CABLE FABRICATION

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

SECTION I

Simplifying Cable Fabrication

SECTION II

Cable Fabrication

SECTION III

Connectors and Fittings

Foreword

To install the electronic equipment that is so important in modern military aircraft, it is necessary to tailor the interconnecting cables to fit the job. The ability to take a piece of electronic equipment from the warehouse and install it in any type of aircraft adds to the efficient flexibility for which our installation bases are justly proud.

Beginning with suggestions for the construction of a cable workshop, the text gives detailed instructions for fabricating cables in the field and provides solutions for many of the difficulties encountered in field construction of cables.

Detailed descriptions of the various connectors used in aircraft installations, and directions for their assembly, are also contained in this manual. Immediately following the Table of Contents are two reference tables of the number-symbols assigned to connectors, with corresponding symbols, the number of contacts, and the page in the text on which is given information on the use and fabrication of the connector. One is indexed by Army-Navy numbers and the other by Philco numbers. Since some of the corresponding connector numbers are not assigned at present, some spaces are left blank and should be filled in when the number is assigned.

ARMY-NAVY (AN) TYPE CONNECTORS

(Indexed by Army-Navy Numbers)

NOTE: MANUFACTURER'S PART NUMBER SAME AS ARMY-NAVY NUMBER

ARMY-NAVY NUMBER	PHILCO NUMBER	NUMBER OF CONTACTS	PAGE NUMBER
AN3100-18-16S	358-5390	1	37
AN3100-28-2S	358-5386	14	37
AN3102-8S-1S	358-2471	1	38
AN3102-12S-3P	358-2955	2	38
AN3102-12S-4S	358-2009	1	38
AN3102-14S-1P	358-7528	3	38
AN3102-14S-2P	358-2890	4	38
AN3102-14S-2S	358-2472	4	38
AN3102-16S-1P	358-2485	7	38
AN3102-16S-1S	358-1877	7	38
AN3102-18-1P	358-4220	10	38
AN3102-18-1S	358-5759	10	38
AN3102-18-4P	358-2816	4	38
AN3102-18-5P	358-2411	3	38
AN3102-18-16P	358-2692	1	38
AN3102-18-16S	358-2691	1	38
AN3102-20-1P	358-2298	14	38
AN3102-20-1S	358-2007	14	38
AN3102-22-1S		2	38
AN3102-22-5P	358-1370	6	38
AN3102-28-1S	358-8746	9	38
AN3102-28-2P	358-2292	14	38
AN3102-28-2S	358-2004	14	38
AN3102-28-4P	358-2275	9	38
AN3102-28-4S	358-2005	9	38
AN3106-12S-3S	358-5982	2	39
AN3106-12S-3P	358-8065	2	39
AN3106-14S-1S	358-4673	3	39
AN3106-14S-2S	358-3459	4	39
AN3106-14S-5P	358-5380	5	39
AN3106-14S-5S	358-5387	5	39

ARMY-NAVY NUMBER	PHILCO NUMBER	NUMBER OF CONTACTS	PAGE NUMBER
AN3106-16S-1S	358-2486	7	39
AN3106-16S-8P	358-2010	5	39
AN3106-18-1P	358-5969	10	39
AN3106-18-1S	358-5968	10	39
AN3106-18-4S	358-2045	4	39
AN3106-18-5S	358-2046	3	39
AN3106-18-11S	358-5384	5	39
AN3106-18-16P	358-3037	1	39
AN3106-18-16S	358-2690	1	39
AN3106-20-1S	358-2043	14	39
AN3106-22-5P		6	39
AN3106-22-5S	358-3039	6	39
AN3106-24-5P	358-5848	16	39
AN3106-24-7P	358-5385	16	39
AN3106-24-7S	358-5391	16	39
AN3106-28-2P	358-3035	14	39
AN3106-28-2S	358-2041	14	39
AN3106-28-4S	358-2039	9	39
AN3106-28-16P	358-4941	16	39
AN3106-28-16S		16	39
AN3106-28-17P	358-7420	15	39
AN3106-28-17S (Special)	358-7419	15	39
AN3106-28-20P	358-5381	14	39
AN3106-28-20S	358-5388	14	39
AN3106-32-810S		12	39
AN3106-32-811P		14	39
AN3106-36-1P	358-5382	22	39
AN3106-36-1S	358-3329	22	39
AN3106-36-15P	358-5383	35	39
AN3106-36-15S	358-5389	35	39
AN3108-8S-1P	358-2414	1	39

ARMY-NAVY (AN) TYPE CONNECTORS—*Continued*

(Indexed by Army-Navy Numbers)

ARMY-NAVY NUMBER	PHILCO NUMBER	NUMBER OF CONTACTS	PAGE NUMBER
AN3108-10S-3S	358-5982	2	39
AN3108-10SL-4S	358-7791	2	39
AN3108-12-5S	358-2977	1	39
AN3108-12S-3P	358-5269	2	39
AN3108-12S-3S	358-2976	2	39
AN3108-12S-4P	358-2297	1	39
AN3108-12S-4S	358-2378	1	39
AN3108-14S-1S	358-2048	3	39
AN3108-14S-2P	358-2341	4	39
AN3108-14S-2S	358-3159	4	39
AN3108-14S-4PY	358-1371	1	39
AN3108-14S-5P	358-4798	5	39
AN3108-14S-5S	358-4872	5	39
AN3108-16S-1P	358-1974	7	39
AN3108-16S-1S	358-2995	7	39
AN3108-16S-3P	358-7345	1	39
AN3108-16S-3S	358-2344	1	39
AN3108-16S-4P	358-3332	2	39
AN3108-16S-4S	358-2974	2	39
AN3108-18-1P	358-8096	10	39
AN3108-18-1S	358-4709	10	39
AN3108-18-3P	358-2946	2	39
AN3108-18-3S	358-2945	2	39
AN3108-18-4S	358-2556	4	39
AN3108-18-5S	358-2343	3	39
AN3108-18-11S	358-5549	5	39

ARMY-NAVY NUMBER	PHILCO NUMBER	NUMBER OF CONTACTS	PAGE NUMBER
AN3108-18-12S	358-4561	6	39
AN3108-18-16P	358-2689	1	39
AN3108-18-16S	358-2694	1	39
AN3108-20-1P	358-2044	14	39
AN3108-20-1S	358-3318	14	39
AN3108-22-5S	358-2217	6	39
AN3108-22-17P	358-3458	9	39
AN3108-22-17S	358-3189	9	39
AN3108-24-5S	358-7146	16	39
AN3108-24-7P	358-4803	16	39
AN3108-24-7S	358-4807	16	39
AN3108-28-1P		9	39
AN3108-28-2P	358-2042	14	39
AN3108-28-2S	358-2047	14	39
AN3108-28-4P	358-2040	9	39
AN3108-28-4S	358-2342	9	39
AN3108-28-16P	358-4800	16	39
AN3108-28-17P	358-7421 (Special) 358-3181 (Reg.)	15	39
AN3108-28-17S		15	39
AN3108-28-20P	358-4799	14	39
AN3108-28-20S	358-4804	14	39
AN3108-36-1P	358-4801	22	39
AN3108-36-1S	358-4805	22	39
AN3108-36-15P	358-4802	35	39
AN3108-36-15S	358-4806	35	39

NOTE: Connectors Marked "Special" Are Wax-Impregnated.

MISCELLANEOUS CONNECTORS

ARMY No.	NAVY No.	PHILCO No.	MFG. No.	BRITISH No.	No. OF CONTACTS	TYPE OF CONNECTOR	PAGE No.
		358-3107	AMPHENOL 80-81		1	Straight Male Coaxial	44
		358-4208	AMPHENOL 93-C(MW)		1	Straight Male Coaxial	41
MC-277	NAF-47848-1	358-1381	AMPHENOL 46-Q5-151	Type 213 10H-701	1	90° Female Coaxial	42
MC-320	NAF-47848-2	358-1308	AMPHENOL 46-Q5-255	Type 187 10H-529	1	90° Female Coaxial	42
TYPE "N"	49218 (Type "N")	358-3513	UCINITE 118076-N		1	Straight Male Coaxial	43
PL-Q167	NAF-C69055-2	358-1311	AMPHENOL 46-Q2-151	Type W150 10H-404	4	90° Female	45
PL-Q171	NAF-E69055-2	358-1312	AMPHENOL 46-Q3-155	10H-414	6	90° Female	45
PL-Q172	NAF-D69055-2		AMPHENOL 46-QL2-153	10H-419	4	90° Female	45
PL-177	NAF-68969-2	358-1209	UCINITE	Type 185 10H-460	2	90° Male Plastic	51
PL-Q221	NAF-B69055-2	358-1310	AMPHENOL 46-QL3-154	10H-420	2	90° Female	45
PL-259	49195	358-3124	AMPHENOL 83-1SP		1	Straight Male Coaxial	47
PL-P173			AMPHENOL 46-P6	Type 158 110H-584	1	Straight Male Coaxial	48
PL-176	NAF-68925-5	358-1244	UCINITE 118005	10H-260B	1	Straight Female	49
PL-180		358-1241	JONES		3	Straight Male Plastic	50
PL-178	NAF-69041-1	358-1242	UCINITE 118006	Type 176 10H-262	3	90° Male Plastic	51
PL-181	NAF-68925-3	358-1252	UCINITE 118008	Type 172 10H-254	5	90° Male Plastic	51
PL-182	NAF-68925-2	358-1250	UCINITE 118109	Type 174 10H-258B	7	90° Male Plastic	51
PL-183	NAF-68925-1	358-1251	UCINITE 118010	Type 105 10H-256B	7	90° Female Plastic	51
PL-265	NAF-47908-1	358-1357	UCINITE 118018	Type 395 10H-13079	5	90° Female Plastic	51
	CN49121	358-3043	NAT'L ELEC. 49121		1	Straight Female Coaxial	52

RESTRICTED

ARMY-NAVY (AN) TYPE CONNECTORS

(Indexed by Philco Numbers)

NOTE: MANUFACTURER'S PART NUMBER SAME AS ARMY-NAVY NUMBER

PHILCO NUMBER	ARMY-NAVY NUMBER	NUMBER OF CONTACTS	PAGE NUMBER
358-1209	PL-177 NAF-68969-2	2	
358-1241	PL-180	3	50
358-1242	PL-178 NAF-69041-1	3	51
358-1244	PL-176 NAF-68925-5	1	49
358-1250	PL-182 NAF-68925-2	7	51
358-1251	PL-183 NAF-68925-1	7	51
358-1252	PL-181 NAF-68925-3	5	51
358-1308	MC-320 47848-2	1	42
358-1310	PL-Q221 NAF-B69055-2	2	45
358-1311	PL-Q167 NAF-C69055-2	4	45
358-1312	PL-Q171 NAF-E69055-2	6	45
358-1357	PL-265 NAF-47908-1	5	51
358-1369	AN3108-22-5S	6	39
358-1370	AN3102-22-5P	6	38
358-1371	AN3108-14S-4PY	1	39
358-1381	MC-277 NAF-47848-1	1	42
358-1877	AN3102-16S-1S	7	38
358-1974	AN3108-16S-1P	7	39
358-2004	AN3102-28-2S	14	38
358-2005	AN3102-28-4S	9	38
358-2007	AN3102-20-1S	14	38
358-2009	AN3102-12S-4S	1	38
358-2010	AN3106-16S-8P	5	39
358-2039	AN3106-28-4S	9	39
358-2040	AN3108-28-4P	9	39
358-2041	AN3106-28-2S	14	39
358-2042	AN3108-28-2P	14	39
358-2043	AN3106-20-1S	14	39
358-2044	AN3108-20-1P	14	39
358-2045	AN3106-18-4S	4	39
358-2046	AN3106-18-5S	3	39
358-2047	AN3108-28-2S	14	39
358-2048	AN3108-14S-1S	3	39
358-2217	AN3108-22-5S	6	39
358-2275	AN3102-28-4P	9	38
358-2292	AN3102-28-2P	14	38
358-2297	AN3108-12S-4P	1	39
358-2298	AN3102-20-1P	14	38
358-2341	AN3108-14S-2P	4	39
358-2342	AN3108-28-4S	9	39
358-2343	AN3108-18-5S	3	39
358-2344	AN3108-16S-3S	1	39
358-2345	AN3108-16S-3P	1	39
358-2378	AN3108-12S-4S	1	39
358-2411	AN3102-18-5P	3	38
358-2414	AN3108-8S-1P	1	39
358-2471	AN3102-8S-1S	1	38
358-2472	AN3102-14S-2S	4	38
358-2485	AN3102-16S-1P	7	38
358-2486	AN3106-16S-1S	7	39
358-2556	AN3108-18-4S	4	39
358-2689	AN3108-18-16P	1	39
358-2690	AN3106-18-16S	1	39
358-2691	AN3102-18-16S	1	38
358-2692	AN3102-18-16P	1	38
358-2694	AN3108-18-16S	1	39
358-2816	AN3102-18-4P	4	38
358-2890	AN3102-14S-2P	4	38

RESTRICTED

ARMY-NAVY (AN) TYPE CONNECTORS—*Continued*
(Indexed by Philco Numbers)

PHILCO NUMBER	ARMY-NAVY NUMBER	NUMBER OF CONTACTS	PAGE NUMBER
358-2945	AN3108-18-3S	2	39
358-2946	AN3108-18-3P	2	39
358-2955	AN3102-12S-3P	2	38
358-2966		1	54
358-2974	AN3108-16S-4S	2	39
358-2976	AN3108-12S-3S	2	39
358-2977	AN3108-12-5S	1	39
358-2995	AN3108-16S-1S	7	39
358-3035	AN3106-28-2P	14 •	39
358-3037	AN3106-18-16P	1	39
358-3039	AN3106-22-5S	6	39
358-3043	CN49121	1	52
358-3107		1	44
358-3124	PL-259 49195	1	47
358-3159	AN3108-14S-2S	4	39
358-3189	AN3108-22-17S	9	39
358-3318	AN3108-20-1S	14	39
358-3329	AN3106-36-1S	22	39
358-3332	AN3108-16S-4P	2	39
358-3458	AN3108-22-17P	9	39
358-3459	AN3108-14-2S	4	39
358-3513	Type "N" 49218 (Type "N")	1	43
358-4208		1	41
358-4220	AN3102-18-1P	10	38
358-4312		1	39
358-4561	AN3108-18-12S	6	39
358-4672	AN3108-14S-5S	5	39
358-4673	AN3106-14S-1S	3	39
358-4709	AN3108-18-1S	10	39
358-4798	AN3108-14S-5P	5	39
358-4799	AN3108-28-20P	14	39
358-4800	AN3108-28-16P	16	39
358-4801	AN3108-36-1P	22	39
358-4802	AN3108-36-15P	35	39
358-4803	AN3108-24-7P	16	39
358-4804	AN3108-28-20S	14	39
358-4805	AN3108-36-1S	22	39
358-4806	AN3108-36-15S	35	39
358-4807	AN3108-24-7S	16	39
358-4941	AN3106-28-16P	16	39
358-5009		1	53
358-5097			55
358-5269	AN3108-12S-3P	2	39
358-5380	AN3106-14S-5P	5	39
358-5381	AN3106-28-20P	14	39
358-5382	AN3106-36-1P	22	39
358-5383	AN3106-36-15P	35	39
358-5384	AN3106-18-11S	5	39
358-5385	AN3106-24-7P	16	39
358-5386	AN3100-28-2S	14	37
358-5387	AN3106-14S-5S	5	39
358-5388	AN3106-28-20S	14	39
358-5389	AN3106-36-15S	35	39
358-5390	AN3100-18-16S	1	37
358-5391	AN3106-24-7S	16	39
358-5393	AN3106-10SL-3S		39
358-5549	AN3108-18-11S	5	39
358-5759	AN3102-18S-1S	10	38
358-5848	AN3106-24-5P	16	39
358-5968	AN3106-18-1S	10	39
358-5969	AN3106 18-1P	10	39
358-5982	AN8106-12S-3S	2	39
358-7146	AN3108-24-5S	16	39
358-7419	AN3106-28-17S	15	39
358-7420	AN3106-28-17P	15	39
358-7421	AN3108-28-17P	15	39
358-7528	AN3102-14S-1P	3	38

RESTRICTED

ARMY-NAVY (AN) TYPE CONNECTORS—*Continued*

(Indexed by Philco Numbers)

PHILCO NUMBER	ARMY-NAVY NUMBER	NUMBER OF CONTACTS	PAGE NUMBER
358-7791	AN3108-10SL-4S	2	39
358-8096	AN3108-18-1P	10	39
358-8746	AN3102-28-1S	9	38
	AN3102-22-1S	2	38
	AN3106-12S-3P	2	39
	AN3108-22-5P	6	39
	AN3106-28-16S	16	39
	AN3106-32-810S	12	39
	AN3106-32-811P	14	39
	AN3108-28-1P	9	39
	AN3108-28-17S	15	39

Special Connectors

Philco #358-5009—a single-contact, high-tension connector of special design; connector must be packed with special insulation compound after assembly to cable; it is impractical to assemble this connector in the field, because special equipment is required; manufactured by Cinch under designation M.I.T. type "A"; used on AN/APS-3, cable "P". See page 53 for details.

Philco #358-4312—This is the complete connector-and-cable assembly-number for the 30′ transmitting-antenna cable CX-10/CPN-3, used on AN/CPN-3. The connector is of special design, and must be packed with special insulating compound; also the length of the cable is very critical; the finished cable must have a standing-wave ratio of not more than 1.25 to 1.0. Because of these facts, it is impractical to assemble this cable in the field; instead, a complete new cable should be ordered. See page 57 for detailed drawing.

Philco #358-2967—This is a complete cable and connector assembly-number for the flexible RF test line of OAK, standing-wave measuring equipment for aircraft radar. It is composed of a 36″ coaxial line, 5L-1235, and a special male connector on each end. As the contact-pins of the connector have to be very accurately spaced before the connector is filled with special insulating compound, it is, therefore, impractical to replace these connectors in the field. See page 56 for detailed drawing.

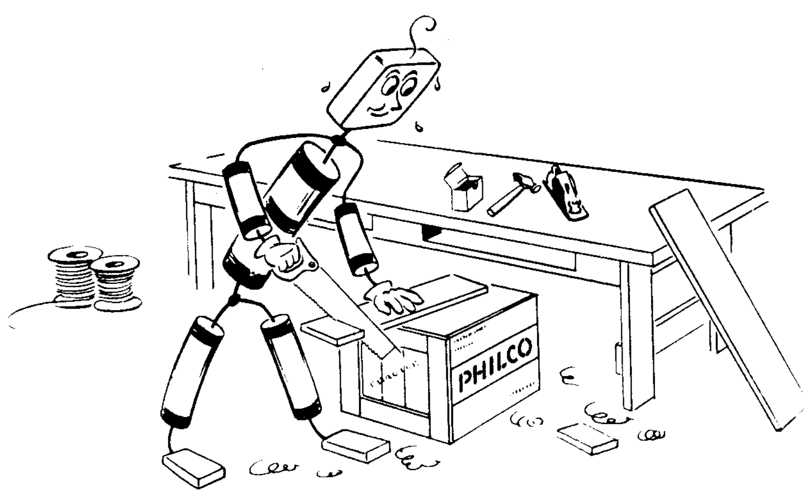
Bell Labs #D165644 and D165645, special 27-contact connectors with trigger-release for main interconnecting cable of AN/APS-4; no Philco number assigned; manufactured by Ucinite. See page 55 for details.

SECTION I

Simplifying Cable Fabrication

The following material offers many suggestions that will help the field man to fabricate cables in the field. Though a field workshop cannot have available all the equipment found in a manufacturing establishment, the construction of certain pieces of equipment will enable the field man to turn out a satisfactory job.

The suggestions offered are complete for the job but are sufficiently flexible to allow the field man to select the equipment that can be built with the available material. Particular emphasis is placed on the construction of a suitable cable jig and test board, and many other valuable notes on soldering, removing insulation and lacing of cables are included.



PREPARING THE WORKSHOP

THE location and size of the workshop depends upon the space available and the quantity and length of the cables to be constructed. If long cables are required, use a bench or table slightly longer than the longest cable. Mark off the edge of this table accurately in feet and inches. Construct a wire-spool holder (figure 1) of lumber and rods, or pipe. If finished lumber is not available, a satisfactory spool holder can be made from a packing case. Without dismantling the case, drill holes for the rods and wires as shown in figure 1. Place this spool holder at one end of the workbench, and arrange the spools so the wires may be run through the spacer-board in the desired order. Shelves on the back of the bench, and drawers in the front of the bench are desirable for storage of small parts, tools, etc. A suitable number of electrical outlets should be provided at convenient points for soldering irons, etc. Drop lights are the most satisfactory for bench lighting.

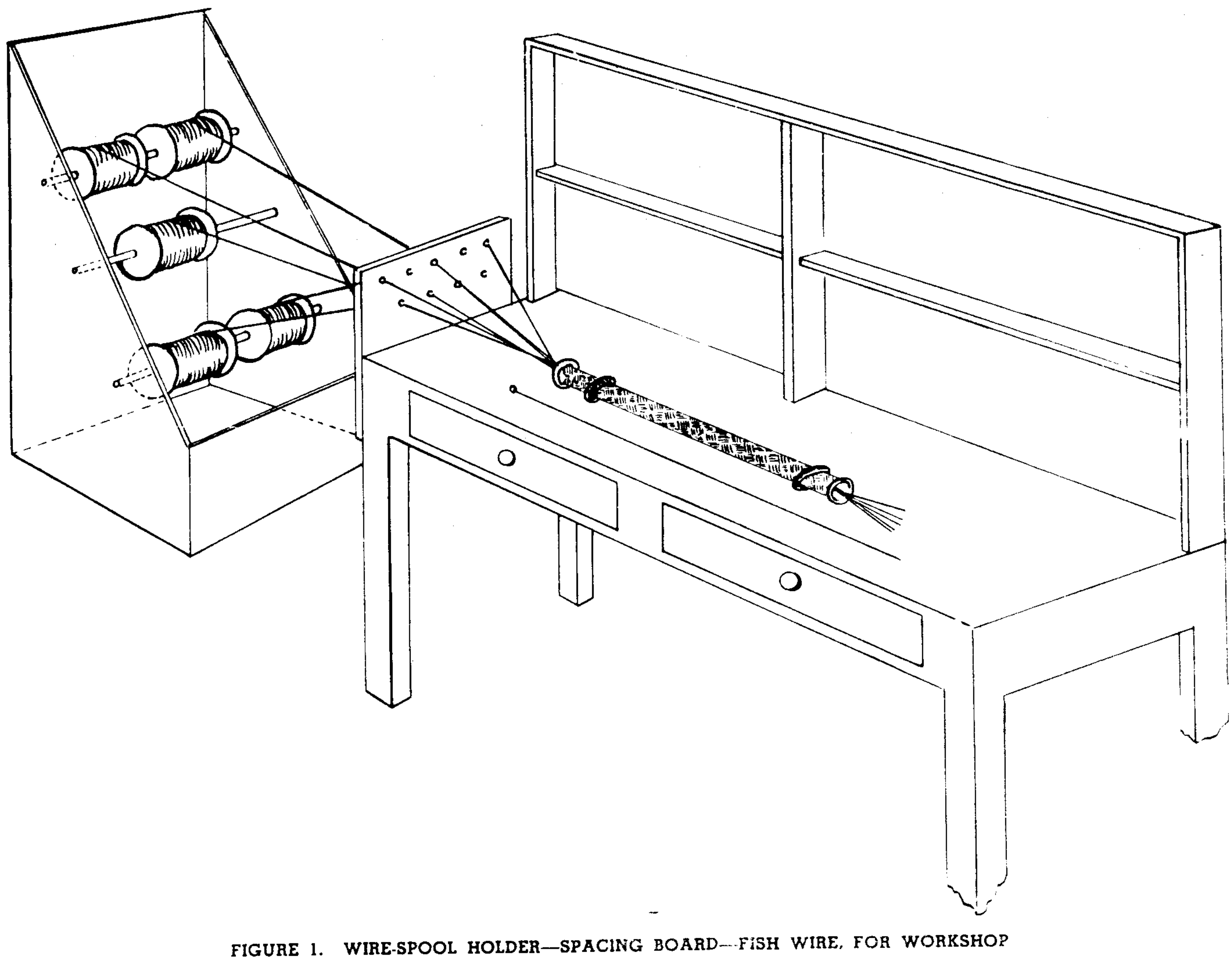


FIGURE 1. WIRE-SPOOL HOLDER—SPACING BOARD—FISH WIRE, FOR WORKSHOP

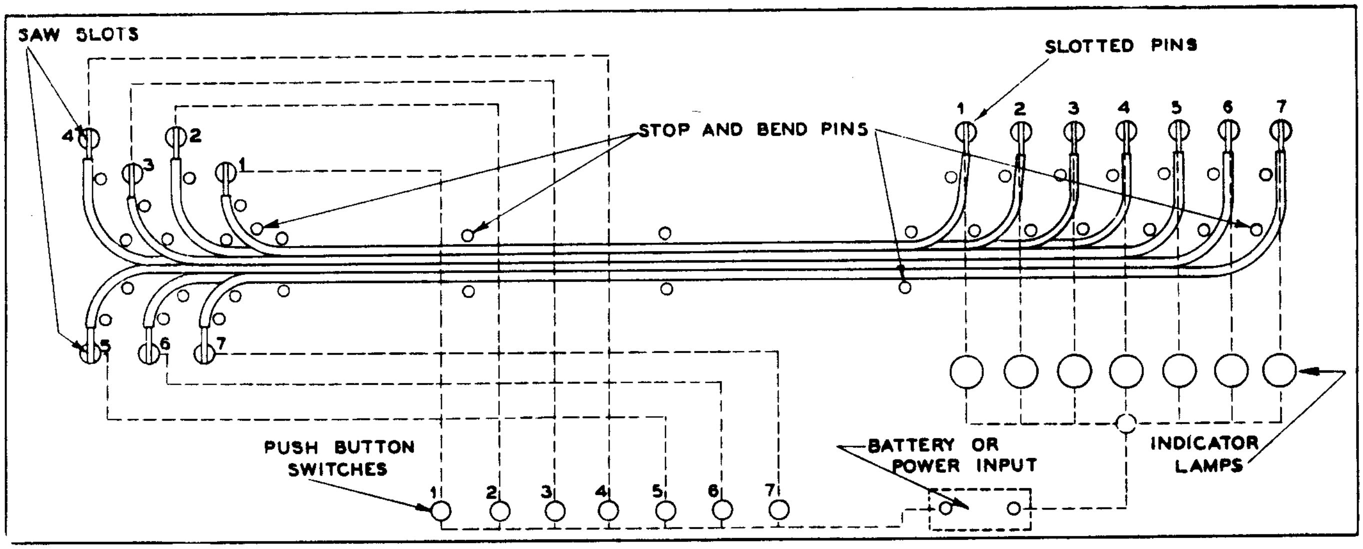


FIGURE 2. HARNESS-TYPE CABLE JIG—SHOWING CONTINUITY AND SHORT TEST CIRCUIT

When the ends of a cable require pre-cutting, arranging, or special termination for attaching to a terminal board or junction box, a harness-cable jig should be used. With a jig constructed for that particular cable, similar to the one shown in figure 2, each conductor can be cut to the correct length, terminated properly, and laced in the desired place. The cable can also be checked for continuity or short-circuits with the jig shown.

