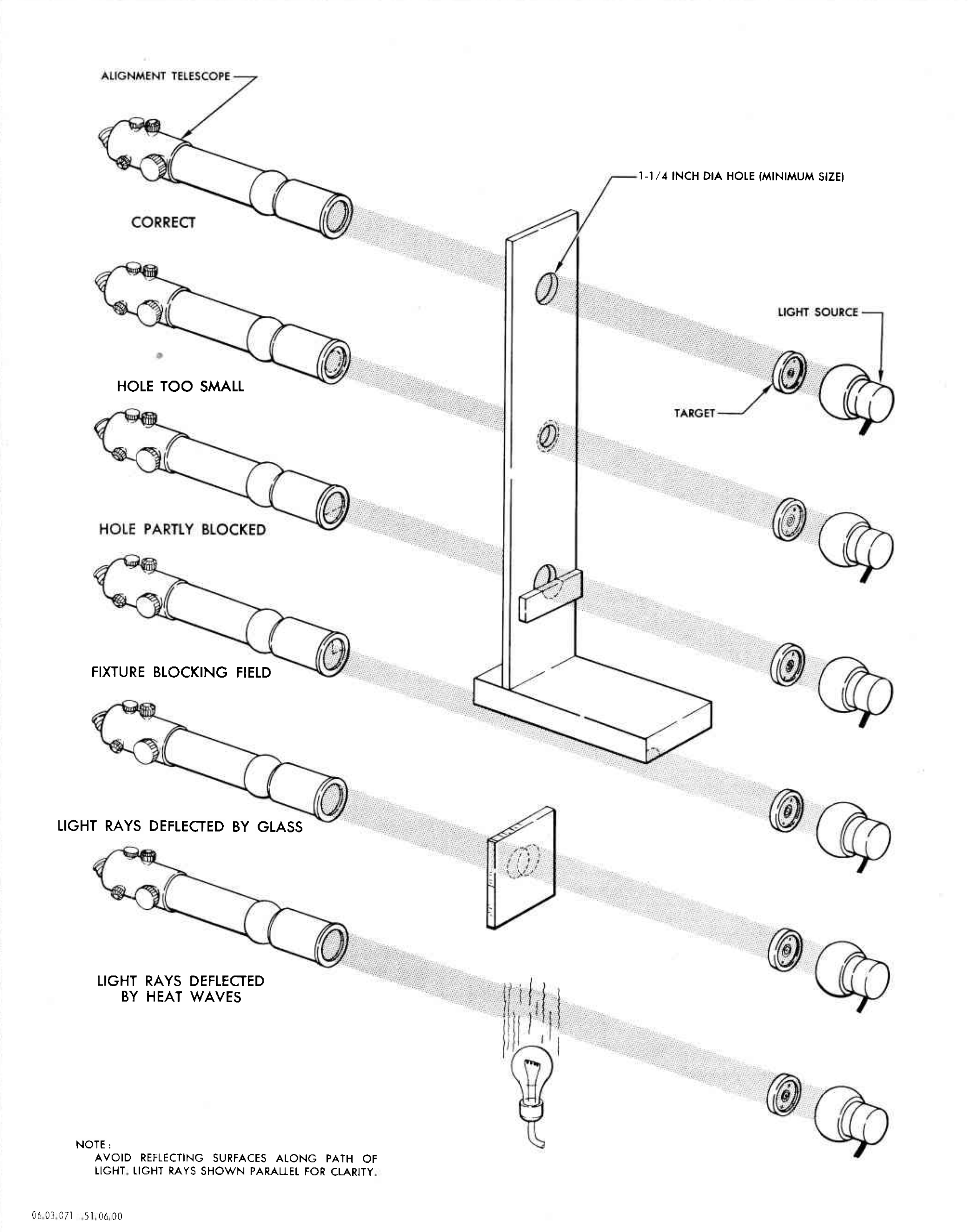


Figure 1-84. Telescope Line of Sight

1-299. Procedure.

a. In accordance with applicable tool design specifications, locate on the fixture and attach one adjustable cup mounting base at each end of the proposed line-of-sight. The cup mounts are secured by screws and dowel pins to a steel plate welded to the fixture. See figure 1-85 for attachment details.

b. If target is not already mounted in spherical mount, push a 2¼-inch diameter target into the bore of a spherical mount with the target positioning tool. The target center will coincide with the c/l of the spherical mount, thus allowing sphere to be tilted slightly without displacing the line-of-sight. Targets should remain installed in spheres at all times.

c. Install sphere containing target on cup mount base and secure with cup mount clamp. Tighten clamp snugly, but do not overtighten. Adjust sphere to face target towards the opposite cup mount.

d. Install the telescope bracket on the cup mount base at the opposite end of the fixture from the target mounting.

e. Carefully remove the telescope from its carrying case and set it on the cup mount with the spherical mount resting in the cup and the eyepiece end of the telescope resting in the adjustable bracket. Place cup mount clamp over the spherical mount on the telescope and tighten it just enough to assure a firm seat between the sphere and the cup.

f. Aim telescope at center of target and focus eyepiece until the image of the telescope cross hair appears sharp and clear. With both micrometers set at "0," adjust telescope focusing knob until target image is sharply defined and appears to be superimposed on telescope cross hairs. See figure 1-79 for an illustration of telescope focusing procedure and elimination of parallax.

g. Adjust the aim of the telescope by turning the adjusting screws on the telescope bracket until the telescope cross hair center point coincides with the target center.

1-300. Establishment of the Remote Line-of-Sight Using the Alignment Telescope.

1-301. The following procedure will reduce the number of optical instruments needed and will permit the fabrication of several fixtures at the same time. The procedure utilizes the remote line-of-sight which is established by mounting a target and an alignment telescope on stands separate from the fixture. Vertical planes at 90-degree angles to the fixture basic line-of-sight may then be rapidly established from the remote line-of-sight.

1-302. Tools and Accessories Required.

FIGURE	QUANTITY	NAME	PART NUMBER
1-90	3	Instrument stand, standard height.	Brunson Mod. 230-2 or Keuffel & Esser No. 9092-20 or equivalent
	2	Adapter, female with 3½-inch diameter x 8 threads per inch, for mounting cup mounting base on instrument stand.	Manufacture locally
1-85	2	Cup mounting base, adjustable.	Farrand No. 87955 or Keuffel & Esser No. 9099-54 or equivalent
1-85	2	Cup mount clamp.	Farrand No. 31354 or Keuffel & Esser No. 9099-54½ or equivalent
	2	Spherical mount, with	Farrand No. 88291 or Keuffel & Esser No. 9099-53 or equivalent
1-85	2	Target plastic, 2¼-inch diameter.	Farrand No. 88342 or equivalent
	1	Tilting (Dumpy) sight level,	Keuffel & Esser No. P-5022 or equivalent
1-85	1	Prismatic viewing level.	Keuffel & Esser No. 5097-46A or equivalent

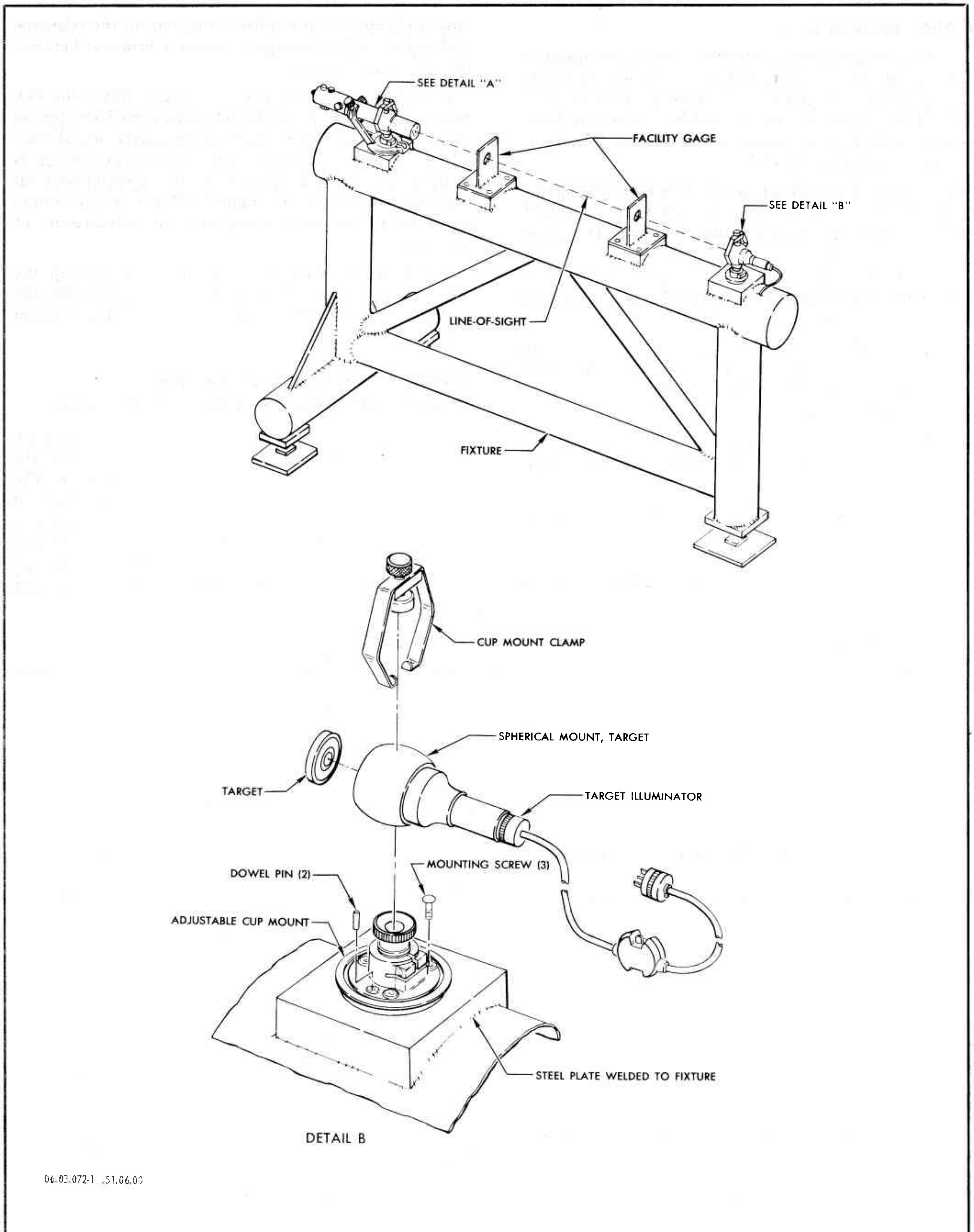


Figure 1-85. Mounting of Alignment Telescope and Target to Fixture (Sheet 1 of 2)

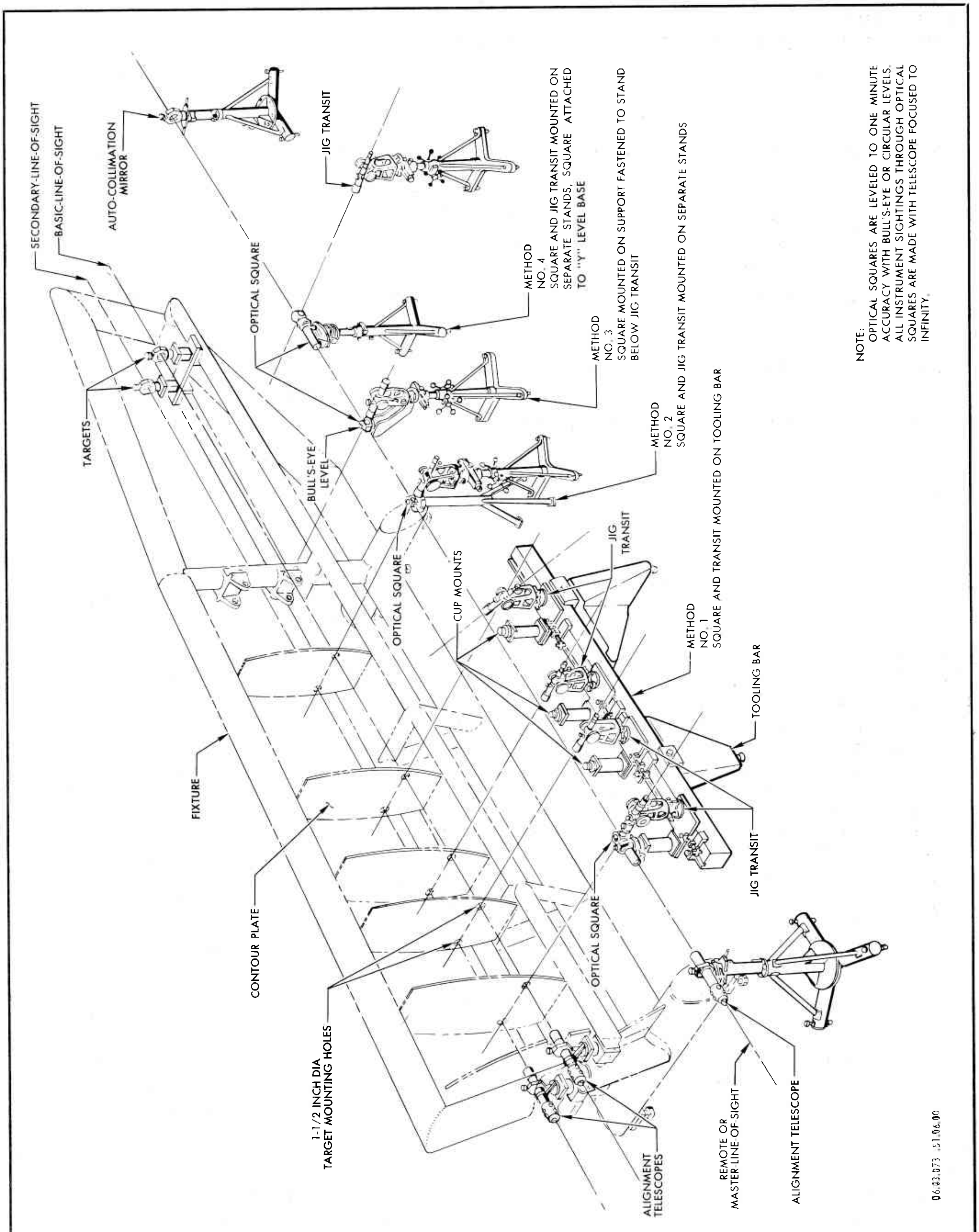


Figure 1-86. Methods of Establishing Right Angle Planes to the Line-of-Sight

1-306. Tools and Accessories Required (Cont).

FIGURE	QUANTITY	NAME	PART NUMBER
	1	Tilting (Dumpy) sight level equipped with	Keuffel & Esser No. P-5022 or equivalent
1-80	1	Prismatic viewing level.	Keuffel & Esser No. 5097-46A or equivalent
1-85	2	Cup mounting base, adjustable.	Farrand No. 87955 or Keuffel & Esser No. 9099-54 or equivalent
	2	Adapter, for mounting cup mounting base on instrument stand, female with 3½-inch diameter x 8 threads per inch.	Manufacture locally
	2	Spherical mount with	Farrand No. 88291 or Keuffel & Esser No. 9099-53 or equivalent
1-85	2	Plastic target, 2¼-inch diameter.	Farrand No. 88342 or equivalent
1-85	1	Bracket, alignment telescope mounting.	Farrand No. 91671 or Keuffel & Esser No. 9099-57 or equivalent
1-82	1	Alignment telescope.	Farrand No. 95360 or Taylor-Hobson TTH 112/365 or equivalent
1-81	1	Jig transit, equipped with	Brunson Mod. 71 or equivalent
	2	Mirror, horizontal axis, autoreflecting.	Brunson No. 189 or equivalent

1-307. Procedure.

a. Establish remote line-of-sight on two instrument stands, employing a target on one stand and an alignment telescope on the opposite stand. Refer to paragraph 1-300 for procedure. Position stands beyond ends of fixture on a line five or six feet to either side and parallel to the level fixture basic line-of-sight. Parallel of the lines-of-sight is established by measurement at each end with a steel tape or other mechanical measuring device.

b. Position instrument stand, equipped with lateral slide or adjuster, between the two stands along the remote line-of-sight and at an approximate right angle to the station or point on the fixture where the vertical plane will be erected.

c. Carefully remove the jig transit from its carrying case and mount it on the instrument stand.

d. Rough level the instrument by means of the bulls-eye or circular level in the base of the jig transit.

e. Adjust the height of the instrument stand until the jig transit axis mirror is intersecting the remote line-of-sight with the jig transit telescope aimed at the station or point on the fixture. See figure 1-81 for an illustration of the jig transit.

f. Insert the autoreflecting light source in the remote line-of-sight alignment telescope and turn it on. See figure 1-82 for an illustration of the light source.

g. Focus alignment telescope until the image of the autoreflection target in the telescope front cover glass is reflected from the jig transit axis mirror and appears sharp and clear. See figure 1-79 for an illustration of telescope focusing procedure.

h. Adjust the two leveling screws in the base of the jig transit that are in line with the remote line-of-sight until the telescope horizontal cross hair is superimposed on the center of the reflected target image. See figure 1-87 for an illustration of the principle of autoreflection.

i. Tighten vertical axis clamp screw (see figure 1-81) just enough to prevent movement of the transit in a horizontal plane and adjust the horizontal motion tangent screw until the telescope vertical cross hair is superimposed on the center of the reflected target image.

j. Sight through the jig transit telescope and focus on the station line or point established on the fixture. Adjust the lateral slide or adjuster on the jig transit instrument stand until the transit vertical cross hair is superimposed on the station line or point on the fixture.

k. Recheck autoreflection by sighting through the remote line-of-sight alignment telescope. Correct any error by repeating steps "g" through "i."

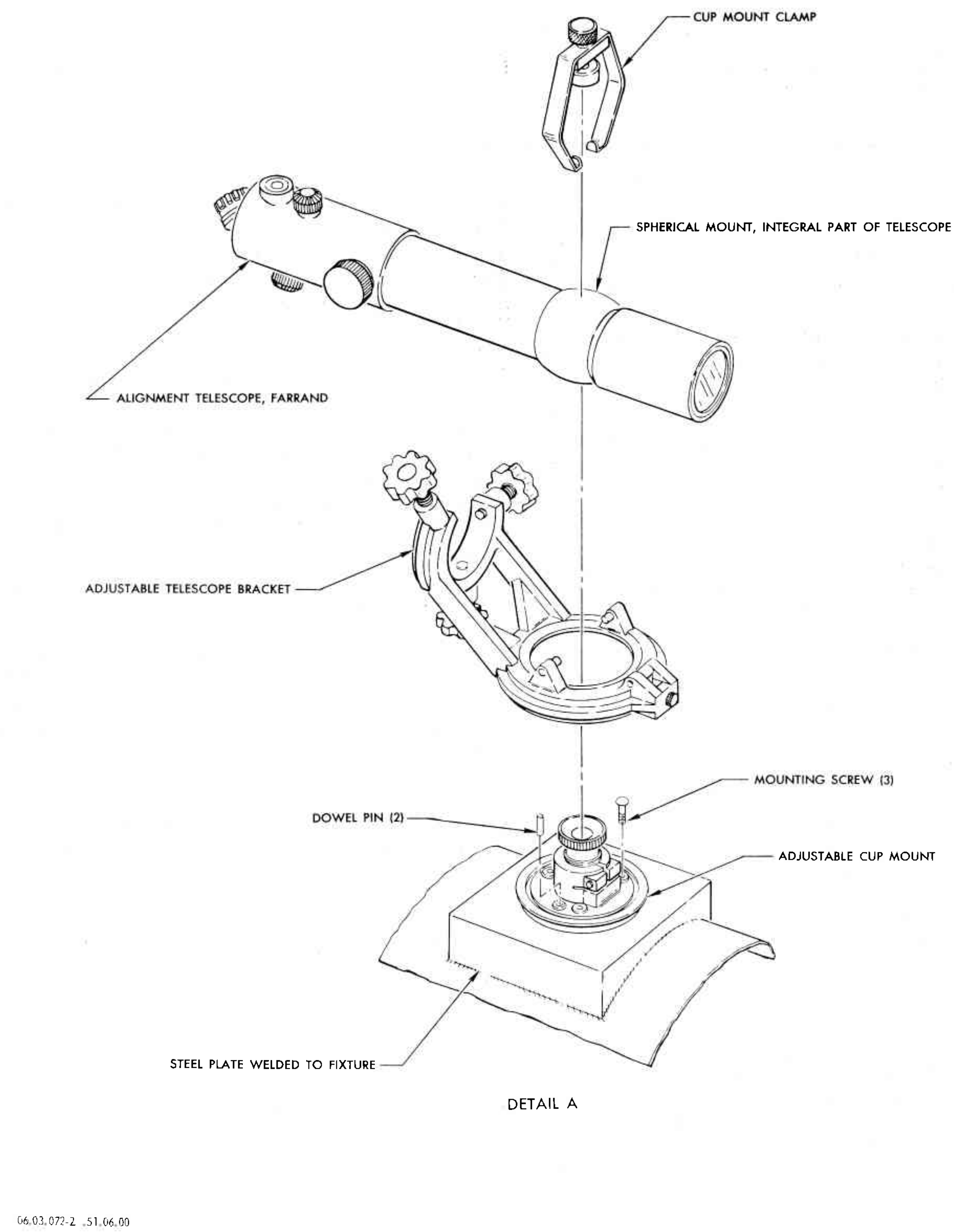


Figure 1-85. Mounting of Alignment Telescope and Target to Fixture (Sheet 2 of 2)

1-302. Tools and Accessories Required (Cont).

FIGURE	QUANTITY	NAME	PART NUMBER		
1-85	1	Bracket, adjustable, alignment telescope mounting.	Farrand No. 91671	or	Keuffel & Esser No. 9099-57 or equivalent
1-82	1	Alignment telescope.	Farrand No. 95360	or	Taylor-Hobson TTH 112/365 or equivalent

1-303. Procedure.

a. Position two of the instrument stands (designate as stands No. 1 and No. 2) as far apart as space will allow. The stands should be placed to the length of the area where the fixtures will be constructed, and to bisect the area. To eliminate the possibility of accidental movement, plaster the bases or feet of the instrument stands to the floor.

b. Install an adapter for cup mount base, a cup mount base, and a spherical mount containing a 2¼-inch diameter plastic target on each of stands No. 1 and No. 2. Secure the spherical mounts with cup mount clamps. See figure 1-85 for an illustration of mounting sequence.

c. Position the third stand (designate as stand No. 3) between stands No. 1 and No. 2 and five to six feet to either side of the line from stand No. 1 to stand No. 2.

d. Carefully remove the sight level from its carrying case and mount it on stand No. 3.

e. Adjust sight level to a rough level as indicated by the bullseye or circular level on the base of the instrument.

f. Crank up stand No. 3 until the sight level line-of-sight is 60 to 62 inches above the floor level.

g. Adjust the height of both targets on stands No. 1 and No. 2 to a level horizontal plane. Follow the sight level operating procedure outlined in paragraph 1-287.

h. Remove one target and spherical mount from either stand No. 1 or stand No. 2.

i. Install the telescope bracket on the cup mount base vacated by the target removed in step "h."

j. Carefully remove the telescope from its carrying case and set it on the cup mount with its spherical mount resting in the cup and the eyepiece end of the telescope resting in the adjustable bracket. Place cup mount clamp over the spherical mount on the telescope and tighten it just enough to assure a firm seat between the sphere and the cup.

k. Aim telescope at center of target and focus eyepiece until the image of the telescope cross hair appears sharp and clear. With both micrometers set at "0," adjust telescope focusing knob until target image is sharply defined and appears to be superimposed on telescope cross hairs. See figure 1-79 for an illustration of telescope focusing procedure and elimination of parallax.

l. Adjust the aim of the telescope by turning the adjusting screws on the telescope bracket until the telescope cross hair center point coincides with the target center. If the remote line-of-sight is 80 to 100 feet long and several fixtures are to be constructed at the same time, it is recommended that the target at the opposite end from the telescope be replaced with an alignment telescope. Both alignment telescopes will then be collimated from either end of the remote line-of-sight.

