HARDENING OF CENTRAL OFFICE AND MAIN STATION COMMUNICATION EQUIPMENT INSTALLED IN 50-PSI BUILDINGS GENERAL EQUIPMENT REQUIREMENTS

CONTENTS PAGE

CONTENTS PAGE

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CONTENTS PAGE

CONTENTS PAGE

1. GENERAL

A. Scope

1.01 This section covers the general equipment requirements for hardening central office and main station (such as carrier terminal) communication equipment and installing superstructure bracing and shock mountings to provide a communications installation capable of withstanding shock enviroment of 50 psi resulting from nuclear explosions. Installations that have been engineered to meet prescribed requirements during and after such exposure are said to be "hard" or to have been "hardened."

(a) The requirements herein which refer to "equipment bays" apply to standard bulb-angle-, channel-, cable duct-, and sheet metal box (electronic switching system)-type equipment bays which are adapted for shock isolation by means of suitable clamping plate and adapter plate details to reinforce the frames and accommodate the shock mounts. Design requirements for similar facilities for sheet metal box-type frames used in No. 5 crossbar system are not included because shock mounting is not presently

specified for installations which employ these frames.

(b) General equipment requirements for hardening of intermediate or auxiliary station communication equipment are covered in Section 800-610-160.

(c) General equipment requirements for hardening of central office and main station communication equipment installed in 10-psi buildings are covered in Section 800-610-163.

(d) General equipment requirements for hardening of central office and main station communication equipment installed in 2-psi buildings are covered in Section 800-610-164.

1.02 This section is reissued to reflect the adoption of a new suspension-type shock isolation system for equipment bays, to rate those requirements and figures of the former standard system A&M Only, add **50-PSI BUILDINGS** to the title, and to add references to Sections 800-610-163 and 800-610-164. Since this reissue covers a general revision, the arrows normally used to indicate changes have been omitted.

1.03 The requirements covered in this section shall be followed, except as modified by applicable specifications and drawings.

B. Building Construction

1.04 The hardening requirements covered herein are based on the assumption that the equipment will be installed in special underground buildings of shock resistant reinforced concrete construction which have been designed to withstand an atmospheric overpressure pulse of 50 psi resulting from a nuclear explosion. The Bell Telephone Laboratories, Department 5425, shall be consulted before proceeding with any jobs involving survival of exposure to atmospheric overpressure other than 50 psi.

(a) The building design criteria for 50-psi buildings is covered in X-76091.

1.05 The building design provides for a clear ceiling height of 15 feet 0 inch in all main equipment areas. It also allows for the equipment to be adequately fastened to the floor, walls, and columns and for suspending the overhead structures and the upper ends of equipment bays from the ceiling.

1.06 With the application of suspension mounting to the intermediate floor slab or the roof slab of a building, special consideration must be given to the ability of the slab to sustain the double loading, that is, a shock load or floor load on top and a suspended load below.

1.07 Continuous channel inserts are embedded in the reinforced concrete ceiling in parallel rows and extend over all the equipment area. The embedded ceiling channel rows are dimensioned from the lines of building column centers which are 18 feet 6 inches apart. The exterior rows in a building are on the column center lines with the adjacent rows spaced 3 feet 9 inches inside the column center lines and the remaining two rows spaced at 3-foot 8-inch intervals as shown on ED-97716-10. Rows of embedded ceiling channel inserts are similarly spaced over the areas between column lines and the walls of the equipment room. In all instances the embedded ceiling channel rows extend to the equipment room walls.

1.08 The following precautions shall be followed where the suspension-type shock mount system is added in existing buildings which were originally designed for the cone-type shock mount system.

(a) Consideration must be given to additional inserts which will give a support grille pattern comparable to the embedded channel pattern.

(b) Before initially adding suspended bays, a study must be made of the building structure and floor plans since it is possible in buildings with both types of shock mount system to overload the floor and ceiling.

C. Basic Principles

1.09 ***The hardened equipment units*** (including such items as mounting plates, panels, and relay rack units) within the equipment bays are designed to withstand direct vibratory accelerations up to 3G. Acceleration in excess of 3G is absorbed by the shock mount system.

1.10 ***Equipment bays*** are provided with a suspension-type shock mount system to take

the vertical and horizontal shock load that would result from a nuclear explosion.

1.11 ***Cable racks, cable terminals, lighting fixtures,*** and other framework associated with bulb-angle, channel-, and cable-duct type equipment bays are supported by auxiliary framing which is fastened directly to the ceiling and entirely independent of the shock mounted bays.

1.12 ***Electronic Switching System:*** Cable racks, cross aisle cable troughs, and lighting fixtures in the electronic switching system equipment area (using sheet metal box-type bays) are fastened directly to the framework structure of the shock mounted bays and not attached to the ceiling.

1.13 ***Cables feeding from cable racks*** to the equipment bays are provided with sufficient slack to permit relative motion in any direction between cable racks and equipment, as covered in subsequent paragraphs.

1.14 ***Power equipment mounted in box type framework,*** such as 302B power plants, floor and rack mounted battery cells, and large cabinet-type rectifiers are fastened to shock isolation platforms which are isolated from the floor of the building through a system of shock mounts. Power equipment mounted in relay rack type framework or small power plants mounted in cabinets are provided with a suspension-type shock mount system to take the vertical and horizontal shock load that would result from a nuclear explosion.

1.15 ***Engine-alternators*** are provided with shock isolation mountings furnished by the manufacturer. These mountings are bolted to the floor.

1.16 ***Ladder-type cable racks*** serving the suspended power bay lineups are supported directly from the embedded ceiling channels by threaded rods. Bracing is not provided. Spring-supported, hinged sections of cable rack are provided to facilitate relative motion of equipment and cable rack. Cable racks, bus bar, or bus duct are mounted on top of equipment bay lineups where all cabinets are on the same shock isolation platform.

2. DESIGN CONSIDERATIONS

A. Basic Criteria

2.01 The object of hardening individual equipment units is to enable them to withstand a direct transient input of 3G peak acceleration without shock mounting. The performance criteria which hardened equipment shall meet when subjected to this shock are as follows.

(a) The equipment shall suffer no physical damage.

(b) Established connections shall remain intact, but momentary interruptions of the transmission path due to vibration of components, chattering of relay contacts, etc, will be permissible during the period of shock. Continuity of normal switching operations will not apply to connections which are in the process of being established during the shock period.

(c) The equipment shall be capable of functioning subsequent to the period of shock without manual reset.

2.02 Equipment shall not overload the part of the building on which it is mounted. During the shock period, the sum of the total static and dynamic loads shall not exceed the rated building floor loading.

2.03 Structural response of the supporting floor, ceiling, or wall shall not be considered as providing any shock isolation to equipment mounted on it.

2.04 Electrical, duct, and pipe connections to equipment shall operate satisfactorily after the shock period.

B. Modification of Apparatus and Wiring

2.05 Standard equipment and apparatus that is to be specified for use in hardened applications should be investigated to ascertain its capability of meeting the requirements specified in 2.01.

2.06 Tests have been made on a wide and representative variety of apparatus and equipment codes to determine the severity levels required to cause failure in operation and permanent physical damage. These tests show that the fragility

level of Bell System equipment varies from about 1G to at least 20G.

2.07 Most equipment units will require some modification, but standard communication equipment and apparatus that can ordinarily be shipped safely without special or unusual packing precautions will in general need a relatively small number of comparatively simple changes to achieve the 3G fragility level required for use in hardened installations.

2.08 When modification of an existing design of unit is required to make the unit suitable for use in hardened installations and will not be required for normal use, the modification shall be covered by a list added to the J code. The list shall require stamping 3GHDN in close proximity to the stamped J code. The list shall be worded, "Equipment and assembly required in addition to list ..... to meet the requirements of BSP Section 800-610-157."

2.09 When an existing design has been shown to meet the requirements of this section or a new unit has been designed to meet them, the unit need not be stamped. An engineering note to which reference is made for any code falling into this classification shall be added to the covering specification, reading as follows: "This unit, as manufactured, meets the requirements of BSP Section 800-610-157."

2.10 It is not practicable to list all of the modifications that may be required to strengthen equipment units and apparatus so that they will be suitable for use in hardened applications. However, the following list of the most frequently required modifications should serve as a guide to the general type of modification likely to be required. The modifications in the following list shall be incorporated wherever applicable in the manufacturing information for all hardened equipment units or apparatus.

(a) Plug-in or snap-on type apparatus or covers, other than electron tubes having positively locked shields, shall be secured by adequate holding clamps.

(b) Pigtail-connected electronic parts which either exceed 1/2-ounce weight or have leads greater than 1 inch shall be given adequate independent mechanical support to prevent lead breakage. This can be accomplished by mounting on cards or by use of brackets as follows.

BRACKET	USED WITH
P-40H709	Individually mounted U- or Y-type relays
P-40H710	280- or B-type relays
P-41N399	Wire-spring relays
P-44V760	Y-type relays
P-44V814	B-type relays
Clip	
P-263678	Nonrelay apparatus and relays where only one mounting hole is available

(1) Where 185A or 186A networks are connected across the coil terminals of relays for contact protection, they shall be mounted on brackets or clips as listed above in all cases and secured in accordance with 3.01 or 3.02.

(c) Replace fragile apparatus items with more rugged designs. Other things being equal, use the lightest weight item available. In doubtful cases, consult the appropriate apparatus development organization for suitable apparatus codes.

(d) Add cable form bracing to reinforce unsupported cable arms such as those feeding jack fields in accordance with Section 800-612-156 and ED-64578-30.

(e) Replace mounting plate piece parts having open-end notches for the mounting screws with mounting plates having holes or closed-end slots.

(f) Where transformers or other relatively heavy pieces of apparatus are mounted near the center of panels, steps shall be taken to adequately strengthen the panel or independently support the heavy part.

C. Hardness Test Specification X-76048

2.11 ***All WECo supplied equipment*** in hardened 50-psi main stations essential to the operation of the hardened communication system shall be capable of surviving the appropriate test or tests as specified in X-76048.

D. Shock Isolation of Switching Equipment Bays

2.12 ***Equipment bays*** are supported from the ceiling through a system of threaded hanger rods, suspension-type variable load shock mounts, and Unistrut channel details. Lateral movement of the suspended bay lineups under normal environment is restricted by restrainers installed between the bottoms of the bays and the floor. The restrainers are designed so as not to appreciably hinder the response of the bays to shock inputs.

2.13 ***Floor plan arrangements*** for the application of suspension-type shock mount system must give special consideration to the weight capacity of the intermediate building slab or roof slab (see 1.06) in the event of double loading; that is, a shock load or floor load on top and a suspended load below.

2.14 ***Shock Mount System:*** The suspension-type shock mount system consists of a shock isolating mechanism with top and bottom fittings which are designed to accept threaded hanger rods. The hanger rods extend up from the shock isolator to overframe channel (suspended from the ceiling) and down to adapter details at the top of the equipment bay.

2.15 ***Suspension of Bulb-Angle, Channel-, or Duct-Type Bays:*** One suspension mount is required over each bay of bulb-angle, channel-, or duct-type bays to be isolated from shock. The threaded hanger rods between bays and suspension mounts are attached midway between the uprights at the top of each bay. For bulb-angle and channel-type frames, the mounts are located over the center line of the bay. For duct-type bays in single lineups or in back-to-back arrangements, the center of the mounts are 4 inches from the rear of the bay framework except as follows.

(a) Duct-type bays with rear-mounted equipment are suspended approximately 1 inch from the rear of the bay framework.

2.16 ***Suspension of Electronic Switching System Sheet Metal Box-Type Bays:*** ESS bays are supported by suspension mounts located over the bay uprights. The uprights of adjacent bays are junctioned together and supported by a single mount. This is accomplished through a system of suspension rods which are located in the bay uprights and joined from the tops of the bays through coupling rods to the suspension mounts as shown on ED-2A017-10.

2.17 ***Suspension mounts*** are provided as KS-20243 Shock Mount (Variable Load). ***Sway braces*** are provided as KS-20539 Restrainer.

2.18 ***Overframe Channels:*** Continuous rows of overframe channels parallel with and located over each equipment bay lineup are suspended from the ceiling channels by 5/8-inch threaded rods. All channel details are of Unistrut design and will accommodate junction and support fittings and associated hardware at any point in the row. The overframe channels provide an anchorage for the suspension mounts located over each equipment bay. Bays of the same or varying widths may be assembled in a lineup without modification of the superstructure or support details by adjusting the space between hanger rod supports secured to the continuous overframe channel. Typical superstructure for suspension mounting of equipment bays is shown on ED-97716-10.

2.19 ***Cone-Type Shock Mount System:*** In early installations, a different type shock mount system was installed that is now rated A&M Only. The shock mounts in this system consist of a set of top and bottom truncated rubber cones furnished by the Barry Wright Corporation of Watertown, Mass. as Barrymount Isolation System Type 17555 for bays weighing 550 to 1100 pounds and as Type 17975 for bays weighing 275 to 550 pounds. Equipment bays are provided with a shock mount under each bay to take the vertical and horizontal load at the floor and with a shock mount at the top of the bay to take the horizontal thrust at the top. The bottom shock mounts are fastened to the floor through bolted anchor plates and the top shock mounts are fastened to the ceiling through hardened superstructure.

(a) ***Modification of Bays:*** The following drawings cover the modification of equipment bays when such bays are to be installed in early hardened sites with cone-type shock mounts.

ED-50119-11 (A&M Only)	Hardened Equipment Racks and Shock Mounting Arrangement for Duct-Type Bays
ED-95134-12 (A&M Only)	Hardened Relay Racks Modification and Installation of Standard Relay Racks in Hardened Areas (bulb angle and channel type)

(b) The ***hardened superstructure*** consists mainly of vertical columns of square tubing fastened together by a network of structural angle cross braces. Each tube is the vertical member of a welded subassembly in the form of a flat tee which is located over the equipment bays with the top of the tee spanning three ceiling channels to which it is fastened with threaded "U" bolts and clamping bars, thus forming a "tree" brace. Typical tree assemblies are shown in Fig. 35 and 37.

Note: In engineering a specific job, consideration shall be given to growth potential in order to facilitate future installation of hardened superstructure.

2.20 ***Distributing frames and group distributing bays*** are rigid frameworks without fragile equipment and frequently cabled from above and below. No shock isolation is necessary other than earthquake bracing in accordance with Section 800-610-155.

2.21 ***Switchboards:*** Shock isolation platforms per ED-99432-50 are available for mounting the 5D switchboard and associated cable turning section in hardened sites. The cabling and cable rack arrangement are shown on ED-99432-10.

2.22 ***Maintenance Centers:*** The shock isolation of maintenance centers is covered on ED-97708-10 and ED-97709-10.

E. Shock Isolation of Power Equipment

2.23 ***Shock isolation of power equipment*** is provided through shock isolation platforms, suspension-type shock mounting, or built-in shock isolation systems such as on engine-alternator equipment.

2.24 ***Shock Isolation Platforms:*** Four types of platforms are used as follows:

(a) Platform per ED-82218-50 is used for 302B power plants.

(b) Platform per ED-82314-50 is used for 521A power plants.

(c) Platform per ED-82219-52 is used for floor-mounted KS-20048 battery cells.

(d) Platform per ED-82099-71 is used for rack-mounted KS-20106 battery cells.

2.25 ***The shock mount system*** under each platform consists of combinations of KS-20424 shock mounts as specified on the platform drawings.

2.26 ***Suspension-Type Shock Isolation System:*** Power equipment mounted in relay rack type framework or small power plants mounted in cabinets are provided with a suspension-type shock mount system to take the vertical and horizontal shock load that would result from a nuclear explosion. Lateral movement of the suspended bay lineups under normal environment is restricted by restrainers installed between the bottoms of the bays and the floor. The restrainers are designed so as not to appreciably hinder the response of the bays to shock inputs.

2.27 ***Suspension mounts*** are provided as KS-20243 Shock Mount (Variable Load). ***Sway braces*** are provided as KS-20539 Restrainer.

2.28 ***The superstructure*** over suspended power bays consists of an arrangement of Unistrut channels. The uppermost level (intermediate channel) is suspended over the entire equipment area. Overframe channels are added above bay lineups in accordance with job conditions and as follows:

(a) Where lineups are perpendicular to ceiling channels, one continuous overframe channel is secured to the intermediate channel above the lineup and at two points beyond the last bay on each end.

(b) Where lineups are parallel to ceiling channels, 12 footbridge channels are secured perpendicular to 4 intermediate channels. The overframe channel is secured within the center span of

the bridge channel above the lineup and at two points beyond the last bay on each end.

2.29 ***Typical superstructure arrangements*** for suspension mounting of power bays are shown on ED-97713-10.

F. Auxiliary Framing and Cable Racks

Arrangement Over Switching Equipment Bays

2.30 ***Auxiliary framing*** for supporting cable racks is generally run in continuous lengths in line with the embedded ceiling channels from which it is supported by threaded rods.

2.31 ***Ladder-type cable racks*** are run over the aisles and secured to the auxiliary framing in the standard manner.

2.32 ***The auxiliary framing and cable racks*** are entirely independent of the suspended equipment bays with minimum clearances of 6 inches vertically to the tops of bays and 2 inches laterally to the shock mounts and their supporting rods. The whole structure (auxiliary framing and cable racks) is "free floating" (not braced to walls, columns, or ceiling). A 3-inch clearance is provided between the auxiliary framing and cable racks and the walls, columns, and any objects rigid to the building.

2.33 ***Earthquake bracing,*** used in offices employing the cone-type shock mount system (rated A&M Only), should not be used where the suspension-type system is used.

2.34 ***Ceiling Attachment:*** The particular method of attaching threaded rod supporting the auxiliary framing to the embedded ceiling channel is dependent upon the ultimate weight or dynamic load on each ceiling attachment. As shown on ED-97716-10, where the dynamic load is 10,000 pounds or less, attachment is made using a P-48G686 slotted fitting. Where dynamic load is greater than 10,000 pounds, a P-49G999 support (spreader channel) is used in addition to the slotted fitting.

2.35 ***Dynamic Load:*** The dynamic load (pounds) per attachment from a hanger rod to the embedded ceiling channel at points spaced not closer than 18 inches apart is calculated by multiplying the estimated weight of cables, cable rack, auxiliary framing, and lighting at point of attachment times the maximum verticle ceiling acceleration (18) or $P_D = W_C \times 18$.

2.36 ***Weight of Cables and Cable Rack:*** The weight of cable runs is computed on the basis of 0.6 pound per square inch of cross section per foot of length between supports in accordance with Section 800-614-157. The following weights may be used to determine the weight of steel in addition to the weight of cable.

		WEIGHT (lbs/ft)
Ladder-Type Cable Rack	10"	4.67
	12"	4.85
	15"	6.41
	20"	6.87
	25"	8.57
	30"	9.29
Auxiliary Framing Channel		1.90
3/8" x 1-1/2" Bar		1.91
3/8" x 2" Bar		2.55
5/8" — 11 Threaded Rod		0.85

Arrangement Over Power Equipment

2.37 ***Power Cable Racks:*** Ladder-type cable racks serving the suspended power bay lineups are supported directly from the embedded ceiling channels by threaded rods. Bracing is not provided. Cable racks for platform-mounted power bays are supported on top of the bays. A spring hanger cable support is provided where cables turn down from the ceiling supported racks to the bay-mounted racks.

