

BUS BARS

BENDING, CUTTING, DRILLING, SUPPORTING, ERECTING AND CONNECTING

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2. GENERAL

2.1 Scope

2.11 This section covers requirements and installation procedures to be followed when bending, cutting, drilling, supporting, erecting, and connecting either open bus bars or bus bars in bus ducts. It is to be used with other sections in the 8 series.

2.2 Cautions

2.21 Wear R-3055 safety goggles when using the drill in such a position that chips might fly into the eyes.

2.22 Do not use an electric drill, whether the drill frame is grounded or not grounded, on live bus bars. In these cases use ungrounded hand drilling tools.

NOTE: By ungrounded hand tools, it is meant that a metallic bar should not be applied as a lever in contact with a grounded object and the hand drill.

2.23 It is satisfactory to use the electric drill with grounded frame on bus bars at ground potential provided additional precautions are taken to protect adjacent live bus bars or equipment from contact with the drill frame.

3. INSTALLING EQUIPMENT

3.1 The required tools and supplies are shown in Section 8A.

4. BENDING

4.1 Though all required bus bar bends are normally furnished it may be necessary to make an occasional bend on alteration jobs. The nature of the bend and the size of the material will determine whether the bend can be made on the job. If the bend is to be made in a local shop, a sketch or template should accompany the order to the shop to insure that the bend will be satisfactory.

5. CUTTING

5.1 For cutting bus bars up to and including 12" widths, portable power hack saws may be used. The R-3030 saw cuts widths to 4" and the R-2557 saw to 12". Lubrication and maintenance for the R-2557 and R-3030 portable power hack saws are covered in Handbook 28.

5.2 Before connecting the saw to the power line be sure that the type of current, the voltage, and the frequency available at the point where the saw is to be used, corresponds to that shown on the motor name plate.

5.3 It is recommended that cutting oil, if available, or any other light lubricating oil be used as a coolant and lubricant.

5.4 Apply oil with an R-1298 oil can or the equivalent. Care should be exercised to insure that an oil can containing cutting oil is not used in the lubrication of any rotating equipment.

5.5 Remove burr by lightly stroking the sharp edge on a 45° angle with an R-1482 flat file.

6. DRILLING

6.1 When drilling bus bars, it is suggested that the work be done on a bench whenever possible. Holes up to 5/16"

can be drilled with the R-1285 electric drill. Where larger sized holes are to be drilled, use the R-3032 electric drill and the R-3033 drill stand when required. Information on these tools and drill sharpening will be found in Handbook 28.

6.2 It is recommended that cutting oil, if available, or any other light lubricating oil be used as a coolant and lubricant.

6.3 Apply oil with an R-1298 oil can or the equivalent. Care should be exercised to insure that an oil can containing cutting oil is not used in the lubrication of any rotating equipment.

6.4 Deburr all holes. Use an R-1458 countersink or an R-1482 flat file. Burrs should be removed to insure that the bus bars will be flat and afford maximum area in good electrical contact.

7. SUPPORTING

7.1 Bus bar supports consist of clips, details and piece parts securing the bars to porcelain, asbestos or plastic insulators which are equipped with metal inserts. These in turn are supported by auxiliary framing or other details.

7.2 When aluminum bus bars are added to existing aluminum installations in open cell battery rooms, insulators with alloy inserts and aluminum-alloy sleeves, clips, bolts, nuts, rods, framing bars, etc., are used.

7.3 Insulators with steel inserts and steel clips, sleeves, bolts, nuts, rods, etc., are used with the present closed-cell installations.

7.4 Bus bar support arrangements are covered on standard drawings furnished the job. If these drawings are not furnished, they should be ordered, as required. Where large capacity plants require special details, job drawings covering these details will be supplied.

7.5 Bus bars shall be supported on maximum of 6'-0" centers.

7.6 In supporting laminations of 3 or 4 bars, it is not necessary to clip the outside bus bars if they are held by clamps at the proper spacings.