The method of jig making described below is used in cable manufacture, and may provide some ideas which can be used in the field. First, make up a sample cable, or model on the radio equipment installed as it will be used. Select the proper wire-size and insulation for each conductor. Determine the correct length for each wire, allowing for slack, bends, lacing, etc. One foot of slack is usually allowed for each 20 feet of open cabling. Then lace the entire cable, so each conductor is in the most desirable position, and enters or leaves the cable at the desired point. Remove the sample cable from the equipment and stretch it out flat on the work-bench. Now, the jig for quantity production of this cable may be constructed.

The jig is constructed on a sheet of plywood, sufficiently large for the end of the cable to be laid out flat, and space for the push-buttons and lights of the test circuit. It is not necessary to use a board the length of the entire cable unless it is a short cable, or contains various bends or branches that must be shaped or spaced properly.

The pins used on the jig-board to hold the end of each conductor should be made from a nail or bolt whose diameter is three or four times that of the wire to be used. The head is sawed off square, leaving the pin about two inches long. Clamp the pin in a vise and saw a slot in the center of the flat end and sharpen the other end. The saw-blade must have enough set to leave a slot wide enough to take wire of the proper size. See figure 3. The

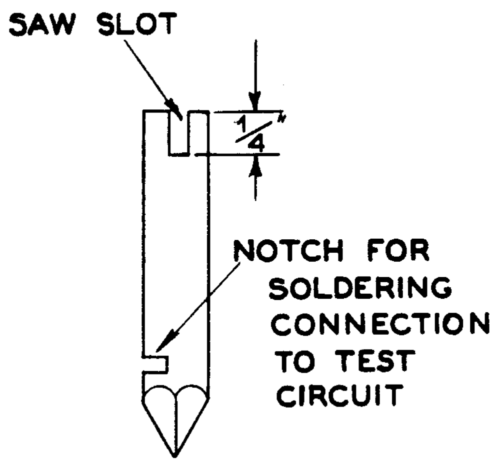


FIGURE 3. CONSTRUCTION OF TERMINATING PIN AND JIG

pins are then driven through the plywood at the points where each conductor of the cable will terminate. About one inch of the pin must remain above the board, and enough of the pin must project from the back side of the board to provide for a soldered connection. A slot or ring may be sawed into the pin near the pointed end to facilitate making the soldered connection to the test circuit. Similar pins should be driven into the board at various points to support the conductors, and at points where bends are to be made, thus acting as an outline for the cable. If a soldering lug is to be used on the end of the conductor, strip the insulation back $\frac{3}{16}$", clean and tin the wire, and solder on the lug. The lug is then hooked over the pin. If the end of the conductor is bare-tinned, slip the bare wire in the slot and bend the outside end of the wire to one side, so it will remain in the slot and make a better electrical connection for testing.

Mark corresponding numbers at the terminating pins for each conductor, so that each conductor will run from 1 to 1 or 2 to 2, etc. Mark the board, showing the start and finish points of lacing, and points along cable where each lock-stitch should be. See figure 5.

Draw lines from each terminating pin showing the course of the conductor. The prefabricated wires to be used in the cable should be placed in a partitioned rack near the jig, and numbered 1, 2, 3, 4, etc. Make up a chart showing number and color of each conductor and paste in a corner of the jig-board. Cover this chart with shellac to preserve it. Thus #1 wire in the rack should be #1 on the chart and run from #1 to #1 on the board. This systematic method will save time and help prevent errors. This same number should be marked at the push-button and indicator light in the test circuit for that particular conductor.

A simple test circuit can be made, using push-buttons and a battery or other source of power, with the proper indicator light (figure 2). Each cable should be carefully checked with this circuit before it is removed from the jig. If any conductor is broken or left out of the cable, or has slipped off its terminating pin, the light will not come on when its push-button is pressed. If two or more conductors are shorted together, then two or more

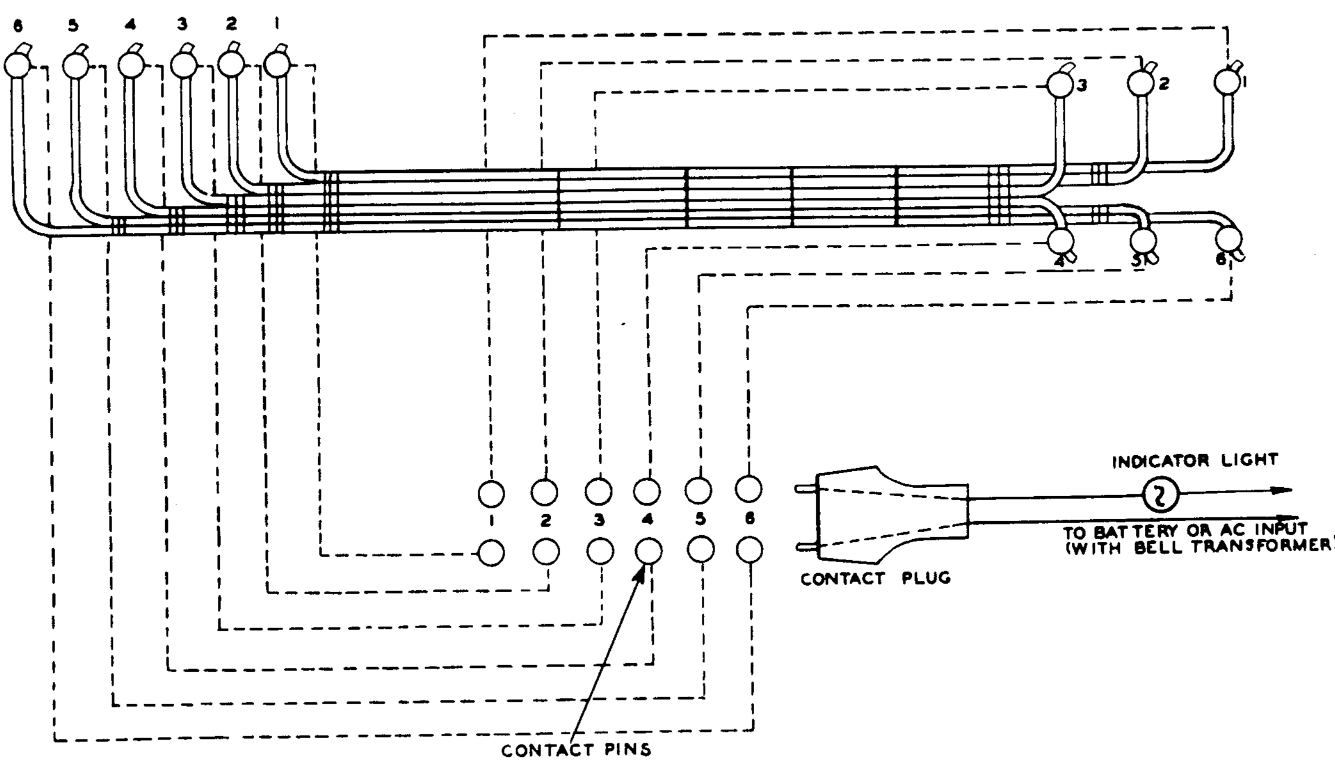


FIGURE 4. ALTERNATIVE CIRCUIT FOR CONTINUITY CHECKING

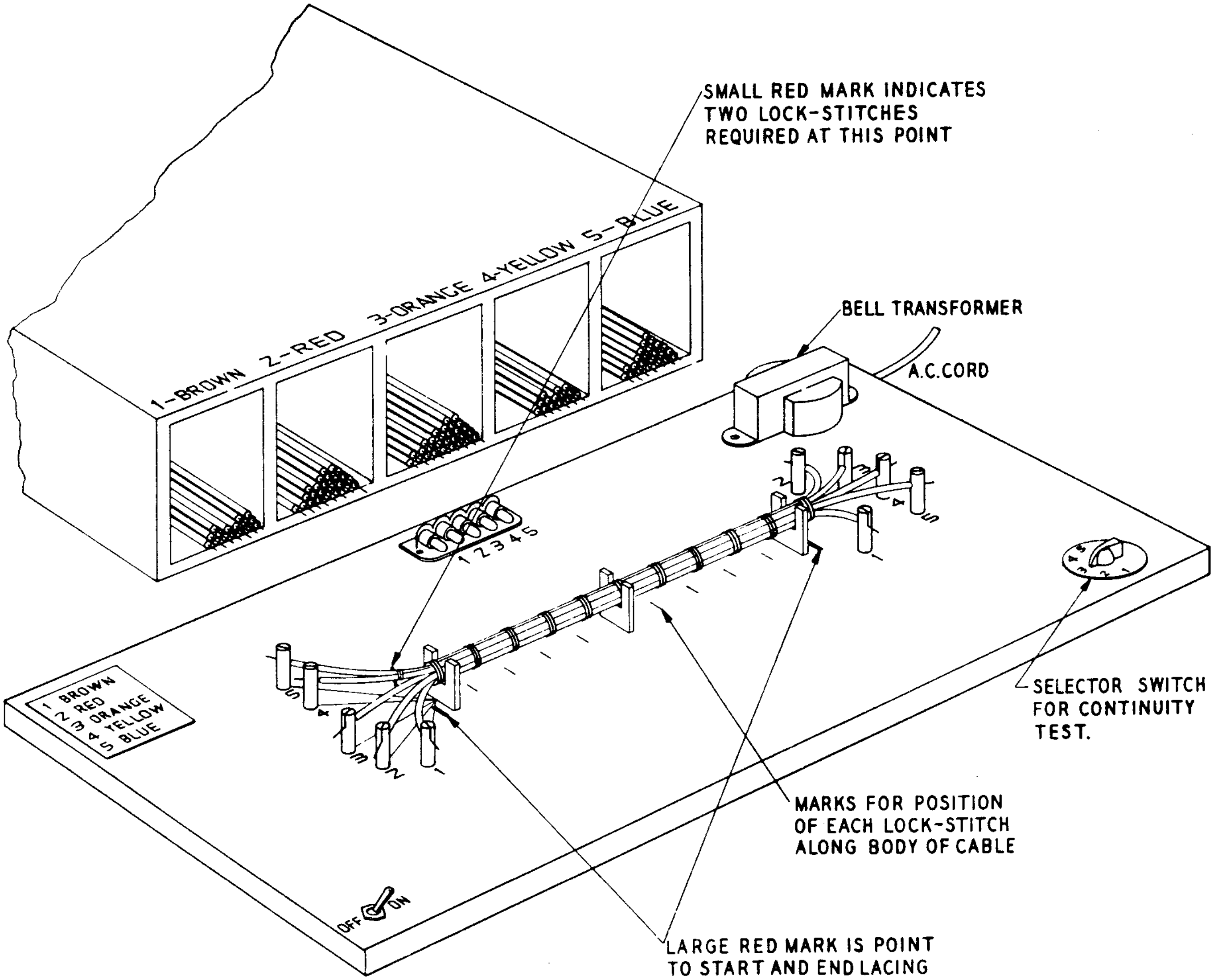


FIGURE 5. PHYSICAL LAYOUT OF JIG-BOARD ON WORKBENCH

lights will come on when the button is pressed, indicating which conductors are shorted.

Another test circuit, using either a.c. or d.c. for power and only one indicator light, is shown in figure 4. This test circuit requires less material and is satisfactory for checking continuity of the cable. With these test circuits it is known, before a cable leaves the jig, that it is electrically complete.

Jigs can be used in constructing cables that are sheathed in flexible conduit also. Extreme care must be used to see that the conductors are not cut too long or too short for the conduit, as these conditions would cause a severe strain on the soldered connection.

The elasticity of the flexible conduit, when it is installed, must be considered when cutting the conductors. Since most cables using flexible conduit use some type of connector on the ends, it will be more satisfactory to have a receptacle for the connector mounted on a vertical board on the bench. The contact pins of this receptacle are then connected to the test circuit, as shown in figure 6. The connector being applied to the cable is fastened into the receptacle while the connections to the contacts are being made and tested.

After a jig has been properly constructed, it becomes a routine matter to construct any number of duplicate cables, electrically complete.

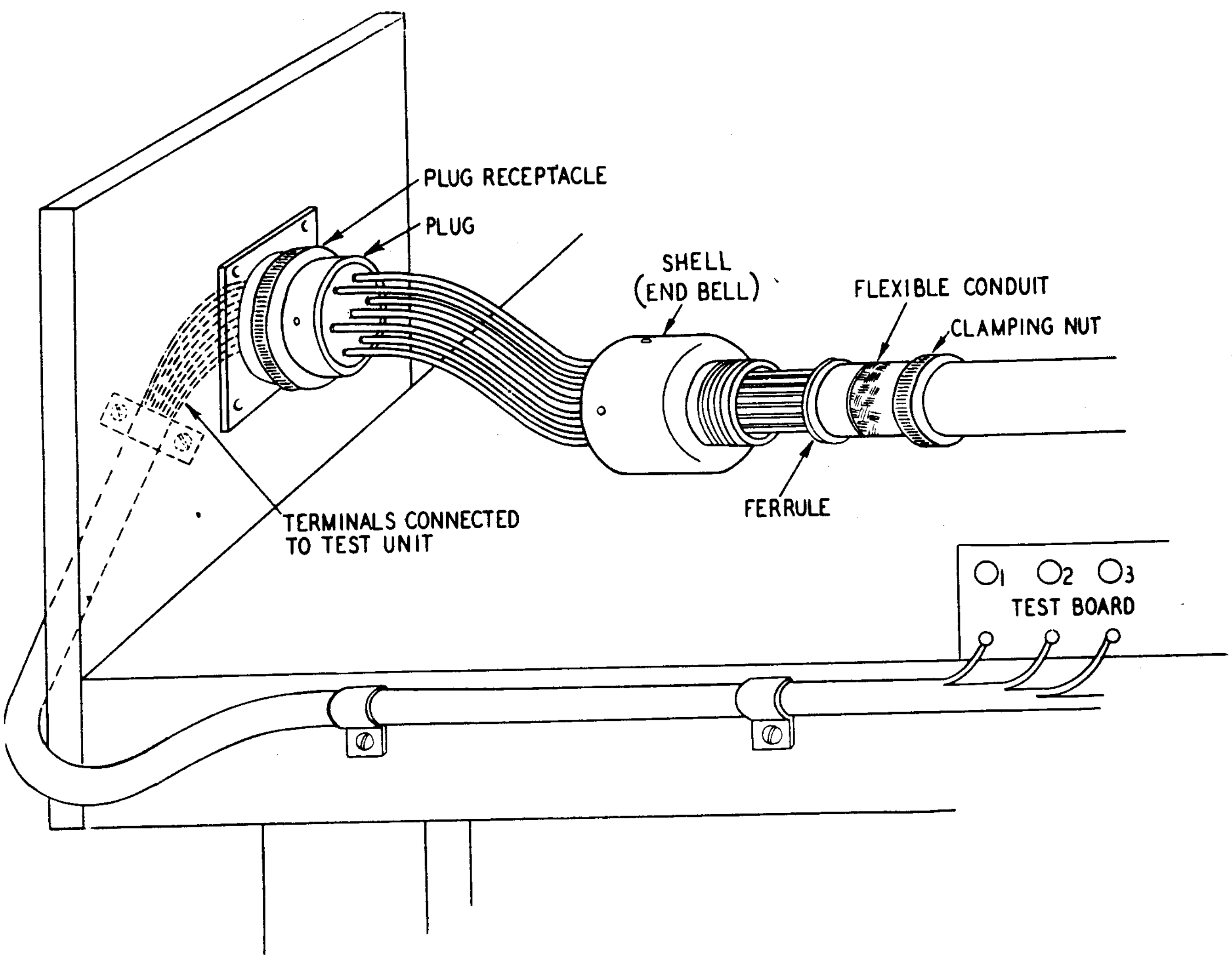
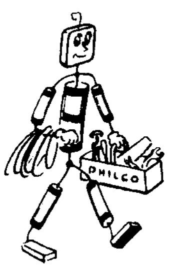


FIGURE 6. PLUG RECEPTACLE MOUNTED ON BOARD FOR SOLDERING AND CHECKING MULTI-WIRE FLEXIBLE CONDUIT CABLES

USEFUL TOOLS AND MATERIALS



MANY different tools are needed in the fabrication of cables. To assist the technician in equipping the workshop, the tools most frequently used and some of the materials required are listed below.

Hacksaw and assorted blades; for cutting conduit.

Reamers, various sizes; for increasing size of rear opening of shell of some connectors, and for removing burrs from inside of conduit after cutting.

Knife, general purpose; for stripping conductors or coaxial cables.

Wire brush; for cleaning contacts, connectors, joints, files, etc., and for unbraiding shields.

Scissors; for cutting tape, insulation, templates, etc.

Scriber or metal pick; for unbraiding shields and cleaning in small, close places.

Soldering irons, heavy-duty and light-duty, and assorted special tips.

Hammer, ¾ or 1-pound.

Razor blades, single-edge; for stripping.

Bench-vise; for clamping work while sawing or filing.

Cable-vises, various sizes; for use in bench-vise while cutting conduit.

Center-punch; for starting drills and making indentations.

Screwdrivers, assorted sizes.

Diagonal cutters.

Electricians pliers, 5″ and 8″ sizes.

Spanner-wrenches, assorted sizes; for tightening certain connectors.

Long-nose pliers.

Gas-pliers; for assembly of fittings.

Insulation stripper.

Steel rule or tape.

Files, assorted.

Radio-speaker cement or clear lacquer, in fireproof container; for cementing lacing or binding in place and for dressing ends of insulation to prevent raveling.

Lacing cord, waxed; #6 for average cable, #8 for heavy cables.

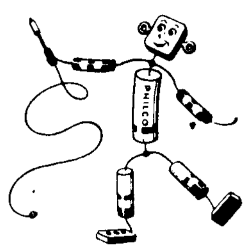
Carbon-tetrachloride or equivalent; for cleaning contacts, joints, etc.

Rosin-core solder.

Nails and screws, assorted.

Tape, scotch and friction.

Sandpaper, assorted.



This list does not contain the special tools needed on certain types of cabies. Conversely, all the tools listed are not needed on every job. Less time is required for cable fabrication if the proper tools are available when needed, and arranged in an orderly manner, with a place for each tool. A shelf or wide board on the back of the bench is a convenient location for a tool-rack.

RESTRICTED

A number of tools that are useful in cable fabrication can be made from suitable scrap material. As an example, a general-purpose knife for cutting insulation, stripping coaxial cables, etc., can be made from a used hacksaw blade, in the following manner:

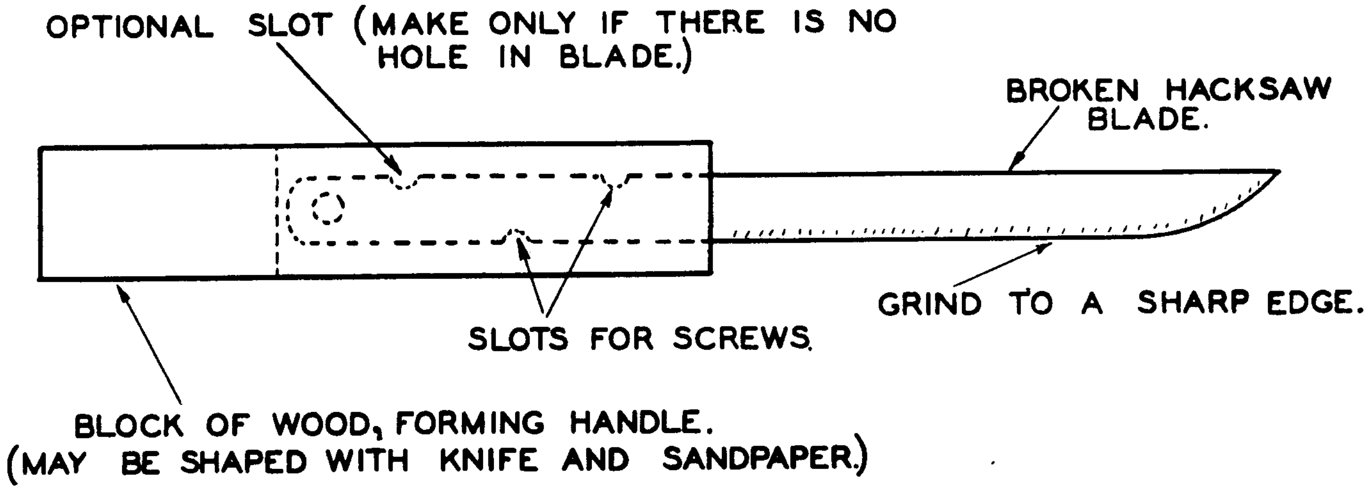


FIGURE 7. CONSTRUCTION OF GENERAL PURPOSE KNIFE

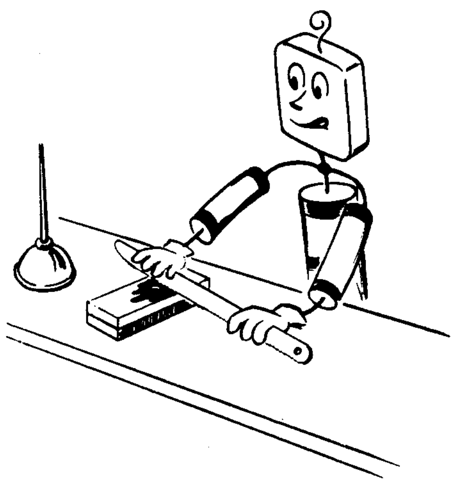
(1) Break the hacksaw blade to the desired length, and shape the point as desired on a grindstone, with two or three slots ground into the edge at the back end of the blade as shown in figure 7.

(2) Grind the teeth off the hacksaw blade slowly, to retain the temper of the steel, and sharpen the edge of the blade.

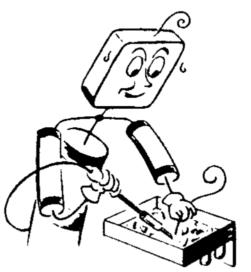
(3) To make a handle, cut a slot in a block of wood, and drill holes for three machine screws. Place the blade on the side of the block to mark the location of the holes.

(4) Fasten the blade in the handle with three machine screws. Countersink the machine screw heads and nuts into the handle, and cover with putty or tape if desired.

No dimensions are suggested, as they depend upon personal preference.



SOLDERING



SOLDERING is a process by which metals, upon the application of heat and a third metal called "solder", are bonded or joined together. The solder, a low-melting alloy, flows between the original metals without melting them and joins them together.

There are two general forms of soldering: hard soldering and soft soldering. Those operations requiring less heat than 750° F. are termed soft soldering. Those requiring more than 750° F. are termed hard soldering. Hard solders are used to solder or braze metal sections. High melting temperatures and special fluxes are required. Soft solders are used to join together metals such as copper, brass, tin, zinc, lead, etc. Comparatively low temperatures and simple fluxes are required. These low temperatures can be produced very conveniently with an electric soldering iron. As radio terminals are made of metals such as copper, brass, or plated steel, the soft solders are used exclusively in radio work. Radio terminals and chassis are plated or tinned with a soft metal to facilitate joining or soldering together of wires and terminals.