2.38 ***A minimum clearance*** of 4 inches is provided between cable supporting material (cable racks, spring hanger cable supports, and associated threaded rods) and the superstructure and shock mounts for suspended bays.

2.39 ***Ceiling Attachment:*** The particular method of attaching threaded rod supporting cable racks to the embedded ceiling channel is dependent upon the ultimate weight or dynamic load on each ceiling attachment. As shown on ED-97713-10, where the dynamic load is 10,000 pounds or less, attachment is made using a P-48G686 slotted fitting. Where the dynamic load is greater than 10,000 pounds and additional threaded rods cannot be installed, a type 20378-1 shock arrester (Barry Controls, Waterbury, Mass.) is provided.

3. REQUIREMENTS

COMMON REQUIREMENTS

A. Support of 185A or 186A Networks

3.01 Where 185A or 186A networks are wired to coil terminals of relays, they shall be supported by brackets as shown in Fig. 44 as follows:

BRACKET	USED WITH
P-41N399	Wire-spring relay
P-40H709	U- or Y-type relay
P-40H710	280- or B-type relay
P-44V760	Y-type relay
P-44V814	B-type relay

(a) Brackets shall be mounted with longer relay mounting screws when mounting relays as follows:

RELAY	BHM SCREW
Wire spring	0.138″ — 32 x 3/8″
B, U, or Y type	0.164″ — 36 x 15/32″
280 type	0.138″ — 32 x 7/16″

(b) Body of network shall be protected with one layer of acetate fiber tape (or commercially available transparent tape) or clear plastic tubing (7/16″ Irvolite, 25 mil wall) before tying to bracket.

(c) Networks shall be secured to bracket with sewing twine, as shown in Fig. 45, before connecting to relay terminals.

3.02 Where 185A or 186A networks are wired to nonrelay apparatus and relays where only one mounting hole is available, they shall be supported by P-263678 cable clips as shown in Fig. 45A.

B. Multiplate Equipment Units

3.03 Where mounting plate clips P-44J074 and P-44J075 are used in place of unit mounting bars on multiplate equipment units, each unit mounting plate shall be fastened to the frame uprights with two screws, one in the top hole at each end of the plate, in accordance with ED-27723-01.

INSTALLATION REQUIREMENTS

C. Basic Requirements

3.04 This section covers the installation of shock-mounted equipment in 50-psi buildings. These requirements cover both ceiling suspension (and platform) type shock mount systems. To insure that the shock mounting for the equipment will operate properly under shock, it is essential that adequate horizontal and vertical clearance and slack in connecting cables be provided to permit relative motions.

3.05 The following procedures shall be followed when installing shock mounted equipment.

(a) All electrical and mechanical connections shall be of the flexible type.

(b) Where cables feed into equipment, such as bays, cabinets, panels, or machines, sufficient slack cable shall be provided to permit 6 inches of relative displacement in all directions.

(c) Where suspension-type shock mounted equipment is located adjacent to a wall, column, or other fixed structure or equipment, a minimum of 3 inches of horizontal clearance shall be provided.

(d) Where suspension-type shock mounted equipments are adjacent but not attached, a minimum of 6 inches of horizontal clearance shall be provided.

(e) A minimum vertical clearance of 6 inches shall be provided both above and below suspension-type shock mounted equipment. This clearance shall be provided between the equipment and fixed objects, such as floor, ceiling superstructure, lighting, cable racks (except electronic switching system where the cable racks are fastened to the tops of the equipment bay frameworks), and other hardware.

D. Shock Isolation of Switching Equipment Bays

Suspension-Type Shock Mount System

3.06 ***Associated Drawings:*** The following drawings cover the hardening of equipment bays and cabinets, cable racks for electronic switching systems, No. 5 D switchboard, test equipment, shelving, and superstructure. These drawings, together with the requirements herein, shall be followed in the installation of this equipment.

Hardened Bulb-Angle, Channel-Type, and Duct-Type Equipment Bays, and Superstructure

ED-50119-12—Anchor Bolt Assemblies
ED-50262-10—Duct-Type Bays—TD-2 Equipment
ED-50262-12—Duct-Type Bays
ED-97716-10—Superstructure
ED-99376-11—Bulb-Angle and Channel-Type Bays

Electronic Switching System

ED-82105-10—Spare Parts Storage Cabinet—4-Wire ESS
ED-97714-50—Shock Isolation 35ASR Teletypewriter Units—ESS
ED-97715-50—Shock Isolation 35BJ Teletypewriter Units—ESS
ED-1A229-10—Typical Spare Parts Storage—No. 1 or No. 2 ESS
ED-2A017-10—Modification of Framework—ESS Equipment
ED-2A022-10—Modification of Cable Racks—ESS

Cabinet-Type Equipment Bays

ED-50261-11—Variable Load Shock Isolation—Cabinet-Type Bays (British and Japanese)
ED-97702-10—Variable Load Shock Isolation—Cabinet-Type Bays (French)
ED-97705-10—Variable Load Shock Isolation—G2-91191 Cabinet—BMEWS
ED-97706-10—Variable Load Shock Isolation—ED-92141-70 Cabinet—Telemetry
ED-97708-10—Variable Load Shock Isolation ED-59258-90 Cabinet—Maintenance Center
ED-97709-10—Variable Load Shock Isolation ED-92712-70 Floor Supported Duct-Type Bay—Auxiliary Repeater Bay Associated With Maintenance Center
ED-97710-10—Hardened Alarm Cabinet—Wall or Column Mounted

Teletypewriter Units

ED-97725-50—Shock Isolation Framework for 35AK Teletype Unit

No. 5D Switchboard

ED-99432-10—Cable and Cable Rack Plan in CTS for No. 5D Switchboard on Shock Isolation Platform
ED-99432-50—Shock Isolation Platform for No. 5D Switchboard

Shelving and Test Equipment

ED-50346-10—Shock Isolation Shelving for Use at Hard Sites
ED-59844-10, ED-5G332-10—Shock Isolation System for Fault Location Test Equipment at Hardened Submarine Cable Stations

Standard Drawings Modified for Hardened Application by Addition of a Note To Indicate Modification

Testboards

ED-64356-01, ED-64356-10 — 18B Toll Testboard

ED-64500-01 — 19A Testboard

ED-6G010-01, ED-6G011-01, ED-6G012-01, ED-6G013-01 — 21A Testboard

3.07 It is desirable to have the shock mounting applied to all bays in a complete lineup. Where job specifications require that only a part of the total bays in a lineup be shock mounted, a clear space of at least 3 inches shall be provided

between the shock-mounted and nonshock-mounted portions of the lineup to prevent contact under shock action. A clear space of at least 3 inches shall also be provided between shock-mounted bays and columns or walls; this includes the pipe used for the alignment and grounding of duct-type bays.

(a) The pipe mentioned above may be cut at the end of the last bay of an incomplete lineup. However, where the pipe has not been cut and it extends more than 4 feet beyond the last bay in the lineup, it shall be braced to the overframe channel to prevent whipping during a period of shock. Extensions less than 4 feet shall not be braced. Under no circumstances shall the brace be closer than 4 feet to the last bay in the lineup.

3.08 Where extensions to existing lineups equipped with the cone-type shock mount system are made using the suspension type shock mount system, a clear space of at least 6 inches shall be provided between cone-type and suspension-type portions of the lineup to prevent contact under shock action.

3.09 Where shock-mounted and nonshock-mounted bays or suspension-mounted and cone-mounted bays are adjacent, the clear space between bays shall be bridged with a flexible ground connection. The minimum length of flexible ground connections shall be 6 inches longer than the distance between end connections.

3.10 Adjacent shock-mounted bulb-angle or channel-type bays equipped with the same shock isolation mechanism shall be junctioned together in the standard manner.

3.11 Adjacent shock-mounted duct-type bays shall be junctioned together as shown on ED-50262-12.

3.12 Adjacent shock-mounted sheet metal box-type (Electronic Switching System) bays shall be junctioned together as shown on ED-2A017-10.

3.13 ***Nonshock-mounted bays*** shall be fastened directly to the floor in the manner described in Section 800-614-154 using three bolts per bay. The bolts shall be placed in accordance with ED-50119-12.

(a) When drilling the bolt holes in the concrete floor, care shall be exercised that the building reinforcing rods are not cut. Where reinforcing rods occur where holes are planned, the floor drilling locations shall be changed slightly to avoid the rods.

(b) Where steel billets around columns do not have sufficient depth of concrete over them, the billets shall be drilled and tapped to accept a 3/8-inch threaded rod for fastening the bays.

3.14 Nonshock-mounted bays shall be installed in accordance with Section 800-610-155 covering requirements for earthquake bracing.

Cone-Type Shock Mount System (Rated A&M Only)

Note: The following requirements (3.15 through 3.28) [marked by a dagger (†)] are rated A&M Only and are superseded by the requirements for installation of the suspension-type system (3.06 through 3.14).

†**3.15** ***Shock Mounts:*** Top and bottom shock mounts shall be installed in accordance with the following drawings.

ED-50119-11 (A&M Only)	Hardened Equipment Racks and Shock Mounting Arrangement for Duct-Type Bays
ED-95134-12 (A&M Only)	Hardened Relays Racks Modification and Installation of Standard Relay Racks in Hardened Areas (bulb angle and channel type)

†**3.16** The design of the top shock mount is such that a limited amount of vertical excursion of that bay is permitted through the sliding action of a steel plunger which rides through the center of the mount. The length of the exposed portion of the plunger shall be 1-1/4 $\pm$5/8 inches. Where building construction is such that these limits are exceeded, the following procedures shall be followed.

(1) For high ceilings an additional set of hex. nut and washer shall be placed between ceiling channel and ceiling.

(2) For low ceilings an adjustment is provided by means of slots in the base of the tree assembly for fastening the overframe angle supports.

†**3.17** It is desirable to have the shock mounting applied to all bays in a complete lineup. Where job specifications require that only a part of the total bays in a lineup be shock mounted, a clear space of 3 inches shall be provided between the shock-mounted and nonshock-mounted portions of the lineup to prevent contact under shock action. A clear space of at least 3 inches shall also be provided between shock-mounted bays and columns or walls; this includes the pipe used for the alignment and grounding of duct-type bays.

(a) Where the pipe mentioned above extends more than 4 feet beyond the last duct-type bay in a lineup, it shall be braced to the auxiliary framing to prevent whipping during a period of shock. Extensions less than 4 feet shall not be braced. Under no circumstances shall the brace be closer than 4 feet to the last bay in a lineup.

(b) Where shock-mounted and nonshock-mounted bays are adjacent, the 3-inch clear space between bays shall be bridged with a flexible ground connection. The minimum length of flexible ground connections shall be 6 inches longer than the distance between end connectons.

(c) Adjacent shock-mounted bulb-angle or channel-type bays shall be junctioned together in the standard manner.

(d) Adjacent shock-mounted duct-type bays shall be junctioned together as shown on ED-50119-11 (A&M Only).

†**3.18** ***All floor fastenings for shock-mounted bays*** shall be made by means of bolts extending through supplemental steel anchor plates. The bolts shall be set head down in the floor with Sonite Epoxy Concrete which is prepared at the site of installation (see ED-50119-12). In mixing and applying this concrete, precautions noted on the containers in addition to those covered in Section 637-241-011 shall be observed.

(a) When drilling the bolt holes in the concrete floor, care shall be exercised that the building reinforcing rods are not cut. Where reinforcing rods occur where holes are planned, the plates may be rotated to avoid the rods.

(b) Where steel billets around columns do not have sufficient depth of concrete over them, the billets may be drilled and tapped to accept a 3/8-inch threaded rod for fastening the plates.

(c) Nonshock-mounted bays shall be fastened directly to the floor in the manner described in Section 800-614-154 using three bolts per bay. The bolts shall be set head down in the floor with Sonite Epoxy Concrete as described above.

(1) The tops of nonshock-mounted bays shall be provided with earthquake bracing in accordance with Section 800-610-155.

†**3.19** ***Anchor plates shall be installed*** in accordance with the following drawing.

ED-50120-51 **Anchor Plates for Various Frameworks for Use at Hardened Sites**

†**3.20** ***Ceiling channels*** of 3-inch, 5-pound structural channel shall be bolted to the ceiling inserts as shown in Fig. 33. The channels shall be run, as far as possible, in continuous rows parallel with the bay lineups and extend over all the equipment bay areas.

†**3.21** Threaded ***ceiling inserts*** are set in a rectangular grid pattern dimensioned from the lines of column centers which are 18 feet 6 inches apart. The exterior rows of inserts in a building bay are on the column center lines with adjacent rows spaced 2 feet 6 inches inside the column center lines and the remainder of the interior rows spaced at 2-foot 3-inch intervals. This grid pattern of ceiling inserts also extends over the areas between column lines and the walls of the main equipment rooms.

†**3.22** ***Single Lineup of Frames or Racks:*** As shown in Fig. 34 and 35, the trees for single lineup of frames or racks shall be located directly over the bay uprights and spaced two bays apart over each lineup. The bottom ends of the trees shall be joined by a pair of overframe angle

supports which provide the actual mounting surface for the top end of the top shock mounts.

(a) Since each tree spans three ceiling channels, a row of trees normal to the equipment bay lineups cannot support consecutive lineups. Consequently, one row of trees shall be used to support odd-numbered lineups and an adjacent row of trees (one bay distant) to support even-numbered lineups. This results in rows of trees, one bay apart, with staggered verticals supporting alternate lineups.

†**3.23** ***Double Lineup (Back-to-Back) of Duct-Type Frames:*** As shown in Fig. 36 and 37, the trees for double lineup of duct-type frames shall be centered over the 1/4-inch space at the rear of the frames and 6-1/4 inches from the center line of the equipment bays and spaced one bay apart over each lineup.

(a) The bottom ends of the trees shall be joined by angle supports in a manner similar to single lineups. However, for double lineups, transverse bars (1/2 inch thick) are required across the bottom of the overframe angle supports to support the double row of shock mounts with the result that the trees are 1/2 inch shorter for this application.

(b) Adjacent rows of trees shall be centered 6-1/4 inches on either side of the center line of the bay, with staggered verticals supporting alternate double lineups similar to the arrangement for single lineups.

†**3.24** Since the ceiling insert pattern and the floor plan layout are dimensioned independently from the building column center lines, the dimensional relationship between ceiling channels and equipment bay lineups will vary. This variation will determine the extent to which the length across the top of the tree must vary.

†**3.25** ***Angle supports*** shall be continuous throughout the shock-mounted portion of each lineup and arranged in accordance with Table A for single lineups and Table B for double lineups.

(a) Where splicing of angle supports is necessary, it shall be done adjacent to a tree and never on both supports at the same location. The ends of the supports shall be butted at the splice with splice plates bolted through both flanges of the angles as shown in Fig. 38.

†**3.26** ***Diagonal Cross Braces:*** In each lineup, the trees shall be joined by two diagonal cross braces in each intermediate space and the end trees braced to the ceiling as shown in Fig. 35 and Table C for single lineups and Fig. 37 for double lineups.

†**3.27** ***Fastening Tree Assembly to Ceiling Channel:*** The tree assemblies shall be fastened to the ceiling channels in accordance with Fig. 39 through 43 as follows.

(a) Where no obstructions are encountered, the tree shall be fastened to the ceiling channel using two "U" bolts and straps as shown in Fig. 39.

(b) Where the space between trees at a ceiling channel is 1-1/2 inches maximum, both trees shall be fastened to the channel using two "U" bolts and straps as shown in Fig. 40.

(c) Where one tree falls short of a ceiling channel and the space between trees at the channel does not exceed 3 inches, both trees shall be joined together using angles, channels, straps, and cap screws. The angles shall be fastened to the ceiling channel as shown in Fig. 41.

(d) Where the tree upright obstructs the normal fastening to the ceiling channel, side angles shall be fastened to the channel using "U" bolts and the angles in turn shall be fastened to the tree using a channel strap and cap screws as shown in Fig. 34.

(e) Where the tree angle brace obstructs the normal fastening to the ceiling channel, side angles shall be fastened to the channel using "U" bolts and the angles in turn shall be fastened to the tree using channel straps and cap screws as shown in Fig. 35.

†**3.28** ***Tightening Torque:*** Screws and nuts used to assemble the hardened superstructure shall be cold rolled mild steel with a zinc plate finish and shall be tightened to 15-1/2 and 35 foot-pounds of torque for the 3/8-inch and 1/2-inch sizes, respectively.

E. Shock Isolation of Power Equipment

3.29 ***Associated Drawings:*** The following drawings cover standardized arrangements for hardening power equipment. These drawings, together with the requirements herein, shall be followed in the installation of this equipment.

ED-80483-20	Typical Box-Type Framework for 504B Power Plant—Variable Load Shock Mounts
ED-81593-20	Typical Cabinet Lineup for 425A-250V Plant—Variable Load Shock Mounts
ED-82039-12 (A&M Only)	Cone Shock Mounts for J86447A Power Control Bay and J86324A Battery Distribution Fuse Board—L3 Carrier
ED-82039-14	Suspension Shock Mount (KS-20243), J86447A Power Control Bay, and J86324A Battery Distribution Board—L4 Carrier
ED-82044-10	Typical Hardened Installation of KS-15929, KS-15777, KS-15954 Engine Alternators
ED-82047-10	KS-15727 AC Cabinet in 11-Foot 6-Inch Framework
ED-82082-12	Typical Cabinet Lineup for 425A-12V, 1600-Amp Plant Variable Load Shock Mounts
ED-82099-31	Application Drawing for ED-82099-71
ED-82099-71	4-Row 2-Tier Platform Mounted Battery Stand
ED-82114-10	Shock Isolation System Cabinet Type Bays Variable Load Shock Mount for 411B Power Plant
ED-82218-30	Application Drawing for ED-82218-50 and ED-82314-50
ED-82218-50	Shock Isolation Platform for 302B Power Plants
ED-82219-31	Application Drawing for ED-82219-52 Shock Isolation Platforms for KS-20048 Cells
ED-82219-52	Shock Isolation Platform for KS-20048 Cells
ED-82278-30	Typical Exhaust for KS-19896 Gas Turbine Alternator
ED-82294-10	Wall-Mounted Fuse Cabinet Shock Mounting
ED-82305-10	Typical Cabinet Lineup for AC Switchboard (KS-15697) Variable Load Shock Mounts
ED-82314-50	Shock Isolation Platform for 521A Plants
ED-97710-10	Shock Mounting for Alarm Panels
ED-97713-10	Superstructure Arrangement for Suspension Mounting of L-4 Power Equipment Frames

Cabling

ED-82264-30	Bus Bars, Supports, and Flexible Interconnection Details—302A or 302B Power Plant
ED-82274-11	Power Cabling and Cable Racks (Korfund Spring Hangers)

Lighting

ED-82264-10	Frame and Aisle Lighting Arrangement for 300-Type Power Plant

3.30 ***302B power plants*** shall be mounted on shock isolation platforms in accordance with ED-82218-30 and ED-82218-50.