7.7 Place supports as close to right angle bends and risers as practicable.

7.8 The installation of auxiliary framing bars and insulator supports is covered in Handbook 30.

8. ERECTING

8.1 Clearance

8.11 Bus bars shall maintain a spacing of at least 3" from metal pipes, cable racks, auxiliary framing, etc., where this spacing can be obtained without excessive expense. If practicable this clearance should be increased to 1'-0" and in no case should it be less than 1/2" for voltages up to 125 and 3/4" for voltages between 125 and 250 to ground. Allow 7'-0" clearance over passageways, sufficient clearance over open tank batteries for removal of plates, and sufficient clearance over cells on stands for maintenance.

8.2 Height Adjustment

8.21 Adjust the height of horizontal runs by locating one end from the floor and using a bench level to adjust the balance of the run. Start with the Battery Control Bay.

8.22 Use C clamps for temporarily clamping together or supporting bus bars, during the erecting operations.

8.3 Lap Joints

8.31 For in line extensions the minimum overlap for bus bars shall be the width of the bus bar. The maximum overlap shall be the width of the bus bar plus two inches.

8.32 Lap joints at right angles shall have their sides and ends flush.

8.33 To compensate for the offset when splicing succeeding sets of bars in the same direction place alternate bars in line.

8.34 Joints in horizontal bus runs shall not be made at the point of taps such as the attachment of risers from the Generator Control Bay.

9. CONNECTING

9.1 General

9.11 Aluminum bus bars shall not be connected to lead or lead-coated bus bars, posts or details or directly to fuse mountings, switches, shunts, or other heat producing apparatus. Aluminum bus bars shall not be tapped for fastening terminal lugs or for fastening bar to bar. Use through bolts or clamp joints.

9.12 Bus bar connections are made up the same for both ac and dc circuits, that is, as far as cleaning and the use of a protective compound is concerned.

9.2 Type of Joints

9.21 Bus bar joints are made with either clamps or with bolted connections.

9.22 Bolted joints are ordinarily used with the smaller details on the rear of power boards and for bars forming parts of most shop built assemblies.

9.23 In open cell battery rooms, bolted joints are used for copper bus bars and aluminum alloy clamps with aluminum alloy nuts, bolts and washers are used with aluminum bus bars.

9.3 Preparation of Contact Surfaces

9.31 Contact surfaces on bus bars that are current carrying connections shall be cleaned so that metal-to-metal contact is maintained.

9.32 When frames are grounded by auxiliary framing, cable rack, and/or conduit structure the surfaces between the associated ground bar and the framework need not be prepared.

9.33 Prepare contact surfaces between ironwork, and bus bars, and bus bar details used to ground isolated frames.

(a) The principal equipment room ground bar, which is usually located at the bottom of the MDF & CDF frames, should have the surfaces between the bar and the iron work prepared whenever the frame is isolated (independent of the main auxiliary structure) or whenever the bonding ground bar at the top of the protector verticals has been omitted. Under all other conditions the surfaces need not be prepared.

(b) At the top of MDF and CDF frames, the junction of the ground bar and each protector vertical is a current carrying connection and must have the surfaces prepared.

9.34 Just prior to making a connection, clean copper, brass or iron contact surfaces with R-3163 abrasive paper. Apply a thin coating of R-3266 NO-OX-ID "A" Compound immediately after cleaning.

9.35 A metallic coating or plating is sometimes used on bus bars to reduce the resistance of the connecting joints. These contact surfaces should be cleaned with a cloth to remove grease and other foreign matter but should not be sanded or the surface otherwise scratched. Apply NO-OX-ID "A" Compound.

9.36 Clean aluminum contact surfaces with R-3163 abrasive paper to remove dirt, hard grease, etc., and to break down the hard oxide. Attach the abrasive paper to the R-3162 paper holder and secure by operating the clamping device and handle. When using the holder and paper make sure it is parallel with the surface to be cleaned in order to avoid gouging which reduces the area of contact. Apply a coat of R-3266 NO-OX-ID "A" Compound and use an R-2628 wire brush to break up any soft oxide that may have reformed. Aluminum connections should be clamped together within five minutes, if possible, without removing NO-OX-ID "A" Compound.

