JP36152

ON-THE-JOB TRAINING PACKAGE

TELEPHONE INSTALLER-REPAIRMAN

PREPARED BY SHEPPARD AIR FORCE BASE , TEXAS

AIR TRAINING COMMAND

NOVEMBER 1958

DEPARTMENT OF THE AIR FORCE

OJT PROGRAM
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FOREWORD

1. Purpose. This program is designed as a guide for supervised training on-the-job for Air Force personnel. Directives and responsibilities for this type of training are set forth in Air Force Regulation 52-2, "On-The-Job Training."

2. Contents. This program contains the OJT Outline and Training Standard, job knowledges, work experiences, references, and guidance to develop the required proficiency in the designated Air Force Specialty (AFS).

3. Recommendations. Recommendations for the improvement of this program are invited. Recommendations should be forwarded to the Commander, Air Training Command, Randolph Air Force Base, Texas.

4. Distribution.

a. Initial distribution requirements are determined and distribution is accomplished in the same manner as for other Air Force publications which receive functional distribution. (See Sections 4 and 7, Chapter 4, AFM 5-4.)

b. Bulk shipment is made to the USAFE distribution depot for distribution within that command. Direct distribution is made to all other installations.

c. Additional copies may be requisitioned in accordance with AF Manual 5-4. An index of OJT Packaged Programs is published quarterly, listing programs that are currently rescinded or superseded, and future programs. Requisitions should be submitted on AF Form 124 to Commander, Wright-Patterson Air Force Base, Ohio, Attn: EWBFW, by the Publications Distribution Officer concerned. Quantities requested should be held to the minimum number necessary to conduct the OJT Programs.

5. Individual Issue. This publication is organizational rather than personal property and is authorized to remain in the personal possession of the individual to whom issued only so long as it is required in the performance of his duties.

BY ORDER OF THE SECRETARY OF THE AIR FORCE:

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DISTRIBUTION: F

This program is a revision of and supersedes OJT Packaged Program JP36152, Telephone Installation Repairman, November 1955.

CONTENTS

INTRODUCTION

Just what is meant by the term "on-the-job" training. The following official definition is from AFR 52-2: "On-the-Job Training is that planned training program designed to qualify a person, through supervised instruction, in the performance of the duties of a given AFS while he is working in a duty assignment of the career field ladder. The training is not on-the-job training unless the airman spends a portion of his time in a productive capacity on the job." This definition, in a few words, sums up the overall mission of the Air Force on-the-job training program.

You must keep certain principles in mind in order to get the most out of this program. Some of these principles are:

* Air Force training will never end; therefore, on-the-job training will always be required.

* Training is your business, my business, everybody's business.

* Your unit mission is paramount. However, your unit mission stands a much better chance of being accomplished efficiently if training is given its proper importance.

* A training program must include the trainer as well as the trainee.

* You cannot apply rigid formulas to different people, different types of training, or different levels of training. A successful program must be flexible.

Flexibility in this sense means that you must be prepared to use combinations of training methods depending on the nature of the subject, time available, and the capabilities of the trainee. The following methods of training are basic to any well-planned unit training program:

DIRECT SUPERVISION (Apprentice or coach-pupil). No other method of training is as effective as an intelligent and interesting application of the coach-pupil method of instruction. In addition to being the quickest way of fitting a new worker into the operation of a unit, it serves as one of the best methods of training. Without specific directions and guidance in learning to perform the necessary duties, a worker is likely to waste time and material, and form bad habits of work.

Many organizations in industry have apprenticeship courses which are designed to train workers in a trade or skill. Their training consists of coach-pupil supervision under skilled workers with periodic group instruction when it is advantageous.

SELF-STUDY. Skilled and semi-skilled jobs require a considerable amount of job knowledge and judgment ability. Even in simple jobs there is much basic job information that the worker must acquire. The more complicated technical jobs involve both basic and highly specialized technical knowledges and related skills, which must be taught. In skilled jobs, the training given through direct supervision is seldom complete within itself in developing basic airmen into skilled workers. In such cases, formal technical training courses should be utilized to the fullest extent. Workers who come to the job with a fair technical background and some experience can acquire much of the needed job knowledge information through self-study and other self-improvement methods.

GROUP INSTRUCTION is a practical adjunct to direct supervision and self-study. It is a time saver when several workers are to be instructed in the same job knowledges or procedures. It provides opportunity for frank discussions and group problem-solving. It develops good judgment characteristics, provides time to motivate the trainee, and leads to better cooperation among the workers. It affords an opportunity for the supervisor or trainer to check training progress and clarify matters which are difficult for the trainees to understand.

Do not confuse group instruction with classroom or so-called "academic-type" instruction. The two are not the same. Academic-type instruction will certainly hinder production; while group instruction, intelligently used can expedite production. For example, suppose you have six trainees learning the same job. Four of the trainees are having trouble with a certain job element, while the other two have it "cold." The four men having trouble can be brought over to the other two, and in a short time, the difficulties will probably be solved. In on-the-job training, this is what we mean by group instruction.

Let us now consider the key steps in implementing an on-the-job training program.

* Survey unit assignments and insure that each assignment is in the best possible accord with the individual's classification and his specific skills background.

* Determine the exact need for training. To determine this need, two things must be established.

  Let "a" = the specific job requirements or skills needed.
  Let "b" = the individual skills of the trainee.
  Let "c" = the on-the-job training required.

  When a and b are known, the on-the-job training required can be determined by a simple formula: a - b = c.

* Determine the method or methods of training which will be most effective. Number of people, time available, facilities required, nature of training and individual capabilities are factors which will affect this decision.

* Select the people who will actually conduct the training, remembering that the end product will be no better than those who conduct the program.

* Procure all available materials which may be helpful (such as this packaged course) to supplement the program.

* Follow-up. This should be a continuous monitoring job to insure that the program does not lag, that training records are kept current, and that proper utilization of newly-developed skills is being made.

This is truly a large order. But now, more than ever before, our Air Force is dependent upon quality training. It is an important job and it is one that never ends.

OJT PROGRAM OUTLINE & TRAINING STANDARD

TELEPHONE INSTALLER-REPAIRMAN AFSC 36152

SECTION I - EXPLANATION

1. Purpose of Standard: Section II of this Standard is designed to:

   a. Indicate knowledges or tasks necessary for an airman to perform duties in the Telephone Installation and Repair Ladder of the Wire Maintenance Career Field (Column A). These knowledges and tasks are based on the specialty description dated 1 March 1956 (Revised) in AFM 35-1.

   b. Reflect the minimum skill level recommended for each element for qualification to the three (3) level (Column B).

   c. Reflect the minimum proficiency recommended for each element for qualification to the five (5) level as provided by OJT Program JP 36152 (Column C).

   d. Provide the trainee with a convenient chapter reference (Column D).

   e. Form the basis on which supervisors can plan and conduct individual OJT Programs.

2. Explanation of Coding: The numbers appearing in Section II are based on the following code key. These represent the skill levels attained in the courses or recommended for the other stages of job progression.

CODE KEY

\- No experience or training on this item

1. Has only a limited knowledge of this subject or task. Has not actually used the information. Cannot be expected to perform the task.

2. Has received a complete briefing on the subject or task but can use the knowledge or skill only if assisted in every step of the operation. Requires much more training and experience.

3. Understands the subject or task to be done. Has applied part of the knowledge, either on the actual job or on a trainer. Can do the job if closely supervised in the more difficult parts.

4. Understands the subject or task to be done and has done the job enough times to make sure he can do it. Needs more practice under limited supervision.

5. Has a complete understanding of the subject or task. Can do the task completely and accurately without supervision.

6. Has complete understanding of the subject or task, can do the task completely and accurately without supervision, and can apply the techniques and skills to similar equipment or situations.

SECTION II - JOB TRAINING STANDARD

(A) REQUIRED KNOWLEDGE OR TASK	(B) PROFICIENCY LEVEL App (3) Level	(C) PROFICIENCY LEVEL Skill (5) Level	(D) Refer to Chap.
1. Demonstrates a general understanding of the Wire Maintenance Career Field and a specific knowledge of the duties and responsibilities of the Telephone Installer Repairman Ladder	2	5	1
2. Observes safety principles			
a. In climbing and working on poles	3	5	8
b. In use of tools	3	5	8
3. Installs and maintains field wire systems			
a. Pays out field wire using:			
(1) hand operated wire laying equipment	4	4	
(2) power operated wire laying equipment	3	3	
b. Secures field wire to poles	5	5	
c. Constructs overhead crossing using lance poles	3	3	
d. Makes field wire ties and splices	5	5	
e. Makes buried road crossings	4	4	
f. Installs loading coils and test stations	3	3	
g. Uses field telephone in testing for opens, shorts and grounds	4	4	
h. Removes, recovers, services and stores field wire	4	4	
i. Installs tactical switchboard	4	4	
4. Installs and maintains rubber covered cable			
a. Pays out cable, using power equipment	4	4	
b. Raises and attaches rubber covered cable to messenger	3	3	
c. Attaches the cable to poles using:			
(1) drive hooks	4	5	7
(2) laycit grips	4	5	7
(3) basket hitches	3	5	7
d. Constructs ground surface lines	3	3	
e. Field splices rubber covered cable	4	4	
f. Connects rubber covered cable to open wire	3	3	

(A) REQUIRED KNOWLEDGE OR TASK	PROFICIENCY LEVEL (B) App (3) Level	(C) Skill (5) Level	(D) Refer to Chap.
g. Determines correct sag clearance and span lengths from cable specifications	3	3	
h. Maintains correct sag and clearance in cable	3	3	
i. Removes, recovers, services and stores rubber covered cable			
Installs tactical switchboard and telephone equipment	4	4	
	4	4	
5. Terminates such tactical equipment as:			
a. switchboard SB-22PT	3	3	
b. switchboard SB-86-P	3	3	
c. switchboard BD-71 or BD-72	3	3	
d. telephone TA-43/PT	3	3	
e. telephone TP-3	4	4	
f. telephone EE-8	5	5	
6. Identifies and corrects troubles in such field equipment as:			
a. telephone TA-43PT	3	3	
b. telephone TP-3	3	3	
c. telephone EE-8	4	4	
7. Substation Installation			
a. Installs telephone line from outside source to building			
(1) Climbs pole using gaffs	5	5	
(2) Plans routing between terminal can and point of entry into structure	3	5	3
(3) Contacts test board from terminal connection	5	5	
(4) Tests assigned pair for serviceability	4	5	3
(5) Runs outside wire between terminal can and building			
(a) Fastens wire to pole	5	5	
(b) Fastens wire to messenger	4	4	
(c) Fastens wire guard arm	4	4	
(d) Makes drop wire run on external wall of structure	4	5	3

SECTION II - JOB TRAINING STANDARD

(A) REQUIRED KNOWLEDGE OR TASK	(B) PROFICIENCY LEVEL App (3) Level	(C) PROFICIENCY LEVEL Skill (5) Level	(D) Refer to Chap.
(e) Installs protector	4	5	3
(f) Installs ground rods	4	5	3
(g) Connects protector to ground	4	5	3
(h) Provides passage for wire through:			
(1) wood	5	5	
(2) masonry	4	5	3
(3) metal	4	5	3
(i) Protects wire passing through:			
(1) wood	5	5	
(2) masonry	4	5	3
(3) metal	4	5	3
(j) Connects drop wire to terminal can lugs and to protectors	5	5	
b. Installs inside wiring			
(1) Installs wire:			
(a) Under floor duct system	3	5	3
(b) Baseboard and molding and raceways	3	5	3
(c) Over floor duct system	3	5	3
(2) Installs house cable	3	3	
(3) Installs and secures conduit	3	4	3
c Installs telephone			
(1) Mounts connector block	5	6	3 & 6
(2) Connects inside wire to connector block	5	5	
(3) Terminates lines at common subsets	4	5	3
(4) Terminates lines at such equipment as:			
(a) Western Electric Company Key Telephone (400 series)	3	3	
(b) Western Electric Company Key Telephone (500 series)	3	3	
(c) 1 A Key Telephone system	3	3	
(d) 1 A 1 Key Telephone system	2	3	6
(5) Connects additional equipment including:			

SECTION II - JOB TRAINING STANDARD

(A) REQUIRED KNOWLEDGE OR TASK	(B) PROFICIENCY LEVEL App (3) Level	(C) PROFICIENCY LEVEL Skill (5) Level	(D) Refer to Chap.
(a) external bells and horns	3	3	3
(b) line transfer equipment (BE-54A)	3	3	
(c) signal lamp	3	3	
(d) signal buzzers	3	3	
(e) recording devices	2	3	3
(f) extension ringers	3	3	
(6) Performs operational test on installed systems	3	4	3
Maintains wiring, telephone equipment and inter-office equipment			
(a) Maintains telephone subset installation			
(1) Isolates trouble to cable drop, inside wire or equipment	4	5	4
(2) Determines cause of common subset malfunctions (through reference to diagrams and use of test equipment)	3	3	
(3) Determines cause of key telephone malfunctions through reference to diagrams and use of test equipment as:			
(a) Western Electric Company Key Telephone (400 series)	2	3	4 & 6
(b) Western Electric Company Key Telephone (500 series)	2	3	4 & 6
(c) 1 A Key Telephone System	2	3	4 & 6
(d) 1 A 1 Key Telephone System	2	5	4 & 6
(4) Makes minor repairs to equipment	4	6	4 & 6
(5) Repairs or replaces faulty drop or inside wire	4	5	4
b. Maintains inter-office equipment installation			
(1) Isolates trouble to cable or equipment	3	4	5
(2) Repairs or replaces faulty cable	3	3	

(A) REQUIRED KNOWLEDGE OR TASK	(B) PROFICIENCY LEVEL App (3) Level	(C) Skill (5) Level	(D) Refer to Chap.
(3) Replaces faulty inter-office equipment	3	4	5
9. Installs inter-office communication equipment			
a. Prepares inter-office installation equipment worksheet	3	4	5
b. Plans layout	3	3	
c. Makes cable run	3	3	
d. Installs and connects equipment	3	3	
e. Performs operational test	3	3	
10. Performs emergency maintenance of the outside plant system			
a. Replaces poles	3	3	
b. Installs stub poles	3	3	
c. Lashes cracked poles	3	3	
d. Splices open wire	3	3	
e. Splices lead-covered cable	3	3	
f. Makes temporary seal of lead covered cable	3	3	
g. Clears broken cable ends	3	3	
11. Determines substitutions of materials	3	3	
12. Determines alterations of installation plans when necessary	2	3	3
13. Maintains tools and equipment			
a. Performs preventive maintenance on tools	4	5	8
14. Uses Air Force technical publications and the Federal Catalog systems			
a. Researches numerical, alphabetical, and cross references indeses to locate technical orders and supply catalogs	3	3	
b. Uses technical orders to determine installation, operation and maintenance specifications	3	3	
c. Uses USAF Stock catalogs and Federal catalogs to locate stock numbers	2	3	2

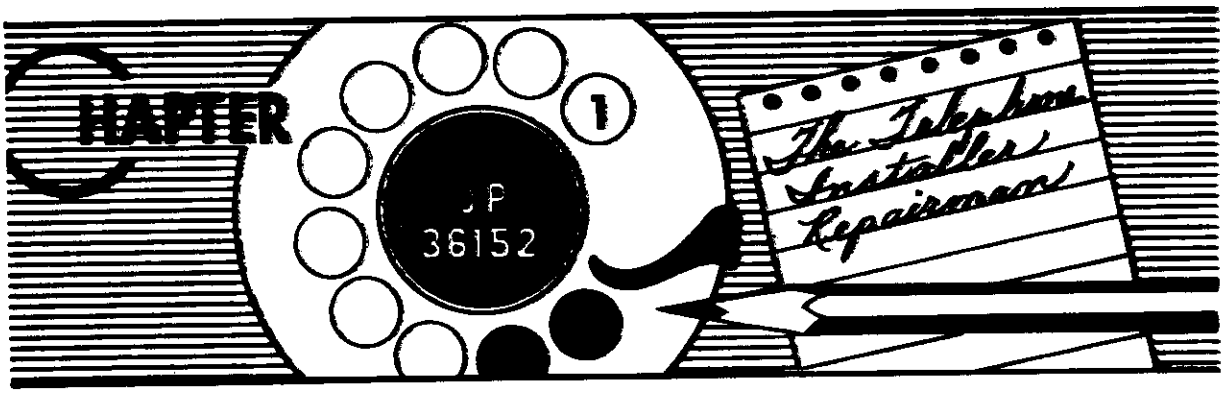
(A) REQUIRED KNOWLEDGE OR TASK	(B) PROFICIENCY LEVEL App (3) Level	(C) Skill (5) Level	(D) Refer to Chap.
15. Product Improvement Program			
a. Prepares failure reports			
(1) Makes necessary entries on failure report forms for each job performed on equipment falling under this program	2	3	2
(2) Forwards failure report to the Product Improvement Control Office	2	4	2
b. Initiates U.R.'s			
(1) Determines need for U.R.s	2	3	2
(2) Makes appropriate entries on U.R.	2	3	2
(3) Forwards U.R. worksheet to Product Improvement Control Office	3	4	2
16. Plans organization of telephone installation and repair sections			
a. Develops unit organizational charts	-	-	
b. Determines manning requirements	-	-	
c. Plans repair shop facilities	-	-	
17. Plans activity of telephone installation and repair personnel			
a. Establishes priorities for work to be performed	-	-	
b. Prescribes methods for:			
(1) installing field wire systems	-	3	8
(2) terminating field wire system with tactical equipment	-	3	8
(3) installing wiring for fixed telephone installation	-	3	3 & 8
(4) installing cable for inter communications system	-	3	5 & 8
(5) installing telephones	-	3	8
(6) installing inter-office communications equipment	-	3	5 & 8
(7) repairing telephone equipment	-	3	4 & 8
c. Establishes controls to assure adherence to prescribed standards	-	-	
d. Plans and schedules work and duty assignments and rotates			

SECTION II - JOB TRAINING STANDARD

(A) REQUIRED KNOWLEDGE OR TASK	(B) PROFICIENCY LEVEL App (3) Level	(C) PROFICIENCY LEVEL Skill (5) Level	(D) Refer to Chap.
personnel where desirable	-	-	
e. Schedules leaves	-	-	
18. Directs operations in conformance with principles of good supervision			
a. Prepares orders and directives	-	-	
b. Gives instructions to subordinates	-	3	8
c. Resolves personnel conflicts	-	-	
d. Resolves grievances	-	-	
e. Resolves personal problems	-	-	
19. Evaluates operation of installer crews and repair shops			
a. Conducts continuing review of operations to assure compliance with prescribed methods and achievements of prescribed standards	-	-	
b. Determines skill level and rates subordinates	-	-	
20. Trains subordinate personnel			
a. Orients new personnel	-	-	
b. Submits requests for DAF OJT Packages	-	-	
c. Plans work schedule for subordinates (through use of an official progress and qualification record) to provide training of airmen on as many as possible of those duties and tasks of installer repairmen which occur in the particular assignment involved	-	-	
d. Guides subordinates and demonstrates (or arranges for demonstration of) correct performance of assigned duties	-	3	8
e. Makes off duty study assignments	-	-	
f. Plans and schedules training programs based on DAF OJT package to coincide with daily job activities	-		
g. Selects, trains, and assigns	x		

SECTION II - JOB TRAINING STANDARD

(A) REQUIRED KNOWLEDGE OR TASK	PROFICIENCY LEVEL (B) App (3) Level	(C) Skill (5) Level	(D) Refer to Chap.
instruators for training program	-	-	
h. Maintains progress and qualification records	-	-	
21. Performs supervisor's administrative functions			
a. Requisitions supplies for the activity	-	-	
b. Revises manning document requirements	-	3	7
c. Requests replacement personnel	-	-	
d. Prepares promotion and reclassification action recommendations	-	-	



Have you ever given any thought to the enormity of the United States Air Force and to the great number of diversified skills and knowledges required for its operation? As you know, the Air Force is charged with many responsibilities set forth in Department of Defense Directives. If you have read these directives, you are undoubtedly aware of the many Air Force responsibilities. If not, a few of the primary wartime functions of the Air Force stated here will give you an idea of their importance.

1. **Conduct strategic air warfare.**
2. **Defend the United States against air attack.**
3. **Defeat enemy air forces.**
4. **Control vital air areas.**
5. **Furnish close combat and logistical support to the Army.**

In short, the people of the United States have handed the Air Force a mighty big order!

To meet these demands, the Air Force was organized on a functional basis -- that is by the job to be performed. This means that each command and unit right on down to the individual airman, has a specific job or responsibility in the accomplishment of the total mission. To state an example, the Continental Air Defense Command is charged with the specific job of defending the United States. Some units within this command such as Aircraft Control and Warning sites, are responsible for the detection and identification of all aircraft. Tracing this functional type organization still further, we find certain individuals in the Air Force responsible for the specific job of installing and repairing the equipment used for aircraft detection and identification. It is possible, of course, to trace this functional type organization through all elements of the Air Force. One great advantage of such organization lies in the fact that each command, unit and individual understands exactly his responsibilities in the accomplishment of the over-all mission. Men and units not only become expert in their assignments but are able to accomplish their jobs in any region and under almost any circumstance.

THE USAF CAREER PLAN

Functional organization is also used in the assignment, training and promotion of Air Force personnel. This personnel program is based on the functional similarity of knowledges, skills, and other abilities required by the total mission. The knowledges and skills are grouped into career fields which in most cases are patterned after civilian career groupings. Obviously, due to the many different jobs required in the operation of the Air Force, there are many different career fields. For example, there are at this time forty-two different fields. The number of career fields change as job requirements of the Air Force change. A few of the current career fields are as follows: intelligence, photo-mapping, photographic, weather, and - of course - wire maintenance. As you can see from the titles, these career fields are broad in scope; therefore, a further sub-division is necessary. The wire maintenance career field, for example, is currently sub-divided as follows: inside plant maintenance, and outside wire maintenance.

The difficulties of learning all of the duties and tasks involved in one career field sub-division is apparent. The Air Force does not expect you to learn and specialize in all the skills; therefore, career field sub-divisions are further divided into career field ladders. The ladders are primarily a means by which the untrained or inexperienced airman can learn and progress in his field. Each ladder consists of an Air Force Specialty (AFS) consisting of closely related knowledges and skills placed together. These ladders or specialties are stepped -- just like a terminal pole; that is, there are different job proficiency levels. Each level has a specialty description which outlines the required qualifications for each particular level or step. Numbers are assigned to the specialties for identification purposes. As you know, a coding system is used in this number assignment. Following is an example of the coding system:

36			Career Field	Wire Maintenance
	1		Career Field Sub-division	Outside Wire Maintenance
		5	Skill Level	Skilled
			2 Specific AFS	Installer Repairman

The over-all program offers many distinct advantages to both the Air Force and Air Force personnel:

1. It provides an arrangement whereby personnel may be grouped, trained, and assigned to career fields based on their natural aptitudes.

2. It sets a goal for airmen in that men assigned to a particular career field know exactly what knowledges and skills must be developed in order to progress.

3. The advancement of airmen from one step on the career ladder to another is based on demonstrated ability, proficiency testing, and the individual's own initiative.

4. It provides a just means of pay progression.

These are but a few of the many advantages provided by the career plan; generally, the plan includes all the better points of the best civilian and military personnel programs combined in one workable program for the Air Force.

THE WIRE MAINTENANCE CAREER FIELD

For a detailed picture of your own particular career field, study the chart in figure 1-1. Note the two career field sub-divisions: outside wire maintenance and inside plant maintenance. As you can see, there are three ladders by which the position of Inside Plant Maintenance Superintendent may be reached and three ladders provided for climbing to the position of Outside Wire Maintenance Superintendent.

As pointed out previously, the career ladders provide a pattern for career progression. The left hand column in figure 1-1 graphically shows this grade level progression from E-1 through W/O. Note that your particular AFSC (36132) calls for the grade E-3. The next level -- your goal, 36152 -- calls for the grade E-4.

As a 3- level man reaching for the 5- level, you should be primarily concerned with the qualifying requirements for the next step-up. In other words, what are the tasks, skills, and knowledges that you must know in order to advance in your career? You will find the answer to this question in two documents, your Air Force specialty description and your job training standard. Carefully study these two documents and you should obtain a clear picture not only of the skills and knowledges required but of the degree to which you must be able to perform each task in order to qualify as a 36152.

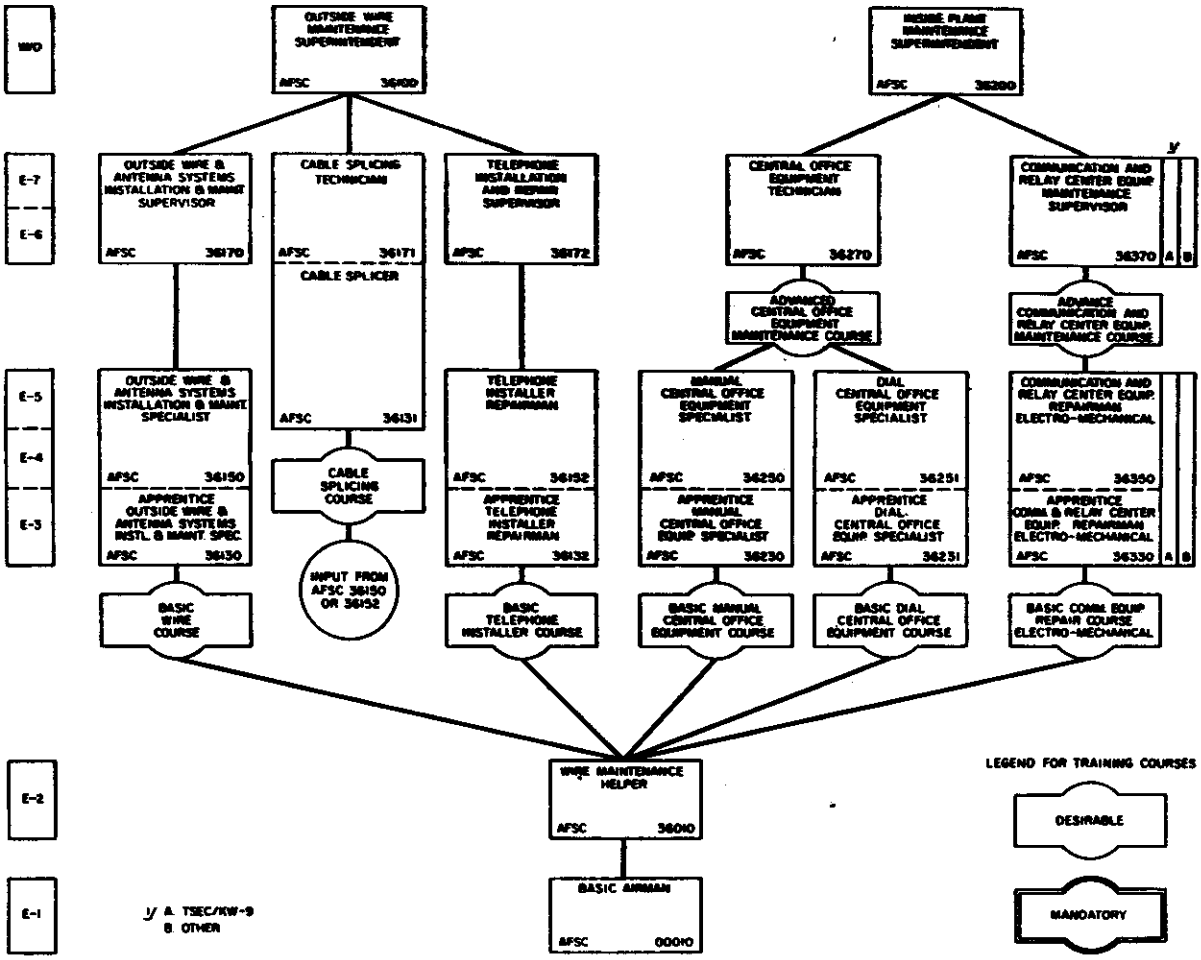


Figure 1-1 Wire Maintenance Career Field

AIRMAN AIR FORCE SPECIALTY
TELEPHONE INSTALLER-REPAIRMAN

1. SPECIALTY SUMMARY

Installs, replaces, and maintains telephone and interoffice voice communications systems.

2. DUTIES AND RESPONSIBILITIES

a. Installs telephone line from outside source to building: Plans routing of outside wire to avoid obstacles such as trees, buildings, power lines or other obstructions. Climbs pole, attaches telephone test set to lugs in terminal can. Calls central office to determine serviceability of wire pair designated in work order and notes new pair assignment if change is necessary. Fastens wire to pole, using drive hooks, wire clamps, brackets or other fastening devices. Strings wire to building. Screws lightning arrestor to building and attaches appropriate wire to protector block and ground rod to prevent damage to telephone from excessive voltage. Drills holes through masonry and wood using brace and bit, star drill and hammer to provide passage for wires. Protects wires passing through wood by use of porcelain insulators and tapes wires passing through masonry to prevent damage to insulation.

b. Installs inside wiring: Runs interior wiring or cables in conduits between walls or along baseboards, molding, windows or door frames. Secures wires with insulated staples or millimite tacks. Bends, shapes, and secures conduit, when used, to provide a neat and orderly installation of tubing and minimize safety hazards to personnel.

c. Installs connector blocks, telephones, and interoffice sets: Screws connector block in appropriate location near telephone and connects inside and outside wires to lugs in connector block. Connects outside wires to designated lugs in terminal can on pole to complete circuit between user and central office. Dials central office and conducts transmission, foreign noise, cross talk and dial speed tests. Requests central office to return call in order to determine effectiveness of signal bell. Makes necessary adjustments such as regulating dial speed or tone of signal bells by adjusting screws and tightening lock nuts. Writes dial number in center of dial.

d. Maintains wiring, telephone and interoffice equipment: Inspects, repairs and replaces faulty wiring, telephones, or interoffice equipment. Disassembles and inspects phones for frayed or broken wires, missing or broken posts, poor electrical contacts and presence of excessive oil, grease or dirt. Makes minor repairs, replacing bad wiring or broken diaphragm. Replaces defective telephones. Checks wiring on interoffice equipment, making minor repairs or replaces defective wiring. If trouble is not in wiring portion of interoffice equipment, makes note of trouble in the set itself for referral to radio maintenance personnel. Maintains system records.

e. Supervises telephone and interoffice installation personnel: Evaluates performance of subordinate personnel in terms of quality of work performed. Inspects completed work, recommending training for personnel wherever necessary. Conducts OJT programs to raise and maintain quality of work performed. Recommends duty assignments based on training and ability to personnel assigned.

3. SPECIALTY QUALIFICATIONS

a. Education:

(1) Knowledge of telephone circuit diagrams and blueprints; telephones; interoffice communications equipment and wiring practices and standards is mandatory. Attaining a qualifying score on the APT applicable to the specialty described herein satisfies these mandatory knowledge qualifications.

(2) Knowledge of emergency cable repair procedures is desirable.

b. Experinece: Experience in functions such as installing interior telephone wiring; outside telephone wiring from source point to building; telephone installation; interoffice communication installation; maintenance of telephones; or repair of interoffice communication wiring systems is mandatory.

c. Training:

(1) Completion of a course in telephone installation and repair is desirable.

(2) High school level course in electricity is desirable.

d. Other:

(1) Physical profile serial 222222 is desirable for field or base assignment.

(2) Normal color vision as determined by the 19-plate AOC test is mandatory.

(3) Only male airmen will be awarded this AFS.

4. SPECIALTY DATA

a. Grade Spread: Airman second class through staff sergeant.

b. Source Jobs (DOT):

Combination Man (Tel & Tel)

ADVANCING IN YOUR CAREER

Now that you know what the requirements are for a 5- level telephone installer repairman - your goal is established. The next question should be, how do I reach this goal or how do I go about qualifying myself for a 36152? The Air Force has held nothing back in its effort to provide you with the ways and means of attaining your goal. Formal courses of instruction are conducted, factory training is available, and on-the-job training programs are provided.

On-the-job training is probably the most effective type of training offered. The principal advantage of this program is that airmen are taught the proper working procedures and skills and allowed to practice them in real situations. In short, the Air Force is applying the old maxim "experience is the best teacher". If you have carefully read the introduction in this manual, you no doubt have a good understanding of the principles and techniques used by the program. This packaged course is in the true sense of the word a tool provided for your use in completing your on-the-job training. How well you use this tool will determine to a large extent your degree of success. This manual was prepared with one objective in mind and that was to aid you in developing the skills and understanding the knowledges required by the 5- level telephone installer repairman. You may have noticed from the Table of Contents and the Job Training Standard that the chapters included deal primarily with the job elements and tasks that are up-graded in the job training standard.

It should be clear to you at this point that your chances for advancement are good. First, your career field is a growing one; second, you know what knowledges and skills you must master; third, you have the means for developing the required skills and knowledges in your OJT Program.

SUMMARY

The Air Force has provided you with everything you need to progress and grow in the service. A good workable career plan has been provided and you have a sound program of training at your finger tips. The only element not handed to you is the desire to advance and the initiative to do the job. These things cannot be given to you -- they must come from yourself. Therefore, start your on-the-job training with a firm desire to do your level best, pay close attention to your instructors and supervisors, complete the work problems in this package to the best of your ability, and study the references suggested. If you conscientiously follow this advice, you will not only become a 5- level technician and receive more pay but you will develop working habits that can very easily carry you to the top position of your career ladder.

References

AFM 35-1 Warrant Officer and Airman Classification Manual

REVIEW QUESTIONS

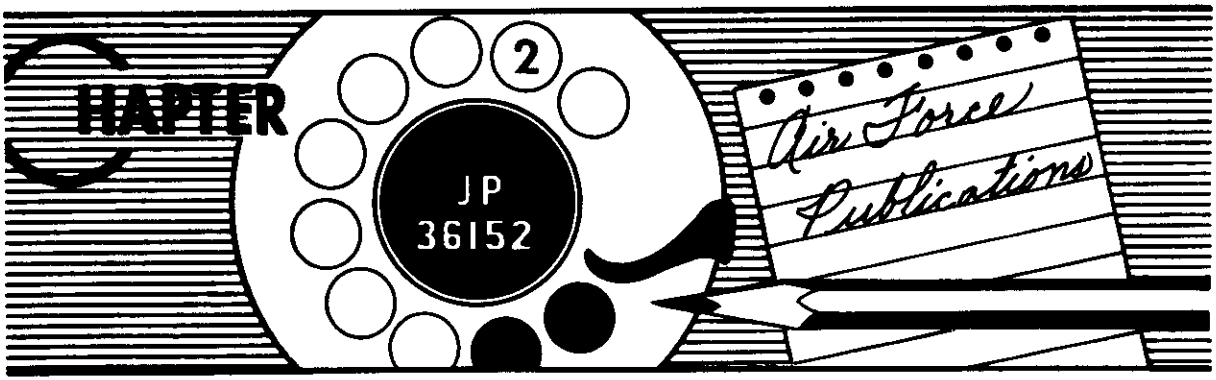
1. On what is the advancement of airmen from one level to another based?

2. By what three career ladders may the position of Outside Wire Maintenance Superintendent be reached?

3. According to the 36152 specialty description, what supervisory duties must you be able to perform?

4. What telephone experience must you acquire before you qualify as a 36152?

5. What two paths of progression to the position Outside Wire Superintendent are available to you after you have received the 36152 AFSC?



In any large complex organization various publications are needed to insure that personnel within the organization are not only advised of their duties and responsibilities but are also kept current on policies and working procedures. Private industry often publishes manuals and handbooks for this purpose. Telephone companies, for example, publish specifications concerning the installation, operations, and maintenance of their equipment. Such publications, in addition to insuring uniformity in working practices, aid in keeping personnel advised of new procedures and policies.

The Air Force publishes and distributes similar materials for much the same purpose. Due to the many and varied elements within the Air Force, several different types of publications are required. Most of the Air Force publications used by the 5-level installer repairman are contained in the Air Force Technical Order System and the Air Force Supply Catalog Data and Stock List System. This chapter, therefore, is directed primarily to the publications within these two systems. There are, of course, many other Air Force publications that directly affect the telephone installer repairman such as regulations, letters, manuals, pamphlets, etc. However, the 5-level man is not required to have a complete understanding of all of these publications. The information they contain is generally used by higher level personnel. You may look forward to learning how to use these latter publications when studying for the 7-level position.

AIR FORCE TECHNICAL ORDER SYSTEM

Exactly what is the Technical Order System? Air Force Regulation 5-1 states: "The Air Force Technical Order System is established as the official departmental source of all technical data pertaining to the operation and maintenance aspects of all equipment (except experimental) or material used by the Air Force, including the installation, inspection, servicing, modification and overhaul of such equipment." In short, it is a publication system embracing all the technical information needed by the Air Force for the installation, operation and maintenance of its equipment. As you can see from the above quotation the system is broad in scope. Hence, the subject matter included in the system is divided into two groups namely: Technical Order Publications Group and Supplementary Publications Group. The 5-level installer repairman is concerned mainly with publications contained in the Technical Order Publications Group, shown in Figure 2-1. The following paragraphs include a description of the publications included in this group.

TIME COMPLIANCE TECHNICAL ORDERS

The title of these Technical Orders should give you a good idea of their use. When a job must be done within a certain time limit, a Time Compliance Technical Order is distributed. There are different types of Time Compliance Technical Orders:

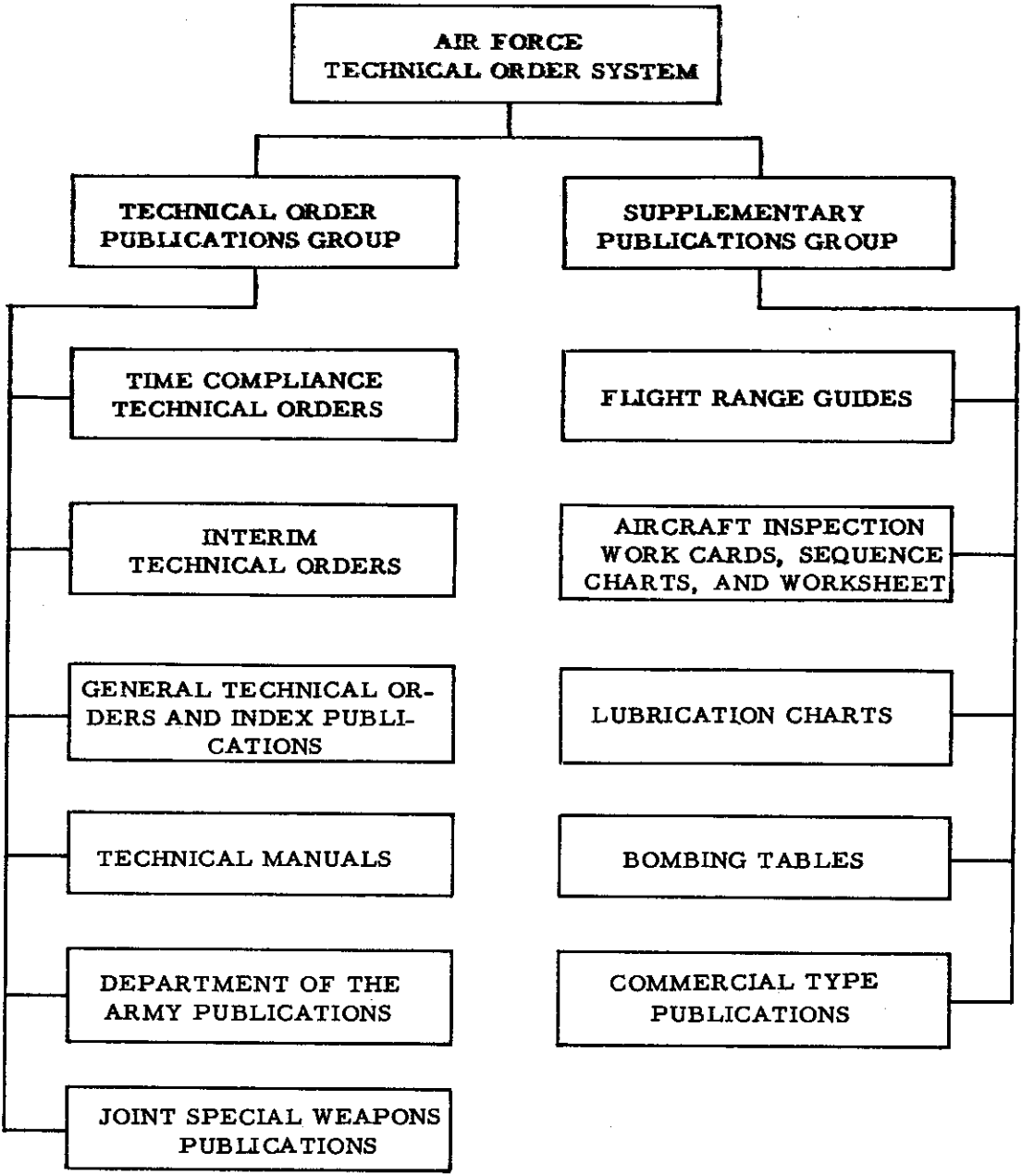


Figure 2-1. Major Groups and Types of Technical Publications

1. Immediate Action Technical Orders. These publications are issued under the governing factors of safety conditions, the uncorrected existence of which could result in fatal or serious injury to personnel, or extensive damage to or destruction of valuable property. Such conditions embody risks that are calculated to be intolerable. These Technical Orders can be identified by red X's along the border of the first page, and the words "Immediate Action" printed in red at the top of the page.

2. Urgent Action Technical Orders. These publications are issued under the governing factors of combat necessity or potentially hazardous conditions, which could result in injury to personnel, damage to valuable property, or unacceptable reductions in combat efficiency. Such conditions compromise safety and embody risks calculated to be tolerable only within definite time limits. These Technical Orders can be identified by the alternately spaced red diagonals (/) and circled red X's (X) on the first page, and by the words "Urgent Action" printed in red at the top. These technical orders specify that the work is to be accomplished within one to ten days after receipt of the technical order.

3. Routine Action Technical Orders. These Technical Orders are issued under the governing factors of equipment or procedural deficiencies of a material, mechanical, operational or tactical nature, the uncorrected existence of which would: (1) constitute a hazard through prolonged continued usage, or (2) have a negative effect on operational efficiency, or (3) reduce tactical or tactical support utility, or (4) reduce operational life or general service utilization of equipment. Such conditions embody degrees of risk or requirements calculated to be tolerable within broad time limits. Routine Action Technical Orders are printed on plain white paper without distinguishing red symbols.

4. Record Type Technical Orders. These Technical Orders do not affect the telephone installer repairman in that they are primarily issued for record purposes only.

INTERIM TECHNICAL ORDERS

These Technical Orders are issued to Air Force activities by means of radiograms, telegrams, teletype message form or other swift means of communication. This type of Technical Order is used when circumstances preclude the timely publication of urgently needed instructions in formal technical order form.

GENERAL TO'S AND INDEX PUBLICATIONS

Publications in this group provide information and instructions, usually for administrative and supervisory personnel, concerning such typical subjects as the Air Force Technical Order System; Visual Inspection System; standard and special procedures relating to Air Force maintenance and supply functions. The Index type publications included in this category are issued to provide Air Force personnel with information concerning the availability and status of all authorized Air Force technical publications.

TECHNICAL MANUALS

Included in this group are instructions for ground electronics equipment such as operating, service, preventive maintenance, overhaul and installation instructions. Also included in the group are illustrated parts breakdowns.

Up to this point, we have given you a brief description of the first four types of publications listed in figure 2-1 under Technical Order Publications Group. The descriptions are by no means complete; and, as you can see from figure 2-1, all types are not explained. You should, however, now have a general picture of what is contained in the Technical Order Publications Group. A complete explanation of all types of Technical Orders is included in the Technical Order numbered 00-5-2.

IDENTIFICATION OF TECHNICAL ORDERS

Publications within the Technical Order System are numbered for quick, easy identification purposes. The numbers generally consists of three or four parts separated by dashes. The first part of the number designates the category and/or major group; the second part shows the general technical order series or a major assembly; and the third part identifies the major assembly by type model or part number. The fourth part of a number identifies the type of information in the manual, such as: operation, service or maintenance instructions, overhaul instructions, parts catalog, planning data, preventive maintenance instructions, standard installation instructions, etc. Figure 2-2 illustrates typical breakdowns of four-part numbers.

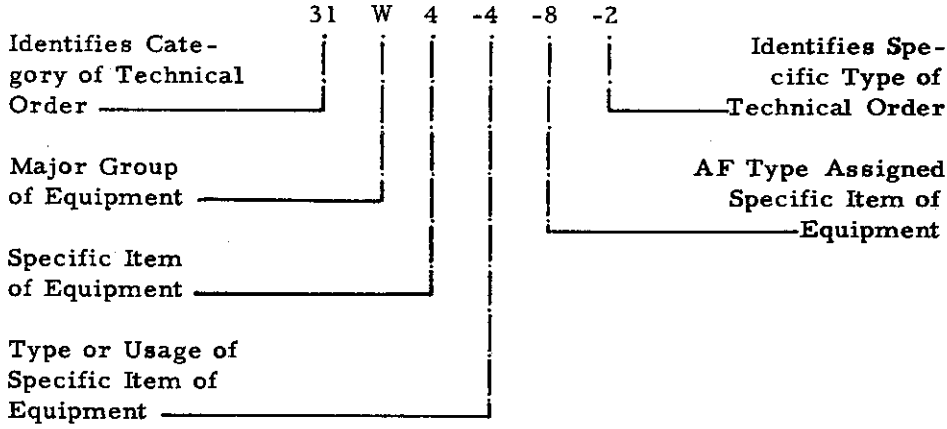


Figure 2-2. Typical Breakdown of a Four-part Technical Order Number

TECHNICAL ORDER INDEXES

The entire Technical Order System is of little value unless you understand the procedure for locating any specific information that you might need. As in any publication, technical order indexes tell where to find the information desired. There are three indexes provided: the numerical index numbered 0-1-01, the alphabetical index numbered 0-2-1, and a cross-reference index. These indexes are usually located in the first book of a technical order file. The procedure for using these indexes is quite simple. For example, suppose when planning a station installation you find that the drop wire must run parallel to an electric service wire and you do not know the specific clearance or separation required.

Using the numerical index, T.O. 0-1-01, you determine the category in which the required information is located. In this case, the information needed is located in the 31 series titled "Ground Electronic Equipment Publications."

The next step is to look at the labels on the technical order binders and locate the book containing the index for the 31 category. This index is numbered 0-1-31 and titled "Ground Electronic Equipment Publications." Consult the table of contents.

Here it is determined that the desired information is located in the Major Group 31W titled "Wire Fixed, Electronic Equipment." The Major Subgroup also is given. In this case it is 31W3 or Outside Plant. The page number is also listed.

Following through, turn to page 110 in T.O. 0-3-31, same book, and locate the section 31W3. It is now merely a matter of reading down the list of titles until one is found that you think might contain the required information. The original problem was to find information concerning the clearance required between a telephone service drop and an electrical service drop. The most likely title here is "Telephone, Outside Plant Construction - Drop and Block Wiring and Station Installation." The T.O. number for this particular publication is 31W3-1-17.

The final step, of course, is to check the labels on the book binders and locate the binder containing T.O. 31W3-1-17.

The use of the Alphabetical Index of Technical Publications number 0-2-1 is also quite simple. The publications listed in this index are grouped under equipment subject headings indicating the name of the equipment. The arrangement of listings under the equipment subject heading is generally as follows: Equipment part, type or model number; name of equipment, type of publication, name of manufacturer and publication number. Back to the example used in the explanation of the numerical index, the procedure to locate the required information would be to read the listings under the section titled "Telephone Plant Engineering" in the alphabetical index.

A word of caution at this point: After locating a particular T.O. check the "Basic date" listed in the numerical index to be certain that the technical order you use is the most recent one published.

The other index provided is named the "Cross-Reference Table of Former to New Numbers for Air Force Technical Publications," (T.O. 0-4-1). This publication contains a complete list of all Air Force technical publications numbers that were affected by the renumbering program. Both old and new numbers are indicated.

Additional information concerning the types of technical publications, how changes to technical publications are accomplished, the method of distribution, and filing procedure are contained in T.O. 00-5-1 and T.O. 00-5-2. Considerable knowledge may be gained by reading these two technical orders.

SUPPLY CATALOG DATA AND STOCK LIST PUBLICATIONS SYSTEM

It is obvious that many different kinds and types of equipment, accessories, component parts, and supplies, are required to support airmen in the performance of their assigned tasks. The job of getting these items of supply from those who are the source of supply to the users is no small undertaking in such a large and complex organization as the Air Force. There must be a system and publications to support the system. The publications in addition to serving as guides for supply activities also establish rules, principles and an orderly system for:

a. Naming items
b. Identifying items
c. Describing items
d. Classifying items
e. Determining substitute or interchangeable items
f. Publishing data in a catalog or stock list for official use and general reference
g. Furnishing data in special forms
h. Distribution and usage of publications and data

The publications contained in the system are grouped according to the purpose they serve. Figure 2-3 illustrates the major groups included in the system. The 5- level telephone installer repairman is not required to have a working knowledge of all the publications but it is necessary for him to understand and be able to use those dealing with identification of stock numbers. Prior to discussing the individual publications, it should be pointed out that two supply systems are involved in the Supply Catalog Data and Stock List Publications System.