3.31 ***521A power plants*** shall be mounted on shock isolation platforms in accordance with ED-82218-30 and ED-82134-50.

3.32 ***Floor-mounted KS-20048 battery cells*** shall be mounted on shock isolation platforms in accordance with ED-82219-31 and ED-82219-52.

3.33 ***Rack-mounted KS-20106 battery cells*** shall be mounted on shock isolation platforms in accordance with ED-82099-31 and ED-82099-71.

3.34 ***Power equipment mounted in relay-rack type framework*** or small power plants mounted in cabinets shall be ceiling suspended on variable load shock mounts in accordance with ED-97713-10.

F. Auxiliary Framing, Cable Racks, and Cabling

Arrangement Over Switching Equipment Bays

3.35 ***Auxiliary framing*** for supporting cable racks shall generally be run in continuous lengths in line with the embedded ceiling channels and supported by threaded rods in accordance with ED-97716-10.

3.36 ***Ladder-type cable racks*** shall be run over the aisles and secured to the auxiliary framing in the standard manner.

3.37 ***Clearance:*** The auxiliary framing and cable racks shall be entirely independent of the suspended equipment bays with minimum clearances of 6 inches vertically to the tops of bays and 2 inches laterally to the shock mounts and their supporting rods in accordance with ED-97716-10. The whole structure (auxiliary framing and cable racks) shall be "free floating" (not braced to walls, columns, or ceiling). A 3-inch clearance shall be provided between the auxiliary framing and cable racks and the walls, columns, and any objects rigid to the building.

†**3.38** In offices employing the cone-type shock mount system, auxiliary framing, and cable racks shall be fastened to the ceiling with earthquake bracing in accordance with Section 800-610-155 and shall be entirely independent of the shock-mounted equipment bays and the hardened superstructure.

† A&M Only and superseded by 3.35 through 3.37.

3.39 ***Installation of Cables:*** Cables shall be installed in accordance with Section 800-614-152. Where cables feed from the cable racks to the equipment bays, sufficient slack shall be provided to permit at least 6 inches of relative motion in any direction between bays and cable racks.

(a) In order to meet the relative motion requirement between bays and cable racks, the maximum unsupported cable limits as specified in Section 800-614-152 may be exceeded.

3.40 ***L- and U-Shaped brackets,*** P-30H127, P-30H128, and P-30H129, shall be used to separate high-level from low-level transmission leads in accordance with ED-91689-30.

Arrangement Over Power Equipment

3.41 ***Cable Racks Serving Suspended Power Bay Lineups:*** Ladder-type cable racks shall be supported directly from the embedded ceiling channels by threaded rods. The particular method of attaching threaded rod to ceiling channel is dependent upon the ultimate weight at each attachment and shall be in accordance with ED-97713-10.

3.42 ***Cable Racks Serving Platform-Mounted Power Bays:*** Ladder-type cable racks shall be supported on top of platform-mounted power bays.

3.43 ***Spring Hanger Cable Support:*** Where cables turn down from ceiling supported racks to bay-mounted racks they shall be supported at the turndown by a spring hanger cable support in accordance with ED-82274-11.

3.44 ***Installation of Cables:*** Cables shall be installed in accordance with ED-82274-11.

(a) Cables shall not be tied or banded together between point of leaving the cable rack and entry within the equipment, or upon another cable rack.

3.45 ***Clearance:*** A minimum clearance of 4 inches shall be provided between cables or cable supporting material (cable racks, spring hanger cable supports, and associated threaded rods) and the superstructure and shock mounts for suspended bays.

3.46 ***Power wiring*** shall be provided with more flexible stranding in accordance with the following table. This cable is not identified in any manner different than the standard. The strands must be observed in order to verify type.

WIRE SIZE	SEE NOTES	WIRE TYPE	NO. OF STRANDS
14 to 2	1,2	KS-5482-01 with Class B stranding	7
1	2	KS-5482-01 with Class B stranding	19
0 to 0000		KS-5482-01 with Class C stranding	37
300MCM to 500MCM		KS-5482-01 with Class D stranding	91
550MCM up		KS-5482-01 with Class D stranding	127

Notes

1. Since 14-, 12-, and 10-gauge wire are normally furnished as solid wire, it will be necessary to specify B stranding.

2. 8-gauge to 1-gauge wire is normally provided as Class B stranded.

G. Frame and Aisle Lighting

3.47 Two- or 4-foot fluourescent-type lighting fixtures shall be furnished for frame and aisle lighting in all main equipment and power areas in accordance with job information as follows.

KS-15857 for distributing frames and test areas

KS-15673 for equipment areas

KS-20440 for power areas

4. CHECKING LIST FOR FIGURES

4.01 The figure numbers in this section are frequently referred to in associated instructions and drawings. In order that these references may remain correct, the figure numbers will not be changed in subsequent issues of the section.

4.02 The complete list of all figures used in this issue is as follows:

Fig 4 to 9, and 17 to 24	Ceiling Fastenings for Overframe Channels (A&M Only)
Fig. 11	Overframe Channel Splice (A&M Only)
Fig. 33	Fastening Ceiling Channel (A&M Only)
Fig 34 to 37	Typical Arrangements of Tree Assemblies (A&M Only)
Fig. 38 to 43	Fastening Tree Assemblies (A&M Only)
Fig. 44, 45, and 45A	Support of 185A and 186A Networks
Fig. 56 to 63, and 65 to 67	Power Cable Racks (A&M Only)

4.03 Figures discontinued with this issue of the section are as follows:

Fig. 1 to 3, 10, 12 to 16, 25 to 32, 46 to 55, and 64.

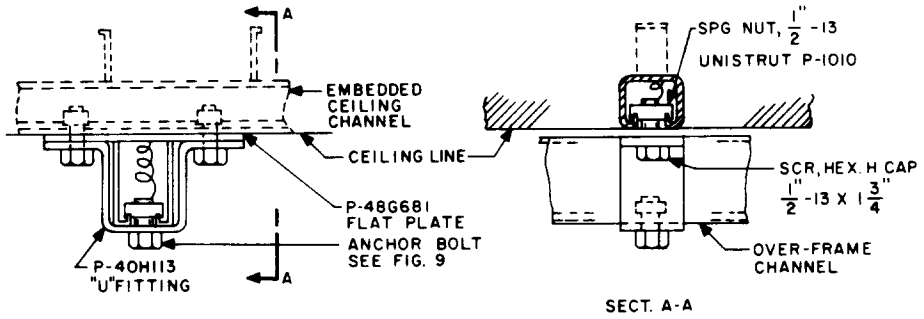


Fig. 4—Fastening Overframe Channel—Directly to Embedded Ceiling Channel —Single Lineup—Up to 1200-Pound Bays (A&M Only)

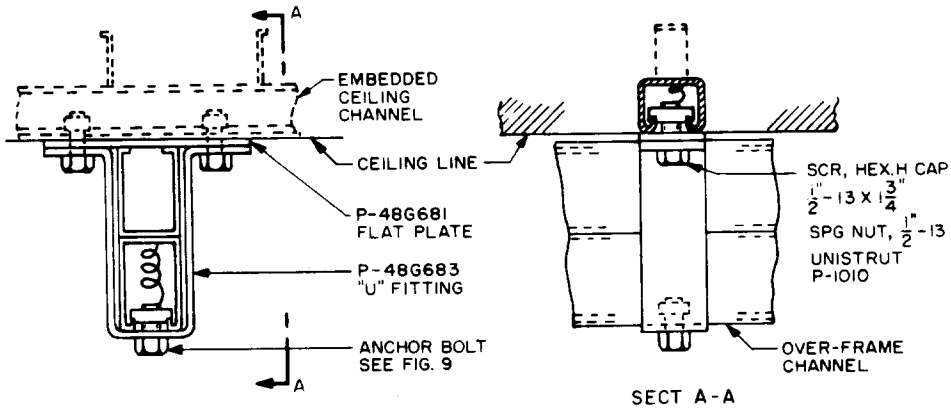


Fig. 5—Fastening Overframe Channel—Directly to Embedded Ceiling Channel —Single Lineup—1200- to 1400-Pound Bays (A&M Only)

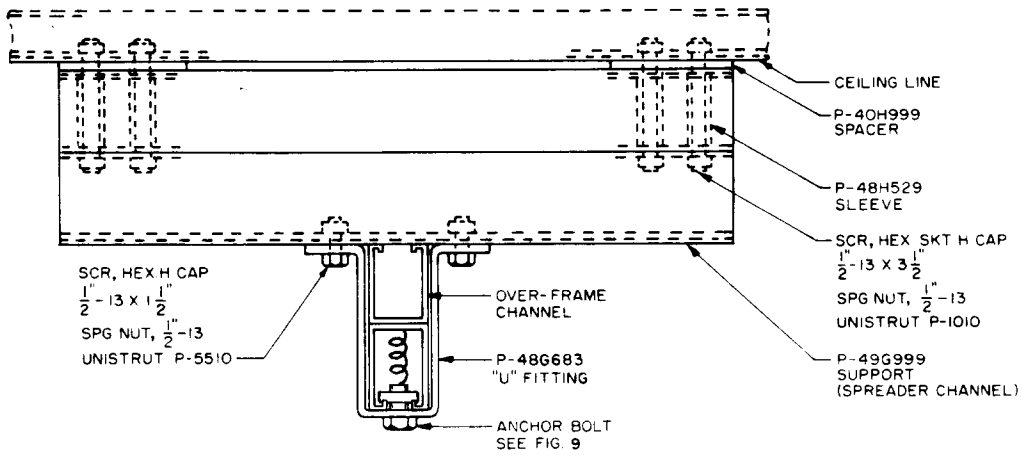


Fig. 6—Fastening Overframe Channel—Using Spreader Channel Between Ceiling and Overframe Channel—Single Lineup 1400- to 2000-Pound Bays (A&M Only)

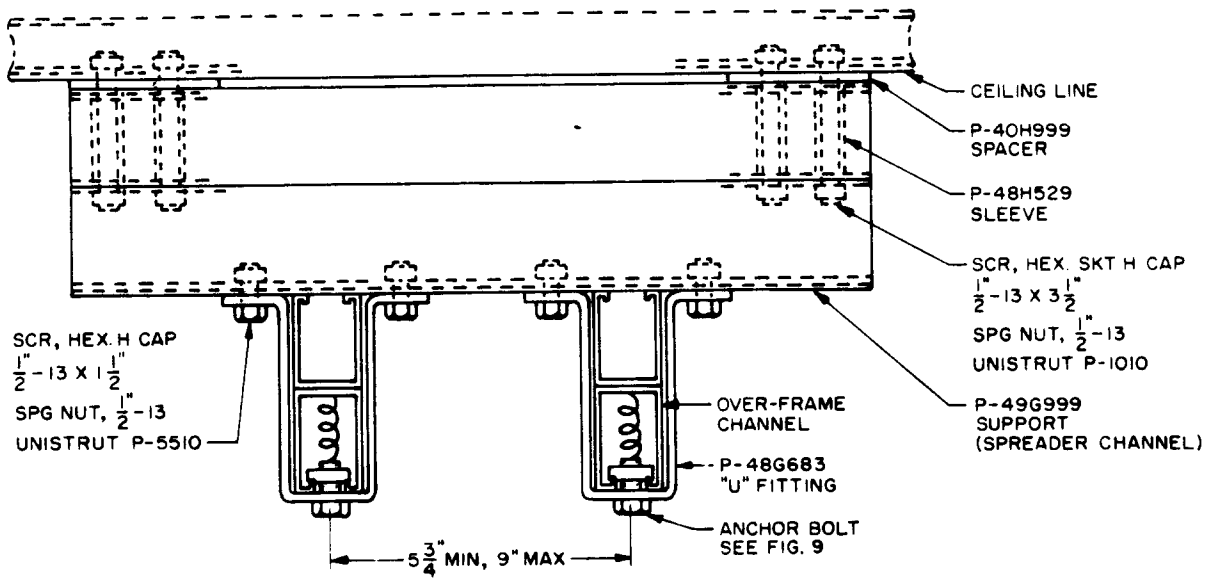


Fig. 7—Fastening Overframe Channel—Using Spreader Channel Between Ceiling and Overframe Channel —Back-to-Back Lineup—Up to 1400-Pound Bays (A&M Only)

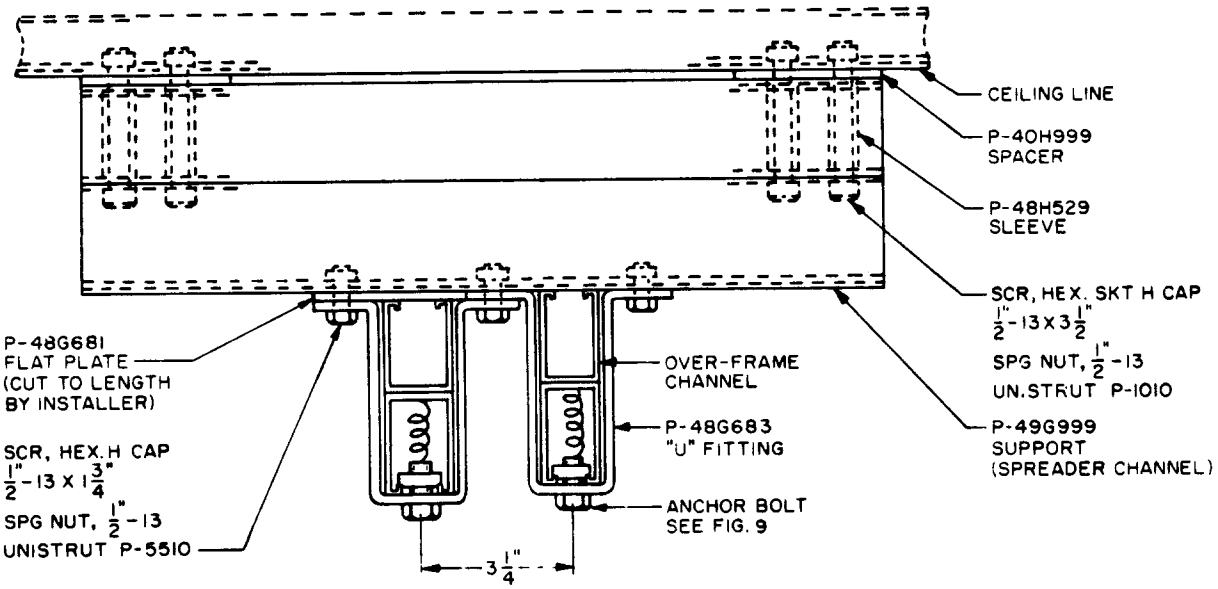


Fig. 8—Fastening Overframe Channel—Using Spreader Channel Between Ceiling and Overframe Channel —Adjacent Bays on Different Support Centers (A&M Only)

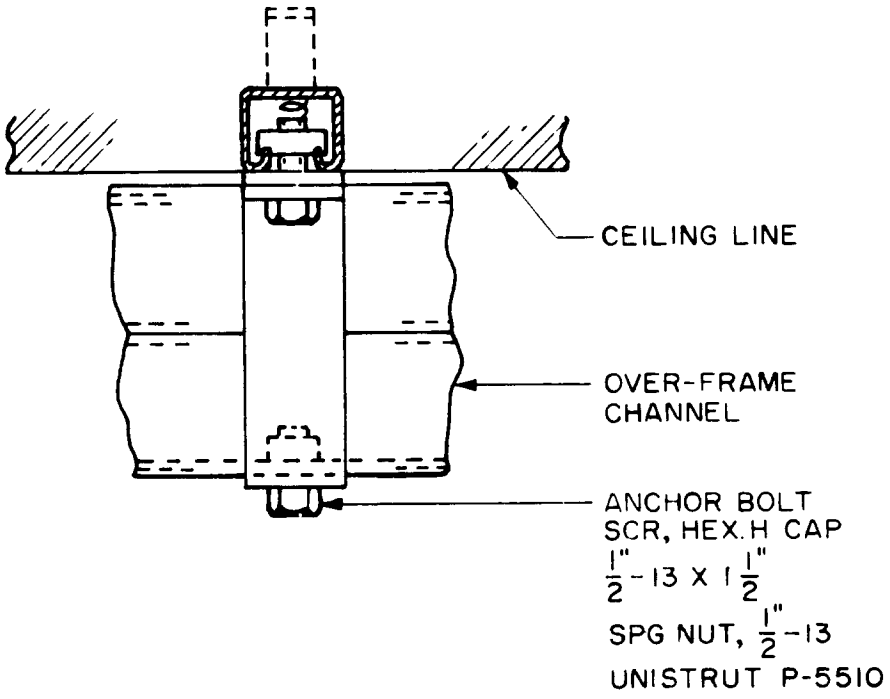
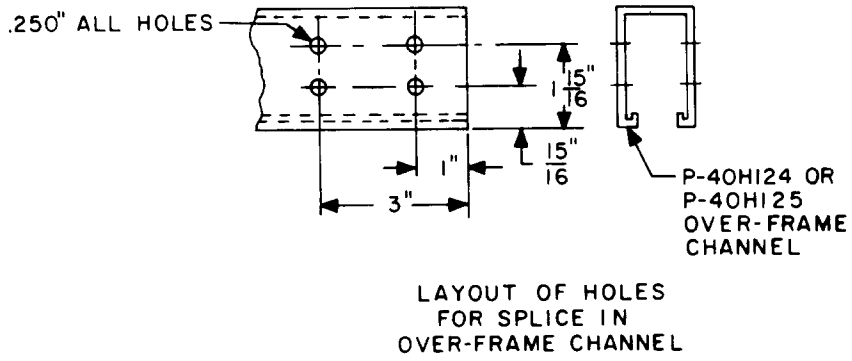


Fig. 9—Anchor Bolt for Overframe Channel (A&M Only)



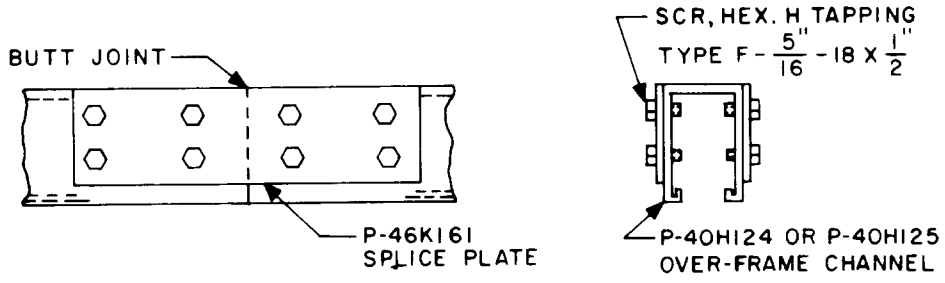


Fig. 11—Overframe Channel Splice for P-40H124 or P-40H125 Channel (Unistrut Catalog No. P-5500) (A&M Only)