1-304. Establishment of a Vertical Plane 90 Degrees to the Line-of-Sight with the Jig Transit Being Autoreflected by Using the Jig Transit Axis Mirror.

1-305. The following procedure will establish a vertical plane at right angles to the line-of-sight. See figure 1-86 for an illustration of the method described in this procedure.

1-306. Tools and Accessories Required.

FIGURE	QUANTITY	NAME	PART NUMBER		
1-90	3	Instrument stand, standard height, with cross-slide.	Brunson Mod. 230-2	or	Keuffel & Esser No. 9092-20 or equivalent
	1	Lateral adjuster, for Kueffel & Esser instrument stand if used.	Keuffel & Esser No. 9099-71		

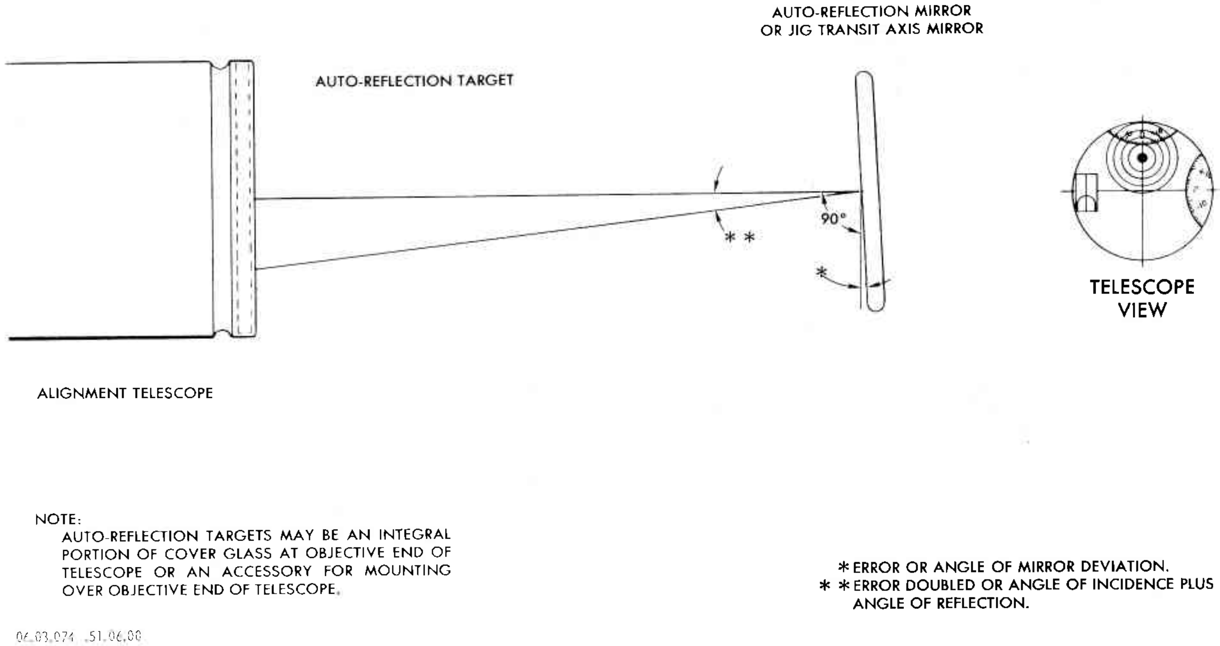


Figure 1-87. Principle of Autoreflection

1-308. THE OPTICAL SQUARE.

1-309. An important operation in the construction of aircraft jigs and fixtures is the establishment of station planes perpendicular to the lines-of-sight. One widely used method employs the optical square. The optical square provides a means of sighting targets at 90 degrees to the basic line-of-sight. The optical square consists of two reflecting mirrors located in a penta-prism relationship and mounted within a rigid metal frame. The frame is provided with a large bore for mounting the square over the objective end of the alignment telescope. The mounting surfaces for the mirrors are precision machined and lapped to hold the deviation from 90-degree angle to a tolerance of plus or minus two seconds. The reflecting mirror, located in line with the telescope sighting axis, is a partial mirror which permits viewing of the target in the line-of-sight without removing the square from the telescope. The optical square may be attached to an adapter and mounted on a separate instrument stand or support at a distance from the telescope. Separation of the optical square from the telescope will allow the square to be moved to any point along the line-of-sight and applied to a control system of linear measurement with the tooling bar. The jig transit may be fixed at right angles to the line-of-sight at any linear station location by mounting the optical square in the sighting axis of the alignment telescope and collimating by sighting through the jig transit and the optical square to the infinity-focused telescope. Two optical squares may be combined to determine parallel lines-of-sight. See figure 1-88 for an illustration of the optical square.

1-310. Establishment of a Vertical Plane 90 Degrees to the Basic Line-of-Sight by Collimation of the Jig Transit Through the Optical Square to the Alignment Telescope.

1-311. The following procedure will establish a vertical plane at right angles to the basic line-of-sight on the fixture. See figure 1-86 for an illustration of the methods described in this procedure.

1-312. Tools and Accessories Required.

FIGURE	QUANTITY	NAME	PART NUMBER
1-90	2	Instrument stand, standard height.	Brunson Mod. 230-2 or Keuffel & Esser No. 9092-20 or equivalent

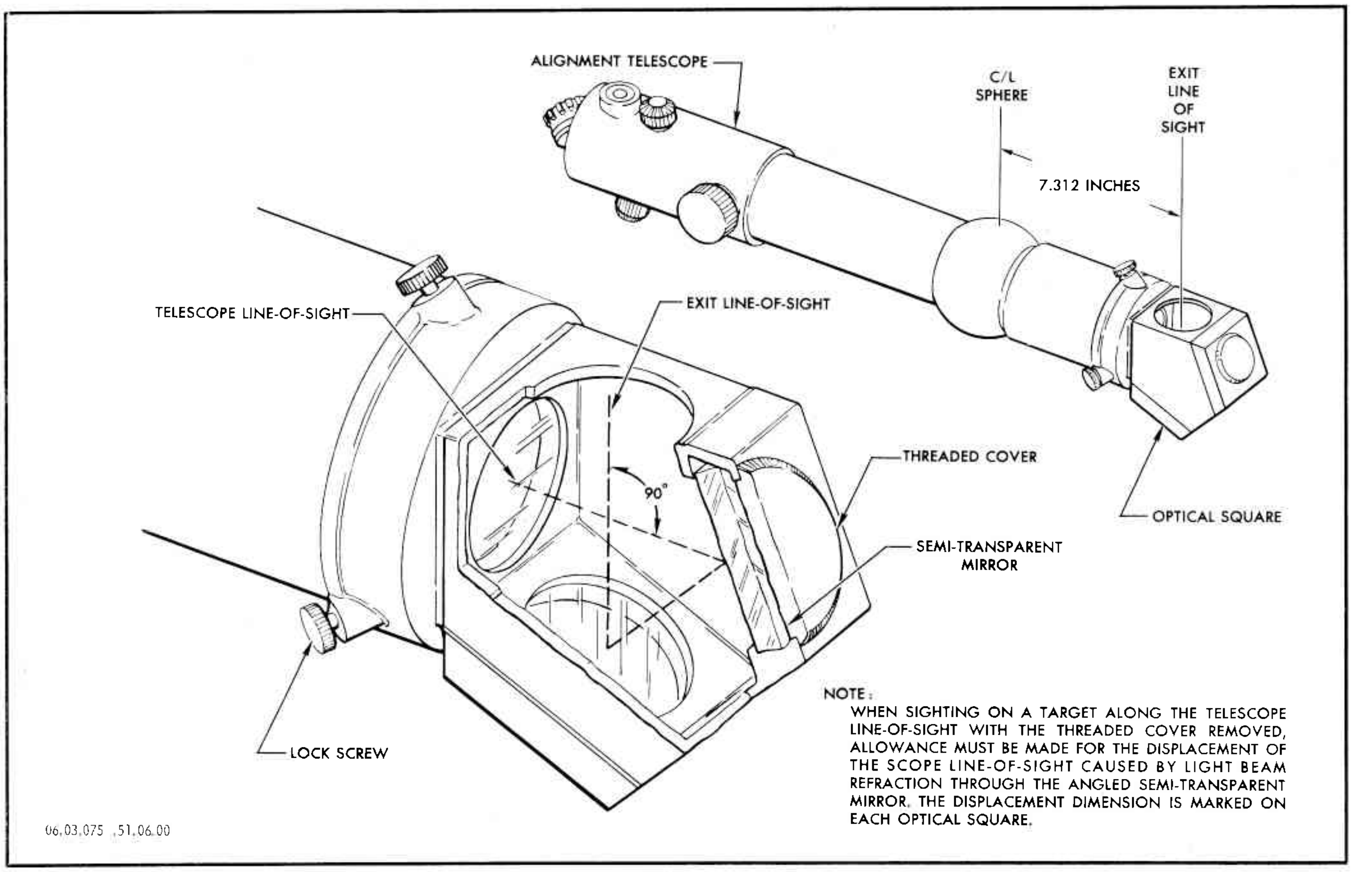


Figure 1-88. The Optical Square

1-312. Tools and Accessories Required (Cont).

FIGURE	QUANTITY	NAME	PART NUMBER
	1	Lateral adjuster, if Keuffel & Esser stand is used.	Keuffel & Esser No. 9099-71 or equivalent
1-81	1	Jig transit.	Brunson Mod. 71 or equivalent
1-88	1	Optical square.	Farrand No. 88305 / Farrand No. 88183 or equivalent
	1	Adapter, optical square mounting.	Farrand No. 88308 or equivalent
1-85	1	Cup mount base.	Farrand No. 87955 or Keuffel & Esser No. 9099-54 or equivalent
1-78	1	Spherical mount.	Farrand No. 88291 or Keuffel & Esser No. 9099-53 or equivalent
1-78	1	Cup mount clamp.	Farrand No. 31354 or Keuffel & Esser No. 9099-54½ or equivalent

1-313. Procedure.

a. Establish remote line-of-sight on two instrument stands, employing a target on one stand and an alignment telescope on the opposite stand. Position stands beyond ends of fixture on a line five or six feet to either side and parallel to the level fixture basic line-of-sight. The lines-of-sight are made parallel by measuring between them at each end with a steel tape or other mechanical measuring device. Refer to paragraph 1-300 for the remote line-of-sight setting procedure and tool requirements.

b. Position instrument stand, equipped with lateral slide or adjuster, between the two stands along the remote line-of-sight and about 13 inches from the remote line-of-sight in a direction away from the fixture. Locate instrument stand at an approximate right angle to the station line or point on the fixture where the vertical plane will be erected.

c. Carefully remove the jig transit from its carrying case and mount it on the instrument stand.

d. Rough level the jig transit by means of the bullseye or circular level in the base of the instrument.

e. Mount the optical square with one opening intersecting the remote line-of-sight and the other opening facing the jig transit. Four methods of mounting the optical square are shown on figure 1-86. Method No. 1 is effected by securing the optical square to an adapter, Farrand No. 88308, which is an accurately ground tube that is, in turn, secured within a spherical mount. Farrand No. 88291. The spherical mount is then clamped in a cup mount base. Methods No. 2 and No. 3 utilize a flat metal plate which is mounted on an instrument stand or a support attached to the instrument stand below the base of the jig transit. The metal plate and the support arms are fabricated locally. Method No. 4 requires an adapter, Farrand No. 88308, to which the optical square is secured, and a "Y" support base. The tube of the adapter rests in a horizontal plane in the vees of the "Y" support which is in turn mounted on an instrument stand. The "Y" support is fabricated locally and incorporates a bullseye or circular level in its base. Regardless of the type of mounting employed, it is recommended that the optical square be leveled to one-minute accuracy by a bullseye or circular level mounted on the side of the square housing in order that the square may be set in the same plane each time it is moved.

f. Level jig transit telescope with the prismatic viewing level on the tube of the telescope. Refer to paragraph 1-293 for leveling procedure.

g. Aim the jig transit at the opening in the optical square and focus until the target pattern on the front glass of the alignment telescope is sighted. Adjust the transit horizontal motion tangent screw until the transit vertical cross hair is centered on the target bullseye. It is not necessary to center the transit horizontal cross hair on the target center.

h. Focus both the alignment telescope and the jig transit to infinity. Collimate by superimposing the transit vertical cross hair over the alignment telescope cross hair which will be faintly visible. Make minor adjustment of transit horizontal motion screw until the vertical cross hairs are aligned.

i. Aim and focus jig transit on the station line or point on the fixture where the vertical plane will be erected. Remove square if necessary. Adjust lateral slide or adjuster on the instrument stand until the jig transit vertical cross hair is superimposed on the station point on the fixture. Do not adjust the horizontal motion tangent screw.

j. Recheck square relationship of jig transit to the remote line-of-sight by repeating step "h."

1-314. Establishment of a Vertical Plane 90 Degrees to the Basic Line-of-Sight with the Optical Square and the Tooling Bar.

1-315. Linear station control and squaring of the station planes along the fixture may be achieved by employment of tooling bars, alignment telescopes, and optical squares. The tooling bar may be any form of dimensionally stable bar or beam that is fixed in a parallel relationship to the lines-of-sight. The bar is provided to support one or more instruments to be used for squaring purposes. The tooling bar may be designed as a separate portable unit or it may be attached as a permanent and integral part of the fixture to provide a permanent linear dimension control. The bar is usually constructed with a base or slide unit attached to mount an optical instrument. The slide unit may be moved along the bar to any station plane and is designed to index into a series of precise, jig-bored holes spaced evenly at 10.000-inch intervals along the length of the bar. The following procedure will fix a station vertical plane at right angles to the fixture basic line-of-sight and at the proper linear dimension point along the fixture, assuming the basic line-of-sight on the fixture has been leveled and cup mounts are installed on each end of the portable tooling bar. See figures 1-86 and 1-89 for an illustration of the tooling bar.

1-316. Tools and Accessories Required.

FIGURE	QUANTITY	NAME	PART NUMBER
1-89	1	Tooling bar, portable, with index and slide unit and cup mounts at each end of the bar.	Fabricate locally

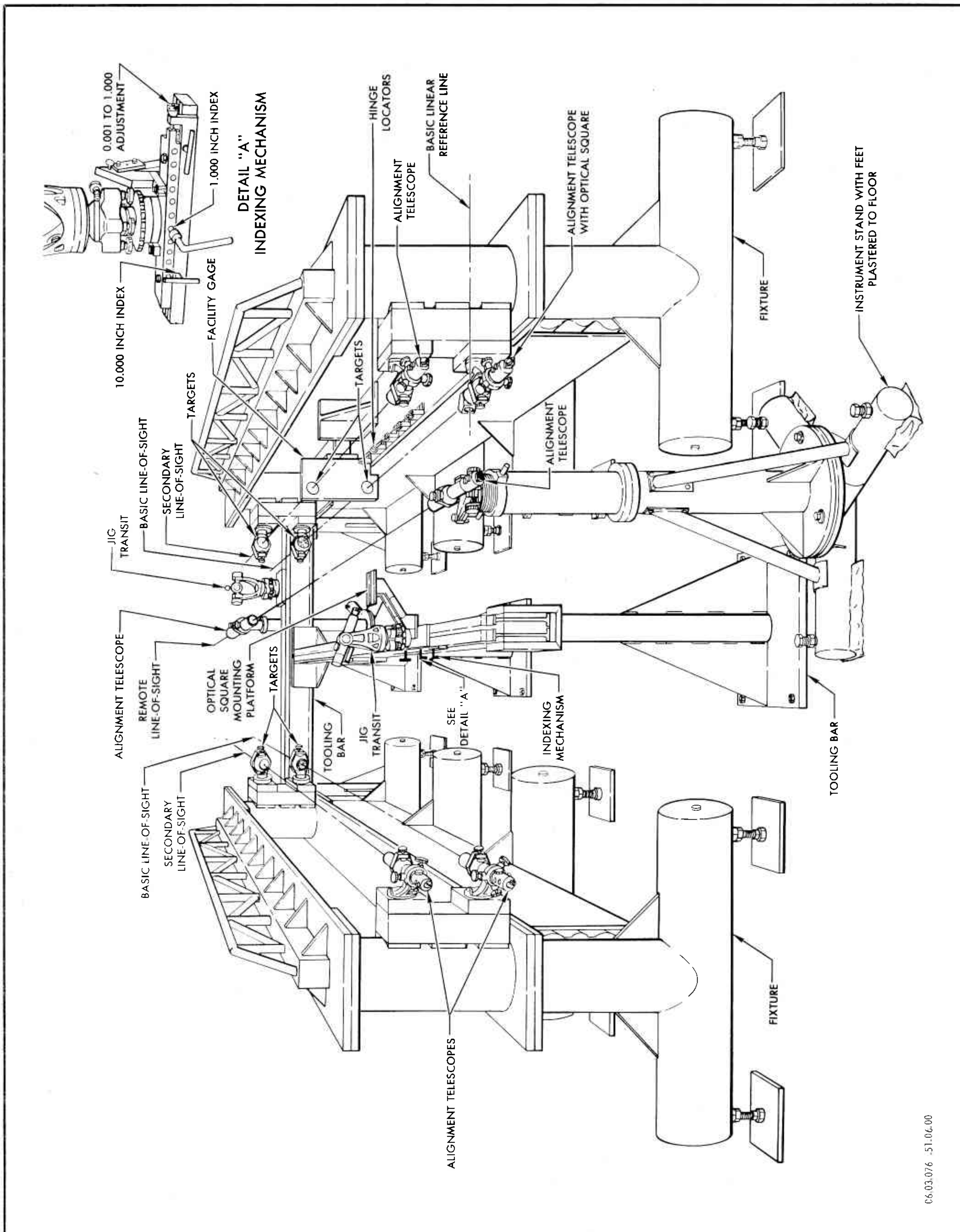


Figure 1-89. Optical Tooling Index Bars Used in "T" Formation

1-316. Tools and Accessories Required (Cont).

FIGURE	QUANTITY	NAME	PART NUMBER		
1-85	1	Cup mount base, adjustable.	Farrand No. 87955	or	Keuffel & Esser No. 9099-54 or equivalent
1-85	2	Spherical mount.	Farrand No. 88291	or	Keuffel & Esser No. 9099-53 or equivalent
1-85	2	Target, plastic, 2¼-inch diameter.	Farrand No. 88242	or	equivalent
1-85	3	Cup mount clamp.	Farrand No. 31354		Keuffel & Esser No. 9099-54½ or equivalent
1-90	1	Instrument stand, standard height.	Keuffel & Esser No. 9092-20	or	Brunson Mod. 230-2 or equivalent
1-85	1	Tilting (Dumpy) sight level equipped with	Keuffel & Esser No. P-5022	or	equivalent
	1	Prismatic level and	Keuffel & Esser No. 5097-46A	or	equivalent
	1	Optical micrometer.	Keuffel & Esser No. 9092-7	or	equivalent
1-82	2	Alignment telescope.	Farrand No. 95360	or	equivalent
1-88	3	Optical square.	Farrand No. 88305	or	Farrand No. 88183 or equivalent

1-317. Procedure.

a. Move the tooling bar alongside the level fixture and parallel to the fixture basic line-of-sight. The basic line-of-sight setting procedure is outlined in paragraph 1-296. Locate the tooling bar at a minimum distance of five to six feet from the fixture basic line-of-sight. Position the tooling bar so that one of its end cup mounts is located at an approximate right angle to the alignment telescope cup mount on the fixture. (The tooling bar will be moved to a more precise relationship with the fixture in the steps that follow.) Check for an approximate parallel with as much accuracy as may be determined by direct measurements between the long axis of the tooling bar and the fixture basic line-of-sight, with a steel tape or other mechanical measuring device.

b. Set a spherical mount containing a target on each of the two cup mounts on the tooling bar, one at each end. Secure the spherical mounts with cup mount clamps.

c. Position the instrument stand alongside the tooling bar and level targets on tooling bar ends to a horizontal plane by means of the sight level. Refer to paragraph 1-280 for the sight level operating procedure. The tooling bar elevation may be above or below the fixture basic line-of-sight but both of them must be level.

d. Remove the spherical mount and target and mount an alignment telescope on one end of the tooling bar (opposite the alignment telescope mounted on the fixture) and aim for the target on the other end of the tooling bar. Establish a reference line-of-sight on the tooling bar.

e. Secure an optical square on the objective ends of both alignment telescopes, one on the tooling bar and one on the fixture. Rotate both of the squares so that the exit sighting axis of one square is aimed at the exit opening of the opposite square. Both telescopes and both squares must be of the same type in order that the line-of-sight between them will be located at the same distance from the telescope cup mounts. See figure 1-88 for an illustration of the optical square.

f. Insert telescope internal illuminating light (see figure 1-82) in each of the telescopes. Designate the fixture telescope as scope No. 1 and the telescope on the tooling bar as scope No. 2.

g. Turn on the light in scope No. 2.

h. Sight through scope No. 1 and adjust the focusing knob until the target on the front glass of the lighted telescope is visible. The path of the line-of-sight will then be through the fixture telescope, through an optical square, across to the square on the tooling bar, and through it to the front glass target of scope no. 2 Revolve the telescope on its optical axis in the cup mount until the telescope horizontal cross hair is superimposed on the center of the target image.

i. Turn off the light in scope No. 2 and turn on the light in scope No. 1. Sight through scope No. 2 and repeat step "i." Alignment of both of the optical squares in one plane is then established.

j. Move the base of the tooling bar assembly slightly along the long axis of the tooling bar until the telescope vertical cross hair is superimposed on the center of the front glass target image. This will establish the spherical mounts of both telescopes on the same station plane.

k. Collimate by turning the focusing knobs on both telescopes to infinity and sighting through scope No. 2 to scope No. 1. The cross hairs of the tooling bar telescope should be superimposed on the faint image of the cross hair from within the telescope on the fixture. Make final adjustment by slightly moving the tooling bar until both the vertical and horizontal cross hairs are aligned. The parallel alignment of the fixture and the tooling bar lines-of-sight is then assured.

l. Mount a third telescope (designate as scope No. 3) with an optical square attached to its objective end on the index slide unit on the tooling bar. Adjust the telescope until its sighting axis is aimed at the objective end of scope No. 2.

m. Turn on the light in scope No. 2 and remove the screw-type covers from the ends of the optical squares on scopes No. 2 and No. 3. See figure 1-88.

n. Collimate by turning the focusing knobs on scopes No. 2 and No. 3 to infinity and adjusting the slide unit telescope aim until the cross hairs in both telescopes are superimposed on each other. The slide unit telescope sighting axis will then be parallel to the sighting axis of the end telescope on the tooling bar.

o. Index the slide unit to the desired station setting and recheck collimation of the two telescopes on the tooling bar.

p. Replace the screw-type cover on the slide unit optical square and rotate the square by revolving the telescope in the cup mount until the desired station point on the fixture is visible.

q. Recheck collimation by again removing the square cover on scope No. 3 and sighting to the end telescope. The right angle plane to the fixture basic line-of-sight is now established.

1-318. The Contour Plate and the Facility Gage.