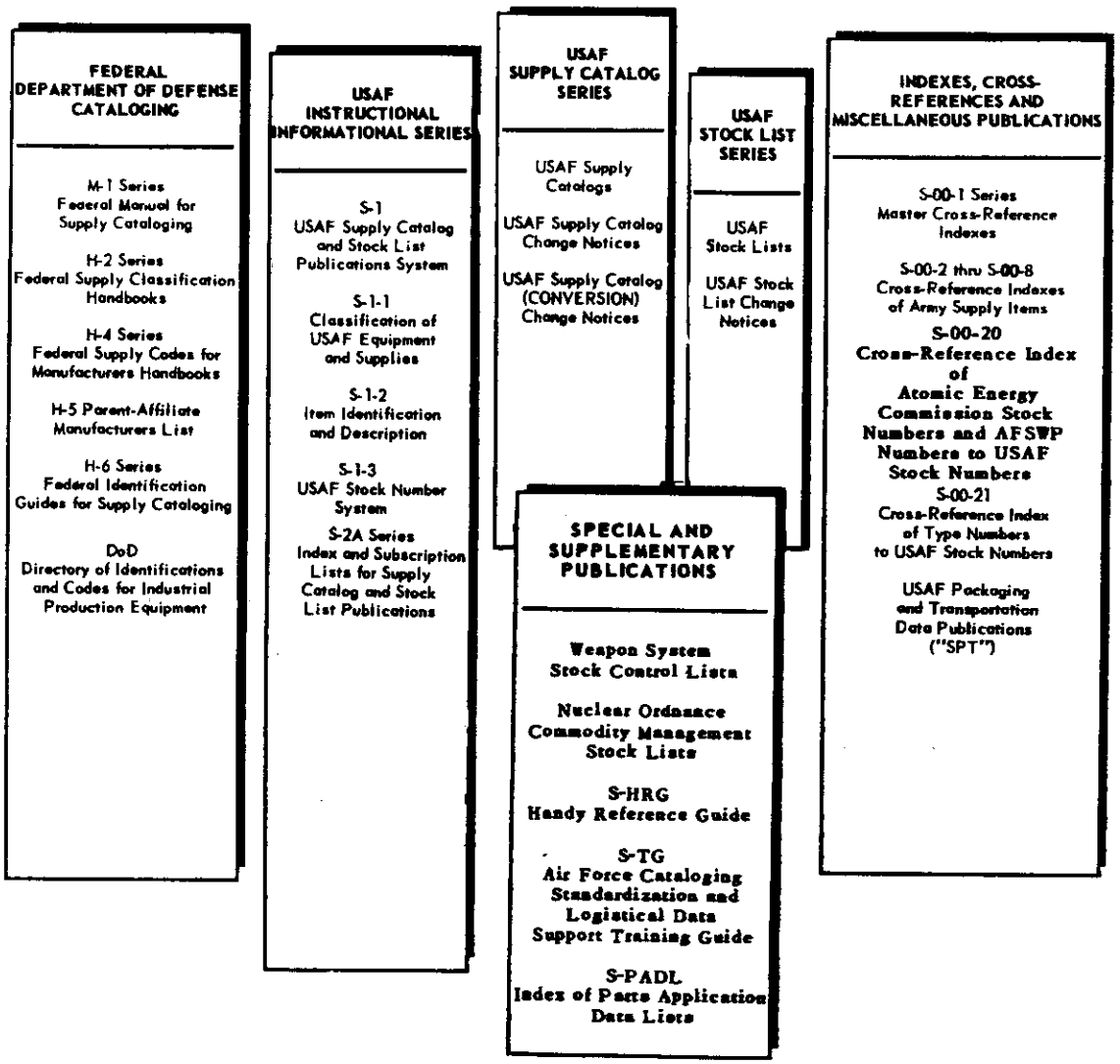


Figure 2-3. USAF Supply Catalog and Stock List Publications

Until approximately twelve years ago, each branch of the Armed Forces grouped, classified and identified items of supply by different methods. This practice resulted in confusion and duplication of effort; therefore, the Department of Defense established a system for classifying supply items to be used by all branches of the Armed Forces. It was recognized that the conversion from one system to another could not be accomplished at one time, consequently, the conversion was set to take place over a period of years. At the present time a large portion of the conversion is completed. However, as long as some items of supply still remain classified under the old system, it is necessary to study both systems.

USAF PROPERTY CLASSIFICATION

Property classification is a systematic grouping of related items into classes and subclasses in a logical sequence. Each class is identified by a "Class Symbol" which is a two position number. The numbers start with "01" (Aircraft and Airframe Structural Components) and range upward. Subclasses are indicated by the addition of letters after the class symbols, for example:

Class Symbol	Sub Class	Title
16	L	Communications Equipment Telegraph, Teletypewriter, Facsimile Equipment and Maintenance Parts
	M	Ground Radio Communication Equipment and Maintenance Parts
	N	Telephone and Wired Audio Equipment and Maintenance Parts

The items of supply are listed under each subclass, for example, 16N includes equipment such as: chest sets, handsets, intercom equipment, etc.

FEDERAL SUPPLY CLASSIFICATION

As pointed out above, Federal Supply Classification was established to insure uniform commodity classification for use by all agencies of the Federal Government. The classification principles used are basically the same as those for Air Force classification; however, the Federal System is wider in scope and therefore divided into more classes. Property is classified as follows in the Federal Supply Classification System: A four-digit coding structure is utilized, the first two digits identify the group, the last two digits identify the classes within the group. At the present time, there are 75 groups sub-divided into 530 classes. Following is an example showing the Federal Coding structure:

Group	Class	Title
58	05	Communication Equipment Telephone and Telegraph Equipment

You will find a complete list of all classes and subclasses of AF property in S-1-1. In addition S-1-1 contains information pertinent to Federal Supply Classification. Section VII of S-1-1 includes a listing of FSC groups and classes which have been implemented for AF use. In short, both the AF and Federal classification of an item in many instances can be located in S-1-1.

Going back to publications designed primarily for use with the Federal Supply Classification System, there are the H-2 Cataloging Handbooks. Three such handbooks have been developed for use in establishing the Federal Classification of an item. H2-1 shows all groups and classes presented in the arrangement of the four-digit FSC code numbering system; H2-2 is an alphabetical index of the items included in each class; H2-3 has the item names arranged in alphabetic sequence with the applicable FSC class code number opposite the name. The above explanation might be summed up as follows:

You want to know:	Look for it in:
a. The USAF Class Symbol and AF property class	a. S-1-1
b. The Federal Group and class of item	b. H-2 Handbooks or S-1-1

USAF SUPPLY CATALOGS

Supply Catalogs are official item identification lists of USAF equipment, supplies, and spare parts. They are composed of several volumes arranged by AF supply property class. The volumes are identified by the property class code symbol, for example, class code 16N with the letter S placed in front (S-16N) is the catalog used for identifying items in AF property class 16N. The catalogs contain such item identification information as part numbers, description, class code, serial numbers and stock numbers.

The installer repairman is primarily interested in the stock numbers and item descriptions. Air Force stock numbers consist of two distinct portions:

AF Classification Code **and** Manufacturer's Part Number or Assigned Serial Number

The first portion of the stock number, AF classification code, is assigned for the purpose of grouping related items into categories. It consists of four characters, either all numerals or a combination of numerals and letters. The second portion of the stock number is either the manufacturer's part number or in cases where the manufacturer's part number cannot be used an assigned serial number is used. The assigned serial number consists of 6-digits and ranges from 000001 thru 999999. When the 6-digit serial number is used to identify a group of like items having the same basic description, the variables within this group (such as size, color, dimensions, etc.) are further identified through the use of dash-numbers added to the basic 6-digit serial number.

Example:

AF Class Code	Assigned Basic Serial Number		Dash Nr
8860	828502	-	217 size 6AWG
Identify a certain type of wire (standard, tinned, copper)			Identify the variables-sizes

The Item Descriptions contained in USAF Catalogs furnish descriptions for each item cataloged. The description generally includes physical and performance characteristics, manufacturer's name, part and/or drawing number, government type number and other data to insure positive identification. To summarize again:

If you want to know:	Locate it by:
AF Stock Number and/or item description and/or part number	Determining the property code in S-1-1. Use property code to determine Supply Catalog number

The USAF Supply Catalogs, of course, furnish other information in addition to stock numbers and item descriptions described here. Since this information is used primarily by personnel involved in supply activities and the catalogs will soon be replaced by USAF Stock Lists (due to conversion to the Federal System), there will be no further effort to expand on the catalogs. If, however, you desire a complete explanation, study the publication S-1.

USAF STOCK LISTS

These publications, as pointed out earlier, replace AF Stock Catalogs for the purpose of listing items of Air Force use cataloged under the applicable Federal Supply Classification. This means that a given Federal class may include items that were converted from various Air Force property classes. For example, AF classes 17-A, 17-C, 20-B, 34-B, 50-A, and 50-J are included in Federal Class 4610.

Generally, USAF Stock Lists are completed and published in individual volumes by Federal Supply Classification commodity groups, classes, or portions thereof. They contain the following types of data:

1. Table of Abbreviations - a list and explanation of all abbreviations used in item identification.

2. Alphabetical Index of Names - a list of all approved item names and colloquial names related to items of supply reflected in that particular stock list.

3. Cross Reference Indexes - There are several kinds of numbers in use for item identification. Therefore, these numbers must be related through cross reference indexes.

4. Air Force Stock Number To Federal Stock Number Index.

5. Manufacturer's Identifying Number Index - a list of manufacturer's identifying numbers is cross referenced to the applicable Federal Supply Codes for Manufacturer's and Federal stock numbers.

6. Manufacturer's Federal Code Index - a list of Federal code numbers cross-referenced to manufacturer's name and address.

7. Manufacturer's Name and Address Index - an alphabetical listing of manufacturer's names and addresses, cross referenced to manufacturer's Federal code numbers.

8. Stock Control Data Section - This section of the Stock List includes the following data:

   a. The Federal Stock Number.
   b. Index Number - Each Federal stock number in the stock control data section is assigned an index number. This index number is used to locate the same item in the item identification section of the stock list.
   c. Issue and Fund Control Codes - Used for managing, ordering and issuing items.
   d. Status Codes - Designates the status of items as to procurement and issue.
   e. Expendability Categorization Codes - Indicates the grouping of items into degrees of expendability.
   f. ICC Labeling Codes - Indicates Interstate Commerce Commission labeling requirements.
   g. Unit of Issue - Indicates whether the item is issued in units of each (EA) by the pound (LB), etc.
   h. Price Data - Indicates the official prices for all centrally procured items.
   i. Former Stock Number - Shows former AF or Technical Service numbers.
   j. Source or Category Codes - In general indicates the source of procurement.

9. Item Identification Section, Part I - this section lists items alphabetically within each class, the Federal stock number, and index number.

10. Item Identification Section, Part II - contains those items of supply that are identified and assigned Federal stock numbers on the basis of the name of the item. The lists contain the index number, Federal stock number, manufacturer's identification number and AF item description.

Since the stock number is the first consideration in your work connected with supply, and the AF stock number has already been discussed we are now concerned with the Federal Stock Number. This number for an item of supply is uniformly 11 digits, arranged in groups of 4, 3, and 4 digits respectively; with the groups separated by dashes. For example, the number 8430-241-2778 consists of:

a. the applicable 4-digit FSC class code number (8430).
b. plus the applicable 7-digit Federal item identification number (241-2778).

A more complete breakdown of the same Federal Number is as follows:

84 FSC Group titled "Clothing and Individual Equipment"
30 FSC Class 8430 titled "Footwear", Mens'
241-2778 Specific items of supply, namely, Boot, Hip

For your purposes, the information presented thus far on the Federal Supply System might be summarized as follows:

If you want the Federal stock number for a particular telephone handset:

1. Determine the FSC class from either S-1-1 or from the H2 Handbook. In this case the FSC class is 5965.
2. Obtain applicable AF Stock List. In this case SL5965.
3. Turn to the Item Identification Section and locate the desired handset. (If you have trouble reading the description due to abbreviations, turn to the Table of Abbreviations for clarification.)
4. Note the Federal stock number for the desired handset.
5. If you desire further information such as unit of issue, status of expendability, etc., use the index number provided alongside the stock number and turn to the applicable section of the stock list.

Your "best bet" in acquiring a good understanding of exactly what information is contained in a stock list is to obtain one from your supply section. Thumb through it and note the various sections and the purposes they serve.

Thus far this chapter has discussed use of such supply publications as: S-1-1, H2 Handbooks, USAF Supply Catalogs and USAF Stock Lists as they pertain to the installer repairman. It goes without saying that these publications can be put to more extensive uses than those described here. Therefore, you are again urged to study S-1. Other publications useful in researching for stock numbers are the various cross reference indexes (S-00 Series). S-00-1, USAF Master Cross-Reference Index, consists of three parts each containing three columns of information in the same fixed position (part numbers, Air Force stock numbers, and Federal item identification numbers (FIIN), but each in different sequence within the columns. For clarification: in Part I, the part numbers are arranged in sequence; in Part II, the AF Stock numbers are arranged in sequence; and in part III, the FIIN are arranged in sequence. This particular publication, however, will phase out due to the conversion program and be replaced by new publications the S-00-1-1 and the S-00-1-2.

S-00-1-1 contains three separate columns. The first column lists all known Manufacturer's Identifying Numbers (part, drawing, catalog, model, etc.) arranged in

sequence. Each identifying number is cross-referenced first to the 5-digit Federal Supply Code for Manufacturers (second column), and then to the Federal Stock Number (third column).

S-00-1-2 also contains three separate columns. The third column is in Federal Item Identification Number (FIIN) sequence, prefixed by the FSC class code. Each entry is cross-referenced to the Manufacturers' Identifying Number (first column) and the Federal Supply Code for manufacturers' (second column).

Another cross-reference index that may prove useful to you is the S-00-2. This publication includes a complete range of Army stored and issued Signal Corps items which the Air Force uses and Army items which have been integrated into the Air Force supply system.

MATERIAL DEFICIENCY REPORTING

The Air Force has established a policy whereby deficiencies in MATERIEL will be reported and the information used for:

1. Correcting deficiencies on equipment in service, and making certain that it comes up to established standards.
2. Improving the reliability and operational effectiveness of equipment and making it easier to maintain.
3. Establishing standards for new production and new design of material.

The procedures used in reporting deficiencies are outlined in T.O. 00-35D-54. This technical order also includes information as to types of deficiencies to be reported such as: equipment, mechanical, and electrical operational deficiencies; workmanship errors; errors in technical publications (except editorial or spelling errors); deficiencies contributing to accidents resulting in personnel injury or property damage, etc.

Whenever conditions are found that fall within the policy expressed in T.O. 00-35D-54, they will be reported on AFTO Form 29 as shown in Figure 2-4. AFTO Form 29A, a continuation sheet, will be used when necessary. When completing this report make certain that the information is accurate and use plain, simple language in the body of the report (note figure 2-4 - Details).

Reports will be forwarded to your base UR control activity (Product Improvement Program Control Office). Here they will be screened to insure that no reports the cause of which are traceable to base procedures or lack of technical ability, are processed.

In addition to the UR described above "Emergency" UR's are provided. This type UR describes safety conditions, the known or suspected and uncorrected existence of which could result in fatal or serious injury to personnel, extensive damage or destruction of valuable property, or have a serious effect on the safety of the nation. Such conditions embody risk calculated to be intolerable.

Whenever conditions are found that fall within the policy expressed aboye, an Emergency UR will be accomplished. The reports will be forwarded immediately by telephone, multiple address teletype, radio or air mail message.

ELECTRONIC FAILURE REPORTS

In addition to UR's there is another method for reporting materiel deficiencies known as Electronic Failure Reports.

UNSATISFACTORY REPORT

1. ACTION AGENCY

SERIAL NO.
PROJECT NO.

2. CATEGORY (1. *Emergency* 2. *Urgent* 3. *Routine*)

☐ REPORTING ACTIVITY ☐ MAJOR COMMAND ☐ ACTION AGENCY

3. REPORTING ACTIVITY

UR SERIAL NO.	DATE	ORGANIZATION	STATION
	26 April 54	380th Bomb Sq (M)	F. E. Warren AFB, Wyo.

4. IDENTIFICATION

ITEM	Motor,Elec.,AC,1HP,1725 RPM, 115V
PROPERTY CLASS	Electrical Equipment --7700
STOCK OR PART NO	7700-572357-35
PRIME CONTRACTOR	
MANUFACTURER	Brown-Brockmeyer
ORDER OR SHPMT NO.	
PARTS CATALOG TO NO.	
FIGURE AND INDEX NO.	

5. SUPPLEMENTARY DATA

QUANTITY IN USE	4
QUANTITY IN STOCK	1
QUANTITY INSPECTED	5 QTY DEFECTIVE 1
NO. PREVIOUS FAILURES	1
LAST RECOND ACTIVITY	Civilian Contractor

6. USAGE (*Hours-Miles-Operations*)

SINCE NEW	48 hours
SINCE RECONDITION	

7. INSTALLED ON (*Indicate major components and end item on which defective item installed or applicable to*)

NAME	TYPE, MODEL AND SERIES	SERIAL NO.
Air Conditioning Unit	F 2	BB-643892

8. EXHIBIT DISPOSITION AND INCLOSURES (*Place X in proper blocks*)

☐ Attached ☐ Sent under separate cover ☐ Held for disposition instructions ☐ Repaired or returned to service ☐ To overhaul facility indicate below ☐ Disposed of (explain below) ☐ Inclosures (Indicate below)

9. DETAILS (*1. Circumstances prior to difficulty. 2. Description of difficulty. 3. Cause 4. Action taken. 5. Recommendations*)

1. Normal service and operating conditions are reflected by the log of operation and record of maintenance.

2. The armature winding was short-circuited, causing the motor to burn out.

3. Examination disclosed that defective insulation caused the wiring to become short-circuited.

4. No corrective action taken locally. The defective armature has been sent to Commanding General, Air Material Command, Wright Patterson AFB, Ohio.

5. The armature winding should be vacuum impregnated with insulating varnish and then baked until the varnish is set.

ALEX B. SMITH
1st Lt., USAF
Unit Supply Officer

AFTO 23 FORM JUN 54 29 REPLACES DD FORM 535, 1 OCT 53 WHICH IS OBSOLETE IN THE USAF.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1954-107226

Figure 2-4. AFTO Form 29

Due to the large number of electronic devices now in use by the Armed Forces, it has become imperative that pertinent electronics performance data be disseminated between military departments in order to:

1. Identify high failure-rate parts and tubes within specific equipments, including determination of misapplication.

2. Avoid the use of inferior parts, tubes, and materials in electronic equipment.

3. Identify equipments, circuits, parts, and tubes which are reliable.

4. Predict maintenance requirements.

Electronic Failure Reports will be submitted on the equipment listed in Appendices III, IV and V of T.O. 00-35D-54. You will not find many equipment items in these appendices that are directly involved with your job with the exception of some test sets. Generally, the reporting of failures on ground communication electronics and meteorological equipment is limited to equipment newly acquired in the inventory or equipment selected for special evaluation.

Electronic Failure Reports will be accomplished on DD Form 781-1 as shown in Figure 2-5. You can see from Figure 2-5 that not many entries are required in completing the Electronic Failure Report. It is important, however, that the entries made are accurate. The completed reports will be submitted to the prime Air Materiel Area or Air Force Depot as listed in the appendices mentioned above. In the case of ground communications and electronic equipment the reports are submitted to Rome Air Force Depot, Griffiss Air Force Base, New York.

REPORT THE FAILURE OF ONLY ONE PART OR TUBE ON THIS FORM

1. REPORT NO. 14	2. REPORTING ACTIVITY 58FIS ADC		3. REPAIRED OR REPORTED BY (NAME) A/3c F. James	4. DATE OF FAILURE 10-11-58
5. EQUIPMENT INSTALLED IN (TYPE AND NO.) P-58		6. TIME METER READING OR INSTALLATION LOG TIME 145.0	7. WAS MISSION ABORTED? ☐ YES ☒ NO	8. OPERATIONAL CONDITION 2-1.3
EQUIPMENT	9. MODEL DESIGNATION AND MOD. NO. GRT 3	10. SERIAL NO. 173	11. CONTRACTOR (Leave Blank)	12. CONTRACT OR ORDER NO. (Leave Blank)
COMPONENT (MAJOR UNIT)	13. MODEL DESIGNATION AND MOD. NO. T 282	14. SERIAL NO. 174	15. CONTRACTOR Gilfillan Brothers	16. CONTRACT OR ORDER NO. 176
ASSEMBLY OR SUBASSEMBLY	17. ASSEMBLY AND MOD. NO.	18. SERIAL NO.	19. MANUFACTURER	20. (LEAVE BLANK)
PART DATA	21. PART NAME OR TUBE TYPE 12AT7	22. STOCK NO. OF FAILED ITEM (Leave Blank)	23. PART REF. DESIG. (V-101, R-101, ETC.) U 10701	24. REPAIR TIME (MAN-HOURS) (Leave Blank)
	25. HOURS IN SERVICE (Leave Blank)	26. MANUFACTURER OF FAILED PART Sylvania	27. SERIAL NO. (Leave Blank)	28. WAS REPLACEMENT PART AVAILABLE LOCALLY? ☒ YES ☐ NO

29. FIRST INDICATION OF TROUBLE
1 ☒ INOPERATIVE
2 ☐ INTERMITTENT
3 ☐ LOW PERFORMANCE
4 ☐ NOISY
5 ☐ OFF FREQUENCY
6 ☐ OUT OF ADJUSTMENT
7 ☐ OVERHEATING
8 ☐ UNSTABLE
9 ☐ OTHER

30. CHECK TYPE(S) OF TUBE OR PART FAILURE
007 ☐ ARCING
710 ☐ BEARING FAILURE
760 ☐ BENT
040 ☐ SHORING
070 ☐ BROKEN
720 ☐ BRUSH FAILURE
080 ☐ BURNED OUT
130 ☐ CHANGED VALUE
170 ☐ CORRODED
001 ☐ GASSY
300 ☐ GROUNDED
380 ☐ LEAKAGE
730 ☐ LOOSE
004 ☐ LOW GM OR EMISSION
750 ☐ MISSING
006 ☐ NOISY
450 ☐ OPEN
099 ☐ OTHER
790 ☐ OUT OF ADJUST.
009 ☒ SHORTED
770 ☐ SLIP RING OR COMMUTATOR FAILURE
018 ☐ TESTED OK – DID NOT WORK
020 ☐ WORN EXCESSIVELY
☐ SEE INSIDE FLAP FOR ADDITIONAL CODES

31. CAUSE OF FAILURE
2 ☐ FAULTY PACKAGING
5 ☐ MISHANDLING
6 ☐ INSPECTION OR TEST
1 ☐ NORMAL OPERATION
3 ☐ STORAGE
7 ☐ ASSOCIATED FAILURE-EXPLAIN
4 ☒ OTHER 9

32. WAS THE PART REPLACED DURING PREVENTIVE MAINTENANCE? ☒ YES ☐ NO

DD FORM 787-1, 1 AUG. 54

Figure 2-5. Electronic Failure Report

PRODUCT IMPROVEMENT DIGEST

This particular publication is used for disseminating to service agencies (those who submit the UR's in the first place) information regarding unsatisfactory conditions reported to Headquarters. The Product Improvement Digests are distributed through the technical order system and in general accomplish the following:

1. Provide a digest of the deficiencies and problems being experienced on equipment which is subject to deficiency reporting.

2. Provide information on a continuing basis as to the correct action being taken or contemplated on existing problems.

3. Keep commands and activities informed of inherent deficiencies in AF equipment.

4. Portray chronologically corrective action on individual problems.

5. Provide a source from which interested agencies can build a historical reference file of equipment deficiencies.

This digest, T.O. 00-10-1, is revised each month and reissued as necessary to delete obsolete entries. The digest contains all information pertinent to unsatisfactory reports. It lists all the faults found which are applicable to Air Force equipment. Therefore, reference to this publication should be made prior to submitting an Unsatisfactory Report to ascertain if the deficiency you are concerned with is not already listed and action being taken to correct the deficiency.

SUMMARY

This chapter contains a general discussion of the Air Force Publications that the telephone installer repairman is most likely to use. To get answers to questions concerning the installation, maintenance, and operation of telephone equipment, you will use the publications contained in the Technical Order System. As with any type of publication, it is necessary to use the indexes provided. There are three indexes available: the numerical index (T.O. 0-1-01), the alphabetical index (T.O. 0-2-1), and a cross-reference index (T.O. 0-4-1). These indexes are contained in the first numbered binders of any properly maintained technical order file. To obtain information relative to the supply of items needed in the accomplishment of your job, it is necessary to use the indexes, catalogs, and stock lists contained in the Supply Catalog Data and Stock List Publications System.

At the present time there are two systems involved in the classification of supply items: USAF Property Classification and Federal Supply Classification. Under the USAF Property Classification System, items are grouped into classes and sub-classes. The class is identified by a class symbol (a two position number), the subclass is indicated by a letter. Under the Federal Classification System, supply items are classified into groups and classes. A four-digit coding system is used, the first two digits identify the group and the second two digits identify the class. Air Force property classification is gradually being replaced by the Federal Classification system. To gain a more thorough knowledge of the various publications discussed in this chapter, you will have to use them in a practical manner and study such references as T.O. 00-5-1, T.O. 00-5-2 and S-1. In addition, considerable knowledge may be gained by accomplishing the work problems that accompany this chapter.

REFERENCES

TO 00-5-1	AF Technical Order System
S-1	Supply Catalog and Stock List Publications
S-2	Distribution of Supply Catalog and Stock List Publications
S-1-1	Classification of AF Equipment and Supplies
TO 00-35D-54	Materiel Deficiency Reporting

REVIEW QUESTIONS

1. What is the purpose for the Air Force Technical Order System?
2. Time Compliance Technical Orders serve what purpose?
3. How can you identify Urgent Action Technical Orders?
4. Explain the numbering system used in the identification of Technical Orders.
5. Name the various Indexes provided with Technical Orders.
6. In general, what are the purposes of the publications contained in the Supply Catalog Data and Stock List Publications System? Name five.
7. Explain the USAF Property Classification coding.
8. Explain Federal Supply Classification coding.
9. List the various sections, or parts, included in a USAF Stock List.
10. Explain one method of determining the Federal Stock number for an item when the USAF stock number is known.
11. When is an Unsatisfactory Report used?
12. When are Emergency UR's used?
13. Why are Electronic Failure Reports used?
14. Electronic Failure Reports on ground communications and electronic equipment are submitted to what Air Force Depot?
15. What is the purpose of Technical Order 00-10-1?

WORK PROBLEMS

PROBLEM 1. Location of technical information.

Training Equipment: Technical Order File.

References: TO 00-5-2

Work Procedures: Using the numerical index, locate the Technical Order that includes information on each of the following items:

a. Field telephones
b. Spiral-four cable
c. Cable plow
d. The distribution of technical orders

PROBLEM 2. Location of stock numbers.

Training Equipment: Supply Catalog and Stock List File.

References: S-1

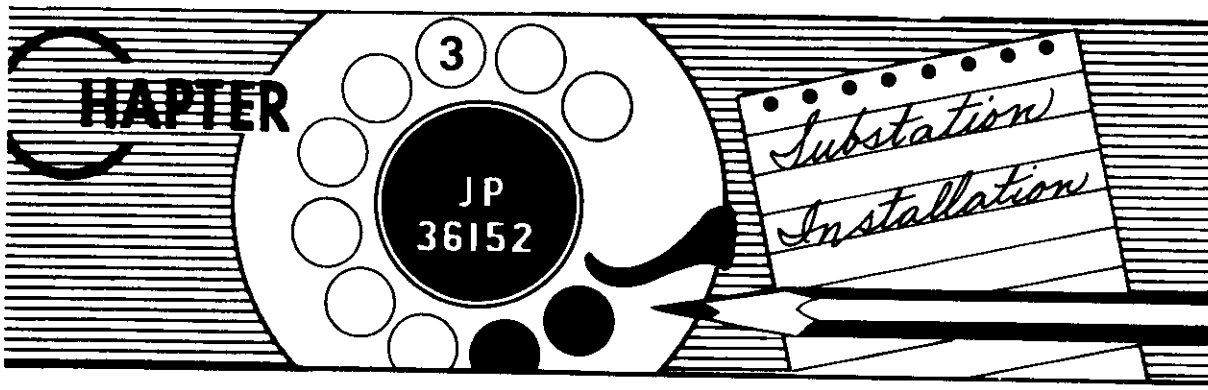
Work Procedure: Find the class code number for electric soldering irons. Find both the AF and Federal Stock numbers for any three items in your tool kit.

PROBLEM 3. Completion of AFTO Form 29.

Training Equipment: One copy of AFTO form 29.

References: TO 00-35D-54

Work Procedure: Using TO 00-35D-54 as a guide look up the information needed to complete a UR on an item of supply suggested by your supervisor.



The objective of this chapter is to aid you in learning the procedures and developing the skills and techniques used in making a complete substation installation. As you already know, the substation installation includes all of the wiring from the pole line or distribution terminal to the telephone set. This chapter will include the procedures used in planning and constructing outside wire runs, the various methods of making inside wire runs, and the techniques involved in mounting and connecting the telephone set and auxiliary equipment.

Substation installation is no hit or miss proposition. Although the over-all job may vary due to local conditions such as weather, base policies, type of installation, and size of installation team, accepted procedures and techniques should be followed to obtain a good installation.

A good installation is one that has a neat and orderly appearance and is capable of giving several years of trouble-free service. To be certain that the installations you make are good installations, and that equipment and materials are economically used, it is essential that you take time to plan the job. Remember, your reputation as an Installer-Repairman depends on the quality of the installations you make.

FACTORS TO CONSIDER IN PLANNING THE INSTALLATION

A great deal of confusion, many headaches and much expense may be avoided by following a planned procedure in accomplishing our work. Planning may be defined as the act of pre-arranging details. It is the method or course of action decided on to accomplish a certain task. Good planning results when such factors as job quality, time, and expense are considered. Determining in advance the steps necessary to solve a particular problem or accomplish some job is not a difficult undertaking. It differs very little from planning a fishing trip. Poor plans are not often made, they all usually have merit. The trouble we get into is generally caused by no plans or incomplete plans.

Your first step in making plans for any installation is to go to the installation site and verify the information on the TWO (Telephone Work Order). Check the assigned pair or circuit with the test board. Talk with the subscriber to determine the desired location of the subset and if there are any unusual activities that would affect the installation. It is also important to look for any unusual conditions that may affect the completed installation at a later date such as the use of cranes or booms within the area, planned building expansion, and temporary buildings or partitions.

You are now ready to plan the routes for the outside and inside wire runs and the approximate location of the building entrance hole. To effectively make these plans, you consider such factors as clearance requirements and protection requirements, and the equipment and materials needed.

Location	Minimum clearance (ft)
Crossings:	
Over railroad tracks of railroads handling freight cars on top of which men are permitted.	27*
Other railroads.	18
Streets or roads.	18**
Spaces or ways accessible to pedestrians only.	10
Along streets, alleys, roads:	
Streets or roads.	18
Rural roads or right-of-ways.	14***

Clearance may be reduced to:

* 25 ft for communication cable on messenger strand which crosses over railroad tracks of railroads handling freight cars on top of which men are permitted.

** 16 ft at the side of the travelled way for service drops, unexposed guys, and effectively grounded or insulated guys exposed to voltages up to 8,700 volts between phase wire and ground where communication conductors cross streets or roads.

*** 8 ft for communication conductors of zero to 160 volts to ground crossing over spaces or ways accessible to pedestrians only; or 13 ft where no part of the line overhangs any part of the travelled way, and where it is unlikely that loaded vehicles will cross under the line at rural roads or right-of-ways.

Figure 3-1. Minimum Vertical Clearances

Separations Measured Between	Applicable Minimum Separations (in.)	
	Up to 8,700 volts	Over 8,700 volts
Power and communication crossarms (center to center).	48	72
Power and communication conductors (at the pole).	40	60
Power conductors and communication equipment.	40	60
Communication conductors and power equipment.	40	60
Power equipment and communication equipment.	40	60

Figure 3-2. Minimum Vertical Separations

*Type of Conductors or Structures Crossed or Paralleled by Telephone Wiring	Minimum Separations or Required Protection For Telephone Wiring			
	Ground Rod		Water Pipe Ground	
	Separation (in.)	Protection	Separation (in.)	Protection
Open Power Wiring (Not over 750 volts)	3	insulating tube	2	insulating tube
Conduit and Armored Lead or Plastic Sheath Cables Enclosing Foreign Wires Other Than Radio Wires	3	two layers of rubber tape and two layers of friction tape	½	two layers of friction tape
Radio Antenna Lead-in and Ground Wires	4	insulating tube	4	insulating tube
Open Signal Wires Confined to Building or Equipped with Approved Protector at Building Entrance	3	two layers of rubber tape and two layers of friction tape	½	two layers of friction tape
Open Signal Wires Extended Beyond Building and Not Equipped with Approved Protector	3	insulating tube or two layers of rubber tape and two layers of friction tape	2	insulating tube or two layers of rubber tape and two layers or friction tape
Water Pipes	3	two layers of rubber tape and two layers of friction tape	½	one layer of rubber tape and one layer of friction tape
Sewer, Gas or Oil Pipes and Across Metal Beams	3	two layers of rubber tape and two layers of friction tape	½	two layers of friction tape
Bare Steam Pipes	3	insulating tube	½	insulating tube
Exposed Telephone Wires	2	insulating tube	2	insulating tube
Neon Signs	6	cable with grounded sheath	6	cable with grounded sheath

Figure 3-3. Minimum Separations and Alternate Protection Requirements

WIRE CLEARANCES

The Air Force has established various wire clearance specifications that must be complied with to insure safe, trouble-free installations. It should be obvious that in assuming the duties of a 5-level technician, you will need a working knowledge of specifications. Clearance specifications for outside wire runs consists of the vertical distance between the ground level and the lowest point in the wire span, and the vertical separation between the telephone plant and other services. Inside wire runs also require specific separation from foreign obstacles unless certain mechanical protection is used. Figures 1, 2, and 3 list the required clearances that affect substation installations.

PROTECTION REQUIREMENTS

Installing protectors is probably "old stuff" to you; but, do you know why a protector is used, when one is required, and what type to use for a particular installation? The purpose of station protectors is to protect station apparatus (subsets and auxiliary equipment) against abnormal surges of current from power lines and lightning. Long aerial telephone circuits are particularly subject to these abnormal current surges. On the other hand, underground cables which have no connections with aerial wire are so well shielded that lightning affects them very little. If protectors are not used on circuits subject to abnormal surges of current (exposed plant), equipment may be damaged and persons using the equipment may be injured.

To determine the need for protectors in any installation you plan, follow this rule. A station protector must be installed at <u>all</u> aerial drop and block wire installations, unless all of the following conditions apply:

1. The installation order specifies that a station protector is not required.

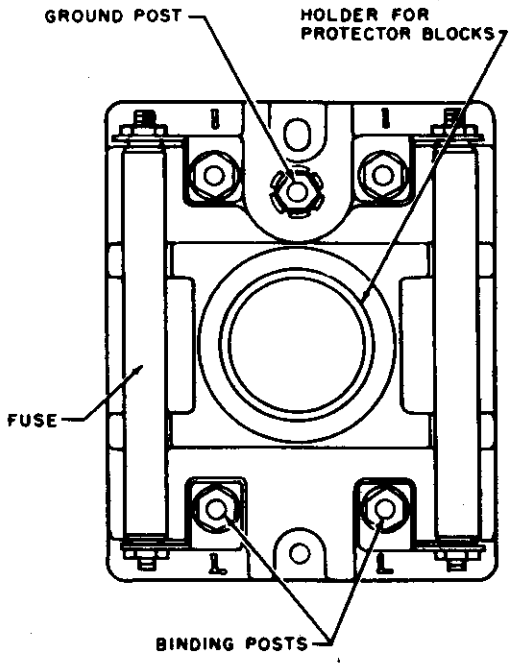


Figure 3-4. Typical Station Protector, Fused Type

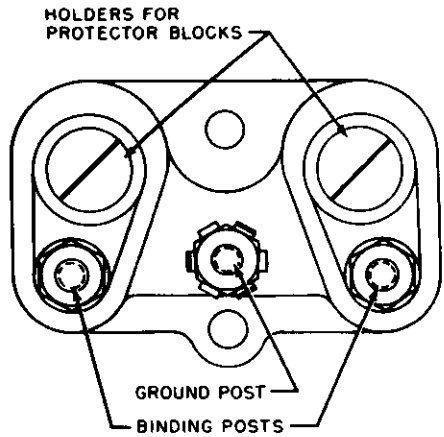


Figure 3-5. Typical Station Protector, Fuseless Type

2. No exposure will be introduced to the installation by drop or block wire installation.

3. The drop or block wire will not be connected to an exposed facility.

NOTE: A drop or block wire shall be considered exposed under the following conditions: (1) when the wire crosses or parallels below power lines operating at 300 or more volts, (2) when the wire bridges to an open wire circuit, and (3) when the wire bridges to an exposed cable.

All telephone circuits involving aerial cable or open wire plant are generally classified as exposed. Therefore, as a general rule, protectors are used with all installations connected to aerial plant facilities.

There are two general types of station protectors--fused and fuseless. The design of each type varies slightly, depending on the manufacturer. The fused type (figure 3-4) is the type generally used in conjunction with aerial drop and block wire runs. The fuseless type protector (figure 3-5) may be used only at stations served directly from grounded sheath cable.

MATERIAL REQUIREMENTS FOR OUTSIDE WIRE RUNS

Another responsibility of the Crew Leader when planning an installation is to make sure that his crew is well equipped with the proper tools, wire, building attachments, and anchoring devices necessary to complete the installation. The normal drop and block wire installation can usually be accomplished with the regular installer's tools and additional special tools, as required by the particular installation; however, it is best to make a careful survey of the materials needed. In selecting wire for outside runs you have three types to choose from: Parallel drop, twisted pair block, and twisted pair bridle. Each type of wire is designed for a specific purpose; to insure a good installation, use it accordingly.

Parallel drop wire is primarily intended for use in span runs. (The portion of aerial or block wire run extending from the open wire or cable terminal to the first building attachment). Parallel drop wire may also be used on building runs to avoid the necessity for splicing. For economy and ease of handling, however, twisted pair block wire is preferred for building runs. Twisted pair block wire is intended for use on building runs (the portion of drop or block wire run between the first building attachment and the station protector). Twisted pair block wire is also used as an inside duct wire in locations where extreme moisture is present. Never use twisted pair block wire in span runs, except in building to building spans less than 35 feet in length. Twisted pair bridle wire should be used for building connections between open wire circuits and pole mounted drop wire and cable terminals. Twisted pair bridle wire should not be used for span or building runs. Figures 3-6, 3-7, 3-8, and 3-9 illustrate the types of outside wire.

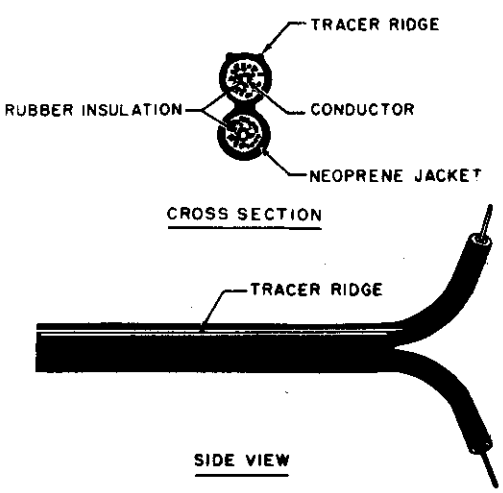


Figure 3-6. Parallel Drop Wire Dumbbell

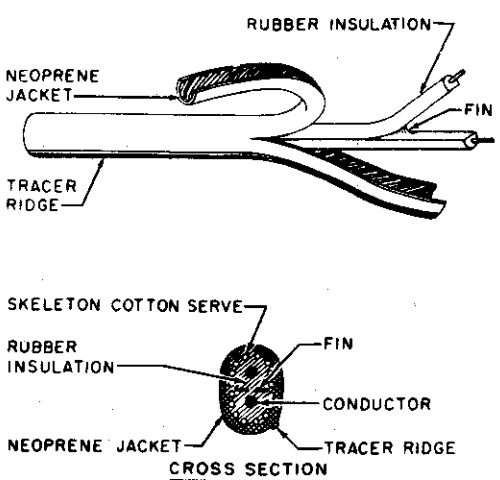


Figure 3-7. Parallel Drop Wire Jacketed

There are different types and kinds of building attachments and anchoring devices provided to support drop and block wire runs. Just as with wire, the attachments are designed for specific uses. It is necessary to consider the following conditions in selecting the attachments to be used:

1. The number of wires to be supported.

2. The building surface (frame, brick, masonry) on which the wires are to be installed.

3. The storm loading district.

4. Is the installation exposed or unexposed?

NOTE: All exposed building runs must be insulated from flammable or conducting surfaces; in other words, the wire must be supported so that it does not make contact with the building.

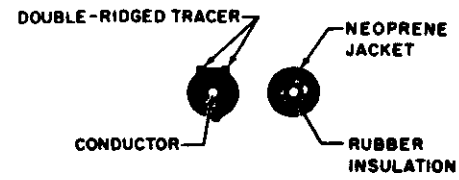


Figure 3-8. Twisted Pair Block Wire

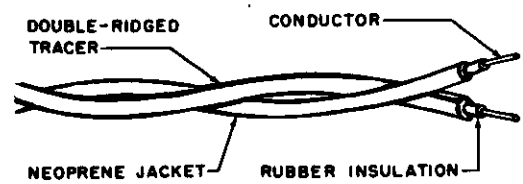


Figure 3-9. Twisted Pair Bridle Wire

Mounting Surface	No.	Anchoring Device Description
Masonry or Substantial Brick Veneer		
Corner Bracket	2	¼ x 1¼ in. hammer drive anchors
Split Knob	1	2½ in. No. 10 rd hd wood screw in 10-14 x 1 in. screw anchor
Drop Wire Hook	1	7/16 x 1¾ in. hammer drive anchor
⅝ or ⅞ in. Drive Ring	1	¼ x 1 in. hammer drive anchor
Hollow Tile		
Corner Bracket	2	¼ x 3 or 4 in. rd hd toggle bolts
Split Knob	1	⅛ x 4 in. bd hd toggle bolt with washer under bolt head or 5/16 x 4 in. bd hd toggle bolt without the washer
Drop Wire Hook	1	5/16 x 5 in. rd hd toggle bolt with 5/16 x 1 in. rd washer between hook and mounting surface
Thin-Wall Brick Veneer		
Corner Bracket	2	No. 14 rd hd wood screws long enough to penetrate the wood backing for approx. 1 in.
Drop Wire Hook	1	No. 18 rd hd wood screw long enough to penetrate the wood backing for approx. 1 in.
⅝ or ⅞ in. Drive Ring	1	¼ x 1 in. hammer drive anchor
Exposed Woodwork		
Corner Bracket	2	2 in. No. 14 rd hd wood screws
Split Knob	1	2½ in. No. 10 rd hd wood screw
Drop Wire Hook	1	2 in. No. 18 rd hd wood screw
Stucco on Wood		
Corner Bracket	2	2½ in. No. 14 rd hd wood screws*
Split Knob	1	3 in. No. 10 rd hd wood screw

* Use 3-in. screws if necessary to penetrate sheathing or studding.

Figure 3-10. Anchoring Devices for Use with Building Attachments

The selection of anchoring devices depends on the attachment to be installed and the building's surface on which the installation is to be made. Figures 3-10 and 3-11 will aid you in the selection and proper use of building attachments and anchoring devices.

Maximum Number of Drops	First Attachment	Intermediate Attachment	Last Attachment
		Masonry (Concrete, brick, tile)	
1 or 2	Drop Wire Hook or Corner Bracket	5/8 in. Drive Rings	5/8 in. Drive Rings
3 or More	Drop Wire Hook for Each Two Drops — Corner Bracket for Each Four Drops	5/8 in. Drive Rings*	5/8 in. Drive Rings*
		Frame (wood, stucco on wood, metallic siding on wood, thin brick veneer)	
1 or 2	3/8 in. Angle Screw or Corner Bracket	Split Knob or Insulated Screw Eye	Split Knob
3 or More	3/8 in. Angle Screw for Each Two Drops**** — Corner Bracket for Each Four Drops**	Split Knob for Each Two Drops — 5/8 in. Insulated Screw Eye***	Split Knob for Each Two Drops

* When maximum number of drops exceeds six, use 7/8 in. Drive Ring.

** For Heavy Loading District, maximum number of drops reduced to two.

*** When maximum number of drops exceeds six, use 1 in. Insulated Screw Eye.

**** For Heavy Loading District, maximum number of drops on 3/8 in. Angle Screw is reduced

Figure 3-11. Types of Building Attachments for Use

MATERIAL REQUIREMENTS FOR INSIDE WIRE RUNS

The materials and equipment needed for placing the inside (station) wiring is usually determined by the wiring facilities already available. Most large, modern buildings are constructed with conduit systems to provide for inside wire runs. In planning this type of installation the best approach is to obtain a drawing of the conduit system. The drawing should indicate the type of conduit, the duct routing or runs, and the location of outlets.

There are three types of wire generally used for station wiring: plastic-jacketed station wire, block wire, and cross-connecting wire. Plastic-jacketed station wire should be used for all station wiring except on wire runs or parts or wire runs that are close to heating ducts, furnaces, or other locations where temperatures might exceed 212° F, or where extreme moisture might exist. Block wire should be used where the wire will be exposed to extreme heat or moisture and where the station wiring extends outside the building to outdoor telephone sets or extension ringers. Cross-connecting wire is used for making cross-connections in cable terminals. The various attachments provided for supporting station wire are illustrated in figure 3-12.

Some station wire runs require mechanical protection at various points along the run; consequently, it is necessary that a good supply of friction tape, rubber tape, and insulating tubes are available for installing the station wire. Figure 3-3 lists the requirements for placing mechanical protection.

After your preliminary plans are complete for the building run, span run, and inside wire run, it is good practice to recheck and make certain that all parts of your plan will fit together. You may find it necessary to revise your proposed wire routes due to clearance and separation requirements, insulating problems, type of building construction, and other obstacles. Remember, a little more time spent in planning any job results in fewer problems and less time spent in doing the job.

Up to this point, general areas that the installer should consider in planning an installation have been explained. To help you apply these requirements to actual installations, we will now cover the detailed procedures used in installing a substation.

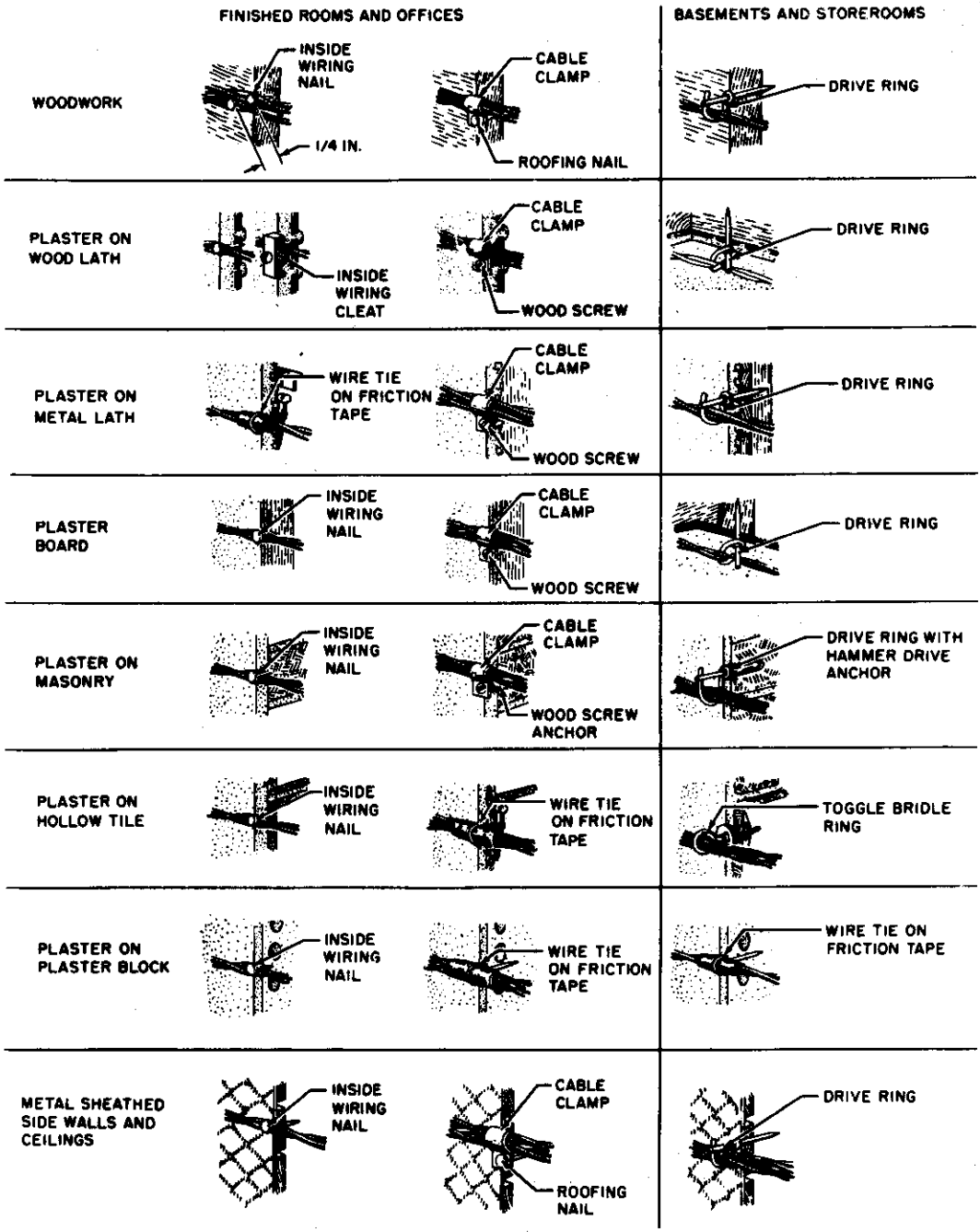


Figure 3-12. Typical Station Wire Attachments on Usual Types of Wall Surfaces

PLACEMENT OF BUILDING RUNS

The following procedure is suggested for your use in placing building runs.