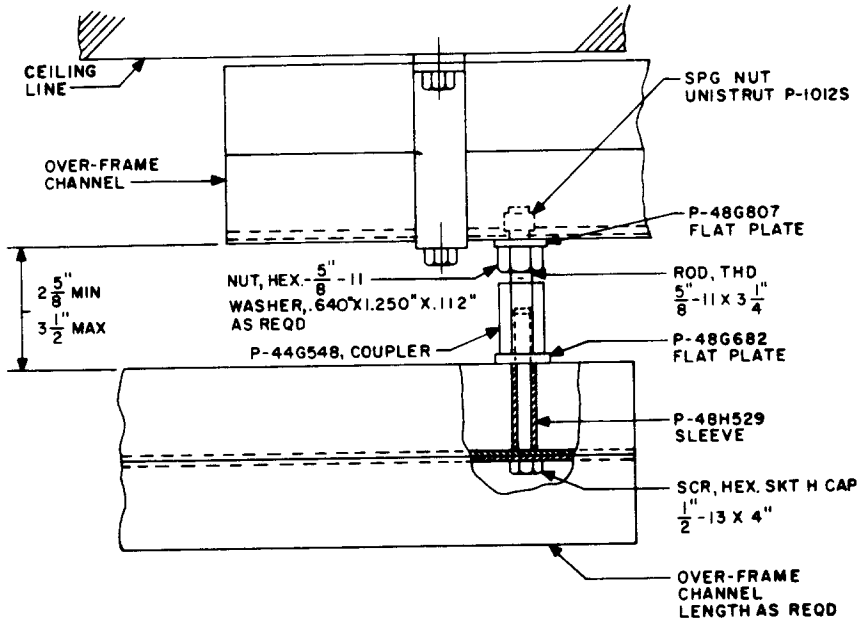


Fig. 17—Fastening Overframe Channel to Overframe Channel to Clear Column Cap (A&M Only)

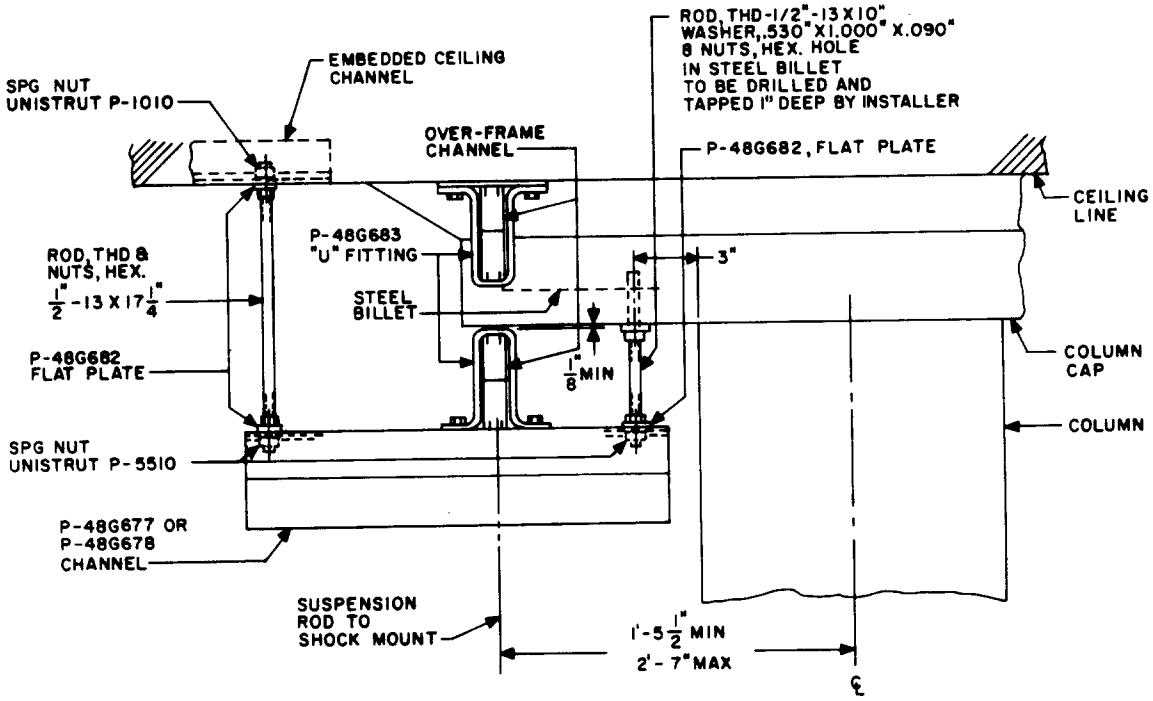


Fig. 18—Fastening Overframe Channel to Embedded Ceiling Channel and Column Cap (A&M Only)

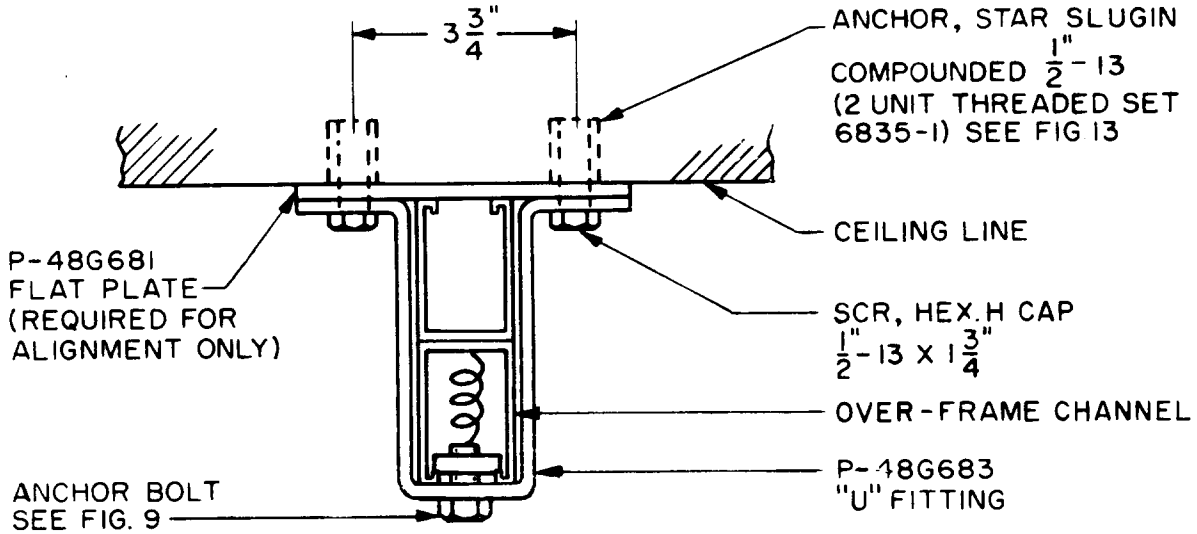


Fig. 19—Fastening Overframe Channel to Ceiling at Vent Duct or Column Cap—Using Cap Screws (A&M Only)

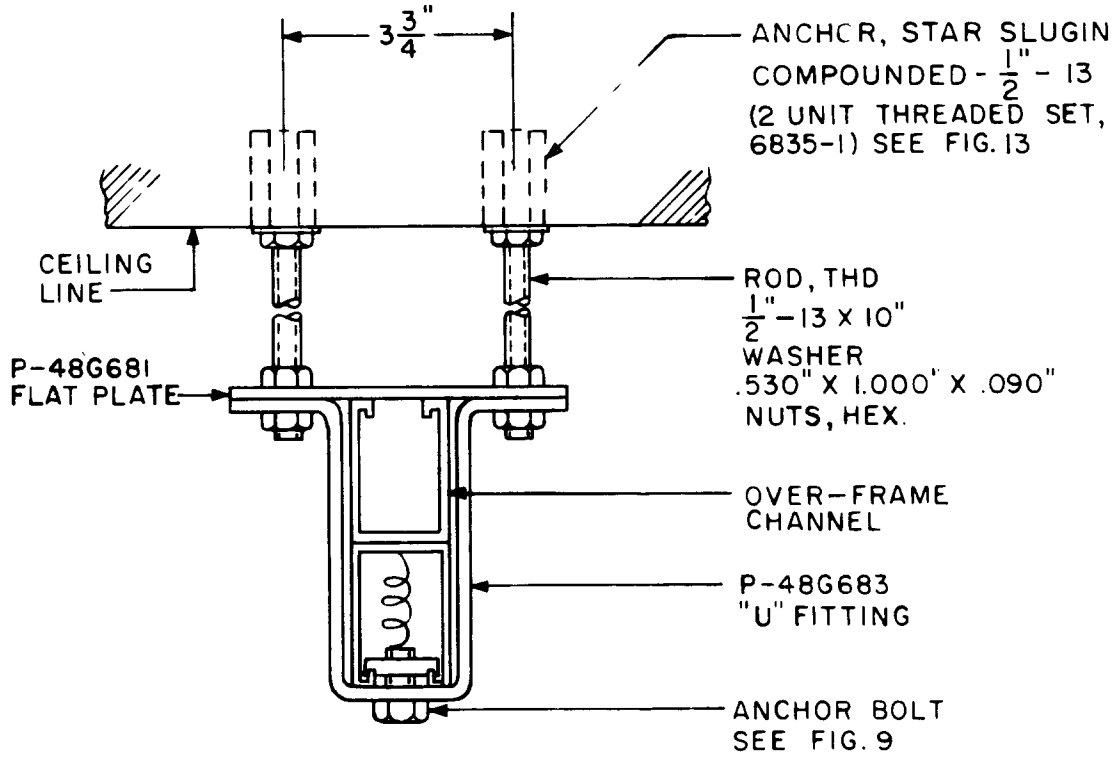


Fig. 20—Fastening Overframe Channel to Ceiling at Vent Duct or Column Cap—Using Threaded Rod (A&M Only)

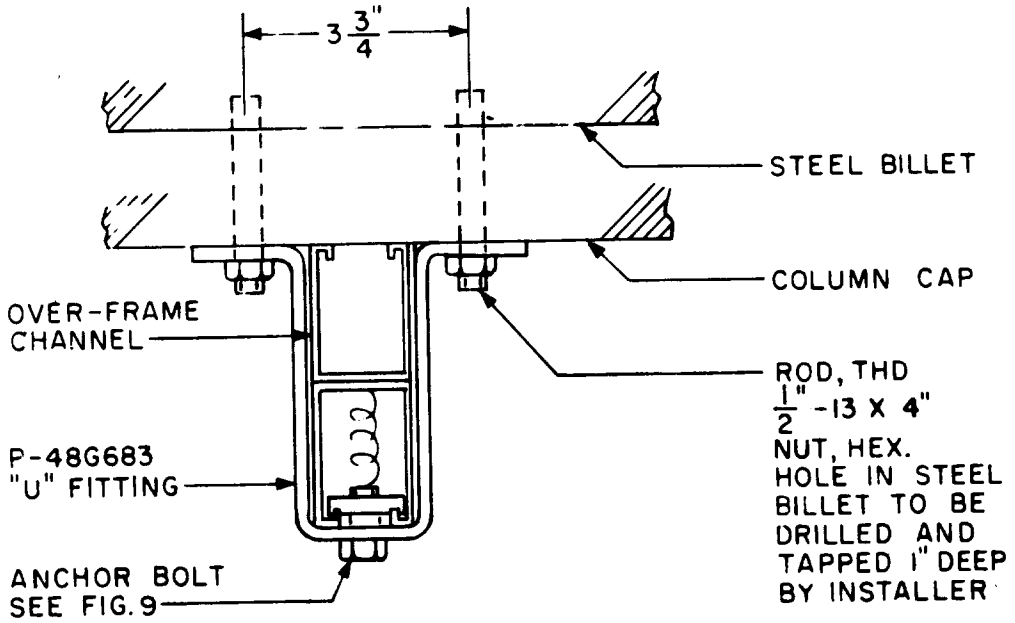


Fig. 21—Fastening Overframe Channel to Column Cap (A&M Only)

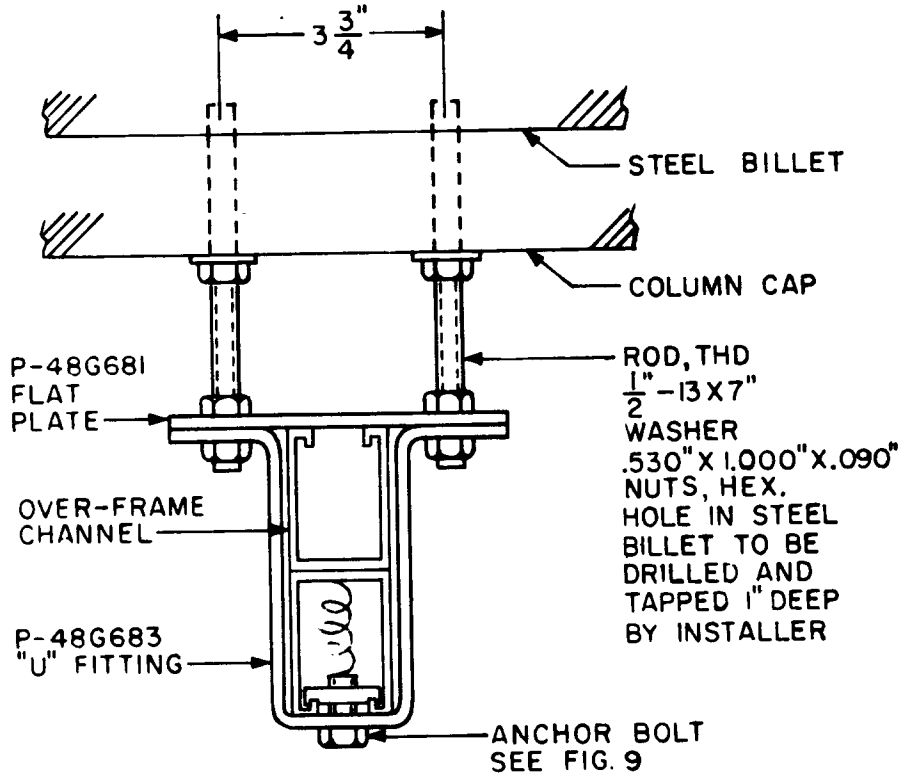


Fig. 22—Fastening Overframe Channel to Column Cap (A&M Only)

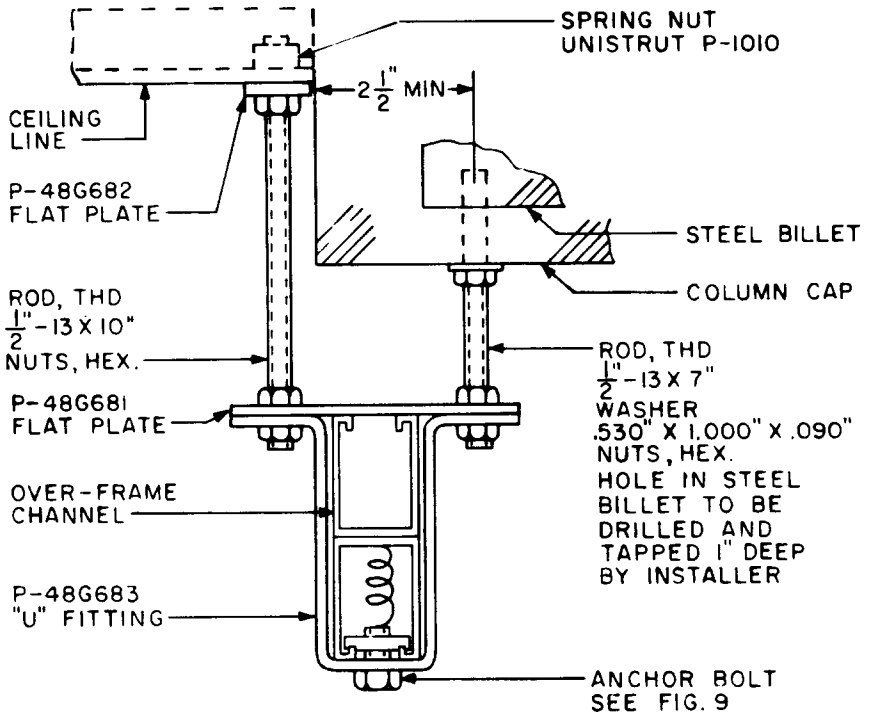


Fig. 23—Fastening Overframe Channel to Ceiling and Column Cap (A&M Only)

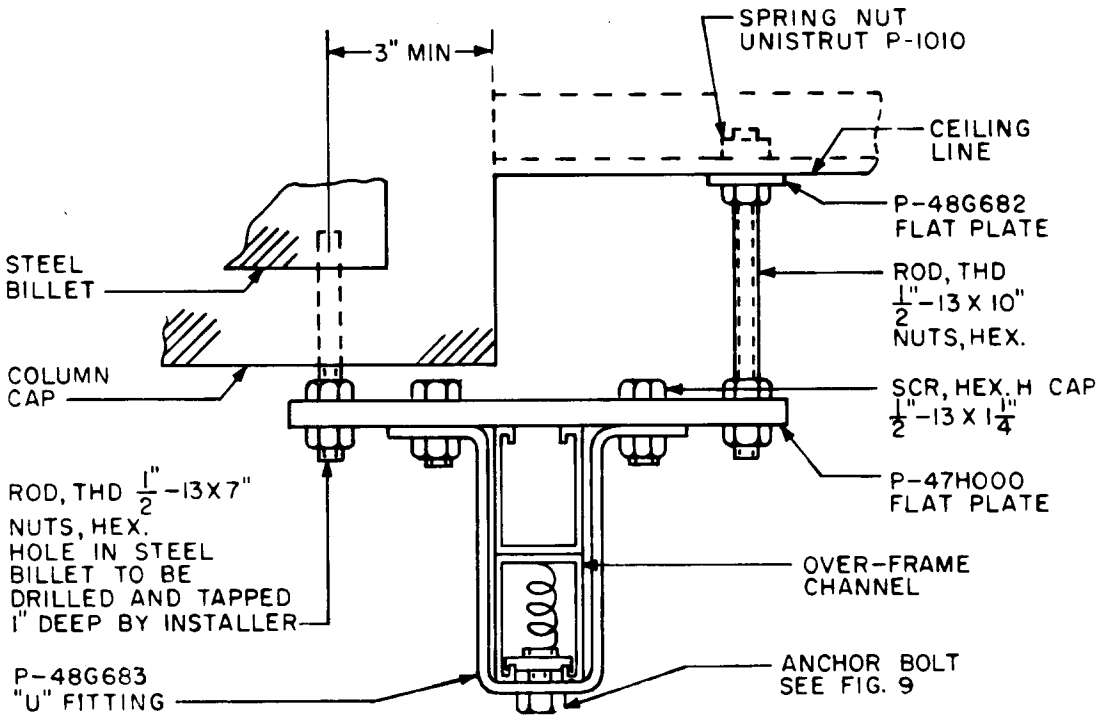


Fig. 24—Fastening Overframe Channel to Ceiling and Column Cap (A&M Only)