1-319. The contour plate is similar to the facility gage in function but is designed to fix a contour outline, whereas the facility gage is designed to locate specific points on the fixture. The contour plate and the facility gage are tailored to the specific requirements of the fixture being constructed. They are designed for the purpose of fixing airplane reference points at the proper location in the fixture and with the proper relationship to the line or lines-of-sight. They serve as a link or mechanical extension from the line-of-sight to locate fixture details at precise airplane reference points. They must be made of metal of sufficient thickness to insure dimensional stability. They may be of any shape or size needed to incorporate a target or targets in one or more lines-of-sight and to incorporate one or more reference points of the airplane assembly to be constructed. These tools may be set or fixed in the line-of-sight at any point between the target and the telescope, keeping in mind that most telescopes have a minimum focal length of from 10 to 20 inches forward of the objective end of the telescope. Therefore, the nearest detail to the telescope must be located at a distance slightly more than the minimum focal length. See figure 1-89 for an illustration of a typical facility gage and figure 1-86 for an illustration of a typical contour plate.

1-320. Preparation of the Contour Plate or Facility Gage.

1-321. Dimensions, materials, hole locations and other pertinent details for fabrication of contour plates and facility gages are generally called out on the tool design specification for the fixture under construction. Frequently the jig builder will be required to design and build supplementary facility gages or contour plates to accomplish the job in hand. A contour plate is indicated if, for example, a contour outline is to be established at a fixture station point. The contour plate is prepared by selecting a thick sheet of metal, preferably aluminum, and shaping the edge of the sheet to the desired contour outline. The edge of the contour plate is shaped to the skin or bulkhead contour by inscribing the contour outline on the sheet and trimming away the portion of the plate outside the skin. Target mounting holes are jig-bored to 1½-inch diameter at a point or points where the target center will intersect one or more lines-of-sight. A facility gage is indicated when it is desirable to fix a specific point on a fixture detail such as a hinge point, which will be installed on the fixture at a point not intersecting the line-of-sight. The facility gage must be designed to bridge the gap between a point on the detail and the line-of-sight. These gages are usually a flat metal plate having one or more 1½-inch diameter target mounting holes to intersect the lines-of-sight and one or more dowel pin holes to match identical holes in the detail. Both the facility gage and the contour plate may be mounted to the detail or fixture by dowel pins or by a surface that coincides with a related surface on the detail or fixture.

1-322. Establishment of the Contour Plate or Facility Gage in the Fixture.

1-323. The following procedure will locate and fix a contour plate or facility gage in the fixture in the proper relationship to the line-of-sight:

1-324. Tools and Accessories Required.

FIGURE	QUANTITY	NAME	PART NUMBER
1-90	As required	Target, plastic, 1½-inch diameter.	Farrand No. 88383 or Keuffel & Esser No. 8013956 or equivalent

1-325. Procedure.

a. Establish the line-of-sight by mounting an alignment telescope at one end of the fixture and a target at the opposite end. Refer to paragraph 1-297 for procedure.

b. Mount the small plastic target by pushing it into the 1½-inch diameter hole in the contour plate or facility gage. If more than one line-of-sight is employed, additional targets are mounted as indicated.

c. At a point beyond the telescope minimum focal length between the telescope and the target secure the contour plate or facility gage to the detail or fixture with C-clamps.

d. Adjust the contour plate or adjust the facility gage and the detail by movement in vertical and horizontal directions until the telescope cross hairs are centered on the bullseye of the target mounted in step "b." Two men are required for this operation.

e. Bolt and dowel pin the detail in place.

f. Recheck telescope sighting on contour plate or facility gage target.

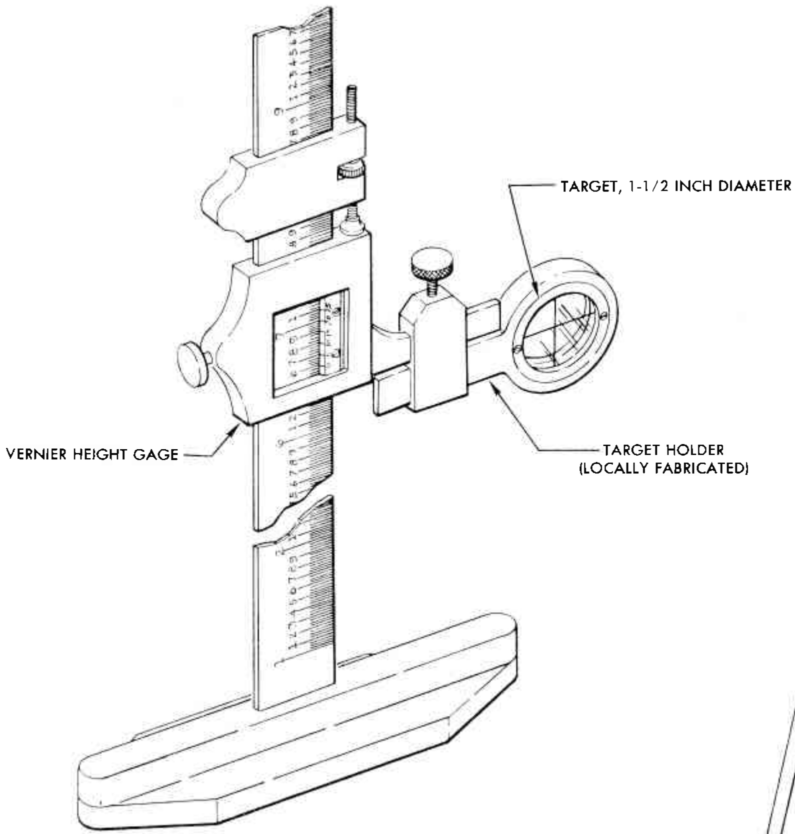
g. Remove the 1½-inch diameter target from the facility gage or contour plate and recheck the telescope sighting on the target at the end of the fixture.

1-326. Establishment of Vertical Planes Either Parallel or 90 Degrees to the Basic Line-of-Sight.

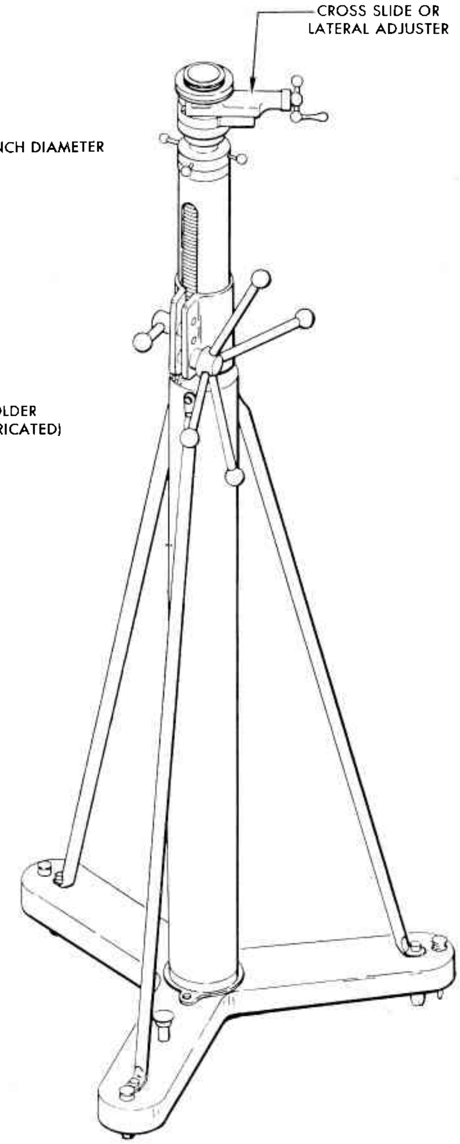
1-327. Fabrication of several fixtures simultaneously may be expedited by utilizing two tooling bars and a remote line-of-sight. The remote line-of-sight established in this procedure is separate from the indexed tooling bars to allow the tooling bar to serve as a mounting stand for more than one jig transit. The tooling bars are located to form a "T," one bar parallel to the remote and the fixture basic lines-of-sight and the other at right angles to the lines-of-sight. This setup permits rapid changes from one vertical plane either parallel or at right angles to the lines-of-sight, and maintaining precise linear dimension control by use of the indexing mechanism on the tooling bars. An understanding of the previous paragraphs describing the use of the four basic instruments, i.e., sight level, jig transit, alignment telescope, and optical square, is a prerequisite to setting up this optical system. See figure 1-89 for an illustration of this system.

1-328. Tools and Accessories Required.

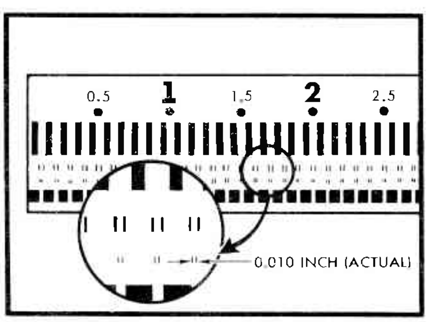
FIGURE	QUANTITY	NAME	PART NUMBER
1-89		Tooling bar, with indexed slide unit.	Fabricate locally
	1	Jig transit, equipped with	Brunson Mod. 71 or equivalent
1-81		Prismatic level, and	Brunson No. 174 or equivalent
	2	Mirror, horizontal axis, autoreflection.	Brunson No. 189 or equivalent



VERNIER HEIGHT GAGE, TARGET, AND HOLDER COMBINATION



INSTRUMENT STAND, WITH CROSS SLIDE



WYTEFACE SCALE

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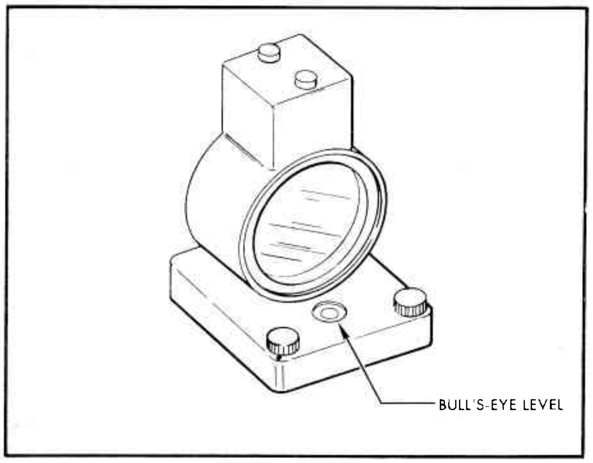
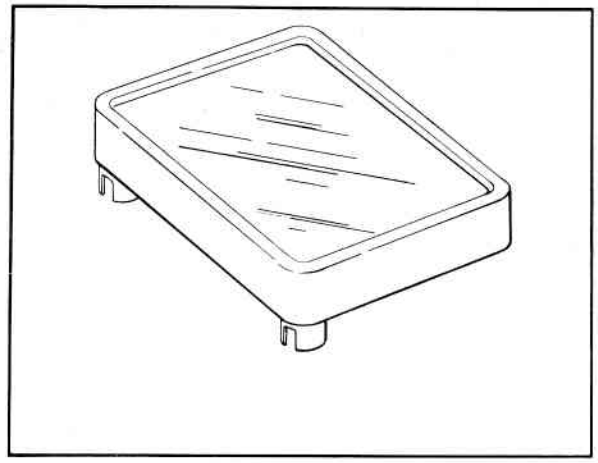
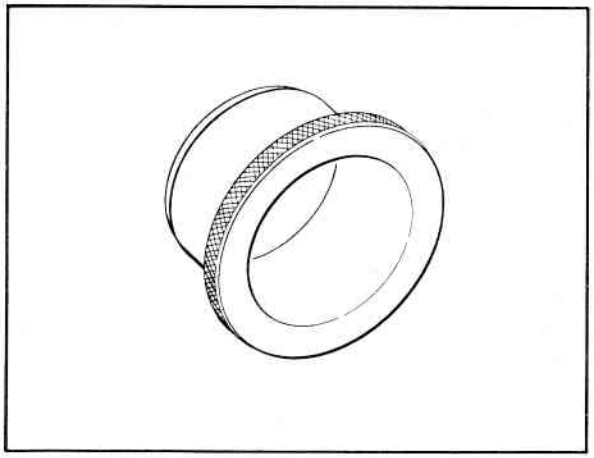
Figure 1-90. Optical Tooling Accessories (Sheet 1 of 2)



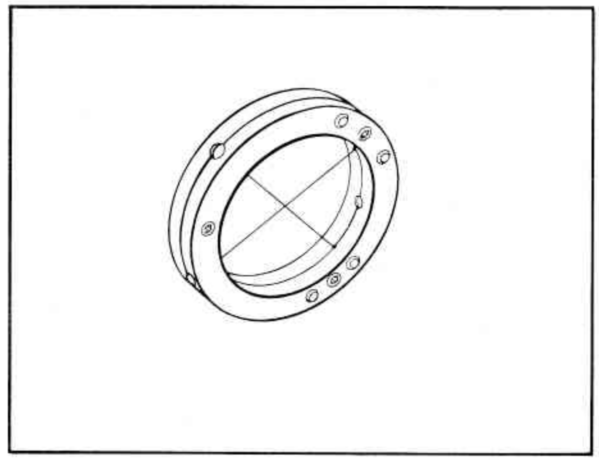
VERTICAL MIRROR



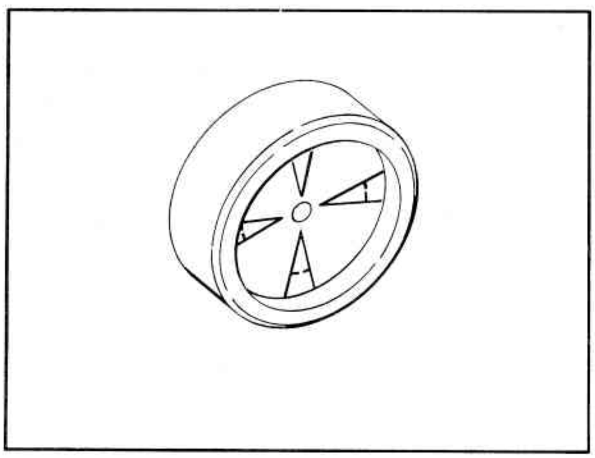
MAGNETIC MIRROR



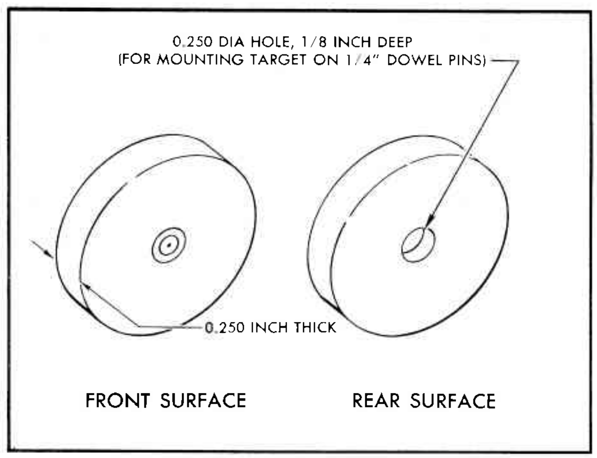
TARGET POSITIONING TOOL



CROSS WIRE TARGET



GLASS TARGET



PLASTIC TARGET, 1-1/2 INCH DIAMETER

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Figure 1-90. Optical Tooling Accessories (Sheet 2 of 2)

1-329. Procedure.

a. Establish a remote line-of-sight in the most practical location available in the work area to allow fixture construction on both sides along the line-of-sight. Refer to paragraph 1-300 for tools required and a step-by-step procedure. Plaster stand bases to floor.

b. Position one of the tooling bars on either side parallel to the remote line-of-sight. Accomplish parallel alignment by scale measurement. Locate the center line of the tooling bar about 13 inches from the remote line-of-sight.

c. Adjust the height of the tooling bar top surface to a position about 15.625 inches below the remote line-of-sight. This dimension will compensate for the height of the slide unit, mounting adapter and the jig transit. Level bar with a sight level. Refer to paragraph 1-280 for tools required and the procedure for leveling tooling bar. Plaster bases of bar to floor.

d. Position the second tooling bar at right angles to the first tooling bar so as to form a letter "T." Adjust the height of the top surface of the bar and the level to the same horizontal plane as established for the first tooling bar in the previous step.

e. Mount a jig transit equipped with axis mirrors on the second tooling bar with the slide unit moved near a point midway between the bar ends and so the axis mirrors intersect the remote line-of-sight. Align the sighting axis of the jig transit with the center line of the second tooling bar by "plunging" transit telescope to sight on first one end and then the opposite end of the center line. Compensate until center line of transit is on center line of bar. Refer to paragraph 1-293 for operational procedure of the jig transit.

f. Sight through the remote line-of-sight alignment telescope and square the second tooling bar by autoreflection from the jig-transit axis mirror. Move tooling bar slightly until the alignment telescope cross hairs are superimposed on the reflected target image of its front glass target. Refer to paragraph 1-304 for a detailed procedure employing autoreflection from the jig transit axis mirror. Plaster bases of bar to floor.

g. Move fixtures into position parallel to the remote line-of-sight. Parallel alignment is established by direct measurement with steel tape. Locate the fixtures at a minimum distance of five or six feet from remote line-of-sight, allowing a two-foot clearance between the end of the fixture and the second tooling bar. Establish a basic line-of-sight on the fixture and level fixture with the sight level. Refer to paragraph 1-297 for tools required and procedure for setting the basic line-of-sight.

h. Establish vertical planes on the fixture by mounting optical squares in the remote line-of-sight and collimating to jig transits mounted on the tooling bar. Refer to paragraph 1-312 for procedure and tools required for this operation.

1-330. Procurement of Instruments and Accessories.

1-331. Optical instruments and their accessories which have been mentioned in the foregoing procedures may be obtained by contacting the following manufacturers:

Brunson Instrument Co.
1405 Walnut St., Kansas City, Missouri

Farrand Optical Co., Inc.
Bronx Blvd & East 238 St., New York 70, N.Y.

Keuffel & Esser Co.
Hoboken, New Jersey

Taylor, Taylor & Hobson Ltd.
Stoughton St., Leicester, England

1-332. GLOSSARY OF OPTICAL TOOLING TERMS.

ABERRATION—The failure of rays of light to converge to a focal point passing through a lens.

ALIGNING BRACKET—A clamping and/or adjusting device which holds an optical instrument on its mounting base and permits alignment of this instrument with a predetermined line-of-sight.

ALIGNMENT TELESCOPE—A telescope containing cross hairs with its optical axis coinciding to the center of the bore of the tube. Provisions for mounting the telescope on a standard spherical mount are also incorporated on the scope.

AUTOCOLLIMATION—The process of establishing 90-degree angles by means of a mirror which reflects the telescope reticle. The angular deviation is measured by the amount of displacement of the reflected cross hairs from the original reticle.

AUTOREFLECTION—The process of checking 90-degree angles to the line-of-sight by using a mirror to reflect the image of a target placed at the objective lens of the telescope. The image is observed through the telescope.

BUCKING IN—To bring the telescope optical axis into alignment with two or more predetermined points.

CLAMP, SPHERICAL MOUNT—A clamping device which holds a spherical mount on the mounting base.

COLLIMATE—To bring into line; to make parallel.

COLLIMATION LINE—The correct line-of-sight or the optical axis of a telescope. Refer to line-of-sight definition.

COLLIMATOR, JIG—A transit type instrument used to establish vertical planes, also referred to as a jig transit.

COLLIMATOR, OPTICAL—A ground tubular instrument containing a displacement graticule, a diffusing lens, a colored filter, and a light source, used for determining deviations from the line-of-sight.

ERECTION LENS—A lens placed between the eye piece and objective lens of a telescope to give normal appearance of the object viewed. Without the erection lens the image would appear to be upside-down.

FOCUS—The point at which light rays converge after being refracted by a lens; also the act of adjusting an optical instrument so that the eye may see an image clearly.

GRATICULE, DISPLACEMENT—The graduated pattern of an optical target which is used to detect or measure horizontal and vertical displacement.

GRATICULE, TILT—The graduated pattern of an optical target which is used to detect and measure angular deviation.

INCIDENCE, ANGLE OF—The angle formed between a ray of light which strikes a surface and an imaginary perpendicular to the surface from that point.

LEVEL, OPTICAL (Sight Level)—A telescope with spirit level attached. The level is parallel to the optical axis.

LEVEL, PRISMATIC—A spirit level with a prism and mirror device for viewing the level bubble to give the appearance of two half-bubbles, which, when brought into coincidence, assures a level position.

LEVEL STRIDE—A spirit level mounted on vee-shaped legs; used for leveling tubular objects.

LINE-OF-SIGHT, BASIC—An optical reference line established by means of an alignment telescope and target mounted in a permanent location on the jig; the line-of-sight from which secondary or auxiliary lines-of-sight are determined.

LINE-OF-SIGHT, REMOTE—An optical reference line established by means of an alignment telescope and target mounted in a separate temporary location on instrument stands or on a tooling bar near the jig.

MONOCHROMATIC LIGHT—A light which gives off a single color light, all the rays of which are of approximately the same wave length.

MOUNTING BASE, ADJUSTABLE—A pedestal type base with a female cone for supporting spherical mounts. This base is normally mounted permanently to the tool being set optically.

MOUNTING BASE, FIXED—A pedestal-type base with a female cone for supporting spherical mounts. This base is nonadjustable and is normally mounted permanently to the tool being set optically.

OBJECTIVE LENS—The lens at the end of a telescope which is normally presented toward the object viewed; the lens which receives the light from the object.

OPTICAL FLAT—A section of fused quartz or glass, ground and polished flat. Opposite faces are parallel within close tolerances. It can be mounted in an optical instrument to displace the line-of-sight. It can be used to measure the flatness of smooth surfaces using the principal of interference of visible light.

OPTICAL MICROMETER—A calibrated device used to provide and measure refracted rays of light within certain limits.

OPTICAL MIRROR—A front surface mirror which is flat within extremely fine tolerances.

OPTICAL REFERENCE PLANE—A plane determined by any two lines-of-sight.

OPTICAL SQUARE—Any optical instrument which will turn the line-of-sight 90 degrees from its original path.

OPTICAL TOOLING—A tooling system using precision optical instruments to establish and maintain lines-of-sight as reference lines.

PARALLAX—The apparent movement of the cross hairs of an instrument across the image of the object being viewed when the eye is moved; caused by cross hairs and image not being in same focus.

PENTA-PRISM—A five-sided prism which bends a ray of light at a 90-degree angle.

PHYSI-OPTICAL—A mensuration or measurement system combining features of both optical and physical methods of measurements.

PLANIZE—To erect a perpendicular to a line-of-sight.

PLUNGE—To rotate jig transit telescope 180 degrees in vertical plane.

PRISM—A transparent body bounded in part by two plane surfaces which are not parallel.

REFLECTION, ANGLE OF—The angle between the line-of-sight and a line perpendicular to the surface of the reflecting medium.

REFRACTION—The bending of light rays passing obliquely through materials of different optical densities, i.e., air and water, air and glass.

RESOLUTION—The ability of a lens or an optical system to distinguish between two adjacent points. Resolution is often expressed in terms of the minimum angle between two points that can definitely be resolved or separated.

RETICLE OR RETICULE—The pattern of an optical target or cross hair used to establish alignment.

SPHERICAL MOUNT—A steel sphere bored through the center to permit the mounting of optical instruments on the axis of the sphere. Refer to Specification N.A.S. 900.

TARGET, OPTICAL TOOLING—A mounted graticule, reticle or other device for determining accurate positions when viewed by a telescope or other optical instrument.

THEODOLITE—An instrument identical in function to a transit.

TRANSIT—An instrument which permits the establishment of horizontal, vertical, or inclined lines-of-sight and capable of measuring angles between lines-of-sight in the horizontal and vertical planes. Normally used in surveying.

TRANSIT, JIG—A transit type instrument used to establish vertical planes.

1-333. SUPPORT OF STRUCTURE DURING REPAIR.

1-334. When planning a major repair requiring removal or replacement of a structural component, two important factors must be considered:

a. Support of the part to be repaired or replaced during working operations.

b. Support of adjacent structure subject to static loads when damaged component is removed.