1. Locate the entrance hole. The hole should be located to provide the shortest possible run on the outside of the building without causing inside wiring problems. It is best to select a point at or immediately above the building foundation sill or at wooden door or window frames. Entrances through metal frames should be avoided.

2. Drill the entrance hole. In general, make the hole large enough to accommodate the immediate and anticipated number of wires that will be run into the building; however, do not make the hole diameter greater than one-half the width of the material through which the hole is made. If necessary, drill another hole. If an insulating tube is used, refer to figure 3-13 to determine the hole size.

Entrance holes should be drilled so that they slope upward from the outside. When entering through brick walls however, make the hole in a seam between the bricks. It is good practice to drill from the side where good appearance is most desirable.

CAUTION: Use goggles when drilling to avoid injury from flying particles.

Tube Size	Size of Entrance Hole
3/8 inch	3/4 inch
3/4 inch	1 1/4 inch
1 inch	1 1/2 inch

Figure 3-13. Entrance Hole Sizes for Insulating Tubes

When it is necessary to locate the entrance hole at metal window frames set in masonry, drill halfway from the inside of the building and halfway from the outside. Start the holes so that they meet approximately three inches behind the visible end of the window frame.

3. Place the insulating tube. All exposed stations require the use of tubes except where service entrance conduits are provided or when the entrance hole is made entirely through brick or masonry. Install the tube so that there is at least 1/4 inch of the tube projecting beyond the surface of the wall. However, do not allow more than a one-inch projection; cut the tube if necessary. Place enough layers of friction tape around the outside end of the tube to provide a snug fit in the entrance hole.

4. Locate and install protector. Station protectors should be located where they are readily accessible for inspection and maintenance and as close as possible to the entrance hole. Select a location that will permit as short and direct run for the ground wire as possible. When the protector is mounted outside, do not place it more than five feet above the ground level. A clearance of one foot or more is required between protectors and any power installations. Figure 3-14 illustrates typical conductor terminations at both fused and fuseless protectors.

Figure 3-15 shows the conductor arrangement for protectors mounted on the outside of a building in a protector mounting.

As you know, all station protectors must be connected to ground. Following is a list of suitable grounds listed in the order of their preference. The installer has no choice in the matter but must select the first listed ground available.

1. The cold water pipe of a public or base water system.

2. The cold water pipe of a private water system, provided the system contains at least ten feet of buried pipe.

3. A permanently installed metal tank, conduit, or pipe.

4. A ground rod. In some types of soil (dry and sandy), and in extremely cold regions, one rod will not provide an adequate ground. In such cases, install several ground rods at least six feet apart and strap them together.

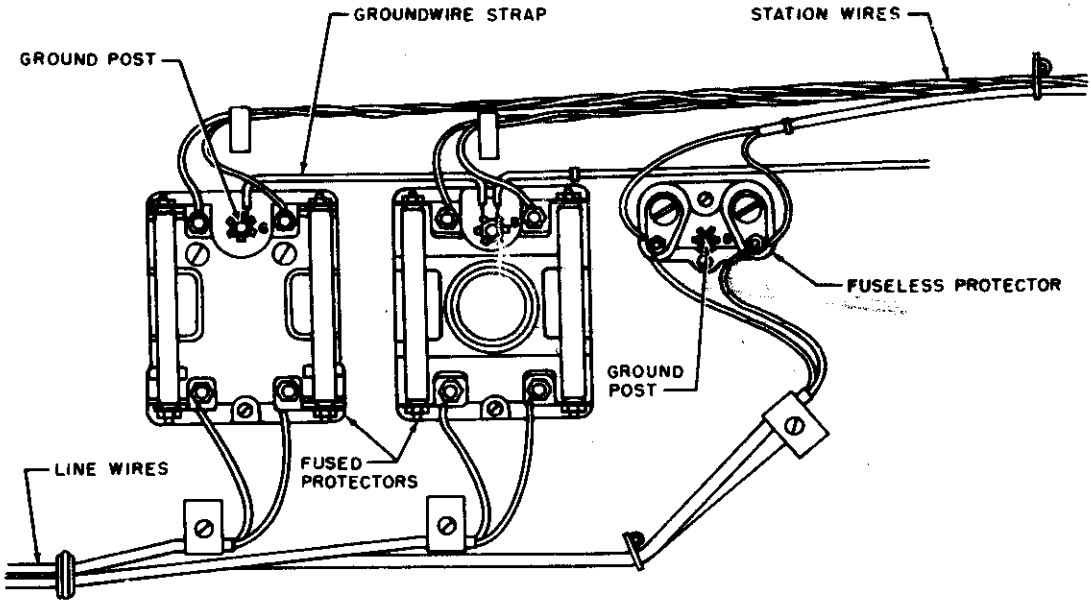


Figure 3-14. Typical Conductor Terminations at Station Protectors

There are three sizes of ground wire available for making ground connections: numbers 6, 12, and 14 AWG rubber or plastic insulated wire. One fuseless protector or three fused protectors may be grounded through number 14 wire. Two fuseless or five fused protectors may be grounded through number 12 wire. Any number of protectors may be grounded through number 6 wire. If a ground rod is used instead of the other perferred grounds, a separate rod with separate ground wiring must be placed for each protector and the rods must be at least 12 inches apart.

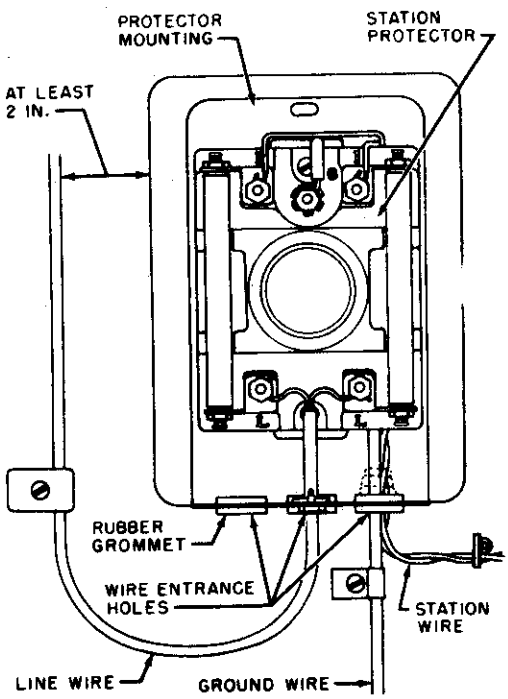


Figure 3-15. Typical Conductor Arrangement, Station Protector in Protector Mounting

5. Place the building attachments. Locate the first building attachment to provide the best point of departure for the span run. (Do not forget the ground level clearance requirement, figure 3-1.) Locate the last building attachment close to the entrance hole and, if possible, below the level of the entrance hole. Next, locate and install intermediate attachments as required to support the wire in accordance with insulating and clearance requirements. Intermediate attachments in horizontal runs should be spaced not over 9 feet apart; in vertical runs, the attachments should not be placed over 12 feet apart. Uniform spacing adds to the appearance of the installation. Figures 3-16, 3-17, and 3-18 are illustrations of typical building runs.

6. Connect the building run to protector. See figures 3-14 and 3-15.

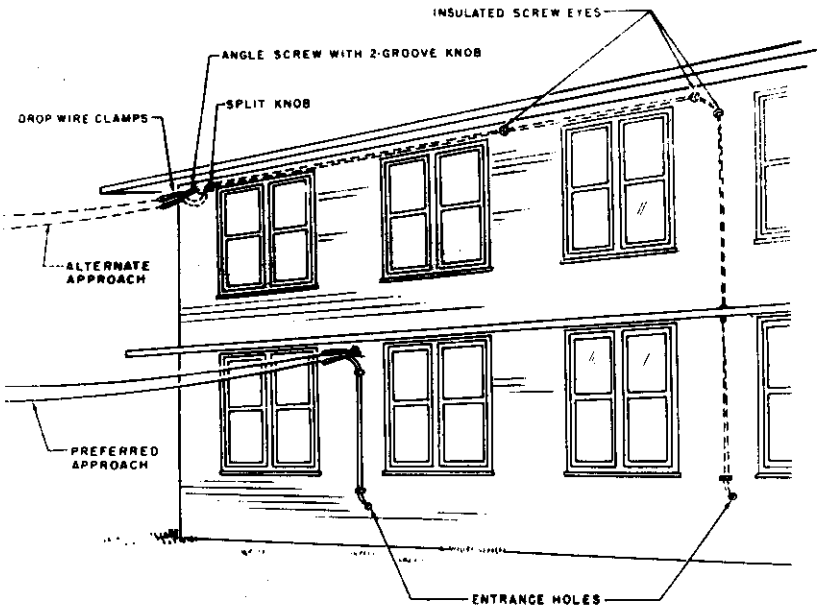


Figure 3-16. Typical Building Run, Frame Building

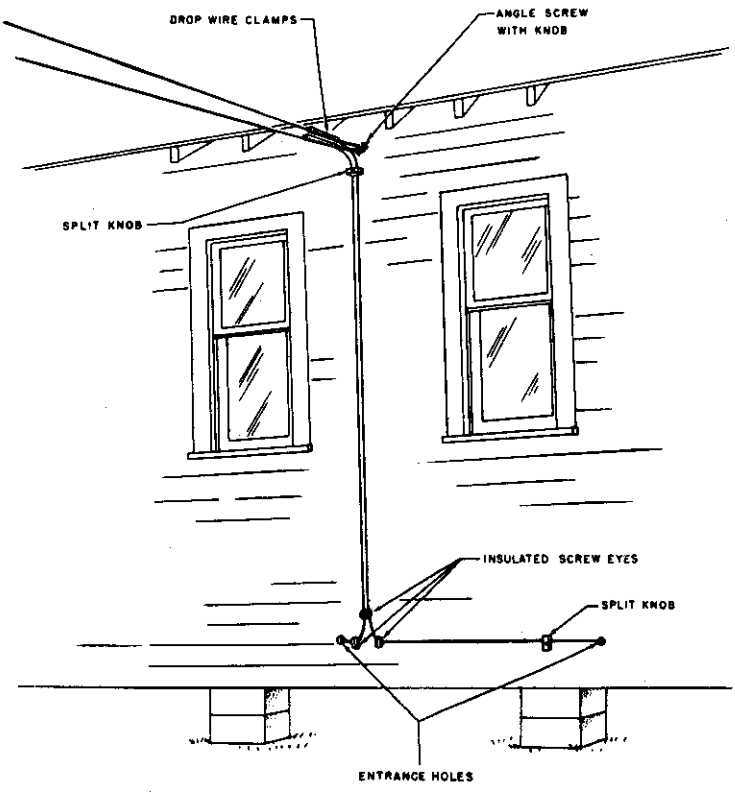


Figure 3-17. Typical Building Run, Frame Building

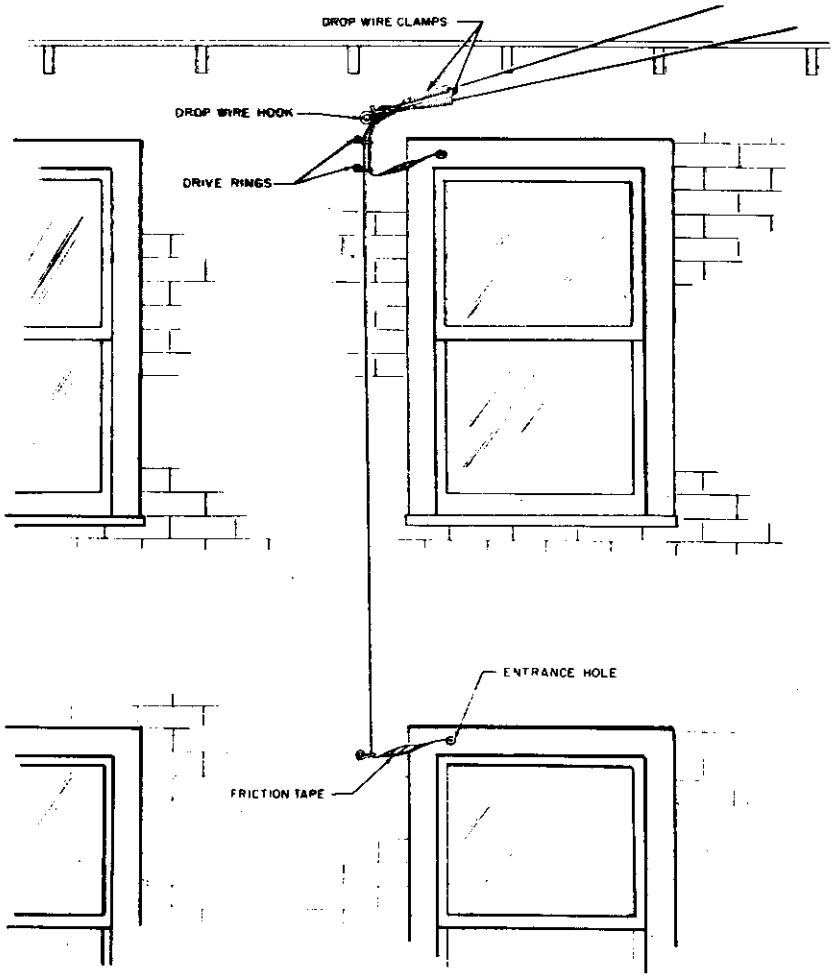


Figure 3-18. Typical Building Run, Masonry Building

7. Run wire through attachments. Start with the last building attachment and through the intermediate attachments to the first attachment. If the last attachment is not located below the entrance hole, make a 2-inch drip loop in the wire as shown in figure 3-19.

8. Secure the end of building run. Loop the wire around the first attachment and close the loop with a drop wire clip.

9. Attach drop wire clamp. Attach the clamp to the free end of the drop wire and place the loop of the clamp over the first building attachment. Allow a little slack between the clamp and the building attachment to avoid sharp bends in the wire. (See figures 3-20 and 3-21.)

On installations where it is necessary to make turns in the outside building run, make the turns according to specifications to insure a well constructed, neat appearance. Drive rings, insulated screw eyes, or split knobs may be used to make turns in the building run. Again, the selection of attachments depends on whether an insulated run is required.

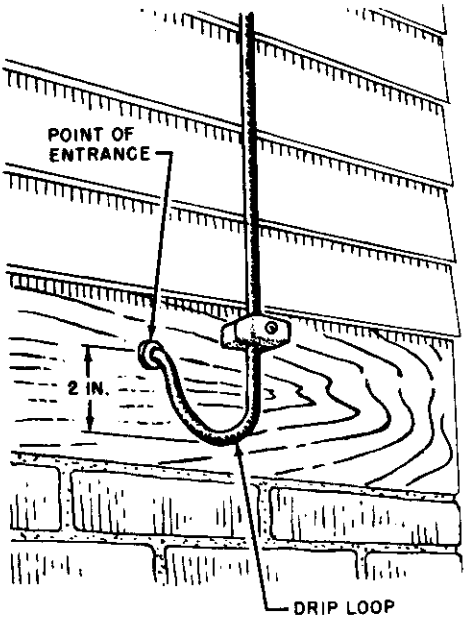


Figure 3-19. Last Attachment above Level of Entrance Hole

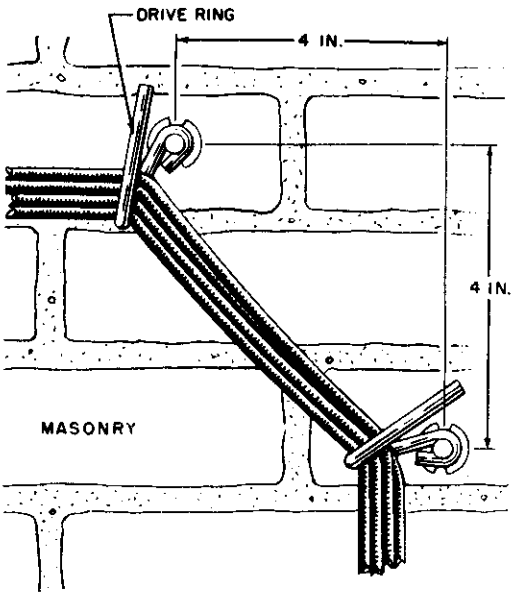


Figure 3-22. Vertical to Horizontal Turn, Drive Rings

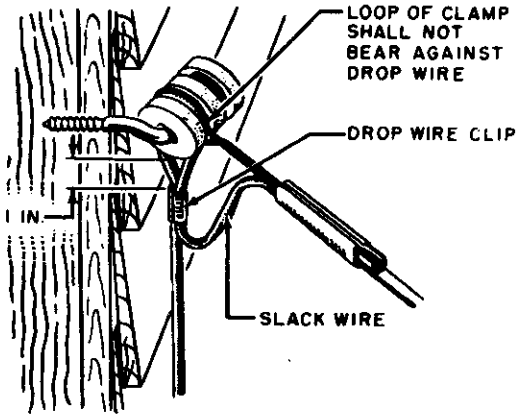


Figure 3-20. Typical Arrangement of Drop Wire at First Building Attachment, Angle Screw

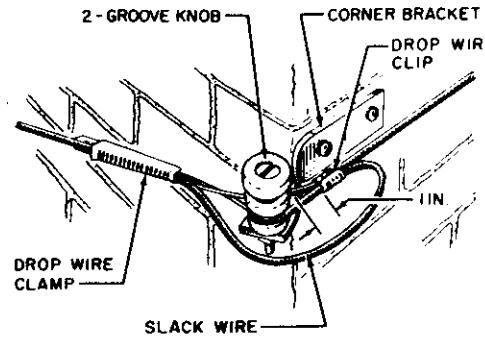


Figure 3-21. Typical Arrangement of Drop Wire at First Building Attachment, Corner Bracket

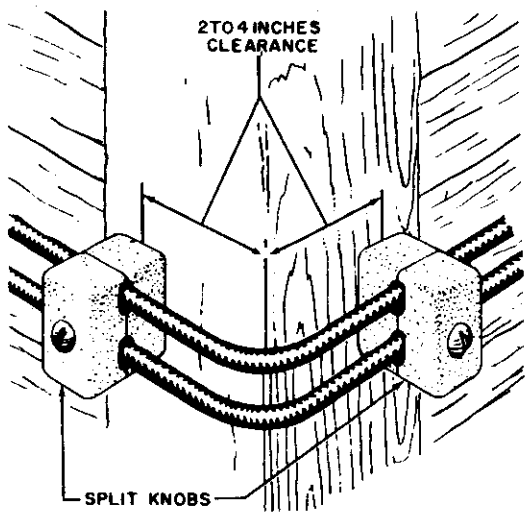


Figure 3-23. Outside Corner Turn Split Knobs

10. Provide mechanical protection as required. If the installer is not thinking, he may overlook this step. You are aware that frayed drop or block wire insulation is often the cause of trouble reports during wet weather. Wire that has been crushed or rubbed on sharp edges breaks easily. These conditions often result because the installer did not provide the necessary mechanical protection for the wire.

Building runs should be mechanically protected from all direct contact with building projections, overhangs, gutters, rain spouts, gratings, and other obstacles. Mechanical protection is also required at all points along the building run where minimum separations cannot be maintained between foreign wires and drop or block wires. Figure 3-3 shows protection requirements. Figures 3-24, 3-25, and 3-26 illustrate methods of providing mechanical protection.

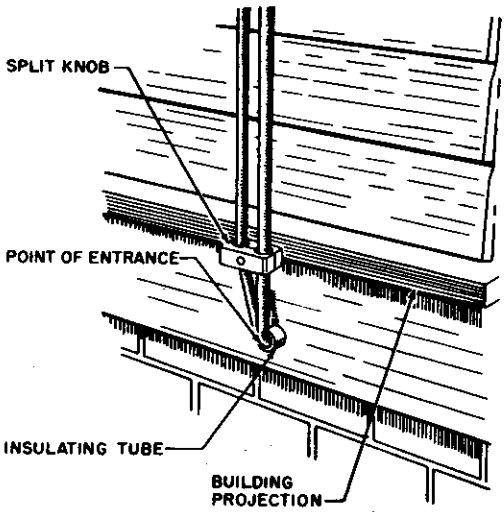


Figure 3-24. Typical Use of Split Knob at Building Projection

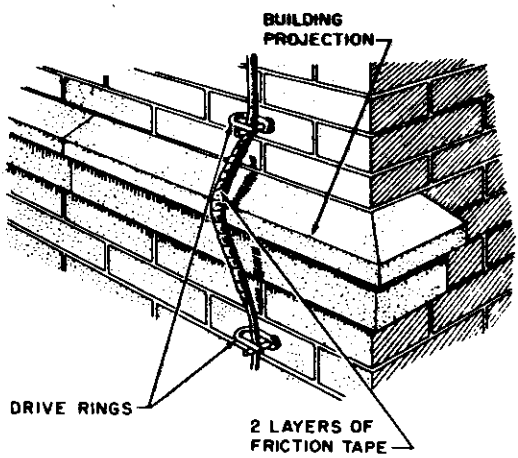


Figure 3-25. Typical Mechanical Protection at Building Projection

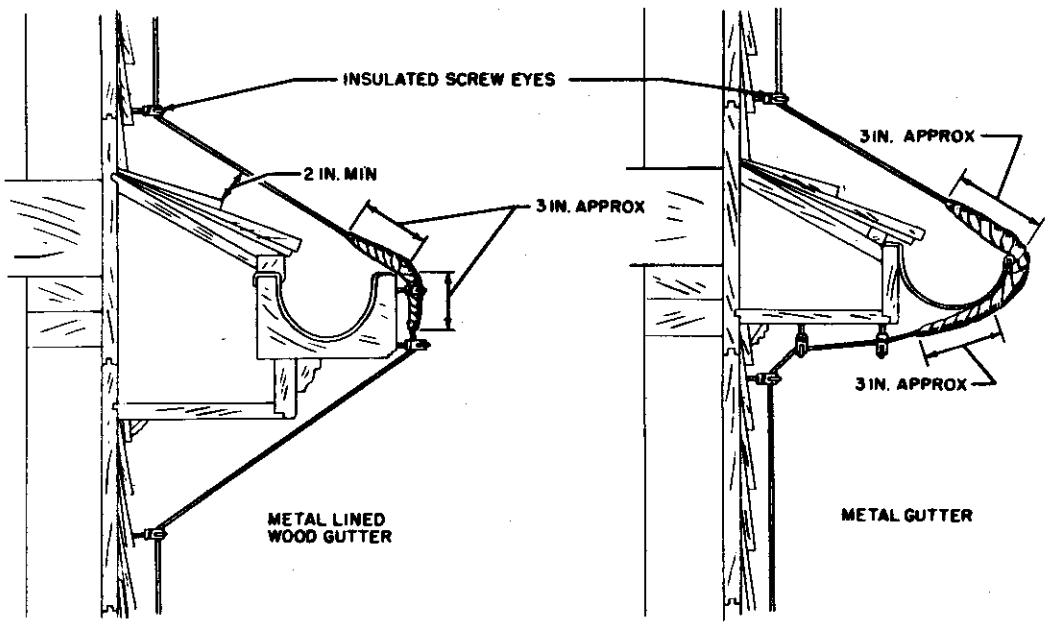


Figure 3-26. Typical Mechanical Protection at Overhang or Gutter

PLACEMENT OF SPAN RUNS

Installing drop wire from the first building attachment to the cable terminal or open wire connection in accordance with sag, tension, and clearance specifications, can be a difficult part of the installer's job. To understand the importance of proper sag and tension you should realize that in any aerial wire construction, sag and tension are related and each will change with changes in the temperature and with loads of ice or wind. It is these changes that cause trouble in aerial drops. For example, during periods of hot weather the wire expands in length causing an increase in the amount of sag; the increased sag may allow the drop to contact power wires, trees, or other obstacles resulting in damage to the wire and a breakdown of service. During periods of extremely cold weather the reverse is true; the wire decreases in length (tightens up) and if improperly sagged causes excessive strain on the wire and building and pole attachments. The effects of wind and ice are obvious.

SAGS AND TENSIONS

On short spans or where clearance is not a critical factor, an experienced installer can usually determine the proper sag by the amount of pull on the wire and a rough line of sight along the span. However, if you are not certain of your sag or tension and if clearances are critical, measure to be sure that you obtain at least the minimum sag requirement.

Minimum stringing sag requirements are listed in figure 3-27. The following procedure can be used in obtaining correct drop wire sags.

Span Length (ft)	*Stringing Sag*	*Approx. Final Unloaded Sag Following Storm Loading*	*Sag Increase From Stringing To Final Condition*
HEAVY LOADING AREA			
50 (or less)	0 ft 6 in	0 ft 6 in	—
75	1 ft 0 in	1 ft 0 in	—
100	1 ft 9 in	2 ft 0 in	0 ft 3 in
125	2 ft 10 in	3 ft 4 in	0 ft 6 in
150	4 ft 0 in	4 ft 10 in	0 ft 10 in
175	5 ft 6 in	6 ft 7 in	1 ft 1 in
200	7 ft 0 in	8 ft 6 in	1 ft 6 in
225	9 ft 0 in	10 ft 10 in	1 ft 10 in
250	11 ft 2 in	13 ft 4 in	2 ft 2 in
MEDIUM AND LIGHT LOADING AREAS			
50 (or less)	0 ft 6 in		
75	1 ft 0 in	Same	No
100	1 ft 9 in	as	
125	2 ft 10 in	Stringing	Increases
150	4 ft 0 in	Sags	
175	5 ft 6 in		
200	7 ft 0 in		
225	9 ft 0 in		
250	11 ft 2 in		

Figure 3-27. Minimum Stringing Sags for Drop Wire Spans

1. Measure the span length.

2. Consult figure 3-27 for the minimum sag in inches for the measured span length.

3. Measure down from the first building attachment a distance equal to the required stringing sag and place a suitable sighting mark or target.

4. Measure and mark the same distance down from the pole attachment.

5. Sight from the marked point on the pole to the sighting mark or target on the building. If any part of the wire span falls below this line of sight, the sag exceeds the minimum requirement. If clearance specifications are not met, pull up the drop wire until the low point meets the line of sight. If the wire is completely above the line of sight, let out the wire until the low part in the span meets the line of sight.

The maximum sag in drop wire span runs is determined by the clearance requirements, appearance, and the possibility of damage from swinging contacts with other wires or obstructions. Normal practice is to sag drop wires at approximately (but not less than) the minimum sags listed in figure 3-27. These listed stringing sags are set up to give good operating tensions (about 30 lbs.) in drop wire spans and still maintain required ground clearances under usual conditions.

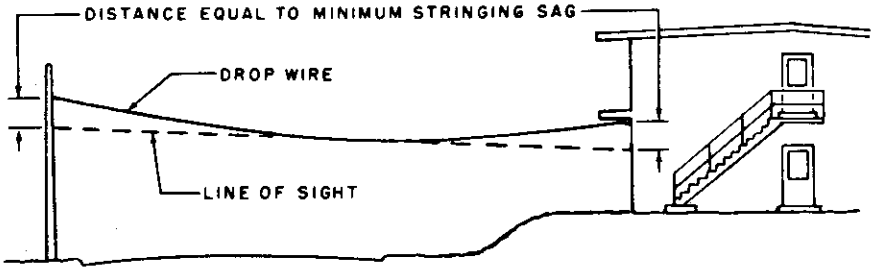


Figure 3-28. Drop Wire Strung to Minimum Stringing Sag

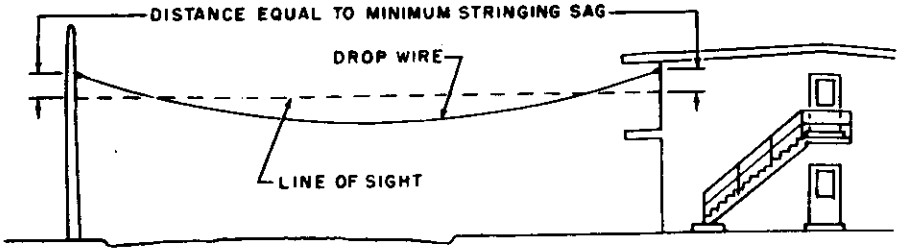


Figure 3-29. Drop Wire Strung to Exceed Minimum Stringing Sag

PLACEMENT OF ATTACHMENTS

You will find situations where it is impossible to obtain the required clearance in your proposed span run. There are several ways to overcome this problem:

1. Locate the first building attachment high enough to gain the proper clearance.

2. Locate the first attachment on the side of the building away from driveways, thoroughfares, or other obstacles.

3. Decrease the minimum sag requirement by dividing the span into shorter span lengths. (When the installation is fed by an aerial cable lead, shorten the span length by running the drop wire from the first building attachment to a nonterminal pole, or to a span clamp on the cable strand nearer to the building than the terminal pole, and hence along the strand to the terminal pole.)

4. Run a building-to-building span from an adjacent building.

5. Erect intermediate poles.

Figures 3-30, 3-31, and 3-32 illustrate different methods of routing span runs.

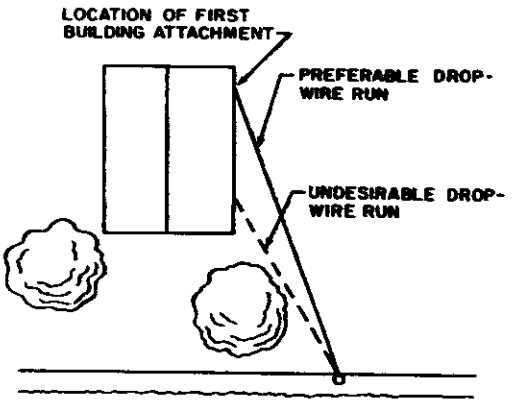


Figure 3-30. Avoiding Tree Interference, Location of First Building Attachment

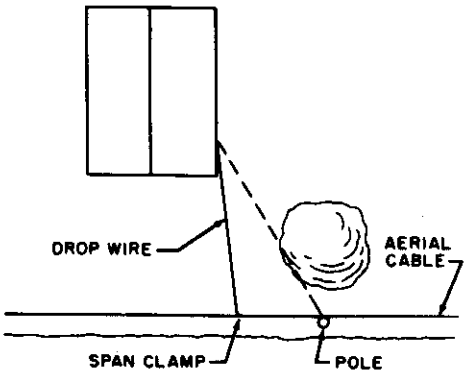


Figure 3-31. Avoiding Tree Interference, Run to Span Clamp

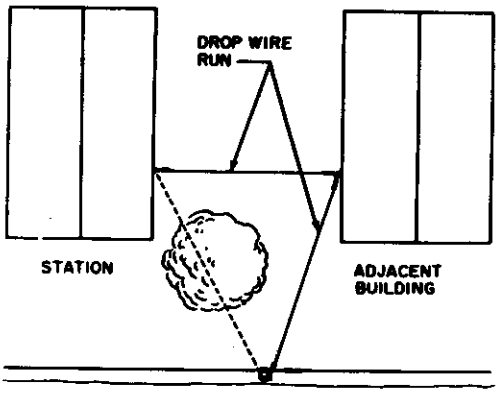


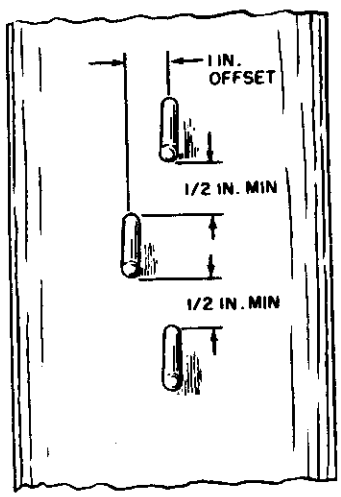
Figure 3-32. Avoiding Tree Interference, Run to Adjoining Building

Depending on the method you use, the drop wire will run from the building directly to the terminal pole or to an intermediate pole, to a span clamp, or perhaps to another building.

The most commonly used devices for attaching drop wire to poles are drive hooks and drop wire clamps. Locate drive hooks below the strand if the required clearance above the ground and from foreign wires and other obstacles can be obtained. You may locate drive hooks above the strand where clearance is critical. The distance from the strand may be varied. If more than one drive hook is placed on the same side of the pole, stagger the hooks at least one inch, and leave a one-half inch space between the top of the bottom drive hook and the bottom of the top drive hook as shown in figure 3-33.

Install drive hooks deep enough into the pole to leave only one-half inch space open for the attachment of the drop wire clamp.

The number of drop wires that may be attached to one drive hook varies according to the directions of the spans away from the pole. Use figure 3-34 in determining how many drops may be attached to one drive hook.



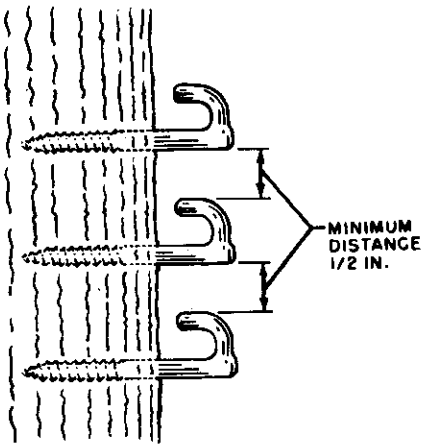


Figure 3-33. Staggering of Close Spaced Drive Hooks

Figure 3-35 shows the use of drive hooks in supporting a span run along an aerial cable lead.

Direction of Spans	Paralleling Pole Line	Crossing Highway	Not Crossing Highway	Total Allowable
Maximum Number of Spans	0	3	4	7
	1	2	3	6
	2	1	2	5
	3	0	0	3

Figure 3-34. Maximum Allowable Span Combinations on One Drive Hook

The device used for attaching wire to the suspension strand is called a span clamp. Span clamps are to be used only when a direct pole-to-building run cannot be made. The location of the clamps on the strand is, of course, determined by the clearance requirements. However, if the wire run along the strand is over 36 inches, you must use drop wire clamps on both ends of the run as shown in figure 3-36.

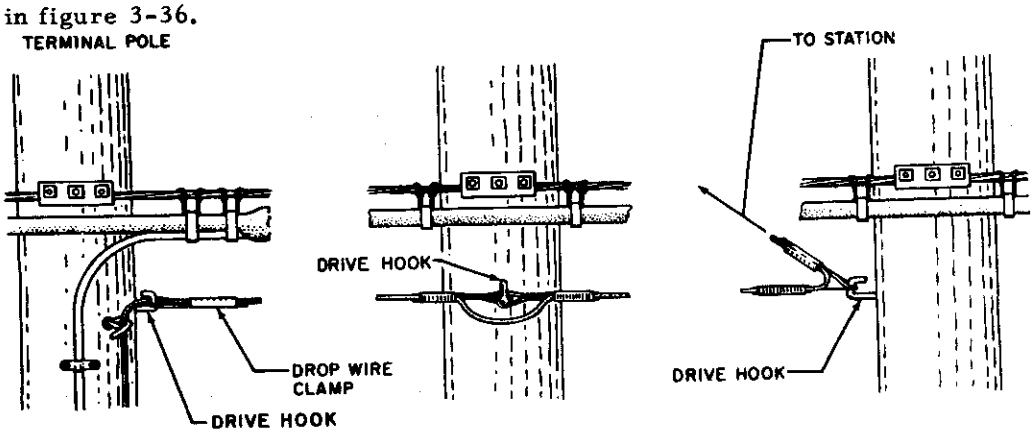


Figure 3-35. Drive Hooks Supporting Span Run Along an Aerial Cable Lead

Figures 3-37 and 3-38 show the use of span clamps where the run is less than 36 inches. Note how the drop wire clamps are placed to resist the pull on the drop wire. In addition, figure 3-35 illustrates the use of two span clamps where the pull is in two directions.

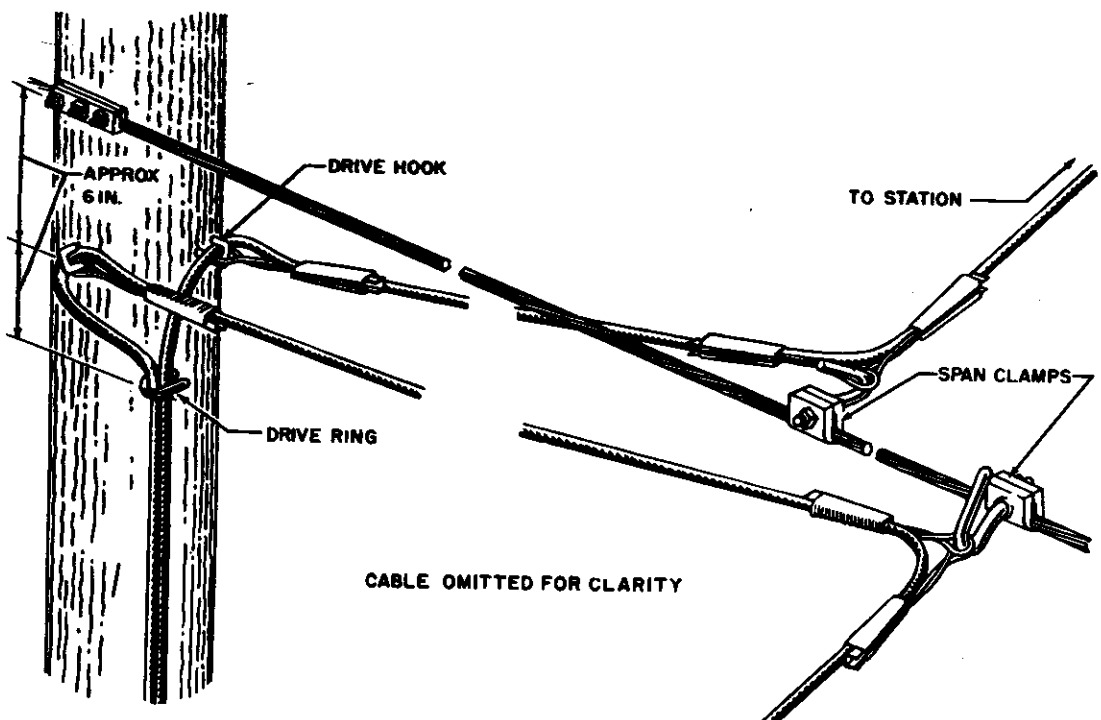


Figure 3-36. Pole-to-span Clamp Run, Over Thirty-six Inches

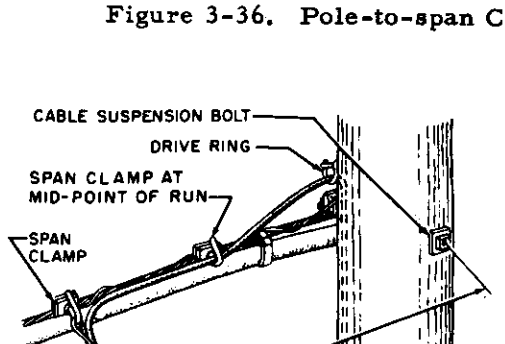


Figure 3-37. Pole-to-span Clamp Run Thirty-six Inches or Under on Lashed Cable

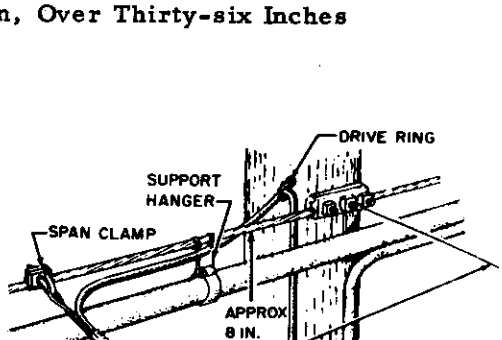


Figure 3-38. Pole-to-span Clamp Run, Thirty-six Inches or Under on Ring Supported Cable

Where drop wire is terminated on "jointly" used poles (poles to which both power and communication lines are attached), a guardarm is installed to provide climbing clearance for the power lineman. Figure 3-39 illustrates drop wiring on a pole equipped with a guardarm. It is particularly important that poles equipped with guardarms be properly wired. Proper wiring not only provides climbing space for the power lineman (a safety factor), but also reduces the probability of the drop wire being damaged by lineman climbing to a higher position on the pole.

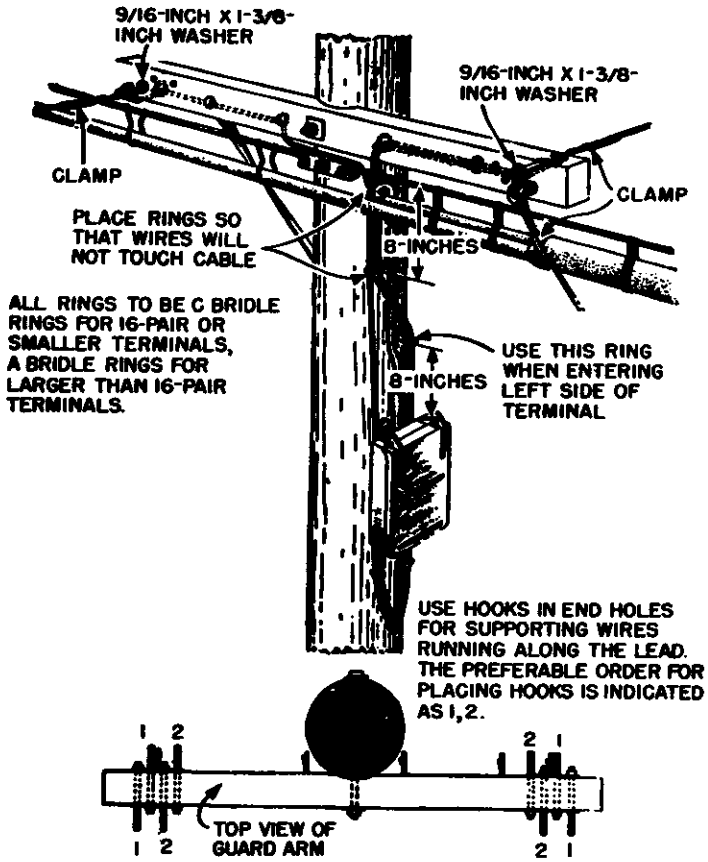


Figure 3-39. Use of Pole Requiring Guardarms

TERMINAL WIRING AND CONNECTIONS

You have probably made many drop wire terminations while working as a 36132; but to give you an opportunity to check yourself so you are certain the terminations you

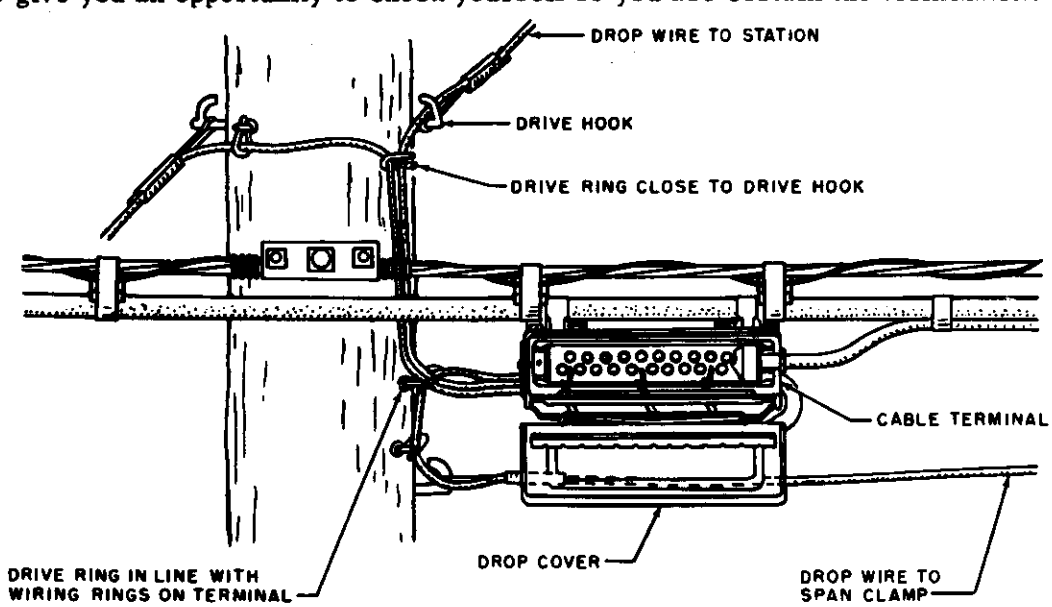


Figure 3-40. Typical Arrangement of Wires and Attachments Strand Mounted Terminal, Front View

make are according to specifications, we will review the procedures used with the more common types of strand and pole mounted terminals.

Generally, the requirements for drop wire runs from the drive hook or first pole attachment to the terminal are the same as for the rest of the drop wire run. The run must be neat and clearances must be maintained. Sufficient slack to prevent strain or sharp bends in the wire should be left. Place supports so there is at least three inches of clearance from pole steps. Figures 3-40, 3-41, and 3-42 illustrate typical drop wire arrangements.

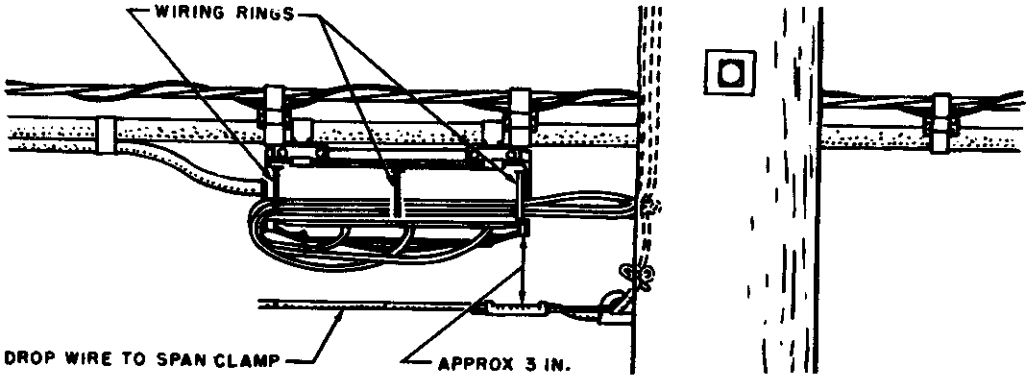


Figure 3-41. Typical Arrangement of Wires and Attachments Strand Mounted Terminal, Rear View

CABLE TERMINALS	SPACING-INCHES A
10-, 11-, and 16-PAIRS	3
26 PAIR	5

As you know, the drop is now connected to the terminal pair designated on the TWO. A part of this task that might be overlooked is the installation of binding post insulators. Your wire chief should designate the circuits requiring such protection; however, it is well to remember that special service lines such as teletypewriter, fire, and police circuits require the use of binding post insulators.

Drop wires terminated to open wire lines necessitate the use of drop wire terminals and bridle wire. Figure 3-43 shows the use of a drop wire terminal on a standard crossarm; notice that bridle wire is used from the drop wire terminal to the open wire connection.