The soft solders used in radio usually consist of certain proportions of tin and lead, soft metals having low melting points. Tin melts at 450° F. Lead melts at approximately 620° F. A combination of the two metals, in certain proportions, forms an alloy which melts at a lower temperature than either metal separately. The addition of tin to lead lowers the melting point. A 20/80 mixture (20% tin, 80% lead) melts at 554° F. A 30/70 mixture melts at approximately 500° F. A 40/60 mixture melts at 460° F. The temperature is low enough so that delicate terminals can be soldered without damage to them or to surrounding parts. Excessive heat would cause burning or warping of surfaces, adjacent ceramic parts used in radio could be fractured or their electrical properties changed, and high temperatures would make it impossible to solder a terminal in the midst of congested wiring.

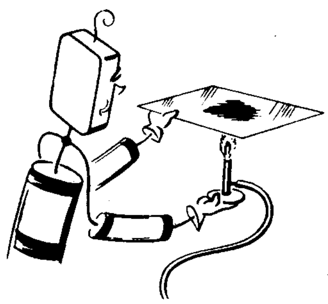
The commercial 50/50 solder, used a great deal in plumbing and miscellaneous commercial applications, has a melting point of 414° F. For special applications other substances, such as bismuth are added for still lower melting points. For example, a combination of 40% bismuth, 40% lead, and 20% tin will melt at 231° F., slightly above the boiling point of water.

The addition of tin makes the solder hard and imparts a luster to the soldered joint. It also aids the solder to flow readily. Too much tin will make the soldered joint too brittle. Adding lead makes the solder softer. Selecting proper proportions of these metals combines the desirable features of each.

The scarcity of tin has made it necessary to reduce the tin content in present day solders. A 20% tin, 80% lead combination is popularly used in radio work. Silver is sometimes added to increase the hardness and ease the flow. Solders containing a high proportion of silver are used to braze together a wide variety of metals, including iron and steel.

The primary considerations in soldering are a clean plated terminal, a hot tinned soldering iron, proper solder, and a suitable flux. Regardless of the condition of the terminal or the type of solder used, it is impossible to solder without flux.

The oxides that form on the surface of most metals upon exposure to the air, particularly when the surface is hot, constitutes one of the greatest obstacles with which the solderer has to contend. This oxidizing is much more likely to occur while the metal is hot, making some reducing agent absolutely necessary to good soldering. A flux may be defined as a substance which will chemically free a surface from oxide. The flux may be applied to the surface immediately before the solder, or it may be applied simultaneously with the solder. The solders used in radio have a central core filled with rosin flux, which melts instantly upon being applied to a hot surface. The action of the flux may be demonstrated as follows:



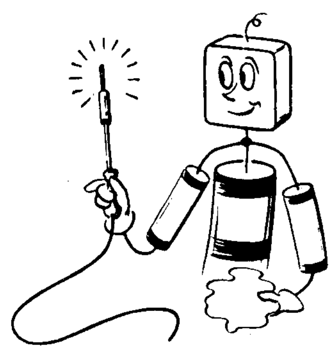
A small sheet of copper is cleaned and polished until it has a bright clean surface. Heat is applied to the under side of the sheet, either with a gas flame or a hot iron. It will be noticed that after a time a dull brown film will appear on the copper. This is a layer of oxide formed by chemical action of the hot copper with oxygen in the air. Wires and terminals heated by a soldering iron acquire this film. This oxide is an insulator for both heat and electricity. It will not permit solder to come in proper contact with the surface of the copper.

A particle of rosin (or tallow from a candle) applied to the hot surface will melt instantly and run over the surface. It will be noticed that the original bright surface of the copper has been restored in that region touched by the flux, because it has dissolved the oxide film and reproduced the original bright finish. If solder is now applied to this bright surface, it will flow and readily join with the copper. However, if the copper sheet is subjected to prolonged heating, the oxide film will become thicker and thicker until finally the rosin flux may be unable to dissolve it. In this case a stronger flux will be required. Different fluxes are used with different solders. For radio work rosin is used most frequently. Various diluted acids, such as zinc chloride, are also used as fluxes, and if the film of oxide becomes too thick for rosin, an aciduous flux can dissolve the film by corrosive action. (It will eat away the surface.)

Aciduous fluxes are not permitted in radio work. Rosin flux or similar fluxes, after cooling on or near a terminal, will harden and remain. On the other hand, an aciduous corrosive flux does not dry readily but will creep along the wires to cause possible corrosion of terminals or weakening of insulation. A corroded terminal will result in a poor electrical connection, thus impairing or preventing proper functioning of the radio.

At times, a strong corrosive flux may appear necessary, as the oxide film is so thick the rosin flux does not affect it. This will occur if the plating is incorrect or the terminal has been subjected to excessive prolonged heat. It is advisable in the latter case to scrape the surface of the terminal until it is bright and clean. Then, resolder, using rosin core solder. It is important to bear in mind that the surfaces to be soldered must be absolutely clean, and the soldering iron tinned and heated to the proper temperature for the job. Touching the terminal with the fingers will deposit an oily film that will oppose union of the solder.

The flux cannot clean a dirty terminal. The iron should be wiped periodically with a cloth to remove surface scale. This scale will hinder proper heat transfer from the iron and can also lodge on the terminal. Proper care and application of the soldering iron to the work are discussed further in a later section.



Proper soldering is of the utmost importance in radio today. It is imperative that all terminals be correctly soldered. A casual glance often fails to reveal a poor solder joint. A film of dirt or layer of rosin may prevent a good electrical connection. Time or usage of the unit in the field will aggravate this condition until finally the set fails to operate, possibly at a crucial moment. The tempo of modern mechanized warfare is such that continuous communication and coordination between different branches of a combat force are of critical importance. The success or failure of a campaign may well depend on the quality of the soldered connections in the complex radio apparatus so necessary on the battlefield.

Care and Application of Soldering Irons

The soldering copper or soldering iron, as it is most frequently called, is the most common tool used for the purpose of soldering. It is made of copper because copper is a good conductor of heat and will give up that heat readily to the joints being soldered. Copper will not oxidize as rapidly as other metals and will thus retain a tinned surface longer. Soldering irons are made in various sizes and shapes, designed for different applications. Large irons are heated by applying them directly to a flame. The seams of large tin sections or plumbing joints can thus be soldered. The electric soldering iron is used almost exclusively for the light delicate work found in radio and telephone work. These irons are designed so that the tips and elements can be removed for repairs or replaced in the event of wear or damage.

In using a soldering iron, it is important that there be complete contact between the iron and the work. Improper contact, which will not transfer sufficient heat to the terminal, will result in poor soldering. The tinned flat surface of one side of the iron should be applied squarely to the work and be allowed to remain long enough to bring the temperature of the work up to the melting point of the solder. The solder should then be applied to the work and not to the iron. The solder should melt readily upon contacting the hot surface of the joint. On small work, where the pieces to be soldered are delicate, the point of the iron, only, should be applied to the work. However, for delicate work a small iron is advisable, since too much heat applied to a tiny terminal may burn off the plating, making it difficult for solder to combine with the joint.

Soldering iron tips are usually made of copper and range in size from $\frac{3}{8}$ to $1\frac{5}{8}$ inches in diameter. This tip size, as well as the wattage rating, is a factor in determining the size of the iron. The wattage will range from about 50 to 500 watts. The 150-watt size is popular for radio work.

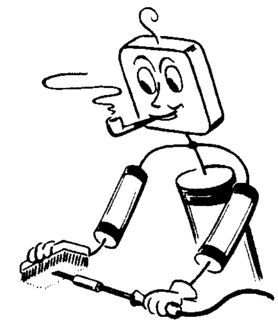
The electric soldering iron tip must be carefully tinned and conditioned before using. A clean tinned surface is essential for good soldering. This tinned surface, when in contact with a terminal, will transfer heat from the iron very rapidly. It will melt solder readily and facilitate its flow. If an iron is unused for a time and becomes too hot, a film of oxide will form on its surface. This film acts as an insulator of heat, preventing transfer of sufficient heat to the terminal. The iron should be wiped periodically while in use to remove this film. Occasionally, it is necessary to re-tin an iron. This is done by filing the tip on all sides until a smooth bright surface is visible. Solder, with a suitable flux, is then applied to all sides until the surfaces are brightly tinned. The tip can also be tinned by applying a flux and dipping into molten solder. Excess solder is wiped off with a cloth.

Selection of the correct tip will facilitate proper soldering. A large tip is necessary when soldering large terminals or bus bars. If too small a tip is used, the bus bar will conduct heat away from the joint more rapidly than the iron can produce it. The joint will be too cold for proper soldering, thus a cold solder or rosin joint will result. Setting the iron aside on a metal table top for prolonged periods is also undesirable. The metal table conducts heat from the iron tip, thus cooling it.

When an electric soldering iron is not being used and left turned on, its temperature gradually increases. This is because the tip cannot radiate heat as rapidly as the heating element produces it. The element may be overheated or the tinned surface burned off. An overheated element may be ruined or weakened. A burned-off tinned surface necessitates refiling and retinning. This reduces the life of the tip. A suitable iron rest is required to maintain the temperature of the tip fairly constant. Thermostatically controlled iron rests have been designed for this purpose. These controls will automatically maintain the iron temperature within predetermined limits. However, their cost and other factors involved do not warrant their use on the production line.

A suitable iron rest has been devised whereby just enough heat is radiated to maintain the iron temperature within safe limits. This heat dissipation rest must be suitably designed so that it does not permit too much heat to escape from the iron. As the iron tip normally cools slightly upon contacting a cold terminal, it must thus be kept hot enough to maintain the proper temperature while in continual use.

The iron tip should be removed and cleaned at various intervals; once or twice per day is desirable. The scale deposited throughout its length should be removed either by filing or brushing with a steel bristled brush, as this oxide scale prevents transfer of heat from the heating element to the tip. This scale or carbon will also make it very difficult to remove the tip from the iron. At the first signs of an untinned or pitted surface showing under the plating, the tip should be given proper attention.



The tip should be properly seated to the full depth of the barrel of the iron. A tip should not be lengthened by drawing it out part way from the barrel. This lengthening forms an excess formation of carbon inside the barrel, freezing the tip and crystallizing the barrel; and it reduces the operating temperature of the iron. Use the proper length tip for the job and have it cared for regularly. Sheathed tips should not be filed; this type tip has a special plating which gives it a longer life than plain tips. Removing this plating renders the tip useless. Care should be taken to refrain from dropping an iron as this causes serious damage to the element.

Adherence to the above considerations will lengthen the life of a soldering iron and tend toward fewer soldering difficulties.

Soldering Procedure:

(1)—A firm mechanical connection is necessary before beginning to solder. Firmly clasp wire to terminal to be soldered.

(2)—A clean surface is essential or the solder will not adhere properly. Wipe all dust, dirt, or oil from terminal. It should have a bright shiny surface. Do not touch clean terminal with fingers, as an oily film may be deposited as a result.

(3)—See that soldering iron is in good condition; it is impossible to make a good joint with an improperly tinned or dirty iron. The tip should have a bright tinned surface. Wipe the iron periodically with a cloth. This will remove particles of flux and dirt and restore a lustre to the tip.

(4)—Apply the iron to the terminal to be soldered. Permit it to remain a moment until sufficient heat has been transferred to terminal. Applying the side rather than the point of tip will transfer more heat, enabling terminal to be heated more quickly.

(5)—Apply the solder to the work, not to the iron. If the terminal is heated sufficiently, the solder will melt readily upon contact. Applying solder to iron is undesirable. The solder will melt instantly upon contacting hot iron, but if the terminal to be soldered is insufficiently heated, the solder will not combine with it properly. The hot solder will cool upon contact and remain on the surface, thus forming a cold soldered joint which can be dislodged easily.

(6)—Permit desired quantity of solder to flow upon terminal. The terminal should be hot enough to cause the solder to flow readily to completely envelop joint. If the solder acts similar to water on a greasy surface, forming globules and running off the surface of terminals, it indicates the presence of dirt or oil on surface. Refusal of solder to combine with a hot clean terminal may be indicative of improper tinning or plating of surface.

(7)—After permitting desired quantity of solder to flow upon terminal, remove soldering iron quickly and carefully from terminal. Permit the solder joint to solidify. Extreme care must be taken not to disturb or move the terminal until it has solidified or hardened sufficiently. This is very important, as it means the difference between a good, hot soldered joint and a poor, cold soldered joint. Any movement of solder while it is solidifying from the molten state, will cause it to cool and crystalize into a granular mass. It will then fail to adhere properly and become molecularly part of the terminal; it will merely stick on the surface insecurely, thus making a poor, high-resistance connection.

(8)—A hot solder joint can be distinguished from a cold solder joint rather easily. A proper, hot solder joint should have a smooth, shiny, hard surface, adhering firmly to terminal. A poor, cold solder joint has a dull irregular, rough surface. If touched or disturbed before having properly hardened, it will have a dull, granular, porous surface. It may be so porous and pasty, that slight pressure on its surface with the blade of a screw driver will cause it to disintegrate or fall apart. In addition it will be quite soft.

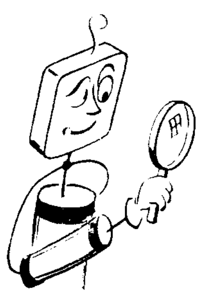
(9)—Remove excess rosin or flux only when you are certain the solder has had time to solidify. Removal of rosin surrounding joint tends toward a neat, workmanlike appearance. In addition, the presence of rosin may interfere with electrical action of radio on high frequencies.

(10)—A dull cold solder joint can be remedied immediately. Simply apply hot iron to solder until solder melts; remove iron without jarring connection. It should solidify to a bright finish.

(11)—Ascertain that no particles of solder have fallen from terminal, to wedge between adjacent connections.

(12)—When soldering in difficult places see that no damage or short circuits have been caused by contact of iron with surrounding wiring. It is advisable to use an iron with a long slender tip, as a large tip may burn insulation of nearby wires.

Inspection Procedure



Adherence to the following seqeunce will enable an inspector to become observant of every little detail present in a wired assembly. Begin by inspecting the unit for the first item only, namely, soldered connections. Observe every detail concerning them. Next inspect for the second item only, or dressing of wires and leads. Continue in this manner until all items have been covered. Practice will result in familiarity with the various items and ultimate maximum efficiency will result.

Soldered Connections

(1) Examine each connection for evidence of cold solder or rosin joint. Excessive amounts of rosin may be concealing a poor connection.

(2) See that an undue amount of solder has not been used, also that the solder is not encroaching upon an adjacent terminal to cause a possible short circuit.

(3) Loose, unsoldered ends should not protrude from a connection.

(4) Observe that loose solder particles are not adhering to wire insulation or lodged between terminals.

Dressing of Leads and Wires

(1) Examine wiring for broken or frayed insulation.

(2) The insulation should not be stripped back too far from soldered end.

(3) Examine bare wires for broken strands. (A limited number of broken strands is permissible.) Bare wires and adjacent parts must not touch.

(4) See that all cables are properly laced with wax-impregnated cord.

(5) Cables and conductors should be neatly dressed to expose as much as possible of underlying wiring. Cables should be held securely to chassis by clamp provided.

(6) Leads should be dressed away from switch contacts.

(7) See that spaghetti tubing is properly in place where required.

(8) Wiring should not be subjected to abrasion, due to rubbing against sharp edges of chassis or components.

(9) Leads connecting to multipronged plugs or coaxial terminals should be neatly laced and spaghetti used over each connection.

Special Soldering-Iron Tips

Soldering-iron tips, made of copper cut from rods which are frequently available in stock, may be fashioned into many ingenious shapes for special jobs. Figure 8A shows a general-purpose tip used

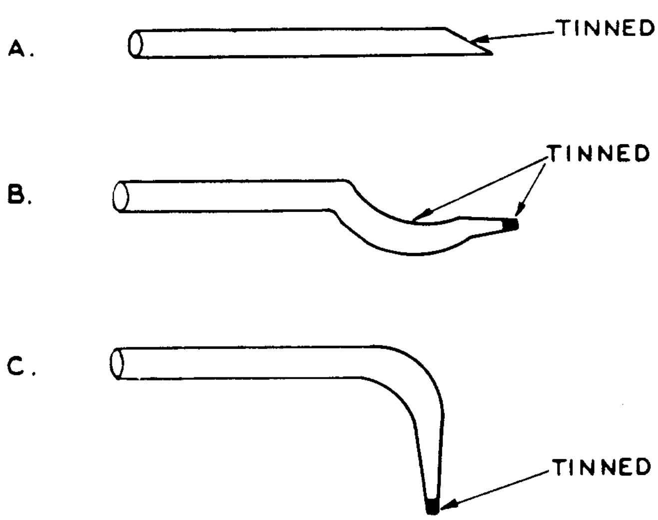


FIGURE 8. VARIOUS SHAPES OF SOLDERING-IRON TIPS MADE FROM COPPER ROD

for soldering leads to various plugs and connectors. It differs slightly from conventional tips, as it is flattened rather than pointed. Figure 8B shows a special tip for soldering the shield of the coaxial lines to the shell of the plug. When using this tip, solder a spot in each of the four holes around the plug, then place the curved portion around the plug, and smooth the solder while rotating the plug. Figure 8C shows a narrow, tapered tip, used to solder connections that are difficult to reach. In soldering leads to a plug, as shown in figure 9, make connections starting at the bottom, and complete each row before starting on the next. This keeps the first leads soldered out of the way of subsequent connections.

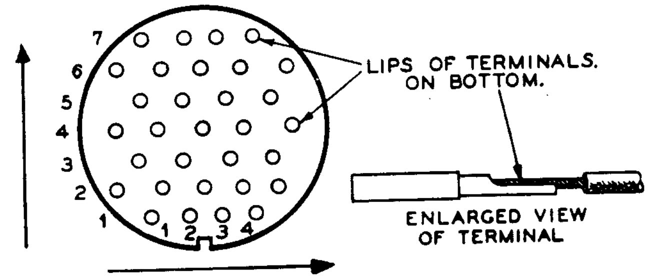


FIGURE 9. ORDER OF SOLDERING CONNECTIONS ON MULTI-PIN PLUG

After the wires composing the cable have been prepared for soldering, place the first one in its terminal. Apply the solder and soldering-iron tip to this operation or there will be an excessive amount of heat conducted to the wire, terminal, and plug, and the insulation on the wire might be damaged.

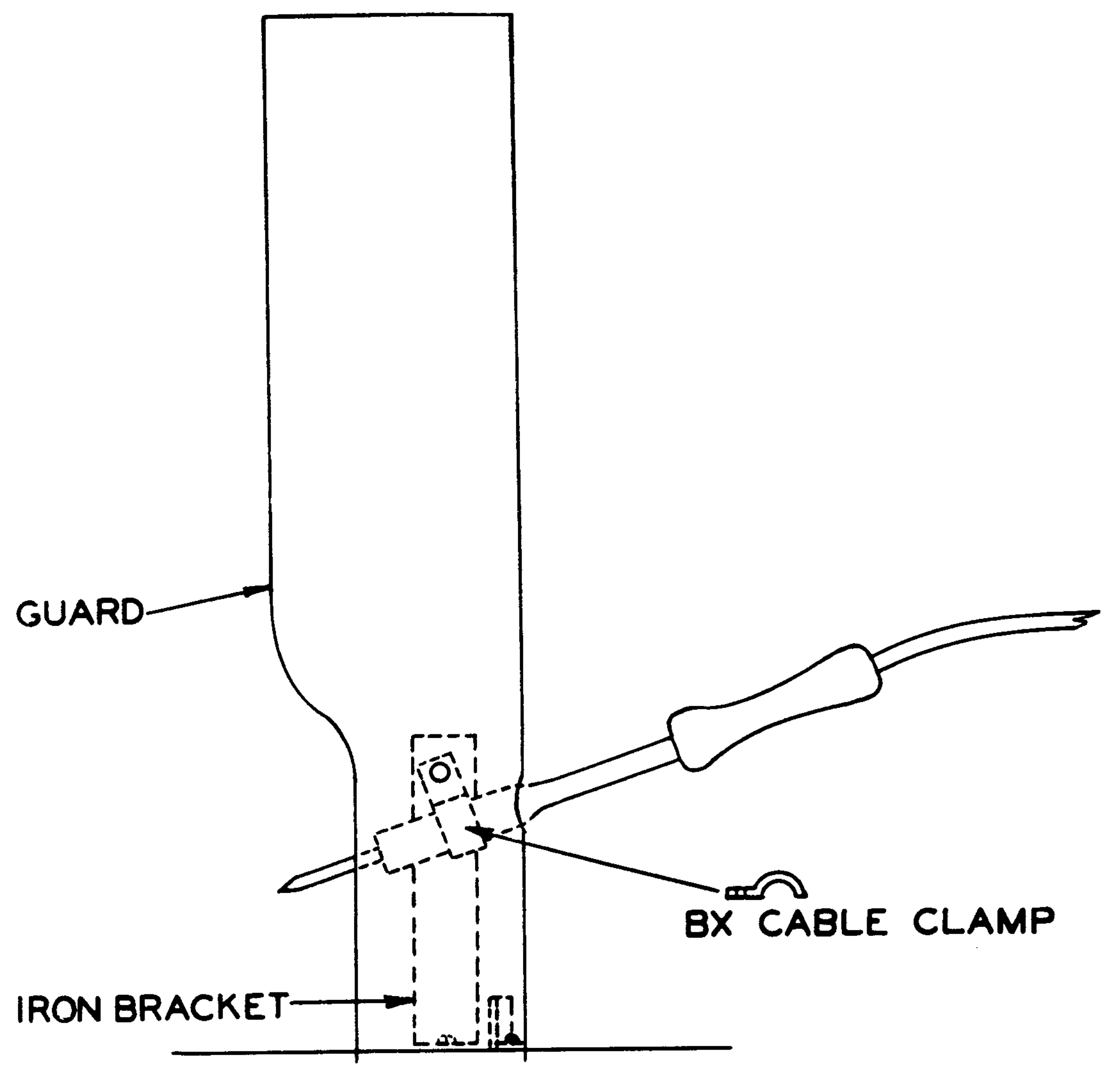


FIGURE 10. CONSTRUCTION OF SOLDERING-IRON HOLDER

the top of the wire and terminal until the solder flows freely into the terminal about the wire. Do not allow an excessive amount of solder to flow into the terminal. This is a reversal of a previous suggestion, but it would be difficult to place the iron *under* the terminal after the first row of wires was in place. All terminals are connected in the same manner. It is necessary to use a small clean tip in Perform soldering operations on plugs rapidly so that a minimum of heat is transferred to the plug and the wire insulation. Certain insulation used on conductors in cables (especially coaxial lines) cannot stand a very high temperature. Be extremely careful when soldering near such insulation. In soldering coaxial lines, excessive heat on the center conductor causes the insulation to burn away from the conductor, which may move and cause a change in impedance.

In some cable soldering, the iron may be held in a fixed position by a bracket and clamp device. See figure 10. This frees both hands for holding the work and solder. The iron should be suspended at an angle that will permit the heat to rise without striking the handle of the iron. For small, close soldering, a large magnifying glass may be fastened over the work for better observation. For this purpose use a bracket and clamp, similar to the one used to hold the iron.

When using a soldering iron intermittently, and it is not fixed in a stationary position, the soldering iron should be placed in a metallic holder. A metal holder having a large surface will dissipate some of the heat from the iron, and prevent it from becoming too hot when not in use. Such a holder can be made from an old aluminum automobile piston, sawed off at the center of the wrist-pin hole.

To simplify the soldering of connections to a multi-pin connector, mount a receptacle for the connector on a board fastened to the bench, as shown in figure 6. The connector is then held firmly by the receptacle while the wires are soldered to the connector terminals, and the connections can be checked for continuity, or short circuits, as explained.

Many ingenius ideas can be worked out to simplify difficult soldering jobs. As an example, the insulated snap-connector for the high-tension lead to a cathode-ray tube usually requires extreme care to prevent damaging the rubber cover and sleeve when soldering the lead. Figure 11 shows a novel

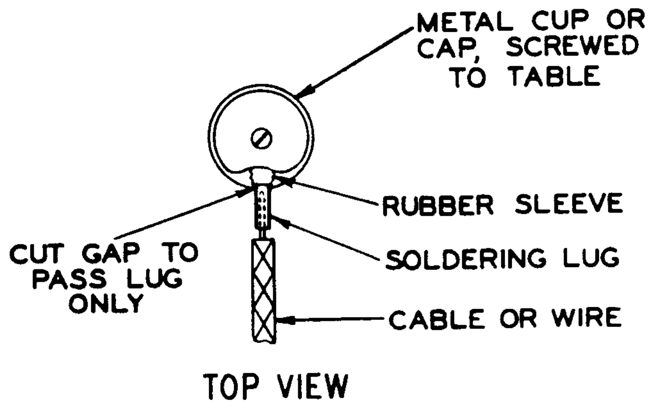
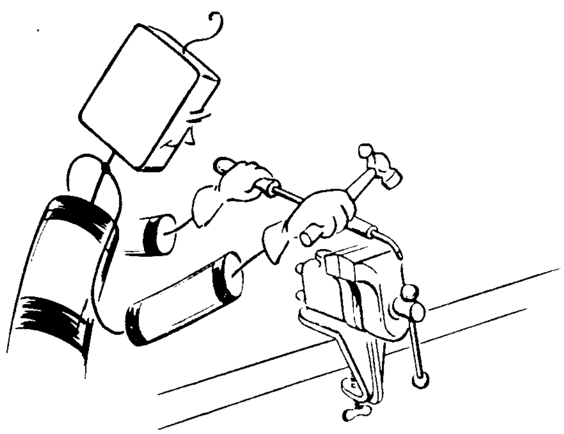


FIGURE 11. DEVICE FOR FACILITATING SOLDERING OF RUBBER-COVERED CONNECTOR

idea which will simplify this job. A metal, screw-on dust cover for coaxial receptacles is screwed to the bench, hollow side up. A gap is then cut in the side of it with a thin file or hacksaw. Make the gap wide enough to take just the soldering lug of the connector, but not wide enough for the rubber sleeve. Force the rubber-covered connector into this cup, so that the lug passes out through the gap and the rubber sleeve remains pushed up inside the cup. The lead can now be soldered to the lug without damage to the rubber insulation.