The airplane can be supported adequately by the landing gear and/or jacks in cases where repair work is to be accomplished on removal components, except the wings. To remove or replace wings, use a cradle designed for support of fuselage structure as shown on figure 1-91. Removal components may be supported on sawbucks padded with small sandbags. The sandbags should measure about 8 by 12 inches with parallel seams spaced every 2 inches so the sand will readily conform to the contour of the component placed upon it. An adequate number of padded sawbucks and sandbags spaced from 3 to 5 feet apart to avoid possible distortion of the component involved should be employed under spars, bulkheads, or other main structural members of the component. For built-up repair support fixtures, refer to Sections II and IV.

1-335. MAJOR COMPONENTS — F-106A AND F-106B.

1-336. The F-106A and F-106B airplanes are broken into 29 major comoponents as shown on figures 1-92 and 1-93. Each of the major components is designated by name and by a Convair engineering blueprint number.

1-337. IN-SERVICE USE CRITERIA.

1-338. Refer to paragraphs 1-78 through 1-82.

1-339. WEIGHT AND CENTER OF GRAVITY.

1-340. General.

1-341. Gross weight and balance must be maintained within stipulated limits. Therefore, the weight of materials used to repair the airplane structure must be held at the minimum consistent with design requirements. Refer to Table 1-L for airplane and airplane component weights. It is important that accurate records of all repairs which affect weight and balance be maintained in accordance with T.O. 1-1B-40.

1-342. Basic Weight.

1-343. The basic weight of an airplane is that weight which includes all fixed operating equipment and trapped fuel and oil, to which it is necessary to add only the "variable" or "expendable" load items. Basic weight changes with structural modifications and may vary widely between airplanes of the same model. Basic weight plus the variable items which remain constant for a certain mission, including oil, crew and emergency equipment, is referred to as the operating weight.

1-344. Gross Weight.

1-345. The gross weight of an airplane is the total weight of the airplane including all variable items and modifications. Takeoff gross weight is the operating weight plus the expendable load items. Landing gross weight is takeoff gross weight less the expendable load items.

1-346. Moment.

1-347. Moment is the weight of an item multiplied by its arm. Arm of an item is the horizontal distance in inches from the reference datum and center of gravity of the item. Average arm is that distance obtained by adding the weights and moments of a number of items and by dividing the total moment by the total weight. Basic moment, when using data from an actual weighing of the airplane, is the total moment of the basic airplane in respect to the reference datum.

1-348. Reference Datum.

1-349. Reference datum is an imaginary vertical plane, at or forward of the nose of an airplane, from which all horizontal distances are measured for balancing purposes. The horizontal reference datum for F-106A and F-106B airplanes is located at station 0.0 which is 103.23 inches aft of the tip of the nose boom. The vertical reference datum for F-106A and F-106B airplanes is 100.00 inches below waterline 0.0.

1-350. Center of Gravity.

1-351. The center of gravity of an airplane is that point about which it would balance if suspended. The center of gravity distance from the reference datum is obtained by dividing the total moment by the gross weight of the airplane. Limits are the extremes of movement which the center of gravity may have without resulting in the airplane becoming unsafe to fly. The center of gravity of a loaded airplane must be within these limits at takeoff. Refer to Table 1-LI for airplane center of gravity information.

1-352. PACKING AND CRATING.

1-353. High-value components, such as the radome, fin tip, rudder, elevons, etc., must be packed and crated to prevent further damage when shipped to repair facilities. The crate or container in which the new part is received should be used for this purpose. Care must be exercised when serviceable components are removed from shipping crates. The correct disassembly sequence must be followed to prevent unnecessary damage to the crate, and all

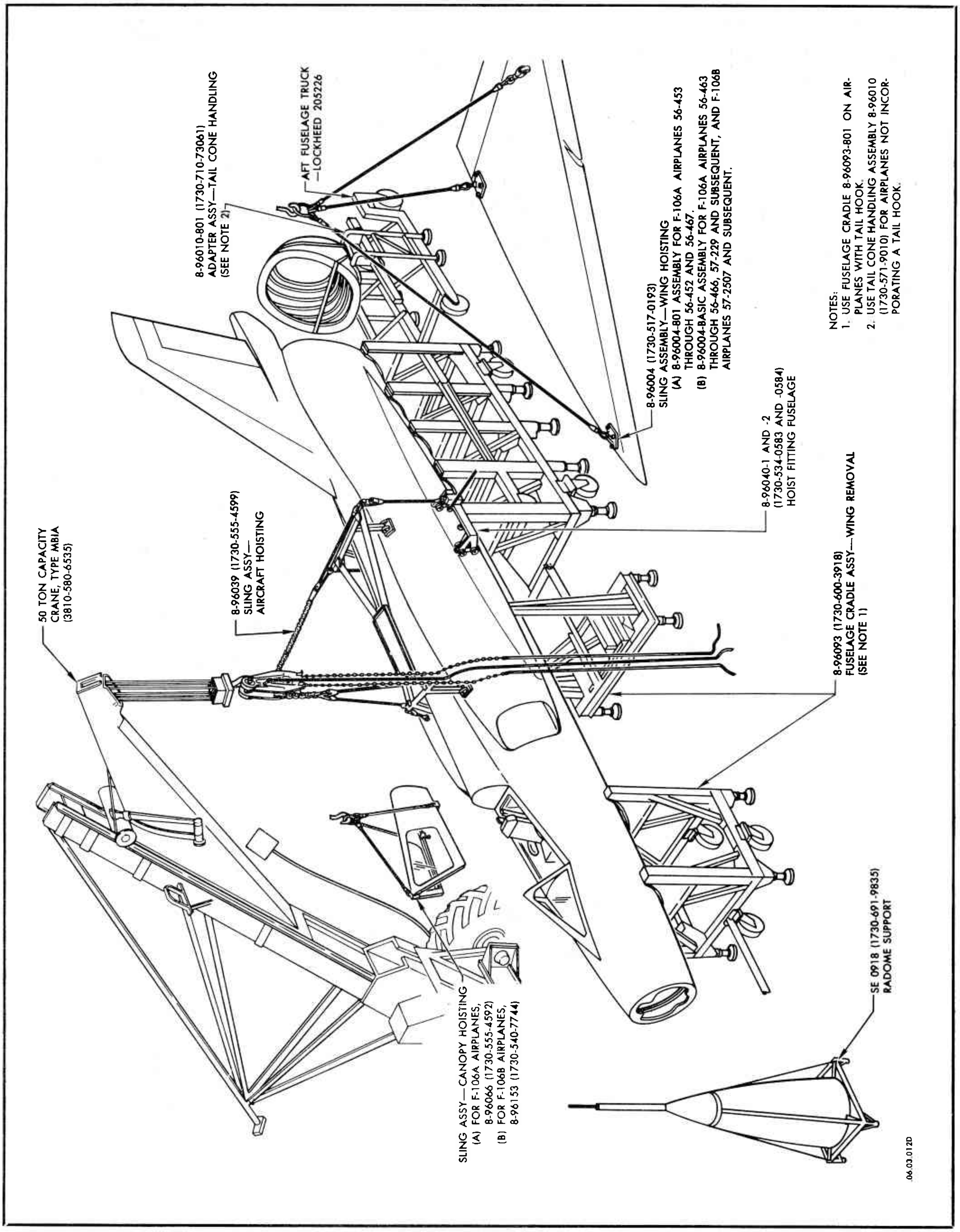


Figure 1-91. Airplane Handling Equipment

KEY	FIGURE NUMBER	NOMENCLATURE	ENGINEERING DRAWING NO.
1.	2-1	WING LEADING EDGE	8-18230
2.	2-1	WING FORWARD TANK	8-18030
3.	2-1	WING TIP	8-18910
4.	2-1	WING AFT TANK	8-18032
5.	2-1	WING TRANSFER TANK	8-18033
6.	2-1	ELEVON	8-13020
7.	3-1	FIN LEADING EDGE	8-14230
8.	3-1	FIN STRUCTURE	8-14035
9.	3-1	FIN TIP	8-14540
10.	3-1	RUDDER	8-15041
11.	4-1	SPEED BRAKE AND DRAG CHUTE HOUSING	8-74870
12.	4-1	TAIL CONE STRUCTURE	8-74490
13.	6-1	ENGINF SHROUD	8-22679
14.	4-1	FUSELAGE INSTALLATION	8-74470
15.	4-1	DORSAL FAIRING	8-74498
16.	4-1	DORSAL FAIRING	8-74497
			66J40244 (SEE NOTE 1)
			66J40245 (SEE NOTE 1)
17.	4-1	FUSELAGE INSTALLATION	8-74477
18.	4-1	VARIABLE RAMP INLET DUCT	8-74566
19.	5-1	MAIN LANDING GEAR FUSELAGE DOOR	8-44545
20.	4-1	FUSELAGE INTEGRAL FUEL TANK	8-74430
21.	4-1	FUSELAGE MISSILE BAY DOORS (SEE NOTE 2)	8-74463
21A.	4-1	FUSELAGE MISSILE BAY DOORS, GUN NOT INSTALLED (SEE NOTE 3)	7144550
21B.	4-1	FUSELAGE MISSILE BAY DOORS, GUN INSTALLED (SEE NOTE 3)	7144550
21C.	4-1	M61A1 GUN ENCLOSURE ASSEMBLY (SEE NOTE 3)	7144521
21D.	4-1	M61A1 GUN FAIRING/ASSEMBLY (SEE NOTE 3)	7144522
22.	4-1	FUSELAGE INSTALLATION	8-74405
23.	5-1	NOSE LANDING GEAR DOOR	8-74626
24.	5-1	NOSE LANDING GEAR	8-52003
25.	4-1	FORWARD RADAR ELECTRONICS COMPARTMENT	8-74600
26.	4-1	RADOME	8-70410
27.	4-1	WINDSHIELD AND CANOPY STRUCTURE	8-74800
28.	5-1	MAIN LANDING GEAR WING FAIRING	8-17630
29.	5-1	MAIN LANDING GEAR	8-51013

NOTES:

1. APPLICABLE AFTER INCORPORATION OF TCTO 1F-106-986
2. APPLICABLE PRIOR TO INCORPORATION OF TCTO 1F-106A-558
3. APPLICABLE AFTER INCORPORATION OF TCTO 1F-106A-558
4. TCTO 1F-106A-558 IS APPLICABLE TO F-106A VERTICAL INSTRUMENTED AIRCRAFT

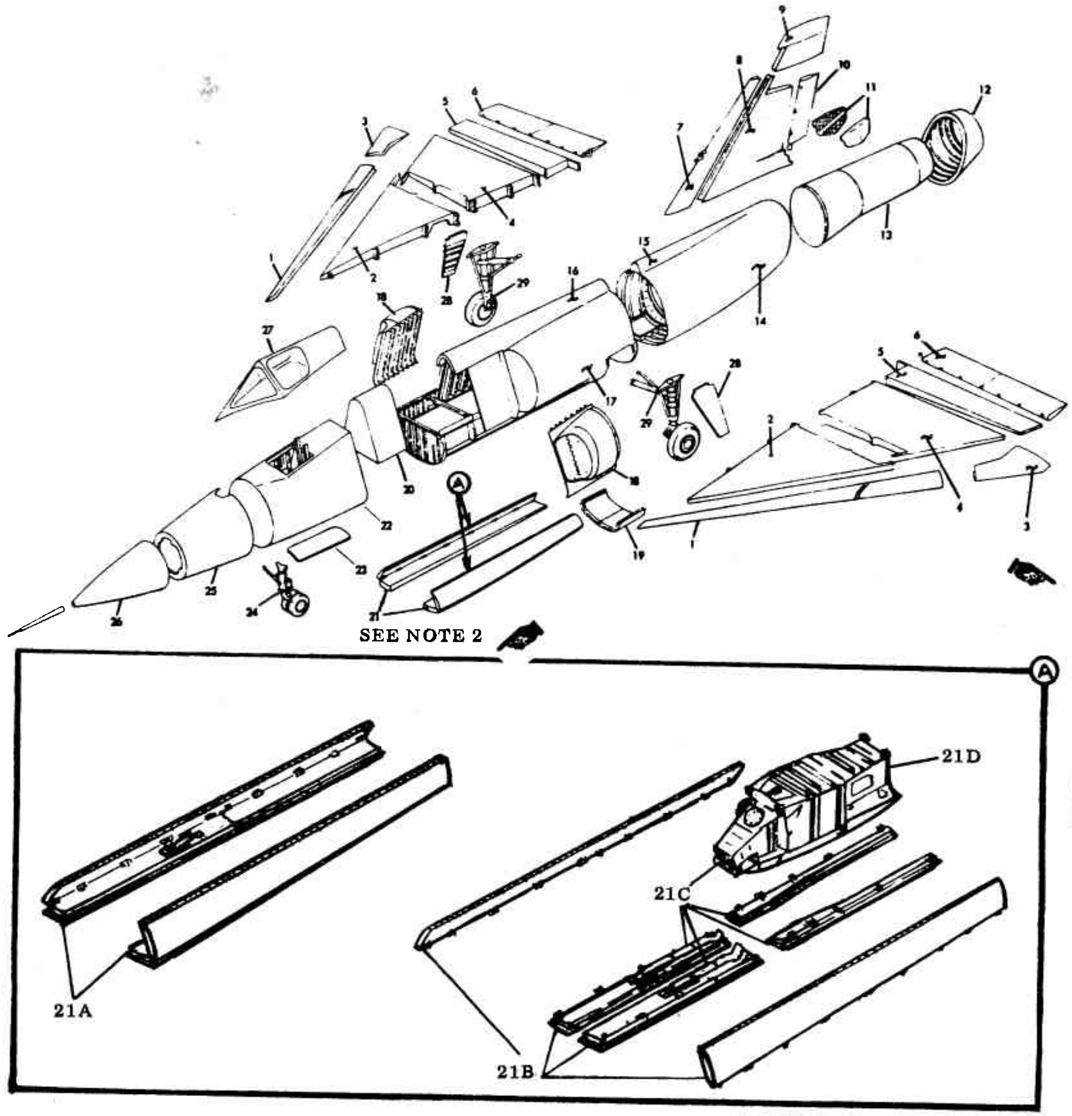
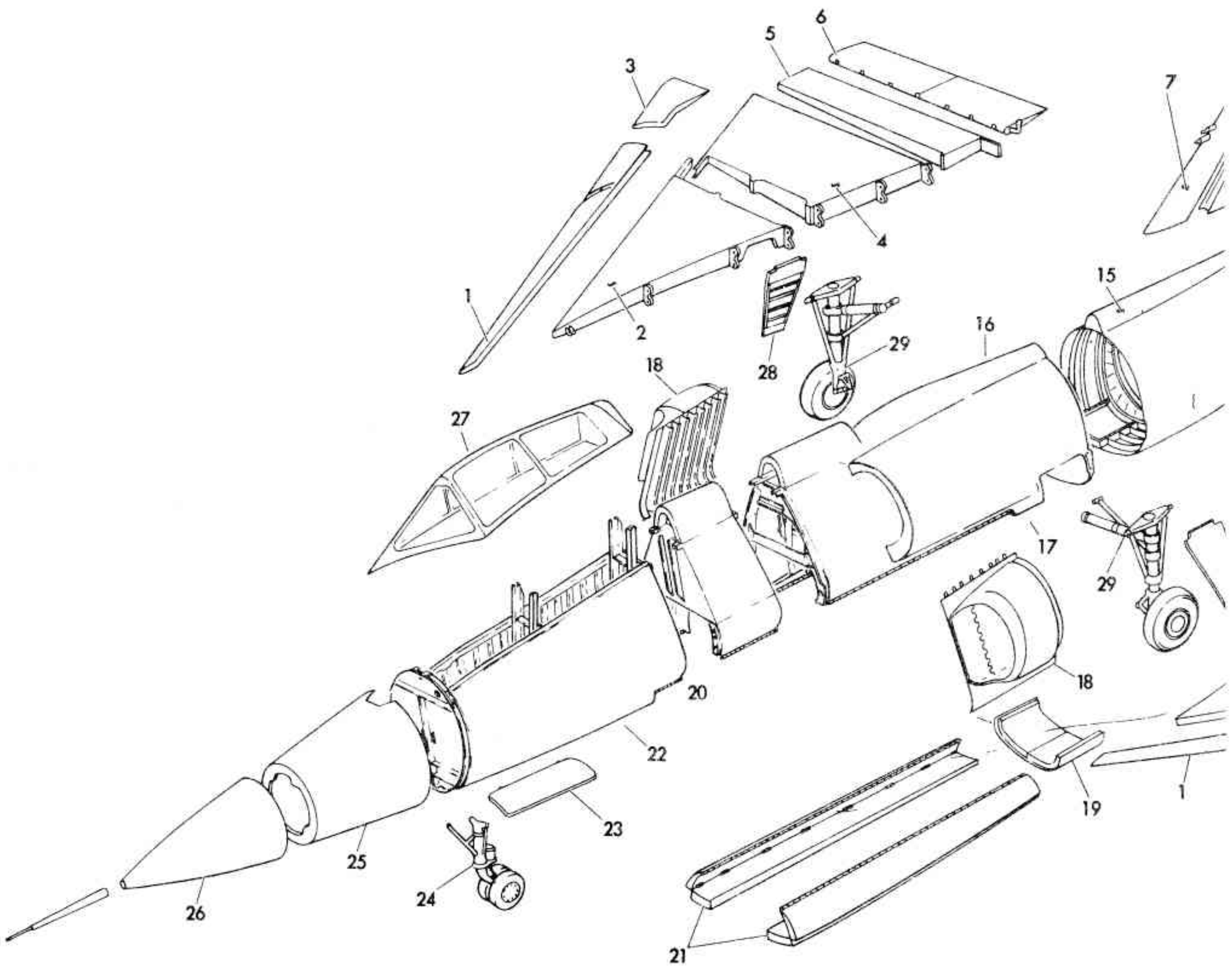


Figure 1-92. Major Components — F-106A



NOTE:
APPLICA

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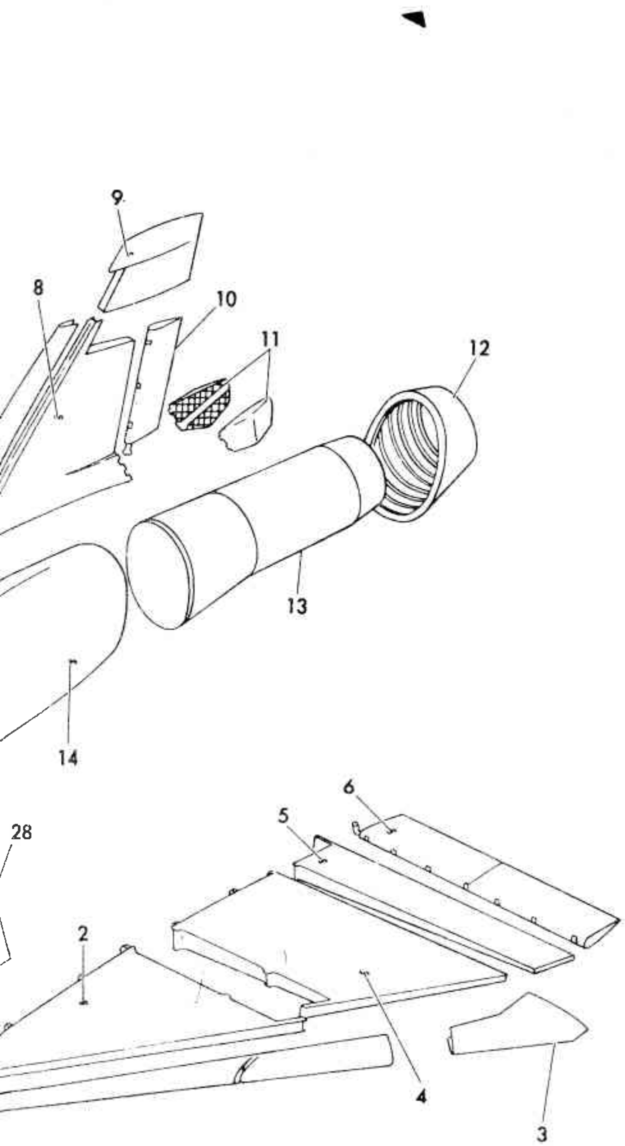


LE AFTER INCORPORATION OF TCTO 1F-106-986.

KEY	FIGURE NUMBER	NOMENCLATURE	ENGINEERING DRAWING NO.
1.	2-1	WING LEADING EDGE	8-18230
2.	2-1	WING FORWARD TANK	8-18030
3.	2-1	WING TIP	8-18910
4.	2-1	WING AFT TANK	8-18032
5.	2-1	WING TRANSFER TANK	8-18033
6.	2-1	ELEVON	8-13020
7.	3-1	FIN LEADING EDGE	8-14230
8.	3-1	FIN STRUCTURE	8-14035
9.	3-1	FIN TIP	8-14540
10.	3-1	RUDDER	8-15041
11.	4-1	SPEED BRAKE AND DRAG CHUTE HOUSING	8-74870
12.	4-1	TAIL CONE STRUCTURE	8-74490
13.	6-1	ENGINE SHROUD	8-22679
14.	4-1	FUSELAGE INSTALLATION	8-74470
15.	4-1	DORSAL FAIRING	8-76501
16.	4-1	DORSAL FAIRING	8-76498 66J40240 (SEE NOTE)
17.	4-1	FUSELAGE INSTALLATION	8-76002
18.	4-1	VARIABLE RAMP INLET DUCT	8-74568
19.	5-1	MAIN LANDING GEAR FUSELAGE DOOR	8-44545
20.	4-1	FUSELAGE INTEGRAL FUEL TANK	8-76467
21.	4-1	FUSELAGE MISSILE BAY DOORS	8-74663
22.	4-1	FUSELAGE INSTALLATION	8-76003
23.	5-1	NOSE LANDING GEAR DOOR	8-74626
24.	5-1	NOSE LANDING GEAR	8-52003
25.	4-1	FORWARD RADAR ELECTRONICS COMPARTMENT	8-74600
26.	4-1	RADOME	8-70410
27.	4-1	WINDSHIELD AND CANOPY STRUCTURE	8-74800
28.	5-1	MAIN LANDING GEAR WING FAIRING	8-17630
29.	5-1	MAIN LANDING GEAR	8-51013

Figure 1-93. Major Components — F-106B

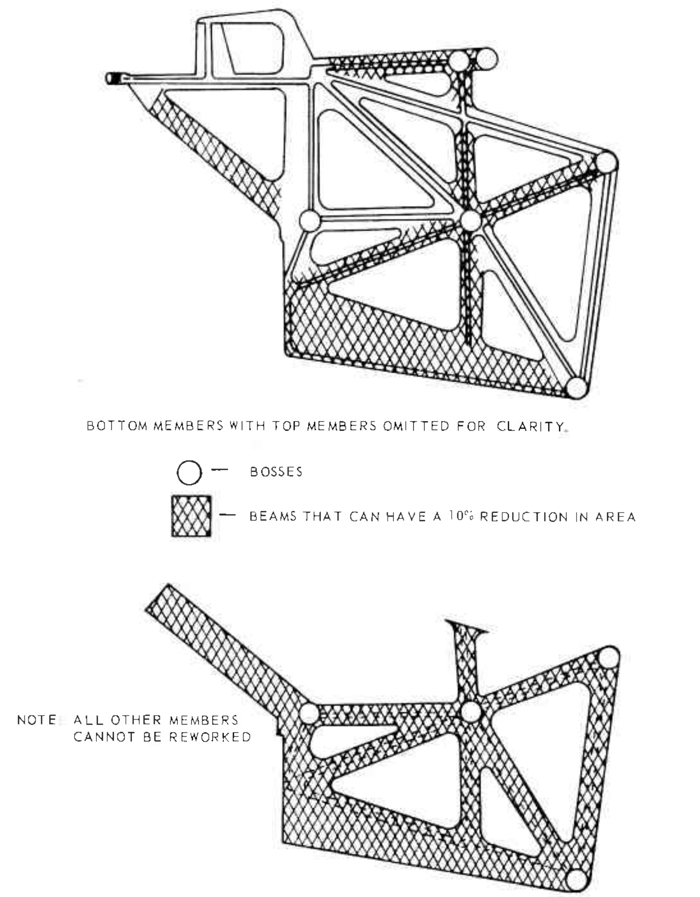
attaching parts and hardware held to recrate the old part. Unless otherwise specified, all shipping crates are marked in accordance with Military Standard MIL-STD-129. The words "Removable End—Reversible Crate" are stenciled on both ends. Heavy crates have the words "Sling Here," and "Centef of Balance" stenciled in their proper places. All bearings and bearing surfaces of components must be cleaned. Use a clean cloth and a solvent conforming to Federal Specification P-S-661 to remove dirt, metal chips, or other foreign substances. After cleaning, the lubricant normally used in service should be applied and the bearing or bearing surface covered with a greaseproof barrier material conforming to Military Specification MIL-B-121. Unless authorized to the contrary, the repairable component should always be packed and crated to the same configuration in which the serviceable component was received. Should repair or manufacture of crates be necessary, instructions and procedures provided in this manuel should be followed. These instructions are explained and illustrated at the end of the section in which the component is discussed. Should airlift of components be necessary, Table 1-LII provides dimensions, weights, and center of balance data for detached, uncrated components.