TABLE A

ANGLE SUPPORTS FOR TREES AND BARRYMOUNTS FOR SINGLE LINEUP OF DUCT-TYPE FRAMES (A&M Only)

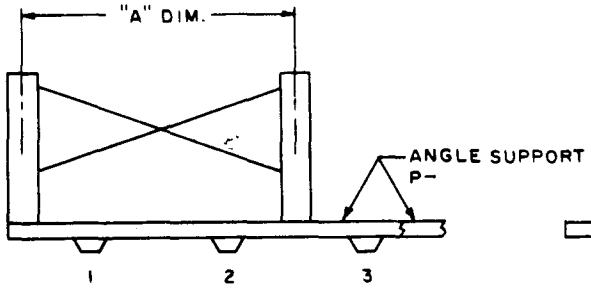


Fig. A — Old Numbered Lineups

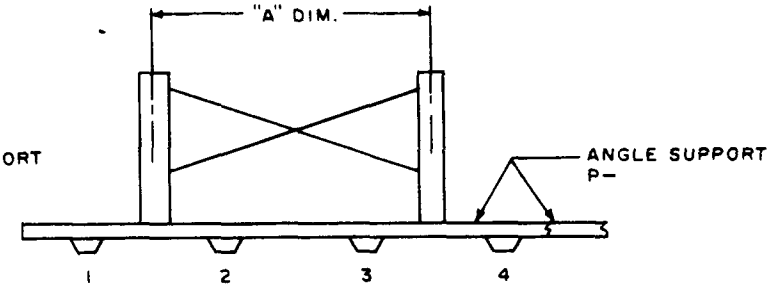


Fig. B — Even Numbered Lineups

NO. OF BAYS	FIG. A	FIG. B
	BAYS ON 1'-10-1/2" CENTERS, "A" DIMENSIONS = 3'-9"	
2	P-41P774 P-41P774	
3	P-41P776 P-41P775	P-41P775 P-41P776
4	P-41P777 P-41P777	P-41P778 P-41P778
5	P-41P780 P-41P779	P-41P779 P-41P780
6	P-41P781 P-41P781	P-41P782 P-41P782
7	P-41P784 P-41P783	P-41P783 P-41P784
8	P-41P785 P-41P785	P-41P786 P-41P786
9	P-41P788 P-41P787	P-41P787 P-41P788
10	P-41P784 + P-41P755 P-41P775 + P-41P784	P-41P789 P-41P789
11	P-41P784 + P-41P778 P-41P775 + P-41P786	P-41P786 + P-41P775 P-41P778 + P-41P784
12	P-41P784 + P-41P779 P-41P775 + P-41P788	P-41P786 + P-41P778 P-41P778 + P-41P786
13	P-41P784 + P-41P782 P-41P775 + P-41P789	P-41P789 + P-41P775 P-41P782 + P-41P784
14	P-41P788 + P-41P779 P-41P779 + P-41P788	P-41P789 + P-41P777 P-41P777 + P-41P789
15	P-41P788 + P-41P782 P-41P779 + P-41P789	P-41P789 + P-41P779 P-41P782 + P-41P788
16	P-41P788 + P-41P783 P-41P779 + P-41P786 + P-41P776	P-41P789 + P-41P782 P-41P782 + P-41P789
17	P-41P788 + P-41P786 P-41P779 + P-41P786 + P-41P778	P-41P778 + P-41P786 + P-41P779 P-41P786 + P-41P788

(Cont)

TABLE A (Contd)

NO. OF BAYS	FIG. A	FIG. B
	BAYS ON 1'-10-1/2" CENTERS, "A" DIMENSION = 3'-9"	
18	P-41P788 + P-41P787 P-41P779 + P-41P786 + P-41P780	P-41P782 + P-41P786 + P-41P778 P-41P789 + P-41P786
19	P-41P788 + P-41P789 P-41P779 + P-41P786 + P-41P782	P-41P782 + P-41P786 + P-41P779 P-41P789 + P-41P788
20	P-41P784 + P-41P789 + P-41P775 P-41P775 + P-41P789 + P-41P784	P-41P782 + P-41P786 + P-41P782 P-41P789 + P-41P789
	BAYS ON 2'-3-1/2" CENTERS, "A" DIMENSION = 4'-7"	
2	P-41P950 P-41P950	
3	P-41P952 P-41P951	P-41P951 P-41P952
4	P-41P953 P-41P953	P-41P954 P-41P954
5	P-41P956 P-41P955	P-41P955 P-41P956
6	P-41P957 P-41P957	P-41P958 P-41P958
7	P-41P960 P-41P959	P-41P959 P-41P960
8	P-41P956 + P-41P951 P-41P951 + P-41P956	P-41P961 P-41P961
9	P-41P956 + P-41P954 P-41P951 + P-41P958	P-41P958 + P-41P951 P-41P954 + P-41P956
10	P-41P960 + P-41P951 P-41P951 + P-41P960	P-41P958 + P-41P954 P-41P954 + P-41P958
11	P-41P960 + P-41P954 P-41P951 + P-41P961	P-41P961 + P-41P951 P-41P954 + P-41P960
12	P-41P960 + P-41P955 P-41P955 + P-41P960	P-41P961 + P-41P954 P-41P954 + P-41P961
13	P-41P960 + P-41P958 P-41P955 + P-41P961	P-41P958 + P-41P959 P-41P961 + P-41P956
14	P-41P952 + P-41P961 + P-41P951 P-41P959 + P-41P960	P-41P961 + P-41P958 P-41P958 + P-41P961
15	P-41P952 + P-41P961 + P-41P954 P-41P959 + P-41P961	P-41P954 + P-41P961 + P-41P951 P-41P961 + P-41P960
16	P-41P960 + P-41P958 + P-41P951 P-41P951 + P-41P958 + P-41P960	P-41P961 + P-41P961 P-41P954 + P-41P961 + P-41P954
17	P-41P960 + P-41P958 + P-41P954 P-41P951 + P-41P961 + P-41P958	P-41P954 + P-41P961 + P-41P955 P-41P961 + P-41P958 + P-41P952
18	P-41P960 + P-41P961 + P-41P951 P-41P951 + P-41P961 + P-41P960	P-41P961 + P-41P958 + P-41P954 P-41P954 + P-41P958 + P-41P961
19	P-41P960 + P-41P961 + P-41P954 P-41P951 + P-41P961 + P-41P961	P-41P954 + P-41P961 + P-41P959 P-41P961 + P-41P961 + P-41P952
20	P-41P960 + P-41P961 + P-41P955 P-41P951 + P-41P961 + P-41P958 + P-41P952	P-41P961 + P-41P961 + P-41P954 P-41P954 + P-41P961 + P-41P961

(Cont)

TABLE A (Contd)

NO. OF BAYS	FIG. A	FIG. B
	BAYS ON 2'-8-1/2" CENTERS, "A" DIMENSION = 5'-5"	
2	P-41P965 P-41P965	
3	P-41P967 P-41P966	P-41P966 P-41P967
4	P-41P968 P-41P968	P-41P969 P-41P969
5	P-41P971 P-41P970	P-41P970 P-41P971
6	P-41P972 P-41P972	P-41P973 P-41P973
7	P-41P975 P-41P974	P-41P974 P-41P975
8	P-41P971 + P-41P966 P-41P966 + P-41P971	P-41P964 + P-41P973 P-41P973 + P-41P964
9	P-41P971 + P-41P969 P-41P966 + P-41P973	P-41P973 + P-41P966 P-41P969 + P-41P971
10	P-41P975 + P-41P966 P-41P966 + P-41P975	P-41P969 + P-41P973 P-41P973 + P-41P969
11	P-41P975 + P-41P969 P-41P970 + P-41P973	P-41P973 + P-41P970 P-41P969 + P-41P975
12	P-41P971 + P-41P974 P-41P974 + P-41P971	P-41P969 + P-41P969 + P-41P969 P-41P973 + P-41P973
13	P-41P967 + P-41P973 + P-41P969 P-41P974 + P-41P973	P-41P973 + P-41P969 + P-41P966 P-41P969 + P-41P969 + P-41P971
14	P-41P971 + P-41P969 + P-41P970 P-41P974 + P-41P975	P-41P969 + P-41P969 + P-41P973 P-41P973 + P-41P969 + P-41P969
15	P-41P971 + P-41P973 + P-41P969 P-41P966 + P-41P973 + P-41P973	P-41P973 + P-41P973 + P-41P966 P-41P969 + P-41P973 + P-41P971
16	P-41P975 + P-41P973 + P-41P966 P-41P966 + P-41P973 + P-41P975	P-41P969 + P-41P973 + P-41P973 P-41P973 + P-41P973 + P-41P969
17	P-41P975 + P-41P973 + P-41P969 P-41P970 + P-41P973 + P-41P973	P-41P973 + P-41P973 + P-41P970 P-41P969 + P-41P973 + P-41P969 + P-41P967
18	P-41P971 + P-41P973 + P-41P974 P-41P974 + P-41P973 + P-41P971	P-41P969 + P-41P973 + P-41P969 + P-41P969 P-41P973 + P-41P973 + P-41P973
19	P-41P967 + P-41P973 + P-41P973 + P-41P969 P-41P974 + P-41P973 + P-41P973	P-41P969 + P-41P973 + P-41P973 + P-41P966 P-41P973 + P-41P973 + P-41P973
20	P-41P967 + P-41P973 + P-41P973 + P-41P970 P-41P974 + P-41P973 + P-41P975	P-41P969 + P-41P969 + P-41P973 + P-41P966 P-41P973 + P-41P973 + P-41P969 + P-41P969

TABLE B

ANGLE SUPPORTS FOR TREES AND BARRYMOUNTS FOR DOUBLE LINEUP (Back-to-Back) OF DUCT-TYPE FRAMES ON 1-FOOT 10-1/2 INCH CENTERS (A&M Only)

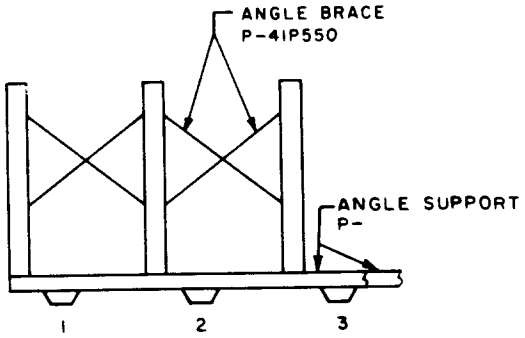


Fig. A—Odd Numbered Lineups

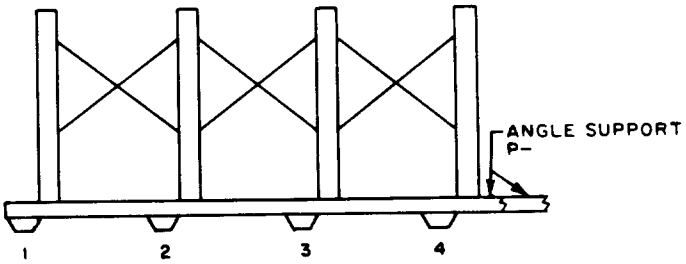


Fig. B—Even Numbered Lineups

NO. OF BAYS	FIG. A	FIG. B
1	P-41M718 P-41M728	
2	P-41M719 P-41M729	P-41M729 P-41M719
3	P-41M720 P-41M730	P-41M730 P-41M720
4	P-41M721 P-41M731	P-41M731 P-41M721
5	P-41M722 P-41M732	P-41M732 P-41M722
6	P-41M723 P-41M733	P-41M733 P-41M723
7	P-41M724 P-41M734	P-41M734 P-41M724
8	P-41M725 P-41M735	P-41M735 P-41M725
9	P-41M726 P-41M736	P-41M736 P-41M726
10	P-41M727 P-41M737	P-41M767 P-41M777
11	P-41M774 + P-41M741 P-41M761 + P-41M754	P-41M754 + P-41M761 P-41M741 + P-41M774
12	P-41M775 + P-41M741 P-41M761 + P-41M755	P-41M775 + P-41M761 P-41M741 + P-41M775
13	P-41M776 + P-41M741 P-41M762 + P-41M755	P-41M755 + P-41M762 P-41M741 + P-41M776
14	P-41M727 + P-41M741 P-41M762 + P-41M756	P-41M756 + P-41M762 P-41M741 + P-41M727
15	P-41M727 + P-41M742 P-41M762 + P-41M767	P-41M762 + P-41M762 P-41M742 + P-41M727

TABLE B (Contd)

NO. OF BAYS	FIG. A	FIG. B
16	P-41M727 + P-41M743 P-41M763 + P-41M767	P-41M767 + P-41M763 P-41M743 + P-41M727
17	P-41M727 + P-41M744 P-41M764 + P-41M767	P-41M767 + P-41M764 P-41M744 + P-41M727
18	P-41M727 + P-41M745 P-41M762 + P-41M757 + P-41M750	P-41M750 + P-41M757 + P-41M762 P-41M745 + P-41M727
19	P-41M727 + P-41M746 P-41M762 + P-41M757 + P-41M751	P-41M751 + P-41M757 + P-41M762 P-41M746 + P-41M727
20	P-41M727 + P-41M777 P-41M762 + P-41M757 + P-41M752	P-41M752 + P-41M757 + P-41M762 P-41M777 + P-41M727

TABLE C

ANGLE CROSS BRACING BETWEEN TREE ASSEMBLIES
SINGLE LINEUP OF FRAMES (A&M Only)

TYPE OF FRAME	FRAME CENTERS	ANGLE BRACE
Duct	1 Ft – 10-1/2 In.	P-41P543
	2 Ft – 3-1/2 In.	P-41P544
	2 Ft – 8-1/2 In.	P-41P545
Bulb-Angle or Channel	Variable	In accordance with job information

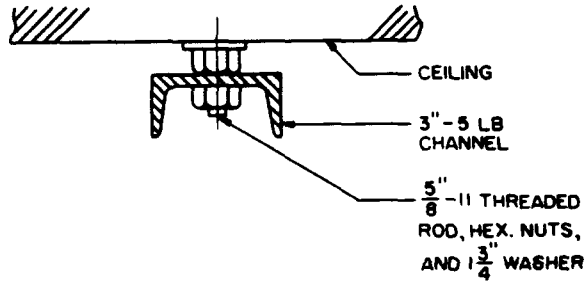


Fig. 33—Fastening Ceiling Channel (A&M Only)

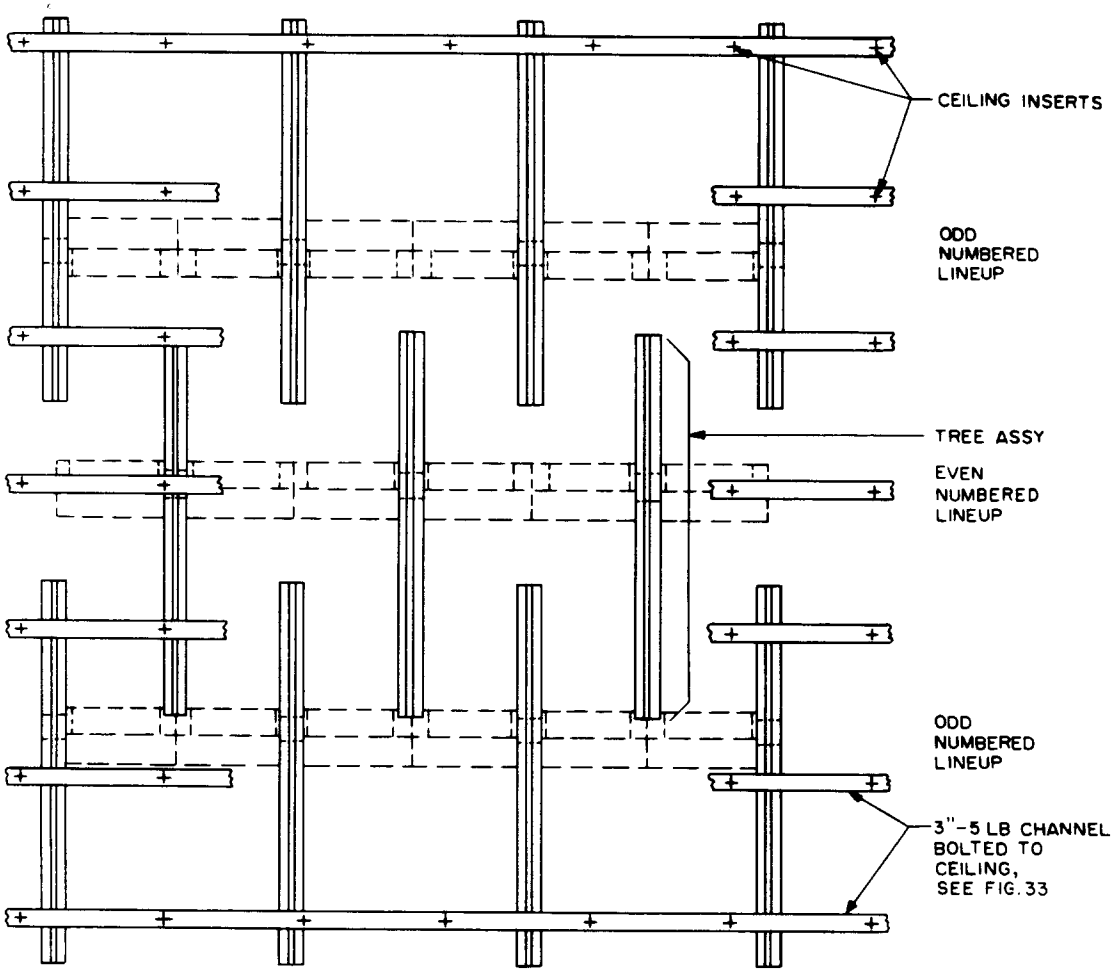


Fig. 34—Typical Arrangement of Tree Assemblies for Single Lineup of Duct-Type Frames (A&M Only)