LACING CABLES

THE wires of all open-wiring cables should be laced or bound together to form a neat, single cable. This operation is best performed before the cable is removed from the jig. If only a single cable is being made, not using a jig, the lacing should be done on the installed equipment, so it will have the proper shape for the installation. Waxed #6 or #8 lacing cord is used for the binding. The #6 size is used on small and medium sized cables, and #8 is used on large or heavy cables. Two of the most common methods used are as follows:

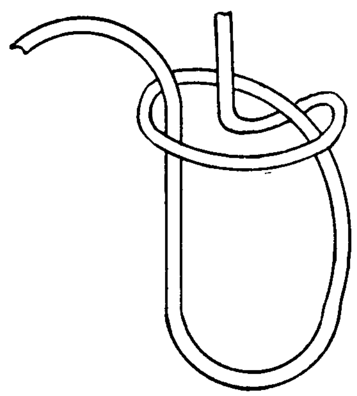


FIGURE 12. STARTING STITCH FOR LACING CABLES

1. Using the above lacing cord and beginning at one end of the cable, tie the first two conductors firmly together near the point where they separate. Use a slip knot and two lock-stitches, pulled tightly, and push the loose end under the winding or between the wires. See figure 12. Lead the cord along the cable and make two lock-stitches (figure 13) at the point where each conductor enters the

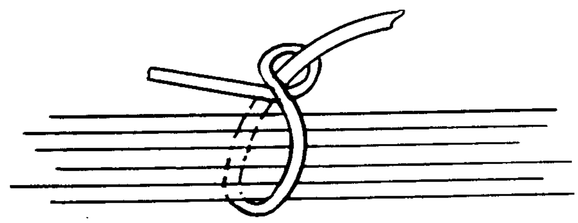


FIGURE 13. LOCK-STITCH FOR LACING CABLES

cable. Along the main body of the cable, continue to lead the cord and make lock-stitches approximately every ½ inch. See figure 14. At the other end of the cable, use the same method as at the beginning of the cable, making the final knot very tight, as shown in figure 15. The tie-points and

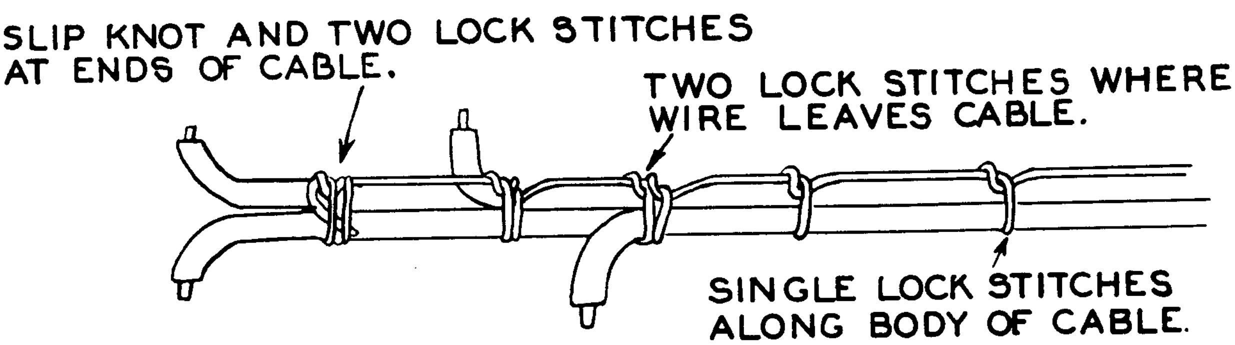


FIGURE 14. METHOD OF LACING CABLE USING LOCK-STITCHES

RESTRICTED

knots are then coated with clear lacquer or speaker-cement to hold them in place. The cable must be formed to its desired shape, with the necessary turns and branches at the right place before lacing.

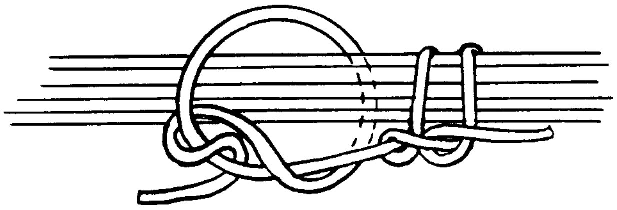


FIGURE 15. FINAL KNOT AT END OF LACING

2. The second method of lacing or binding is a series of individual bindings at the desired points along the cable. Cut off a piece of binding cord long enough to make 10 or 12 turns around the cable. Make a loop about one inch long in one end of the cord and lay it on the cable, parallel to the wires. See figure 16. Start winding the remainder of the cord over this loop, very tightly. At the last turn, push the loose end of the twine through the loop which extends out from under the binding, then pull on the first end of the cord. This will pull the tail end of the cord under the binding.

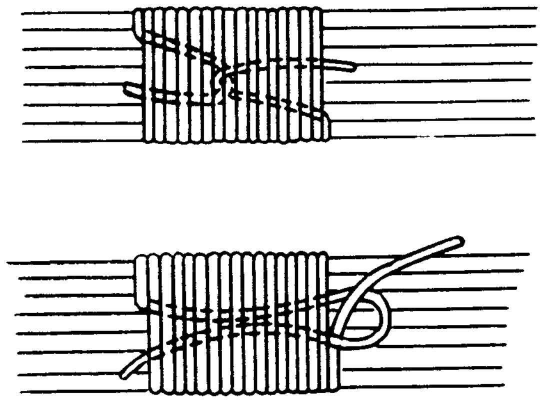
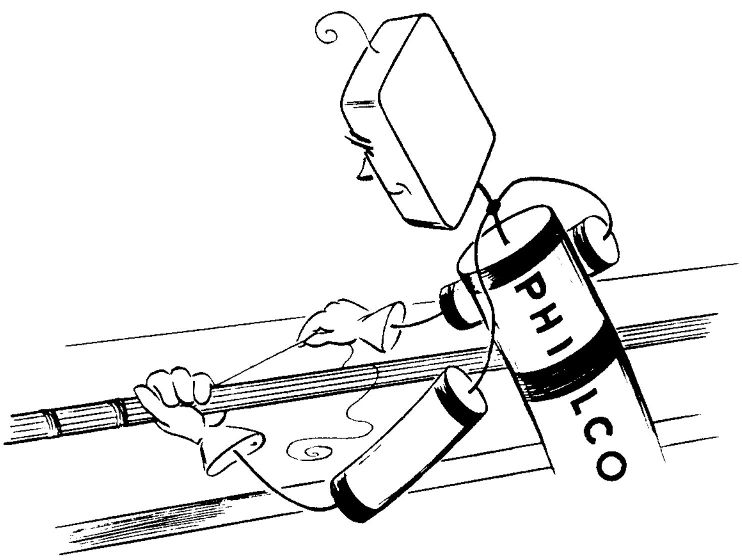


FIGURE 16. ALTERNATIVE METHOD OF LACING CABLES USING INDIVIDUAL BINDINGS

Pull the first end only far enough that the cross-over of the ends will be about the center of the binding, then cut off the loose ends remaining outside the binding. These bindings are repeated along the cable, and the size of the cable will determine how many bindings are necessary. Each binding is then coated with clear lacquer or speaker cement to hold it in place.



REMOVING INSULATION

MEASURE the wire, and cut to the correct length. Measure amount of insulation to be cut off; then, using a razor blade, score around the outer rubber covering of wire, and, if necessary, score lengthwise. When scoring around the outer rubber covering, take care that the razor blade does not cut any strands of the conductor, because even a [illegible]t cut will weaken them and, in time, cause the [illegible]tor to break. After the rubber casing has been properly scored, remove by hand or with a pair of pliers. Separate the cotton filler with a small pick or wire brush, and trim with a pair of scissors. Using a wire brush, clean off all excess rubber on conductor strands and twist strands together. Solder conductor strands, and clean off any excess solder or flux. Using lacquer or speaker cement, coat all the small cotton strands to prevent raveling.

Extra precautions should be taken with spun-glass insulation to prevent it from raveling. This material will ravel just like a "run" in a silk stocking, and the "run" may start long after the fibers have been weakened. Lacquer or speaker cement should therefore be used whenever there is a suspicion that some of the fibers are broken. If the wire is kinked, always lacquer that place after removing the kink. Always lacquer the cut ends of the insulation and continue lacquering for about an inch from the end of the wire.

When a large quantity of wires is needed, a quicker method of removing insulation is advisable. Special insulation cutting machines are often available at the bases (figure 17), but when they are not, several types of cutters can be devised, which accomplish the same results.

Figure 18 shows the details of an insulation cutter made from wood, a discarded hacksaw blade, screws and nails, as follows:

(1) Grind the teeth off the hacksaw blade slowly, to retain the temper of the steel, and sharpen the blade.

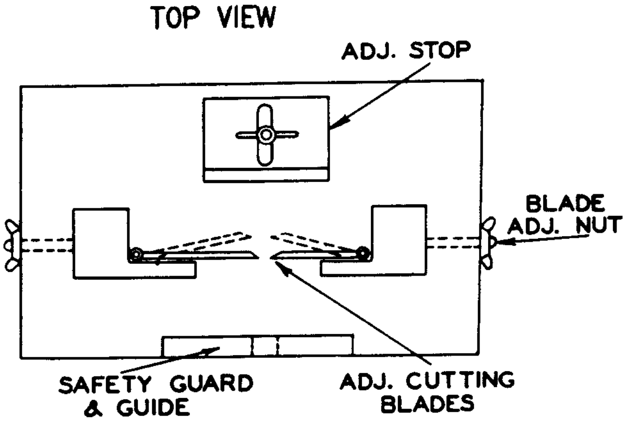


FIGURE 17. PRINCIPLE OF INSULATION CUTTER

(2) Cut a slot in the blade-holding block deep enough to allow the blade to move freely.

(3) Anchor the blade in the holding block with a nail or screw through the hole in the end of the blade.

(4) Fasten the holding block permanently to the base with two screws.

(5) Cut a slot in the adjusting block deep enough to allow the blade to slide freely between the two nails driven through the block above and below the blade.

(6) Adjust the blade for proper depth of cut by placing a sample wire, which has had a portion of the insulation removed, under the blade, with the outside insulation against the adjusting block. Slide it to the right or left until the blade is adjusted to the proper depth of cut, and fasten the block to the base with two wood screws. See figure 18.

(7) Push the wire to be cut against the sharp blade, and turn slowly until the insulation is cut. Remove the wire from the cutting device and pull off insulation by hand or with a pair of pliers.

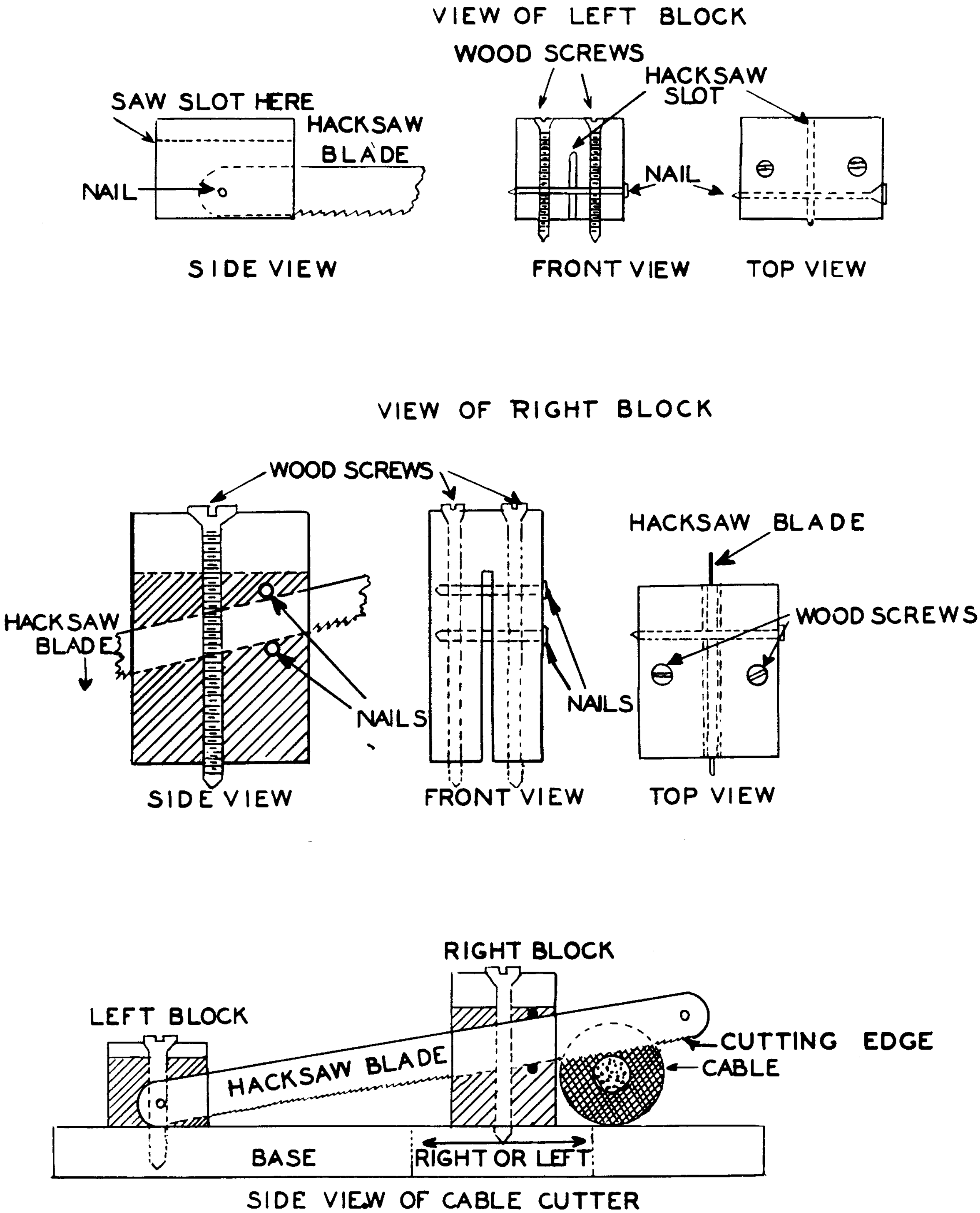


FIGURE 18. DETAILS OF INSULATION CUTTER TO BE MADE IN THE FIELD

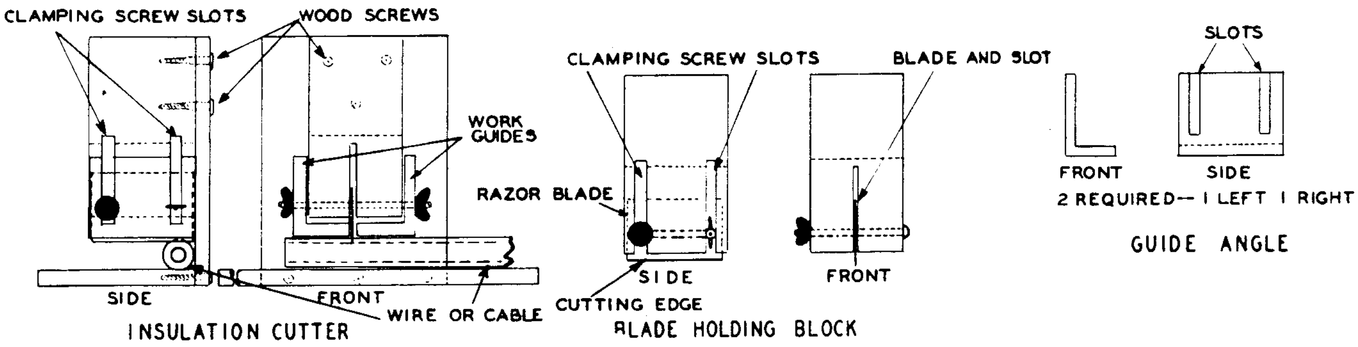


FIGURE 19. DETAILS OF ALTERNATIVE INSULATION CUTTER TO BE MADE IN THE FIELD

Figure 19 shows the details of another device which may be used for cutting the outer covering. This device can be constructed from scraps of wood, two machine screws with wing nuts, a few wood screws, and a used razor blade, as follows:

(1) Make the base and back from scraps of wood.

(2) Saw two blocks of wood into "L" shapes for the guide angles. (Metal angles may be used if available.)

(3) Saw blade slot in the blade holding block.

(4) Saw two clamping screw slots at right angles to the blade slot.

(5) Attach the blade holding block to the back support.

(6) Attach the back support to the base.

(7) Place the blade in the slot, and install the clamping screws through the guide angle blocks and holes in the razor blade.

A wood stop, mounted on the base at the end of the wire, insures uniformity in the position of the

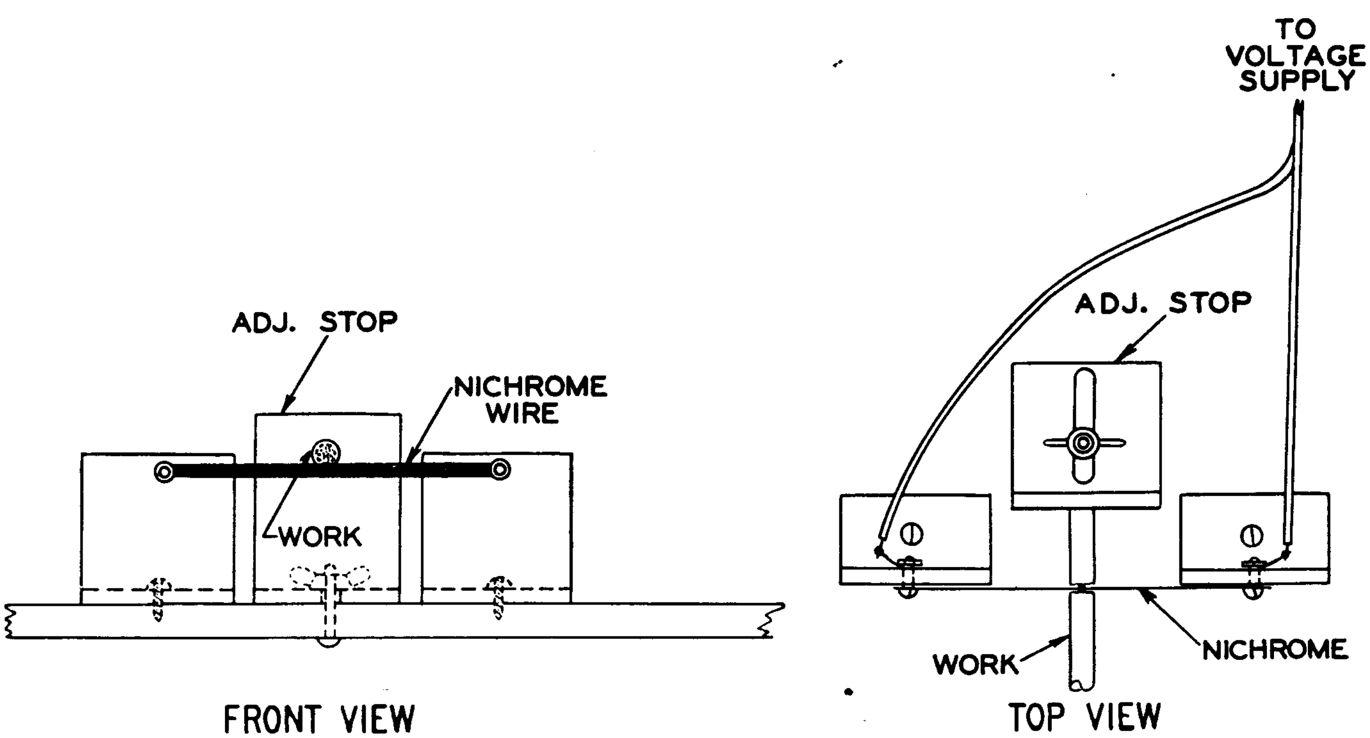


FIGURE 20. DETAILS FOR MAKING INSULATION BURNER

cut on successive cables. When a large quantity of wires is to be fabricated, the following procedure is recommended:

(1) Remove a portion of outer covering from a sample of the wire with a razor blade or knife.

(2) Place this sample in the device with the cut portion under the blade.

(3) Loosen guide angles (by loosening the clamping screws) and then adjust them to barely touch the top of the wire as it lies flat on the base.

(4) Adjust the blade to the correct depth of cut, and tighten the clamping screws.

(5) Remove the sample wire from the device.

(6) Push the wire to be fabricated under the razor blade, and rotate until the blade cuts around the outside covering.

(7) Pull off the outer covering by hand, or with a pair of pliers.

A device to burn insulation or dielectric through to the conductor will speed up cable fabrication. This device can be made with a transformer to supply the proper voltage, a 5 or 6-inch strip of nichrome wire $\frac{3}{16}$" or $\frac{1}{4}$" wide, and the necessary mounting brackets. See figure 20. The rear stop is adjustable and may be set to burn through the insulation any distance from the end of the wire. To use this insulation burner, the end of the wire is butted against the back-stop and the insulation held against the red-hot nichrome strip, while the wire is turned slowly to burn the insulation all around the wire. When the insulation is burned through to the wire, it can be stripped off with the fingers or pliers. The voltage required will be determined by what is required by the nichrome strip to keep it cherry-red hot.

DETERMINING WIRE SIZE

(1) Wire size for an application must be determined so that neither the applicable current capacity of Table I, nor the permissable voltage drop of the circuit, will be exceeded.

(2) In determining wire size for an application, the required length of wire and current which wire is to carry, must be known.

(3) First, select a wire which will carry the required current.

(4) Second, to calculate the voltage drop (E) of the wire selected, combine its length, resistance, and current by means of the following formula:

E = RI.

Where E = Voltage Drop.

R = Total Wire Resistance = Length in Feet x Resistance per Foot.

I = Current.

In general, if the voltage drop adversely affects equipment operation, select a larger wire size, and repeat the calculations, to determine the wire size meeting both requirements. See paragraph 1.

(5) Since the voltage drop of the return circuit through the aircraft structure is usually negligible, it has not been taken into account in the above calculations. However, where the voltage drop of this return path is appreciable it must be considered.

(6) Because of its low mechanical strength, wire size #22 must not be used for other than instrument wiring, unless specifically approved for the application.

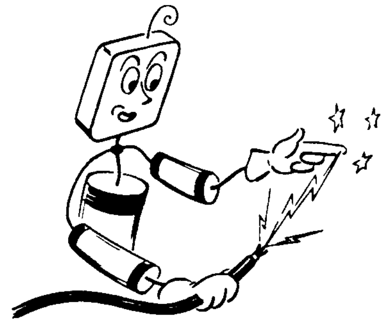


TABLE I

CURRENT CAPACITY OF SOLID COPPER WIRE

ARMY-NAVY WIRE No.	WIRE SIZE A.W.G.	CONTINUOUS RATING AMPERES	ONE-MINUTE INTERMITTENT AMPERES	FIVE-SECOND INTERMITTENT AMPERES	OHMS PER FOOT
AN-22	22	5	10	15	.01645
AN-20	20	7.5	15	22.5	.01025
AN-18	18	10	20	30	.00644
(ALP-1) AN-16	16	13	26	39	.00476
(ALP-2) AN-14	14	17	34	51	.00299
(ALP-3) AN-12	12	23	46	69	.00188
(ALP-4) AN-10	10	33	66	99	.00110
(ALP-5) AN-8	8	46	92	138	.00070
(ALP-6) AN-6	6	60	120	180	.00044
(ALP-7) AN-4	4	80	160	240	.00027
(ALP-9) AN-2	2	100	200	300	.00018
AN-1	1	125	250	375	.00015
(ALP-11) AN-0	0	150	300	450	.00011
AN-00	00	175	350	525	.00009
AN-000	000	200	400	600	.00007
AN-0000	0000	225	450	675	.00006

TESTING SUGGESTIONS

CHECKING a newly constructed cable, or locating trouble in a cable already in use, offers a large field for the use of ingenuity and imagination. The use of an ohmmeter or voltmeter is standard practice, and probably the most widely used testing method. If meters are not available, batteries, buzzers, bells, or light bulbs, usually found where there is radio equipment, may be used to advantage in checking cables.