1-354. REWORK OF REPLACEMENT PARTS.

1-355. Some replacement parts and assemblies drawn from stock require a small amount of rework in order to fit. This is due to manufacturer's tolerances or engineering changes to the parts. Table 1-XLIX lists the part number, nomenclature and brief instructions for reworking or fitting these parts and assemblies. Parts are listed by part number numerical sequence.

1-356. Repair of Bellcrank Part Numbers 8-42694-5 and 8-42694-6.

1-357. Loose bushings in flight control bellcranks may be reworked by handwelding to reduce the bushing hole and remachining the hole to the original size. Heat treatment will be required per MIL-H-6857. This procedure may be used several times to accomplish repairs and will permit reuse of standard size bushings.



THE MEMBERS THAT MAY BE GROUND DOWN TO REMOVE CRACKS AND NICKS ARE INDICATED ON THE ABOVE SKETCH. NO MEMBER MAY BE GROUND DOWN MORE THAN TEN PERCENT OF ITS MINIMUM CROSS-SECTIONAL AREA. THE GRINDING MUST BE DONE IN SUCH A MANNER THAT THE REDUCTION IN CROSS-SECTIONAL AREA WILL BE GRADUAL ALONG THE LENGTH OF THE BEAM. ALL BOSSES IN THE MIXER FRAME MAY HAVE A REDUCTION IN CROSS-SECTIONAL AREA OF FIFTEEN PERCENT.

1-358. WELDING PROCESS CONTROLS.

1-359. Accepted welding practice shall be in accordance with T.O. 34W4-1-5, Welding Theory and Practice and/or T.O. 1-1A-9, Aerospace Metals - General Data and Usage Factors. If additional process details are needed, these are to be furnished to the welding shop in Process Orders in accordance with applicable AFLC directives.

1-360. Weld repair F-106 elevon (mixer) casting.

a. PROBLEM:

1. Surface defects are found on mixer castings after fluorescent penetrant inspection (zyglo).

2. Internal defects may also be present.

b. AUTHORIZE:

Rejected and condemned castings tagged as such will be processed and weld-repaired per instructions contained herein.

c. RESTRICTIONS:

1. The maximum number of weld repair areas per casting shall be four or less.

2. Only one repair area is allowed at each intersection, boss area, or leg strut.

d. MATERIAL IDENTIFICATION:

1. The minor casting is manufactured from magnesium alloy AZ91-HTA, QQ-M-56.

2. The casting classification is ZA, MIL-C-6021.

e. PROCESS:

1. Remove zyglo indication by hand filing or grinding. Periodically zyglo inspect to determine if the defect has been removed.

2. Metal removal shall be performed only on one side of an area. The maximum metal removal shall be one-half the thickness of the member.

CAUTION

Observe precautions as specified in T.O. 1-1A-9, Section IV, for grinding and subsequent welding for magnesium.

3. Clean area to be welded by stainless steel wire brush and vapor degreasing.

4. Locally preheat area at 400°-450° F with a neutral acetylene flame.

5. Weld repair the defective area, using TIG fusion process (heliarc).

(a) Use AZ92 filler rod per MIL-R-6944, and build-up sufficiently for clean up.

6. Stress releive immediately upon completion of one repaired area at 400°-450° F with torch.

7. Hand file or grind repair area to original configuration.

8. Apply a local "brush on" chromic acid treatment to the repaired areas, T.O. 42C2-1-7, Section XIV.

f. QUALITY STANDARD:

1. Radiographic inspection of the welded areas shall show no cracking.

2. The repaired casting shall have no warpage or distortion that would prevent proper installation.

1-361. Stylus plating elevon troque tube plug.

a. PROBLEM:

Some elevon torque tubes (part No. 8-42365 and part No. 8-48348) are unserviceable due to wear and gouges in the bearing surface of the plugs (part No. 8-23467). The defects in the aluminum base bearing surface can be eliminated by stylus plating as a means of restoring the plug to a serviceable condition. See paragraph g.3.

b. AUTHORIZE:

The following materials equipment and process details for stylus plating bearing surfaces of plugs (Part No. 8-42367).

c. MATERIALS.

1. Anodes, special high purity, high density graphite, (6810-201-7030).

2. Cotton batting, U.S.P. long fiber, lint free, surgical grade 1, (6510-201-7030).

3. Gauze, surgical tube, (6510-200-7010, 7015- and 7020).

4. Tape, electroplaters', (8135-833-7311).

5. "Electro Coated" abrasive paper, grit 120 through 600, (6350). No substitute. Available at the following compainies.

(a) 3M, Dri-Lube (Electro Coated) paper.

(b) Armour, Electrocoated paper.

(c) Bear Manning, no-load (Electro-Coated) paper.

6. Paper, filter, Whatman No. 41 and 41H, (6640 N/L).

7. Trichloroethylene, (0810--223-2731).

8. Freon TF solvent, (6830-082-2411).

9. Electrocleaning solution, (6810 N/L).

10. Activating solution No. 2, (6850 N/L).

11. Nickel acid stylus plating solution, (6810 N/L).

d. EQUIPMENT:

1. Stylus plating power unit and accessories, (3426-759-0187.)

2. Glass beakers, 100 to 400 cc, (6640 N/L).

3. Porcelain evaporating dishes, 30 to 200 cc capacity, (6640 N/L).

e. OPERATOR:

The stylus plating operator shall be trained in techniques of stylus plating in an approved course, and be certified by a Materials and Process Laboratory.

f. PROCESS:

1. Degrease in a trichloroethylene vapor degreaser.

2. Open up the affected area so that it is 3 to 5 times wider than it is deep, and remove anodize from the surface to be plated by some suitable mechanical means. The S.S. White abrasive blaster is an excellent tool for removing old anodic coatings, and for opening up surface defects. Measure minimum diameter of plug in opened up area. If minimum diameter is less than 2.00 inches, plug should be condemned.

3. Choose styli of suitable size and configuration for cleaning, activating and plating the defective surface. Wrap the styli appropriately in cotton batting and gauze.

4. Clean the surface electrolytically with electrocleaning solution. Use 12 volts direct current. Move the stylus at a medium rate during the electrocleaning step. Rinse thoroughly with cold tap water.

5. Treat with activating solution No. 2. Use 8 volts reverse current and move the stylus at a moderate rate until a gray color just forms on the surface being treated. Rinse thoroughly with cold tap water.

6. Swab with a stylus soaked in electroclean solution. Do not apply current. Rinse.

7. Swab thoroughly with a stylus soaked in nickel acid solution. Move the stylus at a moderate rate. Do not apply current.

8. Now apply current to the stylus used for swabbing in Step f.7 above and plate immediately with nickel acid solution. Use 10 volts direct current and moderate anode-cathode movement. Plate just until the full color of nickel is evident over the surface. Rinse thoroughly with cold tap water.

9. Use no load electrocoated abrasive paper or other suitable abrasive to abrade the nickel deposit for deposition of subsequent layers of nickel and to blend the nickel with the surrounding unplated area. If additional nickel is required for filling a defect, proceed at step f.11 thru f.12.

10. Clean electrolytically. See Step f.4. Rinse thoroughly with tap water.

11. Plate with nickel acid solution (See Step f.9) so that the diameter of the finished bearing surface is within the specification of $2.0630 \pm^{.0000}_{.0005}$. This will give a minimum of 0.0015 interference fit of plug-bearing and a maximum of 0.0010 loose fit.

12. Use electrocoated abrasive paper or other suitable abrasive to blend and finish the nickel plated plug to print specification.

g. INSPECTION:

1. Each stylus plated electrodeposit shall comply with the requirements of the respective specification listed in paragraph h.

2. The stylus plated electrodeposits shall not pull away when electroplaters' tape is applied with heavy hand pressure and pulled away suddenly at right angles to the plated surface. Any plate adhering to the tape shall be cause for rejection.

3. Defects, which penetrate to a depth exceeding 10% of the original part thickness, shall not be filled by stylus plating unless otherwise authorized.

h. REFERENCES:

1. Drawing No. 8-42367.

2. T.O. -42C2-1-7, Metal Treatments.

3. Federal Specification QQ-N-290, Nickel Plating (Electrodeposited).

TABLE 1-I

Material Substitution Table

SUBSTITUTE MATERIAL FOR SHEET STOCK AND EXTRUSIONS

Material to be Replaced	Ultimate Tensile Strength	2024 T3 Clad	2024 T4 Clad	2024 T4 Ex-truded	2024 T6 Bare	2024 T81 Clad	2024 T86 Clad	7075 T6 Clad	7075 T6 Ex-truded	7075 T6 Bare	7178 T6 Clad	7178 T6 Ex-truded	7178 T6 Bare	Titanium AMS 4900	Titanium AMS 4901	Titanium AMS 4908	Titanium AMS 4925	Stainless Steel ¼ hard 301	Stainless Steel ½ hard 301	Stainless Steel 321 & 347 Cres
6061-T6 Extruded	38,000 PSI	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
AZ31A-H Magnesium	39,000 PSI	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
6061-T6 Clad	42,000 PSI	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
2024-T4 Extruded	57,000 PSI	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
2024-T4 Clad	58,000 PSI	1.00	1.00	1.02	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
2024-T3 Clad	60,000 PSI	1.00	1.04	1.05	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
2024-T6 Bare	62,000 PSI	1.03	1.07	1.09	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
2024-T81 Clad	64,000 PSI	1.07	1.10	1.12	1.03	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
AMS 4900 Titanium														1.00	1.00	1.00	1.00	1.00	1.00	1.00
2024-T86 Clad	70,000 PSI	1.17	1.21	1.23	1.13	1.09	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
7075-T6 Clad	72,000 PSI	1.20	1.24	1.27	1.16	1.13	1.03	1.00	1.00	1.00	1.00	1.00	1.00		1.00					
7075-T6 Bare	78,000 PSI	1.30	1.35	1.37	1.26	1.22	1.11	1.09	1.00	1.00	1.00	1.00	1.00		1.00					
7075-T6 Extruded	78,000 PSI	1.30	1.35	1.37	1.26	1.22	1.11	1.09	1.00	1.00	1.03	1.00	1.00		1.00					
7178-T6 Bare	84,000 PSI	1.40	1.45	1.48	1.36	1.32	1.20	1.17	1.08	1.08	1.10	1.00	1.00		1.05					
7178-T6 Extruded	84,000 PSI	1.40	1.45	1.48	1.36	1.32	1.20	1.17	1.08	1.08	1.10	1.00	1.00		1.05					
AMS 4901 Titanium	80,000 PSI													1.23	1.00	1.00	1.00	1.00	1.00	1.00
Type 321 and 347 CRES	100,000 PSI																	1.00	1.00	1.00
AMS 4908 Titanium	120,000 PSI													1.85	1.50	1.00	1.00	1.00	1.00	1.20
Type 301 Stainless steel, ¼ hard	125,000 PSI														1.56	1.04	1.00	1.00	1.00	1.25
AMS 4925 Titanium	140,000 PSI														1.75	1.17	1.00	1.12	1.00	1.40
Type 301 Stainless steel, ½ hard	150,000 PSI																1.07	1.20	1.00	1.50

a. Locate the material to be replaced on the line in the left hand column.

b. Locate the substitute material in the vertical columns.

c. To obtain the minimum thickness of the substitute material, multiply the thickness of the material to be replaced by the factor shown at the intersection of the line and column found in steps "a" and "b." Substitute standard gage equal to this thickness or nearest standard gage.

TABLE 1-IA

Sheet Metal Gages

Standard Gage	Superseded Standard Gage		
	Aluminum	Corrosion Resistant Steel	Steel
0.006 0.008 0.010 0.012			
0.016		0.015	
0.018 0.020 0.022 0.025 0.028			
0.032		0.030, 0.031	0.030
0.036		0.035	0.035
0.040		0.042	0.042
0.045		0.044	
0.050	0.051		
0.056	0.057		
0.063	0.064		0.062
0.071	0.072		0.072
0.080	0.081		0.078, 0.083
0.090	0.091	0.093	0.093
0.100	0.102		
0.112	0.114		0.109
0.125			
0.140	0.144		
0.160	0.156		0.156
0.180			
0.190	0.188		0.187
0.200			
0.224	0.218		

TABLE 1-II

Rivets Required Per Inch of Seam — Protruding Head Rivets or 100 Deg Countersunk Rivets in Dimpled Sheet

*2024-T3 Sheet Material or 2024-T4 Extrusions						
Type	AN426 and AN470 Rivets					
Rivets	AD				DD	
Diameter	3	4	5	6	6	8
Gage						
0.025	6.0	4.5				
0.032		4.5	3.5			
0.040		5.2	3.5	3.0	3.0	
0.051		6.6	4.3	3.0	3.0	2.3
0.064			5.4	3.0	2.9	2.1
0.072			6.1	4.2	3.1	2.1
0.081				4.8	3.5	2.1
0.091				5.3	3.9	2.3
0.102				6.0	4.4	2.6
0.125				7.3	5.4	3.2
0.156					6.7	4.0
0.188						4.6

*Also applicable to 2024-T6 and 6061-T6 materials.

NOTE: This table is computed by using a design factor of 80 percent of 2024-T3 alclad ultimate tensile strength.

*7075-T6 Sheet Material or 7075-T6 Extrusions						
Type	AN426 and AN470 Rivets					
Material	AD				DD	
Diameter	3	4	5	6	6	8
Gage						
0.025	7.2	4.6	3.8			
0.032		5.2	3.8			
0.040		6.9	4.1	3.1	3.1	2.3
0.051		8.2	5.4	3.7	3.1	2.3
0.064			6.7	4.6	3.4	2.3
0.072			7.6	5.2	3.8	2.3
0.081				6.9	4.3	2.5
0.091				6.6	4.8	2.8
0.102				7.4	6.6	3.2
0.125						3.8
0.156						4.8
0.188						5.5

*Also applicable to 2024-T81, 2024-T86 materials and AMS 4901 annealed titanium.

NOTE: This table is computed by using a design factor of 80 percent of 7075-T6 extrusion ultimate tensile strength.

TABLE 1-III

Rivets Required Per Inch of Seam — Protruding Head or 100 Deg Countersunk Rivets for 7178-T6 Material

7178-T6 bare sheet or 7178-T6 extrusions						
Type	AN470 Rivets					
Material	AD				DD	
Diameter	3	4	5	6	6	8
Gage						
0.025	8.0					
0.032	9.9	5.8				
0.040		7.0	4.7			
0.050		8.7	5.7	4.0	3.2	
0.063			7.1	4.9	3.6	2.1
0.071			8.0	5.6	4.0	2.3
0.080				6.2	4.6	2.6
0.090				7.0	5.2	2.9
0.100				7.8	5.7	3.2
0.125				9.7	7.1	4.0
0.160					9.1	5.1
0.190						6.0

7178-T6 bare sheet or 7178-T6 extrusions						
Type	AN426 Rivets					
Material	AD				DD	
Diameter	3	4	5	6	6	8
Gage						
0.025	10.8					
0.032	12.1	7.9				
0.040	14.0	8.8	6.5			
0.050		9.9	7.1	4.6	4.4	
0.063			8.1	6.0	4.8	3.3
0.071			8.8	6.5	5.1	3.4
0.080			9.6	7.0	5.4	3.5
0.090				7.7	5.9	3.7
0.100				8.2	6.3	3.9
0.125				9.9	7.4	4.5
0.160						5.4
0.190						6.1

NOTE: These tables are computed by using a design factor of 80 percent of 7178-T6 ultimate tensile strength.

TABLE 1-IV

Rivets Required Per Inch of Seam — 100 Deg Countersunk Head Rivets

*2024-T3 Sheet Material or 2024-T4 Extrusions						
Type	AN426 Rivets					
Rivets	AD				DD	
Diameter	3	4	5	6	6	8
Gage						
0.032	9.3	6.0				
0.040	10.5	6.5	4.8			
0.051		7.6	5.4	4.5	3.4	
0.064		8.9	6.6	4.9	3.7	2.5
0.072			6.7	5.3	3.9	2.6
0.081				5.7	4.1	2.7
0.091				6.2	4.6	2.8
0.102				6.3	4.8	3.0
0.125						3.5
0.156						3.9

*Also applicable to 2024-T6 and 6061-T6 materials.

NOTE: This table is computed by using the design factor of 80 percent of 2024-T3 alclad ultimate tensile strength.

*7075-T6 Sheet Material or 7075-T6 Extrusions						
Type	AN426 Rivets					
Material	AD				DD	
Diameter	3	4	5	6	6	8
Gage						
0.032	11.3	7.5				
0.040	13.1	8.3	6.1			
0.051		9.6	6.8	5.2	4.3	
0.064		11.6	7.5	5.1	4.5	3.1
0.072		12.8	8.6	6.3	4.9	3.3
0.081			9.1	6.7	5.2	3.4
0.091				7.3	5.5	3.5
0.102				7.8	6.1	3.8
0.125					7.0	4.3
0.156						4.8

*Also applicable to 2024-T81, 2024-T86 materials and AMS 4901 annealed titanium.

NOTE: This table is computed by using a design factor of 80 percent of 7075-T6 extrusion ultimate tensile strength.

TABLE 1-V

Rivets Required Per Inch of Seam — Protruding Head Blind Rivets

***2024-T3 Sheet Material or 2024-T4 Extrusions**

Type Rivets	Cherry Blind Rivets		
Diameter	**4**	**5**	**6**
Gage			
0.020	6.2		
0.025	7.1	4.5	
0.032	7.9	5.1	3.8
0.040	9.2	6.0	4.3
0.051		6.8	5.1
0.064		7.3	5.8
0.072			6.3
0.081			6.8

*Also applicable to 2024-T4 and 6061-T6 materials.

NOTE: This table is computed by using a design factor of 80 percent of 2024-T3 alclad ultimate tensile strength.

***7075-T6 Sheet Material or 7075-T6 Extrusions**

Type Rivets	Cherry Blind Rivets		
Diameter	**4**	**5**	**6**
Gage			
0.020			
0.025	8.3	5.7	
0.032	9.7	6.3	4.7
0.040	11.0	7.1	5.1
0.051	12.3	8.1	6.1
0.064		8.9	7.0
0.072			7.5
0.081			8.1

*Also applicable to 2024-T81, 2024-T86 materials and AMS 4901 annealed titanium.

NOTE: This table is computed by using a design factor of 80 percent of 7075-T6 extrusion ultimate tensile strength.

TABLE 1-VI

Rivets Required Per Inch of Seam — DuPont Aluminum Noiseless or Huck Blind Rivets

*2024-T3 Sheet Material or 2024-T4 Extrusions							
Type Rivets	Brazier Head		Dimple		100° Countersunk		
Diameter	4	5	4	5	4	5	6
Gage							
0.032	6.4	5.0	6.1	4.1			
0.040	7.2	5.6	5.9	3.9	10.0		
0.051	8.6	6.7			9.8	13.1	
0.064						9.3	8.4
0.072							7.0

*Also applicable to 2024-T6 and 6061-T6 materials.

NOTE: This table is computed by using a design factor of 80 percent of 2024-T3 alclad ultimate tensile strength.

*7075-T6 Sheet Materials or 7075-T6 Extrusions							
Type Rivets	Brazier Head		Dimple		100° Countersunk		
Diameter	4	5	4	5	4	5	6
Gage							
0.032	8.0	6.2	7.6	5.0			
0.040	9.0	7.0	7.4	4.9	12.4		
0.051	10.7	8.4			12.1	16.1	
0.064						11.2	10.0
0.072							8.4

*Also applicable to 2024-T81, 2024-T86 materials, and AMS 4901 annealed titanium.

NOTE: This table is computed by using a design factor of 80 percent of 7075-T6 extrusion ultimate tensile strength.

TABLE 1-VII

Rivets Required Per Inch of Seam — DuPont Nickel Noiseless Explosive Blind Rivets

***2024-T3 Sheet Material or 2024-T4 Extrusions**

Type Rivets	Brazier Head		Dimple		100° Countersunk		
Diameter	4	5	4	5	4	5	6
Gage							
0.032	5.1	4.0	3.8	2.6			
0.040	5.8	4.5	4.5	3.0	8.0		
0.051	6.9	5.4			7.8	10.0	
0.064						7.4	6.7
0.072							5.6

*Also applicable to 2024-T6 and 6061-T6 materials.

NOTE: This table is computed by using a design factor of 80 percent of 2024-T3 alclad ultimate tensile strength.

***7075-T6 Sheet Material or 7075-T6 Extrusions**

Type Rivets	Brazier Head		Dimple		100° Countersunk		
Diameter	4	5	4	5	4	5	6
Gage							
0.032	6.4	5.0	4.8	3.2			
0.040	7.2	5.6	5.6	3.7	9.9		
0.051	8.6	6.7			9.7	12.8	
0.064						9.0	8.0
0.072							6.7

*Also applicable to 2024-T81, 2024-T86 materials, and AMS 4901 annealed titanium.

NOTE: This table is computed by using a design factor of 80 percent of 7075-T6 extrusion ultimate tensile strength.

TABLE 1-VIII

Rivets Required Per Inch of Seam — Countersunk Head High-Strength Fasteners for 2024-T3 and 2024-T4 Materials

Type Rivets	Corrosion Resistant Steel			Monel			Huck Lockbolts Steel		Hi-Shear Rivets AN Bolts	
Diameter	5	6	8	5	6	8	6	8	6	8
Gage										
0.051	5.6	4.8		5.6	4.8		4.8		4.8	
0.064	5.7	4.8		5.7	4.8		4.8		4.8	
0.072	5.6	4.5		8.5	4.5		4.5		4.5	
0.081	5.6	4.5		8.4	6.7		4.5		4.5	
0.091	5.6	4.7		8.4	6.9		4.7		4.7	
0.102	5.8	5.1		8.7	7.6		5.1		5.1	
0.125	6.6	4.8	4.0	9.9	7.2	6.0	4.8	4.0	4.8	4.0
0.156	8.0	5.4	3.6	12.0	8.1	5.4	5.4	3.6	5.4	3.6
0.188	9.8	6.3	4.4		9.4	6.6	6.3	4.4	6.3	4.4

NOTES: A. This table also applicable to 2024-T6 and 6061-T6 materials.