CAUTION: Do not use motor driven aids in cleaning aluminum contact surfaces.

9.37 See section 7E for connection of bus bars to studs.

9.4 Clamps

9.41 Bus bar clamps are used to join bus bars together without drilling. The bar contact surface of the clamp halves are convex by design. As the clamp halves are drawn down and flattened against bars the stress set up in the clamp exerts a pressure across the surface of the bars. See Figure 1.

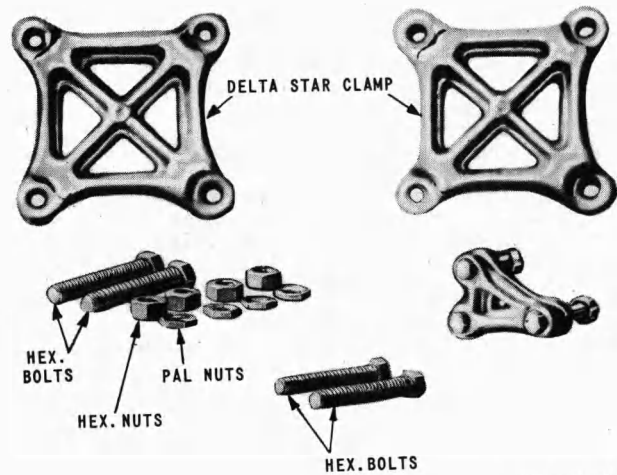


FIG. 1 BUS BAR CLAMPS AND PARTS
(PAR. 9.41)

9.42 The job plan shows the location of clamps and is used with drawings H-569-292 for KS-15761 Bronze Bus Bar Clamps and H-569-293 for KS-15761 malleable iron bus bar clamps. These drawings contain a stocklist and bolting information. Use bus bar clamps as follows:

9.421 Malleable iron clamps (zinc coated) are preferred for clamping copper to copper, aluminum to aluminum, and copper to aluminum except in open cell battery rooms. Normally, zinc or cadmium-plated bolting material will be provided, however, copper-plated bolting material may be furnished and used.

9.422 Bronze clamps may also be used for clamping copper to copper, aluminum to aluminum and copper to aluminum except in open cell battery rooms.

9.423 In open cell battery rooms, bolted joints are used for copper bus bars and aluminum alloy clamps with aluminum alloy nuts, bolts and washers are used with aluminum bus bars.

9.43 Refer to Table A for listings of KS-15761 Bus Bar Clamps.

9.44 Assemble the clamp on the bus bars to be connected. Tighten sufficiently to support and retain the position

of the bus bars. With a block of hard wood, align and square the bars and the clamp. At 90° corners the clamp bolt at the outside corner should clear a straight line extended from both edges of the bus bars.

9.45 When installing bus bar clamp on laminated bus bar runs, alignment (edge to edge) of the bus bars may be facilitated by a job made clamp, applicable especially where the bus bar clamp is located a considerable distance from the last support point.

9.46 With a correctly fitted box type wrench tighten the clamping bolts gradually, going from one bolt to another until all bolts are tight. This may occur before the corners of the clamp are against the bus bar. Do not over tighten the clamp as the center will bow-out and the ears will bend.

9.47 The palnut is a single thread locknut pressed out of sheet steel, hardened and tempered. The working portion is formed of resilient spring jaws that grip the root of the thread and maintain spring tension against the regular nut. See Figure 2. When turned against the stationary surface of the regular nut the jaws follow the thread causing a strong spring pressure (AA) against the regular nut. The jaws (BB) also close and grip the bolt tightly. Thus two separate locking actions take place.