If an ohmmeter is available, use the low-range scale to make a continuity check of each conductor in the cable, making certain that the wire is properly terminated and color-coded or marked. If all conductors check correctly, use the highest range scale of the ohmmeter to check for short-circuiting between the conductors, or between a conductor and the cable sheath. A single strand of fine wire, or a chip of solder that might escape observation, would show up as a reading on the ohmmeter and could be corrected before it caused trouble.

While using any method of checking, shake, twist, or roll the cable, and notice if the checking indicator reading changes. A change in the normal reading during this process indicates a short or open circuit, which will then have to be located and corrected.

The harness-cable test board, shown in figure 2, is one means of cable checking; using a battery, an indicator light, and a switch, in a simple series circuit, it checks for continuity and short circuits. Switches may be made from most any kind of discarded sheet metal. Batteries, available almost any place where signal equipment is used, do not have to be new. Quite often, batteries that have been discarded still have enough life to be used with this type of test circuit. If batteries are not available, and a.c. is, a bell-ringing transformer or a step-down transformer will supply the necessary current. Indicator light bulbs, flash light bulbs, or even regular light bulbs, may be used as an indicator. A door bell or a buzzer may be used in place of the light.

The checking method used in cable manufacture requires elaborate instruments and circuits. Besides the test board in its many forms, oscilloscopes, vacuum-tube voltmeters, and multimeters are used in various ways to make sure that a cable is perfect. Any means of checking may be used, as long as the method proves beyond doubt that no open or short circuits exist. The important point is that every new cable must be thoroughly checked before it is used with the equipment.

Time-saving methods of checking and locating defective conductors can be developed with experience. One example of the many ways that can be worked out to facilitate checking is the following method of locating a desired conductor in a cable with many conductors. With one lead of an ohmmeter connected to the known end of a conductor, gather all the conductors at the other end, and, holding them closely together, run the other lead from the ohmmeter quickly over the ends of the conductors, watching the ohmmeter scale. When the prod touches the opposite end of the known conductor, the general location of that conductor is indicated by a zero reading on the ohmmeter. Disregard all other conductors, except for a few around that general location. It is then an easy matter to find the correct conductor. This method is much more rapid than checking each individual conductor separately.

Another suggestion for simplifying the construction and checking of the cables is: Fasten a duplicate of the other half of the connector (male or female) to the workbench, with wires connected from its pins to the test unit. See figure 6. With this arrangement, each conductor can be checked both before and after the connector is assembled.

SECTION II

Fabrication of Cables

The following material gives the field man an accurate procedure for the fabrication of all types of cables. Starting with flexible conduit cables, complete steps from the method of cutting the conduit to the preparation of the ends to receive the proper connectors and fittings are presented.

The preparatory notes necessary for dealing with coaxial cables are very important and should be followed specifically.

Probably the most difficult cable to fabricate in the field, due to lack of special equipment and tools, is the flexible-shaft type used for remote tuning cables. However, an entirely satisfactory job can be done on these cables by carefully following all the instructions in the chapter concerning this type of cable.

FLEXIBLE CONDUIT CABLES

SINCE flexible conduit is generally used for aircraft cabling, the following procedure can be followed when constructing cable for almost all equipment.

(1) The conduit used to make up these cables is flexible aluminum BX covered with a woven metal braid. In working this conduit, care must be used not to flatten the conduit or ravel the braid. Also flexible conduit should never be stretched tightly, as it then loses its flexibility and the aluminum BX will part if it is bent when stretched.

(2) Lay the conduit on a flat surface and mark off the desired length. Make certain that the conduit is not stretched when extended. See figure 21.

(3) Wrap a layer of scotch or friction tape around the conduit, centering it on the cutting mark. This tape will prevent the braid from being raveled by the saw-blade.

(4) Place the conduit in a conduit cutting vise that fits it tightly, making sure the cutting mark is under the saw slot. If a conduit vise is not available, use a pipe vise for clamping the conduit, first inserting a piece of hard-wood dowel stock that will fit firmly inside the conduit. Do not clamp the conduit so tightly in the pipe-vise that it will be flattened.

(5) Using a hacksaw with a fine-toothed blade, cut off the conduit at the mark, sawing through the tape.

(6) Remove the conduit and cut off any burrs or sharp edges left by the saw with a file or knife. Use a pair of diagonal cutters or metal shears to trim off the frayed ends of braid. Do not remove the tape till ready to apply the ferrule.

(7) Remove the tape and slip the conduit coupling nut onto the cable. The ferrule is now placed on the conduit, making certain all the braid wires are pushed under the ferrule skirt. Use a small screwdriver blade to push any stray wires under. See figure 22.

(8) Place end of conduit in a ferrule crimping machine and crimp the ferrule firmly to the conduit at each end. Use the crimping machine recommended by the manufacturer of the fittings. A hand crimping tool can be used, if available; it is constructed similar to a pipe-cutting tool, except it has crimping rollers instead of the cutting rollers. If no crimping equipment is available in an emergency, place a close-fitting pipe or metal rod inside the conduit; use a center-punch with a rounded point, and light blows from a hammer to put two rows of indentations around the skirt of the ferrule. See figure 23. Make the dents deep enough to shape both skirt and aluminum BX, but not deep enough to cut through the BX. This is only an emergency measure and the old ferrule should be replaced by a new one, properly crimped, as soon as possible.

(9) Measure and cut wires the proper length for the conduit. Figures given here can only be approximate, as they will vary with the size and type of connector used and the length of the cable. For a straight connector, the wire should be cut to extend approximately $2\frac{1}{2}''$ at each end of the conduit. For right-angle connectors, approximately 4″ of wire should extend from each end of the conduit. Add to this an additional inch for each 10′ of cable, for slack.

(10) Strip insulation $\frac{5}{16}''$ from each end of wire. Insert a fish wire through the cable, bend the end of the wires together and attach fish wire. Pull wires straight through conduit.

(11) Slip a piece of insulating tubing over ends of each wire and slide it back out of the way. Cut insulating tubing sufficiently long so that, when it is finally slipped back over terminal pin, it will completely cover terminal sleeve and extend about $\frac{1}{2}''$ into conduit.

(12) Tin exposed ends of wires and insert them

into terminal sleeves. Crimp sleeve around wire and solder, using rosin flux.

(13) Slide insulating tubing over connection. Solder remaining leads and, after aligning keyway, assemble connector plug.

(14) Tighten conduit nut until ferrule is held firmly against rear shell or elbow of connector.

(15) Follow same procedure when connecting and assembling plug connector on opposite end of cable.

and crimp the ferrules in place. Prepare the other conductors in the usual manner, then proceed as follows with the coaxial lead:

(1) Remove $1\frac{7}{8}''$ of outer cover.

(2) Remove $1\frac{3}{8}''$ of shield braid, leaving $\frac{1}{2}''$ of braid and exposing dielectric insulation.

(3) Remove $1\frac{1}{8}''$ of dielectric insulation, exposing bare wire.

(4) Place a 1" length of insulating tubing over the wire, leaving $\frac{1}{8}''$ of bare wire for soldering to pin.

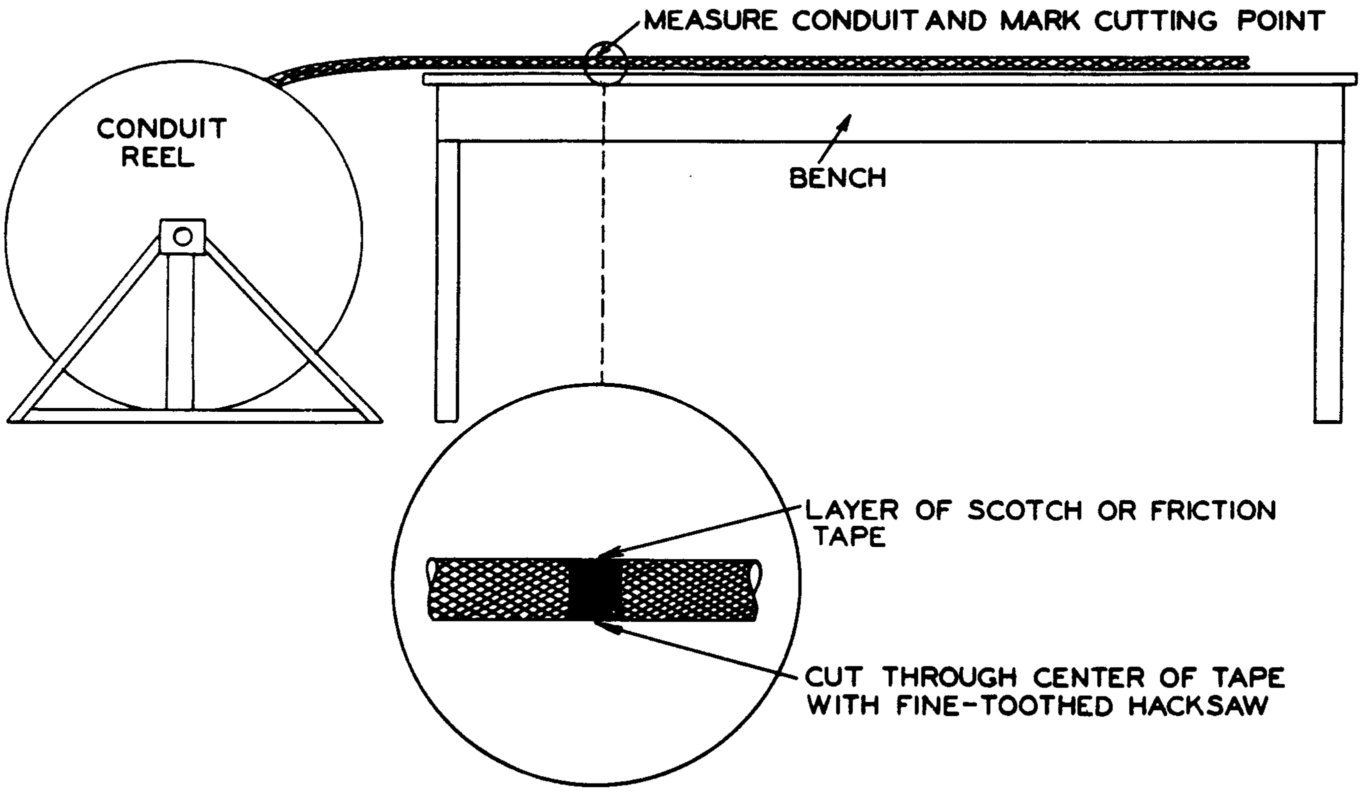


FIGURE 21. PREPARING FLEXIBLE CONDUIT FOR CUTTING

(16) If a cable is to be used where one end terminates directly on a terminal board which does not use a plug, allow wires to extend $8\frac{1}{2}''$ out of conduit. After these wires are connected to terminal board, lace exposed wires neatly together.

If the multi-conductor cable to be used in a flexible conduit contains a coaxial line, special attention must be given to anchoring and grounding the coaxial shield. See figure 24. Cut the flexible conduit to the right length, slip on the clamping nuts

(5) Place a #6 soldering lug on copper braid, large end out, and bind firmly in place with approximately eight turns of #22 tinned wire.

(6) Solder lug into place, using the absolute minimum of heat necessary to make a good connection. Remove all excess solder.

(7) Bend soldering lug upright until it is perpendicular to surface of braid.

(8) Place a "C" washer over conductor on upright portion of soldering lug; center flat surface of

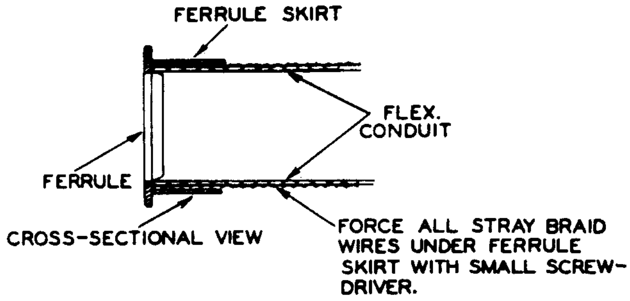


FIGURE 22. LOCATION OF BRAID IN RELATION TO FERRULE

washer to flat surface of lug and solder into place.

(9) Bend soldering lug carefully so that the "C" washer passes through reducing coupling of plug, and pass conductors and washers through reducing coupling, moving coupling back against ferrule.

(10) Solder all conductors to their proper plug pins.

(11) Pass reducing coupling over "C" washer and screw coupling into place in plug assembly.

(12) Bend soldering lug holding "C" washer, until face of washer is again at right angles to braid.

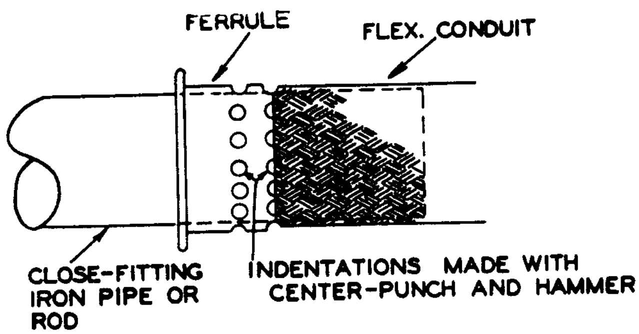


FIGURE 23. TEMPORARY METHOD OF CRIMPING FERRULE

(13) Bring up clamping nut, and screw it onto threads of reducing coupling.

The "C" washer and ferrule are now held firmly in place between the reducing coupling and the clamping nut, providing a ground for the coaxial braid and preventing the coaxial conductor from breaking with vibration.

Different types of connectors may require slight variations in the measurements given, but the overall procedure will be much the same.

Some installations may require brass soldering-ferrules in place of the crimped ferrule. In this case, no crimping machine or special tools are required. The ferrule is simply slipped onto the end of the cable, with the sleeve of the ferrule under the braid, then soldered all around. The same clamping nut is used with a soldering ferrule as with a crimping ferrule.

After split shell type connectors are reassembled, and the screws tightened, thread safety wires through the holes in the screw heads in the following manner:

(1) Thread wire through one screw head, bring ends together, and twist wires for distance to next screw head.

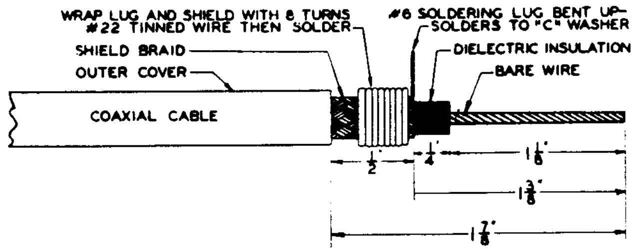


FIGURE 24. ANCHORING AND GROUNDING COAXIAL SHIELD

(2) Thread only one wire through screw head, and twist two wires again to next screw head.

(3) After the last screw, twist the two ends of wire tightly together for about ½", then bend close to shell. See figure 23. The safety wire prevents the screws from working loose with vibration.

On some connectors, holes are provided in the coupling nut, and in a nearby fixed part of the receptacle. A safety wire is also used here in the same manner as described above. Thread the wire through holes that provide a tightening, not a loosening, pull on the coupling nut.

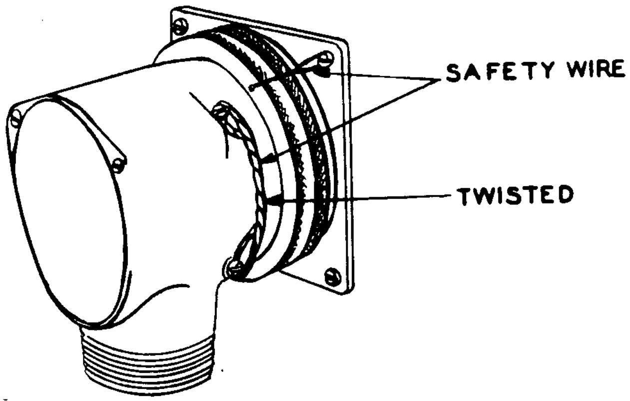
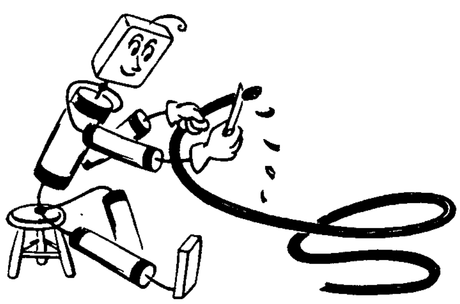


FIGURE 25. METHOD OF SAFETY-WIRING CONNECTORS

MULTI-WIRE CABLES

MULTI-WIRE cables are often used in place of flexible conduit cables in aircraft work and have different types of outer covering as well as different insulation on the conductors composing the cable. The outer covering is composed of one or more layers of braid, or rubber compound. The braid may be either metallic or fabric, and the rubber compound may be either a thin layer, or very thick, depending upon its use in the aircraft.



There are several ways to remove the outer cable coverings and all of them require considerable care. To remove the fabric braid, cut through the braid at the desired point with a razor blade or sharp knife. Perform this operation very carefully, or the conductors composing the cable may be damaged. The fabric usually can then be pulled off by hand, but in some cases it will be necessary to split the fabric before it can be removed. Metallic braid or rubber compound covering may be removed in the same manner. When metallic braid is used, ground the shield through either the plug body or a pin on the plug. There are two methods of making connections to the shield braid:

(1) Wrap the braid with a few turns of bare wire, and solder. This wire is used as the ground lead and may be connected to ground through a pin on the plug, or by the plug shell.

(2) Use a wire brush or metal pick to separate the small wires composing the braid, and twist them by hand into a wire which can be used to ground the shield.

After removing the desired length of the outside covering, remove any inner layers of material that surround conductors which must be removed to expose the wires. Remove these layers in the same manner as the outside covering, except for a layer of cotton cord found in some cables, which should be unwrapped and trimmed off with a pair of scissors or diagonal cutters.

To keep the outside braid from fraying, bind a few inches of the cable at the point where the cable enters the plug. This also adds strength to the point which receives most abuse. Since the outside cover or braid is placed on the cable to protect the conductors, install the cable in the plug or connector so that all strain placed on the cable is transmitted to the outside cover, or braid, and not to the conductors.

Use the following procedure to connect the conductors of multi-wire cables to connectors and plugs:

(1) Cut cable to desired length, allowing $\frac{5}{16}$" for connection, and sufficient slack to allow wires to be connected in plug. An angle connector requires slightly more slack than a straight connector.

(2) Strip insulation $\frac{5}{16}$" from end of each wire.

(3) Slip a piece of insulating tubing over ends of each wire, and slide it back out of way. Cut insulating tubing sufficiently long so that, when it is finally slipped over connector, it will cover connector sleeve and extend about $\frac{1}{2}$" over insulation of wire.

(4) Tin exposed ends of wires, and insert them into connector sleeves. Crimp sleeves around wires, and solder with rosin core solder.

(5) Slide insulating tubing over connections; after aligning keyway, assemble connector plug. Tighten cable clamp until cable is held firmly, but not squeezed tight enough to crush insulation.

(6) Follow same procedure in connecting opposite end of cable.

RESTRICTED

(7) If cable is to be used where one end terminates directly on a terminal board which does not use a plug, cut outside covering back for a distance of $8\frac{1}{2}''$. After these wires are connected to terminal board, lace exposed wires neatly together.

After split-shell type connectors are reassembled, and the screws tightened, thread safety wires through the holes in the screw heads in the following manner:

(1) Thread wire through one screw head, bring ends together, and twist wires to next screw head.

(2) Thread only one wire through screw head, and twist two wires again to next screw head.

(3) After the last screw, twist the two ends of wire tightly together for about $\frac{1}{2}''$, then bend close to shell. See figure 25. The safety wire prevents the screws from working loose with vibration.

On some connectors, holes are provided in the coupling nut, and in a nearby fixed part of the receptacle. A safety wire is also used here in the same manner as described above. Thread the wire through holes that provide a tightening, not a loosening, pull on the coupling nut.

COAXIAL CABLES

AFTER carefully selecting the type of coaxial cable specified by the manufacturer, or its equivalent with respect to dimensions, cut the cable to the required length, allowing some slack for the necessary minimum bending radius of $2\frac{1}{2}$ to $3''$. The smaller coaxial cables consist of an outer covering over the braided conductor, a solid dielectric, and a stranded or solid inner conductor. The inside diameter of the compression nut or plug sleeve must be greater than the outside diameter of the cable. Because of the various possible combinations of fittings, this section applies to coaxial fittings in general. However, once the fittings are seen, it will be obvious which procedure should be followed:

(1) Length of cable to be stripped depends upon fitting used. Cut outer braid at desired point with a knife, circling the covering. See figure 26. Then split covering lengthwise and remove. Take care not to cut so deeply that the braid is nicked.

(2) If a cotton braid cover is used between outer cover and braid, fan cotton braid and trim off with scissors.

(3) In installations where coaxial line does not terminate in a plug, use a wire brush or a fine hooked instrument to unravel outer copper braid conductor shield the required distance from end of stripped outer covering. Then twist outer braid together to form a ground lead. See figure 26. Braids of most connectors should be cut off a short distance from outer cover.

(4) After marking desired length of dielectric to be stripped, follow same procedure as in removing outer covering, and remove dielectric from center conductor. Take care not to nick the conductor.

(5) Tin center conductor and only the end of the twisted outer-braid lead.

(6) On some fittings, a special jam-nut is provided to fasten outer braid. In this event, fan out outer braid with a wire brush, slip on jam-nut and fitting, and push outer braid into fitting, allowing about $\frac{1}{4}''$ of braid to extend past jam-nut when tightened. Then, with a knife, trim off braid flush with jam-nut.

(7) Disassemble coaxial fitting and fit over conductor, seating inner conductor into place. Solder outer braid lead to fitting and tighten entire assembly. Bind outer insulating covering with lacing cord approximately $1''$ from end of fitting, and treat with lacquer or radio speaker cement.

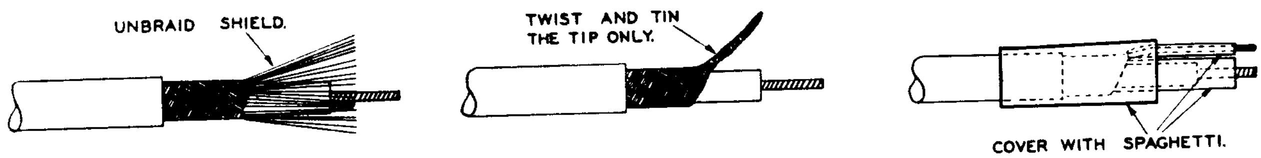


FIGURE 26. METHOD OF MAKING GROUNDING PIGTAIL FROM BRAIDED SHIELD

(8) In some plugs, a "C" washer is necessary to securely anchor outer braid lead to coaxial connector. See figure 26. Solder lug to end of outer braid lead, after lead has been cut off approximately ¼" from junction of twisted strands. Then solder lug to "C" washer, after inner conductor is soldered in place. Assemble fitting and insert "C" washer between sleeve of fitting, and fitting sealing-nut, thus securely connecting outer conductor to fitting shell, and allowing any strain to be transmitted from outer braid to shell instead of to inner conductor. It is important that there should be no slack in the lead between outer braid and "C" washer, as such slack would cause a strain on the inner conductor.

(9) If braided outer conductor is long enough to touch inner conductor, slip a piece of insulating tubing over braided lead, so that it cannot short inner conductor.

(10) When coaxial line terminates at a terminal board, or any other point where the braid is directly grounded by a clamp fastened around the shield, bind end of braid to prevent fraying. See figure 27. Wrap several turns of fine tinned wire tightly around end of shield braid, and push ends of winding under first and last turn. Then carefully solder this binding to the braid.

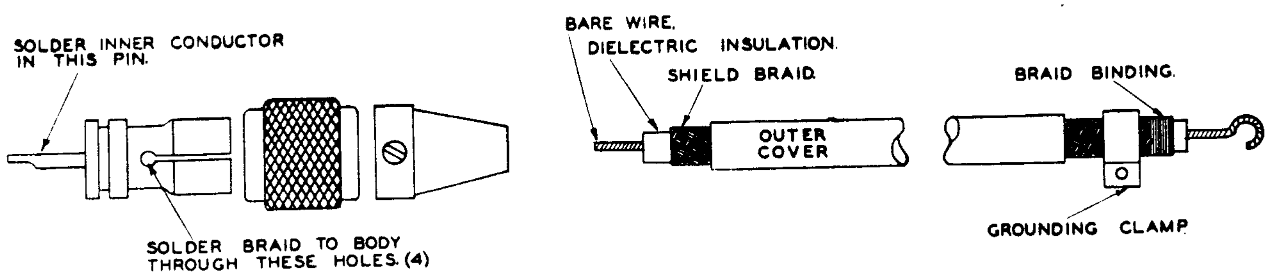


FIGURE 27. BINDING END OF BRAID TO PREVENT FRAYING

REMOTE TUNING CABLES

THE remote tuning cables used with some radio equipments usually consist of a flexible steel shaft inside a flexible metal sheath. Fastened to the ends of the steel shaft and metal sheath are the type of fittings necessary to couple the cable to a specific unit.