B. This table is computed by using a design factor of 80 percent of 2024-T3 alclad ultimate tensile strength.

TABLE 1-IX

Rivets Required Per Square Inch of Seam — Protruding Head or 100 Deg Countersunk Head High-Strength Fasteners in Dimpled Sheet for 2024-T3 and 2024-T4 Materials

Type Rivets	Corrosion Resistant Steel				Monel				Huck Lockbolts Steel		Hi-Shear Rivets AN Bolts	
Diameter	4	5	6	8	4	5	6	8	6	8	6	8
Gage												
0.040	3.5	2.9			4.5	3.0						
0.051	3.5	2.9	2.4		4.4	2.9	2.4		2.4		2.4	
0.064	3.5	2.9	2.5	1.9	4.7	3.1	2.5	1.9	2.5	1.9	2.5	1.9
0.072		3.0	2.5	1.9		3.5	2.5	1.9	2.5	1.9	2.5	1.9
0.081		3.0	2.5	1.9		3.9	2.7	1.9	2.5	1.9	2.5	1.9
0.091		3.2	2.5	1.9		4.4	3.1	1.9	2.5	1.9	2.5	1.9
0.102		3.6	2.5	1.9		5.0	3.5	1.9	2.5	1.9	2.6	1.9
0.125			3.0	1.9			4.2	2.3	2.6	1.9	3.2	1.9
0.156				2.1				2.4	3.1	1.9	4.0	2.2
0.188				2.4				3.5		2.0		2.6

NOTES: A. This table also applicable to 2024-T4 and 6061-T6 materials.

B. This table is computed by using a design factor of 80 percent of 2024-T3 alclad ultimate tensile strength.

TABLE 1-X

Rivets Required Per Inch of Seam — Countersunk Head High-Strength Fasteners for 7075-T6 Material and AMS 4901 Titanium

Type Rivets	Corrosion Resistant Steel			Monel			Huck Lockbolts Steel		Hi-Shear Rivets AN Bolts	
Diameter	5	6	8	5	6	8	6	8	6	8
Gage										
0.051	4.6	4.0		4.6	4.0		4.0		4.0	
0.064	4.7	4.0		4.7	4.0		4.0		4.0	
0.072	4.6	3.7		4.6	3.7		3.7		3.7	
0.081	4.4	3.7		6.6	3.7		3.7		3.7	
0.091	4.5	3.9		6.7	3.9		3.9		3.9	
0.102	4.7	4.2		6.8	6.3		4.2		4.2	
0.125	5.4	4.0	3.3	7.1	6.0	3.3	4.0	3.3	4.0	3.3
0.156	6.7	4.4	2.9	10.1	6.6	4.4	4.4	2.9	4.4	2.9
0.188	8.0	5.2	3.6	12.0	7.8	5.4	5.2	3.6	5.2	3.6

NOTES: A. This table also applicable to 2024-T6, 2024-T81, and 2024-T86 materials.

B. This table is computed by using a design factor of 80 percent of 7075-T6 extrusion ultimate tensile strength.

TABLE 1-XI

Rivets Required Per Inch of Seam — Protruding Head or 100 Deg Countersunk Head High-Strength Fasteners in Dimpled Sheet for 7075-T6 Material and AMS 4901 Titanium

Type Rivets	Corrosion Resistant Steel				Monel				Huck Lockbolts Steel			Hi-Shear Rivets AN Bolts		
Diameter	4	5	6	8	4	5	6	8	6	8	10	6	8	10
Gage														
0.051	3.5	2.9	2.4		3.5	2.9	2.4		2.5			2.5		
0.064	4.1	2.9	2.4	1.8	4.1	2.9	2.4	1.8	2.5	1.9		2.5	1.9	
0.072	4.7	2.9	2.4	1.8	4.7	2.9	2.4	1.8	2.5	1.9	1.5	2.7	1.9	
0.081		3.4	2.4	1.8		5.1	2.4	1.8	2.5	1.9	1.5	3.6	1.9	1.5
0.091		3.8	2.4	1.8		5.7	4.5	1.8	2.5	1.9	1.5	4.0	1.9	1.5
0.102			3.0	1.8			5.5	1.8	2.5	1.9	1.5	4.5	1.9	1.5
0.125			3.7	2.1			6.9	3.2	3.0	1.9	1.5	5.4	1.9	1.5
0.156			4.6	2.6				3.9	3.8	2.1	1.7	6.8	2.2	1.5
0.188				3.1				4.5		2.6	2.0		2.7	1.7
0.210				3.4				5.1		2.9	2.2		3.2	1.8

NOTES: A. This table also applicable to 2024-T6, 2024-T81, and 2024-T86 materials.

B. This table is computed by using a design factor of 80 percent of 7075-T6 extrusion ultimate tensile strength.

TABLE 1-XII

Rivets Required Per Inch of Seam — Countersunk Head High-Strength Fasteners for 7178-T6 Material

Type Rivets	Corrosion Resistant Steel			Monel			Huck Lockbolts Steel		Hi-Shear Rivets AN Bolts	
Diameter	5	6	8	5	6	8	6	8	6	8
Gage										
0.051	5.0	4.3		5.0	4.3		4.3		4.3	
0.064	5.1	4.3		5.1	4.3		4.3		4.3	
0.072	5.0	4.0		5.0	4.0		4.0		4.0	
0.081	4.8	4.0		7.1	4.0		4.0		4.0	
0.091	4.9	4.2		7.2	4.2		4.2		4.2	
0.102	5.1	4.5		7.3	6.8		4.6		4.6	
0.125	5.8	4.3	3.6	7.7	6.5	3.6	4.3	3.6	4.3	3.6
0.156	7.2	4.8	3.1	10.9	7.1	4.8	4.8	3.1	4.8	3.1
0.188	8.6	5.6	3.9	12.9	8.4	5.9	5.6	3.9	5.6	3.9

NOTE: This table is computed by using a design factor of 80 percent of 7178-T6 ultimate tensile strength.

TABLE 1-XIII

Rivets Required Per Inch of Seam — Protruding Head High-Strength Fasteners in Titanium and Steel

Applicable to AMS 4901 and AMS 4908 ½-Hard Titanium and ¼-Hard Corrosion Resistant Steel

Type Rivets	Corrosion Resistant Steel				Monel				Huck Lockbolts Steel		Hi-Shear Rivets AN Bolts	
Diameter	4	5	6	8	4	5	6	8	6	8	6	8
Gage												
0.016	5.2	4.2			5.2	4.2						
0.020	5.2	4.2			5.2	4.2						
0.025	5.2	4.2			5.2	4.2						
0.032	5.2	4.2			5.2	4.2						
0.040	5.2	4.2	3.5		6.2	4.2	3.5		3.6		3.6	
0.051	5.2	4.2	3.6	2.7	7.9	5.2	3.6	2.7	3.7	2.8	3.7	2.8
0.064	6.6	4.3	3.6	2.7	9.9	6.5	4.5	2.7	3.7	2.8	3.7	2.8
0.072		4.9	3.6	2.7		7.3	5.1	2.8	3.7	2.8	3.7	2.8
0.081		5.5	3.8	2.8		8.2	5.7	3.2	3.7	2.8	4.0	2.8
0.091			4.2	2.8			6.4	3.5	3.7	2.8	4.4	2.8

NOTES: A. Also applicable to 100 Deg countersunk head high-strength fasteners in dimpled sheet.

B. This table is computed by using a design factor of 80 percent of 301 corrosion resistant steel.

TABLE 1-XIV

Rivets Required Per Inch of Seam — 100 Deg Countersunk Head High-Strength Fasteners in Titanium and Steel

Applicable to AMS 4901 and AMS 4908 ½-Hard Titanium and ¼-Hard Corrosion Resistant Steel

Type Rivets	Corrosion Resistant Steel			Monel			Huck Lockbolts Steel		Hi-Shear Rivets AN Bolts	
Diameter	5	6	8	5	6	8	6	8	6	8
Gage										
0.040	7.5			7.5						
0.051	7.5	6.3		7.5	6.3		6.3		6.3	
0.064	7.5	6.3		11.2	6.3		6.3		6.3	
0.072	7.2	6.2		10.8	6.2		6.2		6.2	
0.081	7.1	6.0		10.6	8.0		6.0		6.0	
0.091	7.1	6.1		10.6	8.1		6.1		6.1	
0.102	7.5	6.5	4.8	11.2	9.7	7.2	6.5	4.8	6.5	4.8
0.125	8.6	6.5	5.2	12.9	9.7	7.9	6.5	5.2	6.5	5.2
0.156	9.4	7.1	5.5	14.1	10.6	8.2	7.1	5.5	7.1	5.5

NOTE: This table is computed by using a design factor of 80 percent of 301 corrosion resistant steel.

TABLE 1-XV

Rivets Required Per Inch of Seam — 5056 Rivets in Magnesium

Protruding Head Rivets in AZ31A—Magnesium

Type Rivets	5056			
Diameter	4	5	6	8
Gage				
0.016	4.2	3.4	2.8	2.1
0.020	4.2	3.4	2.8	2.1
0.025	4.2	3.4	2.8	2.1
0.032	4.2	3.4	2.8	2.1
0.040	4.2	3.4	2.8	2.1
0.051	4.6	3.4	2.8	2.1
0.064	5.7	3.7	2.8	2.1
0.072	6.4	4.2	2.9	2.1
0.081	7.2	4.7	3.3	2.1
0.091	8.1	5.3	3.7	2.1
0.102	9.1	6.0	4.1	2.3

Countersunk Head Rivets in AZ31A — Magnesium

Type Rivets	5056		
Diameter	4	5	6
Gage			
0.016			
0.020			
0.025			
0.032			
0.040	5.0	3.5	3.4
0.051	5.1	3.7	4.0
0.064	6.2	4.2	3.9
0.072	6.9	5.2	3.9
0.081			
0.091			
0.102			

NOTE: This table is computed by using a design factor of 80 percent of AZ31A magnesium sheet ultimate tensile strength.

TABLE 1-XVI.

Rivets Required Per Inch of Seam—Straylor Fuel-Tight Rivets in 2024-T86 Machined Skins

Type Rivets	Counterbore	Seal Head
Diameter	6	8
Gage		
0.114	5.2	
0.125	5.7	
0.168	7.7	
0.200		5.1
0.250		6.4
0.312		8.0

NOTE

When a repair is required in an area where Straylor rivets are used, the existing rivet pattern should be picked up. Should the extent of the damage be of such a serious nature that a new rivet pattern is required, the above values may be used. The rivet pitch for staggered rows should be 4D and row spacing 2½D. For even or unstaggered rows the rivet pitch and row spacing should be 3D. For extensive repairs, engineering should be consulted. This table is computed by using a design factor of 80% of 2024-T86 ultimate tensile strength.

TABLE 1-XVII.

Rivets Required Per Inch of Seam—Straylor Fuel-Tight Rivets in 7075-T6 Machined Skins

Type Rivets	Counterbore	Seal Head
Diameter	6	8
Gage		
0.114	6.1	
0.125	6.6	
0.156	8.2	
0.218		6.8
0.250		7.8
0.312		9.8

NOTE

When a repair is required in an area where Straylor rivets are used, the existing rivet pattern should be picked up. Should the extent of the damage be of such a serious nature that a new rivet pattern is required, the above values may be used. The rivet pitch for staggered rows should be 4D and row spacing 2½D. For even or unstaggered rows the rivet pitch and row spacing should be 3D. For extensive repairs, engineering should be consulted. This table is computed by using a design factor of 80% of 7075-T6 ultimate tensile strength.

TABLE 1-XVIII.

Minimum Rockwell Hardness Acceptance Values for Metal

Material	Type	Rockwell Scale "A" Min	Rockwell Scale "B" Min	Rockwell Scale "E" Min
Steel	17-4PH	70		
	17-7PH	70		
	4130, H.T. 90,000 PSI	61.5	99	
	4130, H.T. 125,000 PSI	64	104	
	4130, H.T. 150,000 PSI	70		
	301		81	
	302	64	104	
	321	70		
	347	74.1		
Aluminum	2024-T4		74	95
	7075-T6		82	103
	7079-T6		81	106
	2014-T6		74	103
	7178-T6		86	109
	6061-T6		46	85
	2024-T86		81	
	2024-T81		73	
	2024-T3		74	95
	356-T6		29	
	5154-H34		31	
	2024-T80		71	
Magnesium	AZ 91-T6			72
	AZ 92-T6			72
	ZK 51-T5			60
Titanium	Commer. Pure	57		
	A 110-AT	67		
	C 130-AM	65.8		

TABLE 1-XIX

Standard Bend Radii for Flat Sheet

	MATERIAL	MATERIAL CONDITION	FORMING TEMP.	GAUGE .008	.012	.016	.020	.025	.032	.040	.050	.063	.071	.080	.090	.100	.125	.160	.190	.250
ALUMINUM	3003-0, 5052-0, 6061-0	NOTED	ROOM		.03	.03	.03	.03	.03	.06	.06	.06	.09	.09	.12	.12	.16	.16	.19	.25
ALUMINUM	2014-0, 2024-0, 5052-H34, 6061-T4, 7075-0, 7178-0	NOTED	ROOM		.03	.03	.03	.03	.06	.06	.06	.09	.09	.12	.16	.16	.19	.25	.31	.44
ALUMINUM	2014-T4, 2024-T3, 2024-T4 6061-T6, 7075-W, 7178-W	NOTED	ROOM		.03	.03	.03	.06	.09	.09	.12	.16	.19	.22	.25	.31	.38	.44	.69	1.00
ALUMINUM	2014-T6, 2024-T36, 7075-T6, 7178-T6	NOTED	ROOM		.06	.06	.08	.09	.12	.19	.25	.31	.38	.44	.50	.56	.69	.88	1.00	1.50
ALUMINUM	2024-W	NOTED	ROOM		.03	.03	.03	.03	.06	.06	.09	.12	.12	.16	.18	.22	.25	.31	.44	.69
ALUMINUM	7075-T6	NOTED	HOT 300°F ± 25°		.06	.06	.06	.06	.06	.06	.09	.14	.15	.15	.18	.22	.31	.38	.50	.69
ALUMINUM	7178-T6	NOTED	HOT 275°F ± 25°		.06	.06	.06	.06	.06	.06	.09	.14	.15	.15	.18	.22	.31	.38	.50	.69
MAGNESIUM	AZ31A (SPEC. QQ-M-44)	A	HOT 400°F - 625°F			.03	.06	.06	.06	.09	.09	.12	.16	.19	.19	.22	.25	.31	.38	.50
MAGNESIUM	AZ31A (SPEC. QQ-M-44)	A	ROOM			.09	.09	.12	.16	.19	.25	.31	.38	.44	.44	.50	.62	.75	1.00	1.25
MAGNESIUM	AZ31A (SPEC. QQ-M-44)	H	HOT 325°F ± 25°			.06	.09	.12	.12	.22	.25	.38	.44	.44	.44	.44	.50	.62	.81	1.00
MAGNESIUM	AZ31A (SPEC. QQ-M-44)	H	ROOM			.19	.19	.25	.31	.38	.50	.62	.81	.81	.88	1.00	1.25	1.50	2.00	2.50

	MATERIAL	MATERIAL CONDITION	FORMING TEMP.	GAUGE .008	.012	.016	.020	.025	.032	.036	.040	.050	.063	.080	.090	.112	.125	.160	.190	.250
STEEL	1025		ROOM	.03	.03	.03	.06	.06	.06	.06	.09	.09	.12	.16	.19	.22	.25	.31	.38	.50
STEEL	4130	65,000 TO 90,000 PSI	ROOM	.03	.03	.03	.06	.06	.06	.06	.09	.09	.12	.16	.19	.22	.25	.31	.38	.50
STEEL	4130	90,000 TO 125,000 PSI	ROOM	.03	.03	.06	.06	.09	.09	.12	.12	.16	.19	.25	.31	.38	.44	.50	.62	.75
STEEL	CORROSION RESISTANT	ANNEALED	ROOM	.03	.03	.03	.03	.03	.03	.03	.03	.06	.06	.09	.12	.12	.16	.16	.19	.25
STEEL	CORROSION RESISTANT	1/4 HARD	ROOM	.03	.03	.03	.03	.06	.06	.06	.06	.09	.09	.12	.16	.19	.22	.25	.31	.38
STEEL	CORROSION RESISTANT	1/2 HARD	ROOM	.03	.03	.06	.06	.09	.09	.12	.12	.16	.16	.19	.25	.31	.38	.50	.62	.75
STEEL	CORROSION RESISTANT	FULL HARD	ROOM	.06	.09	.09	.12	.16	.16	.16	.19	.19	.25	.31	.38	.44	.50	.62	.75	1.00
TITANIUM	COMMERCIALLY PURE AMS 4901	ANNEALED	ROOM	.03	.03	.06	.06	.09	.09	.12	.12	.16	.19	.25	.31	.38	.38	.44	.56	.75
TITANIUM	ALLOY AMS 4908	ANNEALED	ROOM	.03	.03	.06	.06	.09	.09	.12	.12	.16	.19	.25	.31	.38	.38	.44	.56	.75
TITANIUM	ALLOY CONVAIR SPEC. 0-01014	ANNEALED	ROOM			.09	.09	.12	.16	.19	.19	.25	.31	.38	.44	.56	.62	.78	.94	1.25

TABLE 1-XX

Standard Bend Radii for Aluminum Alloy Tubing

TUBE O. D.	5052-0		6061-T6 & 2024-T4
	STANDARD	*MINIMUM	STANDARD
1/8	0.38	0.38	0.50
3/16	0.75	0.44	0.75
1/4	0.75	0.56	1.00
5/16	1.00	0.69	1.25
3/8	1.25	0.94	1.50
7/16	1.50	1.25	1.75
1/2	1.50	1.25	2.00
5/8	2.00	1.50	2.50
3/4	2.25	1.75	3.00
7/8	2.50	2.00	3.50
1	3.00	3.00	4.00
1 1/8	3.50	3.50	4.50
1 1/4	3.75	3.75	5.00
1 3/8	5.00	5.00	6.00
1 1/2	5.00	5.00	7.00
1 5/8	6.00	6.00	8.00
1 3/4	7.00	7.00	9.00
2	8.00	8.00	10.00
2 1/4	9.00	9.00	11.00
2 1/2	10.00	10.00	13.00
2 3/4	11.00	11.00	14.00
3	12.00	12.00	15.00

*The limits listed for 5052-0 aluminum are also applicable to annealed or ¼ hard corrosion resistant steel.

TABLE 1-XXI

Temper Designations—Old and New for Aluminum Alloys

TEMPER DESIGNATION Old	New	ALLOY Sheet	Extruded	TREATMENT AND CONDITIONS
-F	-F			As fabricated: applies to various aluminum alloy products which acquire some temper qualities in the shaping or manufacturing processes.
-O	-O			Annealed, recrystallized: applies to the softest temper of wrought products.
-W	-W			Solution heat treated: unstable temper.
-T	-T			Treated to produce stable tempers other than -F and -O: applies to products treated to produce stable tempers with or without strain hardening. -T followed by numerals, designates a specific combination of basic operations.
24S-T3	2024-T3	2024-T3		Solution heat treated and then strain hardened.
24S-T4	2024-T4	2024-T4	2024-T4	Solution heat treated and naturally aged to a substantially stable condition.
24ST-80	2024-T6	2024-T6		Solution heat treated and then artificially aged.
24S-RT	2024-T36	2024-T36		Strain hardened by manufacturer.
24S-T81	2024-T81	2024-T81		2024-T3 plus artificial aging.
24S-T86	2024-T86	2024-T86		2024-T36 plus artificial aging.
61S-T6	6061-T6	6061-T6	6061-T6	Solution heat treated and then artificially aged.
75S-T6	7075-T6	7075-T6	7075-T6	Solution heat treated and then artificially aged.
XA78S-T6	7178-T6	7178-T6	7178-T6	Solution heat treated and then artificially aged.

NOTE: Aluminum alloys are designated by numbers and letters rather than names. The number preceding the letter indicates the composition of the alloy. For heat treated materials, the basic temper designation consists of a letter-T followed by one or more numbers which specifically define the type of treatment and conditioning used. See Table 1-I for material strength comparisons.

TABLE 1-XXII
Rivet Substitution

Nominal Fastener Diameter (Inches)	Head Config-uration	Order of Rivets By Increasing Strength	Rivets (See Notes)							
			Blind Rivets (See Note 4)	Standard Aluminum Rivets	Blind Bolt	7075-T6 Huck Lock Rivets	Monel	Cres. 302	Hi-Shear (Steel)	Steel Huck Lock Bolt
3/32	Protruding	1.0		MS20470A						
		2.0		(AN470AD						
		2.1		(MS20470AD						
		3.0	6951							
		4.0	06951							
		5.0	7951							
	Flush	1.0		MS20246AD						
		2.0	6950							
		3.0	06950							
		4.0	7950							
1/8	Protruding	1.0	(MS20600B	AN470B						
		1.1	(NAS1389B							
		1.2	(MS20602B							
		2.0	(MS20600AD	(AN470AD						
		2.1	(MS20602AD	(MS20470AD						
		2.2	(NAS1398D							
		3.0	(MS20600MP				(NAS508M			
		3.1	(NAS1398MW				(MS20615M			
		3.2	(MS20602MP				(MS20615MP			
		4.0	6951				(Q4310			
		4.1					(MS20613C			
		5.0	7951						NAS529	

TABLE 1-XXII
Rivet Substitution (Cont)

Nominal Fastener Diameter (Inches)	Head Config-uration	Order of Rivets By Increasing Strength	Rivets (See Notes): Blind Rivets (See Note 4)	Standard Aluminum Rivets	Blind Bolt	7075-T6 Huck Lock Rivets	Monel	Cres. 302	Hi-Shear (Steel)	Steel Huck Lock Bolt
	Flush	1.0	MS20601B	(AN426B						
		1.1	(NAS1399B	(MS20426B						
		1.2	(MS20603B							
		2.0	(MS20601AD	(AN426AD						
		2.1	(MS20603AD	(MS20426AD						
		2.2	(NAS1399D							
		3.0	(MS2060MP				MS20427M			
		3.1	(NAS1399MP							
		3.2	(MS20603MP							
		4.0	6950					(Q4304		
								(MS20427F		
		5.0	7950					NAS525		
	Protruding	1.0	(MS20600B	AN470B						
		1.1	(NAS1398B							
		1.2	(MS20602B							
		2.0	(MS20600AD	(AN470AD		(ALSF-E				
		2.1	(MS20602AD	(MS20470AD		(ALPPH-E				
		2.2	(NAS1398D							
		3.0	(MS20600MP				(NAS508M			
		3.1	(NAS1398MW				(MS20615M			
		3.2	(MS20602MP				(MS20615MP			
		4.0	6951					(Q4310		
		4.1						(MS20613C		

TABLE 1-XXII
Rivet Substitution (Cont)

Nominal Fastener Diameter (Inches)	Head Config-uration	Order of Rivets By Increasing Strength	Rivets (See Notes)							
			Blind Rivets (See Note 4)	Standard Aluminum Rivets	Blind Bolt	7075-T6 Huck Lock Rivets	Monel	Cres. 302	Hi-Shear (Steel)	Steel Huck Lock Bolt
5/32 thru 1/4	Protruding	5.0			NAS1669					
		6.0	7951		BB-352					(ALPPH-T
		6.1								(ALSF-T
5/32 thru 1/4	Flush	1.0	(MS20601B	(AN426B						
		1.1	(NAS1399B	(MS40426B						
		1.2	(MS20603B							
		2.0	(MS20601AD	(AN426AD		(ACT509-E				
		2.1	(MS20603AD	(MS20426AD		(ALP426H-E				
		2.2	(NAS1399D							
		3.0	(MS20601MP		NAS1674		(MS20427M			
		3.1	(NAS1399MW				(AN427MC			
		3.2	(MS20603MP							
		4.0	6950					(Q4304		
		4.1						(MS40427F		
		5.0			NAS1670					
		6.0	7950		BB-351				NAS525	SAL-100
		6.1			MS90353					ASCT509-T
		6.2								ALP426HT
5/16	Protruding	1.0				(ALSF-E				
		1.1				(ALPPH-E				
		2.0	6951							

TABLE 1-XXII
Rivet Substitution (Cont)

Nominal Fastener Diameter (Inches)	Head Config-uration	Order Rivets By Increasing Strength	Rivets (See Notes)							
			Blind Rivets (See Note 4)	Standard Aluminum Rivets	Blind Bolt	7075-T6 Huck Lock Rivets	Monel	Cres. 302	Hi-Shear (Steel)	Steel Huck Lock Bolt
5/16	Protruding	3.0			P-312					
		4.0	7951		BB-352				NAS529	(ALSF-T
		4.1								(ALPPH-T
	Flush	1.0				(ACT509-E				
		1.1				(ALP426H-E				
		2.0			FA-312					
		3.0	6950							
		4.0			F-312					
		5.0	7950		BB-351				NAS525	SAL-100
		5.1								(ALPH426HT
		5.2								(ACT509H-T

NOTES:

1. Rivets are listed in the above Table by their basic part number. For a more complete description of the above rivets, refer to Table I-XXIII.
2. To select a substitute rivet, use the following procedure:
   a. Find the rivet in the above Table that was used original assembly of the airplane.
   b. Any rivet that is listed in the same size group and is either below or to the right of the original rivet may be used as a substitute. Fasteners below but to the left are not acceptable substitutes.
   c. Brackets indicate fasteners of approximately equal strength.
3. For rivet substitution purposes, rivets may be increased one diameter, except for the following restrictions:
   a. Where the increase of rivet diameter would necessitate decreasing quantity or size of adjacent rivets.
   b. Where increase of rivet size would entail the rivet head riding in a radius, short edge distance, or interference with adjacent parts and/or subsequent installation.
   c. In web splices, door frame splices, skin splices, forged bulkheads and through longerons or outside skins.
   d. When rivet spacing is less than five rivet diameters, no more than one rivet hole is to be enlarged in a group of five nearest adjacent rivet holes.
   e. When rivet spacing is five diameters or more, no more than two adjacent rivet holes may be enlarged.