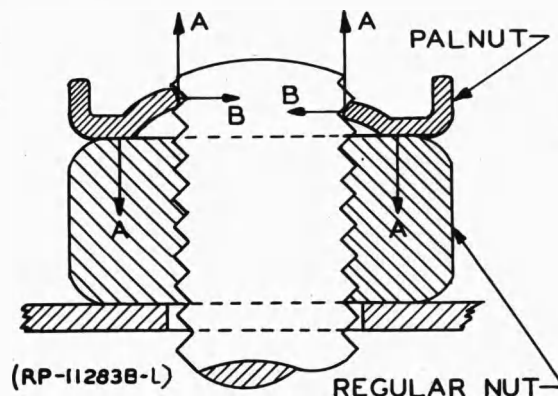


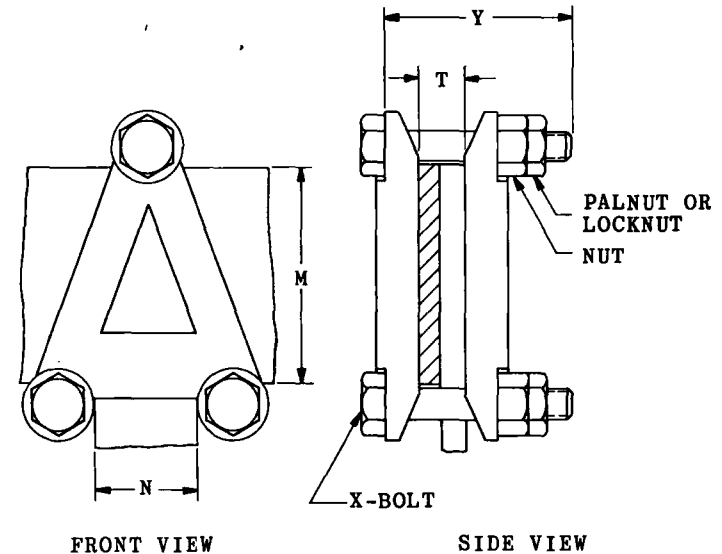
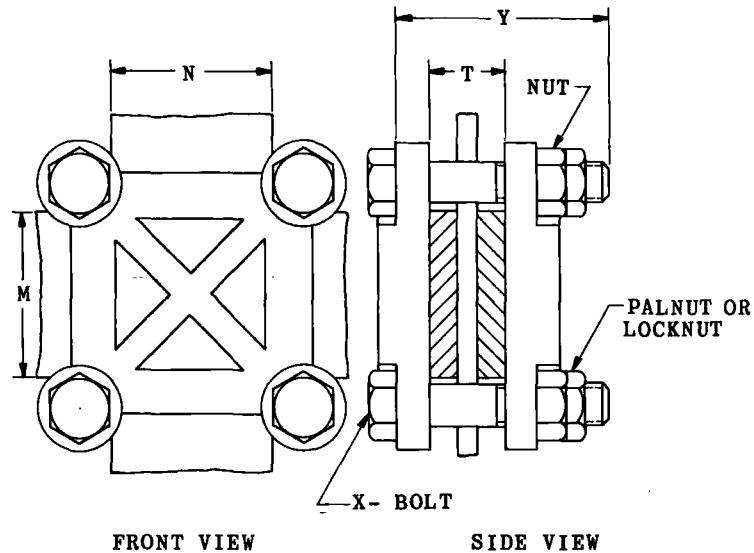
FIG. 2 PALNUT INSTALLED (PAR. 9.47, 9.481)

9.48 Install a palnut or locknut on each bus bar clamp bolt. Verify that the regular nuts are tight immediately before applying the palnuts or lock nuts.

9.481 As shown in Figure 2, apply the palnut with the smooth side first; open side out. Run up to the regular nut finger tight and take up one quarter turn with a wrench.

9.482 On the larger clamps, locknuts may be provided instead of palnuts. Take up with a wrench until snug.

TABLE A - KS-15761 BUS BAR CLAMPS (PAR. 9.43)