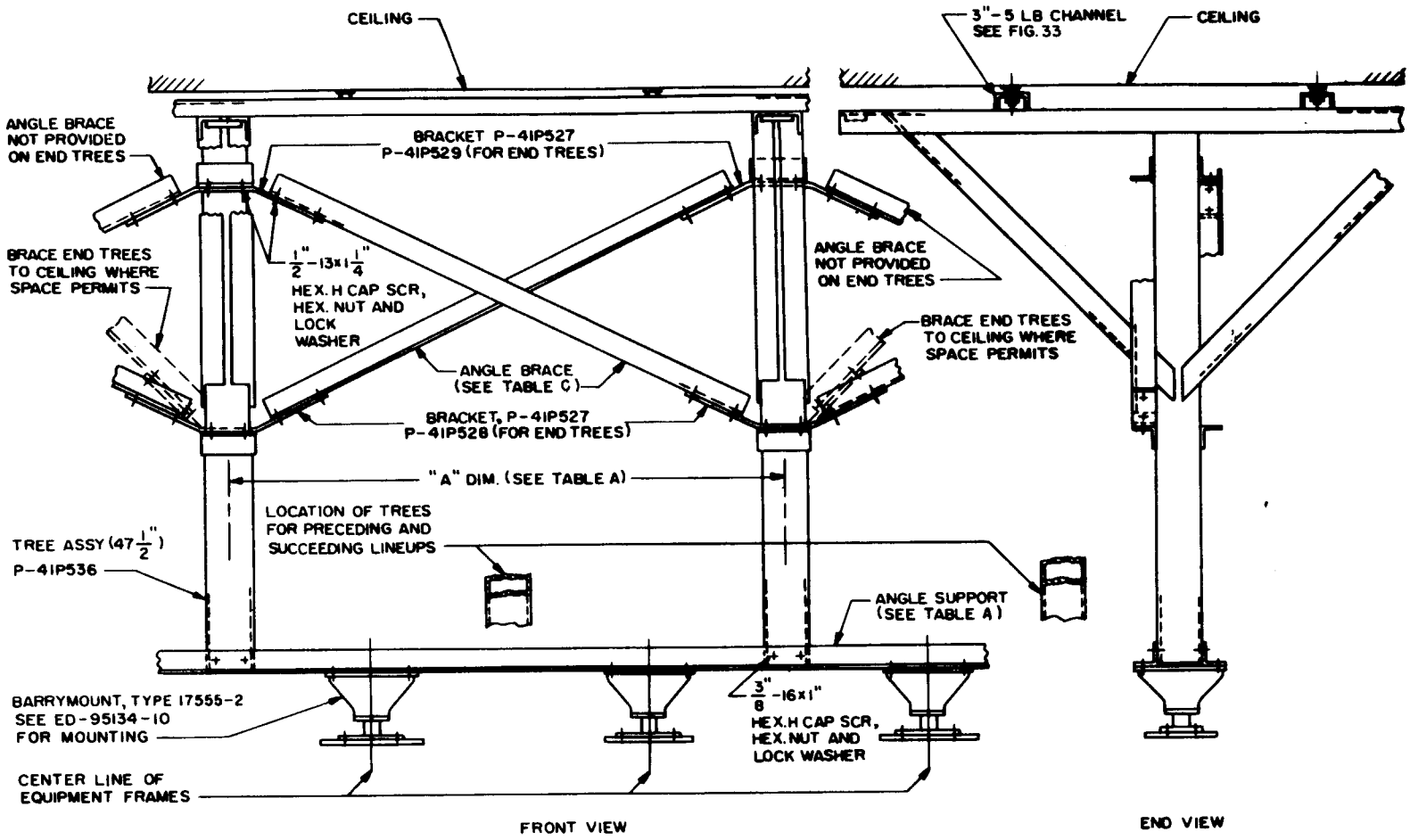


Fig. 35—Typical Tree Assembly for Single Lineup of Frames (A&M Only)

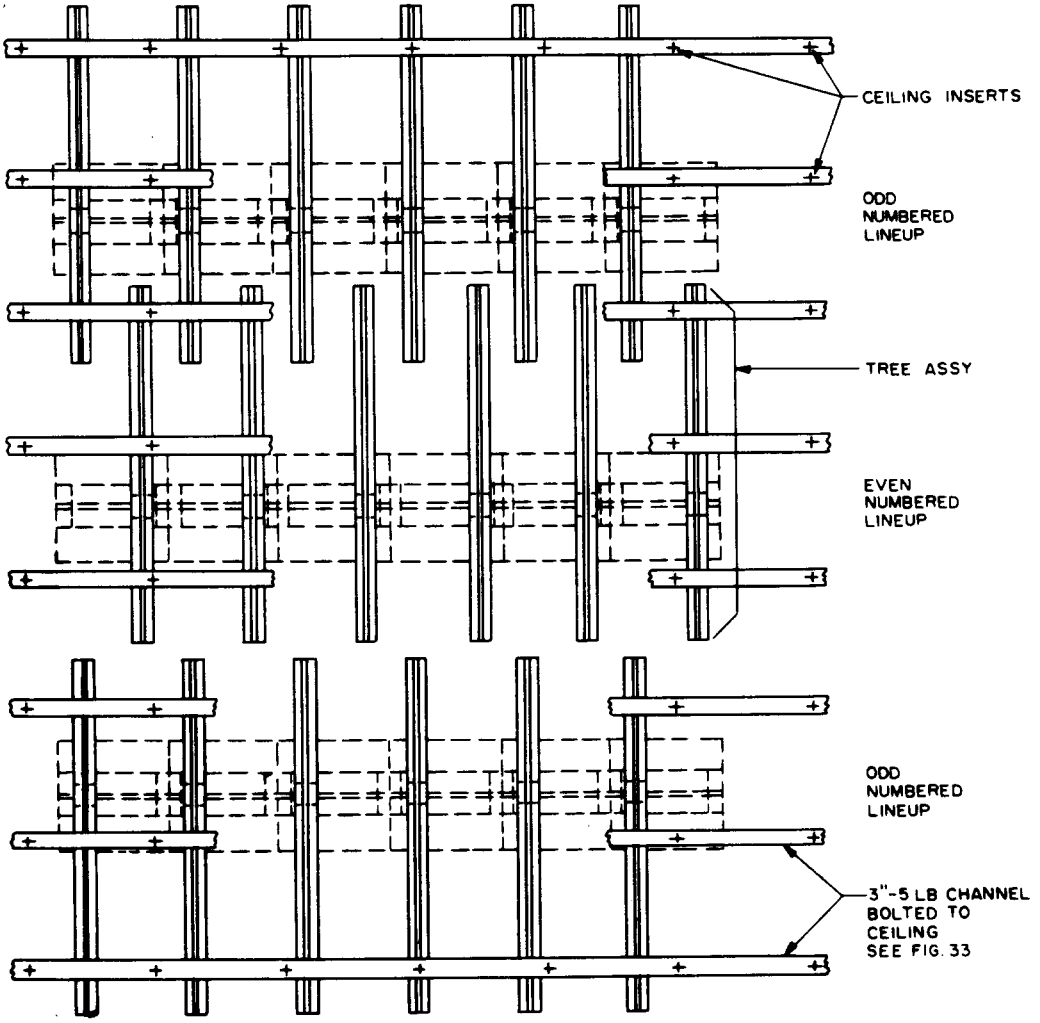


Fig. 36—Typical Arrangement of Tree Assemblies for Double Lineup (Back-to-Back) of Duct-Type Frames (A&M Only)

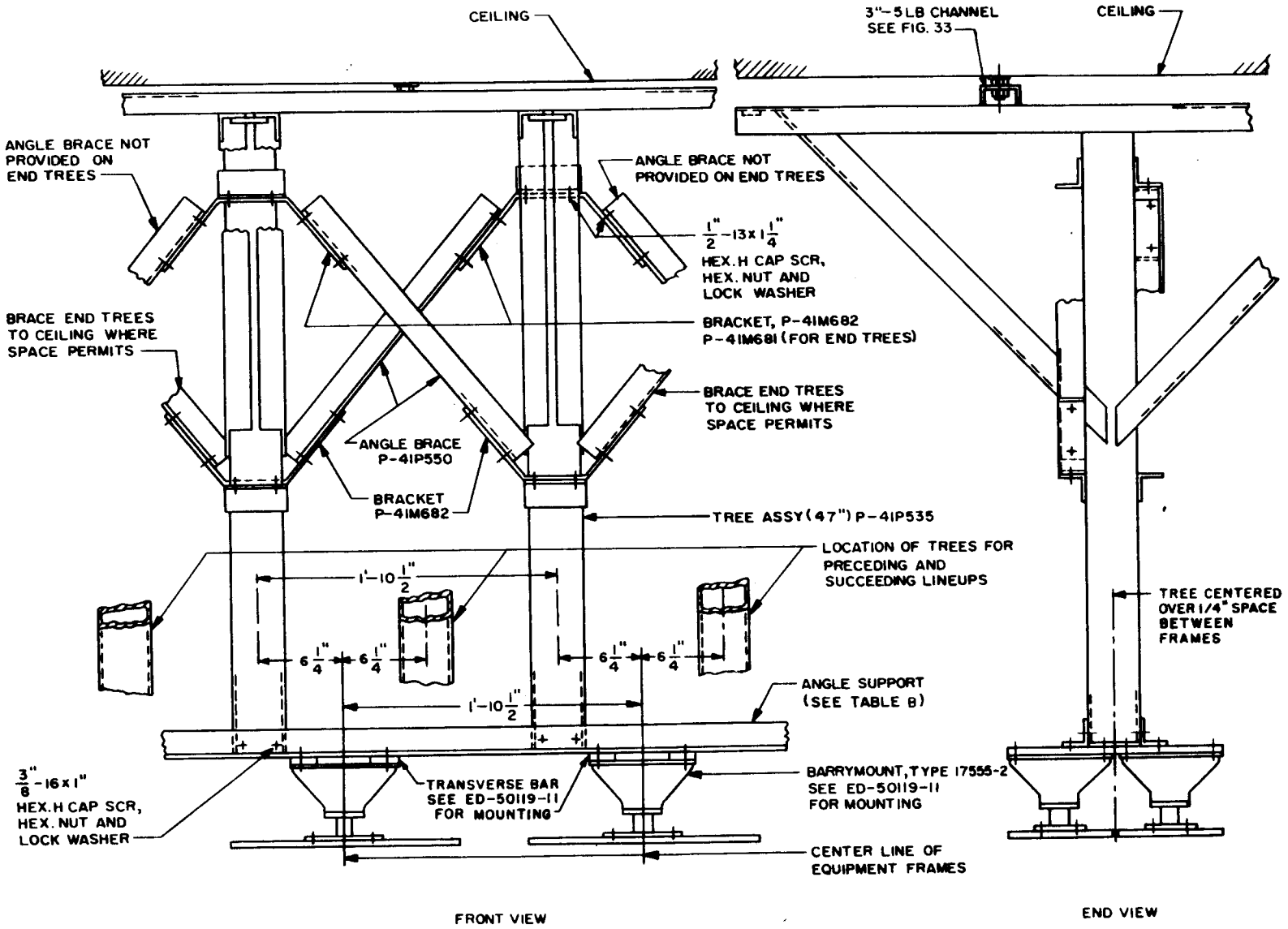


Fig. 37—Typical Assembly for Back-to-Back Lineup of Duct-Type Frames (A&M Only)

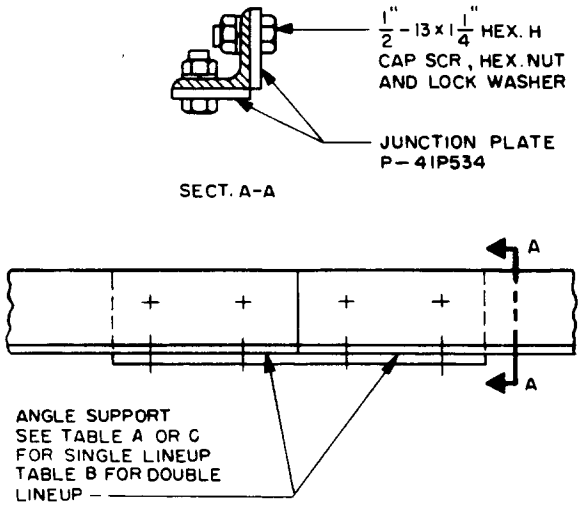


Fig. 38—Splice in Angle Support for Trees and Barrymounts (A&M Only)

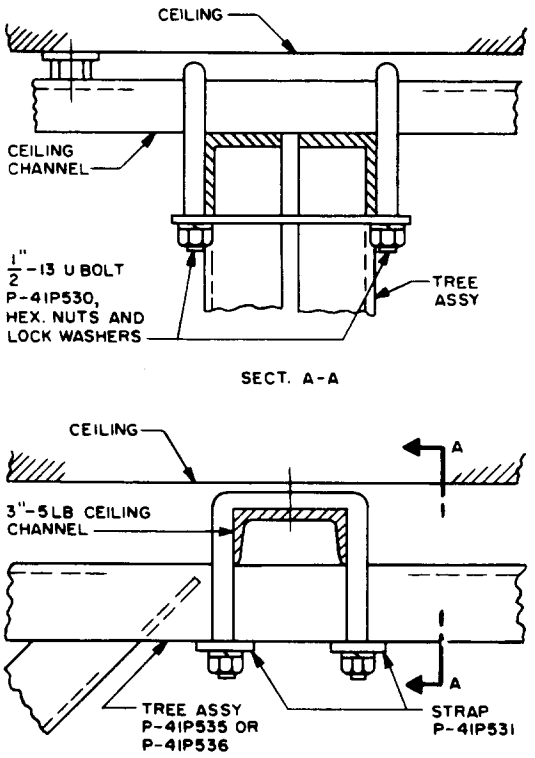


Fig. 39—Fastening Tree Assembly to Ceiling Channel—No Obstruction (A&M Only)

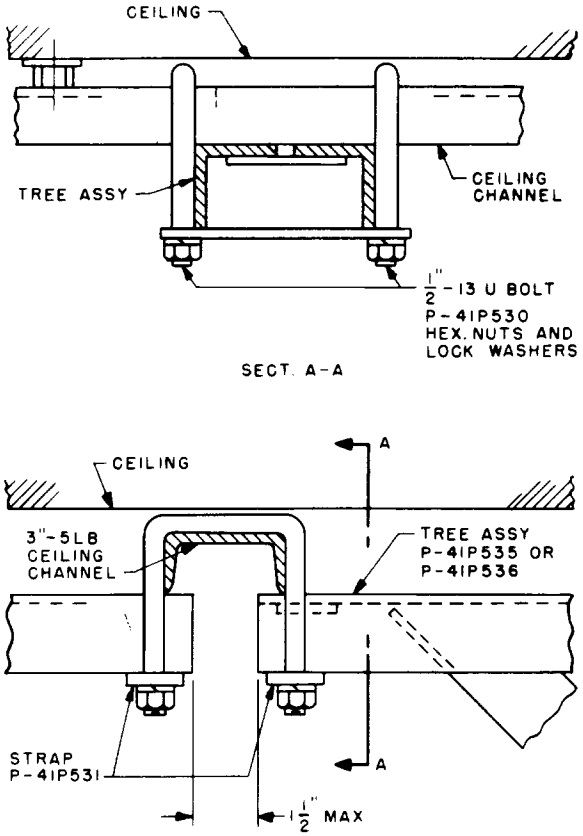


Fig. 40—Fastening Tree Assembly to Ceiling Channel—No Obstruction—Maximum 1-1/2 Inches Between Tree Assemblies (A&M Only)

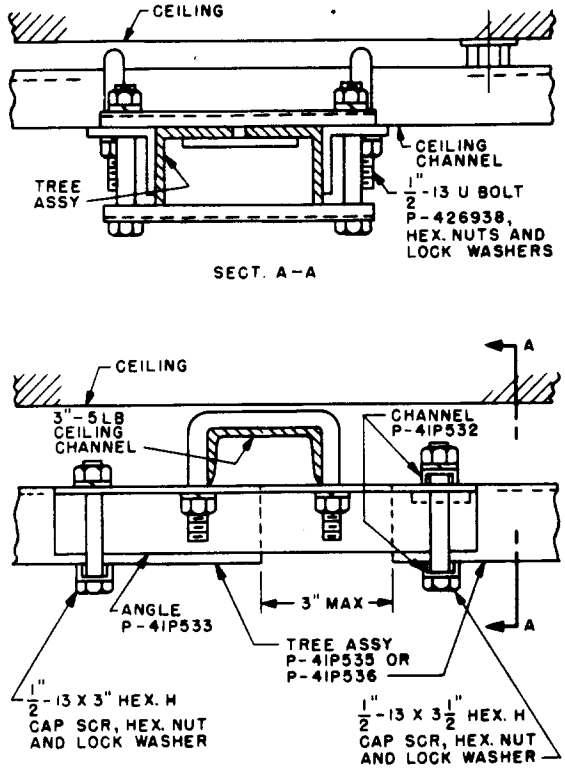


Fig. 41—Fastening Tree Assembly to Ceiling Channel—No Obstruction—Maximum 3 Inches Between Tree Assemblies (A&M Only)

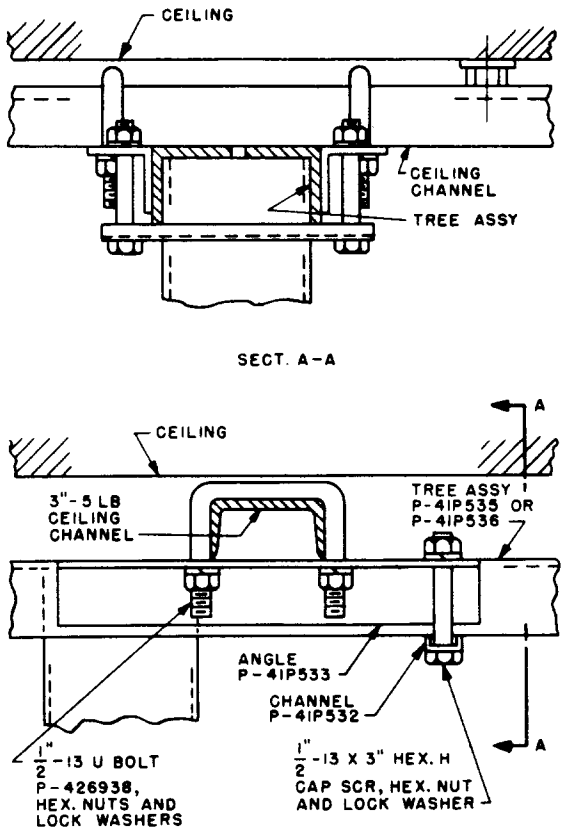


Fig. 42—Fastening Tree Assembly to Ceiling Channel—Obstruction by Upright (A&M Only)