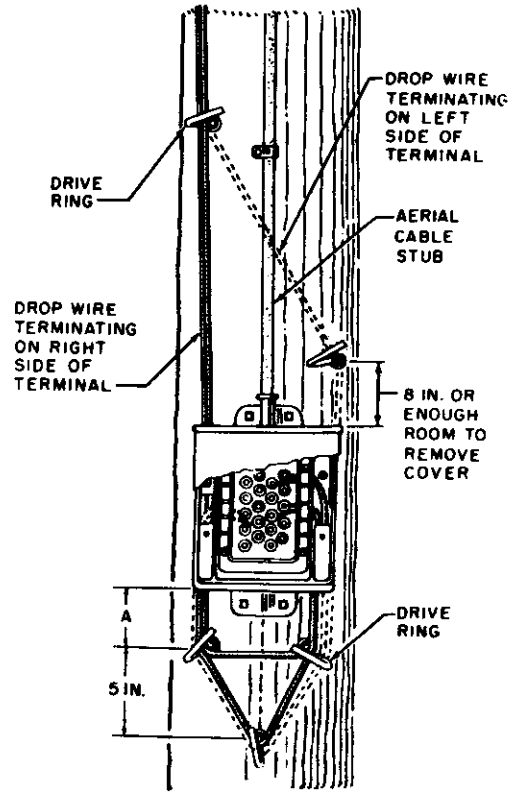


Figure 3-42. Typical Arrangement of Wires and Attachments at Pole Mounted Terminal, Slip Cover Type

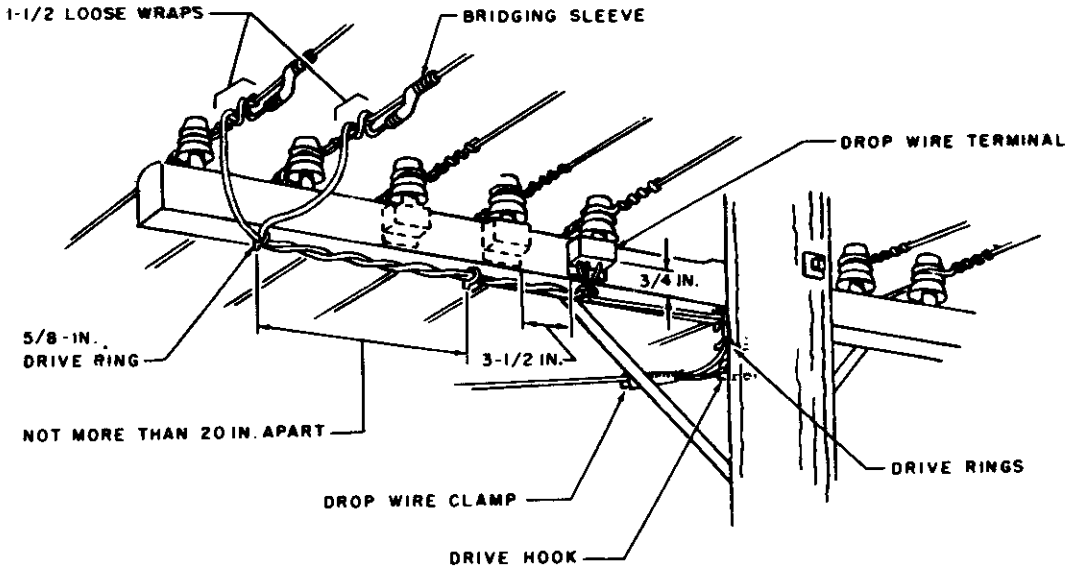


Figure 3-43. Drop Wire Terminal on Standard Crossarm

STATION WIRING

From your experience, you have learned that no two installations are exactly the ıe. The area where most differences occur is in the wire runs inside of buildings. s portion of the installation, from the entrance hole to the telephone set, is known station wiring. To be able to install station wiring properly and in different situa- ıs, it is necessary that you have a good understanding of the various methods used. ıerally, station wiring is installed by means of building conduit systems, wiring at- hments, or concealed wiring arrangements.

ILDING CONDUIT SYSTEMS

There are four general types of building conduit systems: underfloor duct, conduit ıderfloor from wall, base raceway, and molding raceway.

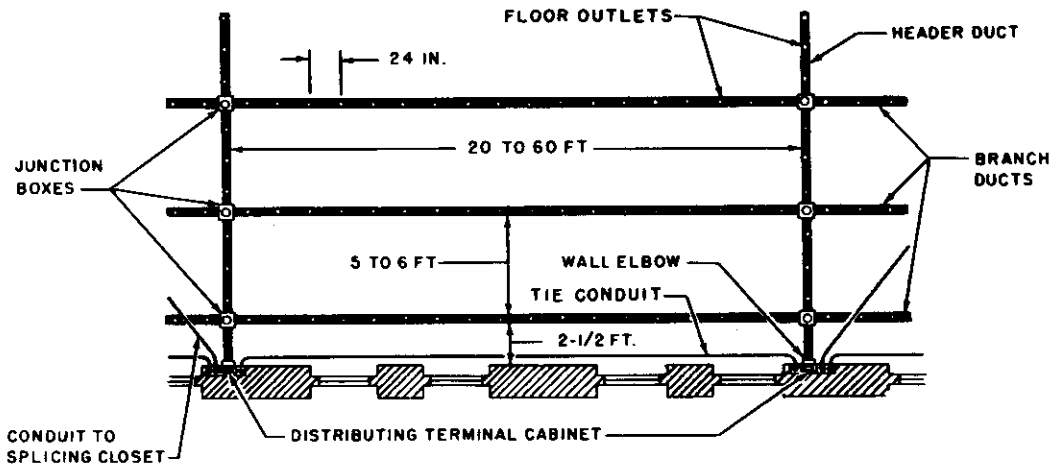


Figure 3-44. Underfloor Duct, Gridwork Type

Underfloor duct systems are of two kinds--gridwork and cellular steel floor. The gridwork system, shown in figure 3-44, is made up of parallel header ducts running from distribution terminal cabinets; the header ducts are placed 20 to 60 feet apart. Parallel branch ducts spaced 5 to 6 feet apart run at right angles to the header ducts. Junction boxes are positioned at the intersections of the header and branch ducts. Floor outlets with removable caps are spaced about every 24 inches along the duct runs. Separate conduit is used to carry tie cables between distributing terminal cabinets and to splicing closets.

In the cellular steel floor system, shown in figure 3-45, the cells or ducts in the floor serve as wiring channels. The ducts are placed on 6-inch centers. Usually, particular ducts are assigned a definite use. For example, telephone wiring is assigned to every third duct, other services (light and power wires) are assigned to the in-between ducts. Thus, the installer has access to the use of ducts spaced at 18-inch intervals across the floor. Outlet heads can be installed at practically any point along the duct runs.

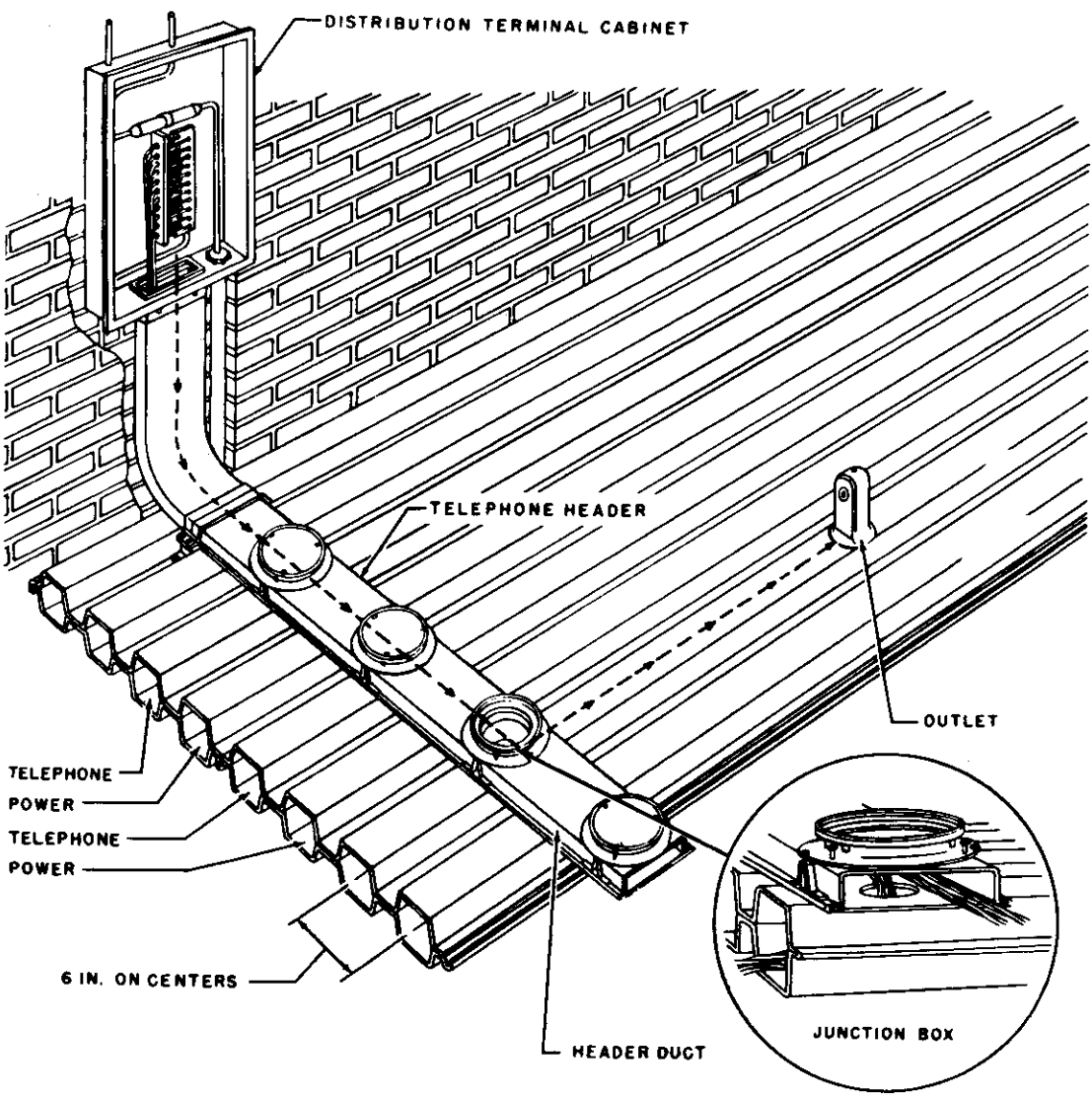


Figure 3-45. Underfloor Duct, Cellular Steel Floor Type

The parallel ducts or cells are crossed by header ducts which run to distribution terminal cabinets. Junction boxes are provided in the header ducts.

The conduit underfloor from wall system, just as its name implies, is a network of conduit extending from distribution terminal cabinets to outlet boxes in the walls, columns, or floors of a building. Figure 3-46 shows a typical underfloor from wall system.

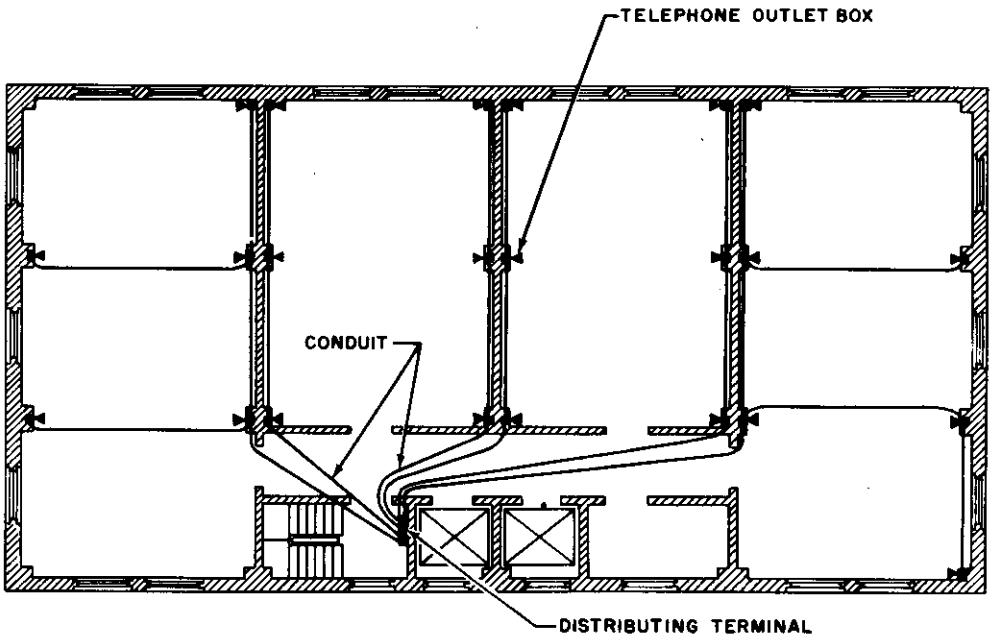


Figure 3-46. Conduit Underfloor from Walls

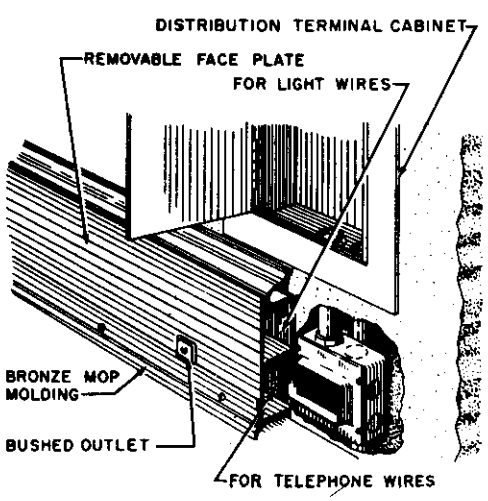


Figure 3-47. Metal Base Raceway

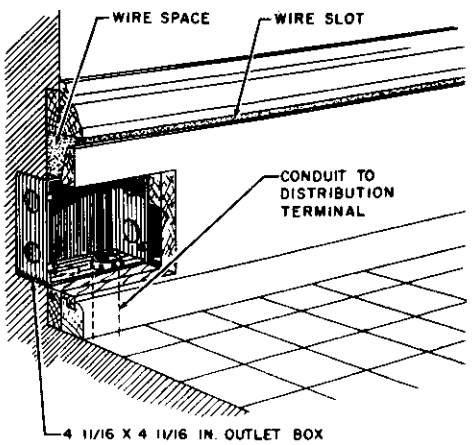


Figure 3-48. Wood Base Raceway

Base raceway systems may be either metal or wood. The metal raceways are merely wall baseboards that contain channels through which wire can be run. Outlets are provided at intervals along the face plate. Wooden raceways are wall baseboards with a space in the rear of the baseboard through which the wire can be run.

A slot between the baseboard and the baseboard molding is used for outlets. Conduit from distribution terminals to boxes mounted in the walls behind the base raceways is used with both the metal and wooden raceway systems. Raceway ducts are illustrated in figures 3-47 and 3-48.

Molding raceway systems are similar to base raceway systems except that the wires are distributed through channels at the rear of ceiling moldings.

When you are required to make station wire runs in buildings equipped with some type of conduit system and no plan of the system can be obtained, trace out the duct runs. Locate outlets to best suit your purpose and use the simplest and most direct route for the wire run.

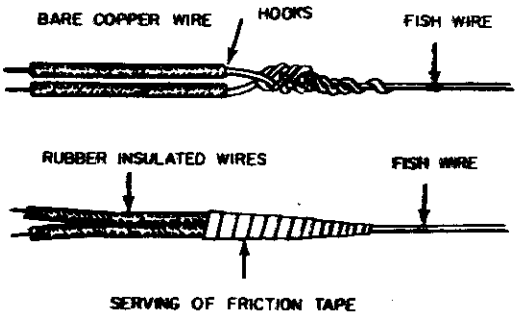


Figure 3-49. Use of Fish Tape

NOTE: Make certain that the telephone wires are not placed in the same ducts with wires from other services such as power, intercommunication system, or electric light wires.

Station wire can usually be placed directly in raceway type building conduit systems. In underfloor systems the wire must be "pulled in." The use of a fishline or tape is required to pull wires through conduit. If a fish tape is not available and there are no sharp bends in the duct run, a length of galvanized steel wire is a good substitute. Figure 3-49 shows the fishline connected to wires for pulling purposes. Figure 3-50 lists the number of conductors that will fit in various sizes of conduit.

MAXIMUM WIRES IN CONDUIT				WIRE	TYPE
1/2" Conduit	3/4" Conduit	1" Conduit	1 1/4" Conduit		
2	4	7	10	JK	Inside Wire Pair Triple Quad
1	2	4	6	NP	Drop Wire (Twisted)
2	4	6	8	W-38	Drop Wire Pair

Figure 3-50. Conduit Capacities

If wire is hard to pull in the conduit due to the length of the run or bends in the ducts, lubricate the wire with Flaxsoap or Carbowax. Only a thin film of lubricant is necessary. Excess amounts, if left in the ducts, will become gummy and tend to clog the ducts. Apply the lubricant by drawing the wire through a cloth pad saturated with the lubricant.

NOTE: Do not use a lubricant on textile-covered wires or cables.

CONCEALED STATION WIRING

When installing station wire in buildings where no built-in conduit system is provided and it becomes necessary to run wire across floor surfaces, some type of overfloor duct should be used.

Two types of overfloor duct are available--metal and rubber. Metal overfloor duct comes in two sizes, each in 5-foot lengths. The smaller size will accommodate five pair of wires or four triple plastic jacketed station wires. The larger size will accommodate as much as two 26-pair inside wiring cables. Various types of fittings (elbows, outlets, and junctions) are provided which the installer may use to construct most any overfloor run required. The fittings have twist-outs of different sizes so that either large or small size ducts can be connected to the same fittings. Metal overfloor duct is intended for use on rough floor surfaces where holes in the floor are not objectionable.

The procedure used in installing metal overfloor duct is outlined as follows:

1. Lay the duct base out along the route of the desired wire run.

2. Cut base sections to required lengths. (Use hack saw or five-toothed blade and smooth the cut edges with a file.)

3. Connect the duct base to required fittings. (Insert the duct base into the tongues provided in the base of the fittings. When fittings are not equipped with tongues, make the connection by using self-tapping number 8 screws in the holes provided in the fittings. The duct base must be drilled with a number 30 [.129] drill.)

4. Secure the duct base to the floor. (Use number 8 flat head wood screws on wood floors. On masonry floors, use either 3/4 inch flat head wood screws with 3/4 inch screw anchors or 3/16 inch x 7/8 inch hammer drive type anchors.)

NOTE: Wear goggles when drilling holes in masonry floors.

5. Lay the wire or cable in the duct base.

6. Install duct capping on duct base. (Position the capping directly over the base and apply pressure to the capping until it snaps in place.)

Rubber overfloor duct is installed as follows:

1. Lay out the base duct sections and necessary fittings along the desired run.

2. Cut ducts and fittings to obtain proper fit. (Use a saw to make cuts.)

3. Place ducts and fittings in the exact desired locations and mark their outline on the floor with a pencil.

4. Lay the prepared ducts and fittings aside and clean the floor in the outlined area. (All wax, dirt, and grease must be removed.)

5. Reassemble the duct run and place wires in the wiring channel.

6. Apply an even coat of linoleum paste to all areas of the rubber duct and fittings that will come in contact with the floor.

7. Allow the paste to dry until it becomes tacky but not set.

8. Set the duct and fittings in the desired position and apply even pressure.

Figure 3-51 shows the use of rubber overfloor duct.

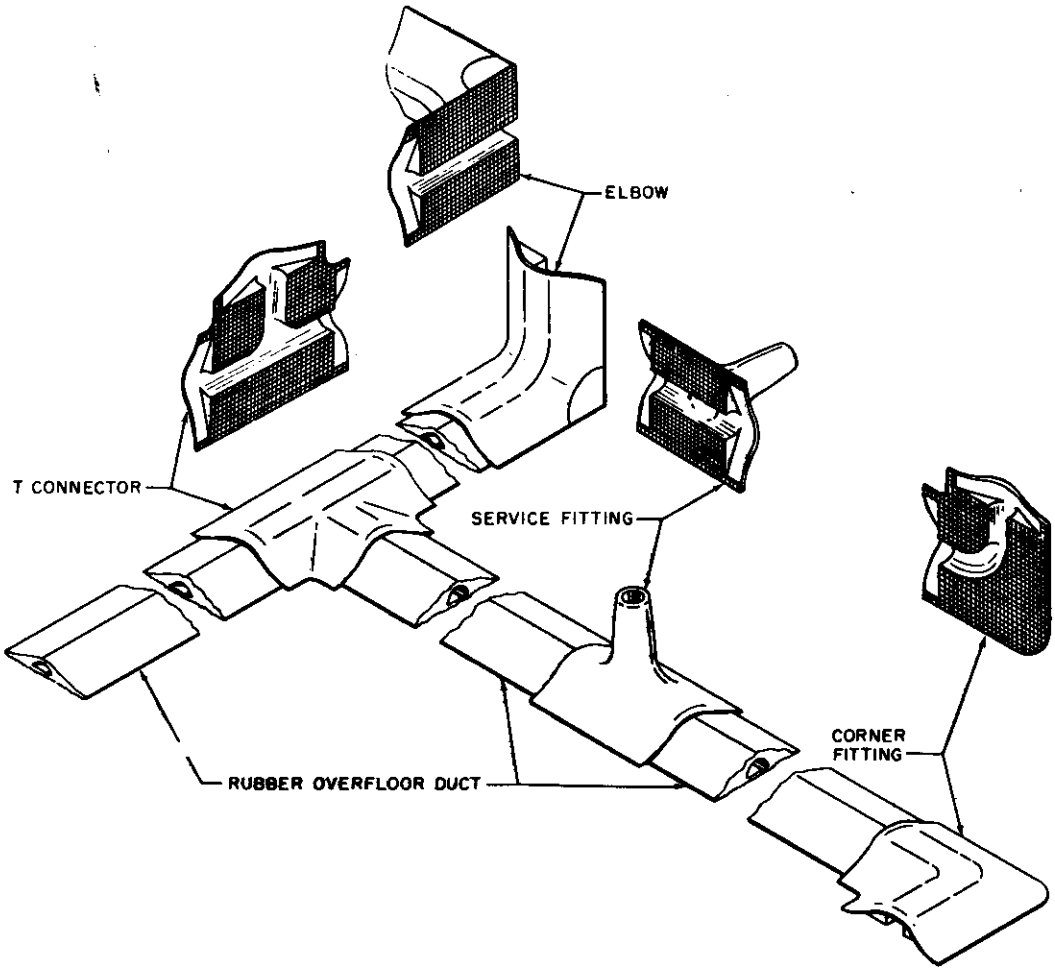


Figure 3-51. Rubber Overfloor Duct Fittings, Typical Installations

In addition to the use of conduit and overfloor duct systems, there are other means of concealing station wiring. The wire may be routed through walls and floors or through closet areas. In other cases, the wire can be run on top of picture moldings, or it might be run outside of the building. Due to the difficulty in running wire through outside walls and partitions, it is best to avoid this type of installation, except where the wire must be concealed and no other method is practicable. If you must install the wire through walls and partitions, it is well to keep the following suggestions in mind:

1. Study the building construction and, if possible, plan the run to avoid obstructions such as corner braces, framing for doors and windows, bridging of partitions and foundation walls.

2. Locate wire exit holes at the baseboard level and preferably where they will be concealed by the baseboard molding. A higher location for the exit hole may be used where a wall mounted telephone set is to be used.

3. Whenever practicable, run the wire through outside walls rather than partition walls.

4. When running wires from floor to floor through partition walls, make certain that the partition on the lower floor is directly below the partition on the upper floor.

5. Do not run the station wire between the same building studs with power wires.

UNCONCEALED RUNS

You will probably be required to make installations in buildings where no conduit system is provided and it is impractical to conceal the wire in the walls, floors, or overfloor ducts. In such instances, if appearance is not important, the wire may be supported by the use of various attachments. Figure 3-12 shows the common types of station wire attachments provided for use on the usual types of wall surfaces. Figure 3-52 reflects the spacing and arrangement of the more common types of attachments.

In addition to using "common sense" the installer should apply the following general rules when installing station wire supported by attachments.

1. Observe minimum separation requirements. See figure 3-3.

2. Locate the wire where it will not be damaged or pulled loose from walls or floors.

3. Run the wire on walls either horizontally or vertically but not iagonally.

4. Avoid damp locations.

5. Avoid running wire across ceilings.

6. If wire must be run across joists in basements, locate the wire run close to walls or other protection.

7. Avoid running wires along or through temporary partitions.

8. Avoid pulling slack wire through installed attachments; take up the slack as the work progresses.

9. Never support wires with attachments anchored to conduit, pipe, or their supports.

10. Avoid placing the wire in a position where it may become a safety hazard.

It should be apparent to you that you will encounter situations where any one or all of the methods of installing station wire described above may be used.

Regardless of what means is employed there may be instances where you will have to install some rigid metal or metallic tubing conduit for protection purposes. Rigid, galvanized conduit is used in extremely wet locations. Metallic tubing (thin wall) is intended for use in dry locations where it is not subject to damage caused by objects striking it. Various fittings are available for both types of conduit. Cut the conduit sections to desired lengths with a hack saw and ream the cut ends. Rigid conduit sections are connected together by means of threaded couplings; consequently, the ends must be threaded. A special tool (conduit bender) is required to make bends in rigid

conduit. When using the bender it must be moved several times during the bending process to prevent kinking and crimping in the conduit. (See figure 3-53.)

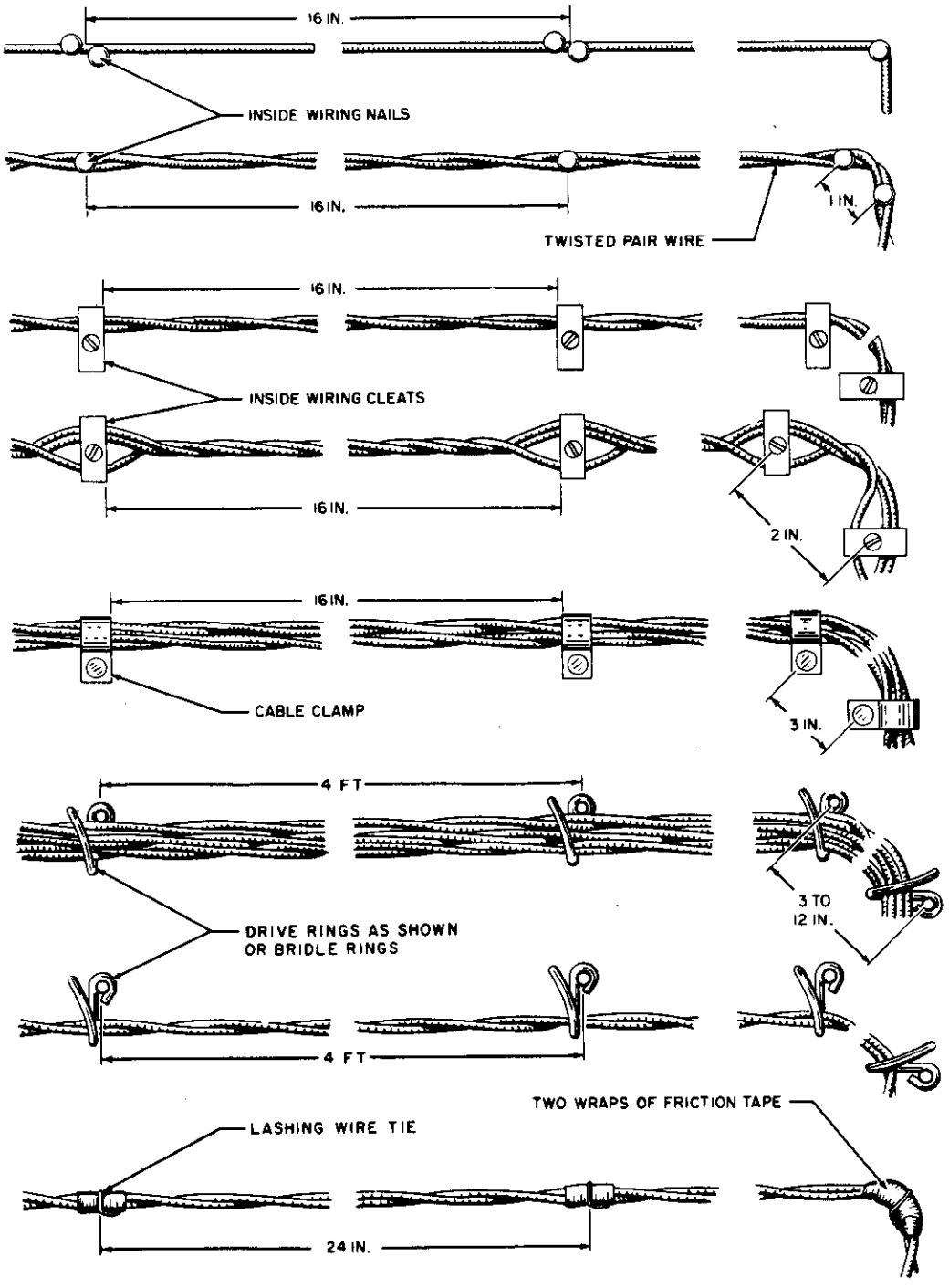


Figure 3-52. Typical Spacing and Arrangement of Attachments for Station Wire

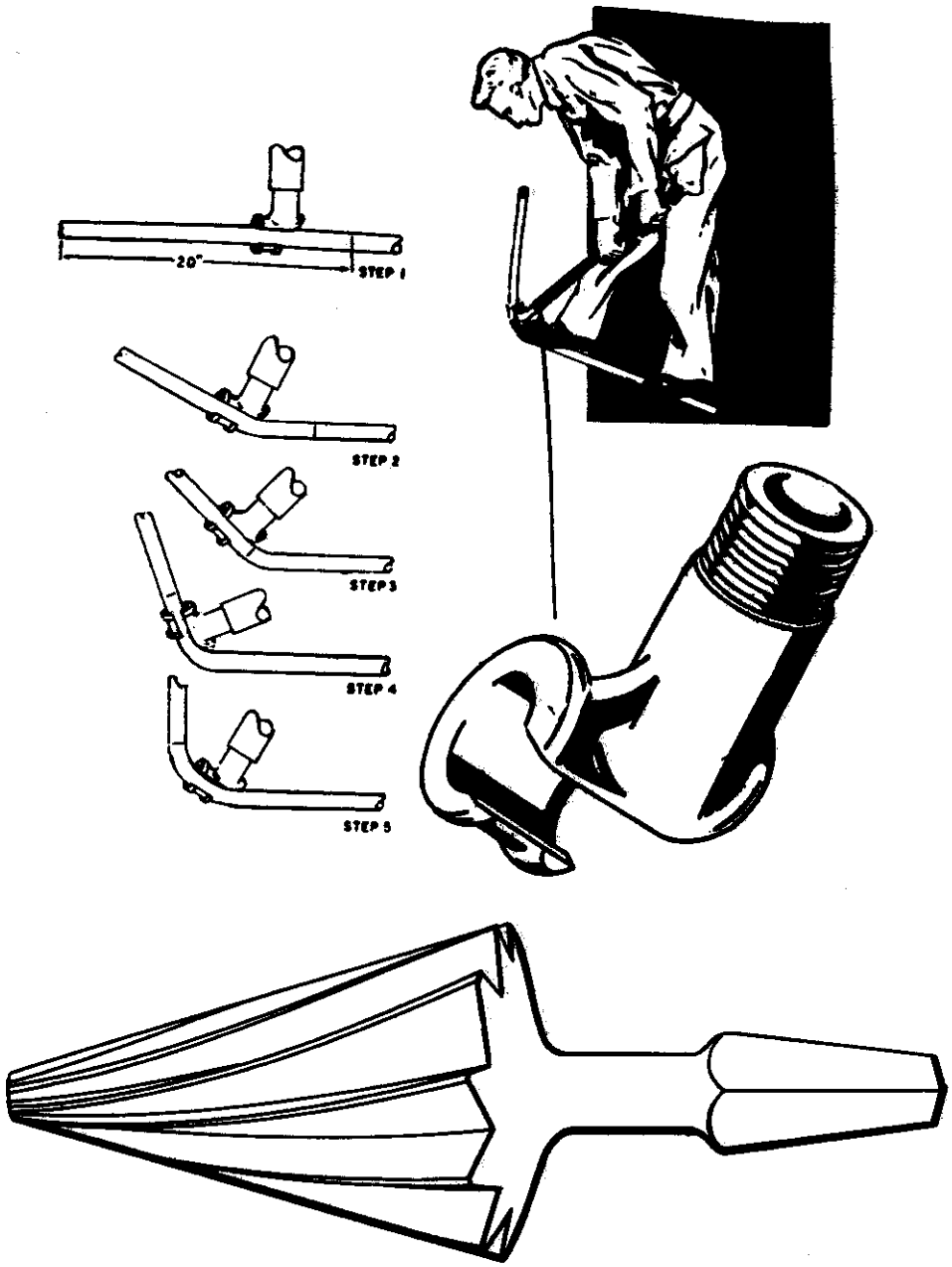


Figure 3-53. Conduit Bender and Brace Type Reamer

Wire is normally "pulled" in rigid and thin wall conduit runs. Bushings should be placed in the ends of the conduit to protect the wire. Cable clamps or pipe straps and appropriate anchoring devices should be used to support the conduit.

STATION WIRE TERMINATIONS

Once the station wire run is complete, all that remains is to make the necessary connections. Generally, station wire is terminated at protectors, connecting blocks, or cable terminals. The use of protectors and station wire connections to protectors has been explained earlier in this chapter.

Connecting blocks are used in three different ways:

1. To terminate line and station wires near the building entrance location when a protector is not required.

2. To bridge station wires.

3. To connect station wire and station cording.

Install connecting blocks on some permanent type of woodwork such as baseboards, beams, window frames, or door frames. It is also permissible to mount connecting blocks on tables and desks although this practice is not advisable unless the tables and desks are permanently located.

When terminating wire on the connecting blocks, make sure that the wire is arranged so that no strain is placed on the terminals. Enough slack should be left in the wire to permit reconnecting it if the bare end of the conductor should break. Such an arrangement is accomplished by winding the wires once around the underside of the connecting block. When connecting station wiring and station cording to the same block, terminate the station wire first. This arrangement facilitates cord replacements and maintenance tests. Figures 3-54 and 3-55 are examples showing wiring arrangements on connecting blocks.

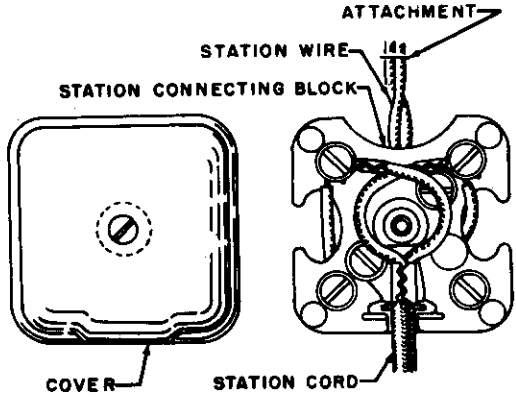


Figure 3-54. Typical Conductor Terminations at Station Connecting Block

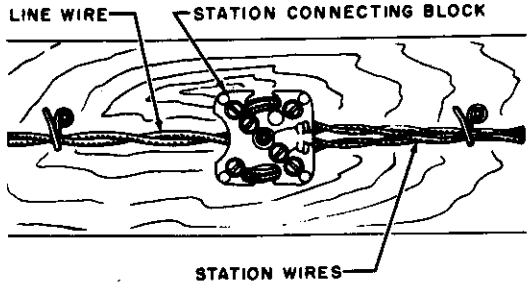


Figure 3-55. Typical Bridging Connections at Station Connecting Block

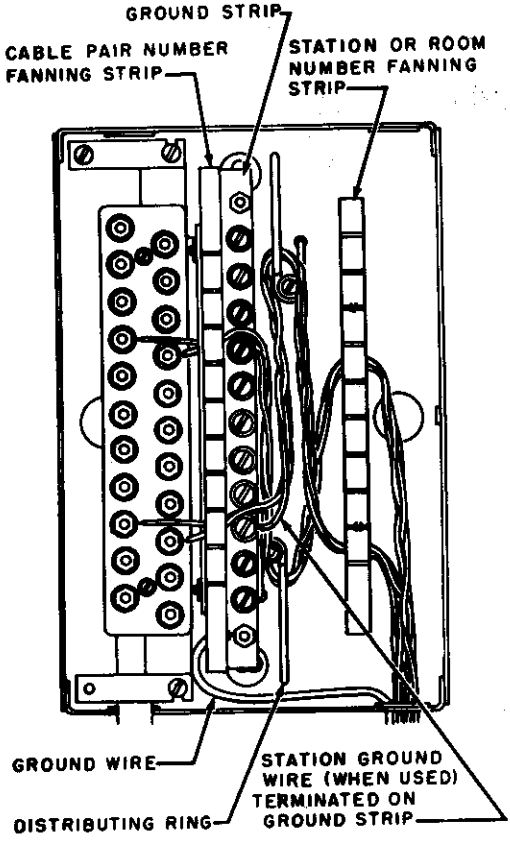


Figure 3-56. Typical Arrangement of Station Wires at a Distribution Terminal

In buildings where a large number of telephones are installed, such as offices, apartment houses, etc., distribution terminals are often used for terminating inside cables. In some instances you will find it advantageous to connect the station wire directly to the distribution terminal. Where such connections are made, leave enough slack in the wire so that the wire can be transferred to any set of binding posts in the terminal. This wiring arrangement is usually accomplished by routing the wire through the distributing ring farthest from the assigned set of binding posts as shown in figure 3-56.

INSTALLATION OF STATION APPARATUS

The next and final step in making a complete installation is to place and connect the telephone set and any other auxiliary equipment required. Auxiliary telephone equipment such as signaling equipment, switching keys, and other special devices is called "Station Apparatus."

Listed below are suggested rules to follow for locating telephone sets and station apparatus.

1. Locate station apparatus where it will be convenient for use and service.

2. Avoid locations where the equipment or equipment user will obstruct traffic.

3. Select locations that are dry and free from mechanical or electrical hazard. Avoid locations over or near sinks, radiators, steam risers, or fixed electrical equipment.

4. Locate dial-equipped telephones where there will be sufficient light for dialing.

5. Avoid locations that will require the attachment of telephone apparatus to marble or other finely finished surfaces.

6. Locate telephone sets and ringing equipment where ringing signals can be clearly heard.

7. Locate switching keys on the right-hand side of desks whenever practicable.

DESK TYPE TELEPHONES

In most cases, it is not good practice to attach wiring to desks. In situations where it cannot be avoided, allow at least one foot of slack wire between the floor outlet or the last wall attachment and the first desk attachment. This wiring arrangement allows the desk to be moved slightly. If a connecting block must be mounted on the desk and the desk panel is less than 3/8 inch thick, build up the panel with a suitable wooden backboard. Wire runs on desks should be neat and concealed as much as possible. To accomplish this, place the wire in the angle formed by the top and sides of the desk, or in the angle formed by the legs and panels of the desk. Use inside wiring nails or staples for attaching wire to the desk.

Some types of desks are equipped with wiring facilities. On metal desks equipped with wiring runs, protect the wire at entrance and exit holes by installing the soft, rubber grommets provided, or by placing several wrappings of friction tape on the wire. Telephone cording is connected as indicated by the wiring diagram on the base plate of the telephone set. Figure 3-57 illustrates the wiring arrangement at a desk equipped with wiring facilities.

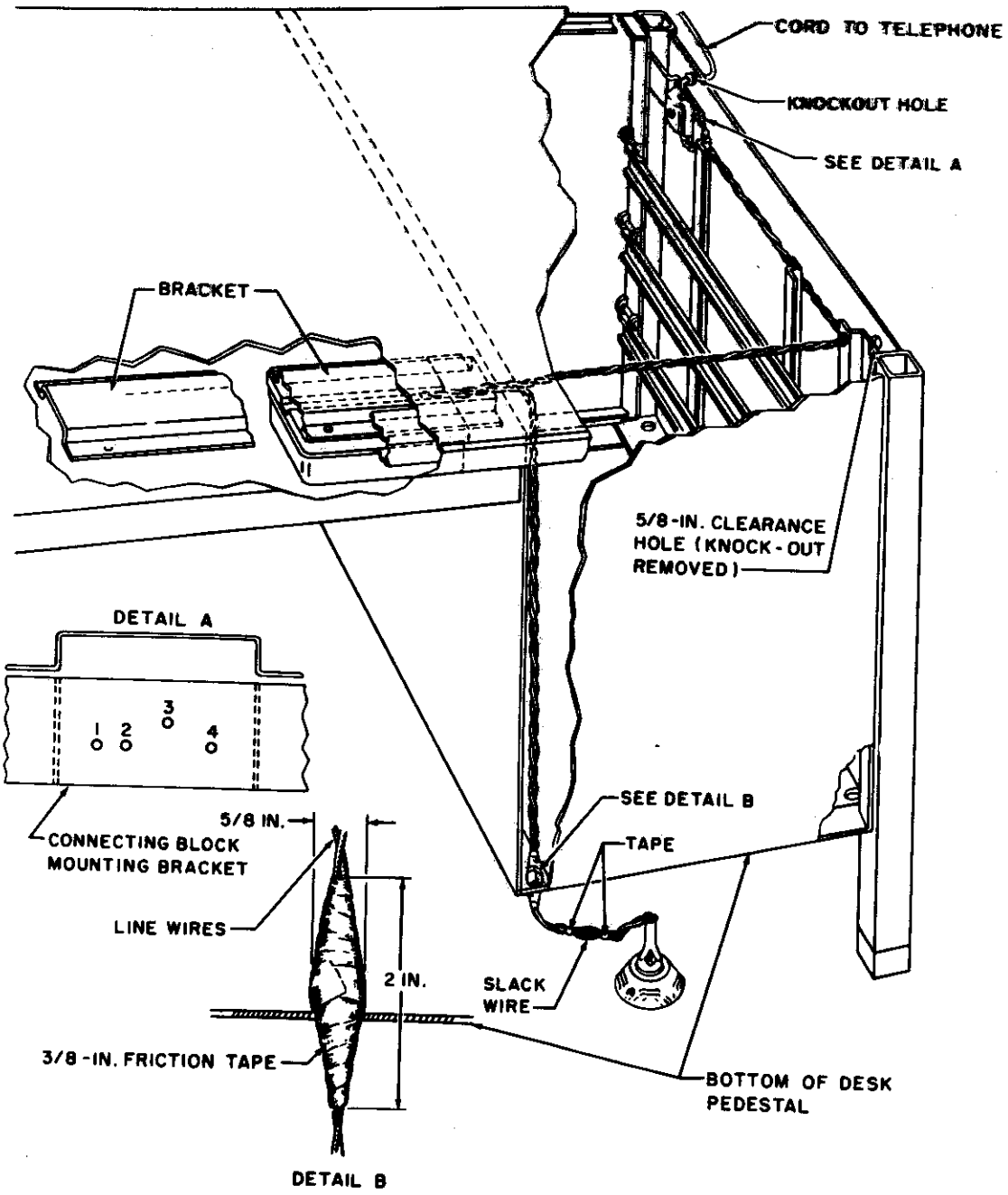


Figure 3-57. Typical Arrangement of Wiring at Desk with Wiring Facilities, Metal Desk

SIGNALING EQUIPMENT

You may come across situations when normal station ringers do not meet the signaling needs of the subscriber. This condition is usually overcome by the use of auxiliary signaling devices, such as extension ringers, loud ringing bells, buzzers, or lamp indicators.

The most commonly used arrangement is the loud ringing bell connected as an extension ringer. Connections for such an arrangement are usually a matter of bridging the bell across the ringer of the subset. The bridging may be made at the protector or at the subset. Another way of connecting the bell is to wire it directly across the line; however, the bell must be equipped with an internal condenser to be installed in this manner.

There are other types of bells sometimes used that do not operate on normal ringing current but operate through relays on alternating current. In any case, if you are in doubt as to how to connect auxiliary station equipment, wiring directions are attached to each piece of equipment. The same methods and procedures used when placing station wire should be followed when installing the wiring for any auxiliary station equipment.

TRANSFER KEYS

Transfer keys are usually used in small installations where it is impractical to install complicated key systems and it is desirable to have more than one line connected to a single telephone set. Again, there are numerous types of keys available, both push button and lever types. Regardless of which type you install, the keys should be located where they are most satisfactory to the user from the standpoint of appearance and convenience. Avoid locating keys in the knee well of desks. The usual practice is to mount the keys at the side of a desk or table, with the face of the key flush with the front edge of the desk or table leg.

Figure 3-58 shows one method of connecting a 3-way lever type transfer key (BE6017E).

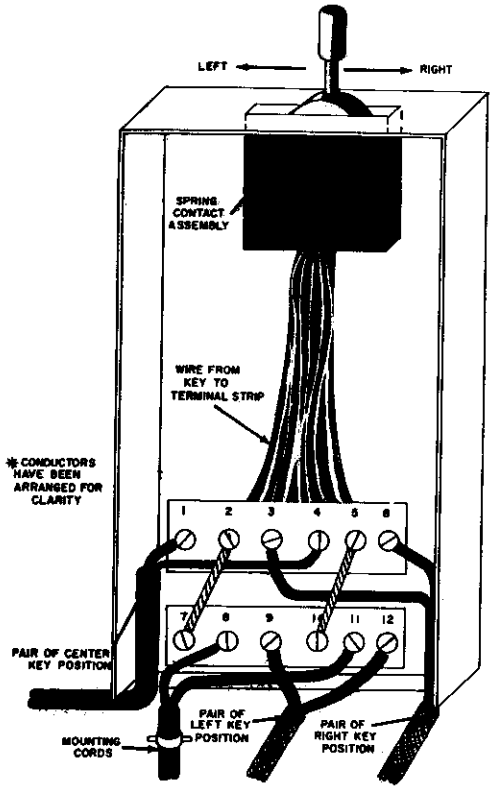


Figure 3-58. 3-way Transfer Key BE6017E

SPECIAL EQUIPMENT

You may be called upon to install special equipment such as explosion-proof telephones, recording devices, and other specially designed apparatus.

Explosion-proof sets are intended for use at all locations where the atmosphere contains gases or vapors capable of exploding. Explosion-proof sets are constructed so that all parts of the apparatus which might cause a spark are completely enclosed. Rigid conduit must be installed with explosion-proof telephones. The conduit must run from the set to a point outside of the hazardous area and all openings in the conduit sealed with an approved sealing compound. Generally, normal installation practices should be followed except that a line switch must be included to discharge the condensers whenever it is necessary to open the telephone set for servicing.

You are probably aware that the recording of telephone conversations is usually accomplished by equipment wired and installed in the central office. There are, however, numerous recording devices manufactured that can be placed at the subset to make recordings. Basically, there are two types: an induction

type that merely requires an ac power source and a directly connected type that must be wired across the line. In any case, such devices are accompanied by complete instructions for installation.

PREOPERATIONAL TESTING

Before any installation is complete, it is necessary to test the equipment to see if it operates as it should. When testing telephone sets, be sure to check the following items with the central office:

1. Is transmission loud and clear?
2. Is the dial speed adjusted properly?
3. Does the line ring back properly and are the bells satisfactory to the subscriber?
4. Is the line clear of troubles and foreign battery?
5. Does the subscriber have a telephone directory?
6. Is the phone and fire number on the card?

(Line testing will be covered in more detail in a later chapter.)

If your tests are satisfactory, complete the TWO. As you know, the installer is required to fill in the "date of completion," "materials used," and "installer's signature" blocks. Figures 3-59 and 3-60 are illustrations of the TWO.

TELEPHONE WORK ORDER

T. W. O. NO. 127 DATE 1 Sept 58

TELEPHONE NO. 845

FROM: Base Communications

CONTRACT AUTHORIZATION

CONTRACT NO.

TO: Wire Chief

RENTED SERVICES C. S. A. NO.

MAINTENANCE SERVICES C. S. A. NO.

YOU ARE HEREBY REQUESTED TO PERFORM THE FOLLOWING SERVICES:

IN		OUT
845	P. B. X. LINE NUMBER	845
Area 12, Bldg 150	ADDRESS	Area 19, Bldg 4
Supply Officer	MAIN LISTING	Supply Officer
Maj. D.E. Cook	ADDITIONAL LISTING	Maj. D.E. Cook
	ADDITIONAL LISTING	
	ADDITIONAL LISTING	
A	CLASSIFICATION	A
5 Sept. 58	DATE DUE	5 Sept. 58
	DATE OF COMPLETION	
	SERVICE AND EQUIPMENT	
	MONTHLY CHARGE	
	NONRECURRING CHARGE	

RECORDS POSTED		APPROVED
WIRE CHIEF RPM	DIRECTORY CLERK JSS	SIGNATURE Chas. Jones
CHIEF OPERATOR	ACCOUNTS CLERK	GRADE AND TITLE Capt. USAF, Comm. Off.

AF FORM 1 FEB 54 1075 REPLACES DA FORM 11-194, 1 DEC 46, WHICH MAY BE USED. 16—80780-3

Figure 3-59. Front of TWO

TELEPHONE WORK ORDER
MATERIAL USED

AMOUNT USED	RECLAIMED	DESCRIPTION	AMOUNT USED	RECLAIMED	DESCRIPTION
1	1	Wecr 302			
1	1	42 A Block			
1	1	997 Protector			
—	60 ft.	108 - Wire			
30 ft.		69A - Wire			

DISTRIBUTING PLANT DATA

CABLE	PAIR	CABLE	PAIR	TERMINAL	PINS
Old	296	1	92	5	9
New	147	3	26	3	3

A/c Jack Smith
(INSTALLER)

REMARKS

C. S. Mann
(WIRE CHIEF)

U. S. GOVERNMENT PRINTING OFFICE 16—80780-1

Figure 3-60. Back of TWO

SUMMARY

The installation of a telephone usually includes the placement of building runs, span runs, and station wire. The 5-level Installer-Repairman is responsible for planning the routes of the various wire runs in accordance with clearance and separation requirements. The installer also determines the need for electrical and mechanical protection and provides the protection as it is required.

In some cases, station wiring is installed by means of conduit systems. The installer is responsible for determining the most suitable routing of wire through such systems.

General methods and procedures are suggested for installing: building attachments, anchors, wire overfloor duct, and pole attachments. The methods and procedures suggested,which incidentally are practical and proven by "line" use,should be followed to insure a safe trouble-free installation.

REFERENCES

TO 31W3-1-17	Telephone Outside Plant Construction, Drop and Block Wiring and Station Installation.
TO 31W-1-4	Grounding Procedure and Protective Devices
TO 31W-1-8	Telephone Substation Installation

REVIEW QUESTIONS

1. Define the term "exposed plant."
2. Can an exposed station be installed in the same manner as an unexposed station? Why?
3. Explain the process used in sagging span runs.
4. Where is overfloor duct used?
5. Name two possible results of improperly sagged drop wire.
6. Why is it necessary to adhere to clearance and separation requirements when making a substation installation?