Great care is necessary when cutting this type of shaft. Unless some preventive measures are taken, the spiral-wound flexible shaft will ravel when it is cut, and destroy the usefulness of the cable. In large cable fabrication departments, a device is used which holds the shaft under sufficient pressure to prevent raveling, while a high electric current passes through a small portion of the shaft. The electric current melts the small portion of the shaft, forming solid ends on the fused shaft. This method is highly efficient, and recommended wherever the necessary equipment is available.

Another method commonly used is to swage the shaft before cutting. If a swaging tool (figure 28) is available, clamp it in a large vise. Place the shaft to be cut between the jaws of the swaging tool and strike the top of the tool with a large hammer. Swage approximately three inches each side of where the shaft is to be cut, pressing the shaft into a square or hexagon shape (depending upon the design of the swaging tool jaws), which will prevent it from raveling when cut.

Where no special tools are available, cut the flexible shaft after sweating solder between the spiral windings of the shaft where the cut is to be made. During the manufacture of these flexible shafts, a small quantity of lubricant is placed between the spiral windings. This lubricant will have to be removed before the solder will adhere to the shaft. To remove some of the lubricant, bathe the portion of the shaft to be soldered in high test gasoline, alcohol or carbon tetrachloride. After the solvent on the shaft has evaporated, cover the cleaned portion with acid flux and apply sufficient heat and solder to allow the solder to run in between, and around, the windings of the shaft for a distance of approximately three inches each side of the point to be cut. After the shaft has cooled, cut with heavy-duty cutting pliers or a bolt cutter at any point within the soldered area. Carefully apply a small quantity of solder to the cut ends of the shaft; file the ends of the shaft to fit the couplings to be used.

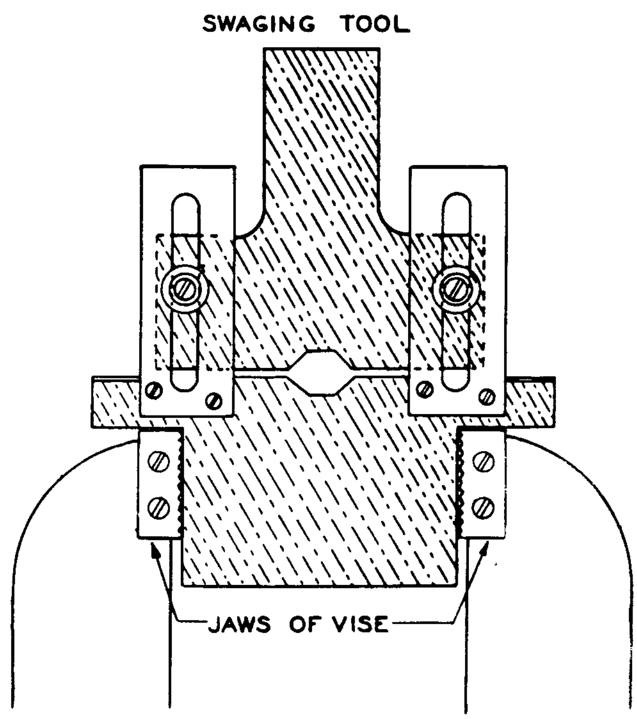


FIGURE 28. SWAGING TOOL FOR REMOTE TUNING CABLES

The flexible sheath can be cut with either a hacksaw or the edge of a grindstone. After it has been measured and cut to the proper length, remove all the rough edges, and grind or file the ends to fit the coupling ferrules.

The following procedure is recommended to make up a complete remote tuning cable:

(1) Accurately measure total length of the sheath from end of each ferrule, as shown in figure 29.

(2) Allow for the type of ferrules to be used, and cut the sheath as suggested.

(3) Slide the coupling nuts over the sheath, and place the sheath firmly into ferrules.

(4) Select a twist drill, equal in size to the inside diameter of the sheath, and insert the shank end of the drill into one end of the sheath and ferrule. See figure 30.

(5) Place the ferrule on a steel block or anvil, and with a center punch and hammer, drive four or five indentations around the ferrule.

(6) Remove any rough spots on the surface of the ferrule with a file, to allow the coupling nut to turn freely.

(7) Repeat steps (1) through (6) on the opposite end of the sheath. This completes the fabrication of the sheath.

(8) Grease shaft with special lubricant (60238) and slide the shaft through the sheath, and carefully measure the length to be cut. Make allowance for the spacer washer and depth of the coupling fittings. See figure 29.

(9) Following any of the methods previously suggested, cut the shaft and finish the ends to fit the coupling fittings snugly.

(10) Slide the spacer washer over one end of the

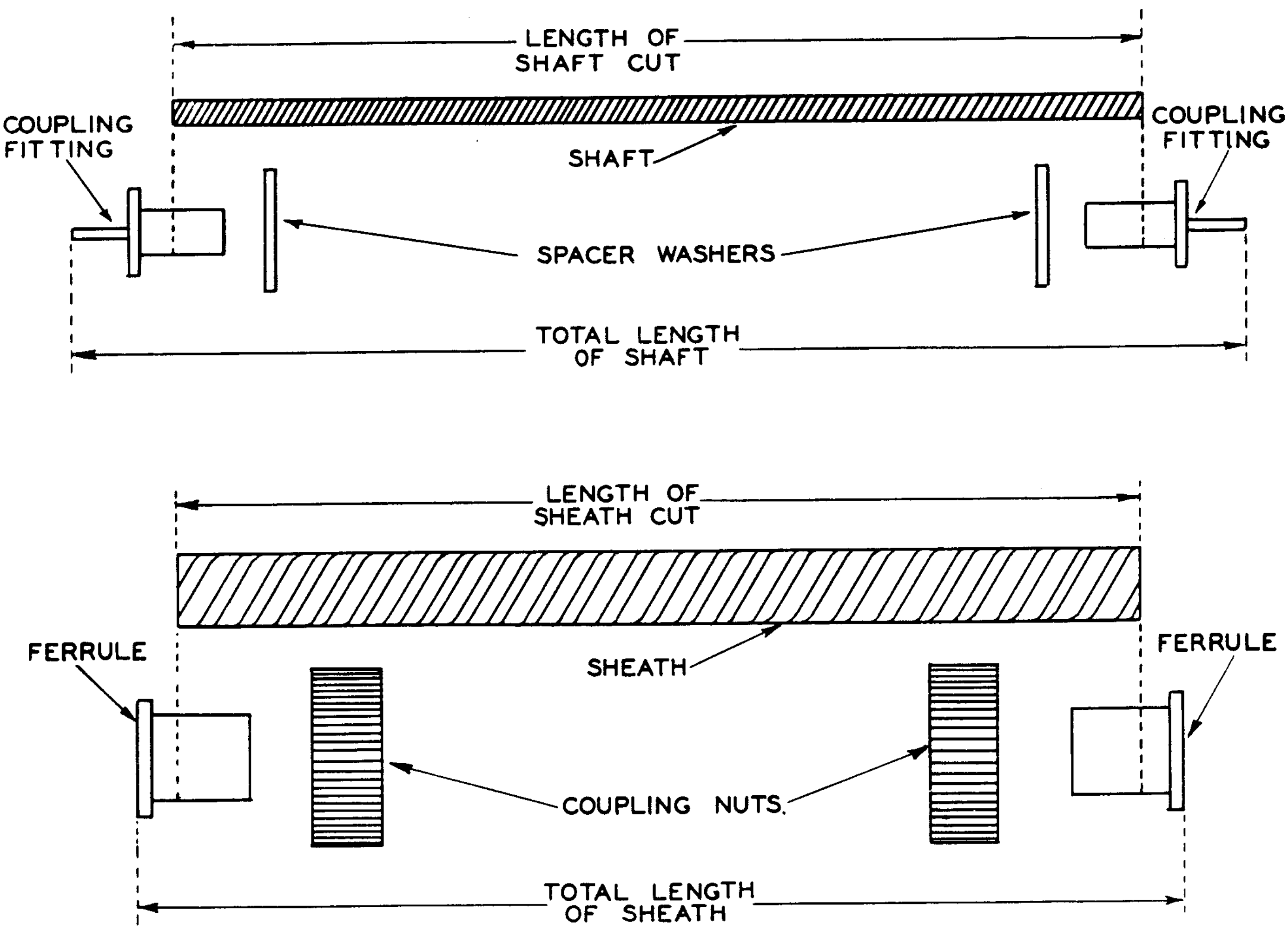


FIGURE 29. PROCEDURE FOR FABRICATING REMOTE TUNING CABLES

shaft, and insert the shaft into the coupling fitting.

(11) Swage or solder the fitting to the shaft. With a file remove any rough spots, to prevent binding of these parts against the sheath.

(12) With the shaft in the sheath, hold the unfinished end of the shaft, and roll up the sheath. This extends the unfinished end of the shaft a few inches from the end of the sheath.

(13) Repeat steps (10) and (11) on the unfinished end of the shaft, and unroll the cable.

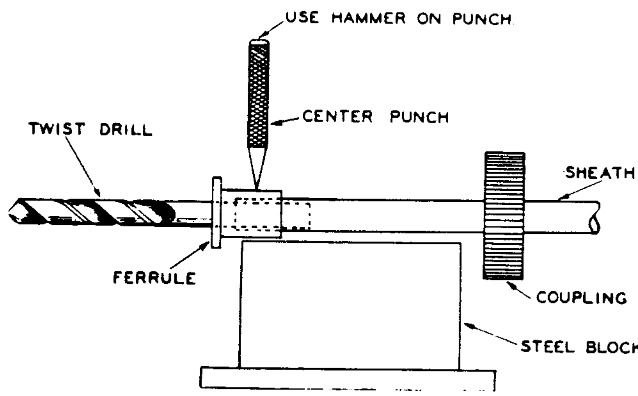


FIGURE 30. METHOD OF CRIMPING FERRULE TO SHEATH

JUNCTION BOXES

JUNCTION boxes, widely used as distribution centers for cables, eliminate the necessity for bringing a large number of cables into the various pieces of equipment, and permit shorter cables to be used. At first inspection, junction boxes seem very complicated, but if a few simple steps are followed, they are relatively easy to repair or test. The wires inside the junction boxes are connections between contacts of connectors on the outside of the box, or in certain cases, make connections to matching transformers inside the junction box. Most junction boxes are assembled with enough slack in the connections to allow the connector to be loosened and pulled out far enough for either repair or replacement. This slack is tied up in the junction box to prevent vibration of the wires, but the cord which holds it may be cut, and, if the connector screws have been removed, the connector may be pulled out to the extent of the slack.

The following procedure is recommended when repairing or making changes in a junction box:

(1) Visually inspect junction box for damages, and remove cover.

(2) Remove screws holding connector which is to be repaired or changed.

(3) Cut cord holding wires for that connector.

(4) Pull connector out from box so that wires and terminals are exposed.

(5) Check wiring diagram for proper connections.

(6) Make necessary repair or replacement.

(7) Replace connector and lace wires neatly and firmly in their original position.

(8) Replace cover on junction box.

SECTION III

Connectors and Fittings

THE following material contains a description of connectors most often used in aircraft radio installations. The description is confined to general types of connectors, as the major difference between individual connectors of the same type is only in the number and location of the terminal pins. For example, AN-3102-18-5P, AN-3102-20-1P, etc., are considered as one general type and designated here as AN-3102-( ), the parentheses indicating that various numbers and letters may follow the type number, AN-3102. The figures show the order in which the individual parts of the connector are assembled to the cable. Lay the parts of the connector on the workbench in the same position as shown in the figure for that connector; then, starting with the part furthest to the right, assemble them onto the cable in the sequence indicated.

Information is also given on the removal of insulation, and the preparation of the wire for each type of connector.

USING ARMY-NAVY NUMBERS

THERE are two standardized receptacle styles: The AN-3100 for wall mounting, and the AN-3102 for box mounting. Both types have internal threads and an internal polarizing key. Either pin inserts or socket inserts may be used.

There are two standardized plug styles: The AN-3106, which is a straight plug, and the AN-3108, a right-angle plug. These plugs have a knurled coupling ring and a key slot, and are designed to fit the corresponding size receptacle. Either pin inserts or socket inserts may be used.

The inserts referred to are the assembled contacts and insulation. Pin inserts have exposed male contacts, designated by the suffix letter P; socket inserts have enclosed female contacts, designated by the suffix letter S. In most cases there is a variety of types of inserts for each receptacle or plug size, these types differing in number, size, and arrangement.

Ferrules are used to form end fittings for flexible conduits to connect them to plugs or other fittings. There are three types of ferrules: the AN-3050, required when a normal size plug is used with a given conduit; the AN-3051, a one-step ferrule with a larger flange, used to connect the next larger size plug to a given size conduit; and the AN-3052, a two-step ferrule with a still larger flange, used when the plug is two sizes larger than the conduit. Thus, the type of ferrule used is determined by the size of the conduit and connector with which it is used. In the case of ferrules, the second number (following the second dash) refers to the inside diameter, in sixteenths of an inch, of the conduit which it will fit. For example, ferrule AN-3050-8 would be used for a ½″ conduit; ferrule AN-3050-12 would fit ¾″ conduit.

The reference chart, page 36, shows, in the first column, the normal size conduit used with the plugs shown in the second column. The third column shows the size of fittings, such as coupling nuts, cable clamps, etc., and the regular AN-3050 type of ferrule, which will fit the plugs in the second column. The fourth column gives the size plug which can be used with a one-step ferrule (AN-3051), with the conduit in the first column. The fifth column shows the size plug which can be used with a two-step ferrule (AN-3052), with the conduit size shown in the first column. For example, line four of the chart shows that a ½″ conduit is the normal size for a 16 or 16S plug; the AN-3054-8 is the coupling nut to be used, and AN-3050-8 the size of the regular ferrule or, as shown in the fourth column of line four, a size 18 plug can be used with ½″ conduit, by using an AN-3051-8 ferrule, and, in the fifth column, a size 20 or 22 plug can be used with ½″ conduit, by using an AN-3052-8 ferrule. The coupling nut used in the latter two cases would be determined by the plug used; that is, a size 18 plug would require an AN-3054-10 nut, and a size 20 plug an AN-3054-12 nut. It can be seen from the table that a given size plug can be used with any of three sizes of conduit. An AN-3106-18, for example, can be used with ⅝″, ½″ or ⅜″ conduit, by using the proper ferrule.

The number AN-3106-18-1P is the complete number of a plug with insert. The prefix AN designates an approved Army-Navy type; 3106 shows that it is a straight plug; 18 gives the size of both the plug and insert, that is, 3106-18 is a straight style plug, size 18; the number of the insert is 18-1P, 18 giving the size and 1P giving the type and arrangement of contacts (the suffix letter P designating exposed pins-male). Note that the 1P does not mean that the plug has only one pin; the number of pins is not directly indicated by this number. The particular plug described, AN-3106-18-1P, would fit either an AN-3100-18-1S, or AN-3102-18-1S receptacle.

In the case of coupling nuts and other fittings, the first number designates the kind of fitting and the second number shows the size (in sixteenths of an inch) of the conduit with which it would be used. Thus, AN-3054-4 is a coupling nut and will fit plugs or receptacles *normally* used with $\frac{1}{4}''$ conduit (that is, when regular ferrules, not one-step or two-step, are required).

REFERENCE CHART FOR CONNECTOR AND CONDUIT FITTINGS

CONDUIT SIZE	RECEPTACLE AND PLUG SIZE		FITTING AND REGULAR FERRULE SIZE	AN-3051 ONE-STEP	PLUG TO BE USED	AN-3052 TWO-STEP	PLUG TO BE USED
$\frac{3}{16}$	-8S	-10S*	-3	-3	-12S		
¼	-12S		-4	-4	-14, -14S	-4	-16, 16S
⅜	-14	-14S*	-6	-6	-16, -16S	-6	-18
½	-16	-16S*	-8	-8	-118	-8	-20, -22
⅝	-18		-10	-10	-20, -22	-10	-24, -28
¾	-20	-22	-12	-12	-24, -28	-12	-32
1	-24	-28	-16	-16	-32	-16	-36
1¼	-32		-20	-20	-36	-20	-40
1½	-36		-24	-24	-40	-24	-44
1¾	-40		-28	-28	-44		
2	-44		-32				

* The suffix "S" indicates connectors shorter than those without "S".

AN DESIGNATIONS FOR CONNECTOR AND CONDUIT FITTINGS

AN NUMBER	DESCRIPTION	AN NUMBER	DESCRIPTION
AN-3100	Wall mounting receptacle	AN-3055	Reduction adapter
AN-3102	Box mounting receptacle	AN-3057	Cable clamp
AN-3106	Straight plug with coupling ring	AN-3058	Straight box coupling
AN-3108	90° angle plug with coupling ring	AN-3060	45° box coupling
AN-3050	Regular flexible conduit ferrule	AN-3062	90° box coupling
AN-3051	One-step flexible conduit ferrule	AN-3064	Box connector
AN-3052	Two-step flexible conduit ferrule	AN-3066	Conduit locknut
AN-3054	Coupling nut		

AN-3100-( )

The numbers following the type number designate the connector size (first number), insert arrangement (second number), and type of insert (letter "P" for pin, "S" for socket). For example: AN-3100-18-16S.

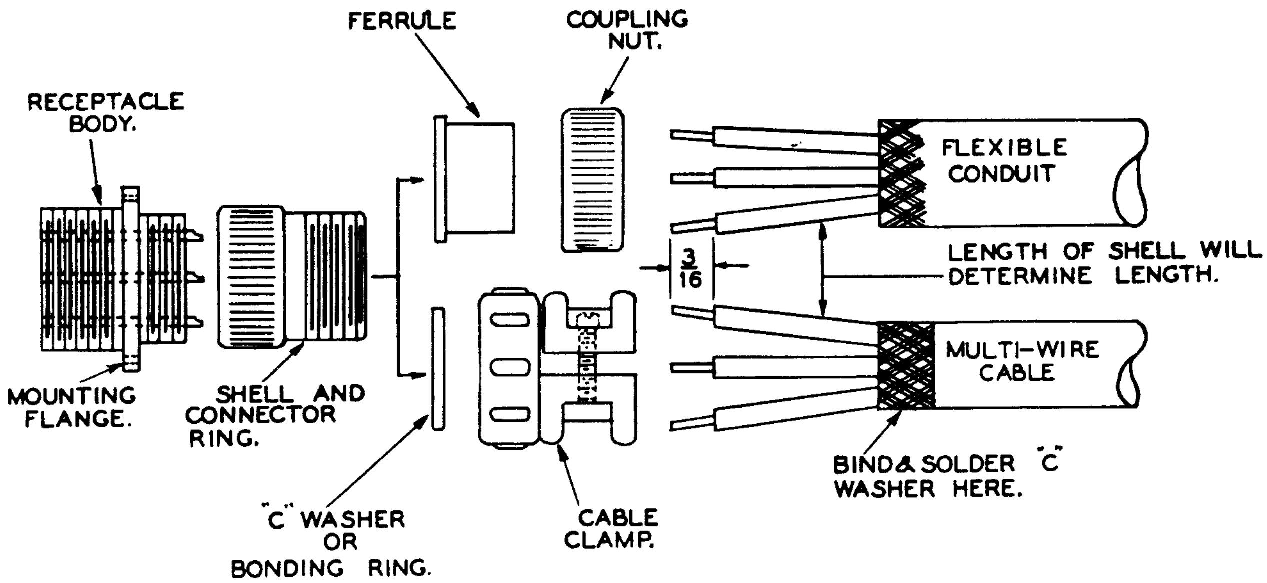


FIGURE 31. ASSEMBLY OF AN-3100( ) CONNECTOR

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.
CONNECTOR	AN-3100-( )	AN-3100-( )	AN-3100-( )	
FERRULE FIXED CONDUIT	AN-3053-( )	AN-3053-( )	AN-3053-( )	
FERRULE FLEXIBLE CONDUIT	AN-3050-( )	AN-3050-( )	AN-3050-( )	
"C" WASHER FOR FLEX. CABLE			AMPHENOL 9767-( ) CANNON 2250-( )	
CABLE CLAMP	AN-3057-( )	AN-3057-( )	AN-3057-( )	
COUPLING NUT	AN-3054-( )	AN-3054-( )	AN-3054-( )	

NOTE

For additional information on the fabrication of cables, refer to page 25 for flexible conduit type, or page 28 for multi-wire type.

AN-3102-( )

The numbers following the type number designate the connector size (first number), insert arrangement (second number), and type of insert (letter "P" for pin, "S" for socket). For example: AN-3102-20-16P.

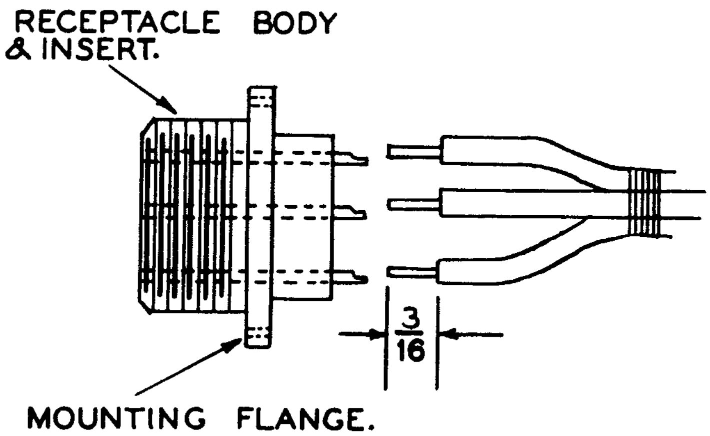


FIGURE 32. ASSEMBLY OF AN-3102( ) CONNECTOR

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.
CONNECTOR	AN-3102-( )	AN-3102-( )	AN-3102-( )	
FERRULE FIXED CONDUIT	AN-3053-( )	AN-3053-( )	AN-3053-( )	
FERRULE FLEXIBLE CONDUIT	AN-3050-( )	AN-3050-( )	AN-3050-( )	
"C" WASHER FOR FLEX. CABLE			AMPHENOL 9767-( ) CANNON 2250-( )	
CABLE CLAMP	AN-3057-( )	AN-3057-( )	AN-3057-( )	
COUPLING NUT	AN-3054-( )	AN-3054-( )	AN-3054-( )	

NOTE

For additional information on the fabrication of cables, refer to page 25 for flexible conduit type, or page 28 for multi-wire type.

AN-3108-( ) — AN-3106-( )

The numbers following the type number designate the connector size (first number), insert arrangement (second number), and type of insert (letter "P" for pin, "S" for socket). For example: AN-3108-12-5S.

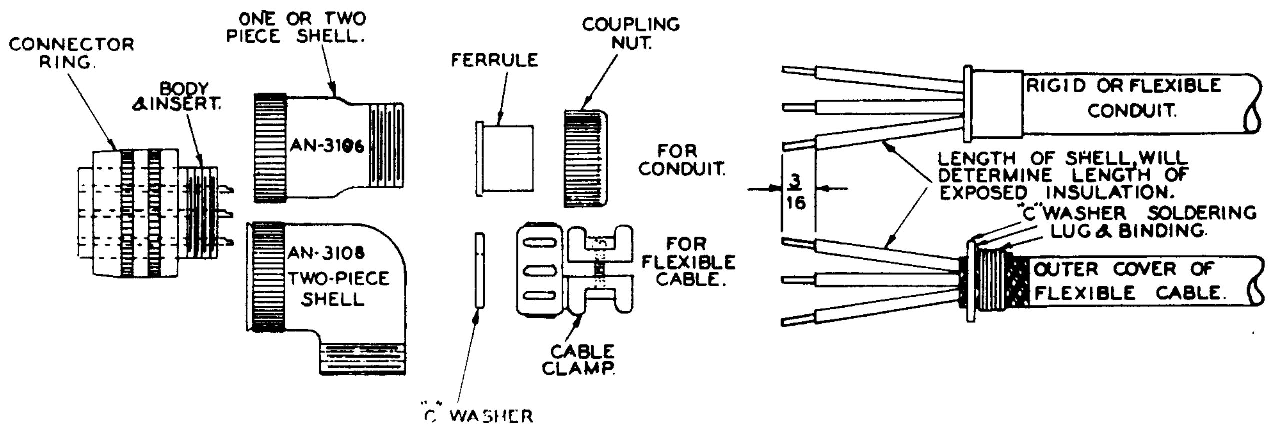


FIGURE 33A. ASSEMBLY OF AN-3108( ) AND AN-3106( ) CONNECTORS

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.
CONNECTOR	AN-3108-( )	AN-3108-( )	AN-3108-( )	
FERRULE FIXED CONDUIT	AN-3053-( )	AN-3053-( )	AN-3053-( )	
FERRULE FLEXIBLE CONDUIT	AN-3050-( )	AN-3050-( )	AN-3050-( )	
"C" WASHER FOR FLEX. CABLE			AMPHENOL 9767-( ) CANNON 2250-( )	
CABLE CLAMP	AN-3057-( )	AN-3057-( )	AN-3057-( )	
COUPLING NUT	AN-3054-( )	AN-3054-( )	AN-3054-( )	

SPECIAL INFORMATION

When the types of connectors designated above are used on a coaxial cable only, use the following procedure in conjunction with the information given on page 30, item 8:

(1) Slide clamp onto cable, then fasten "C" washer to braid with soldering lug.
(2) Bend "C" washer horizontal so that shell passes over it.
(3) Slip shell onto cable, and solder inner conductor to contact.
(4) Slip shell back over "C" washer, and screw onto plug body.
(5) Bend "C" washer back to vertical position, and screw clamp onto shell.
(6) Tighten clamping screws.