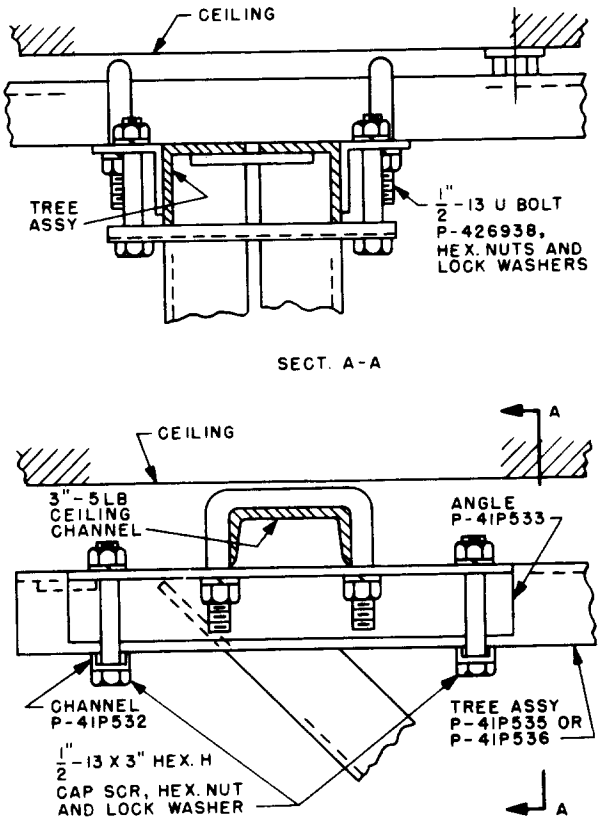
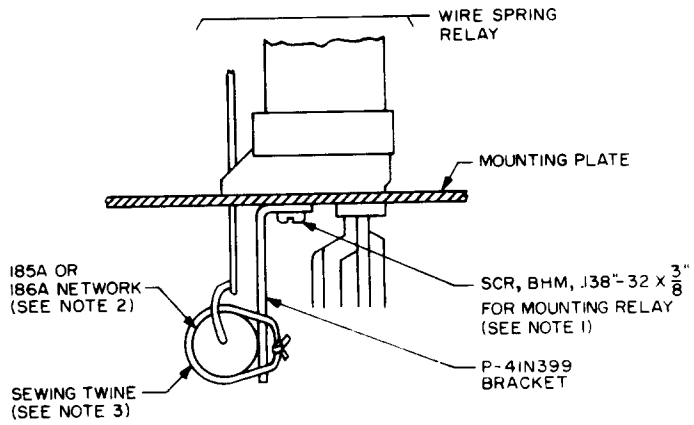


Fig. 43—Fastening Tree Assembly to Ceiling Channel—Obstruction by Angle Brace (A&M Only)



NOTES:

1. MOUNT P-41N399 BRACKET WITH LONGER RELAY MOUNTING SCREWS, (.138"-32 X 3/8" BHM SCR) WHEN MOUNTING RELAY.
2. PROTECT BODY OF NETWORK WITH LAYER OF ACETATE FIBER TAPE BEFORE TYING.
3. SEE FIG. 45B 45A FOR METHOD OF TYING NETWORK TO BRACKET

Fig. 44—Support of 185A or 186A Networks—Wire-Spring Relay and P-41N399 Bracket Shown

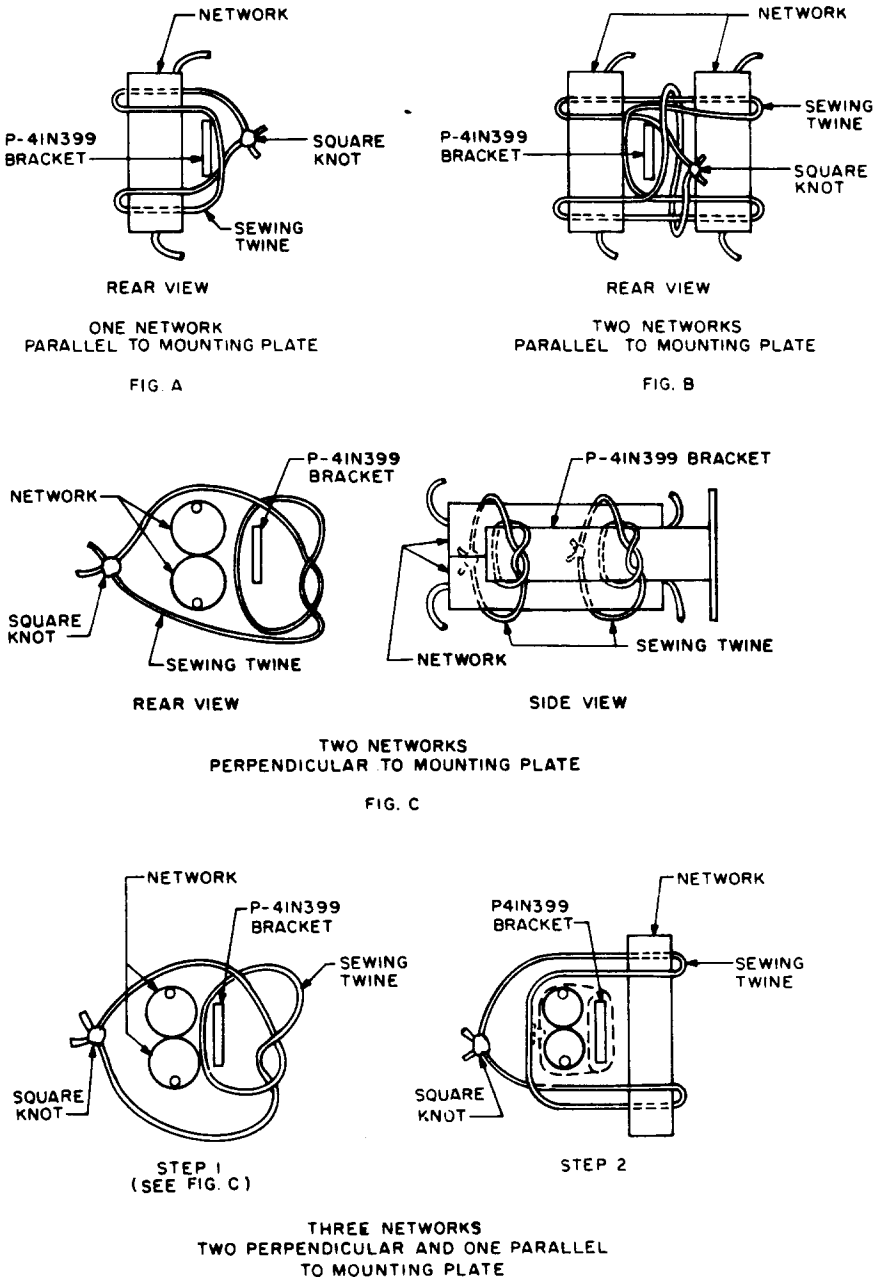
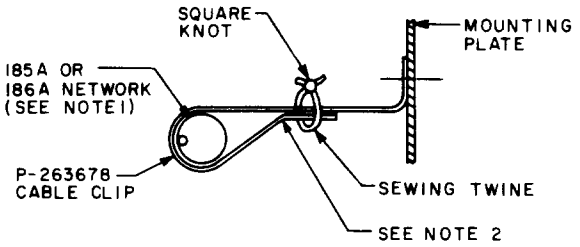


Fig. 45—Method of Tying 185A or 186A Networks to Brackets—P-41N399 Bracket Shown



NOTES:

1. PROTECT BODY OF NETWORK WITH LAYER OF ACETATE FIBER TAPE BEFORE MOUNTING IN CABLE CLIP.
2. BEND CABLE CLIP APPROXIMATELY AS SHOWN BEFORE TYING.

Fig. 45A—Support of 185A or 186A Networks—Only One Mounting Hole Available for Support Detail

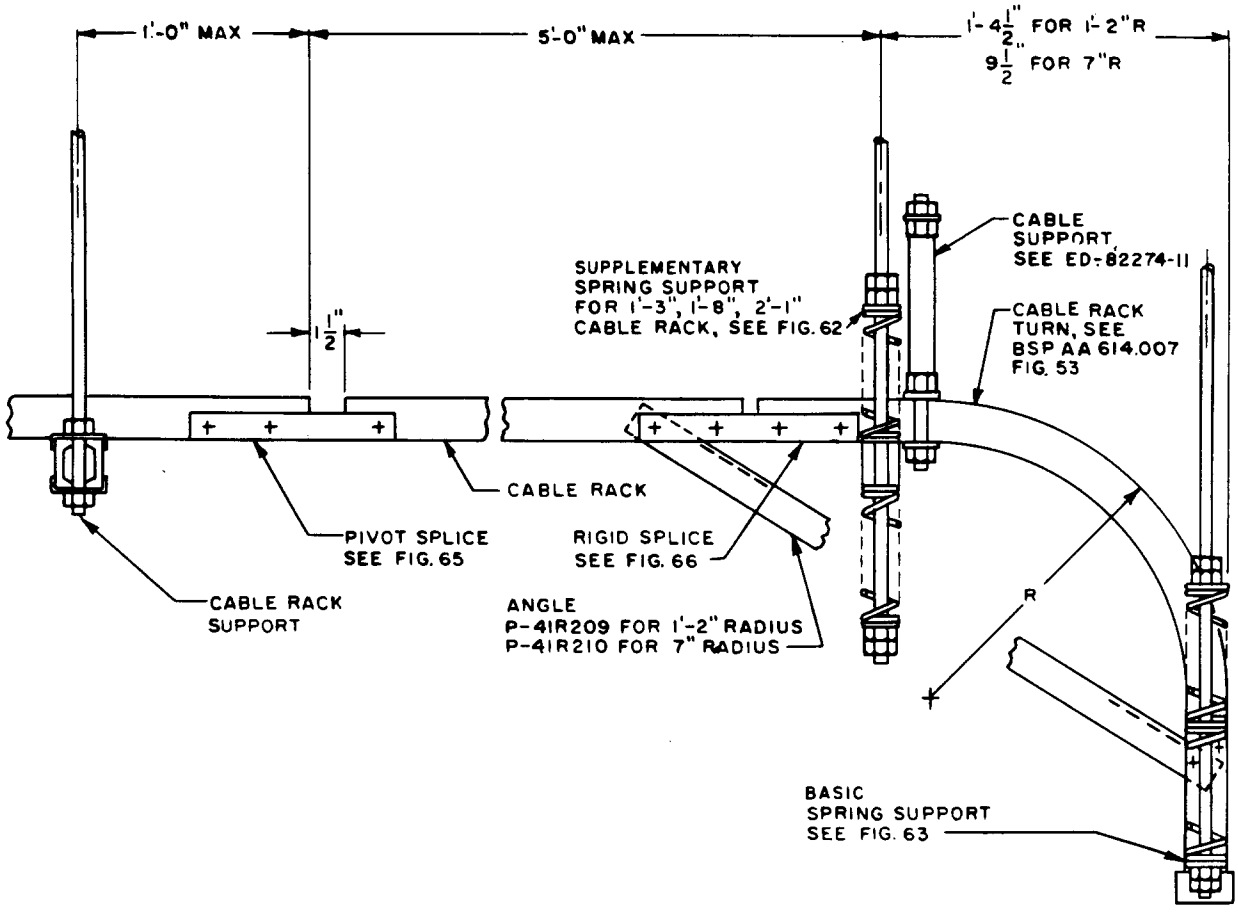


Fig. 56—Spring Support for One 90-Degree Turn—Power Cable Racks (A&M Only)

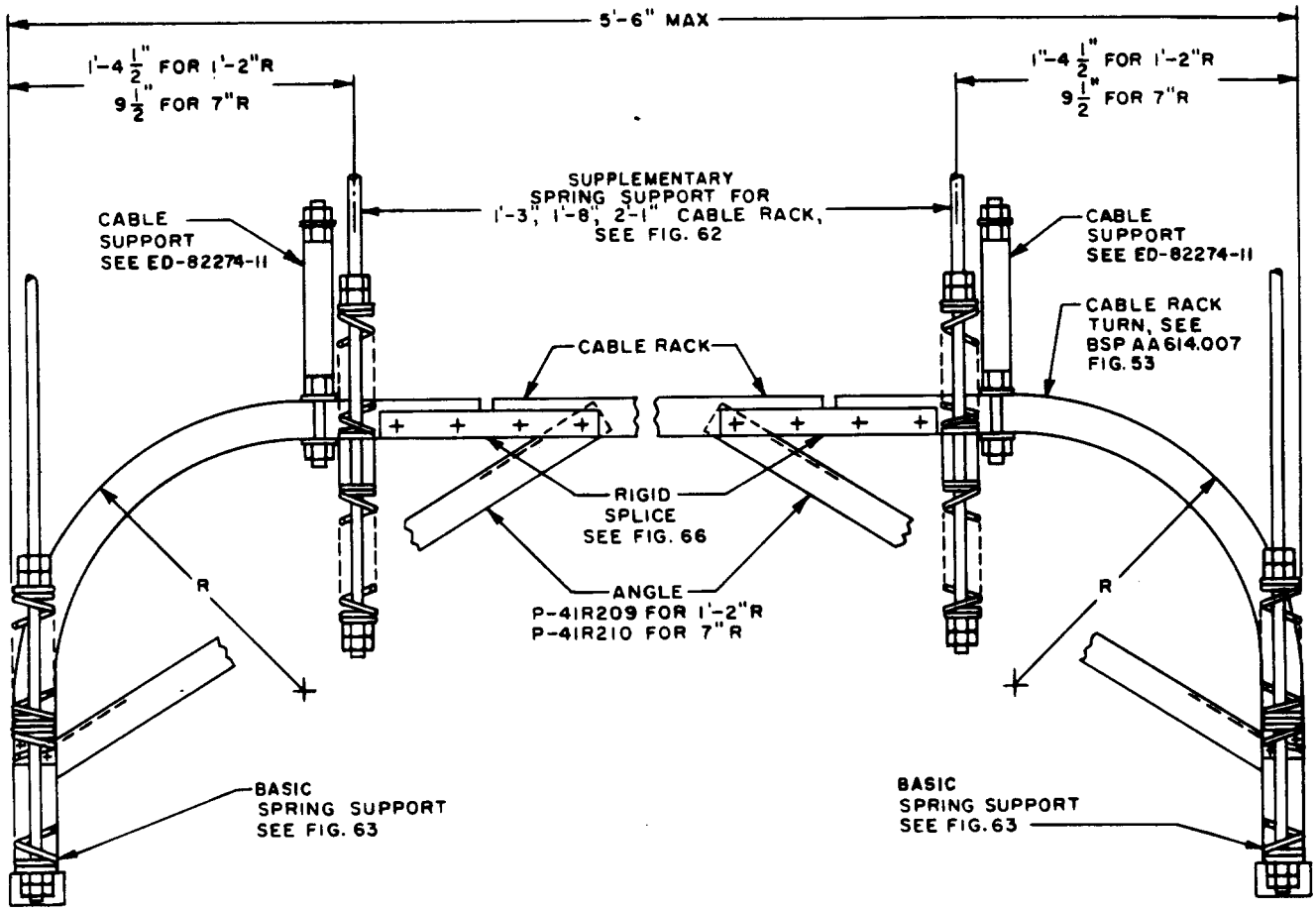


Fig. 57—Spring Support for Two 90-Degree Turns—Maximum 5 Feet 6 Inches Between Turns—Power Cable Racks (A&M Only)

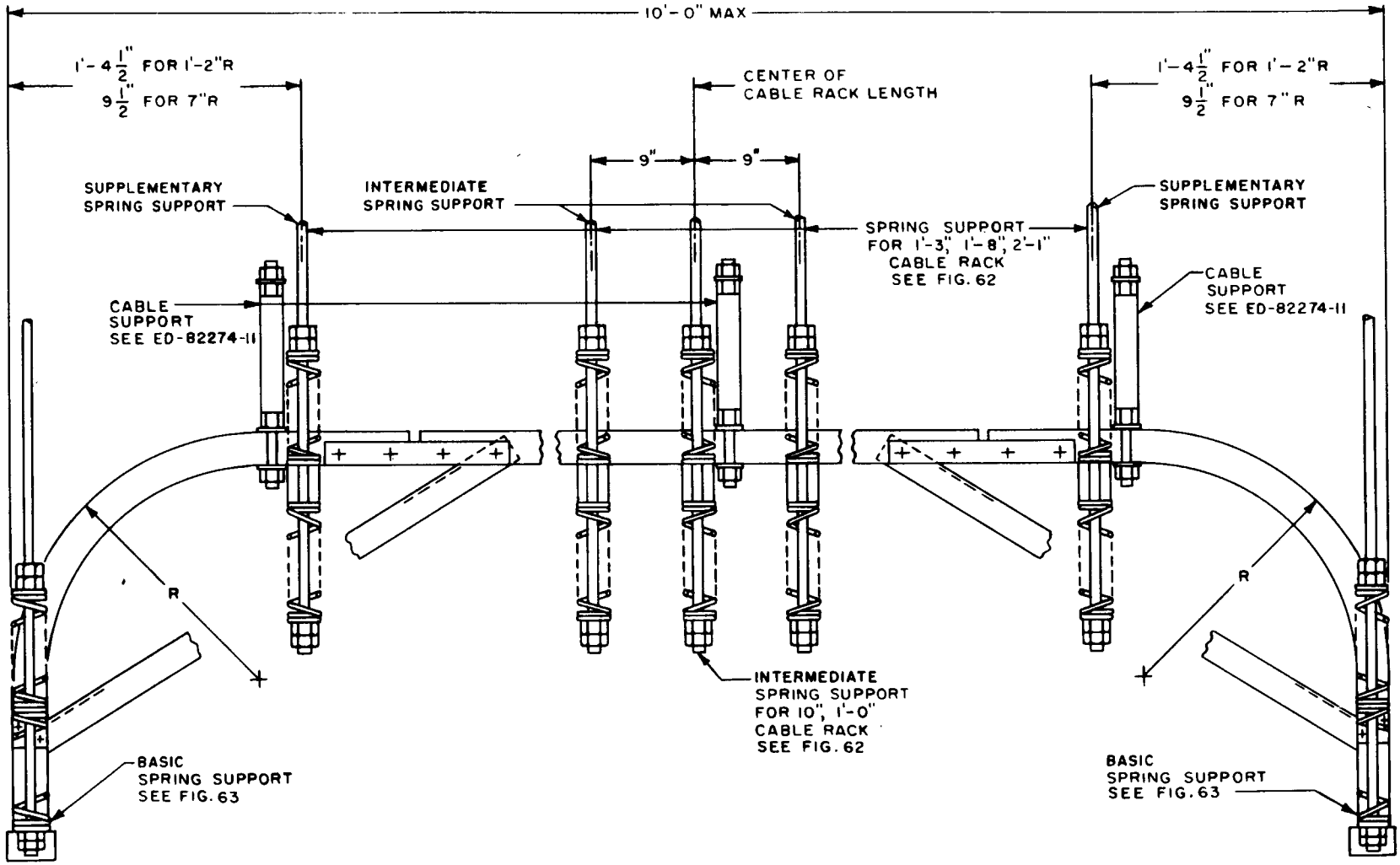


Fig. 58—Spring Support for Two 90-Degree Turns—Maximum 10 Feet 0 Inch Between Turns—Power Cable Racks (Otherwise Same as Fig. 57) (A&M Only)