TABLE 1-XXII
Rivet Substitution (Cont)

NOTES: (Cont'd)

4. Refer to paragraph 1-144 for restricted use of blind rivets.
5. Refer to the appropriate sections of this manual for other rivet substitution restrictions.
6. If a steel rivet is to be substituted for an aluminum rivet, the steel rivet must be treated for corrosion prevention as outlined in paragraph 1-189.
7. Aluminum alloy rivets used in magnesium require corrosion prevention treatment.

TABLE 1-XXIII

Rivet Basic Code

Basic Code	Description	Shank Material	Collar No.	Collar Material	Basic Part No.
AB	Blind, Protruding Head	5056-F			MS20600B
AE	Blind, Flush Head	5056-F			MS20601B
AL	Blind, Protruding Head, Cherry	Monel			CR563
AX	Blind, Flush Head, Cherry	2117-T4			CR116
AY	Blind, Protruding Head, Cherry	2117-T4			CR117
BA	Solid, Flush Head	1100-F			AN426A
BB	Solid, Flush Head	2117-T3			AN426AD
BC	Solid, Flush Head	5056-F			AN426B
BF	Solid, Flush Head	Monel			AN427M
BH	Solid, Protruding Head	1100-F			AN470A
BJ	Solid, Protruding Head	5056-F			AN470AD
BK	Solid, Protruding Head	5056-F			AN470B
BO	Solid, Protruding Head	Monel			NAS508M
BR	Blind, Flush Head, Cherry	Monel			CR562
BS	Hi-Shear Rivet, Flush Head	Steel	NAS528	2117-T4	NAS525
BT	Hi-Shear Rivet, Protruding Head	Steel	NAS528	2117-T4	NAS529
CC	Lockbolt, Blind, Huck	Steel			BL
CS	Lockbolt, Protruding Head, Huck	7075-T6	LC-F	6061-T6	ALPPH-E5
CX	Solid, Protruding Head	2024-T31			AN470DD
CY	Solid, Flush Head	2024-T31			AN426DD
DA	Lockbolt, Protruding Head, Huck	Steel	LC-C	2024-T4	ALSF-T
DB	Lockbolt, Flush Head, Huck	Steel	LC-C	2024-T4	ASCT509-T
DH	Rivet - 100° CSK Head	CRES			MS20427F
DJ	Lockbolt, Flush Head, Huck	7075-T6	LC-F	6061-T6	ALP426-E5
DK	Bolt, Blind, Flush Head Jo-Bolt	Steel			F
DL	Bolt, Blind, Flush Head, Jo-Bolt	7075-T6			FA
DR	Bolt, Blind, Protruding Head, Jo-Bolt	Steel			P
DT	Lockbolt, Protruding Head, Huck	Steel	LC-C	2024-T4	R-3001-T6 & 8
DW	Lockbolt, Flush Head, Huck	Steel	LC-C	2024-T4	R-3002-T10 & 12
DX	Lockbolt, Protruding Head, Huck	Steel	6LC-C	2024-T4	SALP
DY	Lockbolt, Protruding Head, Huck	Steel	6LC-C	2024-T4	SLSP
DZ	Lockbolt, Flush Head, Huck	Steel	6LC-C	2024-T4	SAL100
EA	Lockbolt, Flush Head, Huck	Steel	6LC-C	2024-T4	SLS100

TABLE 1-XXIII

Rivet Basic Code (Cont)

Basic Code	Description	Shank Material	Collar No.	Collar Material	Basic Part No.
FA	Rivet—Blind Explosive 100 deg Csunk (DuPont)	5056-F			56S( )100
FK	Blind, Flush Head, Expl. DuPont	5056-F			P56S( )100
FL	Blind, Protruding Head, Expl. DuPont	5056-F			P56S( )A
HB	Blind, Flush Head Expl. DuPont	Nickel			PN( )100
HC	Blind, Protruding Head, Expl. DuPont	Nickel			PN( )A
HW	Solid, Flush Head, Cad-plated	Monel			AN427MC
HX	Solid, Protruding Head, Cad-plated	Monel			AN435MC
HY	Blind, Flush Head, Expl. DuPont, Cad-plated	Nickel			CPPN( )100
HZ	Blind, Protruding Head, Expl. DuPont, Cad-plated	Nickel			CPPN( )A
JE	Lockbolt, Protruding Head, Huck	Steel	7LC-C	2024-T4	R-3001-T10 & 12
JF	Lockbolt, Flush Head, Huck	Steel	7LC-C	2024-T4	R-3002-T10 & 12
LM	Rivet - Universal Head	CRES			MS20631C
LN	Rivet - Universal Head	Monel			MS20615M
RK	Rivet - Blind, Protruding Head, Locked Spindle	5056			NAS1398B
RL	Rivet - Blind, Protruding Head, Locked Spindle	2017			NAS1398D
RO	Rivet - Blind, 100° CSK Head, Locked Spindle	5056			NAS1399B
RP	Rivet - Blind, 100° CSK Head, Locked Spindle	2017			NAS1399D
SH	Rivet - Universal Head	Monel CAD PLTD			MS20615MP
TK	Rivet - Blind, Protruding Head, Locked Spindle	Monel CAD PLTD			NAS1398MW
TO	Rivet - Blind, 100° CSK Head, Locked Spindle	Monel CAD PLTD			NAS1399MW
VN	Bolt - Blind, Hex Head (Jo-Bolt)	Steel			P312
XA	Solid, Flush Head, CONVAIR Q4304	Cres. 302			97-67001
XB	Solid, Flat Head, CONVAIR Q4310	Cres. 302			97-67002
XC	Solid, Straylor Fuel-Tight, with sealing washer, CONVAIR Q4326	2024-T31			97-67000

TABLE 1-XXIII
Rivet Basic Code (Cont)

Basic Code	Description	Shank Material	Collar No.	Collar Material	Basic Part No.
XD	Solid, Straylor Fuel-Tight, without sealing washer, CONVAIR Q4326	2024-T31			97-67000
XE	Solid, 82 deg Flush Head. Fuel-Tight, CONVAIR Special Rivet	2024-T31			97-67007
	Standard Rivet, Blind, 100 deg Csunk. Made by Deutsch Rivet Co.	Steel		Cres. 303	6950
	Oversize Rivet, Blind, 100 deg Csunk. Made by Deutsch Rivet Co.	Steel		Cres. 303	06950
	Hi-Strength Rivet, Blind, 100 deg Csunk. Made by Deutsch Rivet Co.	Steel		Cres. 303	7950
	Blind, Protruding Head. Made by Deutsch Rivet Co.	Steel		Cres. 303	6951
	Oversize,Blind, Protruding Head. Made by Deutsch Rivet Co.	Steel		Cres. 303	06951
	Hi-Strength,Blind, Protruding Head. Made by Deutsch Rivet Co.	Steel		Cres. 303	7951

NOTE

Rivet-type fasteners which are not included in this table are listed in specification NAS 523.

TABLE 1-XXIV

Strength of AN Bolts and MS2000 Bolts

BOLT SIZE	Area of Solid Section	Moment of Inertia of Solid Section	HEAT TREATED STEEL BOLTS HT 125000 psi min			HEAT TREATED ALLOY STEEL BOLTS HT 160000 psi min		
			Tension	*Single Shear	**Bending	Tension	Single Shear	Bending
	sq. in.	in.^{4}	lbs.	lbs.	in.-lbs.	lbs.	lbs.	in.-lbs.
10-32	0.02835	0.00006399	2210	2126	84			
1/4-28	0.04908	0.0001918	4080	3680	192	5000	4650	245
5/16-24	0.07669	0.0004682	6500	5750	374	8200	7300	479
3/8-24	0.1105	0.0009710	10100	8280	647	12700	10500	830
7/16-20	0.1503	0.001797	13600	11250	1025	17100	14300	1310
1/2-20	0.1963	0.003069	18500	14700	1534	23400	18650	1965
9/16-18	0.2485	0.004914	23600	18700	2184	29800	23600	2795
5/8-18	0.3068	0.007492	30100	23000	2996	38000	29150	3830
3/4-16	0.4418	0.01553	44000	33150	5177	55600	41950	6640
7/8-14	0.6013	0.02878	60000	45050	8221	76200	57100	10510
1-14	0.7854	0.04908	80700	58900	12272	102500	74600	15700
1⅛-12	0.9940	0.07863	101800	73750	17470	128800	94150	22400
1¼-12	1.2272	0.1198	130200	91050	23970	162600	116600	30620

* Based on F_{su} = 75000 psi

** Based on F_{bu} = 125000 psi

TABLE 1-XXV

Strength of 100 Deg Flush Head Screws (AN 509)

Bolt Type	100 Deg Countersunk Screws (AN 509)							
Bolt Material	Steel HT 125000 psi							
Fastened Material	Clad 2024-T $F_{br} = 92000$ psi				Clad 7075-T $F_{br} = 108000$ psi			
Bolt Diameter	3/16	1/4	5/16	3/8	3/16	1/4	5/16	3/8
Bolt Sgl. Shear	2125	3680	5750	8280	2125	3680	5750	8280
Thickness	Strength — Pounds				Strength — Pounds			
0.032	493				569			
0.040	657	761			791	905		
0.051	903	1074	1224		1065	1277	1454	
0.064	1115	1439	1690	1887	1228	1748	1995	2211
0.072	1227	1683	1955	2235	1326	1903	2242	2608
0.081	1354	1848	2268	2600	1447	2053	2415	3067
0.091	1483	2031	2449	3022	1594	2218	2596	3328
0.102	1626	2235	2647	3366	1768	2400	2785	3601
0.125	1929	2622	3001	3838	2126	2842	3147	4048
0.156	2126	3174	3501	4408	2126	3544	3751	4632
0.188		3680	4053	5041		3680	4527	5401
0.250			5106	6295			5750	7302
0.312				7638				8280

TABLE 1-XXVI

Strength of Huck Lockbolts

Pin Material	Heat Treated Alloy Steel		7075-T6	
Collar Material	2024-T4		6061-T6	
Loading	Single Shear	Tension	Single Shear	Tension
Pin Diameter	Strength – Pounds		Strength – Pounds	
5/32	1770	1530		
3/16	2620	2210	1330	1375
1/4	4650	4080	2280	2535
5/16	7300	6500	3620	4025
3/8	10500	10100	5270	6275

TABLE 1-XXVII

Strength of Jo-Bolts

Jo-Bolt Type	100 Deg Flush Head FF200, FF375		Hex Protruding Head PP164, PP200	
Jo-Bolt Material	Bolt – 4130 Steel Nut – 4130 Steel Sleeve – Type 303 CRES		Bolt – 4130 Steel Nut – 4130 Steel Sleeve – Type 303 CRES	
Bolt Diameter	Single Shear	Tension	Single Shear	Tension
0.164			1677	900
3/16	2620	1400	2620	1400
3/8			9750	5600

TABLE 1-XXVIII

Strength of B Rivets

Rivet Type	Universal Head					100 Deg Head in Countersunk Hole		
Rivet Material	5056 (B)					5056 (B)		
	F_{su} = 27000 psi							
Rivet Diameter	3/32	1/8	5/32	3/16	1/4	1/8	5/32	3/16
Single Shear	195	350	536	774	1400	350	536	774
Riveted Material	Strength — Pounds					Strength — Pounds		
0.016	89							
Magnesium 0.020	111	149						
FS—1h 0.025	139	186	231					
F_{br}=58000 psi 0.032	178	239	295	355				
0.040	195	298	369	443	596	291	415	426
0.045	195	335	415	498	670	316	454	441
0.051		350	471	565	760	312	479	459
0.057		350	526	631	850	318	481	522
0.064			536	707	950	325	483	595
0.072			536	774	1070	326	434	633
0.081				774	1210			
0.091					1360			
0.102					1400			
0.125					1400			

TABLE 1-XXIX

Strength of Blind Rivets

Rivet Type	CHERRY CR156 CR157	DU PONT (Blast-free) DR, DR100	DU PONT (Blast-free) DR, DR100	HUCK (Keystone) P, 100V
Rivet Material	5056	5056	Nickel	5056
Rivet Size	SINGLE SHEAR STRENGTH — POUNDS			
1/8	395	387	442	445
5/32	605	624	701	684
3/16	875	800	1094	986
1/4	1580	1360		

TABLE 1-XXX

Strength of DuPont Blast-Free Blind Rivets

Rivet Type	Brazier Head	100 Deg Head in Dimpled Hole	100 Deg Head in Countersunk Hole			100 Deg Head in Countersunk Hole
Rivet Material	5056	5056	5056			Nickel
Riveted Material	7075-T Clad	7075-T Clad	7075-T Clad			1/4 H CRES
Rivet Diameter	1/8	1/8	1/8	5/32	3/16	1/8
Single Shear	387		387	605	800	387
Material Thickness	Strength—Pounds	Strength—Pounds	Strength—Pounds			Strength—Pounds
0.032	254	336	59			186
0.040	278	360	201			
0.051	296		262	196		
0.064				355	398	
0.072					534	

TABLE 1-XXXI

Strength of AD and DD Rivets (Sheet 1 of 2)

Rivet Type		Universal Head							100 Deg Head in Dimpled Holes				
Rivet Material		2117 — T3 (AD) F_{su} = 30000 psi				2024 — T31 (DD) F_{su} = 41000 psi			2117 — T3 (AD) F_{su} = 30000 psi			2024—T31 (DD) F_{su} = 41000 psi	
Rivet Diameter		3/32	1/8	5/32	3/16	5/32	3/16	1/4	1/8	5/32	3/16	3/16	1/4
Single Shear		217	388	596	862	815	1180	2120	388	596	862	1180	2120
Riveted Material		Strength — Pounds							Strength — Pounds				
	0.020	177	236						299				
Clad 2024-T3,	0.025	211	295						360	462			
Clad 2024-T4,	0.032	217	374	468					413	568	722	744	
Bare 2024-T3,	0.040	217	386	574		586			451	635	839	941	879
Bare 2024-T4,	0.045		388	584	791	659	791		466	661	885	1020	1100
Bare 2024-T6,	0.051		388	593	837	746	896	1210	484	693	940	1110	1360
Bare 2024-T81,	0.057			596	851	815	1000	1350		713	973	1170	1530
Bare 2024-T86,	0.064			596	862	815	1120	1510		736	1010	1240	1730
	0.072				862		1180	1700		755	1050	1290	1880
F_{br}=92000 psi min	0.081						1180	1910			1070	1340	2030
	0.091							2120			1090	1380	2150
	0.102							2120					2260
	0.125												
	0.020	206	278						327	452	572		650
	0.025	211	347						413	462	652		812
Clad 7075-T6,	0.032	217	374	550					535	599	725	786	1040
Bare 7075-T6	0.040	217	386	574		687			555	695	891	982	1300
	0.045		388	584	823	774	929		564	733	957	1060	1480
F_{br}=108000 psi min	0.051		388	593	837	811	1050	1420	575	778	1040	1150	1710
	0.057			596	851	815	1168	1580	576	807	1090	1210	1850
	0.064			596	862	815	1180	1770	576	840	1140	1280	2010
	0.072				862		1180	2000		867	1190	1330	2150
	0.081							2112			1230	1380	2260
	0.091							2120			1267	1420	2370
	0.102							2120					2460
	0.125												

TABLE 1-XXXI

Strength of AD and DD Rivets (Sheet 2 of 2)

Rivet Type		100 Deg Head in Countersunk Hole					
Rivet Material		2117-T3 (AD) $F_{su} = 30000$ psi			2024-T31 (DD) $F_{su} = 41000$ psi		
Rivet Diameter		1/8	5/32	3/16	5/32	3/16	1/4
Single Shear		388	596	862	815	1180	2120
Riveted Material		Strength — Pounds			Strength — Pounds		
Bare 2024-T3, Bare 2024-T6, Bare 2024-T81, Bare 2024-T86	0.020						
	0.025						
	0.032	272	306	391	477	553	708
	0.040	309	397	504	489	628	897
	0.045	323	435	534	504	687	951
	0.051	340	479	583	522	758	982
	0.057	351	500	639	634	817	1100
	0.064	363	523	705	651	886	1220
	0.072	373	542	739	726	942	1350
	0.081	388	560	769	735	992	1470
	0.091		575	795	747	1030	1580
	0.102			818		1070	1670
	0.125			853		1130	1877
Clad 7075-T6, Bare 7075-T6	0.020						
	0.025						
	0.032	272	306	391	477	553	708
	0.040	309	397	504	489	628	897
	0.045	323	435	534	504	687	951
	0.051	340	479	583	522	758	982
	0.057	351	500	639	634	817	1100
	0.064	363	523	705	651	886	1220
	0.072	373	542	739	726	942	1350
	0.081	388	560	769	735	992	1470
	0.091		575	795	747	1030	1580
	0.102			818		1070	1670
	0.125			853		1130	1877

TABLE 1-XXXII

Strength of Corrosion Resistant Steel Rivets

Rivet Type	Universal Head				Universal Head				100 Deg Head in Dimpled Hole		100 Deg Head in C sunk hole	
Rivet Material	CRES $F_{su} = 75000$ psi				CRES $F_{su} = 75000$ psi				CRES $F_{su} = 75000$ psi		CRES $F_{su} = 75000$ psi	
Riveted Material	2024-T				7075-T6				7075-T6		7075-T6	
Rivet Diameter	1/8	5/32	3/16	1/4	1/8	5/32	3/16	1/4	5/32	3/16	5/32	3/16
Single Shear	973	1490	2150	3880	973	1490	2150	3880	1490	2150	1490	2150
Material Thickness	Strength — Pounds				Strength — Pounds				Strength — Pounds			
0.020	237				278				296	416		
0.025	296	366	439		347	430			370	520		
0.032	379	468	563		444	550			474	666		
0.040	473	526	704	920	555	687			686	832		
0.045	532	659	791	1035	624	774	929		791	962		
0.051	603	746	896	1172	707	876	1050	1376	918	1118	683	807
0.057	673	834	1002	1311	790	979	1180	1539			764	902
0.064	757	938	1124	1472	887	1100	1320	1728			858	1012
0.072	851	1050	1265	1655	973	1230	1480	1943			1010	1193
0.081	958	1190	1423	1863		1390	1670	2186			1182	1396
0.091	973	1330	1599	2093		1490	1880	2455			1280	1485
0.102		1490	1793	2345			2060	2755			1387	1533
0.125			2150	2875			2150	3375			1451	1947
0.156				3588				3880				2200

TABLE 1-XXXIII

Strength of Steel and Monel Rivets

Rivet Type	100 Deg Head Flat Head	100 Deg Head Universal Head
Rivet Material	CRES $F_{su} = 75000$ psi	Monel $F_{su} = 50000$ psi
Rivet Size	Single Shear	Single Shear
1/8	973	649
5/32	1490	993
3/16	2150	1430
1/4	3880	2590

TABLE 1-XXXIV

Strength of Hi-Shear Rivets

Rivet Size	Heat Treated Steel HT 160,000 psi
	Single Shear
1/8	920
5/32	1438
3/16	2070
1/4	3680
5/16	5750
3/8	8280

NOTE: Use sheet bearing strength same as bolts.