LIST NO.		M	N	X	Y MIN	LIST NO.		M	N	X	Y MIN
MALLEABLE IRON CLAMP (FOR COPPER AND ALUMINUM BUS BARS)	ALUMINUM CLAMP (FOR ALUMINUM BUS BARS IN OPEN CELL BATTERY ROOMS ONLY)					MALLEABLE IRON CLAMP (FOR COPPER AND ALUMINUM BUS BARS)	ALUMINUM CLAMP (FOR ALUMINUM BUS BARS IN OPEN CELL BATTERY ROOMS ONLY)				
30	230	1 1/2	1 1/2	3/8-16	T + 1 1/2	1	201	2	1	5/16-18	T + 1 1/4
31	231	2	1 1/2	3/8-16	T + 1 1/2	2	202	2	1 1/2	3/8-16	T + 1 1/2
32	232	2	2	3/8-16	T + 1 1/2	3	203	2	2	3/8-16	T + 1 1/2
33	233	2 1/2	2	3/8-16	T + 1 1/2	4	204	3	1	5/16-18	T + 1 1/4
34	234	3	1 1/2	3/8-16	T + 1 1/2	5	205	3	1 1/2	3/8-16	T + 1 1/2
35	235	3	2	3/8-16	T + 1 1/2	6	206	3	2	3/8-16	T + 1 1/2
36	236	3	3	3/8-16	T + 1 1/2	7	207	3	2 1/2	3/8-16	T + 1 1/2
37	237	4	1 1/2	3/8-16	T + 1 1/2	8	208	3	3	3/8-16	T + 1 3/4
38	238	4	2	3/8-16	T + 1 1/2	9	209	4	1	3/8-16	T + 1 1/2
39	239	4	3	3/8-16	T + 1 1/2	10	210	4	1 1/2	3/8-16	T + 1 1/2
40	240	4	4	1/2-13	T + 1 3/4	11	211	4	4	1/2-13	T + 2
41	241	6	1	3/8-16	T + 1 1/2	12	212	6	1	3/8-16	T + 1 1/2
42	242	6	1 1/2	3/8-16	T + 1 1/2	13	213	6	1 1/2	3/8-16	T + 1 1/2
43	243	6	2	3/8-16	T + 1 1/2	14	214	6	2	3/8-16	T + 1 3/4
44	244	6	3	3/8-16	T + 1 1/2						
45	245	6	4	1/2-13	T + 1 3/4						
46	246	6	6	1/2-13	T + 2						
47	247	8	3	5/8-11	T + 2 1/4						
48	248	8	4	5/8-11	T + 2 1/4						
49	249	8	6	5/8-11	T + 3						
50	250	8	8	5/8-11	T + 3 1/4						
51	251	10	6	5/8-11	T + 3 1/2						
52	252	10	8	5/8-11	T + 3 1/2						
53	253	10	10	3/4-10	T + 3						

9.5 Bolted Connections

9.51 Prepare the contact surfaces as described above and assemble all nuts, bolts and washers tight enough to restrain the bars. Align the ends and/or sides as nearly as the length of the bars will permit by tapping with a hammer and hardwood block. Once aligned, and with correctly fitted wrenches, tighten the bolts going from one bolt to another until all bolts are tight.

9.52 Make a final check of all bolts for a joint. This serves as final verification. No Palnut or lock nut is required on bolted connections.

10. BOLTS, SCREWS, NUTS AND WASHERS

10.1 Bolts, screws, nuts, washers and clips in contact with copper bus bars shall be copper-plated steel except where lead-coated or lead-encased details are used. Bolts, screws, nuts, washers and clips in contact with aluminum bus bars

shall be zinc or cadmium-plated steel except in open cell battery rooms. Where copper or bronze and aluminum are joined together such as: "(1) copper terminal lugs and aluminum bus bars, (2) aluminum splice plates and copper ground bars or vice versa, (3) copper bus bars and aluminum bus bars," all the bolts, nuts and washers of a joint shall be of the same material but may be either copper-plated steel, or, zinc or cadmium-plated steel.

10.2 Stud bolts, nuts and alloy caps shall be used at the reinforced bus bars of open-tank cells for connecting copper bus bars. Put R-3266 NO-OX-ID "A" alloy caps.

10.3 Requirements on such items as where washers are needed, what the allowable minimum thread engagement is for a nut or cap screw, etc., will be found in Handbook 30.

→ Arrowed lines indicate new or changed information.

[Vertical lines at side of paragraphs indicates requirements.

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