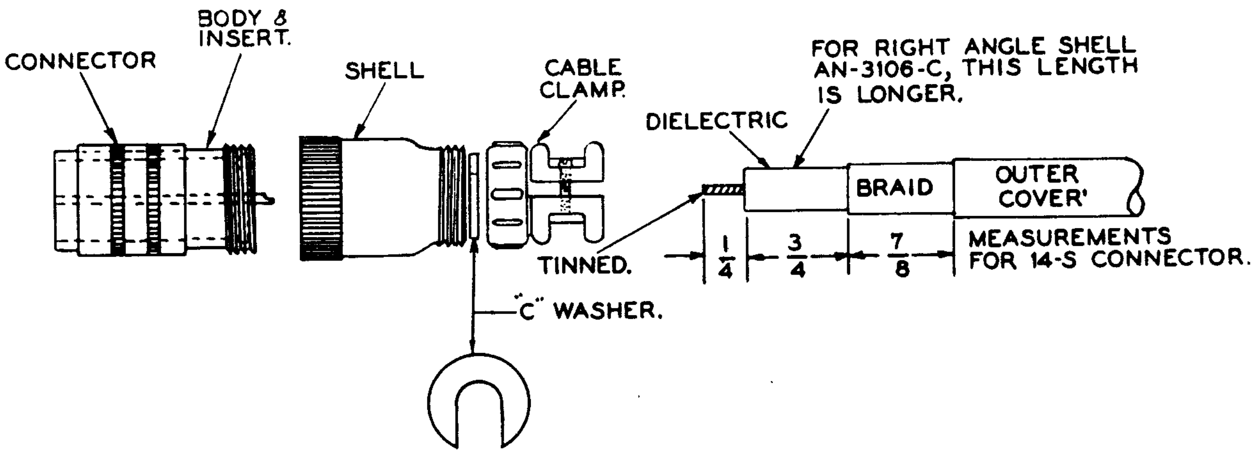
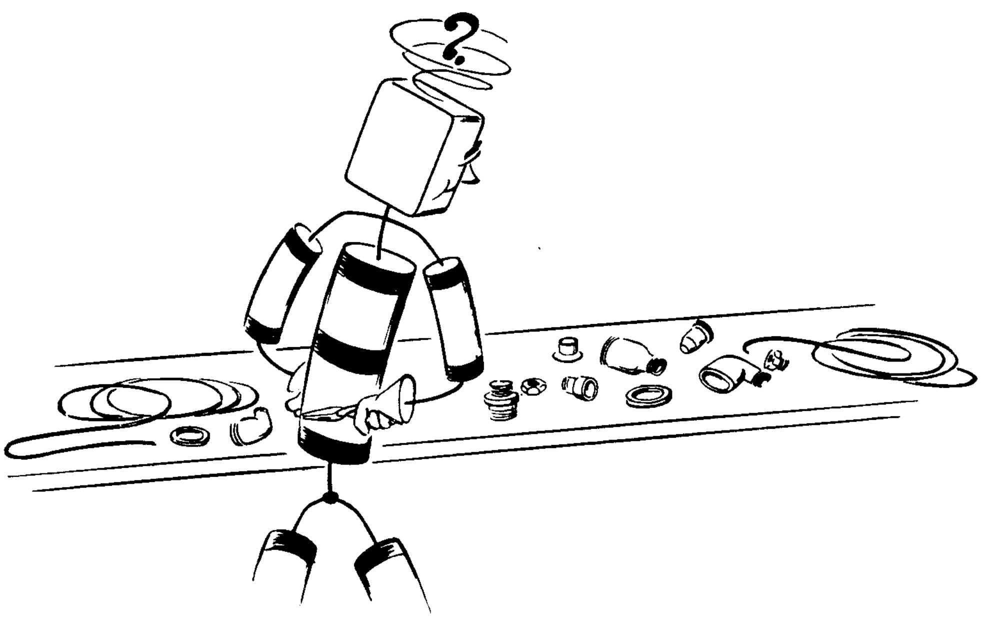


FIGURE 33B. SPECIAL ASSEMBLY OF AN-3108( ) AND AN-3106( ) CONNECTORS WHEN USED WITH COAXIAL CABLE



93C (MW)

STRAIGHT COAXIAL PLUG CONNECTOR

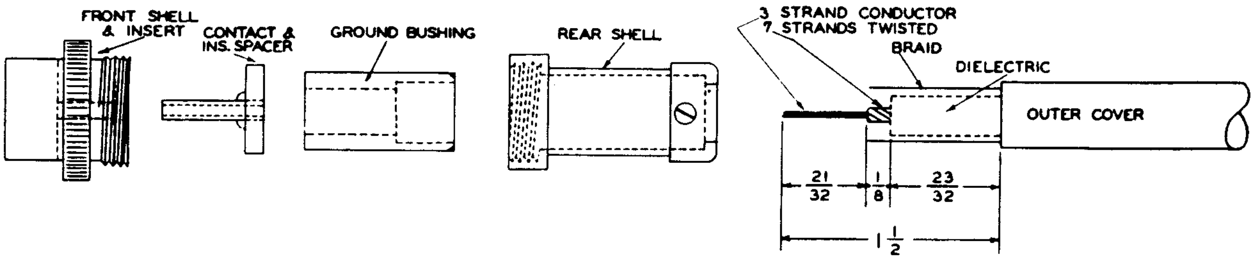


FIGURE 34. ASSEMBLY OF 93C(MW) CONNECTOR

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.	PHILCO No.
CONNECTOR			AMPHENOL 93C(MW)		358-4208

SPECIAL INFORMATION

NOTE

Do not prepare cable like sketch in advance. Follow the steps below.

(1) Cut off coaxial outer cover 1½″ from end of cable.
(2) Cut off braid and dielectric and all but three strands of inner conductor 21/32″ back from end.
(3) Twist and tin the three strands of conductor.
(4) Slip rear shell over cable and push ground bushing onto braid and outer cover, so that outer cover is against shoulder inside ground bushing.
(5) Turn out braid extending in front of bushing and solder to face of bushing, then file flat.
(6) Cut off dielectric flush with face of bushing.
(7) Place contact and insert spacer conductor with spacer up against bushing and dielectric.
(8) Solder conductor in contact and reassemble connector.
(9) Tighten set-screw in rear shell against ground bushing.

For additional information on coaxial cable fabrication, refer to page 29.

MC-277 — MC-320

BRITISH-TYPE COAXIAL CONNECTORS

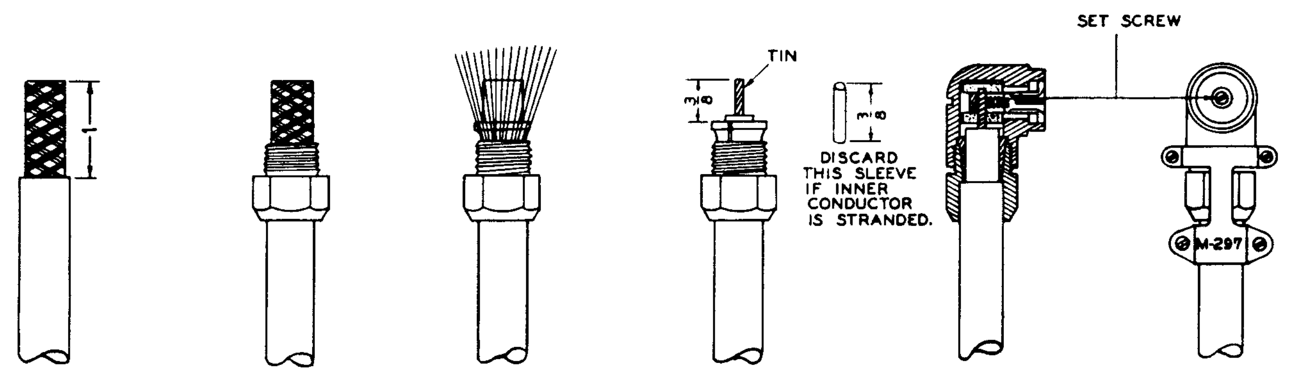


FIGURE 35. ASSEMBLY OF MC-277 AND MC-320 CONNECTORS

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.	PHILCO No.
CONNECTOR	NAF-47848-1 NAF-47848-2	MC-277 MC-320	AMPHENOL 46-Q5-151 46-Q5-255	10H-701 Type 213 10H-529 Type 187	358-1381 358-1308
CABLE CLAMP	NAF-311145-1	M-297	46-238	10H-1774	358-2419

SPECIAL INFORMATION

(1) Prepare cable as shown in drawing, then force hexagonal compression nut onto cable.
(2) Slit shield with scissors and slip split sleeve onto dielectric.
(3) Using vise, force split sleeve into compression nut.
(4) Trim off braid wires even with threads.
(5) Remove set-screw in socket of connector with a 3/32" screwdriver, allowing inner sleeve to drop out.
(6) If coaxial inner conductor is solid wire, sweat-solder this sleeve onto end of conductor. If coaxial inner conductor is stranded, discard the sleeve, twist strands tightly together and tin.
(7) Screw compression nut and cable into plug body, making sure the inner conductor goes into the sleeve hole. In screwing up this compression nut with the split sleeve forced in place, chips of metal will be cut from the threads by the sleeve and cause trouble if not removed. Disassemble connector completely, including the polystrene spacer and washer, and remove all such chips. Reassemble parts and line up screw holes in polystrene spacer and washer.
(8) Replace and tighten set-screw in socket against inner conductor and apply cable clamp. Use 3/32" screwdriver or No. 4 Allen wrench, according to type set-screw used.

For additional information on the fabrication of coaxial cables, refer to page 29.

TYPE "N"

COAXIAL CONNECTOR

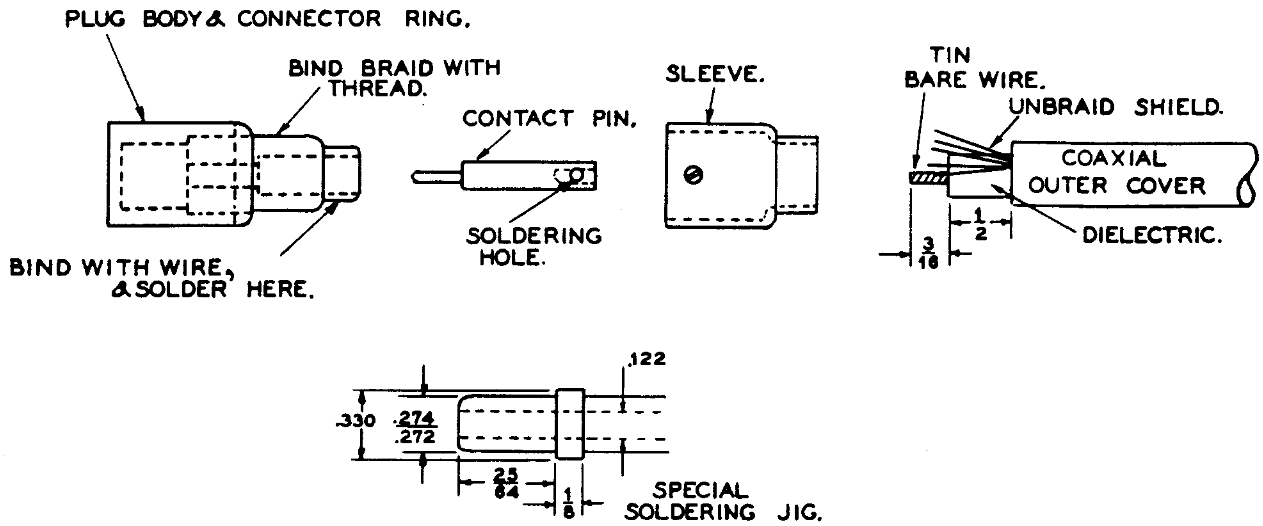


FIGURE 36. ASSEMBLY OF TYPE "N" CONNECTOR

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.	PHILCO No.
CONNECTOR	49218	TYPE "N"	UCINITE		358-3513

SPECIAL INFORMATION

(1) Prepare cable as shown in drawing, and slip sleeve over cable.
(2) Unbraid shield, and push wires back out of way.
(3) Remove contact pin from plug body and force coaxial inner conductor into hole in end of pin, up to dielectric.
(4) Solder conductor into pin through hole in pin.
(5) Push cable and contact into plug body until dielectric is against body insulator. (The special jig, shown in drawing, must be pushed into connector, over contact pin, to maintain proper spacing while the remaining soldering is being done.)
(6) Pull braid up over large part of rear shell, and bind in place with twine or thread. Use size 30 or 32 bare tinned wire to tightly bind the braid down against small part of rear shell.
(7) Solder wire binding to braid and shell and remove twine binding.
(8) Clip off ends of braid wires at shoulder.
(9) Slip sleeve onto plug body and run set-screw into hole in plug shell.

For additional information on the fabrication of coaxial cables, refer to page 29.

80-81

COAXIAL CONNECTOR

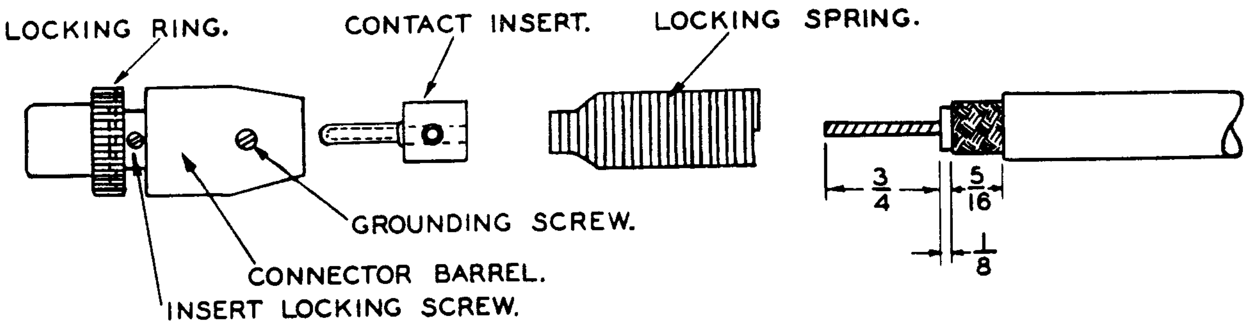


FIGURE 37. ASSEMBLY OF 80-81 CONNECTOR

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.	PHILCO No.
CONNECTOR			AMPHENOL 80-81		358-3107

SPECIAL INFORMATION

(1) Loosen set-screws and disassemble connector.

(2) Slip spring guard over cable and solder to braid so that $\frac{1}{8}''$ of dielectric extends beyond spring and braid.

(3) Slip connector barrel over cable and feed conductor through hollow pin till dielectric touches right edge of contact insert.

(4) Solder conductor in hollow pin at tip.

(5) Reassemble connector, tightening front set-screw into hole in contact insert and rear set-screw firmly against spring guard.

For additional information on the fabrication of coaxial cables, refer to page 29.

BRITISH-TYPE MULTI-PIN

SOCKET TYPE—STRAIGHT (P), RIGHT-ANGLE (Q) OR OPEN WIRING (W)

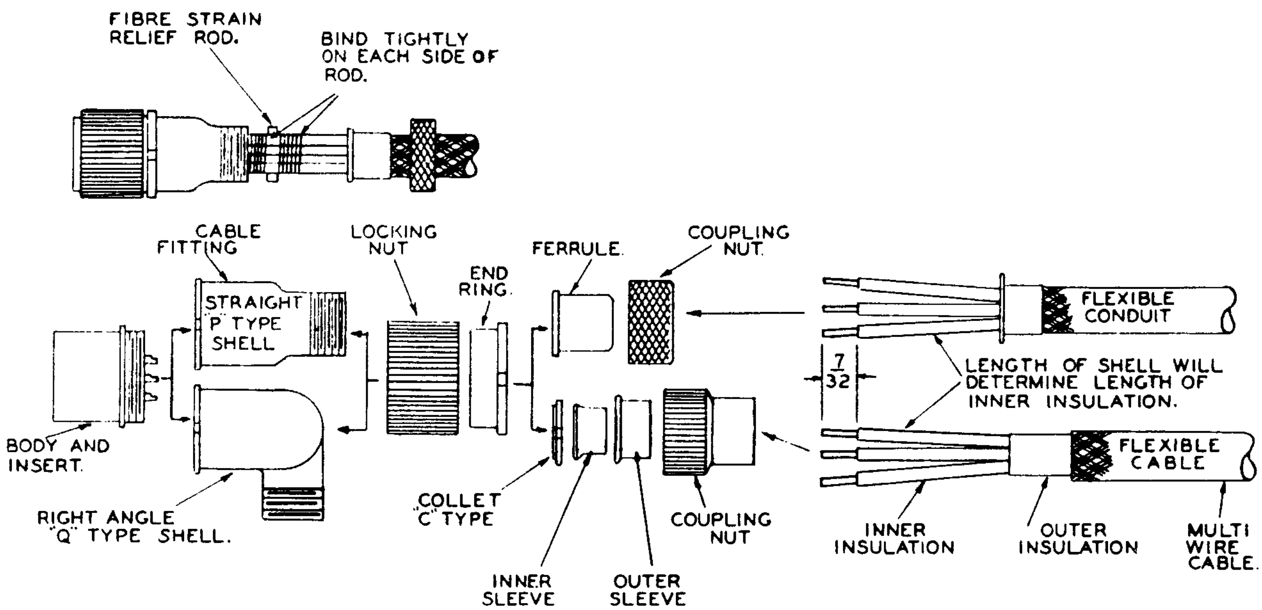


FIGURE 38. ASSEMBLY OF BRITISH-TYPE MULTI-PIN CONNECTORS

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.
CONNECTOR		PL-P ( ) STR. PL-Q ( ) R-A. PL-( ) OPEN	AMPHENOL 46-P, Q or W (Size No.), insert fitting type	W-( )
FERRULE FIXED CONDUIT			46-( )	
FERRULE FLEXIBLE CONDUIT			46-( )	
"C" WASHER FOR FLEX. CABLE			46-183 for 2L 46-188 for 3L	9888-6 for 2L 9258-MKA for 3L
CABLE CLAMP				
COUPLING NUT			46-204, 205, 208, 191, 182, 207, 181, 206	92-93-2 9640-2

RESTRICTED

SPECIAL INFORMATION

a. When these connectors are used with flexible conduit cables:

(1) Slide coupling nut onto flexible conduit. Push ferrule over end of conduit and solder in place.
(2) Slide end ring and locking nut onto conduit in the order shown in the drawing.
(3) Run wires through cable fitting (shell) and solder to contacts in connector body.
(4) Bring locking nut and end ring back over cable fitting (shell) and screw to connector body.
(5) Insert a fibre strain relief rod between wires and wrap wires on each side of rod with twine, keeping strain relief rod as close to end of cable fitting (shell) as possible. (Rod must be of correct length and diameter to fit slots in cable fitting.)
(6) Fit strain relief rod into slots in cable fitting (shell) and tighten coupling nut.

For additional information on the fabrication of flexible conduit cables, refer to page 25.

b. When these connectors are used with multi-wire type cables:

(1) Prepare conductors as shown in drawing.
(2) Slip coupling nut and outer sleeve over cable. Push inner sleeve under cable shielding as far as shoulder. Press outer cable sleeve back over inner sleeve and shielding.
(3) Run wires of cable through collet, end ring, locking nut, and cable fitting (shell) in order stated. Then solder wires to contacts in connector body.
(4) Place locking ring, cable fitting (shell), and end ring in position and tighten coupling nut.

For additional information on the fabrication of multi-wire cables, refer to page 28.

PL-259

COAXIAL CONNECTOR

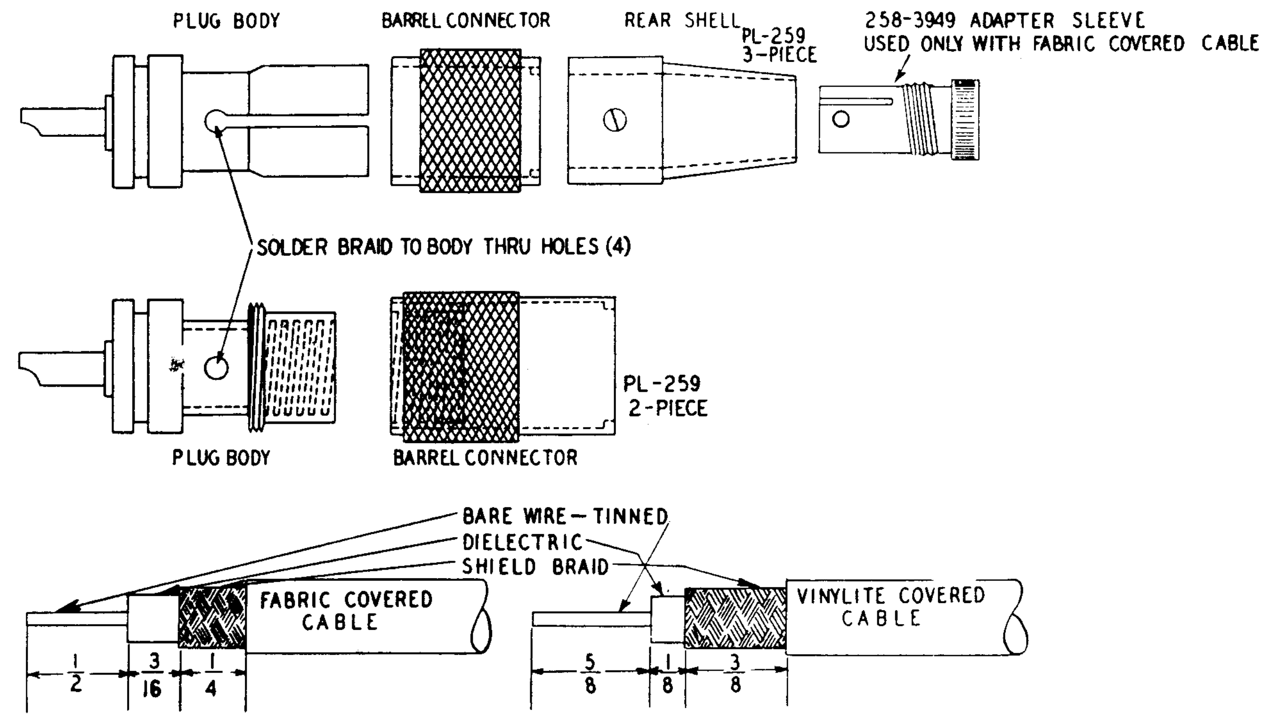


FIGURE 39. ASSEMBLY OF PL-259 CONNECTOR

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.	PHILCO No.
CONNECTOR	CPN-49195	PL-259	AMPHENOL 83-1SP		358-3124

SPECIAL INFORMATION

(1) After preparing cable as in figure 39, assemble connector parts on cable in order shown in drawing. (The coaxial cable will usually have to be screwed into plug body, as the plug body is threaded inside, to take a firm grip on the outer cover of the cable. If fabric-covered cable is used, the adapter sleeve must be used because of the smaller diameter cable.

(2) Using a soldering iron with a special small tip, solder braid through body holes. (See figure 27, page 30.)

(3) When solder has hardened, slide (or screw) the barrel connector over plug body up to shoulder.

(4) Force rear shell of the three-piece plug onto body as far as it will go, or to within 1/32" of barrel connector, and tighten set-screw firmly. The two-piece plug has no rear shell.

For additional information on the fabrication of coaxial cables, refer to page 29.

PL-P173

BRITISH-TYPE COAXIAL CONNECTOR

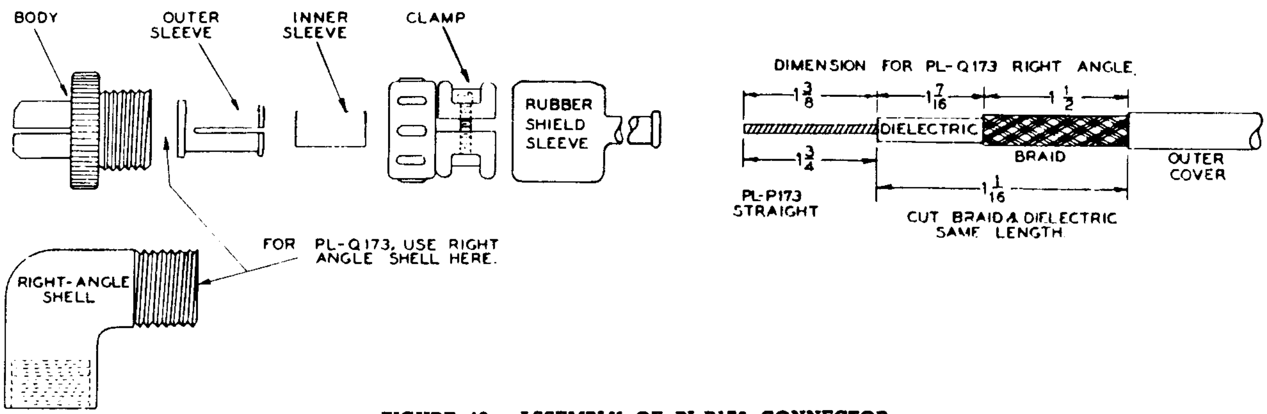


FIGURE 40. ASSEMBLY OF PL-P173 CONNECTOR

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.	PHILCO No.
CONNECTOR		PL-P173	46-P6	110H-584 Type 156	

SPECIAL INFORMATION

(1) With cable stripped as shown in figure 40, push rubber sleeve and cable clamp onto cable.
(2) Push small inner sleeve over shield braid down to outer cover.
(3) Split braid down to left edge of inner sleeve.
(4) Roll braid back over inner sleeve.
(5) Push outer sleeve over inner sleeve and coaxial outer cover, until it is flush with end of inner sleeve.
(6) Insert cable into body of connector, with conductor extending through contact.
(7) Screw cable clamp onto connector and tighten clamping screws.
(8) Solder conductor to front of contact and slip rubber guard over cable clamp.