TABLE 1-XXXV

Strength of Straylor Rivets

Rivet Type	Straylor	
Rivet Material	2024 — T31 $F_{su} = 41000$ psi	
Rivet Diameter	3/16	1/4
Single Shear	1180	2120
Riveted Material	Clad 7075 — T6	
0.102	1136	
0.125	1170	1970
0.156	1175	1970
0.188	1175	1970
0.200	1175	1970
0.250		2083

TABLE 1-XXXVI

Hole Sizes for Hi-Shear Rivets

Rivet Shank Diameter	Convair Modified Hi-Shear Rivets Q4317 and Q4318	Alternate Installation NAS177 or NAS178 Rivets
	Hole Size	Hole Size
3/16	0.1850 + 0.0030	0.1890 + 0.0020
1/4	0.2450 + 0.0030	0.2490 + 0.0020
5/16	0.3065 + 0.0040	0.3115 + 0.0020
3/8	0.3690 + 0.0040	0.3740 + 0.0020

TABLE 1-XXXVII

Countersink Dimensions for Hi-Shear Rivets

Rivet Diameter	3/16	1/4	5/16	3/8
Pilot Hole Diameter	1/8	5/32	5/32	5/32
Nominal Countersink Diameter	0.298	0.391	0.475	0.568
Head Spotface Diameter	3/8	1/2	5/8	3/4
Collar Spotface Diameter	9/16	5/8	3/4	7/8

TABLE 1-XXXVIII

Drill Sizes and Hole Diameter Limits for DuPont Explosive Rivets

Rivet Diameter	Pilot Drill Size	Finish Drill Size	Hole Dia. Limits	
			Minimum	Maximum
1/8	No. 30 (0.1285)	No. 29 (0.136)	0.136	0.140
5/32	No. 21 (0.159)	No. 17 (0.173)	0.173	0.177
3/16	No. 11 (0.191)	No. 6 (0.204)	0.204	0.208

TABLE 1-XXXIX

Minimum Distance from Explosive Rivet to Adjacent Material

Rivet Used		Adjacent Material	
Type	Diameter	Aluminum Alloy	Magnesium
56S	1/8 inch	1/4 inch	1/2 inch
56S	5/32 inch	1/2 inch	1 inch
56S	3/16 inch	3/4 inch	1 1/2 inch

TABLE 1-XL

Grip Length — Aluminum Explosive Noiseless Rivets

Rivet Dia.	Hole Size	Grip Range	Basic Rivet Code "FL" Protruding Head Du Pont No.	Basic Rivet Code "FK" 100 deg Countersunk Head Du Pont No.	Color Code
1/8	0.134 (±0.001)	0.005-0.045	P56S-134A-4		Yellow
		0.045-0.085	P56S-134A-8	P56S-134-100-8	Red
		0.085-0.125	P56S-134A-12	P56S-134-100-12	Brown
		0.125-0.165	P56S-134A-16	P56S-134-100-16	Black
		0.165-0.205	P56S-134A-20	P56S-134-100-20	Blue
		0.205-0.245	P56S-134A-24	P56S-134-100-24	Yellow
		0.245-0.285	P56S-134A-28	P56S-134-100-28	Red
		0.285-0.325	P56S-134A-32	P56S-134-100-32	Brown
		0.325-0.365	P56S-134A-36	P56S-134-100-36	Black
5/32	0.171 (±0.001)	0.025-0.085	P56S-173A-8	P56S-173-100-8	Red
		0.085-0.145	P56S-173A-14	P56S-173-100-14	Yellow
		0.145-0.205	P56S-173A-20	P56S-173-100-20	Blue
		0.205-0.265	P56S-173A-26	P56S-173-100-26	Black
		0.265-0.325	P56S-173A-32	P56S-173-100-32	Brown
		0.325-0.385	P56S-173A-38	P56S-173-100-38	Red
3/16	0.202 (±0.001)	0.025-0.105	P56S-204A-10	P56S-204-100-10	Blue
		0.085-0.165	P56S-204A-16	P56S-204-100-16	Black
		0.165-0.245	P56S-204A-24	P56S-204-100-24	Yellow
		0.245-0.325	P56S-204A-32	P56S-204-100-32	Brown
		0.325-0.405	P56S-204A-40	P56S-204-100-40	Blue
		0.405-0.485	P56S-204A-48	P56S-204-100-48	Red
1/4	0.265 (±0.001)	0.025-0.105	P56S-263A-10		
		0.085-0.165	P56S-263A-16	P56S-263-100-16	Black
		0.165-0.245	P56S-263A-24	P56S-263-100-24	Yellow
		0.245-0.325	P56S-263A-32	P56S-263-100-32	Brown
		0.325-0.405	P56S-263A-40	P56S-263-100-40	Blue
		0.405-0.485		P56S-263-100-48	Red

TABLE 1-XLI

Grip Range—Explosive Blind Rivet—Nickel Alloy

Rivet Nominal Diameter	Grip Range	Basic Rivet Code "HC" Protruding Head Du Pont No.	Basic Rivet Code "HB" 100 deg Countersunk Head Du Pont No.
1/8	0.005-0.073		PN-134-100-X 1/16
	0.010-0.072	PN-134A-X 1/16	
	0.073-0.134	PN-134A-X 1/8	PN-134-100-X 1/8
	0.135-0.197	PN-134A-X 3/16	PN-134-100-X 3/16
	0.198-0.259	PN-134A-X 1/4	PN-134-100-X 1/4
5/32	0.010-0.072	PN-173A-X 1/16	
	0.010-0.134	PN-173A-X 1/8	PN-173-100-X 1/8
	0.073-0.197	PN-173A-X 3/16	PN-173-100-X 3/16
	0.135-0.259	PN-173A-X 1/4	PN-173-100-X 1/4
3/16	0.010-0.072	PN-204A-X 1/16	
	0.010-0.134	PN-204A-X 1/8	PN-204-100-X 1/8
	0.073-0.197	PN-204A-X 3/16	PN-204-100-X 3/16
	0.135-0.259	PN-204A-X 1/4	PN-204-100-X 1/4

TABLE 1-XLII

Drill Sizes and Hole Diameter Limits—Huck Blind Rivets

Rivet Diameter	Pilot Drill Size	Finish Drill Size	Hole Diameter Limits	
			Minimum	Maximum
1/8	No. 32 (0.116)	No. 30 (0.128)	0.129	0.132
5/32	No. 26 (0.147)	No. 20 (0.161)	0.159	0.1635
3/16	No. 16 (0.177)	No. 10 (0.1935)	0.191	0.196
1/4	F (0.257)	I (0.272)	0.272	0.276
5/16	O (0.316)	R (0.339)	0.339	0.343
3/8	V (0.377)	Y (0.404)	0.404	0.408

TABLE 1-XLIII

Grip Range—Huck Blind Rivets

Rivet Diameter	"P" Type Brazier Head		100 deg Countersunk Head	
	Grip Range	Part No.	Grip Range	Part No.
1/8	0.020—0.036	P4A	0.062—0.078	100V4A
	0.037—0.061	P4B	0.079—0.103	100V4B
	0.062—0.086	P4C	0.104—0.128	100V4C
	0.087—0.111	P4D	0.129—0.153	100V4D
	0.112—0.136	P4E	0.154—0.178	100V4E
	0.137—0.161	P4F	0.179—0.203	100V4F
	0.162—0.186	P4G	0.204—0.228	100V4G
	0.187—0.211	P4H	0.229—0.253	100V4H
	0.212—0.236	P4J	0.254—0.278	100V4J
5/32	0.025—0.045	P5A	0.080—0.100	100V5A
	0.046—0.076	P5B	0.101—0.131	100V5B
	0.077—0.107	P5C	0.132—0.162	100V5C
	0.108—0.138	P5D	0.163—0.193	100V5D
	0.139—0.169	P5E	0.194—0.224	100V5E
	0.170—0.200	P5F	0.225—0.255	100V5F
	0.201—0.231	P5G	0.256—0.286	100V5G
	0.232—0.262	P5H	0.287—0.317	100V5H
	0.263—0.293	P5J	0.318—0.348	100V5J
	0.294—0.324	P5K	0.349—0.379	100V5K
	0.325—0.355	P5L	0.380—0.410	100V5L
	0.356—0.386	P5M	0.411—0.441	100V5M
	0.387—0.417	P5N	0.442—0.472	100V5N
3/16	0.030—0.054	P6A	0.100—0.124	100V6A
	0.055—0.091	P6B	0.125—0.161	100V6B
	0.092—0.128	P6C	0.162—0.198	100V6C
	0.129—0.165	P6D	0.199—0.235	100V6D
	0.166—0.202	P6E	0.236—0.272	100V6E
	0.203—0.239	P6F	0.273—0.309	100V6F
	0.240—0.276	P6G	0.310—0.346	100V6G
	0.277—0.313	P6H	0.347—0.383	100V6H
	0.314—0.350	P6J	0.384—0.420	100V6J
	0.351—0.387	P6K	0.421—0.457	100V6K
	0.388—0.424	P6L	0.458—0.494	100V6L
	0.425—0.461	P6M	0.495—0.531	100V6M
	0.462—0.498	P6N	0.532—0.568	100V6N
	0.499—0.535	P6P	0.569—0.605	100V6P

TABLE 1-XLIV.

Drill Sizes and Hole Diameter Limits—Standard AN Rivets

Rivet Diameter	Hole Diameter Limits	Drill Size and Decimal Diameter
1/16	0.067 to 0.073	No. 50 (0.0700)
3/32	0.099 to 0.105	No. 39 (0.0995)
1/8	0.128 to 0.134	No. 30 (0.1285)
5/32	0.161 to 0.167	No. 20 (0.1610)
3/16	0.191 to 0.199	No. 10 (0.1935)
7/32	0.221 to 0.229	No. 1 (0.2880)
1/4	0.257 to 0.265	F (0.2570)
5/16	0.323 to 0.331	P (0.3230)
3/8	0.386 to 0.394	W (0.3860)
1/2	0.515 to 0.523	33/64 (0.5160)

TABLE 1-XLV

Identification of Deutsch Drive Pin Blind Rivets

Rivet Type	Part Number	Pin Color	Sleeve Color
Standard Diameter	6950-6951-69509	Electrofilm Black	Electrofilm Black
Short Pin	6950-6951-SP	Cadmium Plated	Electrofilm Black
Close Tolerance Shank	6950-C 6951-C	Electrofilm Black	Cadmium Plated
Close Tolerance Shank	6950-C 6951-C-SP	Cadmium Plated	Cadmium Plated
1/32 Inch Oversize	06950-06951	Electrofilm Black	Green Dye
1/32 Inch Oversize	06950-06951-SP	Cadmium Plated	Green Dye
High Temperature	7950-7951	Red Dye	Silver
High Temperature	7950-7951-SP	Silver	Silver
1/32 Inch Oversize, High Temperature	07950-07951	Red Dye	Red Dye
1/32 Inch Oversize, High Temperature	07950-07951-SP	Silver	Red Dye

TABLE 1-XLVI

Part Number Identification — Deutsch Drive Pin Blind Rivets
(Sample Part Number 6950-S-C10-6SP)

6950	S	C10	6SP
Head Type	**Material**	**Diameter**	**Grip Length**
6950 — Countersunk Head. 6951 — Protruding Head. 69509 — AN509 Countersunk Head, (Special order only). 06950 — Countersunk Head — 1/32 Inch Oversize Diameter. 09651 — Protruding Head — 1/32 Inch Oversize Diameter. 7950 — High Temperature — High Strength, Countersunk Head. 7951 — High Temperature — High Strength, Protruding Head. 07950 — High Temperature — High Strength, Countersunk Head — 1/32 Inch Oversize Diameter. 07951 — High Temperature — High Strength, Protruding Head — 1/32 Inch Oversize Diameter.	Stainless Steel	04 = 1/8 inch 05 = 5/32 inch 06 = 3/16 inch 08 = 1/4 inch 10 = 5/16 inch 12 = 3/8 inch 14 = 7/16 inch 16 = 1/2 inch NOTE: A "C" before the diameter number indicates close tolerance shank — omit for standard tolerance shank.	(Refer to grip range table.) An "SP" is added to part number for short pin rivets — omit for standard pin rivets.

TABLE 1-XLVII

Drill Sizes and Hole Diameter Limits — Standard Drive Pin Deutsch Blind Rivets

Rivet Diameter	Pilot Drill Size	Finish Drill Size	Hole Diameter Limits Minimum	Maximum
1/8 inch	7/64	1/8	0.125	0.126
5/32 inch	9/64	5/32	0.156	0.157
3/16 inch	#16 (0.177)	#11 (0.191)	0.190	0.194
1/4 inch	A (0.234)	G (0.261)	0.260	0.265
5/16 inch	M (0.295)	O (0.316)	0.315	0.320
3/8 inch	T (0.358)	W (0.386)	0.385	0.390

NOTE: Close tolerance shank rivets should be installed in holes reamed to size to suit the class of fit required by the application in which it is intended.

TABLE 1-XLVIII

Grip Range — Deutsch Drive Pin Blind Rivets

Grip No.	Grip Range Minimum	Grip Range Maximum	Grip No.	Grip Range Minimum	Grip Range Maximum
2	0.103	0.166	16	0.978	1.040
3	0.166	0.227	17	1.040	1.103
4	0.227	0.290	18	1.103	1.165
5	0.290	0.353	19	1.165	1.228
6	0.353	0.415	20	1.228	1.290
7	0.415	0.478	21	1.290	1.353
8	0.478	0.540	22	1.353	1.415
9	0.540	0.603	23	1.415	1.478
10	0.603	0.665	24	1.478	1.540
11	0.665	0.728	25	1.540	1.603
12	0.728	0.790	26	1.603	1.665
13	0.790	0.853	27	1.665	1.728
14	0.853	0.915	28	1.728	1.790
15	0.915	0.978			

Minimum Available Grip No.

Rivet Diameter	Grip No.
1/8 inch	2
5/32 inch	2
3/16 inch	3
1/4 inch	4
5/16 inch	4
3/8 inch	6
7/16 inch	7
1/2 inch	8

TABLE 1-XLIX

Replacement Parts Rework

Part Number	Nomenclature	Rework
8-13601-13 -16	Inboard elevon door	Trim edge 0.030" max.
8-13603-7 thru -36	Elevon nose door	Chamfer and trim edge 0.030" max. Realign by bumping.
8-14116	Fin bay lower aft door	Trim edge 0.030" max.
8-14139-7	Fin bleed air door	Trim edge 0.030" max.
8-14140-1	Fin equipment door panel	Trim edge 0.030" max.
8-14141-1	Waveguide access door panel	Trim edge 0.030" max.
8-14142-3	Fin electrical equipment door panel	Trim edge 0.030" max.
8-14144-3	Fin rudder controls access panel	Trim edge 0.030" max.
8-14228	Fin tip leading edge	Trim edge 0.010" max.
8-14232	Fin lower leading edge	Trim edge 0.010" max.
8-14234-1	Fin upper leading edge	Trim edge 0.010" max.
8-14518-1	Fin tip, lower	Remove and reinstall jo-bolt attachment. Trim 0.030" max.
8-14521-5	Fin tip, upper	Trim 0.030" max.
8-14650-7	Rudder hinge access door	Trim edge 0.030" max.
8-14655-9	Fin hydraulic and control access door	Trim edge 0.030" max.
8-14825-11	Fin tip waveguide access door	Trim edge 0.020" max.
8-17630-81 -82	Main landing gear wing fairing	Trim edge 0.250" max.
8-18004-7 -8	Wing fuselage intersection angle	Match drill for fasteners for fuselage and wing.
8-18004-9	Wing fuselage intersection angle	Match drill for fasteners for fuselage and wing. Replace jo-bolts through fairing to wing.

**Applicable to F-106A airplanes only.*

***Applicable to F-106B airplanes only.*

TABLE 1-XLIX

Replacement Parts Rework (Cont)

Part Number	Nomenclature	Rework
8-18040-15 -16 -67 -68 -69 -70 -87 -88 8-18041-7 -8 -9 -10 8-18060-9 thru -14 -77* & -83*		Same rework requirements as 8-18004-9 for all listed dash no's.
8-18201-1 -2	Stub leading edge assy	Match drill and rivet at attachment to wing-fuselage attach angles. Trim 0.010" max.
8-18202-1 -2	Sta 144 to 216 wing leading edge	Trim 0.010" max.
8-18203-1 -2 8-18204-1 -2 8-18204-3 -4	Wing leading edge Sta 221 to 296 Sta 301 to 334 Sta 338 to 384 Sta 301 to 334	Trim 0.010" max.
8-18231-1 thru 8-18231-803	Wing leading edge panels	Trim 0.030" max.
8-18231-805 -806	Wing leading edge panels	Match drill outboard attachment holes. Trim 0.030" max.
8-18252-3 thru -6	Sta 144 to 216 leading edge	Trim 0.010" max.
8-18254-1 thru -4	Sta 301 to 334 wing leading edge	Trim 0.010" max.
8-18255-3 -4	Sta 338 to 384 wing leading edge	Trim 0.010" max.
8-18256-1 -2	Sta 301 to 344 wing slotted leading edge	Trim 0.010" max.
8-18281-1 thru -14	Wing leading edge panel	Trim 0.030" max.

**Applicable to F-106A airplanes only.*

***Applicable to F-106B airplanes only.*

TABLE 1-XLIX

Replacement Parts Rework (Cont)

Part Number	Nomenclature	Rework
8-18911-1 -2	Wing tip	Trim 0.020" max.
8-18913-7 -8	Wing fuselage intersection angle	Match drill fasteners from wing and fuselage. Replace jo-bolt through fairing to wing.
8-18989-1 -2	Spar I access attachment angle (fairing)	Match drill for fasteners. Replace jo-bolts through fairing to wing.
8-44719*	External power access door	Trim edge 0.030" max. Adjust latch. Drill and lockwire latch screws.
8-44545-7* -8	Main landing gear door	Drill door attachment holes from hinge. Locate and rivet wing fuselage closure angle. Trim 0.080" max.
8-45958-21*	Ram air turbine door	Trim 0.120" max., aft and lower edge. Trim 0.030" max., forward edge.
8-73830-65	Retainer windshield glass	Trim 0.090" max., forward edge. Trim 0.060" max., other edges. Chamfer if necessary.
8-73830-69	Retainer windshield glass	Trim 0.060" max. Chamfer edge where necessary.
8-74017-1 * -3 -5 -805	Canopy assy	Match drill shear plate after aligning. Trim edge 0.060" max.
8-74406-99	Radar compartment lower panel access door.	Trim edge 0.030" max.
8-74497-7 * -8	Fixed dorsal access door.	Trim edge 0.030" max.
8-74498-7 thru -17	Removable dorsal assy	Trim edge 0.030" max.
8-74600-220 -295	Forward radar compartment door	Trim edge 0.250" max. Crimp lower edge if required. Install rivets to retain hinge pin.
8-74602-23	Engine oil cooler door	Trim edge 0.030" max.
8-74606-7 * -9	Fuselage fuel tank door	Trim edge 0.120" max.
8-74609-63	Hydraulic access door	Trim forward and aft edge 0.030" max. Trim inboard edge 0.200" max.

**Applicable to F-106A airplanes only.*

***Applicable to F-106B airplanes only.*

TABLE 1-XLIX
Replacement Parts Rework (Cont)

Part Number	Nomenclature	Rework
8-74614-43 -44	Forward engine mount access door	Trim edge 0.030" max.
8-74626-187	Nose landing gear door	Trim edge 0.060" max.
8-74652-13 * -15	Emergency canopy release door	Trim 0.030" max.
8-74655-25 *	Liquid oxygen access door	Trim 0.030" max.
8-74659-13	Generator oil cooler door	Trim 0.030" max.
8-74663-1 -2 -3 -4 -801	Lower inboard missile bay door	Trim edge 0.090" max.
8-74664-1 -2 -3 -4	Upper outboard missile bay door	Trim edge 0.090" max.
8-74669-3 * -4	Electronics access door	Trim edge 0.120" max.
8-74845-7 *	Canopy access door	Trim edge 0.030" max.
8-74854-65 *	Pilot's canopy aft fairing	Trim edge 0.030" max.
8-74860-23	Drag chute mechanism door	Trim edge 0.030" max.
8-74863-13	Speed brake mechanism door	Trim edge 0.040" max.
8-74870-7 -8	Speed brake mechanism door	Trim edge 0.060" max.
8-77611-7 * -8	Tank inspection door	Trim edge 0.030" max.
8-77620-31	Liquid oxygen access door	Trim edge 0.030" max.
8-77628-31 * -55	Pneumatic starter door	Locate and drill hinge attachment holes from fuselage structure. Trim edge 0.030" max.
8-77629-7	Sta 145 LH access door	Trim edge 0.030" max.
8-77727-7 *	Center refrigeration door beam	Chamfer ends 0.020" max. Trim hinge nodes 0.010" max.
8-77804 *	Windshield deflector	Trim edge 0.030" max.
8-92703	Fuel nozzle ground door	Trim edge 0.030" max.

**Applicable to F-106A airplanes only.*

***Applicable to F-106B airplanes only.*

TABLE 1-XLIX

Replacement Parts Rework (Cont)

Part Number	Nomenclature	Rework
8-76017-1 **	Canopy assy	Match drill phase plate after aligning. Trim forward end 0.075" max. Trim lower edge 0.060" max.
8-76017-3 **	Canopy assy	Same as -1 except no trim to forward end.
8-76204-7 **	Cover, hydraulic access, sta 329 to 357	Trim edge 0.030" max.
8-76198-3 **	Cover plate, access hole, sta 384.50 to 405.20	Trim edge 0.060" max.
8-76315-5 **	Canopy, fuel tank vapor seal	Trim edge 0.020" max.
8-76361-1 ** -2 ** 8-76362-7 ** -9 ** 8-76372-7 ** -8 **	Door, maintenance, missile bay, sta 222.40 to 236.88	Trim edge 0.020" max. NOTE Refer to Air Force drawing number 7545908 for longeron repair.
8-76498-7 ** -9 ** -11 ** -13 **	Removable dorsal assy	Trim edge 0.150" max.
8-76498-105** -107** -109** -111**	Removable dorsal assy	Trim edge 0.030" max.
8-76501-35 ** -43 ** -49 **	Dorsal panel instl, sta 308.50 to 318.44	Trim 0.120" max.
8-76567-65 **	Duct leading edge access door	Trim 0.020" max.
8-76611-51 **	Mid bay electronics access door	Trim edge 0.060" max.
8-76646-29 ** 8-76653-7 ** 8-76870-13 **	Canopy island	Trim lower and aft edge 0.120" max.
8-76652-11 ** -13 ** -15 **	Door assy, emergency canopy release	Trim edge 0.030" max.
8-76802-801** -802**	Canopy, forward, transparent panel	Trim forward edge 0.075" max.
8-76856 -1 **	Aft canopy fairing	Trim edge 0.030" max.

**Applicable to F-106A airplanes only.*

***Applicable to F-106B airplanes only.*

TABLE 1-XLIX

Replacement Parts Rework (Cont)

Part Number	Nomenclature	Rework
8-76873 **	Fairing, canopy assy, telescoping	Trim forward and aft edge 0.060" max.
8-76942-5 **	Dorsal refrigeration compartment door	Trim edge 0.030" max.
8-76948-105** -109** -123** -124**	Heat exchanger exhaust	Countersink attachment holes. Trim 0.030" max.
8-99954-1 ** -3 ** -803** -805** -807** -809**	Cover assy, splash, nose wheel well	Trim to clear cut outs for tubing and harness 0.500" max.

***Applicable to F-106B airplanes only.*

TABLE 1-L

Weight of Airplane and Components

Component	Condition	Weight in Pounds	
		F-106A	F-106B
Airplane.	Basic Weight.	25,227	26,200
Wing.	Basic (Including Main Landing Gear Attach Fittings, Elevon Support Fittings, and Access Doors).	1,661	1,661
Wing Tip.	Basic.	57	57
Elevon.	Basic (Without Support Fittings).	128	128
Fin Tip.	Basic.	71	71
Rudder.	Basic.	71	71
Main Landing Gear.	Wheel. Brake. Actuator (Dry). Side Brace. Oleo Strut (Including Drag Brace, Pivot Beam, and Retract Mechanism). Door.	48 95 15 43 208 57	48 95 15 43 208 57

TABLE 1-L

Weight of Airplane and Components (Cont)

Component	Condition	Weight in Pounds	
		F-106A	F-106B
Nose Landing Gear.	Wheel.	11	11
	Actuator (Dry).	4	4
	Oleo Strut (Including Drag Brace, Steer Unit, Retract Mechanism).	119	119
	Door.	23	23
Missile Bay Door.	Upper Panel.	91	91
	Lower Panel.	53	53
Canopy.	Basic.	131	380
Radome.	Basic.	156	156
Gun (F-106A).	Basic.	870	———

TABLE 1-LI

Airplane Center of Gravity

Airplane	Condition (Landing Gear Down)	Center of Gravity Location	
		Vertical	Horizontal
F-106A.	Basic Weight.	7.8 inches below W.L. 0.00.	Station 422.0
F-106B.	Basic Weight.	8.8 inches below W.L. 0.00.	Station 415.0

TABLE 1-LII

Packing and Crating Information — Airplane Components

Component	Weight Lbs	Dimensions (Inches)	Center of Balance (Inches)	Remarks
Wing.	1661	294½ x 16½ x 166¾	100 forward of No. 7 spar and 54 from inboard edge.	Wing tip, elevon and MLG removed.
Wing Tip.	57	77 x 44 x 8	27 forward of trailing edge and 19 from and perpendicular to outboard edge.	Basic.
Elevon.	128	161 x 11	70 from inboard end.	Basic.
Drop Tank.	236	162 x 26 x 38	134 aft of tank nose tip.	
Radome.	156	38½ Dia. x 83½	57 aft of forward end.	Basic.
Canopy, F-106A.	131	72 x 34½ x 29	39 from apex.	Basic.
Canopy, F-106B.	380	130 x 40 x 36	69 from apex.	Basic.
Fin Tip.	71	82 x 21 x 3	45 from top of aft edge.	Basic.
Rudder.	71	68½ x 27 x 7½	59 from top of trailing edge and 19 from bottom of trailing edge.	Complete with control horn.
Missile Bay Door, Upper Panel.	91	196 x 12 x 5½	98 from forward hinge point.	Basic.
Missile Bay Door, Lower Panel.	53	196 x 13 x 3	96 from forward hinge point.	Basic.
Gun (F-106A)	1540	104 x 46 x 60	56.4 inches from forward end	Gun assembly included.