WORK PROBLEMS

PROBLEM 1. Installation of drop wire.

Training Equipment: TWO, outside wire, station protector, ground wire, building attachments, anchoring devices, pole attachments, span clamps, hand tools, handline, ladder, and climbing equipment.

References: TO 31W3-1-17

Work Procedures: Check assigned pair at terminal, install protector, install ground wire, route and place building run, route and place span run, place pole attachments, and make necessary connections.

PROBLEM 2. Installation of inside wire.

Training Equipment: TWO, inside wire, building attachments and anchoring devices, connecting block, instrument and hand tools.

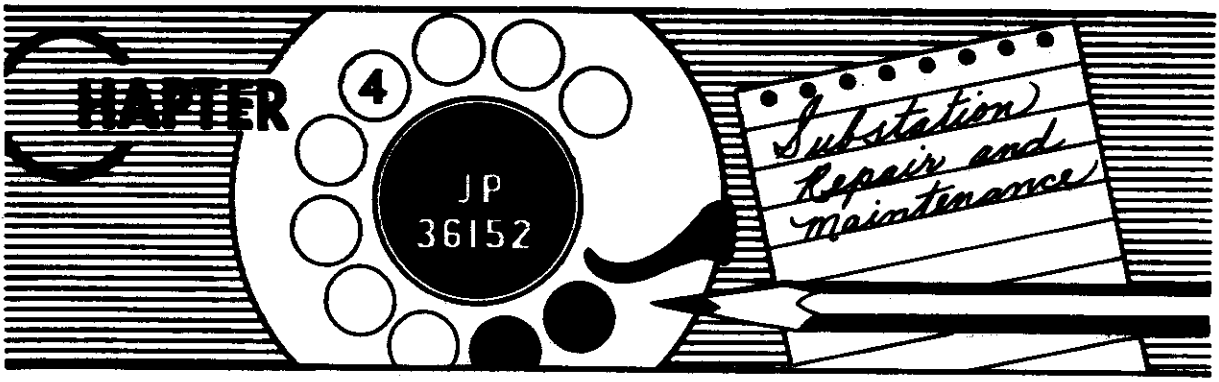
Referentes: TO 31W3-1-17

Work Procedures: Select phone location, plan wire run, install connecting block, drill entrance hole, place inside wire run; make necessary connections.

PROBLEM 3. Installation of inside wire using conduit.

Training Equipment: TWO, inside wire, fishline, conduit system plan, instrument, connecting block, and hand tools.

Work Procedures: Obtain plan of conduit system, determine location of instrument, plan the wire run, pull wire in ducts, install connecting block, and make necessary connections.



One of the definitions given in Webster's dictionary for the word "maintenance" is "to hold or keep in any condition." One of the duties listed in the 36152 job specialty is "maintains wiring and telephone equipment." Hence, the purpose of this chapter is to furnish you with the accepted methods and procedures used to hold or keep telephone wiring and telephone equipment in working condition.

It is not necessary to point out the need for efficient and dependable communications in the Air Force. However, if the Air Force is to have efficient and dependable communications, the installer-repairman must be able to keep the telephone installations on his base in good operating condition. When service interruptions do occur, he must be able to quickly locate the cause of the service interruption and make the necessary repairs.

Generally, maintenance can be divided into two categories: preventive maintenance and corrective maintenance. Preventive maintenance differs from corrective maintenance in that it is intended to prevent service breakdowns and therefore eliminate the need for repairs. On the other hand, the prime function of corrective maintenance is to locate and correct troubles that have caused service breakdowns.

PREVENTIVE MAINTENANCE INSPECTIONS

The importance of preventive maintenance cannot be over emphasized. Outside plant facilities having no moving parts often give the impression that little wear and tear is involved. If you consider, however, such factors as changing temperatures, high winds, heavy snow and sleet storms, it becomes obvious that plant facilities are often placed under severe strains.

Preventive maintenance is accomplished by making systematic inspections of the over-all installation and correcting or repairing any defects found. The Installer-Repairman is also able to perform preventive maintenance while working on other jobs, such as station installations, by being alert to conditions constituting a hazard or potential service interruption to other telephones.

In addition to tests made from the central office to observe transmission and signaling qualities, visual inspections and repairs should be made from the terminating facility to the telephone set. Following is the general procedure adopted by the Air Force for making visual inspections of substation installations.

1. Terminals

   a. Check the terminal for proper and secure mounting.
   b. Inspect the face plate for cracks, broken lugs, and cleanliness. Tighten loose drop connections and inspect all connections for crosses or shorts.

c. Inspect for poor or incorrect stenciling and correct if necessary.
d. Redress wires if necessary.
e. Seal wiring holes.
f. Check all drop wire attachments to poles to make certain that they are secure and properly installed.
g. Remove any dead drops from the terminal.

2. Drop or block wires

a. Inspect all drop wires leading out of the terminal.
b. Replace, repair, or report deteriorated or damaged wires.
c. See that wires are properly placed and that their supports are secure.
d. Check all wires for adequate clearance from trees, power lines, cables, buildings, and poles. Where cases of inadequate clearance are found, the drops should be rerouted, guards placed, or the case reported for correction.

3. Protectors

a. Check the location of protectors with respect to liability to damage from moisture or mechanical injury. If conditions warrant a change in location, either make the change or report the condition.
b. Replace broken or defective protector mountings.
c. Replace broken, defective, improper type, and corroded fuses; tighten loose fuses. Place the fuses so that the slots face the porcelain base.
d. Clean all foreign matter out of the protector.
e. Clean carbon blocks and replace broken or defective ones. The carbon blocks should be held securely in their mountings and the protective caps screwed on tightly.
f. Check the line, inside wire, and ground connections.

4. Inside wiring

a. Check the inside wire at all points along the run where the wire is accessible. If the wire is not properly or securely fastened or if the insulation is defective or damaged, the wire should be rerun, repaired, or reported so that the necessary corrections may be made.
b. Check for prescribed clearance between the inside wiring and power wires, water and gas pipes, etc.
c. Correct or report conditions where the wire is subject to damage from moisture, mechanical injury, or other causes.
d. Inspect and tighten all ground connections and correct any defects found.
e. Check wire connections at connecting blocks and inspect the blocks for broken or damaged parts. Replace broken or damaged blocks.

CORRECTIVE MAINTENANCE

Corrective maintenance, often called "trouble shooting" or "bug hunting" by experienced telephone men, consists of two definite tasks: locating the cause of the trouble and making the necessary corrections or repairs to eliminate the trouble so that service may be restored.

TELEPHONE TROUBLE REPORT

The knowledge of a phone out of service or a complaint involving telephone operation usually reaches the wire chief in the form of a Telephone Trouble Report (AFTO Form 58A). This form is used as a basis for dispatching trouble crews to clear the trouble.

The form is also used when service interruptions and complaints of service are made by the telephone users and when outside line faults are discovered by routine line testing. Figure 4-1 shows a telephone trouble report with typical entries made. Notice the information contained in the report.

TELEPHONE NR 682				LOCATION BLDG 58	
REPORTED BY SUB				DATE AND HOUR 10-2-55 , 0930	
TROUBLE REPORTED (Check Appropriate Items)					
	Bell Doesn't Ring		Cannot Get Operator	✓	Tel. Doesn't Answer
	Bell Rings Faintly		Cannot Hear		Cuts Out
	Permanent Signal		Cannot be Heard		Noisy
OTHER TROUBLE					
TROUBLE FOUND BREAK IN DROP WIRE				DATE AND HOUR 10-2-55,1000	
DATE & HOUR CLEARED 10-2-55, 1000		BY WHOM J.H.D.		WIRE CHIEF S.O.S.	

Figure 4-1. Telephone Trouble Report

As you can see, there is space provided for indicating the type of trouble reported; for example, Bell Doesn't Ring, Cannot Get Operator, Telephone Doesn't Answer, etc. This information should be an immediate clue for you to follow in locating and repairing the trouble. (Remember that the wire chief or test deskman has already established that the trouble is outside the central office.) Your test deskman should also give you additional information such as the cable pair number, the terminal numbers associated with the faulty circuit, and the type of trouble.

TYPES AND LOCATION OF COMMON LINE FAULTS

It may be wise for you--at this point--to review the four common types of line faults (troubles). A solid understanding of what each type of line fault is and the conditions that commonly cause these different faults will make your trouble shooting task a relatively simple one. You know that there are four types of line faults: opens, shorts, crosses, and grounds.

An open exists when the continuity of a conductor or conducting circuit is broken and there is no electrical path to ground. It is possible to have situations where the circuit is opened intermittently. Therefore, opens are classified as "complete opens" or "intermittent opens." Sometimes, high resistance connections (connections where poor contact is made) are classified as opens. Conditions that commonly cause opens in drop, block, or station wiring are:

1. A break in one or both conductors of the circuit.

2. A wire disconnected from the terminal.

3. An improper or split pair connection at a cable terminal.

4. A loose connection at a terminal.

5. An improperly made splice.

6. A high resistance connection is usually caused by the formation of corrosion on conductors, binding posts, nuts, or washers at the terminal.

If the test deskman reported an intermittent open on a particular circuit, where do you think the trouble might be?

A short exists in a telephone circuit when the insulation between two conductors of one circuit breaks down and the conductors make electrical contact with each other. Shorts in drop, block, and station wiring are usually caused by damage to the insulation where the wires are in contact with supporting fixtures, pole or building attachments, and trees or other obstructions along the wire route. Shorts are also often caused by dirt or foreign material accumulating in terminals, protectors, and connecting blocks.

A cross is similar to a short except that the insulation breaks down between two conductors of different circuits. Crosses in drop, block, or station wiring, are usually caused by one of the following conditions:

1. Damaged insulation near pole or building attachments.

2. Improper dressing and connection of conductors at cable terminals, protectors, and connecting blocks. Considering all of the outside plant, central office to substation, where would you think crosses most likely are to be located?

A conductor is said to be grounded when the insulation has broken down and the conductor is in electrical contact with a path to the earth. Grounds in drop, block, and station wire are usually the result of damaged insulation, where the wires are in contact with poles, trees, guys, buildings, cables, ground wires, rain spouts, building projections, and other obstructions.

You can see that it is just as possible to have intermittent shorts, crosses, and grounds on circuits, as it is to have intermittent opens. Intermittent shorts, crosses, and grounds are sometimes referred to as "swinging" grounds or "swinging" shorts, etc., while the completely shorted or grounded circuits are often referred to as "solid" shorts or "solid" grounds, etc.

It is impossible to overestimate the value of a good understanding of the different types of line faults and their causes in fault location. It is not unusual for an airman who knows the common causes of line faults and is familiar with an installation, to go directly to the cause of a reported trouble upon being told the type of fault on the circuit.

USE OF THE HAND TEST SET

The first step in locating line faults is to verify the information obtained from the trouble report and the test deskman. Take nothing for granted; always check the line to assure that the trouble is as reported. The next step is to determine if the trouble is in the cable or in the installation wiring. If the fault is in the cable, report the condition to your wire chief or test deskman, who will probably assign another pair for the circuit. If you find the trouble to be in the installation wiring, determine what part of the installation wiring involves the fault. This procedure of elimination is sometimes referred to as trouble isolation. To accomplish the trouble-isolating process, make the first test at the station protector and proceed in the direction of the trouble to the next convenient test point.

For purposes of clarification, it might be well to go through the complete process. Using figure 4-2 as a reference, assume there is a line fault some place between the central office and telephone. The objective is to isolate the fault.

1. Remove the fuses from the protector and test back towards the central office, "D" to "F". If the test indicates the trouble to be between "D" and "F," proceed from the protector to the terminal "E".

2. Remove drop wire from terminal binding posts and test towards the central office, E" to "F". If "E to "F" is clear of trouble, the fault must be in the drop wire.

NOTE: If in making the first test at the protector (step1), you found the trouble to be in the inside wiring, replace the fuses in the protector and proceed to the connecting block, "A".

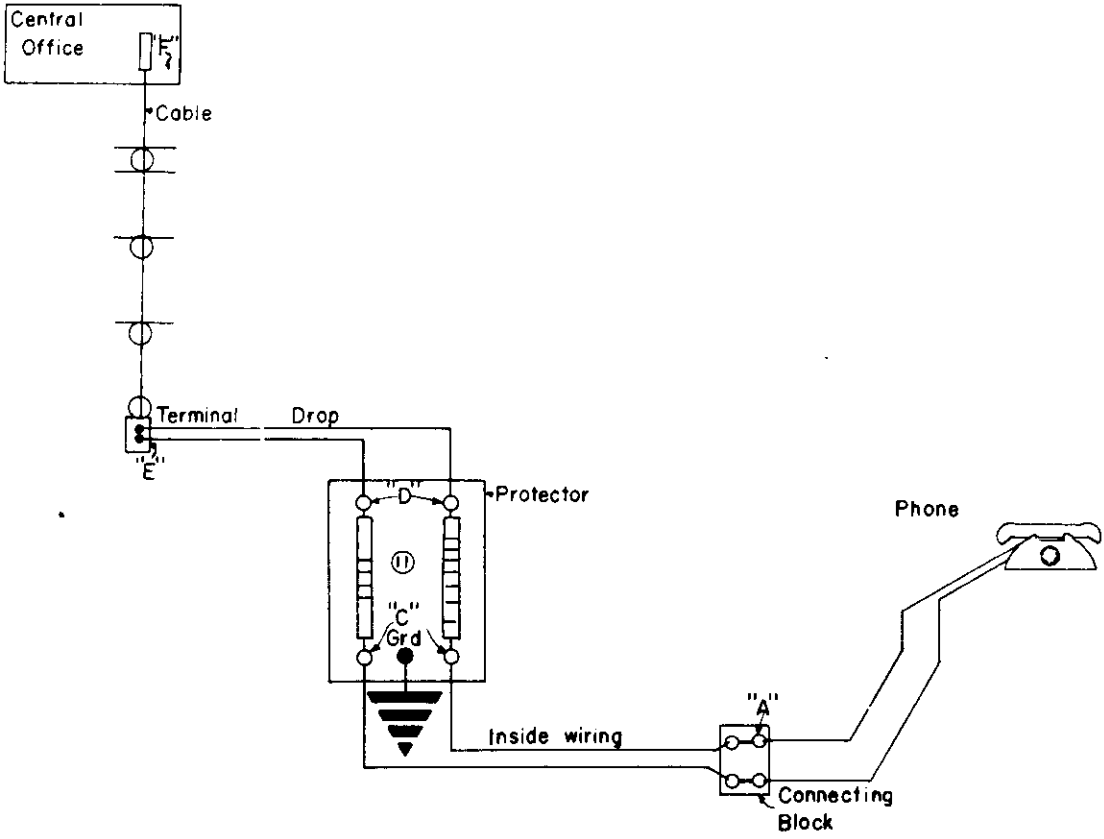
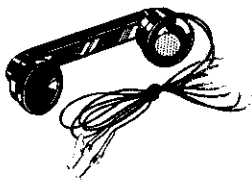


Figure 4-2. Subscriber's Loop

3. Remove the line wire from the connecting block and test back toward the station protector "A" to "C". If line is good the fault lies in the instrument or cords. However, if the line from "A" to "C" test faulty;, the trouble is in the inside wire run.



The testing process can just as well be started at the terminal instead of the station protector. It is wise to start testing from the most convenient place. You might save one trip up the pole if you start at the protector.

Normally, the hand test set is used for testing station lines. However, the type of fault--open, short, cross, or ground--will determine how the set is used. Figure 4-3 shows two commonly used types of hand test sets. The WECo Nr. 1011-BW is equipped with a dial for use on automatic lines. The other set pictured in figure 4-3 is a Kellogg Nr. 1025 for use on manually operated lines.

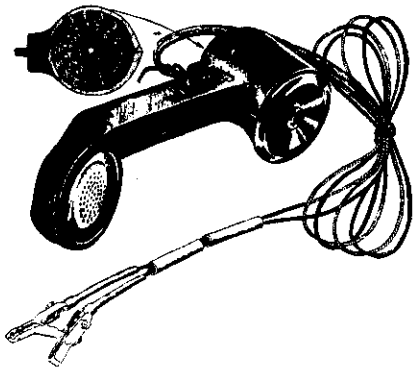


Figure 4-3. Hand Test Sets

The test for a short is a simple process; disconnect the circuit and bridge the test set leads across the circuit. Listen in the test set receiver for dial tone or operator's response, depending on the type of service. If no response is heard you know the short is between you and the central office.

The test for a cross is a little more complicated than the test for a short. You must remember that a cross involves two circuits, or two pair. Use the hand test set as follows in testing for a cross.

1. Disconnect one of the circuits under test from the binding posts.

2. Connect one of the test set leads to one of these binding posts.

3. Touch the free test set lead in turn to each of the disconnected conductors.

4. Listen in the receiver for a battery click on the make and break of each contact. If a click is heard a cross exists between the conductors under test.

5. Repeat the procedures discussed in steps 2, 3, and 4 with the test set lead connected to the other binding post.

The test for an open is quite simple; merely bridge the hand test set across the circuit under test and listen in the receiver for a battery click. If no click is heard the circuit is open.

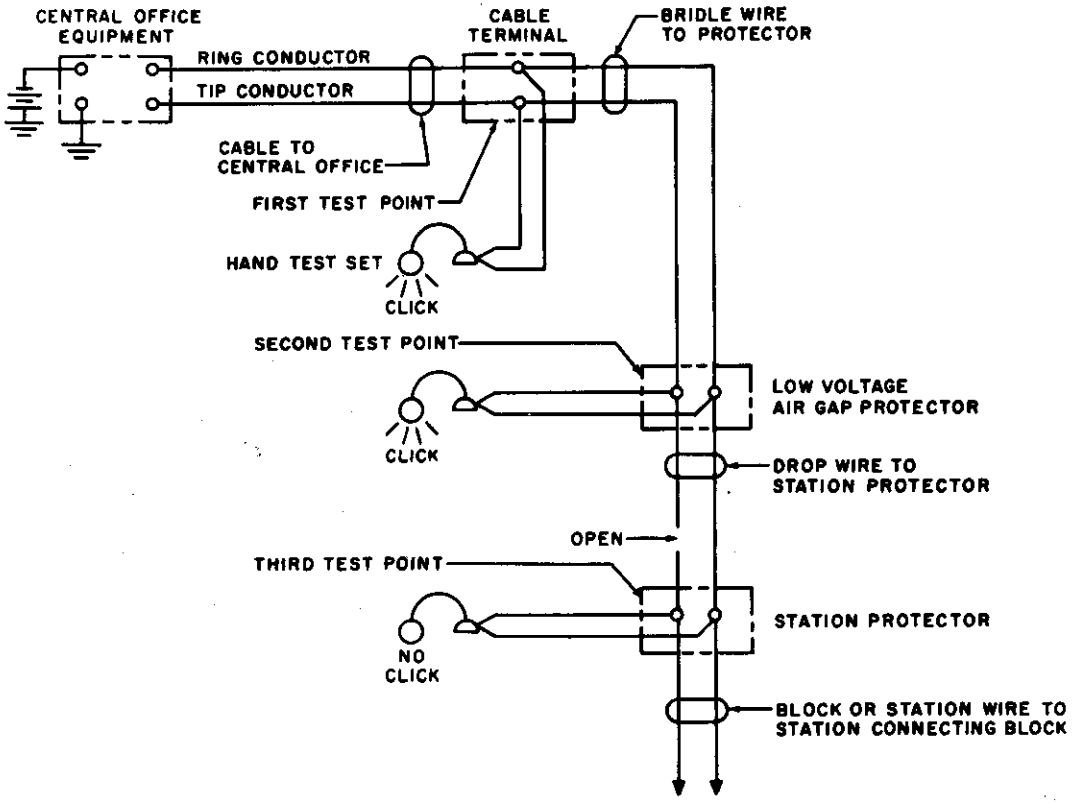


Figure 4-4 Schematic Diagram of Test for an Open

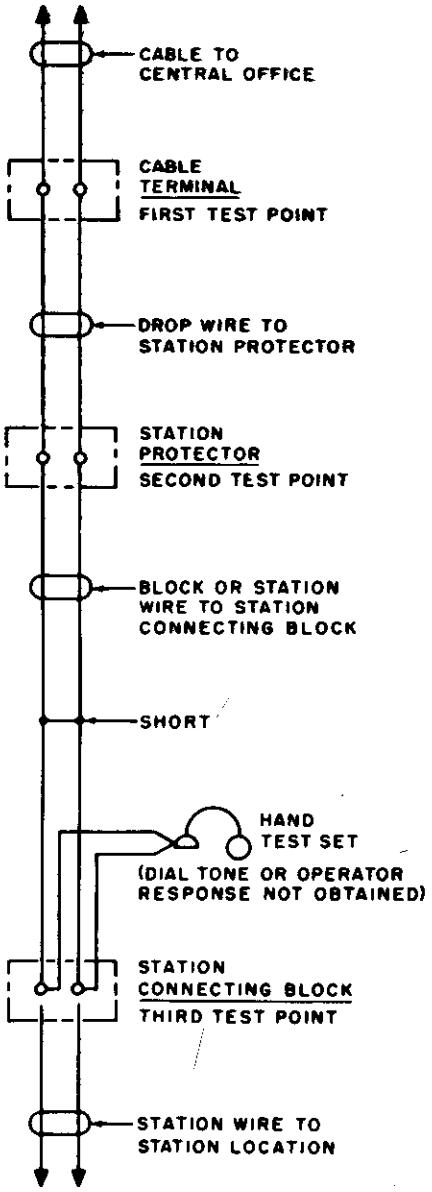


Figure 4-5. Schematic Diagram of Test to Isolate a Short

The hand test set is also used in testing for grounds. The procedure is as follows:

1. Disconnect the station leads under test at the test location.

2. Identify the ring side of the line. Identification is made by clipping one of the test set leads to ground and touching the other lead from the test set alternately to each side of the circuit under test. A battery click will be heard on both sides of the line; however, the click on the ring side will be especially distinct and clearly audible.

3. Clip one of the test set leads to the binding post on the ring side of the line.

4. Touch the free lead of the test set to each of the disconnected leads in turn.

5. Listen in the receiver of the test set for a battery click on the make and break of each contact.

If a battery click is heard on the make and break of either of the test contacts, it indicates that a ground exists on the station side of the test point.

Schematic diagrams of the testing procedures for opens, shorts, crosses, and grounds (using the hand test set) are shown in figures 4-4, 4-5, 4-6, 4-7, and 4-8.

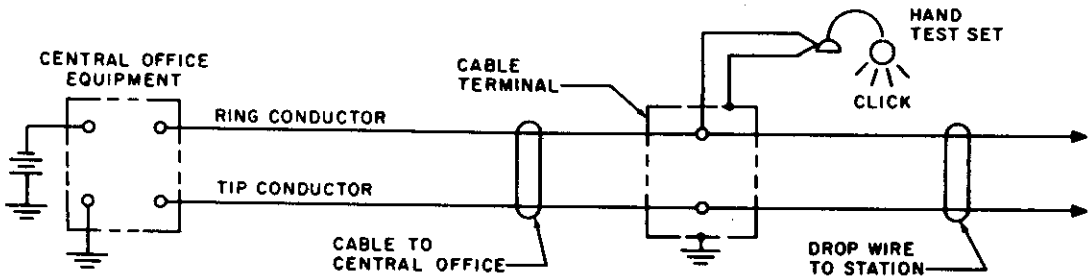


Figure 4-6. Schematic Diagram of Test Procedure to Identify Ring Conductor

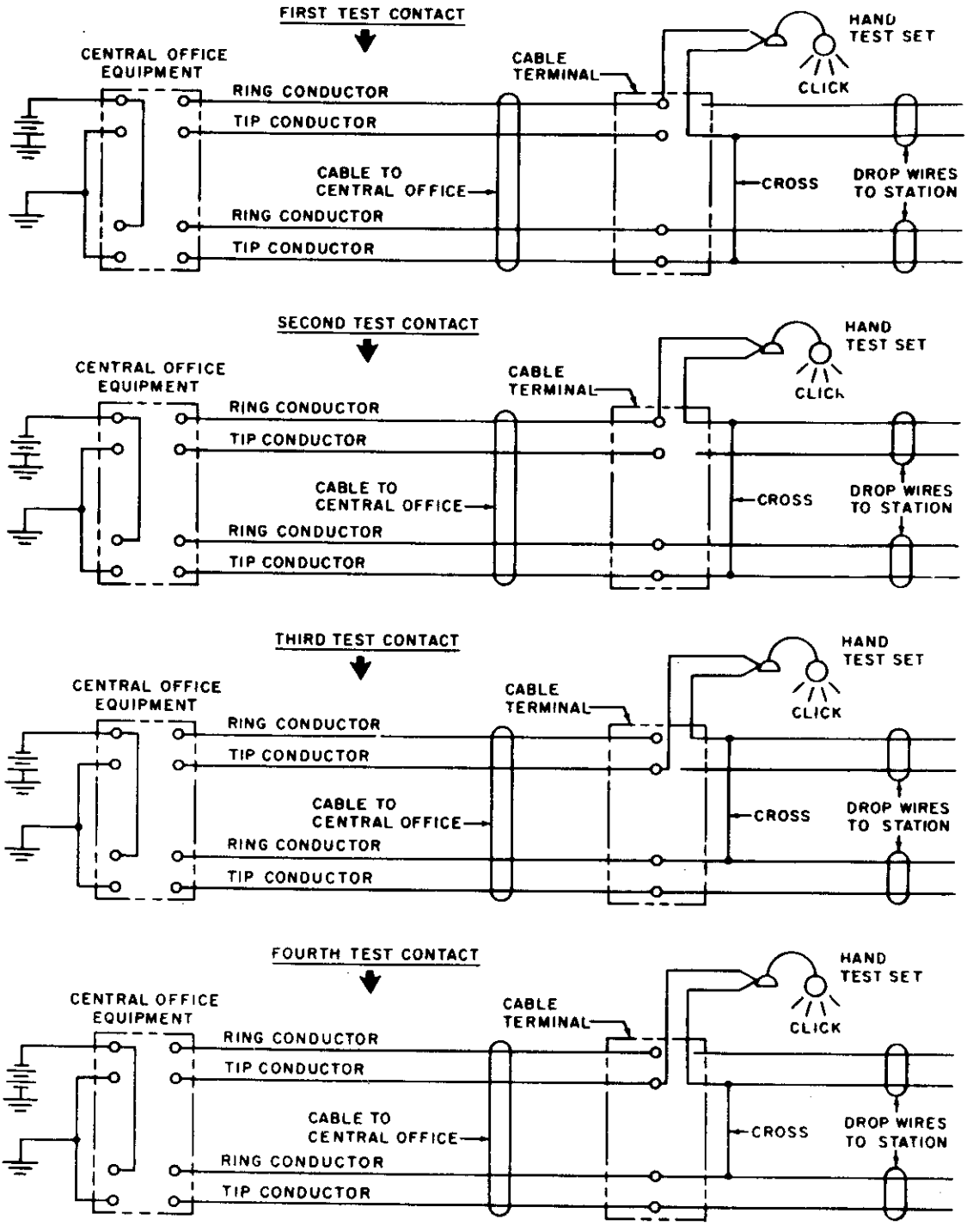


Figure 4-7. Schematic Diagram of Test for a Cross

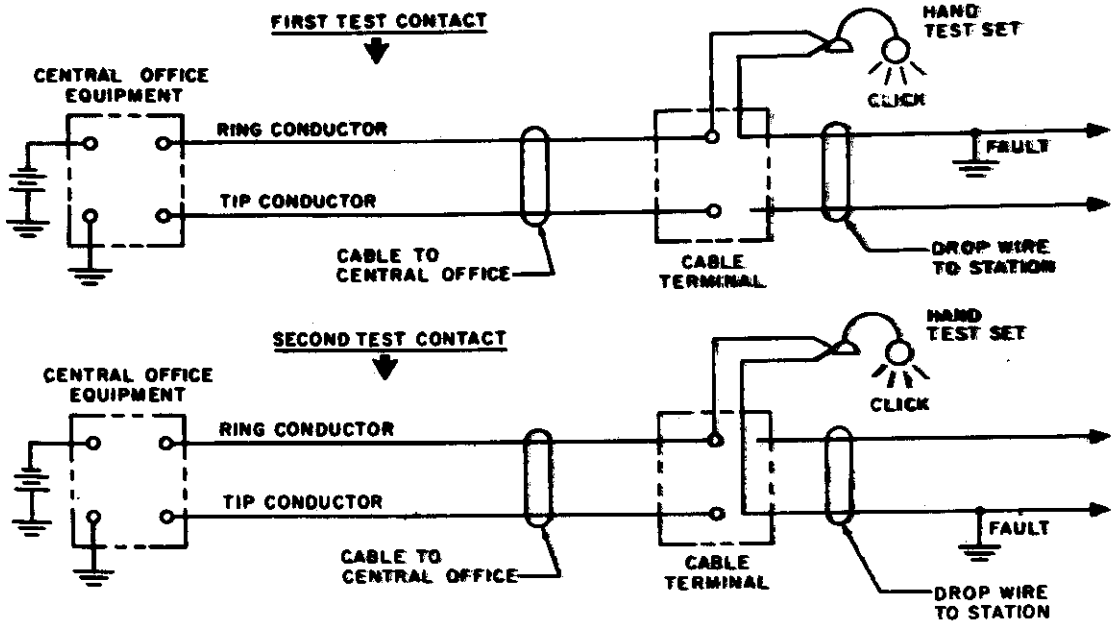


Figure 4-8. Schematic Diagram of Test for a Ground

DROP, BLOCK, AND STATION WIRE REPAIRS

After you have isolated the fault to a particular section of the installation, you must find its specific location. In most cases, it is possible to pin-point the exact location of the fault by a careful visual inspection of the wire involved. If the fault cannot be located by close visual inspection, further tests must be made. In cases of swinging or high resistance faults make sure that all connections are tight and clean.

To repair faults located in sections of drop, block, or station wire runs at new or reasonably new installations, cut out the faulty portion of the wire and splice in a new section. Sometimes it is more practical to replace the complete run involving the fault; this is particularly true where the line has generally deteriorated and further trouble may be expected.

If the trouble is traced to the protector, check the fuses and inspect the carbon blocks. If the carbon blocks are damp, wipe them dry; in some cases, you may have to relocate the protector to avoid damp conditions. On the other hand, if the carbon blocks are dirty or pitted, just replace the blocks. Connecting blocks seldom cause service interruptions unless struck by an object that dents the cover or breaks the base. These troubles are easily corrected by replacement of the damaged parts.

Thus far we have discussed the procedures used in trouble location and trouble repair of the station installation from the cable terminal to the connecting block. The only place remaining where trouble may occur is in the instrument or instrument cord.

FAULT LOCATION AND REPAIR OF TELEPHONE SETS

It was stated earlier in this chapter that the information given in the Telephone Trouble Report is often a clue to the location of the fault. Take another look at the

Trouble Report; note the items listed under Trouble Reported: Bell Doesn't Ring, Bell Rings Faintly, Permanent Signal, Cannot Get Operator, Cannot Hear, Cannot Be Heard, Telephone Doesn't Answer, Cuts Out, and Noisy. Now, in your mind try to isolate each one of the reported troubles to either the telephone instrument or the line. For example, if the trouble is reported as "Bell Doesn't Ring" and no other trouble is indicated such as "Cannot Hear" or "Cannot be Heard," it is a good indication that the trouble lies within the instrument. See if you can reason out the remaining listed troubles.

It should be obvious that by careful analysis of the trouble reported and by line testing, you may isolate the trouble to the telephone instrument. If this is the case, replace the instrument with another. This is usually the quickest means of restoring service. However, if service can be restored more quickly by repairing the faulty subset, do so.

PRELIMINARY TESTING PROCEDURES

There are three basic procedures to follow when trouble shooting a telephone subset.

1. Make an operational check. This check is made to prove which circuit in the set is not operating properly.

2. Make a visual inspection of the set. This check is made to discover any obvious faults; such as opens caused by broken wires or connections, shorts caused by improper contacts between spade clips, and improper mechanical action caused by the presence of foreign materials.

3. Make a continuity test. This test is made to determine if the circuit under test is complete when the trouble is not obvious enough to be seen when the visual check is made.

You do not need elaborate testing devices to accomplish the tests necessary to locate normal troubles in the subset. The hand telephone test set, or a simple test receive, "click set," will do the job. The test receiver may be constructed by using an extra

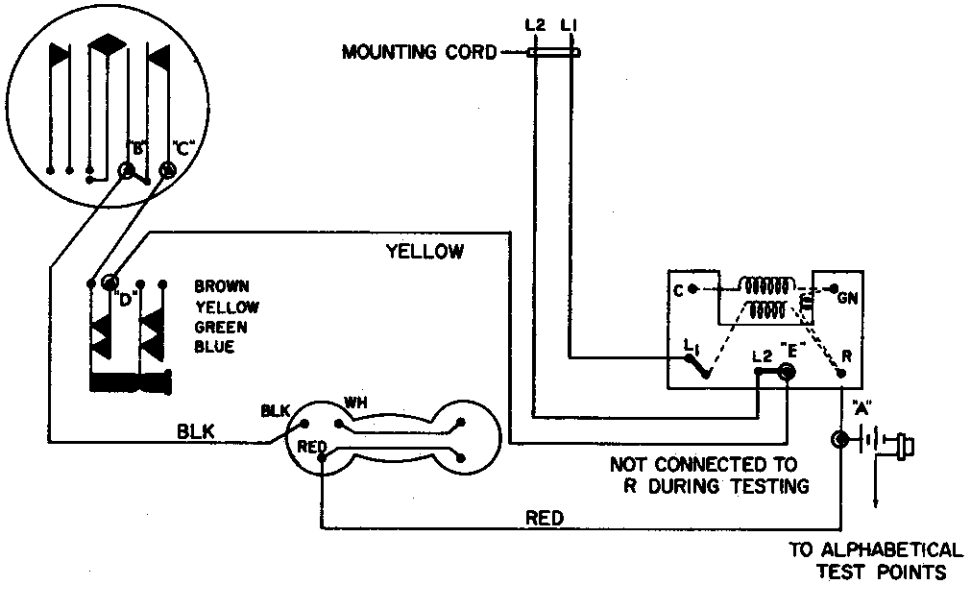


Figure 4-9. Transmission Test

TRANSMISSION TEST

Position of Test Leads	Symptom at Test Rec.	Probable Troubles
"A" and "B"	Hear voice	None
"A" and "B"	No voice heard	Open red lead, open or shorted contacts, open BLK lead, faulty transmitter unit
"A" and "C"	Hear voice	None
"A" and "C"	No voice heard	Open circuit, open pulsing springs
"A" to "D"	Hear voice	None
"A" to "D"	No voice heard	Open brown wire, open contacts of hookswitch
"A" to "E"	Voice	None
"A" to "E"	No voice heard	Open yellow lead from hookswitch

Figure 4-10. Transmission Test Chart

handset with the transmitter removed and a 4 1/2-volt battery connected in series with the receiver and test leads.

From experience you know that the operational and visual checks are relatively simple to make; the continuity or point-to-point test is more difficult and will differ, depending on the type of subset under test. Figures 4-9 and 4-10 illustrate the proper procedure to use when making a point-to-point (continuity) test of the transmitter circuit in WECo 302 and Connecticut desk type telephones. As you know the transmitter circuit must be checked before the receiver circuit when the phone will neither transmit or receive. When making the transmitter circuit test outlined above, remove the red lead of the handset cord from "R" of the induction coil and connect one lead of the test receiver to the removed red conductor. Next, using the other test lead touch the test points indicated in figure 4-10. During each step of the test, blow into the transmitter of the handset and listen at the test receiver. Make the tests in the order shown in figure 4-10.

To make a continuity test of the receiver circuit (WECo 302 and Connecticut-type phones) use the procedures outlined in figures 4-11 and 4-12. Test results are determined by clicks heard in the subset receiver only; do not pay attention to clicks heard in the test receiver. This test is made only after the phone is known to transmit. Follow the testing sequence listed in figure 4-12. Figure 4-13 shows the wiring diagram for this type telephone.

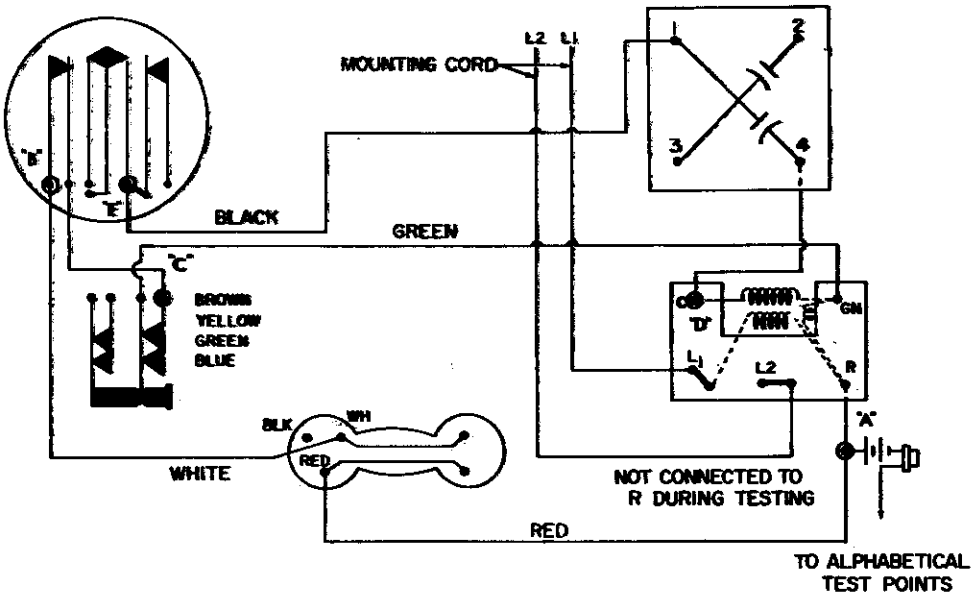
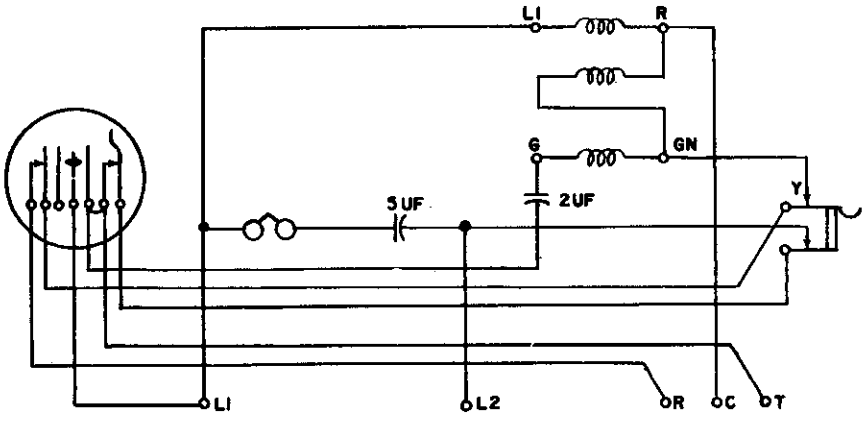


Figure 4-11. Receiver Test

Position of Test Leads	Symptom at Test Rec.	Probable Troubles
"A"* and "B"	Click	None so far
	No click	Faulty receiver unit, poor receiver contacts, open white lead of handset cord, open or shorted straps between transmitter and receiver of handset
"A"* and "C"	Click	None so far
	No click	Open 2nd Shunt Springs, open blue lead of hookswitch
"A"* and "D"	Click	None so far
	No click	Open contacts at make last of hookswitch, open green lead from hookswitch to (Gn) of induction coil, open 3-4 winding of induction coil
"A" and "E"	Click	None
	No click	Open red lead (4) of condenser, faulty condenser, open black lead (1) of condenser

* Test lead remains on common red wire of handset cord removed from induction coil at (R).

Figure 4-12. Receiver Test Chart



NOTES

1. HOOKSWITCH SHOWN WITH HANDSET REMOVED FROM CRADLE.
2. Y CONTACTS OF HOOKSWITCH MAKE LAST.

Figure 4-13. Schematic Diagram WECo 302

DIALS

The location of dial troubles is comparatively simple, but will vary with different type dials. Generally, when looking for dial faults, check the cleanliness and the position of the spring contacts; see that the moving parts operate properly; and check all wires attached to the dial to make sure that they are tight and not shorting out.

Dial speed is, of course, an important factor in the operation of the subset. If the dial speed must be changed or is suspected of being wrong, tests should be made to determine the speed. Correct dial speed is normally ten pulses per second although the speed requirement may vary with the type of central office equipment used. There are various dial speed testers on the market. Usually, the test consists of making a simple connection between the subset and the dial tester. If no test set is available, dial speed may be tested by counting slowly; that is, by pronouncing the words "one thousand and one" while the dial is running down from a zero dialing. The dial should stop just as the word "one" at the end of the phrase is spoken.

If the dial speed is incorrect an adjustment must be made. Use the clamp dial governor holder for governor setting adjustments on the WECo dial. Clamp the holder over the governor to hold the moving parts in position while the governor is adjusted to a faster or slower setting which is indicated on the dial clamp. Figure 4-14 illustrates the use of dial governor holder.

The Automatic Electric Company dial has a revolving governor. The pulsing springs are operated by a two-lobed cam. Adjust this governor by increasing or decreasing the pressure between the governor weights and wings (sometimes called governor spring arms) so that the weights are pressed against the cup. When you bend the two wings, form them as nearly alike as possible. Figure 4-15 shows this type of governor. Another adjustment on the Automatic Electric Company dial which is not usually found on other dials is that of the end movement of the dial governor worm shaft. An end screw, shown in figure 4-15, is adjusted to allow a little end play (not to exceed 1/64 inch) in the governor shaft assembly. To adjust the end play loosen the lock nut, tighten or loosen the adjustment screw as required, and then tighten the lock nut securely.

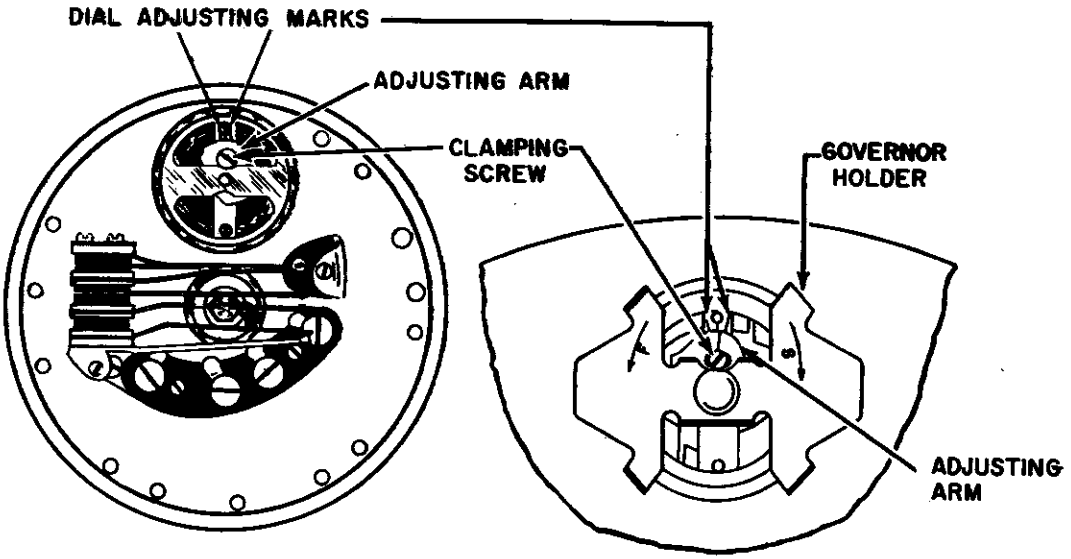


Figure 4-14. Governor Wing Adjustment

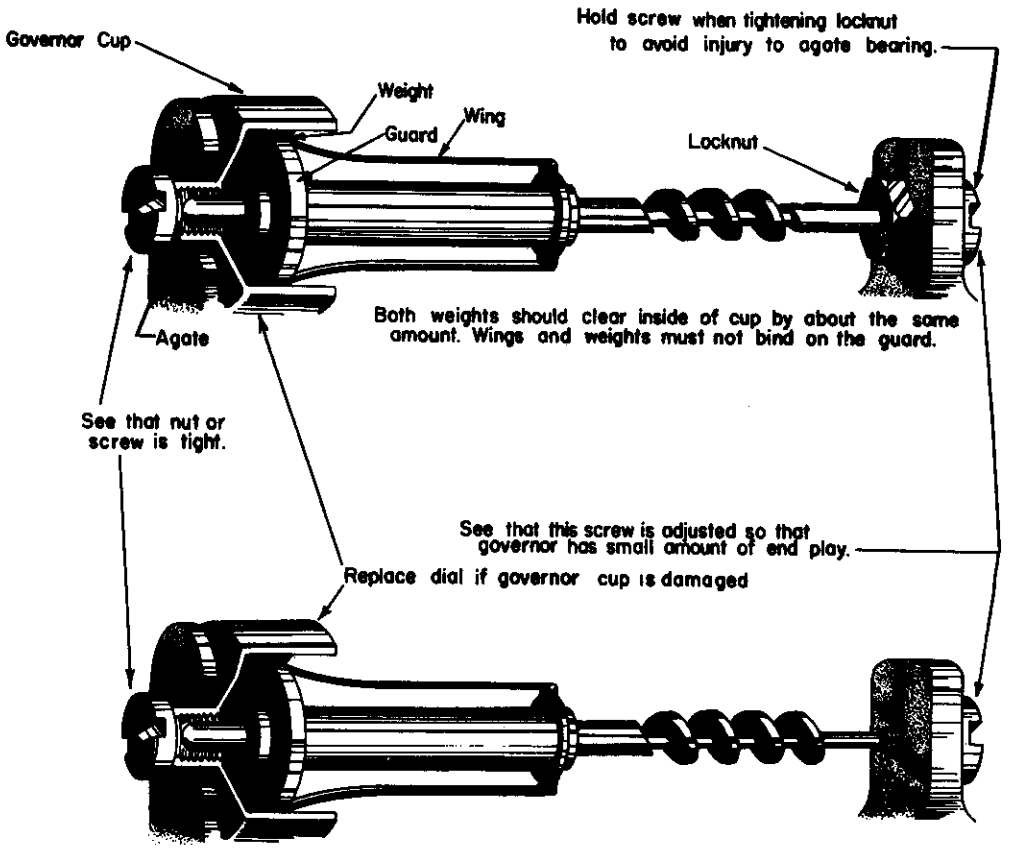


Figure 4-15. Governor Worm Gear Shaft Adjustment

THE HOOKSWITCH

Trouble isolated to the hookswitch of the WECo 302 and TP-6A is usually corrected by checking the wires for continuity and proper insulation. Contacts may become dirty and should be cleaned with a burnishing tool. Contacts should line up so that the full width of the contacting surface falls wholly within the width of the mating contact. To align the contacts, it is usually necessary to loosen the spring pile-up mounting screws, shift the springs until the contacts cross one another at right angles and are as near the middle of the contacts as possible. Tighten the screws securely and replace the switch assembly. The springs may be tensioned by bending; care must be taken when bending the springs to avoid kinking them in the process.

THE RINGER

Reported ringer troubles usually fall into three main categories: (1) doesn't ring, (2) rings too loud or soft, or (3) bell taps when dialing. The first trouble is normally caused by the presence of some foreign material (dirt, metal shavings) between the armature and windings, open leads, or faulty windings. Clear the trouble by cleaning; or in the case of faulty windings, replace the ringer. The second type of trouble is usually corrected by adjusting the armature air gap. The third condition (bell tapping) is corrected by adjusting the bias spring.