For additional information on the fabrication of coaxial cables, refer to page 29.

PL-176

PLASTIC SINGLE-CONTACT SOCKET CONNECTOR

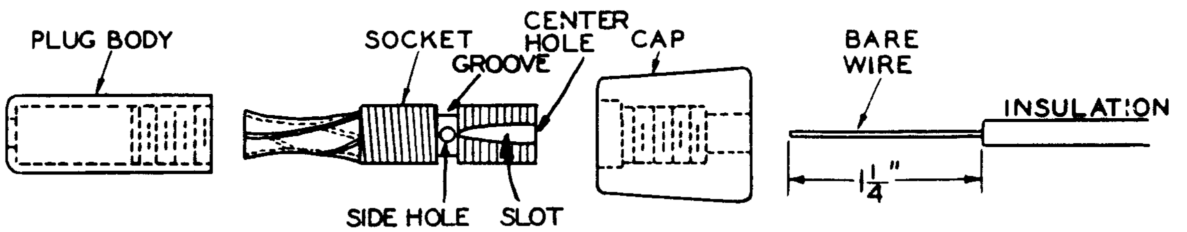


FIGURE 41. ASSEMBLY OF PL-176 CONNECTOR

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.	PHILCO No.
CONNECTOR	NAF-68925-5	PL-176	UCINITE		358-1244

SPECIAL INFORMATION

(1) Strip off approximately $1\frac{1}{4}$" of insulation and leave bare wire untinned.
(2) Slide cap over wire and insert about half the length of bare wire through hole in center of socket, then bend both parts of the bare wire up into the grooves on each side of the threaded section.
(3) Screw cap onto socket firmly. The cap will hold the wire in firm contact with the socket.
(4) Screw plug body firmly onto other threaded section of socket.

PL-180

MULTI-PIN PLASTIC CONNECTOR

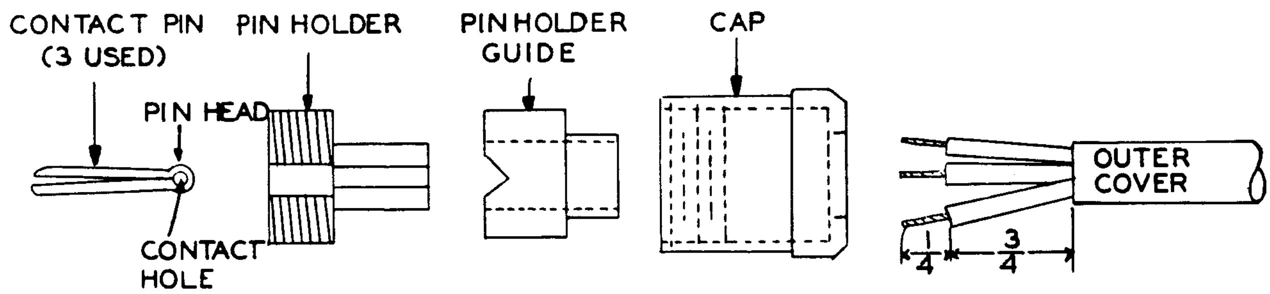


FIGURE 42. ASSEMBLY OF PL-180 CONNECTOR

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.	PHILCO No.
CONNECTOR		PL-180	JONES		358-1241

SPECIAL INFORMATION

(1) Disassemble connector by holding contact pins in one hand and unscrewing cap from pin holder with the other hand.

(2) Slide cap and pin-holder guide onto cable in order stated.

(3) Strip each conductor as shown above, and carefully solder to contacts. The wire must enter contact hole from the side; winding it around the end would make the pin head larger, and the tolerances inside the connector are too close for enlarged pin heads.

(4) Place each contact pin in its proper slot in pin holder. Push pinholder guide onto pinholder and screw cap into place over pin holder.

(5) As cap is being screwed on, make sure that each contact pin head is in a recess in pin-holder guide. Screw cap down firmly.

For additional information on fabrication of multi-wire cables, refer to page 28.

PL-178 — PL-181 — PL-182 — PL-183 — PL-265

MULTI-PIN PLASTIC CONNECTORS

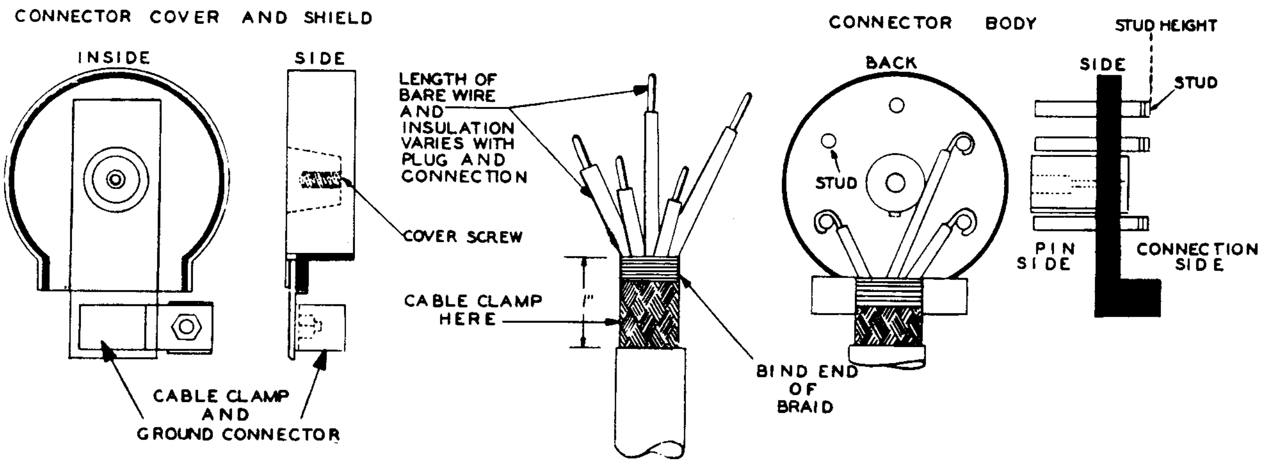


FIGURE 43. ASSEMBLY OF PL-178, PL-181, PL-182, PL-183, AND PL-265 CONNECTORS

NO. OF PRONGS	TYPE	UCINITE No.	SIG. CORPS No.	NAVY No.	BRITISH No.	PHILCO No.
3	Male	118006	PL-178	NAF-69041-1	10H/262	358-1242
5	Male	118008	PL-181	NAF-68925-3	10H/254-B	358-1252
7	Male	118109	PL-182	NAF-68925-2	10H/258-B	358-1250
7	Female	118010	PL-183	NAF-68925-1	10H/256-B	358-1251
5	Female	118018	PL-265	NAF-47908-1	10H/13079	358-1357

SPECIAL INFORMATION

(1) Disassemble plug by removing cover screw in keyway on pin side of connector, and remove cable-clamp locking screw and nut.

(2) After cable is prepared for type of connector desired, make good mechanical and soldered connections to studs, carefully keeping wires below stud height and clear of other studs and center screws.

(3) Be sure connector cover is clean. Place cable clamp around braid and reassemble cover and clamp. Do not run cover screw in too tight, or plastic threads may be damaged.

(4) Fasten one end of a bonding jumper, for grounding the cable to the body of the device used with the connector, to cable-clamping nut.

For additional information on the fabrication of multi-wire cables, refer to page 28.

CN-49121

STRAIGHT COAXIAL CONNECTOR

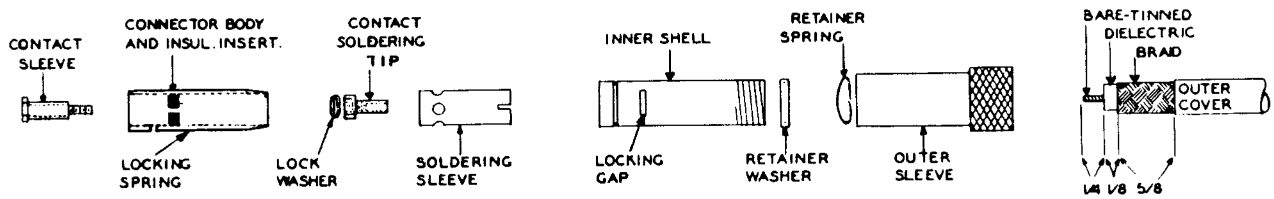


FIGURE 44. ASSEMBLY OF CN-49121 CONNECTOR

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.	PHILCO No.
CONNECTOR	CN-49121		National Elec. Mach. Shops, Inc. 49121		258-3043

SPECIAL INFORMATION

(1) Strip coaxial cable to dimensions shown in the drawing.
(2) Slip outer sleeve, retainer spring, retainer washer, and inner shell onto cable, in order given.
(3) Slip soldering sleeve over braid and force under coaxial outer cover till left end of sleeve is flush with end of braid.
(4) Solder sleeve to braid through soldering holes.
(5) Remove contact soldering tip from connector body by unscrewing contact sleeve.
(6) Tin bare inner conductor and inside of contact soldering tip, then sweat solder tip onto inner conductor.
(7) Slip connector body onto cable and screw contact sleeve to soldering tip. Hold soldering tip firmly with small wrench or long-nose pliers and turn contact in firmly.
(8) Solder sloping end of connector body to soldering sleeve.
(9) Push inner shell onto connector body until locking spring slips into gap in inner sleeve.
(10) Push retainer washer and retainer spring up against end of inner shell. Slip outer sleeve up and screw it onto inner shell.

For additional information on the fabrication of coaxial cables, refer to page 29.

M. I. T. TYPE "A"

SPECIAL HIGH-VOLTAGE CONNECTOR

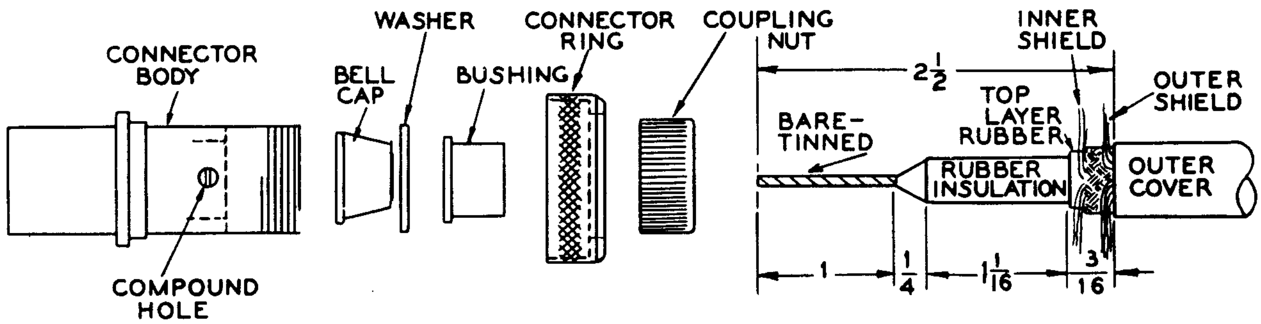


FIGURE 45. ASSEMBLY OF M.I.T. TYPE "A" CONNECTOR

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.	PHILCO No.
CONNECTOR			CINCH		358-5009

SPECIAL INFORMATION

(1) After cable is cut to correct length, slip on small coupling nut, large connector ring, and bushing, in order mentioned.
(2) Strip off outer cover 2½" from end.
(3) Unbraid outer shield back to outer cover and slip washer onto cable, forcing it against outer shield wires.
(4) Hold bushing and washer tightly together and trim braid wires down to edge of washer. Washer is not soldered to braid.
(5) Trim off cotton covering between shields and unbraid inner shield down to washer.
(6) Cut top layer of rubber off 3/16" from washer and scrape bottom layer of rubber insulation to remove residue.
(7) Place bell cap on cable and under inner shield, pushing it back to washer.
(8) Bring inner shield braid wires down onto sloping shoulder of bell cap and bind tightly with several turns of #30 bare tinned wire.
(9) Solder binding, inner shield wires, and bell cap together. Trim off shield wires down to binding. Clean joint with alcohol to remove rosin and flux.
(10) Strip off all insulation 1" from end of cable, then taper end of insulation for ¼".
(11) Clean and tin bare conductor.
(12) Place connector body on cable, slide connector ring onto connector body, and screw coupling nut onto connector body, pulling all parts into place.
(13) Clip off excess wire protruding through center contact and flow solder well into hole in center contact. Round solder with razor blade or small file.
(14) Remove one screw from side of connector and fill connector completely with Anaconda black Super-Seal Compound #150. The compound should be heated in an oil can till it runs freely. Support oil can a few inches above the connector hole and pour compound in freely (do not squirt) until compound overflows. It may be necessary to heat the connector to get best results.
(15) Replace screw and clean off excess compound with alcohol.
(16) Test cable for short circuits and breakdown at 10,000 volts.

358-2966 SPECIAL

SPECIAL CONNECTOR AND CABLE ASSEMBLY No. 358-2966
PROBE CABLE CPR-14AAO OF OAK EQUIPMENT AND
ANTENNA CABLE CYT-66ADL OF OAJ EQUIPMENT
(THREE LENGTHS: 11 FT.—358-3340, 20 FT.—358-2982, 22 FT.—358-3341)

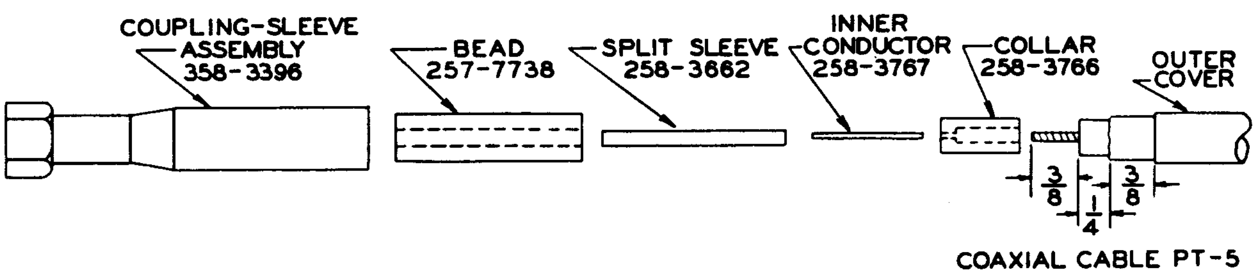


FIGURE 46. ASSEMBLY OF SPECIAL CONNECTOR FOR CABLE ASSEMBLY No. 358-2966

SPECIAL INFORMATION

(1) Tin-dip the bare conductor.
(2) Position collar on conductor and solder through small holes in side of collar near the end.
(3) Insert inner conductor in collar and solder securely.
(4) Open up one end of split sleeve with a pointed pick and position the sleeve on the inner conductor so that outer end of split sleeve is $1\frac{15}{32}''$ from the collar, then solder sleeve to inner conductor.
(5) Position the bead on the split sleeve up against the collar.
(6) Spread cement (70156) over outside of bead.
(7) Position coupling-sleeve assembly over the partly completed assembly above and solder to the copper shielding through the four holes.
(8) Test the connector for continuity and breakdown.
(9) Contact sleeve should come to within $\frac{1}{32}''$ of the front end of the connector.
(10) Completed, cable CPR-14AAO should be 5 ft. ± 1″, from ferrule to ferrule. See page 39 for assembly of AN-type connector on other end of cable.
(11) ±1″ tolerance applies to cable CYT-66ADL also. (Lengths given in heading above.)

D165645 SPECIAL

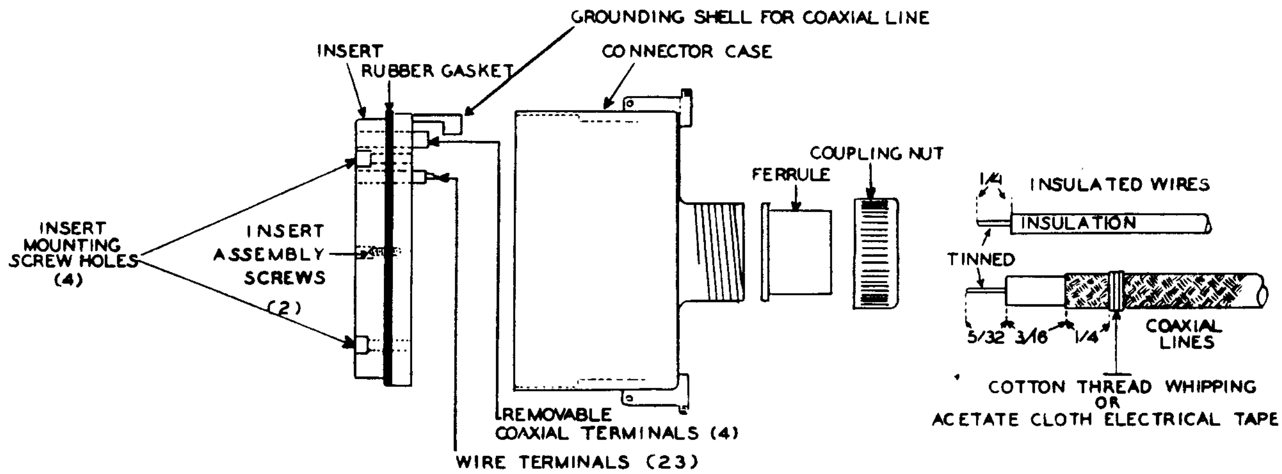


FIGURE 47. ASEMBLY OF D165645 SPECIAL CONNECTOR

SPECIAL CONNECTOR D165645

	NAVY No.	SIG. CORPS No.	MFG'R. No.	BRITISH No.	PHILCO No.
CONNECTOR			UCINITE D165645		358-5097

SPECIAL INFORMATION

(1) Slip coupling nut and ferrule onto flexible conduit and crimp ferrule in place.
(2) Run all conductors through connector case and prepare each conductor, as shown in diagram above.
(3) Slip $1\frac{1}{8}''$ strips of plastic tubing over each conductor and push back out of way.
(4) Solder all insulated wire conductors to their proper contacts.
(5) Solder inner conductors of coaxial lines into coaxial terminals and push terminals into body of insert terminals butt against shoulders in insert.
(6) Slip braided shield of each coaxial line over shell of each coaxial terminal which extends outside of insert, and solder all around.
(7) Do not bend coaxial lines till dielectric has cooled and hardened. Remove all sharp edges from shield or solder.
(8) Slip plastic tubing over soldered joints.
(9) Screw insert into place in case, then screw coupling nut onto case.

358-2967 SPECIAL

SPECIAL CONNECTOR AND CABLE ASSEMBLY No. 358-2967
FLEXIBLE R-F TEST LINE ON OAK. STANDING WAVE
CHECKING EQUIPMENT

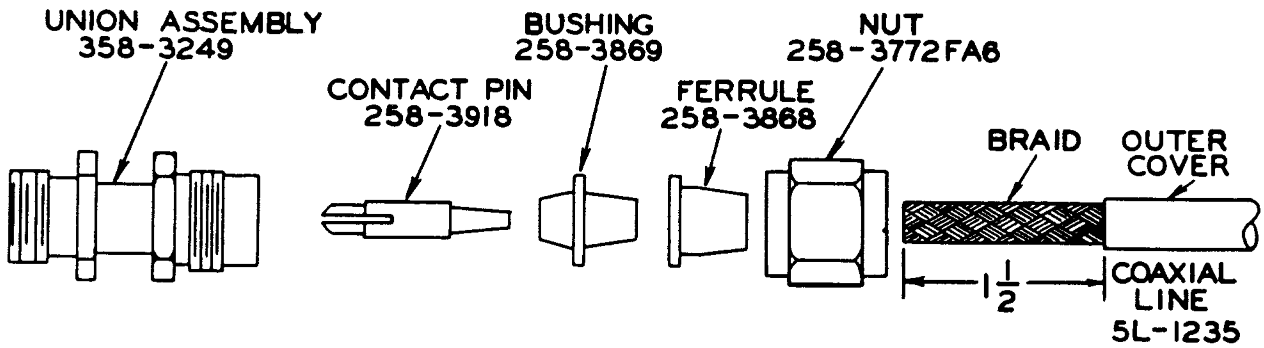


FIGURE 48. ASSEMBLY OF SPECIAL CONNECTOR FOR CABLE ASSEMBLY No. 358-2967

SPECIAL INFORMATION

(1) Cut coaxial cable, 5L-1235, to length of 37.156", ± ½".
(2) Strip off coaxial outer covering approximately 1½" from end.
(3) Place the connector nut on the cable and follow with the ferrule.
(4) The bushing is placed on the cable, forcing the back shoulder under the outer coaxial covering.
(5) Fan shield-braid and turn back over front slope of bushing and trim braid even with top of slope. After braid is turned back, the front edge of the bushing must be 1.156" from the end of the conductor.
(6) The dielectric is shaved down at a 30° angle, beginning the cut ¼" from the front end of the bushing.
(7) Tin the end of the conductor and sweat the contact pin onto it.
(8) Outer union of connector is now slipped in place against bushing and shield braid, and ferrule forced against back edge of bushing; screw nut onto union firmly.
(9) Space between contact pin and union is filled with Monomeric Styrene and Intelin, up to back shoulder of contact pin.
(10) Contact pin must be square and parallel with union assembly, and the space between the front square shoulder of the contact pin and the back edge of the shoulder on the inside of the union assembly must be .250", ± .005". If necessary the end of the union must be dressed down to this dimension.
(11) The overall length of the cable when finished, should be 41$\frac{9}{16}$", ± 1", from the square shoulder of one contact pin to the other.

RESTRICTED

358-4312 SPECIAL

SPECIAL CONNECTOR AND CABLE ASSEMBLY No. 358-4312
TRANSMITTER CABLE CX-10/CPN-3 FOR
AN/CPN-3 EQUIPMENT

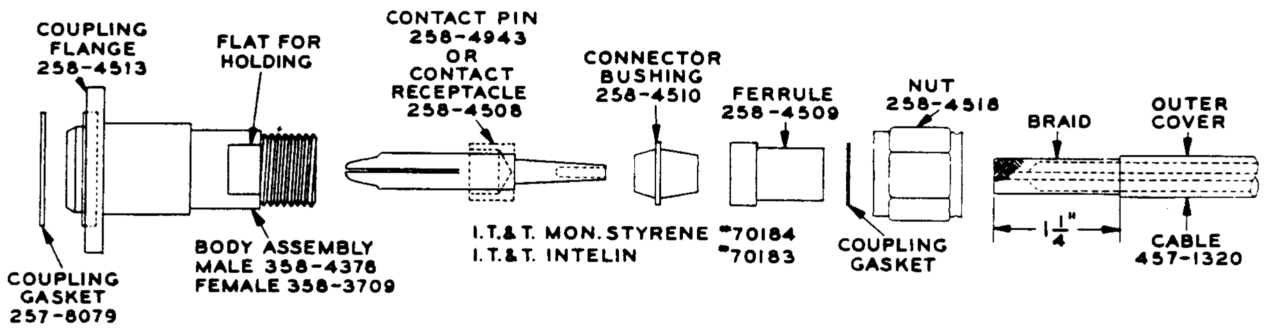


FIGURE 49. ASSEMBLY OF SPECIAL CONNECTOR FOR CABLE ASSEMBLY No. 358-4312

SPECIAL INFORMATION

(1) Cut cable to required length and slip retaining nut, coupling gasket, and ferrule over cable, in order named.
(2) Cut coaxial outer cover back $1\frac{1}{4}$" and strip it off.
(3) Push bushing over metal braid and force leading edge of bushing under outer cover until up to shoulder.
(4) Split braid, turn it back over bushing, and trim so that it goes about two-thirds of distance up to shoulder.
(5) Carefully cut dielectric down to inner conductor, at an angle (like sharpening a pencil), exposing conductor for about half the distance from end of conductor to end of bushing. Be very careful not to nick inner conductor. From end of conductor to shoulder of bushing should be approximately $\frac{7}{8}$".
(6) Insert contact pin on conductor and slide body over assembled parts. Bring up retaining nut with gasket and ferrule and screw it firmly onto body. Position contact pin on inner conductor so exactly $\frac{1}{2}$" of pin extends out in front of body. This distance is critical.
(7) Remove body and solder contact pin on conductor at point previously determined. Reassemble body and retaining nut. This connector depends on pressure between body, bushing, and retaining nut for good contact, so must be tightened securely.
(8) After connector is completely assembled, fill space around back end of the contact pin up to taper shoulder, with Intelin.

For additional information on the fabrication of coaxial cables, refer to page 29.