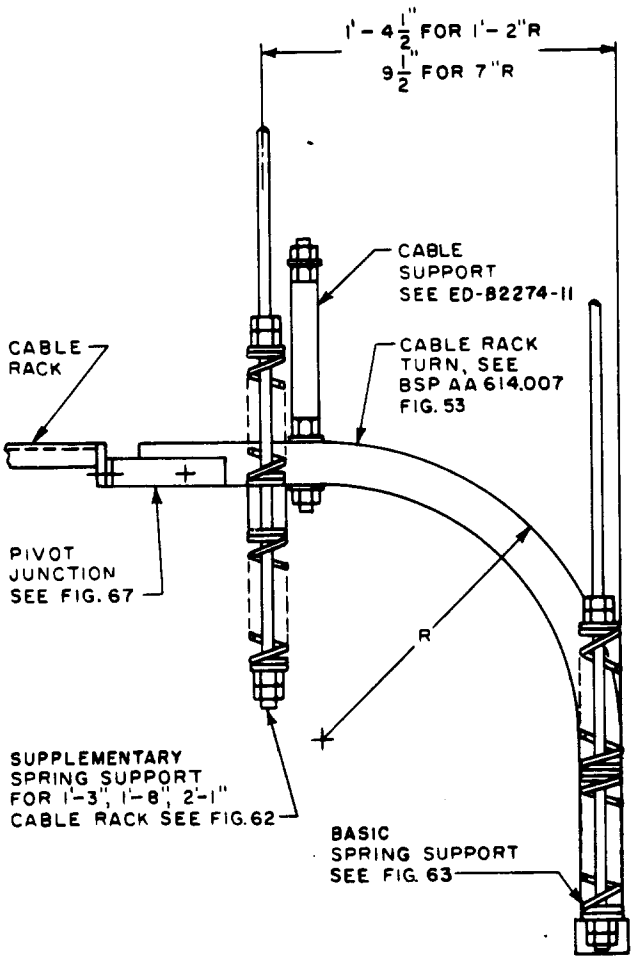


Fig. 59—Spring Support for One 90-Degree Turn at Right Angles to Cable Rack—Power Cable Racks (A&M Only)

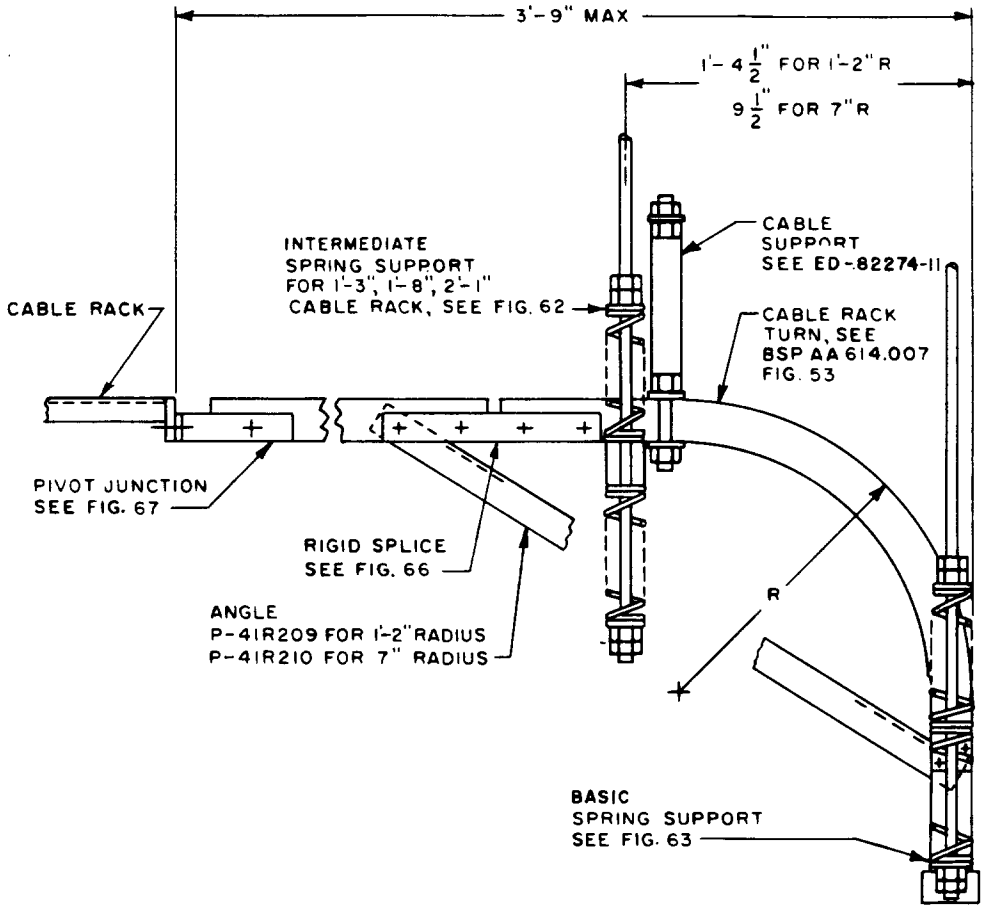


Fig. 60—Spring Support for One 90-Degree Turn at Right Angles to Cable Rack—3 Feet 9 Inches Maximum Between Turn and Cable Rack—Power Cable Racks (A&M Only)

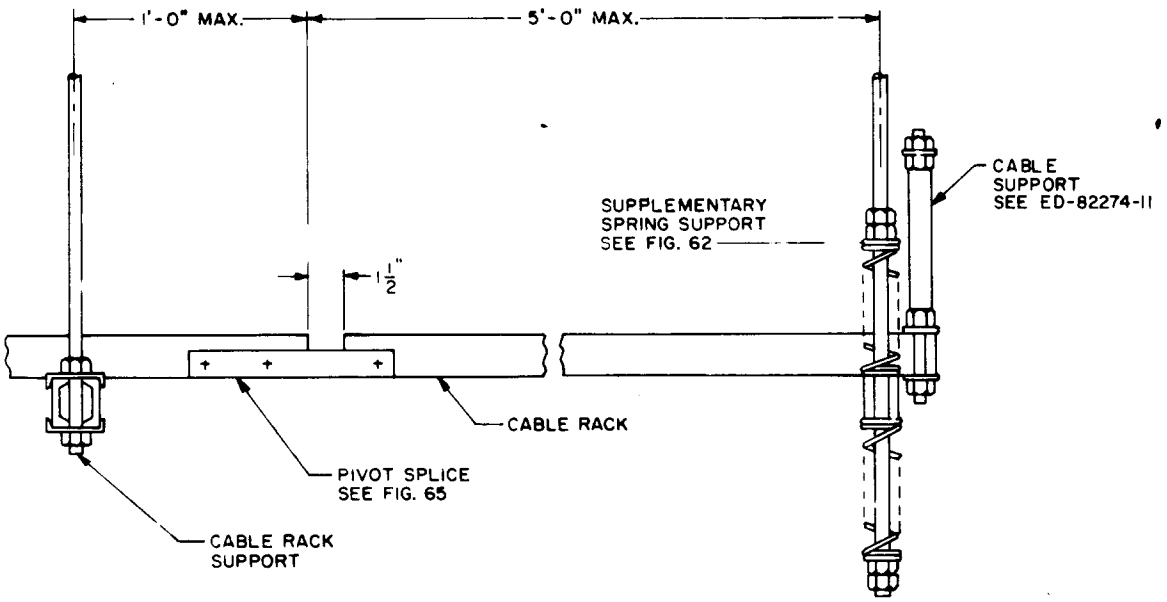


Fig. 61—Spring Support for Cable Rack End—Power Cable Racks (A&M Only)

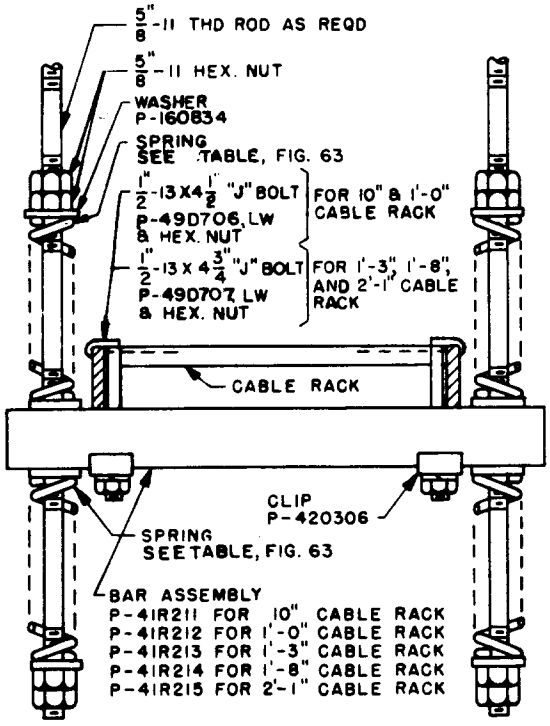
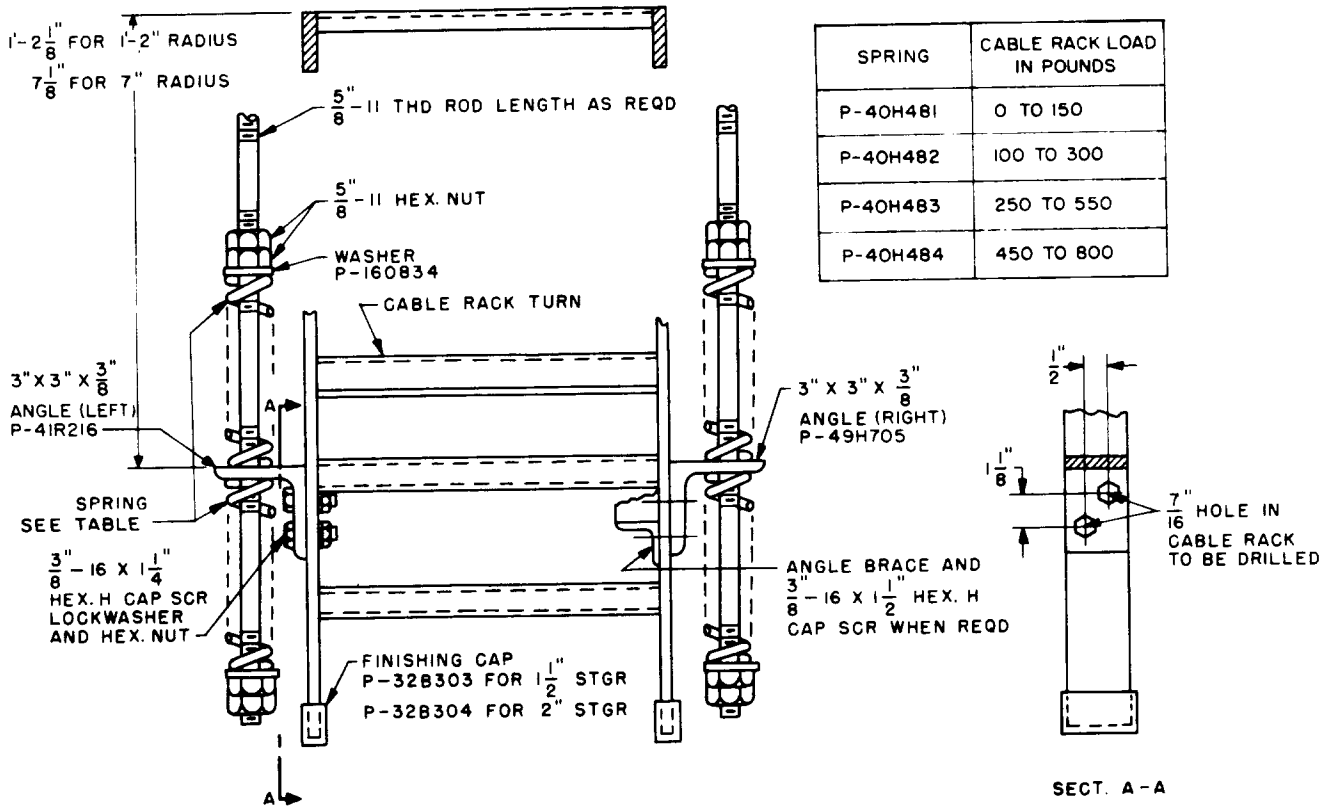


Fig. 62—Supplementary and Intermediate Spring Support—Power Cable Racks (A&M Only)



SPRING	CABLE RACK LOAD IN POUNDS
P-40H481	0 TO 150
P-40H482	100 TO 300
P-40H483	250 TO 550
P-40H484	450 TO 800

Fig. 63—Basic Spring Support—Power Cable Racks (A&M Only)

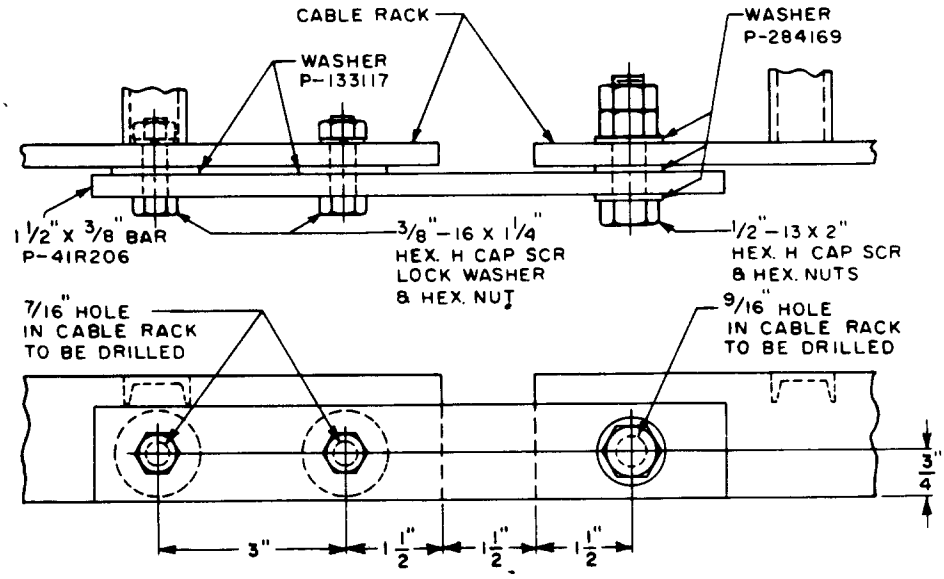


Fig. 65—Pivot Splice—Power Cable Racks (A&M Only)

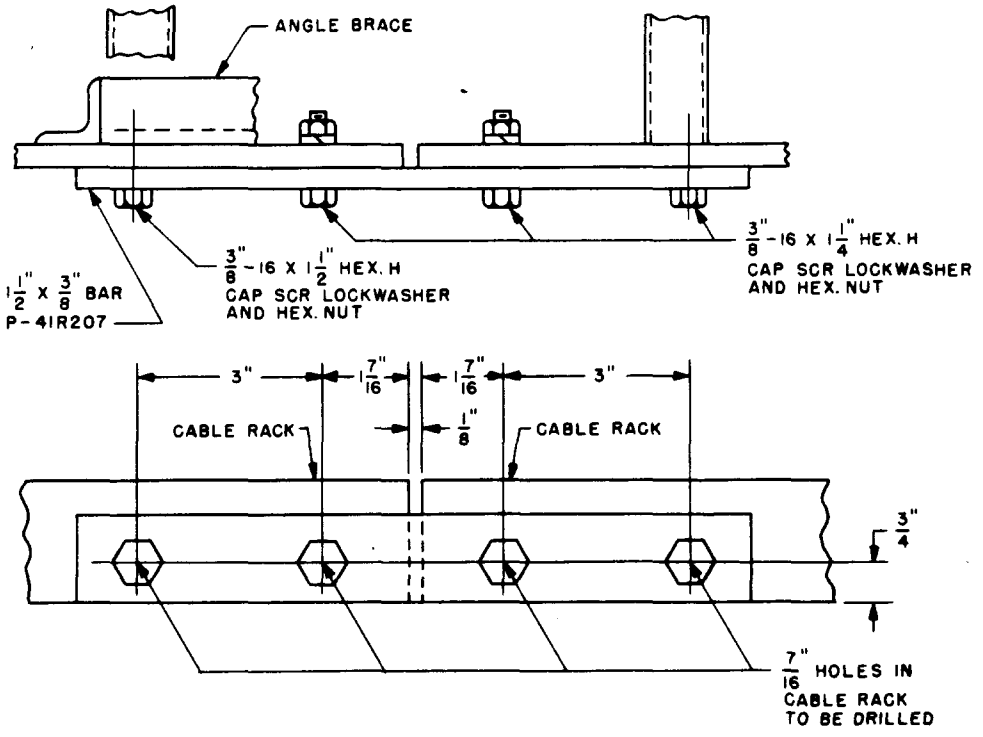


Fig. 66—Rigid Splice—Power Cable Racks (A&M Only)

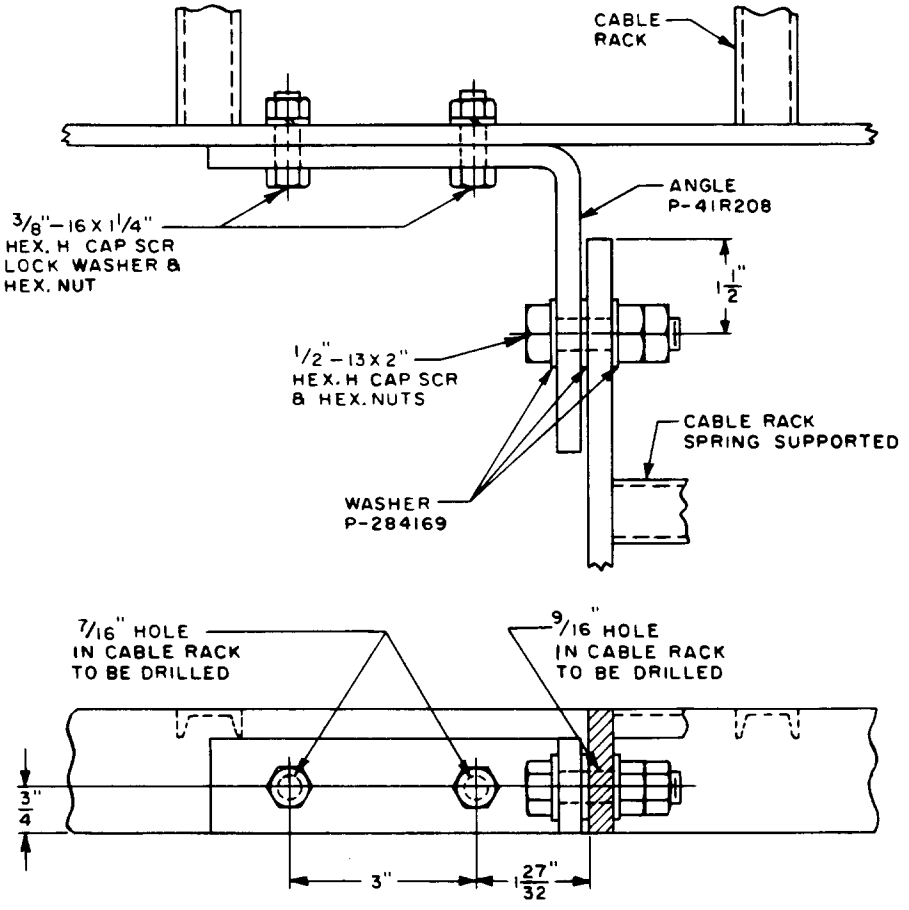


Fig. 67—Pivot Junction—Power Cable Rack (A&M Only)