Another type subset in wide use today is the TA-236/FT or the WECo 500 or Kellogg K-500. The general trouble shooting procedures described earlier in this chapter can be applied to this set, with the exception of continuity testing. The network construction of this set provides no available means of isolating one of the parallel-connected paths from the other (refer to figure 4-17) to allow individual testing. Therefore, when circuit components outside of the network assembly meet requirements and the set still does not operate, replace the network assembly or the telephone set. Do not attempt to repair the network assembly. Figures 4-16 and 4-17 may be used as reference for making test of the TP 236/FT

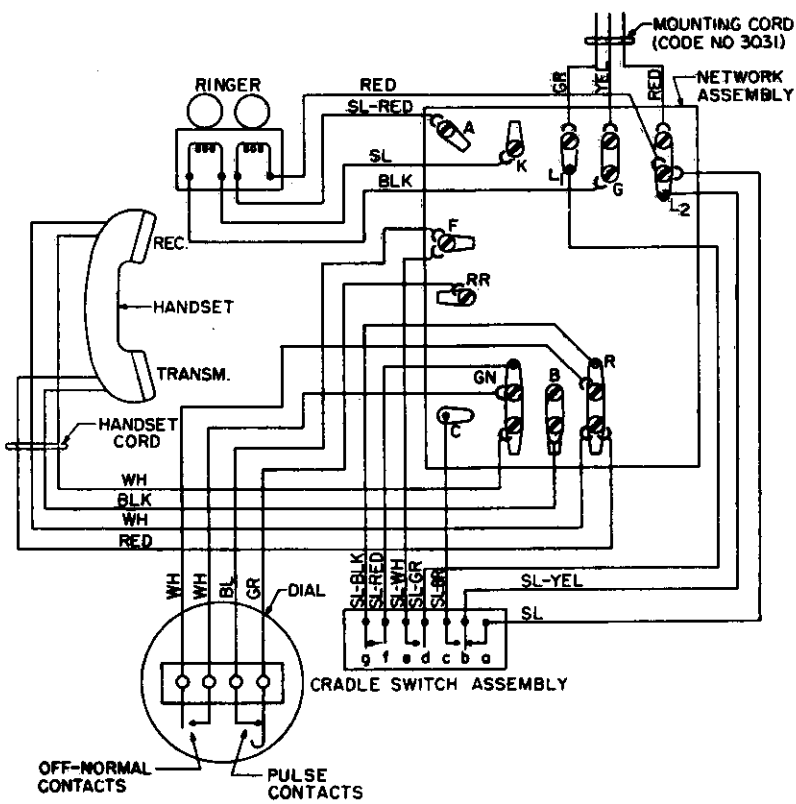


Figure 4-16. Wiring Diagram TA-236/FT

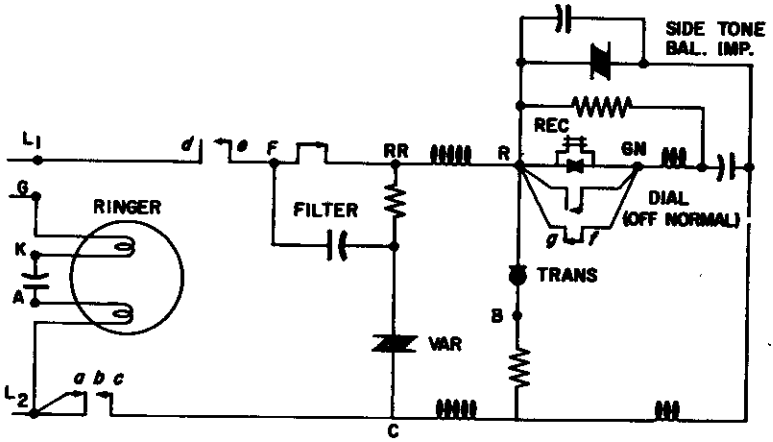


Figure 4-17. Circuit Schematic TA-236/FT

SUMMARY

This chapter has discussed two types of telephone station maintenance: preventive maintenance and corrective maintenance. Preventive maintenance boils down to locating potential trouble and hazardous conditions and correcting them before a breakdown of service occurs. Corrective maintenance takes place after the service has been interrupted. It requires nothing more than common sense to realize that a good preventive maintenance program may almost eliminate the need for corrective maintenance and at the same time provide better service for the telephone user. Probably the greatest incentive you have in promoting a good preventive maintenance program on your base is the fact that it is a lot easier for the installer to make repairs under ideal conditions than to shoot trouble during the night or in rain and snow storms.

The trouble shooting portion of this chapter covered only the major troubles that occur in substation lines and equipment. The combinations of troubles and the methods used in locating and correcting troubles are so widely varied that it would take a large book and several years of application to learn them all. However, you can continue to broaden your knowledge in this phase of the job by studying and applying the principles and practices given in the following technical order references.

REFERENCES

TO 31W-1-6	Plant Operating Procedures
TO 31W-1-102	Substation Maintenance
TO 31W-3-2	Principles of Line Fault Location
TO 31W-1-17	Telephone Outside Plant Construction

REVIEW QUESTIONS

1. If after a severe lightning storm, a circuit is reported open on both sides, where would you look first for the trouble?

2. Make a detailed list of the items included in a routine substation preventive maintenance inspection.

3. Is the Automatic Electric dial adjusted in the same manner as other type dials?

Explain.

4. List the conditions that might cause an intermittent open on a substation line.

5. List conditions that might cause a high resistance short on a substation line.

6. Explain the method used to detect the following line faults with a hand test set:

(a) Opens

(b) Shorts

(c) Crosses

(d) Grounds

7. Explain the process used to isolate trouble in a normal substation installation.

8. What are the three basic procedures that are followed when trouble shooting any telephone set?

9. When a trouble is isolated to the network assembly in a WECo 500 type telephone, what must you do? Why?

10. Can you build a click set? How?

WORK PROBLEMS

PROBLEM 1. Location of line faults.

Training Equipment: Hand telephone test set, hand tools, and repair equipment.

References: TO 31W3-1-17 and TO 31W-1-102.

Work Procedures: Work as a member of a trouble crew and locate troubles to drop wire, inside wiring, and instruments.

PROBLEM 2. Substation preventive maintenance.

Training Equipment: Hand tools and repair equipment.

References: TO 31W-1-6

Work Procedures: Make a systematic preventive maintenance inspection of at least five station installations. Report all potential trouble areas to your supervisor. Make repairs indicated by your supervisor.

PROBLEM 3. Instrument trouble shooting and repair.

Training Equipment: Click set, hand telephone test set, hand tools, and repair equipment.

References: TO 31W-1-102.

Work Procedures: Obtain subsets in need of repair from your supervisor;

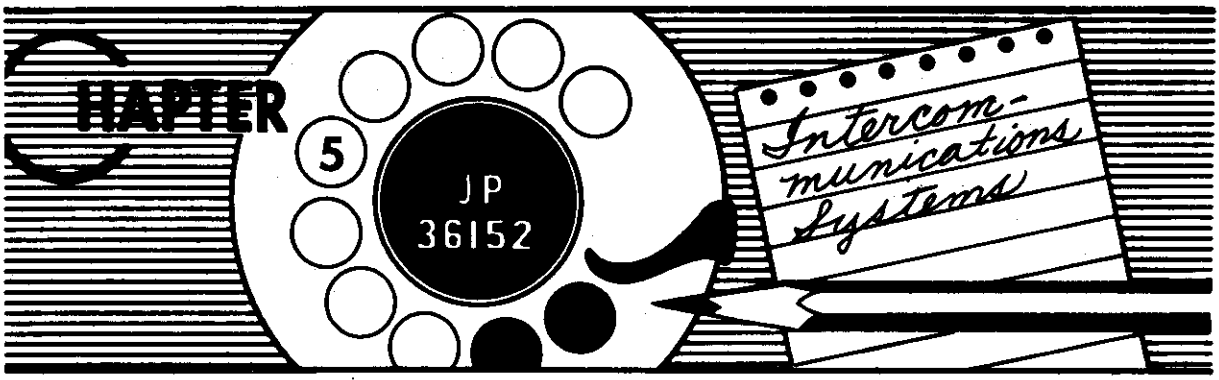
ascertain troubles; repair the troubles; clean the instruments thoroughly and perform an operational check on each set.

PROBLEM 4. Station installation repairs.

Training Equipment: Hand telephone set, hand tools, repair equipment.

References: TO 31W3-1-17 and TO 31W-1-102.

Work Procedures: Work as a member of a trouble crew and repair opens, shorts, crosses, and grounds, located in drop and inside wire runs. Make repairs by running in new wire, splicing in new wire sections and repairing loose connections.



Most publications written about amplifier intercommunication systems begin by enumerating the advantages of the system over telephone communications. Such publications tell us that the use of intercom systems saves many steps, a great deal of time, and in general increases the operating efficiency of the using organization. However, if you have ever lived in a barracks that had a "squawk box" connected directly to the orderly room, you might not go along with such statements. Therefore, we will ignore these so-called advantages of the intercom system and confine the discussion to the description, installation, and maintenance of intercom sets. If, while working as an apprentice 36152, you have had no opportunity to work on intercom systems, some review may be in order.

In general, an amplifier intercom system may be described as a network of master stations and remote stations tied together by cable or wire for the purpose of interoffice communications. Figure 5-1 is a block diagram of a typical intercom system. As you can see, the stations in figure 5-1 are connected so the two master stations can communicate with each other, and either master station can communicate with all remote stations individually or simultaneously. The remote stations cannot communicate with each other.

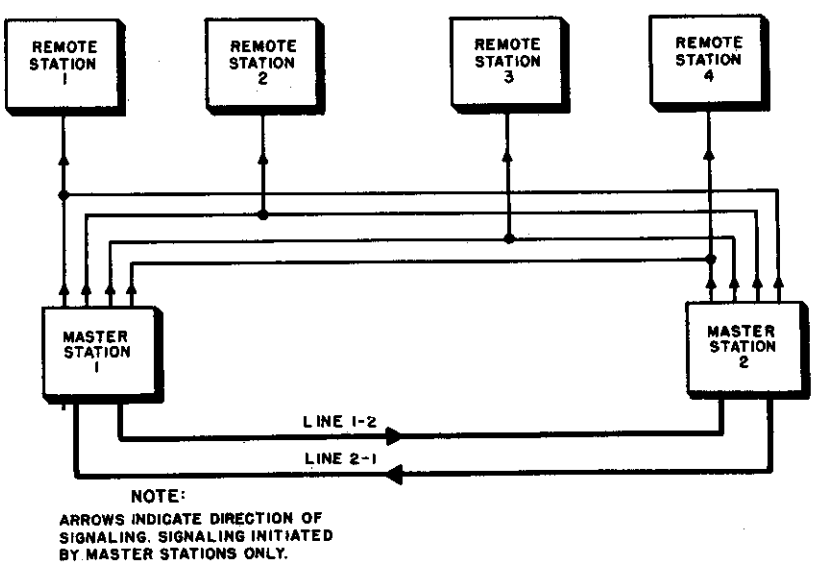


Figure 5-1. Typical Intercommunicating System Block Diagram

Almost any interoffice communication requirement can be accomplished with intercom equipment if you know the operating capabilities of the sets and understand the interconnecting schemes. The master stations can be used to select, call, and talk to any number of master stations or remote stations, individually or in combination that may be connected in the same system. They serve as central switching points and

furnish their own power as well as power for the remote stations. The remote stations (often called slave stations) allow the reception and transmission of voice signals and, in some cases, operate a visual signaling device at the master stations. The equipment normally operates on ac current; however, equipment can be obtained that operates on dc current. There are several different makes of intercom sets on the market; but as representative examples, we will discuss the equipment of two manufacturers: the Webster Electric Company and the Western Electric Company.

THE WEBSTER ELECTRIC INTERCOMMUNICATION SET

The Webster Company manufactures several models of both master and speaker microphone units. As you can see from figure 5-2 the master stations are similar in appearance with the exception of size. However, do not let this similarity fool you; just as with automobiles produced by one company, each model of master station differs from the other in many ways. The difference in models is usually in their operating capabilities; that is, they differ in station capacity, type of power source, accessories, etc. In instances where you must plan a system installation or where it is necessary to replace inoperative equipment in an established system, you must be able to distinguish between the various models. This is a fairly simple matter because the company has coded the model numbers. Each digit and letter in the model number has a specific meaning. For example:

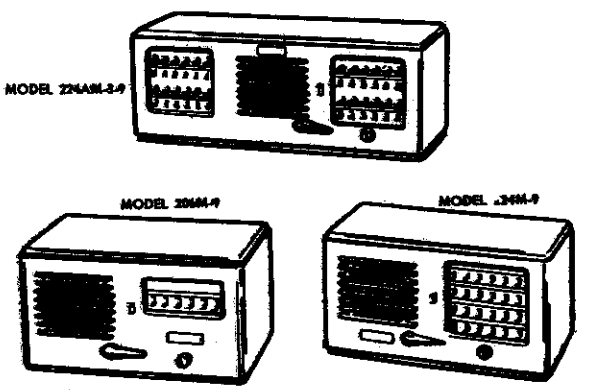


Figure 5-2
Webster Intercommunication Sets

C - denotes that the set is equipped with a supplementing earphone.

A - denotes that the set is equipped with annunciators (devices used for signaling).

M - denotes that the set is designed for use in the "M" system. (A wiring arrangement--to be explained later).

S - denotes that the set is designed for use in the "S" system. (Another wiring arrangement--more later).

L - denotes that the set is provided with a busy lamp arrangement.

-3-* - set is equipped with 3-position selector keys.

-6-** - unit impedance set at 500 ohms.

-9** - unit impedance may be changed to 50 or 500 ohms by operation of a switch.

200 - the 200 group has individual selector keys and is designed to operate on ac power.

Example: 212 indicates 12 selector keys.

300 - the 300 group has individual selector keys but operates on dc power.

* first digit after lettered suffix.
** either first or second digit after lettered suffix.

For further clarification of the coding system used with Teletalk equipment, apply the code to this model number 224AM-3-9. You should determine that this model operates on ac power, has 24 selector keys, is equipped with annunciators for signaling, is designed for use in the "M" system, has three-position selector keys, and the unit impedance may be changed to 50 or 500 ohms by operation of a switch. Using the same code, see if you can work out a description for the other models shown in figure 5-2.

MAJOR COMPONENTS OF MASTER STATIONS

Generally, the set consists of a three-tube chassis, a speaker-microphone, and a selector switch panel mounted in a wooden cabinet. A junction box, used for making line connections is attached to the chassis by a flexible cable. A cord for the power supply connection is also attached to the chassis. If a Teletalk set is available, examine the components and controls listed below. If no set is available, use figure 5-3 for reference.

NOTE: Do not remove the chassis from the cabinet -- high voltages are present when the power supply is connected.

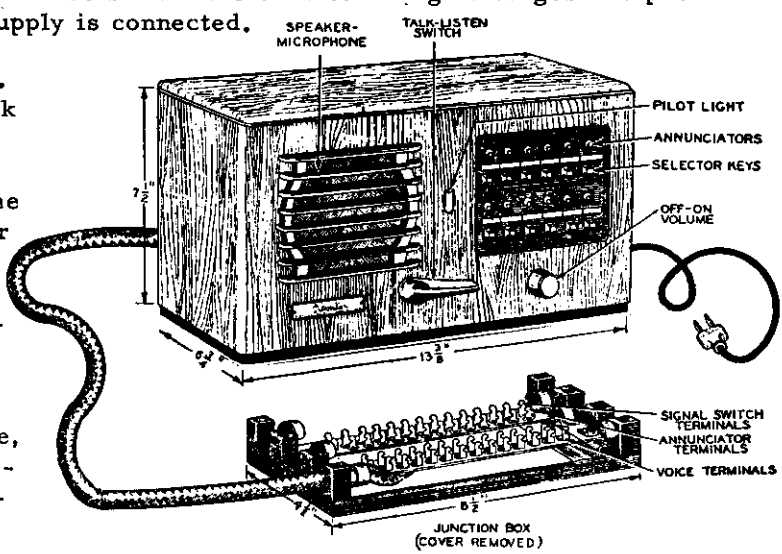


Figure 5-3. Teletalk--Webster Electric 212AM-3

Volume and On-Off Switch. Turn counter-clockwise; a click is heard and the pilot light comes on; this indicates that the current is on and the volume is at its highest point. Further turning in a counter-clockwise direction reduces the volume. It takes the tubes about 15 seconds to heat up.

Talk-Listen Lever. This is a three-position switch: idle, listen, and talk. The idle position is used to monitor the station called to determine if it is busy. The center or listen position is used to listen to communications from remote stations. The lower, or talk position is used to talk to other stations; the lever must be held in the talk position due to a built-in spring action. Since the talk-listen switch is the heart of communications control within an intercom system, we will examine it in more detail than the other controls. There are three circuits within a master station which provide for the rapid change-over from talk to listen to idle.

1. When the lever is in the idle position (up), the power supply is disconnected from the amplifier circuit and the speaker-microphone is connected directly to the calling station.

2. When the lever is in the listen position (straight across) the power supply is connected to the amplifier circuit. The signal from remote stations goes through the selector switch and into the amplifier through the input transformer. The amplified signal then passes through the output transformer to the speaker-microphone.

3. When the lever is in the talk position (down) the power supply is connected to the amplifier circuit. The signal originating at the speaker-microphone enters the amplifier through the input transformer. The amplified signal then goes from the output transformer through the selector switch to the remote station.

Selector Switch. The selector switch is either a two- or three-position switch (depending on the model) used to select or disconnect other stations. The three-position switch is used with systems containing annunciators. The "down" position is used to signal other key cabinets by operating an annunciator. Above each of the selector keys is a space in which the name of the station connected may be written. If more than one master station is used in the same system a selector key should be assigned to each master station. Each master station must leave its assigned key in the "ON" position so that any master station can call any other master station in the system.

Annunciators. The annunciators are bright chrome solenoid plungers mounted on the selector switch panel. One annunciator is mounted above each station selector switch. The annunciators are electrically operated, but must be restored (pushed back) manually. A push button on the remote station operates the annunciator at the master station.

Impedance Switch. This switch is located inside the cabinet at the rear of the chassis. The back of the cabinet and a shield must be removed to expose it. This switch must be set for the impedance at which the system is operating.

Junction Box. The junction box is used as a line terminal. A 4-foot cable furnished with each key cabinet has conductors terminated directly on the pick-up keys, annunciators, and switch. At the other end, the conductors (25 pairs and 1 single) are soldered to terminals in the junction box. The first 12 pairs are used for voice lines, and the second 12 pairs are used for signaling circuits; the 25th pair is the home line in the "S" system. The single conductor connects the chassis to a terminal in the box, but it is not used. Standard color coding arrangement is used; the colors for the second 12 pairs are the same as those of the first 12 pairs except for red instead of white tips. The 25th pair is green (both sides) and the single conductor is black.

MAJOR COMPONENTS OF SPEAKER-MICROPHONE STATIONS

Speaker-microphone units are generally used for slave or remote stations and are relatively simple compared to master stations. Several models are provided for use in conjunction with Teletalk master stations. The 5A45B model consists of a 5-inch speaker with a signaling push-button. Screw terminals for wire connections are mounted inside the cabinet; those for the voice line are on the speaker. This unit is widely used for locations having average room noise. The 5A45 set is capable only of answering calls from a master station. It cannot initiate calls or talk to other remote stations.

Another speaker-microphone set designed for use in damp locations is the 8C-45-2. This set may be used out of doors, but must be protected against direct moisture. It has an 8-inch moisture resistant speaker and is equipped with brackets and fittings for mounting at various angles. Other larger models are available for use in large areas and where room noise makes it necessary to use sets having more power.

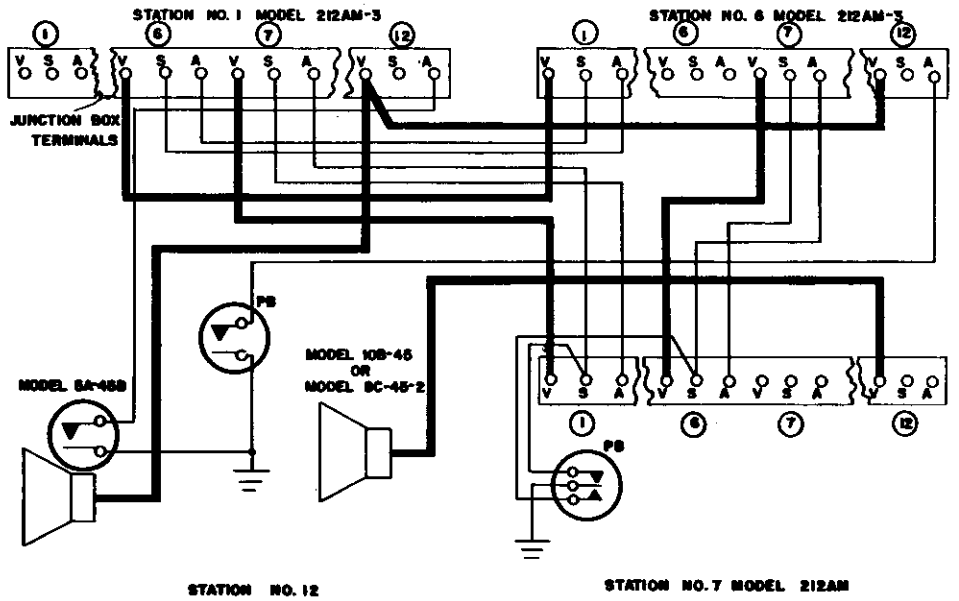
INTERSTATION WIRING

Having studied the various models of Teletalk master stations and speaker-microphones, the next step is to find out how they are connected together to make a complete intercom system. In conjunction with intercom wiring it is necessary to consider certain transmission limitations that are peculiar to the system. First, intercom circuits

cannot be included in any cables or wiring containing telephone circuits due to the probability of crosstalk. Second, precautions must be taken to avoid placing Teletalk circuits near high voltage lines from which a hum or noise is apt to be picked up. If it is possible to maintain one-foot separation between Teletalk circuits and telephone lines, you can use inside wiring type cable and be safe from interference. Direct cross-overs can be made in this case. However, where the safe separation distance cannot be maintained or where precautionary measures cannot prevent the addition of telephone lines alongside the intercom wiring, lead covered cable or shielded wire should be used.

Another factor that must be considered is the loop resistance of the voice circuits. Voice circuits between stations should be limited to 50 ohm loops for maximum performance; however, loops up to 165 ohms may be used where a slight loss of power is permissible. The use of long voice loops will affect the voice pick-up coverage of the speaker-microphones. The resistance of the single conductor used for signaling should not exceed 15 ohms.

As you may have surmised from the description of the master stations, there are two basic wiring systems used with Teletalk equipment: the "M" system and the "S" system.



SYMBOLS

V-Voice Path (Pair)
S-Signal
A-Annunciator (Buzzer)
PB-Added Signal Key
-Speaker-Microphone
-Ground (Common or Chassis)

- - - - - - Not marked in Junction Box

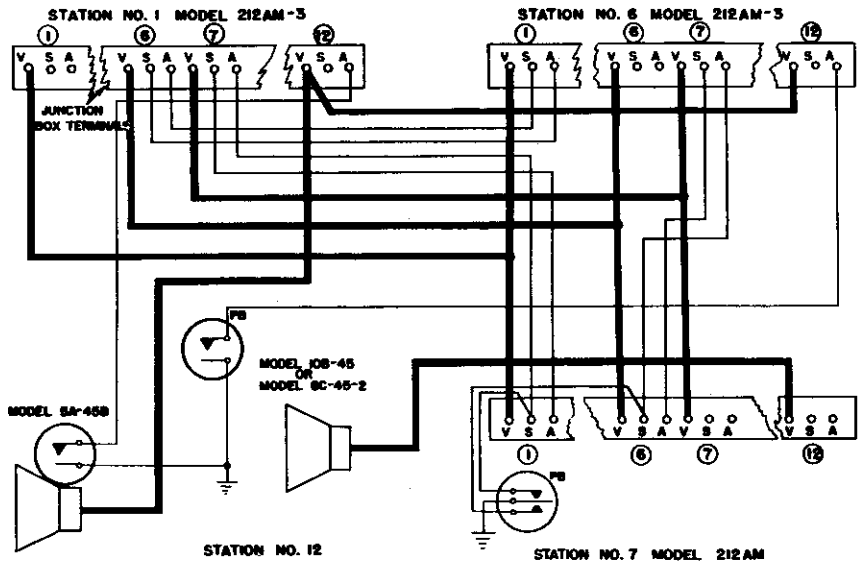
NOTES

1. Cabling and wiring separate from telephone circuit cables.
2. Voice paths (pairs) shown by single heavy lines.
3. Model 212AM does not have "built-in" signaling.
4. All stations equipped with Webster Teletalk.

Figure 5-4. "M" System Individual Station Wiring Plan

The "M" System. In the "M" system two types of stations can be used in various combinations and number: 12 line key cabinets and single line speaker-microphone stations. In this system each voice circuit employs a single pair of conductors for two-way transmission. The circuits between stations may be wired according to either one of two plans: the individual station plan and the bridged station plan. In the individual station plan there is only one station at each end of each line. This plan provides privacy between stations and is therefore well-suited for use between commanders or other official offices. Figure 5-4 illustrates the "M" system individual station wiring plan. Note that the voice paths of each station (heavy lines) are connected directly to other stations, with one exception; station 6 to station 12. However, in this case privacy is still possible due to the signaling arrangement (fine lines) and the use of selector keys at stations 1 and 6.

The bridged station plan differs from the individual station plan in that several stations are bridged to one line. The bridged station plan enables conversations to be monitored by any station having access to the line. Figure 5-5 shows the "M" system bridged station plan; compare this wiring arrangement with the individual station plan; note the equipment used and the wiring connections. You can also see from figures 5-4 and 5-5 that external signaling (push button) is employed between station 12 and station 6. Station 12, model 5A45B speaker-microphone, is equipped with a built-in push-button for signaling station 1.



SYMBOLS

V-Voice Path (Pair)
S-Signal
A-Annunciator (Buzzer)
PB-Added Signal Key
-Speaker-Microphone
-Ground (Common or Chassis)

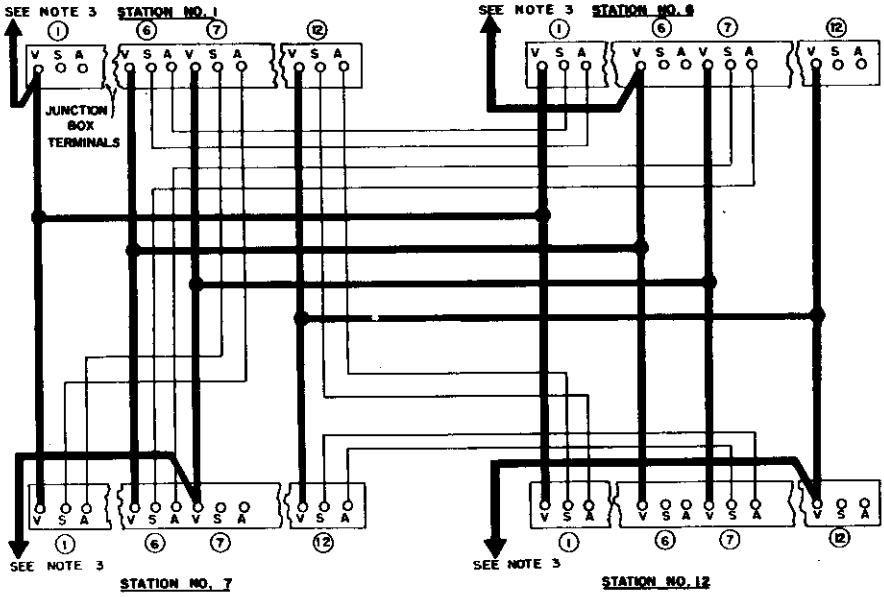
- - - - - - Not marked in Junction Box

NOTES

1. Cabling and wiring separate from telephone circuit cables.
2. Voice paths (pairs) shown by single heavy line.
3. Model 212AM does not have "built-in" signaling.
4. All stations equipped with Webster Teletalk.

Figure 5-5. Interstation Cabling and Wiring for "M" System-Bridged Station Basis

In either "M" system plan, speech and signaling may be accomplished between the twelve line key cabinets and speaker-microphones, but not between the speaker-microphone stations.



SYMBOLS

V-Voice Path (Pair)		Not marked
S-Signal	- - - - - -	in
A-Annunciator (Buzzer)		Junction Box

NOTES

1. Cabling and wiring separate from telephone circuit cables.
2. Voice paths (pairs) shown by single heavy lines.
3. Model 212CASL-3 provides an earphone for optional use. This connection is made through a separate volume control and a hook-switch instead of through the local talk-signal key.
4. All stations are equipped with Model 212CASL-3 Key cabinets. (WebsterTeletalk)

Figure 5-6. Interstation Cabling and Wiring for "S" System

The "S" System. The "S" system is designed to accomplish a greater degree of privacy than the "M" system. This system differs from the "M" system in that one-way transmission is used; two circuits are required for the voice path, one for transmission and the other for reception. The one-way transmission is accomplished by built-in features in the sets that amplify the signal in only one direction. Therefore, the system has relatively low electrical speech volumes and consequently, the chance of crosstalk is minimized. The operation of the Talk-Listen switch also differs from the "M" system in that the switch must be operated at both stations during conversation. Cabinets designed for the "S" system are equipped with earphones which may be used instead of loudspeakers to secure added privacy. Speaker-microphones are not generally used in the "S" system because this feature of amplifying the speech only at the source makes the speaker-microphones suitable only for receiving announcements from key cabinet stations and not talking back.

In the "S" system the one-way path over which a station receives a conversation is called the "home line" of the station. This "home line" is terminated at the station in the speaker or, when the earphone is lifted from the switch hook, the "home line" is connected to the same numbered selector key at every other key cabinet having access to the line. Figure 5-6 shows the interstation wiring for the "S" system.

Installation. Once you know the type of equipment required and have decided on a wiring plan for an intercom installation, the mechanics for installing a Teletalk system are relatively simple. The inside wiring requirements are essentially the same for intercom sets as for telephone subsets. When placing intercom sets the installer should be guided by any location specified on the work order and by the wishes of the user. The key cabinets should be placed to the rear of desks or tables where the space in front of the set is not likely to be obstructed. This allows sound waves to strike the microphone with maximum effect. Key cabinets and speaker-microphones placed on desks or tables are usually not secured. Where speaker-microphones are mounted on wall surfaces, their projection from the wall may be a possible safety hazard. If wall mountings are made in corridors, the speaker-microphones should be at least eight feet from the floor. Attach the sets to walls with the brackets and fittings provided and use the installation methods prescribed for attaching telephone equipment to wall surfaces.

Since each key cabinet requires a power connection, power outlets near the sets must be available. Teletalk cabinets come equipped with 7-foot cords for connection to the power source. Therefore, in some cases it may be necessary for you to make arrangements for the extension of electrical service wires. The use of extension cords is poor practice. Power connections are not required at speaker-microphone stations. After the sets are positioned the next step is to place the necessary wiring.

Recalling the transmission limitations of intercom sets, you know that the loop resistance of the voice circuits should not exceed 50 ohms. Therefore, it follows logically that the guage of the wire used for the voice circuits is governed by the length of the loop. Select the size wire which will give a resistance of less than 50 ohms per pair. Figure 5-7 will aid you in determining what guage wire to use. If due to noisy conditions it is necessary to install shielded wire or cable, ground the shield near the middle or at one end. Wire size must also be considered when establishing the annunciator circuits; loop resistance should be less than 15 ohms.

Size Wire	Resistance Per Pair
No. 22	32 ohms per 1000 ft
No. 19	16 ohms per 1000 ft
No. 16	8 ohms per 1000 ft
No. 14	4 ohms per 1000 ft

Figure 5-7. Wire Resistance Table

Make all the wire connections for master station units in the junction boxes provided and described earlier in the chapter. Solder the wires to their respective terminals on the terminal strip. Make connections at speaker-microphone stations on the terminals provided.

When large systems are installed, connecting blocks mounted in terminal cabinets are often used; they serve as central cross connecting points for cables between key cabinets and between key cabinets and speaker-microphone stations. Twenty-six pair cables from key cabinet junction boxes are terminated on the connecting blocks. Cross connections are made according to the wiring plan used. With "M" system installations having

bridged stations and in all "S" systems, cross connecting wires for the voice circuits are connected to the same numbered connecting block throughout the system. In "M" systems having individual lines between stations, terminals of each line are connected at only two stations.

When it is necessary to ground the key cabinets due to excessive noise and hum, the power cord should be replaced with a three-conductor cord equipped with a three-prong polarized plug. If such a plug cannot be used in the power outlet provided, obtain a three-wire plug adapter to connect the power cord to the outlet. Terminate the ground strap on the plug adapter under one of the screws with which the face plate is secured.

WEBSTER OPERATING PROCEDURES

From the description of the major components and wiring plans given earlier in the chapter you probably understand how the sets are operated. You may, however, glean additional information from the following operations run-down. The operation outlined involves the use of 206M-9 key cabinets and 5A45 speaker-microphone units.

1. Calling from master stations to speaker-microphone stations.

    a. Select the desired station indicated on selector panel and operate selector key to the "up" position.

    b. With the talk-listen lever in the idle position listen for conversation to determine if station desired is busy.

    c. Press talk-listen switch to "talk" position. Volume control should be turned to almost its full clockwise position.

    d. Talk from 12 to 18 inches from the unit in a clear, normal voice.

    e. To listen to the station called, release talk-listen switch to horizontal position and adjust volume to desired level.

2. Answering call at speaker-microphone station.

    a. Answer by speaking toward speaker-microphone unit. It is possible to speak at a distance of up to 50 feet from the unit.

    b. No lever or switch operation is required.

3. Calls between master stations. Such calls are accomplished in the same manner as master to speaker-microphone calls are made.

4. Answering calls from remote master stations.

    a. Talk-listen lever stays in the idle position.

    b. Proceed just as if the master station called were a speaker-microphone unit.

The operation of 224AM-3-9 sets used with speaker-microphone units 5A45B differs somewhat from the operation just described. The main difference is in the use of push-buttons and annunciators for signaling purposes.

If intercom systems are in use on your base, it is to your advantage to become familiar with their operation. Sometimes when new personnel are assigned to operate

the equipment they mistakenly think the system is out of order due to misunderstanding of the operating procedures. As a telephone installer-repairmen, there is little you can do in the repair of inoperative intercom equipment other than make certain the interconnecting lines are good. However, it is possible to make a performance check to determine if the equipment is functioning properly. (See figure 5-8.)

Item No.	Item	Action or condition	Normal indications	Corrective measures
1	Combined volume control and on-off switch.	Turn counter-clockwise from full clockwise position until click is heard.	Pilot lamp and tubes light up when switch is on.	Check power cord and plug connections. Check power supply. Check tubes.
2	Combined volume control and on-off switch.	Turn counter-clockwise. Turn clockwise	Decrease volume. Increase volume.	Check tubes and volume control.
3	Talk-listen switch	Up-idle position. Center-listen position. Down-talk position.	Reply to calling station. Listen to called station. Talk to called station.	Check talk-listen switch and its position.
4	Combined volume control and on-off switch.	Turn full clockwise.	Switch clicks and pilot light goes out.	Check volume control and on-off switch.

Figure 5-8. Equipment Performance Check List

THE LS-124B/FI - INTERCOMMUNICATION SET

The LS-124B/FI is a master intercom station often found in military installations and one of several sets provided by Telectro. These master stations can be used to select, call, and talk to other master stations and remote stations connected in the same system. When a system consists of one master station and a number of remote stations, the maximum number of stations that can be selected is determined by the number of station selector switches on the master station. When an intercom system employs more than one master station regardless of whether there are remote stations involved, the maximum number of stations that can be selected from one master is one less than the number of selector switches.

As a representative example of such sets, we will take a close look at the LS-124B/FI which when used as the only master station in a system has a capacity of 12 remote stations; when used with other master stations in a system it has a capacity of 11.

MAJOR COMPONENTS

The set is primarily a two-stage resistance-coupled amplifier and a power transformer mounted on a single chassis. A case encloses all parts of the master station except a junction box. The set has a 5-inch speaker-microphone and twelve lever-operated selector keys which are mounted below the screen on the front of the case.

Directly above the selector keys is a designation strip on which the name or number of respective stations is placed. The screened front of the case provides the necessary openings for the speaker-microphone and also serves as a mounting panel for the talk-listen lever, pilot lamp, and volume controls. The parts inside the case are accessible and easily replaced. The transformers are hermetically sealed (moisture is excluded during manufacture and cannot enter unless the transformer cover is damaged) and mounted with strip plugs to facilitate replacement. Figure 5-9 is a front view of the set.

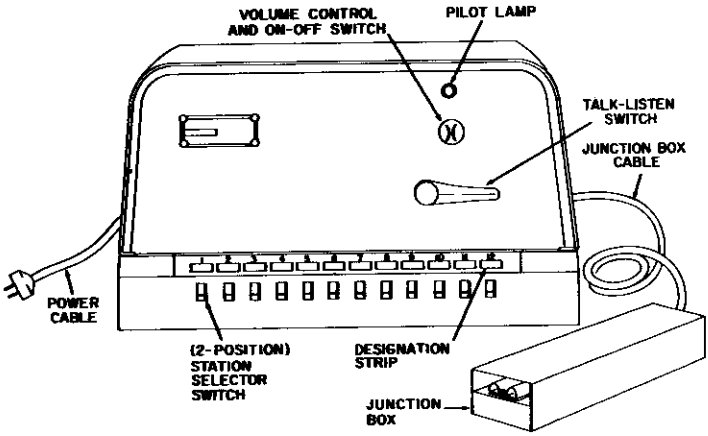


Figure 5-9. LS-124B/FI Intercom Set Front View

The controls are similar to the controls on Teletalk sets. The talk-listen key is a three-position switch: "idle" (up position), "listen" (horizontal), and "talk" (down position). The selector switches connect the set's speaker-microphone to the station or stations whose identification appears above the switch or switches operated (up position). The volume control and On-Off switches are activated by the same knob.

Figure 5-10 is a rear view of the set showing the major components. As a telephone installer, you are concerned only with four of these: impedance switch, junction box, power supply cord and the fuse. However, if you are interested in understanding exactly how all of the components function, refer to Technical Order 31W1-2FI-101, dated August 1956. This publication thoroughly covers the LS-124B/FI in addition to other sets.

Impedance Switch. This switch must be turned to the proper position by the installer when the equipment is installed. The purpose of the switch is to insure the maximum transfer of energy from inter-station lines to the master station amplifier and vice versa. The longer the line, the higher the impedance. If a weak signal due to a long line is fed into an amplifier input transformer of low impedance, low volume and distortion will result. The impedance matching switch overcomes this deficiency; it selects the proper number of turns on the transformers to put either 50 or 500 ohms impedance into the system. To operate the switch to the 50 ohm position, point the knob up; to operate the switch to the 500 ohm position, point the knob down. Measure the loop resistance of the longest

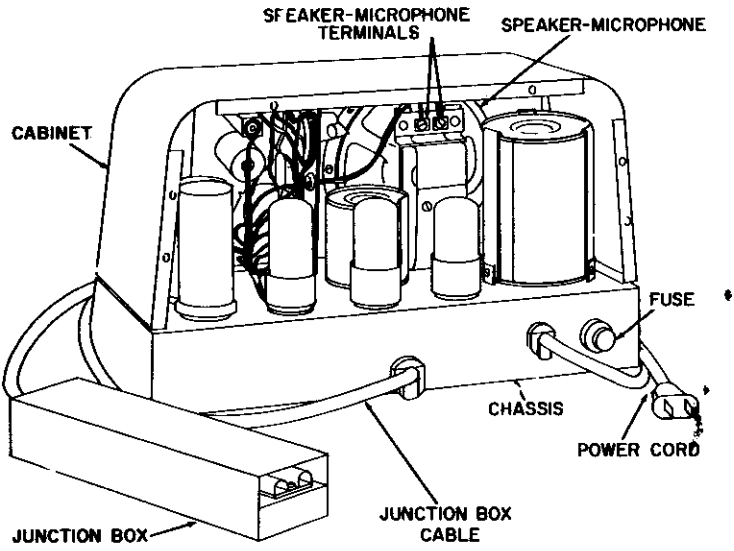


Figure 5-10. LS-124B/FI Intercom Set Rear View

voice line in the system. If the resistance is 50 ohms or less, set the switch to the 50 ohm position. If the resistance is more than 50 ohms, set the switch to the 500 ohm position.

Junction Box. Just as with the Teletalk equipment the junction box serves as a point for making line connections. Exercise care in handling the junction box cable as kinking may result in broken conductors.

Fuse. The installer should be able to determine a blown fuse and be able to replace it. If the pilot light is not lighted and the tubes do not light up, check the power connection and fuse. To remove the fuse, turn the fuse holder cap counterclockwise until it is free and pull out the cap. If the fuse is blown, determine the cuuse, correct the trouble, and replace the fuse.

Power Supply Cord. Make sure of your power source -- ac or dc -- and plug the connection into the outlet. If there is too much line noise or hum, reverse the plug in the outlet.

INTERCONNECTION PROCEDURES

Prior to the actual interconnection of LS-124B/FI type intercom sets into a complete system, certain steps must be taken. First, assign consecutive station identification numbers, starting with number 1. Assign numbers first to the master stations, then to the remote stations. Figure 5-1 illustrates station numbering. As you know, on most master stations the terminal pairs in the junction box are numbered to correspond to the station selector switch number. If, however, a particular master station does not contain a numbered terminal board, tag out the pairs and determine how the pairs on the terminal board are connected to the station selector switches. Next, mark the station selector switch numbers near the corresponding line terminals on the terminal board. You are now ready to connect the various stations of the system together. First it is necessary to determine how the interconnections are to be made. Usually the following procedure is used: The low numbered voice and annunciator terminals are reserved for connections between master stations. The first appearing pair of line terminals after those reserved for master to master connections is reserved for the first remote station connection and additional remote stations are connected to the remaining terminals as required. Having determined what connections are necessary to meet your communications requirements, connect the voice lines between the master stations.

First, connect the same numbered line terminals, reserved for master to master use, in parallel at the voice terminal board of each master station. Figure 5-11 shows an example of voice line connections between master stations. Notice that the master station connections are made on the first four pair of line terminals. You now connect the voice lines between the master station and remote station. If you desire the remote station to be in communication with more than one master station, connect the same numbered line terminals reserved for remote stations connections in parallel at the voice terminal board of each master station. Note terminal five in figure 5-11. You can see that remote station Nr 1 can be called by any of the master stations in the system. If communication between a remote station and only one master station is the requirement, merely omit connecting the same number line terminals together at each master station.

After the voice lines for the system are established, make the annunciator connections between the master stations. As pointed out earlier, the low numbered terminals on the annunciator terminal board are reserved for the connections between the master stations. Figure 12 shows the signaling paths between four master stations; note that each master station is capable of signaling any other master station in the system.

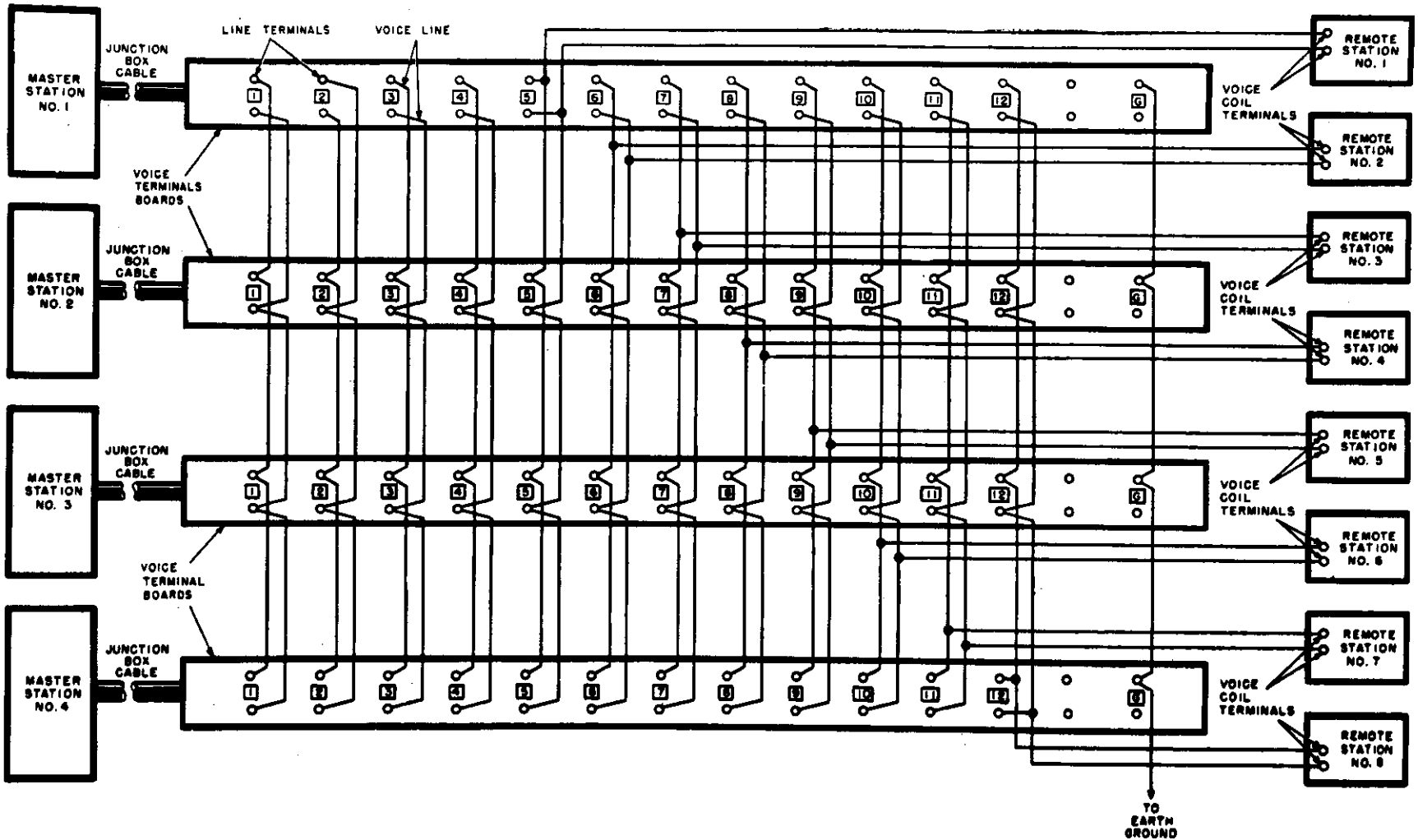


Figure 5-11. Typical Voice Terminal Board Connections on Voice Terminal Board of 12-Station Master Station

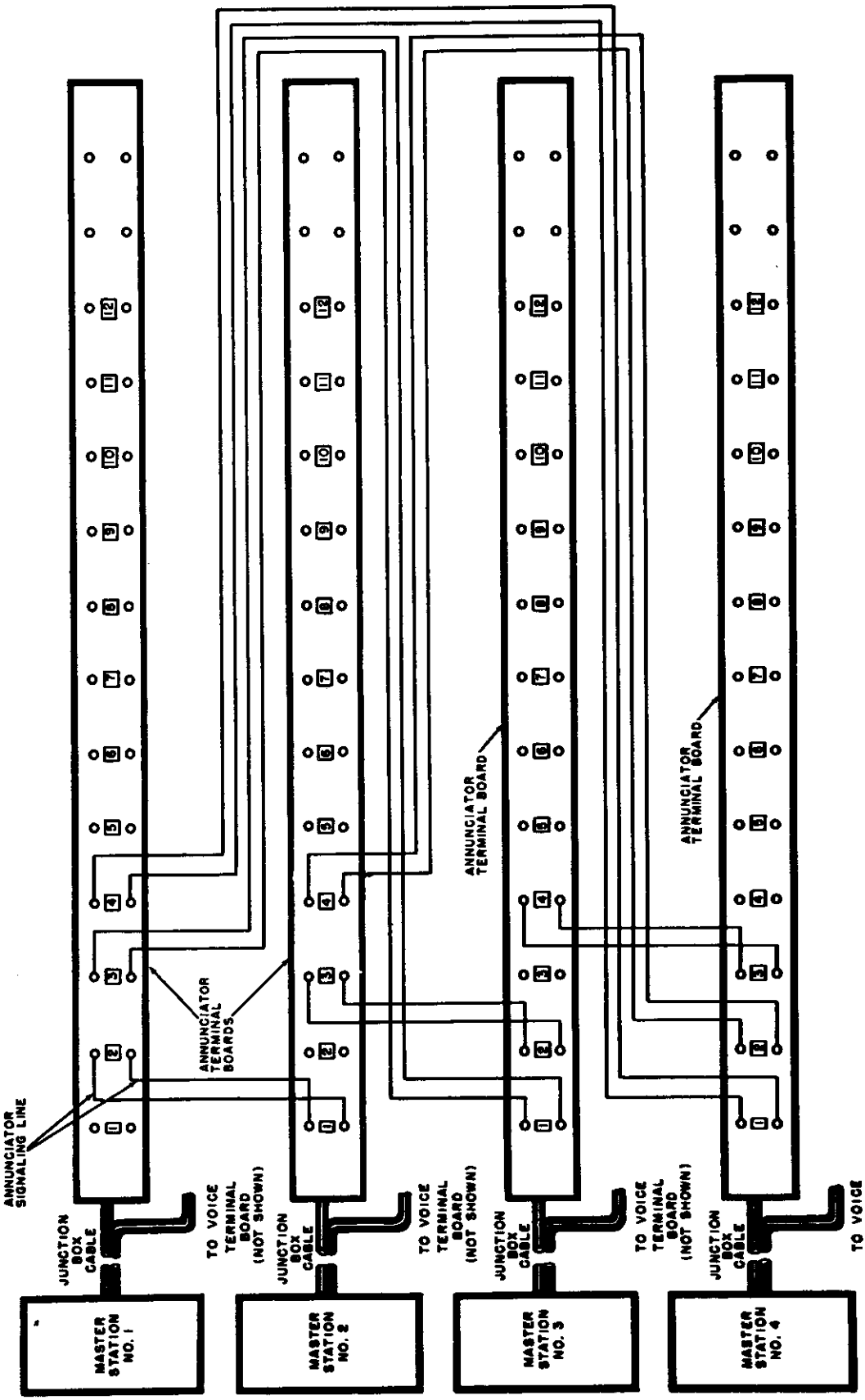


Figure 5-12. Typical Annunciator Terminal Board Connections on Annunciator Terminal Board of 12-Station Master Station

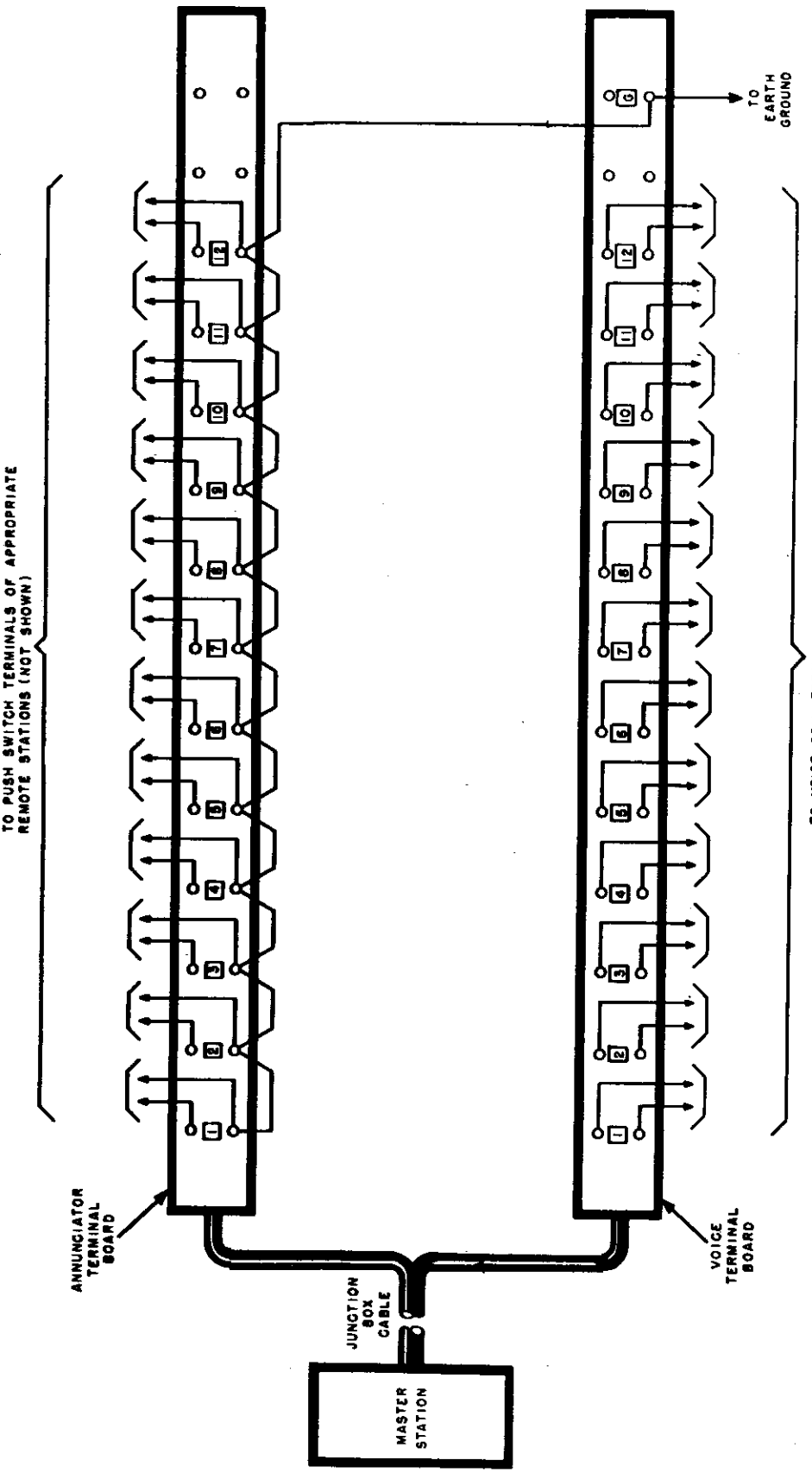


Figure 5-13. Typical Remote Station Connections to Voice and Annunciator Terminal Boards of a 12-Station Master Station.

To make annunciator and voice line connections between a master station and push-button switch equipped remote stations, make the connections in the manner illustrated in figure 5-13. The number on the terminal board in this figure (5-13) corresponds with the station number assigned to the remote stations as no other master stations are included in the system.

Grounding of the system is a step that you must not overlook. Referring back to figure 5-11, you can see how the voice terminal boards are tied together and grounded. The terminal boards are connected in parallel with an insulated conductor and tied to a good earth ground.

Use low resistance wire for all connections and make soldered joints. Color coded cable, if available is best for connections between master stations. The sets will not operate properly over voice circuits having a loop resistance of over 200 ohms and the loop resistance of the annunciator lines should not be greater than 30 ohms. Having completed all the necessary connections, set the impedance switch on the master station and connect the power supply.

TELECTRO OPERATING PROCEDURES

Operation of Telectro sets differs very little from the operation of Teletalk equipment. To call a remote station from a master station, make sure the talk-listen switch is in the idle position; operate the desired selector switch to determine if the station is busy. Turn up the volume and operate the talk-listen switch to the talk position. Speak in a normal voice about 20 inches from the left front of the master station. Release the talk-listen switch for an answer. The talk-listen switch must be moved between the talk and listen positions throughout the conversation.

To receive a call at a master station from a remote station the same procedure is used except that the master station is signaled by a buzzer and the annunciator. Calls between master stations are accomplished in much the same manner; signaling is done by operating the selector switch on master stations equipped with annunciators; on sets not equipped with annunciators signaling is accomplished by operating the talk-listen switch to the talk position and speaking into the speaker-microphone.

PERFORMANCE CHECKLIST

	Item No.	Item	Condition	Action	Normal Indication
PREPARATORY	1	Power cord.	Supplying power for operation.	Plug into ac power receptacle.	Plug should not be loose in receptacle.
	2	Volume control and on-off switch.	Checking unit for off condition.	Turn to extreme clockwise position.	Pilot lamp is not lighted.
	3	Talk-listen switch.	Station is ready.	Set in idle position.	Switch should lock in idle position.
	4	Station selector switches.	Master stations without annunciators.	Set all switches, except home switch in horizontal (off) position.	Unless operator of external master station is calling, no voice signal is heard.

	Item No.	Item	Condition	Action	Normal Indication
			Master stations with annunciators.	Set all switches in horizontal position.	Unless operator of external master station is signaling, no annunciator signal is received.
START	5	Volume control and on-off switch.	Turning on master station.	Turn 1/4 turn counterclockwise.	Pilot lamp is lighted and click is heard.
	6	Station selector switch.	Call to a selected remote station.	Operate selected switch to up position.	Switch should lock in up position.
	7	Talk-listen switch.	Call to a selected remote station.	Operate to talk position.	Switch will have to be held in talk position.
	8	Voice signal.	Calling remote station.	Speak into master station and request a reply.	Voice signal should be heard by operator of remote station.
	9	Talk-listen switch.	Receiving reply from remote station.	Operate to listen position.	Switch should lock in listen position. Voice signal from operator of remote station should be heard.
	10	Volume control and on-off switch.	Checking for loudness.	While operator of remote station is talking, vary volume control.	Volume should increase when volume control is rotated clockwise and decrease when operated counterclockwise.
	11[a]	Station selector switch.	Calling master stations not equipped with annunciators.	Perform actions listed in items 6 through 10.	
	12[a]	Talk-listen switch.	Checking idle position of switch when conversing with other master stations.	Ask operator of external master to manipulate and operate switch to idle position.	It should be possible to converse with external master station without manipulating controls.
	13[b]	Station selector switch.	Signaling master stations equipped with annunciators.	Operate selected switch to down position momentarily and then place in up position.	Annunciator at selected master station should operate. Switch should not lock in down position but should lock in up position.

EQUIPMENT PERFORMANCE

Item No.	Item	Condition	Action	Normal Indication
14[b]	Talk-listen switch.	Awaiting answer equipped master station.	Operate switch to listen position.	Reply from annunciator equipped master station should be heard.
15[b]	Annunciator.	Checking incoming signal on annunciator equipped master stations.	Ask operator of called master station to signal and then operate talk-listen switch to idle position.	When operator of external master station signals, annunciator plunger should slide out. Conversation with the operator of external master station can be held without manipulation.
STOP 16	Volume control and on-off switch.	Checking for off condition.	Turn control to extreme clockwise position.	Pilot lamp is extinguished.

[a] Applicable only to master stations not equipped with annunciators.

[b] Applicable only to annunciator equipped master stations.

MAINTENANCE OF INTERCOMMUNICATION SYSTEMS

To insure the efficient operation and uninterrupted service of any intercom systen, various inspections or checks of the equipment are necessary. Daily and weekly checks are made by operating personnel and monthly checks should be made by the installer-repairman. Occasions may arise, however, when you will be called upon to show master station operators the correct procedure for making daily and weekly checks of the equipment.

Daily Checks. At the start of each operational day, the operator should:

1. Be sure the master station is positioned for convenient operation with controls unobstructed.

2. Wipe dirt and moisture from the cabinet and controls using a clean, dry cloth.

3. Operate and restore each station selector switch, talk-listen switch, and volume control. Check for binding, scraping and excessive looseness.

Weekly Checks. Once a week the operator should:

1. Inspect the cabinet for cracks, scratches, and corrosion.

2. Inspect the controls for cracks and nicks.

3. Inspect the junction box cable and power cable for kinks, cuts, fraying and deteriorated insulation.

The checks listed on the preceding page may, on the surface, appear to be minor and unimportant, but you should keep in mind that dirt and moisture inside the set and in the controls are often the cause of equipment failures.

The monthly check completed by the installer-repairman should be accomplished as follows:

1. Inspect the pilot lamp, fuse, and tubes for proper seating. Do not remove the tubes; check only for looseness.

2. Check the controls for looseness and see that they operate with positive action without scraping or binding. Tighten all loose switches.

3. Inspect all metal surfaces for rust and corrosion.

4. Inspect the power cable, junction box cable chassis wiring, junction box wiring and cabinet wiring for cuts, breaks, frayed or deteriorated insulation, kinks, and strain at the terminals.

5. Look for any loose parts.

6. Inspect tubes and sockets for cracks.

7. Look for bulges, discoloration, or any other signs of over-heating.

The only corrective maintenance the installer-repairman is responsible for is in the interconnecting wiring or external troubles. Usually, when a breakdown of service occurs, the first step is to determine if the trouble is external or internal. An external trouble is a trouble in the line or cable between stations or in the remote stations. An internal trouble is one in the master station. One indication of external trouble is the inability of the operator to signal or converse with one or more master or remote stations. In such cases check the interconnecting wiring for open shorts, crosses, or grounds; use the same trouble shooting procedures as used in detecting, locating and repairing faults in telephone wiring. If the lines are free of trouble the only recourse you have is to have the set repaired by the radio repair section. Another common complaint that may indicate an external fault is excessive hum or noise. Hum and noise can be caused by the interstation lines or cables running near power lines, flourescent fixtures, or other devices having a varying magnetic field. To locate and correct this type trouble proceed as follows:

1. Operate the talk-listen switch to the listen position.

2. Operate and restore each station selector switch. Note the station or stations from which excessive hum is detected.

3. Trace the lines noted to determine where they pass near electrical lines or devices that are capable of inducing line noise. At the suspected trouble points, move the line at least one foot away from the suspected trouble spot and check the hum for any variation; if there is a noticeable decrease in the hum, reroute the line.

Hum and noise may also be caused by an internal fault; to determine if the hum is caused by an internal fault, operate all selector switches to the horizontal position and operate the talk-listen switch to the listen position. If the hum disappears, the trouble is external; if the hum is still present, the trouble is internal.

SUMMARY

The information presented in this chapter may be enough to enable you to "get by" when working with intercom systems. However, if you are interested in becoming a first-class technician in the installation and repair of intercom equipment, study the Technical Orders listed under References.

Basically, this system of communication is not new but it is being used more every day by both military and civilian establishments. As you know, it is widely used in hospitals, hotels, business offices, and shops. There are many established companies whose only purpose is to sell and install intercom systems. The knowledge you gain about this equipment will not only advance you in your military career but may also be of value in civilian life.

Generally, this chapter is concerned with the interconnecting of two makes of intercom sets: Teletalk and Telectro. These sets operate on the same basic principles. The power supply under normal use is 110-120 volts, 60 cycle alternating current. It is possible to obtain equipment that operates on direct current. The controls on the various makes of sets perform similar tasks but are sometimes operated differently. In general, the installation of intercom systems is similar to the installation of telephone equipment. Care must be taken to obtain sufficient separation between intercom lines and power and telephone lines to avoid hum or crosstalk. In cases where it is impossible to obtain at least one-foot separation between intercom lines and foreign wiring, lead covered cable or shielded wire should be used. The total loop resistance of the voice and signal circuits between stations is a factor that must also be considered to obtain maximum performance. This factor will determine the gauge of wire to be used when making new installations or replacing or extending old wiring.

The maintenance of intercom systems involves periodic inspections and the repair and trouble shooting of interconnecting wire, cables, and termination points. The monthly inspections made by the telephone installers is primarily a detailed visual inspection of the complete system. Trouble shooting is accomplished by determining if the trouble is external or internal. If the trouble is found to be external the installer repairman locates and repairs the fault. If the trouble is internal and involves major equipment repairs, the set should be replaced and repaired by base radio personnel.

REFERENCES

TO 31W1-2FI-102	Intercommunication Sets (Webster Electric Models 206M-9, 224AM-3-9, and 224M-9) and Associated Equipment.
TO 31W1-2FI-101	Intercommunicating Stations LS-124B/FI, LS-125A/FI, LS-127A/FI, LS-124C/FI, LS-126A/FI, LS-128A/FI, and LS-128B/FI.
BSP C53.173	Intercommunication System, Webster Electric Teletalk Installation.
BSP C53.171	Intercommunicating System, Webster Electric Teletalk, Description and Operation.

REVIEW QUESTIONS

1. On a separate paper, draw out the necessary wire connections for an intercom system using two Webster master stations, model 212AM-3, and one remote station model 5A45B. Use the individual station plan.

2. Describe the "S" system wiring arrangement.

3. Using the Webster code designations, describe a 212CASL-3 master station.

4. Explain how the daily, weekly, and monthly maintenance inspections of intercom systems are made.

5. What is the procedure used in setting the impedance switch on the LS-124B/FI master station?

6. Generally, what are the transmission limitations of intercom sets?

7. What line conditions may cause excessive hum or noise?

8. How may excessive noise and hum be eliminated?

9. How are the plunger type annunciators on Webster Electric intercom sets operated? How are they restored?

10. To what pairs in the junction box of a Webster Electric set are the voice circuits connected?

11. Explain the method of grounding a system containing Telectro equipment.

WORK PROBLEMS

PROBLEM 1. Monthly maintenance inspection.

Training Equipment: Lint-free cloth, cleaning compound (1-pint can Signal Corps, Stock Number 6G236.5).

References: TO 31W1-2FL-101.

Work Procedures: Perform the repairman's preventive maintenance monthly check on an intercom system.

PROBLEM 2. Performance check list.

Training Equipment: One intercom system.

References: TO 31W1-2FL-101.

Work Procedures: Make an equipment performance check of an intercom system installed on your base.

PROBLEM 3. Wiring Plans.

Training Equipment: Paper, pencil, and ruler.

References: TO 31W1-2FL-102

Work Procedures: Make a drawing showing the voice and signaling circuits required in a system using three (3) 212AM-3 Webster Electric Master Sets and one (1) model 5A-45B remote station. Use the "M" System Individual Station Wiring Plan.

PROBLEM 4. Intercom system trouble shooting.

Training Equipment: Hand tools, test equipment.

References: TO 31W1-2FI-101 and 31W1-2FI-102.

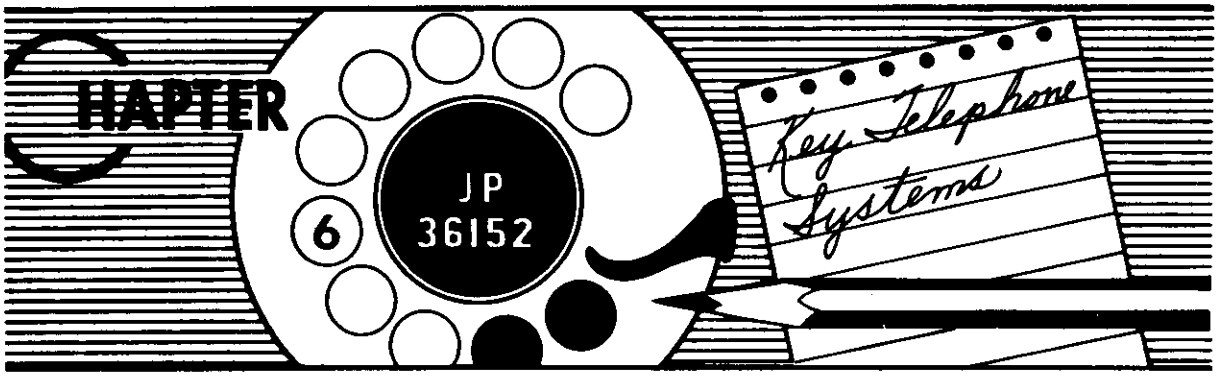
Work Procedures: Detect, locate, and repair faults in intercom system wiring.

PROBLEM 5. Intercom system installation.

Training Equipment: Hand tools, wiring plans, and intercom equipment.

References: TO 31W1-2FI-101 and 31W1-2FI-102.

Work Procedures: Install equipment and wiring according to wiring arrangement and directions of your supervisor.



You may have heard that it is possible to tell the importance of the position a man holds by the number of keys he carries or by the number of telephones on his desk. We know this is a ridiculous statement because the man who carries a lot of keys could be a bank president or a building janitor. The man with several telephones on his desk is a "has been," since he is using obsolete communicating equipment.

Key telephones, in addition to accomplishing specialized telephone service, are: more economical, present a better appearance, and are more versatile than the old numbered wiring plans from which they were developed. For several years numbered wiring plans were used to provide specialized telephone service. Generally the wiring plans were capable of providing the following features: pick-up, hold, intercom, listening-in, cut-off, and signaling features. These features were grouped in combinations to form individual plans and all stations associated with the plan had almost identical features. Obviously, the method was lacking. For example, the station communication requirements of a base commander's office are different from those of his secretary's. To overcome this deficiency and to provide additional features, the standard wiring plans were modified. This, however, required the preparation of special circuits and drawings, added equipment and installation expense which, of course, was undesirable. Key telephones provide all the advantages of the old wiring plans. In addition, the station apparatus and line equipment are set up so that the communicating requirements of each individual station are met. In other words, key equipment allows each station's communicating requirements to be considered as a separate problem. Equipment is then selected to accomplish the needs of each station.

Because of the versatility of key telephone systems, they are now widely used in both military and civilian establishments. The telephone installer-repairman is responsible for the installation, maintenance, and repair of the equipment on Air Force installations; therefore, it is necessary that you know the capabilities of the equipment, understand its operating principles, and be able to use the proper installation procedures. This chapter will discuss two key systems: the 1A and the 1A1. The 1A system was one of the first systems developed; the 1A1 is an outgrowth of the 1A. Key systems are continually being expanded and improved; consequently, it is not unlikely that you may come in contact with more modern systems than the 1A1. However, if you thoroughly understand the operation, installation, and maintenance of the two systems discussed in this chapter, you should be able to apply this knowledge to other types.

KEY TELEPHONE FEATURES

You may or may not be familiar with the features provided by key telephone equipment; therefore, as a review the following paragraphs briefly describe the commonly used features. First, however, the word "feature" used in connection with key telephone equipment should be defined. The term feature is used to identify the characteristics or operative functions performed by the system.

Pick-up. Permits the telephone user to transfer the talking circuit of the telephone to any of the lines connected to the set. Allows several different lines to be used by one telephone.

Holding. Allows the telephone user to hold any line connected to the set. This feature is used for answering a call on one line without discontinuing an existing call on another line.

Intercommunication. Allows conversation between the various telephones within the system without using any central office or PBX lines.

Cutoff. Permits the master set to cut-off an extension or an extension ringer.

Exclusion. This feature permits the station to exclude one and/or all other stations.

Signaling. This feature allows the user to signal another station within the system by depressing a push button which operates a buzzer at the called station.

Lamps: Line and Busy. These features make use of lamps under the transparent keys on the key telephones. When line and busy features are combined, the lamps will flash on incoming calls and burn steady on answered and originated calls.

Buzzers: May be used in place of the ringer within the subset in order to cut down noise and as a means of signaling.

1A KEY TELEPHONE COMPONENTS

Figure 6-1 is a layout showing 1A key system components. As you can see, the system consists of telephones, connecting blocks, terminal boxes and apparatus boxes all interconnected by cables. To get a more detailed picture, a close examination of the individual components is necessary.

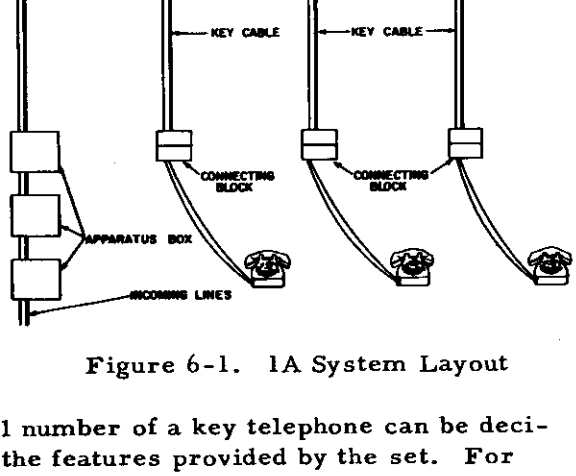


Figure 6-1. 1A System Layout

KEY TELEPHONE SETS

Any desired feature combination can be furnished each station in the system by selecting the proper key telephone set and associated equipment. The question that now comes to mind is how to select the type of key telephone that will provide the features required by a particular station.

Just as with Webster intercom sets, the model number of a key telephone can be deciphered to determine the key arrangement and the features provided by the set. For example, take the number 465HC. Each number and letter indicates a characteristic of that telephone. The first digit (4) indicates the set is a key telephone; the second digit (6) indicates the set has 6 buttons or keys; and the third digit (5) indicates that both illumination and exclusion features are included. If the third digit is a 4, this indicates illumination only. The first letter following the digit shows the arrangement of the pick-up, hold, and cut-off keys or any combination of the features. In the case of the example used, the letter H indicates the key telephone has one hold key, four pick-up keys and one signal key. The second letter indicates whether or not the set is equipped with a dial. If the set is equipped with a dial, the second letter also indicates what type of dial. The letter C, used in the example, indicates that the set is equipped with a 5-HR type

dial. Figure 6-2 further illustrates this coding system.

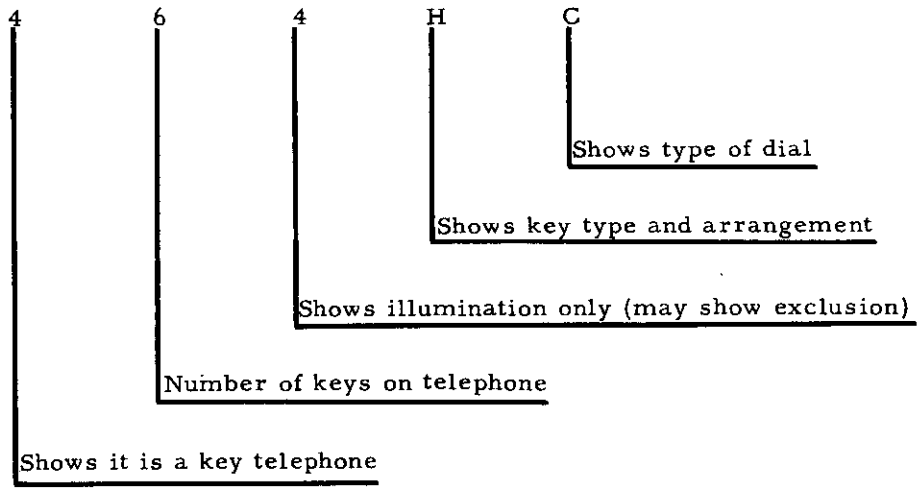


Figure 6-2. Numbering Code for Key Telephone

Type of Keys and Features Provided	With Exclus. Key	Codes					
		Telephone Set Non-Illuminated Key Buttons			Telephone Set Illuminated Key Buttons		
		Manual	5HB Dial	Cord	Manual	5HB Dial	Cord
P P P P	No	440AA	440AC	D10D	444AA	444AC	D16B
	Yes				445AA	445AC	D18C
P P P S	No	440BA	440BC	D10D			
	Yes				445BA	445BC	D16B
P P P C	No						
	Yes				445CA	445CC	D16B
P P S C	No						
	Yes				445DA	445DC	D16B
H P P P	No	440EA	440EC	D14A	444EA	444EC	D18C
	Yes	441EA	441EC	D18C	445EA	445EC	D22B
H P P S	No	440FA	440FC	D12A	444FA	444FC	D16B
	Yes				445FA	445FC	D20B
H P P C	No	440GA	440GC	D12A			
	Yes				445GA	445GC	D20B

Figure 6-3. Feature Combinations for Four Button Sets

Legend:

H – Hold (Push Key)
P – Pickup (Push Key)
S – Signal (Push Key)
C – Cutoff (Turn Key)

Figures 6-3 and 6-4 are tables showing features combinations available and the corresponding codes of the telephone sets and cords for both 4-button and 6-button key telephones. Notice that the key arrangement is also shown on the tables in column one.

Figure 6-5 shows the 465LC key telephone set and the key arrangement. You can see in figure 6-5 that the set is a combined hand telephone.

Types of keys and Features Provided	With Exclus. Key	Codes					
		Telephone Set Non-Illuminated Key Buttons			Telephone Set Illuminated Key Buttons		
		Manual	5HB Dial	Cord	Manual	5HB Dial	Cord
Ⓟ Ⓟ Ⓟ Ⓟ Ⓟ Ⓟ	No	460AA	460AC	D14A			
	Yes				465AA	465AC	D23A
Ⓟ Ⓟ Ⓟ Ⓟ Ⓟ Ⓢ	No						
	Yes				465BA	465BC	D22B
Ⓟ Ⓟ Ⓟ Ⓟ Ⓟ ◐C	No						
	Yes				465CA	465CC	D22B
Ⓟ Ⓟ Ⓟ Ⓟ Ⓢ ◐C	No						
	Yes				465DA	465DC	D22B
Ⓟ Ⓟ Ⓟ Ⓢ Ⓢ Ⓢ	No						
	Yes				465EA	465EC	D18C
Ⓟ Ⓟ Ⓢ Ⓢ Ⓢ Ⓢ	No						
	Yes				465FA	465FC	D16B
Ⓗ Ⓟ Ⓟ Ⓟ Ⓟ Ⓟ	No	460GA	460GC	D22B	464GA	464GC	D29A
	Yes				465GA	465GC	D32A
Ⓗ Ⓟ Ⓟ Ⓟ Ⓟ Ⓢ	No	460HA	460HC	D20B	464HA	464HC	D26B
	Yes	461HA	461HC	D24A	465HA	465HC	D29A
Ⓗ Ⓟ Ⓟ Ⓟ Ⓟ ◐C	No	460KA	460KC	D20B			
	Yes				465KA	465KC	D29A
Ⓗ Ⓟ Ⓟ Ⓟ Ⓢ ◐C	No	460LA	460LB	D18C			
	Yes				465LA	465LC	D26B
Ⓗ Ⓟ Ⓟ Ⓟ Ⓢ Ⓢ	No	460MA	460MC	D18C	464MA	464MC	D22B
	Yes				465MA	465MC	D26B
Ⓗ Ⓟ Ⓟ Ⓢ Ⓢ Ⓢ	No	460NA	460NC	D14A			
	Yes				465NA	465NC	D22B
Ⓗ Ⓟ Ⓟ Ⓟ Ⓟ Ⓢ	No						
	Yes				465JA	465JC	D29A

Figure 6-4. Feature Combinations for Six Button Sets

Legend:

Ⓗ – Hold (Push Key)

Ⓟ – Pickup (Push Key)

Ⓢ – Signal (Push Key)

◐C – Cutoff (Turn Key)

This set includes in a single housing the switching keys, line and busy lamps, ringer, and the additional cords and apparatus necessary for the subset. The exclusion key available with this set is a part of one of the switch-hook plungers and is operated by pulling up the plunger after the handset has been removed. When the handset is replaced on the mounting the key is automatically restored to normal. The keys, shown in figure 6-5, are located in a row in front of the dial. The pick-up keys are locking type push buttons. The common holding key is nonlocking but will release any operated pick-up key. The cut-off key is a locking turn button key. Signal keys are nonlocking. The designation strip located immediately in back of the keys should be used to indicate the key functions. The lamp signals are contained in the keys and are visible through the transparent plastic key buttons. The ringer in this type of set may be connected either as an individual ringer associated with one incoming line or as a common ringer associated with all incoming lines. The cords used with key sets may comtain from 4 to 32 conductors depending, of course, on the number and type of features provided by the set. The conductors are color coded to facilitate connections. Six basic colors are used in the code: red, green, yellow, black, blue, and white. The number of conductors furnished in a cord is always sufficient to take care of the maximum capabilities of the set; in many cases there will be unused conductors. The unused conductors may be stored on spare terminals at the

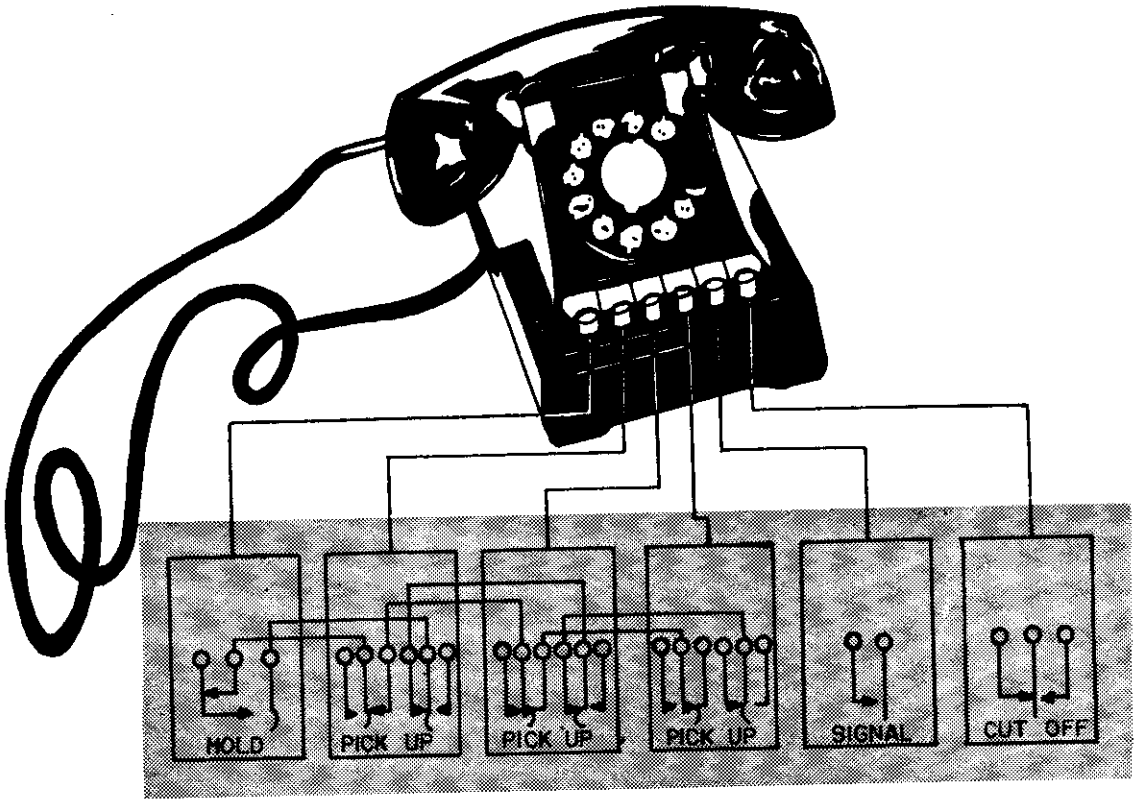


Figure 6-5. 465LC Key Telephone Set and Key Arrangement

set end; but at the connecting block end, it may be necessary to dead-end and tape them. The conductors in the cord are tied together in two groups, which aids in making connections to 44A-type connecting blocks.

CONNECTING BLOCKS

The blocks used to terminate set cords containing more than four conductors have ten terminating points. Block 44A may be used individually or in a multiple arrangement. The blocks are intended for connecting the cord conductors from the key telephone to the wire or cable used in furnishing the various services or features. Two types of back-boards are available for use with the 44A connecting blocks; space is provided for mounting up to three blocks on one board. There are two covers made for the connecting blocks. The 101A is intended for use with one 44A connecting block, and the 101C cover is for use with two or three blocks. Follow general installation practices when installing connecting blocks.

KEY TELEPHONE UNITS

If you will refer back to figure 6-1, you will see that the incoming lines are connected in an apparatus box. The 105A apparatus box is a small black metal box provided to house and protect the key telephone units (KTU's). Key system features are operated by the KTU's. Many different KTU's are provided and each one has a specific job to perform; that is, they provide the relay apparatus needed to operate the desired features in the 1A key system. Each unit has a coded number which designates the feature provided by that particular unit. Units may be combined as required for each installation. KTU's are assembled and wired individually and are arranged to mount on 1-3/4 inch centers. Some of the units are double units depending on the amount of equipment in

each unit. Terminal panels are a part of each unit; the panel includes screw terminals for external connections and soldered terminals for the wiring within the unit. The terminals are numbered from left to right and from top to bottom. Thus, the first row of terminals read 1 to 3; the second row 4 to 6, etc., as shown in figure 6-6.

Selection of KTU's for any particular system depends, of course, on the features required by the system. For example, if the system requires an intercommunicating line between the various stations within the system, a key unit that will supply battery for intercom operation is necessary. Below is a list of some of the KTU's provided along with their functions. A complete list is contained in Bell System Practices C53.152.

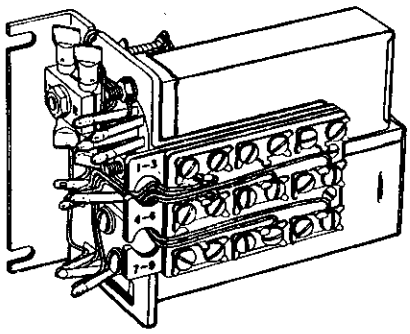


Figure 6-6. 15A KTU

1A KTU - A double unit used for holding the line. One required for each number (line) to be held.

2A KTU - A single unit, supplies 14-26 V battery to intercommunication line. One required per private or intercom line.

6B KTU - A single unit, controls line and busy lamp circuit. One required per central office of PBX line.

7A KTU - A double unit, private line feature. One per line required.

11A KTU - A single unit, provides power to ringing lamps. One per system required.

13B KTU - A double unit, provides two way intercom service with automatic signaling with or without busy lamp supervision. One required per intercom line.

14A KTU - A single unit, a ring up relay which provides line lamps and buzzer signals for manual areas. One per CO or PBX line required.

16A KTU - A double unit, provides common audible signal control to dial areas.

Turning back to the apparatus boxes mentioned above, you recall that their purpose is to house and protect the KTU's. The boxes are designed to hold two double unit KTU's or four single unit KTU's. The boxes may be mounted on one of three sizes of backboards depending on the size of the installation. In large systems where a number of KTU's are required in one location, metal cabinets may be used instead of 105A apparatus boxes.

CONNECTING POINTS

Figure 6-1 indicates the use of 30 type terminals for connecting points between running cables and key cables. However, other devices may be used for this purpose such as 42 or 44 type connecting blocks or similar terminating devices. The selection of the device used will, of course, depend on local conditions such as appearance, size of installation, possible growth, and layout. It is impossible to set down absolute rules that can be followed on all installations but the following suggestions may be helpful to you in selecting connecting devices.

1. Use the same equipment at all points in any one installation. This aids in trouble shooting.

2. 42 type connecting blocks should be used on only the smallest systems where not more than four conductors are needed.

3. 44 type connecting blocks may be used on intermediate size systems. As explained before, this type block may be used in multiples of three. If more than three blocks are required, a different type terminal should be used.

4. 30 and 31 type connecting blocks mounted in terminal boxes are more widely used as they will meet the needs of systems of almost any size. Locate and mount the selected connecting equipment in accordance with normal installation practices.

CABLES

Thus far, this chapter has generally described all the components of the 1A system with the exception of the cables. For connection and description purposes, the cables are grouped in the following classifications.

1. Incoming Cables. Usually the incoming cable is connected directly to the involved KTU's within the apparatus box. The cable includes the central office lines, PBX lines, private lines, ground, battery, generator, etc.

2. KTU Cable. This serves as a connection between the apparatus boxes and terminals.

3. Running Cable. This is used to interconnect the terminals.

4. Key Cable. These are the cables used to connect the terminals and the connecting blocks.

The type of cable used depends upon the surroundings and where the cable will be used. Such items as moisture, high temperatures, and physical damage must be considered when selecting the type of cable. Cables should be placed and fastened in accordance with approved installation practices. Technical Orders Nr. 31W3-1-20 and 31W3-1-17 will aid you in overcoming any problems that you may encounter in this area. The size of cable is determined, of course, by the size of the installation. The exact number of pairs required for any particular cable can be determined from the work sheets and wiring plans. It is good practice, however, to provide extra pairs for future expansion of the system.

Power Supply. 1A key equipment and circuits such as talking circuits, buzzers, and bells are designed for operation on a 14 to 26 volt power supply. Normally, the source of supply will depend on the amount and types of current required and local conditions such as capacity of existing PBX supply, building battery or cable feeders, and availability of ac supply. Small installations generally use dry cells, direct feed or rectifiers; and large installations use local battery.

1A KEY INSTALLATION

Generally, you should follow standard station installation procedures and practices when installing key telephone equipment. Telephone sets should be placed in the same manner as other combination sets except that extremely lighted areas should be avoided. In such areas the telephone user may have difficulty in seeing the key button lights. The apparatus boxes should be located in closets or other inconspicuous locations and mounted

so that they are not subject to physical damage. The cables should be placed so that they are not subject to moisture.

Probably the most difficult part of the installer's job is the interpretation of the worksheets which designate the operating features for each station, the apparatus required, and the necessary interconnections. Before you start the installation of a key system, you should be supplied with the following completed forms (1) a "Worksheet for Key Telephone Systems and Wiring Plans, " (2) a sheet titled, "KTU Connections to Running Cable" and "Circuit Layout -- Key Telephone Systems and Wiring Plans." These sheets are part of the installation. They provide a record of the work done and should be placed in the apparatus box after the installation is completed. Thus, future work or maintenance can be easily accomplished.

WORKSHEET FOR KEY TELEPHONE SYSTEM AND WIRING PLANS

Figure 6-7 is a completed sample of a "Worksheet for Key Telephone System and Wiring Plans" form. Study this example closely. You will see that this form gives an over-all picture of the entire system. It contains the following information:

1. Central Office and telephone number (top left), the TWO number and date (top right).

2. Subscriber's name, room number and station number.

3. The features for each station and telephone line numbers.

4. Code key of abbreviations used on the worksheet (bottom center).

5. Signal arrangement.

6. The features which are part of the set and those which are not a part of the instrument.

7. The type of set required.

8. Other equipment needed for the job such as buzzers, push buttons, connecting blocks, connecting block covers and back-boards.

9. The number and type of KTU's required (right side of sheet under Common Equipment).

10. The number of apparatus boxes required.

11. Person responsible for making out worksheet.

For further clarification of this worksheet, examine the column under Major Brown and by applying the code you should gather this information.

1. Major Brown's office is room number 201 and is Station B.

2. His telephone has four "pick-up" keys, three for phone numbers 5-1324, 5-1325, 5-1326, and one for an intercom line. He also has an exclusion key for line 5-1324 which enables him to disconnect Captain Davis from this line. Combined busy and line lamps are also provided.

3. This signaling arrangement block indicates an external push button and buzzer. The push button is used to signal A/2C Smith, and the buzzer allows A/2C Smith to signal Major Brown.

4. You can see from the "features" block that a six button set is required with one exclusion key and four pick-up keys. One key will be vacant. External equipment required is 1 buzzer and 1 push button.

5. The type of set required is a 445AC.

6. Other equipment needed for Station B is one 7E buzzer, one 360 push button, two 44A connecting blocks, one 101C connecting block cover and one 168B back-board.

Using the code, see if you can decipher the columns under A/2C Smith and Captain Davis.

Note that the symbols "CBL" and "X" are not included in the code key. They stand for "Combined Busy Lamp" and "external."

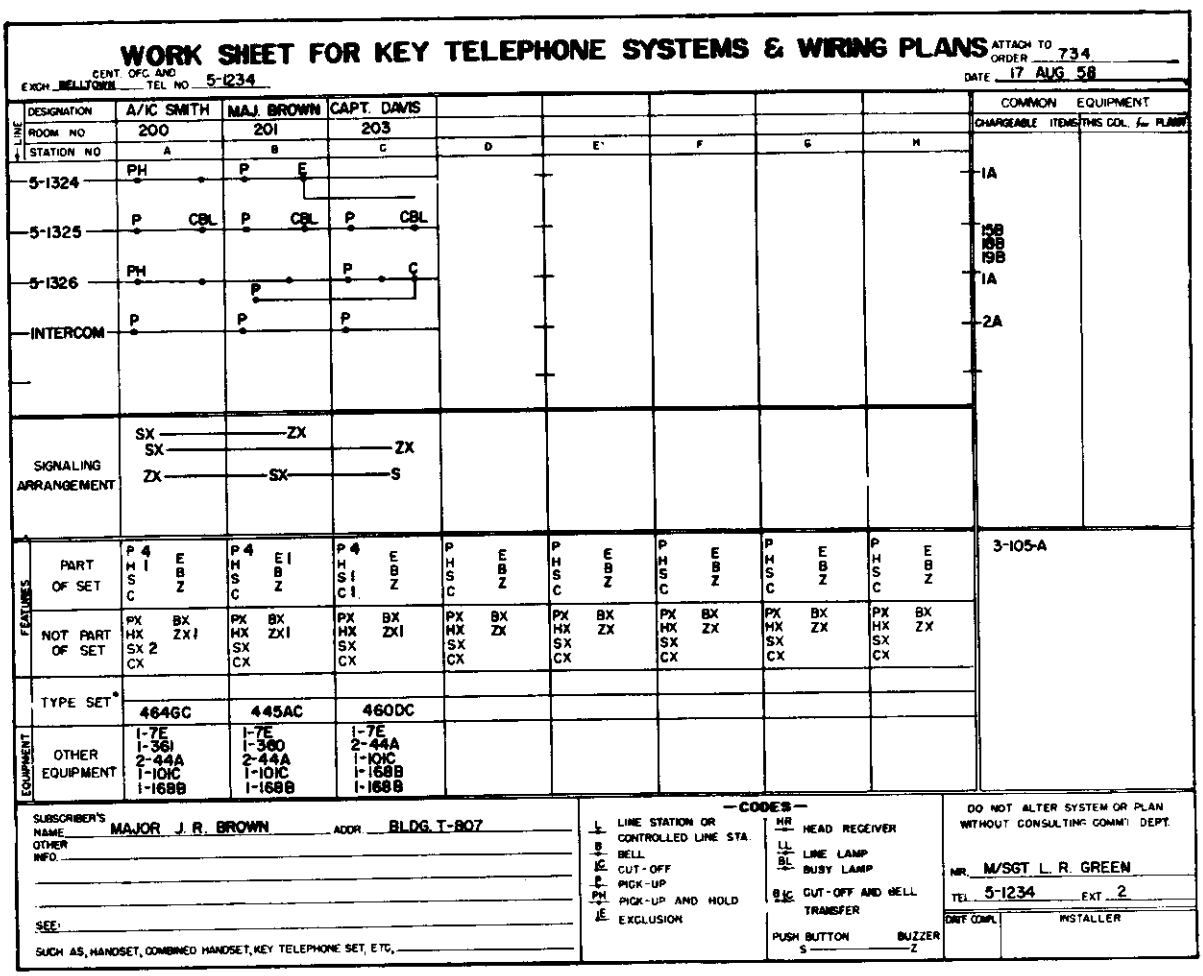


Figure 6-7. Worksheet for Key Telephone System and Wiring Plans

KTU CONNECTIONS TO RUNNING CABLE

The previous worksheet has shown you the equipment required, the location of the

key telephones, and the line requirements. The next step is to determine the necessary wire connections. The KTU Connections to Running Cable Form shows (1) the line numbers, (2) the key telephone units and their strappings. Figure 6-8 is an example of this form. Use the form for reference as you read the following explanation.

On the left-hand side of the worksheet, you will find columns A and B. Column A shows the incoming lines and their line numbers, column B shows the line connections to the KTU's and the required strappings. Now, let us see how one of the incoming lines is connected through the KTU's. Line number 5-1325, ring side, is connected to terminals 8 of KTU 15B and in turn is tied to terminal 10 of KTU 18B; the tip side terminates on terminal 7 of KTU 15B.

Terminals 1 and 9 of KTU 15B and terminal 1 of KTU 18B and KTU 19B are all tied to terminal 1 of the KTU 2A which is the ground for battery feed.

Terminal 5 of KTU 15B is tied to terminal 7 of KTU 18B.

Terminal 6 of KTU 15B is strapped to terminal 2 of 19B.

Terminal 7 of KTU 15B has the tip of line 5-1325 and is strapped to terminal 11 of KTU 18B.

Terminal 10 of KTU 15B is strapped to pin 9 of KTU 19B.

Terminal 6 of KTU 18B is strapped to terminal 10 of KTU 19B.

Terminals 3 and 12 of KTU 15B, terminal 4 of KTU 18B, and pin 3 of KTU's 18B, 19B, and 2A are all connected to the "hot side" of the battery line.

Notice there are four KTU's associated with line and features of 5-1325. They are 2A, 19B, 18B, and 15B KTU's. See if you can make a list of all the straps and connections for the other two lines.

Now, examine column C on the "KTU Connections to Running Cable" form. The column is broken into three parts: (1) KTU, (2) KTU terminal, and (3) KTU Cable Conductor Color. This column also gives you the color code and terminal numbers for connecting the KTU cable to the various KTU's. While studying column C, keep in mind that the KTU cable is that cable running from the KTU's to the 30 type terminals. Find the 1A1 KTU in column C, you can see that it is connected to the KTU cable by terminals 6, 4, 7, and 8. Terminal 6 is connected to the blue cable conductor (BL). The mate (M) of BL is connected to terminal 4 of 1A1. Terminal 7 of 1A1 is connected to the orange (OR) conductor of the KTU cable, and terminal 8 is connected to the orange mate (M).

Perhaps you should stop at this point to look back and see how far through the installation you have progressed. First, you determined how the incoming lines were connected to their respective KTU's. Next, you traced through the required KTU strappings and connected the KTU cable by color code, to the KTU's. You know, of course, that the other end of the KTU cable is connected by color code to one side of the 30 type terminal.

Now look at column D of the form, KTU Connections to Running Cable. Column D is broken into four parts labeled: (1) Terminal 30 type, (2) Conductor Color, (3) Terminal Nr. 8A KTU (replaced with a 30 type terminal), and (4) Circuit Features. Before continuing through the explanation of Column D, it may be a good idea to refer back to figure 6-1 to make certain that the cable designations are clear in your mind.

The column "Term. Nr. 30 type" shows the pair or terminal numbers of one 30 type terminal; the "Cond. Color" column shows the color of the conductor. The third column, "Terminal 8A KTU," is not used in most installations, instead a second type 30 terminal is used. This second type 30 terminal is connected exactly the same as the first. That is, the blue conductor found on terminal 1 of the first type 30 terminal is also found on the first terminal of the second type 30 terminal, etc. As you can see from the column "Cond. Color," the standard color code is used for all connections (blue, mate, orange, mate, green, mate, brown, mate, slate, mate, etc.). The fourth column under "D" shows the circuit features associated with each terminal in the type 30 terminal.

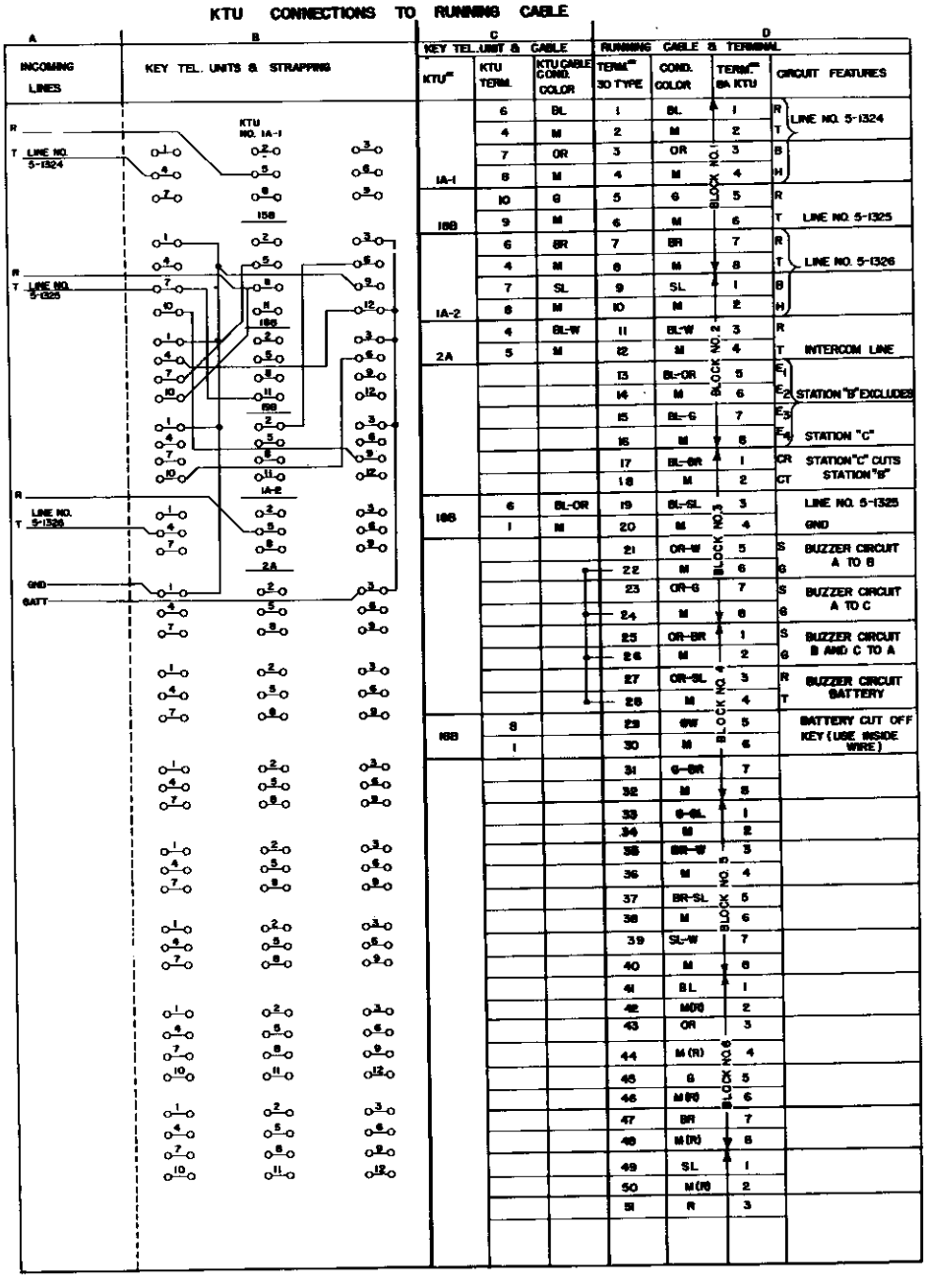


Figure 6-8. KTU Connections to Running Cable

SUPPLEMENTAL WORK SHEET AND CIRCUIT LAYOUT – KEY TELEPHONE SYSTEMS AND WIRING PLANS

EXCHANGE BELLTOWN TELEPHONE NO. 5-1234 DESIGNATION CAPT SMITH ROOM NO. 200 STA. NO. A ORD. NO. 734

FEATURE	TEL. NO.	SET CODE NO. 464GC KEY SET TERM NO.	CONNECTIONS AT STATIONS: KEY SET* CORD COLOR	"464 BLOCK TERMINAL NUMBER	KEY CABLE SOLOR CODE	RUNNING CABLE: COMM. BLOCK TERM. NO.	CONDUCTOR COLOR	KEY CABLE COND TO STA. NO. (FOR USE WHERE RUN CABLE OMITTED)	MISCELLANEOUS INFORMATION
				BLOCK NO. 1					THIS SPACE FOR USE ON SMALL JOBS FOR SHOWING KEY CABLE CONNECTED DIRECT TO KTU
P		1R	R	1	BL	1	BLUE		
	5-1324	1T	G	2	M	2	M		
		1B	Y	4	OR	3	OR		
H		1H	BK	5	M	4	M		
P	5-1325	2R	BL	6	G	5	G		
		2T	W	7	M	6	M		
			*BR-R	9	BR				
			BR-G	10	M				
P		3R	BR-Y	3	SL	7	BR		
		3T	BR-BK	8	M	8	M		
	5-1326			BLOCK NO. 2					
			BR-BL	1	SL-W	9	SL		
H		3H	BR-W	2	M	10	M		
P	INTER-COM	4R	R-G	4	BL-OR	11	BL-W		
		4T	R-Y	5	M	12	M		
			R-BK	6	SL-G				
SIG A-B			R-BL	7	M				
				9	BL-BR	27	BL-G		THESE PAIRS USED FOR SIGNAL EQUIP
SIG A-C				10	M	21	M		
				3	BL-SL	27	BL-BR		
BUZ B&C-A				8	M	23	M		
				BLOCK NO. 3					
				1	OR-W	25	BL-SL		
				2	M	26	M		
			Y-BL	4	OR-G				
			Y-W	5	M				
CBL	5-1325	LG	BK-W	6	OR-BR	20	BL-OR		
			BL-W	7	M				
CBL	5-1325	2L	BK-BL	9	OR-SL	19	M		
				10	M				
				3	G-W				
				8	M				

Figure 6-9. Supplemental Worksheet and Circuit Layout -- Key Telephone Systems & Wiring Plans

SUPPLEMENTAL WORKSHEET AND CIRCUIT LAYOUT

Referring again to figure 6-1, you can see that the next step is to establish the key cable connections. The supplemental worksheet and circuit layout is used to make the remaining system connections. However, due to the difference in features required at the various stations, a separate sheet is needed for each station involved in the installation. Since there are three stations in the system described here, three Supplemental Worksheets are required. Figure 6-9 shows the worksheet for station A in the particular system being described. The first column titled "Feature" shows the code symbol for the particular feature each pair of conductors will carry. The telephone number or line is shown in the next column. The third column titled "Key Set Term No" shows the cord connections within the telephone set. In other words, looking at the worksheet, figure 6-9, the pick-up feature for line number 5-1324 is connected with 1R and 1T terminals; the hold feature of line number 5-1324 is connected with 1B and 1H terminals, etc.

The next section of the worksheet, Connections at Stations, never changes. The first part lists the conductors of the telephone cord by number; the next section tells which terminal of which 44A block each conductor of the telephone cord terminates on. The last section gives the color code of the key cable, which runs between the connecting blocks and the type 30 terminal. Now following through the three sections in the column titled "Connections at Stations," you will find that the red conductor from the telephone set is connected on terminal number 1 of the connecting block which also serves as a termination point for the blue conductor in the key cable, the other end of which is connected to terminal 1 of the type 30 terminal. You find that the blue conductor of the Running cable is also terminated here. The remaining columns on the worksheet explain themselves. They are used where running cable is omitted from the key systems. Sometimes you will find special information concerning the particular station entered in these columns.

If you know and follow standard station installation practices and are able to interpret the worksheets associated with key equipment, you will have no trouble making this type of installation. As you know, many varying factors determine the sequence in which any installation is made. No hard and fast rule will apply to all situations. You may, however, find the following procedure helpful.

1. Mount the Type 30 terminals and terminate the running cable.
2. Mount the 105A Apparatus Boxes, install key telephone units, and run the strappings shown on the worksheet.
3. Terminate the KTU cable at the apparatus box, and then at the Type 30 terminals.
4. Run the key cables between the Type 30 terminals and the station connecting blocks.
5. Mount and terminate all equipment that is not a part of the telephone set at each station.
6. Connect the telephone sets at the stations to the connecting blocks.
7. Make sure that any unused keys in the 4 and 6 button key telephone sets are blocked in their nonoperated position by using the blocking device furnished with these sets. This device is eyelet shaped and is installed immediately under the key button it is desired to block.
8. Terminate the incoming lines to the key telephone units in the apparatus boxes.

Upon completion of the system, make certain that all features of the system are functioning properly. The tests should be made by operating the keys at each station to see if the required features (pick-up, hold, intercom, etc.) operate in accordance with the worksheet.

TROUBLE SHOOTING

Basically, trouble shooting the 1A key system differs very little from trouble shooting a normal telephone installation. The chief difference is that in order to do the job quickly, it is necessary to use the installation worksheets. For example, if the pick-up feature at one of the stations is not functioning, it is possible for you to determine from the worksheets; (1) what components are involved, (2) the color of conductors that provide the pick-up circuit and (3) the terminals to which the circuit is connected.

In most cases, you can determine what feature or features are in trouble by checking the trouble report, the results of the wire chief's tests, or by questioning the telephone user. If this is not possible, make an operational check of the complete system yourself. Here again you have need for the worksheets. After determining what feature or features are not functioning properly, make a point to point test and isolate the fault to the equipment or line. In many cases, equipment faults are the result of an accumulation of dirt. If the equipment needs cleaning, use a brush to remove the foreign particles; if the equipment is damaged, replace it. Faults, traced to open, shorted, crossed or grounded lines should not be difficult to repair. Use the standard trouble shooting and repair procedures covered in chapter 4, Substation Repair and Maintenance.

Outlined below are some of the troubles most commonly reported and suggested methods for locating them.

MAINTENANCE GUIDE FOR 1A KEY TELEPHONE SYSTEM

SYSTEM FEATURE EVIDENCE OF TROUBLE	RECOMMENDED TEST OR INSPECTION	TROUBLE INDICATED OR REMEDY SUGGESTED
PICK-UP KEY		
(Not connecting) NOTE: Disconnect Key Telephone Unit (KTU) from the rest of the system before making the following four tests.	1. Place test leads across ring and tip of line where line enters KTU.	If no side tone, incoming line has trouble.
	2. Place test leads across ring and tip of line where line leaves KTU.	If no sidetone, KTU is bad.
	3. Place test leads across ring and tip terminals of the connector block.	If no sidetone, trouble is in line between KTU and connector block.
	4. Place test leads across ring and tip of line to the inside of the set.	If no sidetone, trouble is in telephone set cord. If sidetone is heard, trouble is in pick-up key at the set.
HOLD KEY		
(Not connecting or holding bridge circuit is not operating properly)	1. Check the 1A KTU to see that H-relay is operating.	If not operating, replace KTU.
	2. Check holding key subset for loose connections, dirty contacts, etc.	If not operating after cleaning contacts and tightening connections, replace KTU.

SYSTEM FEATURE EVIDENCE OF TROUBLE	RECOMMENDED TEST OR INSPECTION	TROUBLE INDICATED OR REMEDY SUGGESTED
Hold Key (Cont'd)	3. Test B&A leads from telephone to KTU for continuity.	If no continuity, replace leads.
EXCLUSION KEY		
(Not disconnecting extensions beyond the set)	1. Check exclusion key of telephone which fails to disconnect extensions.	If contact is not breaking, replace key.
(Extensions remain cut off at all times)	2. Check exclusion key which fails to reconnect extensions.	If contacts are not making, replace key.
	3. Check "Pick-up key of excluded telephone sets as outlined above for third and fourth tests.	Same as the third and fourth tests for "Pick-up" as stated above.
CUT-OFF KEY		
(Not disconnecting designated extensions)	1. Check cut-off key at controlling station.	If contacts are not breaking, replace key.
(Extensions remain cut off at all times)	2. Check cut-off key at controlling station.	If contacts are not making, replace key.
	3. Check "Pick-up" key of station which is cut off, as outlined above for third and fourth tests.	Same as for third and fourth tests for "Pick-up" as stated above.
SIGNALING KEY		
(Buzzer signal not operating)	1. Check signal key contacts for dirt and for contacts not closing.	Clean key unit. If contacts are not closing, replace key.
	2. Check buzzer to see if battery is supplied when key contact is closed.	If battery is applied, replace buzzer. If no battery is applied, check wiring between key and buzzer. Check battery and connections.
LAMPS		
(Lamp does not light)	1. Check lamps to see if they are burned out.	If lamp is burned out, replace lamp.
(Lamp does not light and is not burned out)	2. Check the 15B, 18B, and 19B KTU's to see if they are operating.	If KTU is not operating, replace KTU.

1A1 KEY TELEPHONE SYSTEM

The 1A1 key telephone system is basically an improved and modernized version of the 1A system. It is designed primarily to fulfill the same communication needs and can be used to expand an existing 1A system. Comparing the two systems, you will find the same features but the equipment used to accomplish these features may differ. The 1A line circuit features five relays on a supervisory relay basis and will operate and hold on common battery lines. In addition to the ring and tip conductors required between stations and the apparatus serving the installation, a balance lead and a hold lead must be provided to stations arranged for hold. In the 1A1 system, the line circuit features three relays and requires a lead (called the A lead) between the station and the line equipment for controlling common battery or private lines. An individual ground lead (A1), preferably one per station, must be furnished to supply A lead control through the station hookswitch contacts.

APPARATUS CABINETS

As you know, 1A system relay apparatus (KTU's) are designed for mounting on small angle-bracket mounting plates which are generally mounted in 105-type apparatus boxes. 1A1 system apparatus mounted on unit panel type plates is known as the 200 series type KTU. Apparatus cabinets provided to house these panel type mounting plates, consist of three basic parts: a back-board assembly, a hinged gate, and a cover. The back-board assembly is made of wood and insulates the relay apparatus from any surface on which it is mounted. The hinged gate assembly is provided with tapped holes spaced to accommodate the relay mounting plates. The smaller angle-bracket plates used with 1A equipment may also be mounted in these panel-type apparatus cabinets. The gate arrangement affords easy access to the terminal side of the apparatus for maintenance and installation purposes. The cabinets may be mounted on either vertical or horizontal surfaces and are available in several sizes. The 6-plate cabinet was designed primarily for 1A1 equipment.

Installation of the apparatus cabinets requires a considerable amount of good judgment on the part of the installer. Several factors should be considered in selecting a suitable location. Appearance and the desires of the user must be considered; inconspicuous locations are desirable but the cabinet must also be accessible for maintenance purposes. Adequate backing must be available, inside plaster block or similar soft materials and temporary office partitions will not provide satisfactory support. If the walls will not furnish the needed support, a floor mounting is often used. A floor stand is available for this purpose. Additional factors that the installer should consider are:

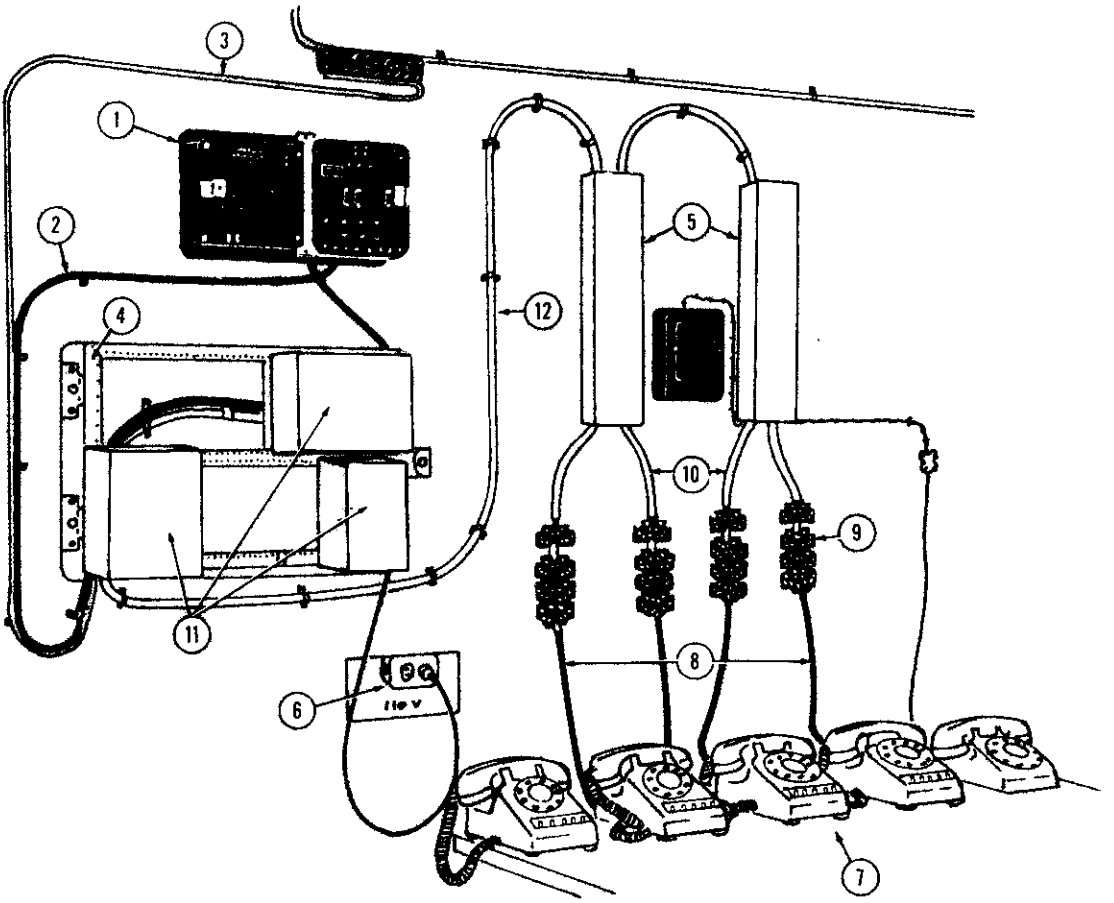
1. Building conduit. If a telephone conduit or duct system is provided, locate the cabinets near an outlet.

2. Space. Locate the cabinet so that there is sufficient space for the gate to open.

3. Damage. Where cabinets are to be mounted on the floor, consider the possibility of damage from water or blows incident to cleaning. A location close to the wall or partition is usually desirable for cabling reasons.

4. Vibrations. Avoid placing cabinets containing relay equipment in places subject to vibration.

5. Heat. Avoid locations near radiators, steam pipes, registers, etc. which would subject the equipment to excessive heat.



1. 101G power plant
2. Power lines
3. Incoming lines
4. Gate assembly-cover removed
5. Terminals
6. AC power
7. Stations
8. Cords
9. Connecting blocks
10. Key cables
11. KTU's covers in place
12. Running cable

Figure 6-10. 1A1 Key System Components

KTU's

Figure 6-10 shows a typical mounting of key telephone units on the gate of a panel-type apparatus cabinet. The key telephone units are secured to the gate assembly with four screws. The space required for the various KTU's is as follows:

KTU Nr.	Hole Spacing
201A	5
202A	7
203A	8
204A	9
205A	9
207A	13
208A	8

KTU Nr.	Hole Spacing
209A	11
210A	6
211A	6
200A	26
200B	33
200C	40

At this point, we should probably take a closer view of the KTU's used in 1A1 systems. Following is a list of KTU's, the features they provide and the number required.

Features	KTU Code	Number Required
Fuse Mounting Unit and Bridging Terminal	201B	1 per 7 fuses
Central Office or PBX Line Circuit	202B	1 per line
Automatic Tie Line Unit	203A	1 per line
Ringdown Tie Line Unit	204A	1 per line
Station Line Circuit	205A	1 per line
Dial Selective Intercom Line Selector	207A	(intercom lines) 1 per 9 stations
Flashing Signal, Intercom Line and Automatic Cutoff Control Circuit	208A	1 per 3 intercom stations
Flashing, Intercom Signal, Time Out	209A	
Without Wink		1 per 6 lines
With Wink		1 per 5 lines
Hold Lamp Wink Circuit	210A	1 per 5 lines
Miscellaneous Common Equipment	211A	1 per system
Two CO or PBX Lines with Common Equipment	200A	1 per 2 lines
Three CO or PBX Lines with Common Equipment	200D	1 per 3 lines
Four CO or PBX Lines with Common Equipment	200E	1 per 4 lines
Three CO or PBX Lines with Common Equipment	212A	1 per 3 lines
Joint Use Line Circuit with Holding	213A	1 per line

From the features listed, it should be obvious that by the proper choice and installation of equipment almost any station requirement can be met. Notice particularly the features listed for the 200A, 200D, 200E, 212A, 213A units. They are almost a complete system in themselves. For example, the 212A key telephone unit is a basic equipment unit which features the components of three 202B's (central office or PBX line circuits) and one 209A KTU (flashing and time out) all on one mounting plate. When this unit is used, it is possible to house four separate 3-line systems of 1A1 equipment in one 6-plate cabinet. The 213A KTU is a joint line circuit used when the 1A1 system is operated in conjunction with the 1A system. This unit provides one central office or PBX line circuit and the common equipment for line, busy, and hold signals.

KEY TELEPHONE SETS

The 540 and 560 series type sets used with 1A1 apparatus are listed in figure 6-11.

CODING		FEATURES			KEY BUTTON ARRANGEMENTS
Manual	Dial	Exclus. Key	Illuminated Key Buttons	Station is Busy Lamp Control	
540BA	540BB				HPPP
544BA	544BB		X		
545BA	545BB	X		X	HPPP^{S}
544AA	544AB		X		PPPP^{S}
564BA	564BB		X		HPPPPP
564CA	564CB		X		HPPPP^{S}
564DA	564DB		X		HPPPSS
564HA	564HB		X	X	HPPP^{S}P^{S}P^{S}
565BA	565BB	X	X	X	HPPP^{S}P^{S}P^{S}
565HA	565HB	X	X	X	HPPP^{S}P^{S}P^{S}
565AA	565AB	X	X	X	PPPP^{S}P^{S}P^{S}
565GA	565GB	X	X	X	PPPP^{S}P^{S}P^{S}
565EA	565EB	X	X	X	HPPPPC
565LA	565LB	X	X	X	HPPPP^{S}C

NOTE: The exclusion feature is operated by raising the left-hand switch hook plunger. May be connected to any one line in the set. 51A lamps must be furnished by the installer.

H --Hold (nonlocking)
P --Pickup (locking)
S --Signal (nonlocking)
C --Cutoff (turn button)
P^{S}--Convertible, either pickup (locking) or signaling (nonlocking)

Figure 6-11. 540 & 560 Type Telephone Set Feature Combinations

Some of the sets, as you can see from figure 6-11, are equipped with one or more convertible pick-up keys (P^S) which may be used for either line pick-up or signaling. New sets received from the manufacturer are arranged for pick-up; to convert the keys from pick-up to signaling remove the small screw (P-12A892) located in the front of the plunger, and make the wiring changes listed in the following table.

Features & Type of Set	To Convert Key Nr.	Change Key Lead Color	From Terminal	To Terminal
$PPPP^S$ 544A	4	S-BR	M	SG
$HPPPP^SC$ 565E	5	S-BR	M	SG
$HPPP^S$ 544B and 545B	4	BR	M	SG
$PPPP^SP^SP^S$ 565A	6	W-BR	M	SG
	5	BK-BR	M	SG
	4	S-BR	M	SG
$HPPPP^SP^SP^S$ 565B	6	BK-BR	X	SG
	5	S-BR	M	SG
	4	BR	M	X

To convert the last pick-up key to a signal key for use as a common signal key on two or three private or intercom lines refer to table below.

Features & Type of Set	Nr. of Lines	Change Key Lead Color	From Terminal	To Terminal
$HPPP^SP^SP^S$ 565B	2	BR	M	X
		S-BR	M	5H
		BK-BR	X	SG
	3	Y-BR	M	X
		BR	M	X
		S-BR	M	5H
		BK-BR	X	SG

NOTE

Remember that the instructions listed above are for Western Electric Telephone Sets. Telephone sets made by other manufacturers may require changes different from those indicated here. The wire coloring may also differ. Therefore check the wiring diagram on any new set received prior to installing the instrument. Before making any wire disconnections be sure you know exactly where the wires will be reconnected. It is quite easy to become confused. A good practice is to jot the changes down on a paper before starting the job.

Install 540 and 560 type sets in the same manner as any other combined telephone set. Use a cable clamp to fasten the cord so that it is off the floor. The cords are designed for connection to station wiring by means of 42, 44, or 47 type connecting blocks. When making cord connections to the connecting blocks, remember that specific cord conductors, connecting block terminals, and key cable pairs are assigned to specific features in these sets. The assignments are the same for all 540 and 560 series sets with the exception of the 565A key telephone. Install the connecting blocks as shown in figure 6-12. Note the numbering of the blocks. It is necessary to position the blocks as shown due to variance in length of the cord conductors.

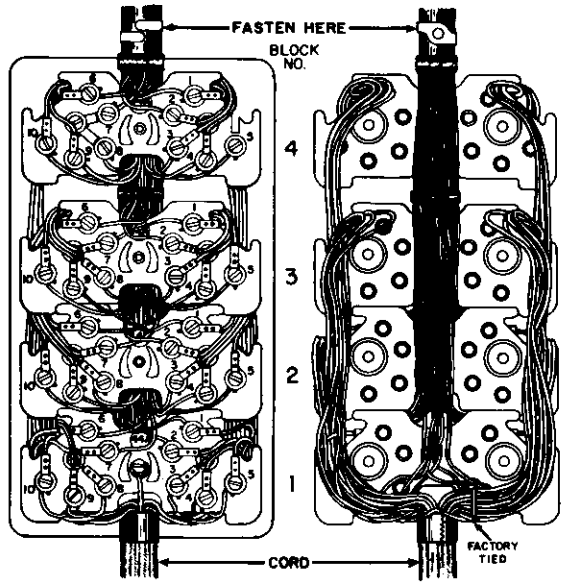


Figure 6-12. Connecting Blocks

Other type telephone sets used with 1A1 systems are the 440 and 460 series. Not all of the sets in these series may be used in 1A1 systems and only certain models are equipped with an additional set of switchhook contacts for the A control lead required in 1A1 systems. The 440 and 460 models that may be adopted to the 1A1 system require internal connection changes in accordance with the system features desired. Figure 6-13 lists the code numbers of 440 and 460 sets that may be used in 1A1 systems and the features provided. As you have surmised, the wiring changes within the set vary as to the particular set used and the features desired. Information concerning these wiring changes should be furnished the installer with the equipment when a complete package or system is purchased by the Air Force.

There are various other key telephone sets that may be used in conjunction with 1A1 apparatus in addition to the sets described here. Regardless of the type of set used, it is imperative that the person who plans the installation and obtains the equipment orders either drawings or specifications that indicate the required connections to provide the desired features.

POWER SUPPLY

Power may be supplied to 1A1 systems through:

1. Local wiring, incoming cables, and/or running cables from
   a. 101G power plants.
   b. Static ringing generators.
   c. Transformers.
   d. Local batteries.
2. Incoming cables and/or running cables from
   a. Central offices.
   b. Private branch exchanges.
   c. Building power plants.

Normally, the installer is not required to select the type of power supply as it is usually specified on the work order. However, for your general information, the method for supplying power is determined by the types and amount of current required

for the system and the availability of ac power. Small installations usually use rectifier power plants or direct central office or building battery feed. Larger installations generally make use of a local battery that is charged by a rectifier or central office feed cable.

One rectifier power plant often used in 1A1 systems is the 101G (1 in figure 6-10). This plant is designed to supply the various ac and dc voltages required. Naturally, the total load of a system cannot exceed the capacity of the unit and a 110-120 volt receptacle must be available. A fuse unit is required with the 101G plant where there are more than 36 lamps in the system. Where fuse units are not required, the power

SET CODE NR.	FEATURES PROVIDED		
	Key Arrangement	Signal Lamp	Exclusion Key
440E			
444E	H P P P O O O O	X	
445E		X	X
440F			
444F	H P P S O O O O	X	
440G	H P P C O O O O		
460G			
464G	H P P P P P O O O O O O	X	
465G		X	X
460H			
464H	H P P P P S O O O O O O	X	
465H		X	X
465K	H P P P P C O O O O O O	X	X
465L	H P P P S C O O O O O O	X	X
460M			
464M	H P P P S S O O O O O O	X	

Figure 6-13. Code Numbers and Features Provided for 400 Series Sets

wiring is connected first to the central office or PBX line units and then bridged to the other units. Again, where there is no requirement for fuse units, the types of power not required for the operation of central office or PBX line units is connected directly to the KTU requiring the power.

Install the 101G power plant as near as practicable to the equipment cabinet and to a 60-cycle ac service outlet not controlled by a switch. The location should be clean, dry and free from excessive dust. Avoid locations where the circulation of air is restricted such as small closets. Use inside wire or inside cable to extend the low voltage power ringing currents from the power plant to the station apparatus. Use twenty gauge wire or its equivalent for the ground connection. Where 36 or more lamps are supplied from the 10-volt ac terminals, the wiring should also be twenty gauge. Three 24-gauge conductors are approximately equal to one 20-gauge conductor.

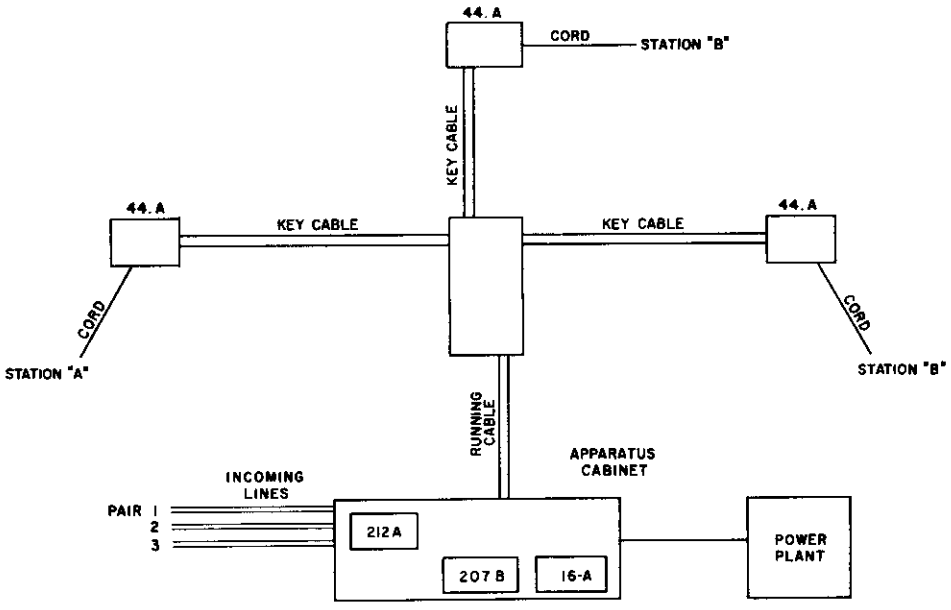


Figure 6-14. Key System Block Diagram

WIRE CONNECTIONS

Thus far, this chapter has described the major components within the 1A1 system; the next and probably the most important part of the chapter is concerned with the interconnection of the components. The manner in which the components are connected is, of course, dependent on the features desired and the equipment used. The connections involved, as you can see from figure 6-14 are:

1. Incoming lines to key units at the apparatus cabinet.

2. Running cables to:

   a. KTU's.
   b. Bridging terminal.

(Running cables are not used in all installations. In some cases, the key cables are connected directly to the KTU's.)

3. Key cables to:

   a. Bridging terminal.
   b. Connecting blocks.

4. Telephone set cords to:

   a. Connecting blocks.
   b. Telephone set.

5. Strappings at KTU's.

6. Power cable to:

   a. Power plant.
   b. KTU.

It would be a simple matter to make the connections listed above if all installations had the same communication requirements and if the same equipment was used to accomplish the requirements. However, since station communication requirements and equipment vary, so do the connections. Information concerning the wire connections in the 1A1 systems is furnished the installer in the form of drawings. These show the required circuit path through the apparatus and telephone sets needed to accomplish the various features. These drawings accompany the equipment when it is received from the manufacturer.

Another method used in determining the required connections is the use of connection tables supplied by the manufacturer. In either case, it is necessary for the installer to develop worksheets, similar to those explained under the 1A system, to guide him in connecting the systems components.

WORKSHEETS

None of the worksheets exhibited in this chapter are standard Air Force forms. They are, however, forms locally developed and borrowed from commercial telephone companies. Your present base may have developed a set of blank worksheets for this purpose or you may develop your own using the forms shown here as guides. In most instances, you should be supplied the completed forms along with the work order calling for a 1A1 installation. You may, however, be called upon to fill in the worksheets with the required connection data. For this reason, carefully study worksheets A, B, and C.

Worksheet A, shown in figure 6-15, was developed for use with the connection tables furnished with Western Electric equipment. The purpose of Worksheet A is to provide the installer with a "ready" reference showing:

1. Incoming line numbers and the amount of lines used.

2. Type of power supply.

3. Type of KTU's.

4. Type of Key telephone sets.

5. The table numbers that in turn will show the connections for:

   a. Power cable to power plant and KTU's.
   b. Incoming lines to KTU's.
   c. KTU strapping.

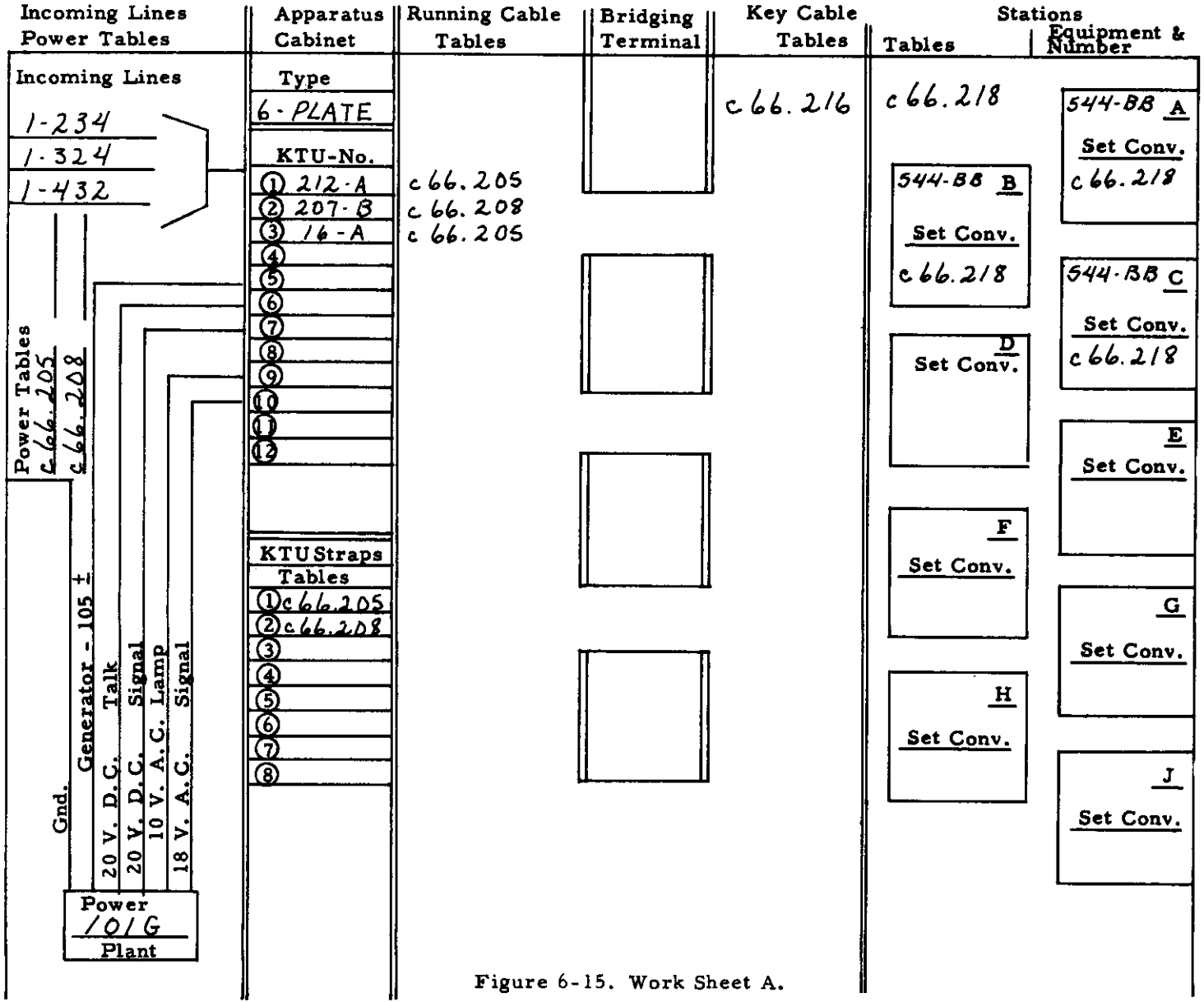


Figure 6-15. Work Sheet A.

d. Running cable to KTU's and bridging terminal.
e. Key cables to bridging terminal and connecting block.
f. Key telephone set cords to connecting blocks and sets.

The connection tables give this information for any combination of features and type of equipment desired. In other words, if the installer knows the requirements for a particular system installation, he can by using the connection tables select the type of KTU required, the type of telephone sets required, and the number of the table that shows the connections necessary to meet the system's requirements.

For further clarification, study the information in Worksheet A. You should note the following:

1. Three incoming lines; numbers 1-234, 1-324, and 1-432.

2. Power is supplied by a 101G power plant.

3. A 6-plate type apparatus cabinet is used.

4. The KTU's needed to accomplish the desired features are the 212A, 207B, and 16A.

5. The system includes three stations; A, B, and C.

6. 544-BB type telephone sets are used.

7. Power cable connections required by the features desired.

8. Strapping required to accomplish the features desired are found in tables C66.205 and C66.208.

9. Running cable connections to KTU's are found in tables C66.205, C66.208, and C66.205.

10. Necessary key cable connections are found in table C66.216.

11. Telephone cord connections are found in C66.218.

12. Wiring changes within the telephones needed to accomplish the desired features are contained in tables C66.218.

Worksheet B is used to list the required wiring connections for:

1. The power plant to the key telephone units.

2. The strappings on the KTU's.

3. Incoming lines to the KTU's.

4. Interconnecting the KTU's.

Worksheet A and the connection tables are both used in completing Worksheet B. For example, to determine the wiring required to connect the 101G power plant: first, check Worksheet A for table numbers, turn to the tables listed and locate the subdivision that lists the connection for the features desired, then enter the connections indicated on worksheet B. If you will refer to the sample worksheet shown in figure 6-16,

TYPE POWER PLANT: 101G		KEY TELEPHONE UNITS							
TERMINALS		209	212 or 202 TEM A B C	202	202	211 or 16A	207 TEM A B	210	208
105 V. AC	+ −	—	19 —			— 7	— 39		
	G	—	20 —			— 3	— 40		
10 V. AC	+ −	—	39						
	G	—	40						
20 V. DC TALK	+ −	—	29						
	G	—	30						
20 V. DC SIG	B	—					— 19		
	G	—					— 20		
18 V. AC	B								
	G								
STRAPPINGS FACTORY			27-37						
			9-16 9-10 9-10						
			26-36 26-36 26-36						
			36- 36-36 —			— 4			
			30 —			— 1			
STRAPPINGS INSTALLER			39				29		
			40				30		
			29				9		
			30				10		
INCOMING LINES									
1-234	T		32						
	R		31						
1-324	T		32						
	R		31						
1-432	T		32						
	R		31						

Figure 6-16. Work Sheet B.

Running Cables			Bridging Term.	Key Cables		Con. Blks.		Cord	Stations				
KTU. No TS No.	Term. No.	Cond.	Pair No.	"C" Type	"D" Type	Bk. No.	Ter. No.	Connections	A	B	C	D	E
212-A A	2			BL	BL	I	1	1R	R				
	1		1	W	W		2	1T	G				
212-A A				O	O		4	1B	Y				
			2	W	W		5	1H	BK				
212-A B				G	G		6	2R	BL				
			3	W	W		7	2T	W				
212-A B				BR	BR		9	--	BR-R				
			4	W	W		10	2H	BR-G				
212-A C				S	SL		3	3R	BR-Y				
			5	W	W		8	3T	BR-BK				
207 B				BL-W	BL	II	1	--	BR-BL				
			6	W	R		2	3H or S	BR-W				
				BL-G	O		4	4R	—				
			7	W	R		5	4T	—				
				BL-O	GN		6	--	—				
			8	W	R		7	4H or S	—				
				BL-BN	BR		9	5R	—				
			9	W	R		10	5T	—				
				BL-S	SL		3	--	—				
			10	W	R		8	5H or S	—				
				O-W	BL	III	1	SG	G-W				
			11	W	BK		2	L2	—				
				O-R	O		4	RR	Y-BL				
			12	W	BK		5	RT	Y-W				
				O-BR	G		6	ER	—				
			13	W	BK		7	ET	—				
				O-S	BR		9	EB	—				
			14	W	BK		10	EH	—				
				G-W	S		3	CR	—				
			15	W	BK		8	CT	—				
212-A A	4			G-BN	BL	IV	1	1	S-Y				
	5		16	W	Y		2	LG	S-BK				
212-A B	4			G-S	O		4	2	S-BL				
	5		17	W	Y		5	--	—				
212-A C	4			BR-W	G		6	3	S-W				
	5		18	W	Y		7	--	—				
207-B B	3			BR-S	BR		9	4	—				
	4		19	W	Y		10	--	—				
				S-W	S		3	5	—				
			20	W	Y		8	--	—				
16 A	9			BL	BL	V	1	--					
	3		21	R	V		2	--					
207 B	12			O	B		4	--					
	36		22	R	V		3	--					
207 A	13			G	GN		6	--					
	14		23	R	V		7	--					
207 A	15			G	BR		9	--					
			24	R	V		10	--					
				BR	SL		3	--					
			25	R	V		8	--					
				S									
			26	R									

Figure 6-17. Work Sheet C.

you can see how the entries are made. In this particular case, the terminal marked 105V AC on the 101G power plant is wired to Terminal 19, Block A at the 212 KTU. Terminal 19 on the 212 KTU is in turn wired to Terminal 7 on the 16A KTU; which in turn is wired to Terminal 39, Block B on the 207. See if you can trace through the remaining connections for the power plant shown on the sample worksheet.

The same procedure is used to determine the factory strappings that must be removed, the additional strappings that must be installed, and the connections for the incoming lines.

The next worksheet (C) serves as a means for listing the remaining connections required. Figure 6-17 illustrates a form that may be used to list the running cable connections to the KTU's and to the bridging terminal, the key cable connections at the

bridging terminal and connecting blocks, and the cord connections at the connecting blocks and telephone set. For clarity as to how this form is laid out, follow across on the first line. You will note that Pair 1 in the bridging terminal is wired to Terminals 2 and 1 on the A connecting panel of the 212A KTU by means of the running cable. The same Pair 1 in the bridging terminal is wired to Terminals 1 and 2 on the Nr. 1 connecting block by means of a key cable. The coding for either C or D type cable is indicated. Connecting block terminals 1 and 2 are connected to 1R and 1T in a 544-BB type set by means of the red and green cord conductors.

The procedure described above is designed for use with the connection tables furnished as a part of Bell System Specifications (G-66 series). The Kellogg Company manufactures 1A1 key equipment very similar to the equipment used by Bell. The connecting information however, is supplied in a different type of connecting table. Kellogg has published an instruction manual that covers the installation, maintenance and operation of their equipment. It is recommended that you obtain and study one of these manuals in order to gain a good working knowledge of 1A1 key equipment. Information contained in Technical Order 00-5-7 may aid you in obtaining this manual. Once you have a set of completed worksheets on hand, the actual installation of the equipment and apparatus varies little from the procedure used for installing 1A key equipment.

Exercise care when preparing and placing all cables; remember that the cable runs must be straight and run either vertically or horizontally on walls, ceilings, or floors. Make smooth rounded turns with the cable as short right angle bends may kink or break the insulation. It is good practice to twist each pair in the cable together at the ends immediately after the sheath is removed. This will avoid split pairs. Make sure that the cable runs are adequately supported and present a good appearance.

Generally, the trouble shooting procedure explained for 1A systems may be used with 1A1 systems. Troubles traced to key telephone units can usually be isolated either to the wiring between the units or to faulty relays. The wiring between the units may be checked with the aid of the worksheets or a wiring diagram and the wires themselves can be tested for continuity with a test set. If a relay is not operating properly, it may be open or shorted in the winding or the contacts may be dirty or out of adjustment. Use a schematic and test set to check the windings; if they do not check out, replace the KTU. If the trouble is not in the relay windings, clean the contacts and look for dirt or other foreign objects. If the trouble still is not cleared, the relay probably needs readjusting.

SUMMARY

Key telephone equipment is designed to provide the user with fast and varied types of telephone service at any one of several stations. The different types of service such as hold, pick-up, cutoff, signaling, etc., are called features. The features may be arranged in different combinations and are primarily accomplished by relays and key telephone sets. The relays and associated equipment are known as key telephone units. These KTU's are mounted in apparatus boxes on cabinets and connected to the telephone sets by means of color coded cables called key and running cables.

The manner in which the cables, incoming lines, and power supply is connected is dependent upon the features desired. The necessary connections are furnished the installer in one of two forms: either in connection data wiring diagrams or in connection tables. In both instances, this wiring information is supplied by the manufacturer. It may be necessary for the installer to develop a set of worksheets to serve as a guide in making the wire connections and for tracing the wiring when trouble shooting.

Generally, installation procedures can be divided into three parts: first, the selection of features that will meet the user's requirements; second, selection of equipment that will accomplish the desired features; and third, the mounting and wiring of the equipment.

This chapter has by no means completely covered all there is to know about key telephone systems; it is confined chiefly to installation and maintenance procedures. For a complete knowledge of the equipment, it is necessary that you obtain and study the drawings of the many circuits involved. The principle factor contributing to a complete knowledge of key telephone equipment is, of course, your ability to read and interpret schematics and wiring diagrams. To become a key telephone expert, you must first be expert at reading and interpreting schematics and wiring diagrams.

REFERENCES

BSP C66.201 through 222

Kellogg Instruction Manual Nr. IM-3003

REVIEW QUESTIONS

1. Explain the advantages of key telephone systems.

2. Explain the following terms: pick-up, hold, and exclusion.

3. Name the major components included in the 1A system.

4. What purposes do the following interconnecting cables serve?

    a. Incoming
    b. KTU
    c. Running

5. How many 44A connecting blocks may be used under one 101C connecting block cover?

6. What is the selection of KTU's for a particular key system based on?

7. List as many differences as you can between 1A and 1A1 equipment.

8. Where can you obtain information concerning the placing of cables?

9. How are the running cable connections to the KTU's determined?

10. What type key telephone sets are generally used with 1A1 equipment?

11. In general, how is power supplied to 1A1 systems?

12. How are convertible pick-up keys (P^S) on 565B type telephone sets wired when received from the factory? What must be done to convert key number six (6) on this set to a signaling key?

13. Under what circumstances may the installer proceed with the installation of a key system without a set of completed worksheets?

WORK PROBLEMS

PROBLEM 1. To become familiar with the key system installed on your base.

Training Equipment: Wiring data and installed key system.

References: JP36152

Work Procedures: Using wiring data or connection sheets supplied by your supervisor or found in the apparatus cabinet, develop a list showing the type and number of key telephones used; the connections at the connecting blocks, bridging terminals, and KTU's; and the features provided.

PROBLEM 2. Trouble Shooting.

Training Equipment: Test set and connection data.

References: JP36152

Work Procedures: Determine the inoperative feature or features; trace the circuit that provides the faulty features; and isolate the fault to key cable, running cable, or equipment. Replace equipment or repair the fault.

PROBLEM 3. Installation of apparatus cabinets.

Training Equipment: Cabinet assembly, attachments, KTU's, wiring chart or completed worksheets and hand tools.

References: TO 31W3-1-17 and TO 31W3-1-20.

Work Procedures: Install back-board, and hinged gate assembly. Mount required KTU's.

PROBLEM 4. Installation of running cables

Training Equipment: Hand tools, test set, cable, cable attachments, wiring chart or completed worksheets.

References: TO 31W3-1-17 and TO 31W3-1-20

Work Procedures: Make cable run, place cable in cabinet and make necessary connections on KTU's.

PROBLEM 5. Installation of key cables and connecting blocks.

Training Equipment: Hand tools, test set, cable, cable attachments, connecting blocks, wiring chart or completed worksheet.

References: TO 31W3-1-17 and TO 31W3-1-20

Work Procedures: Make key cable runs, mount connecting blocks and terminate cable pairs.

PROBLEM 6. Key telephone installation.

Training Equipment: Hand tools, test set, key telephone set and cord, wiring cha or completed worksheet.

References: TO 31W3-1-17

Work Procedures: Make telephone set internal wiring changes if required, and make cord connections.

PROBLEM 7. Power supply connections.

Training Equipment: Power plant or power supply, connection chart or completed worksheet, hand tools, inside wire or cable.

References: TO 31W3-1-17

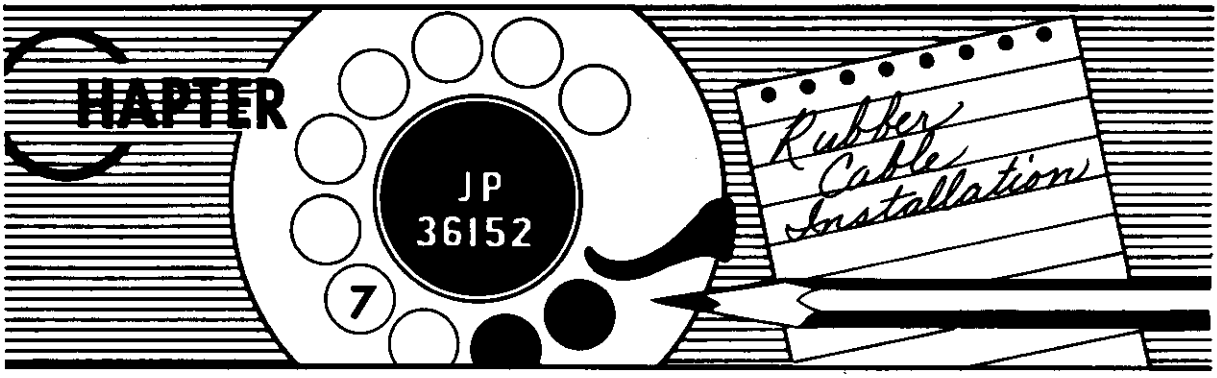
Work Procedures: Position and mount power unit and make required connections.

PROBLEM 8. Incoming line connections.

Training Equipment: Inside wire or cable, connection chart or completed worksheets, hand tools, test set.

References: TO 31W3-1-17

Work Procedures: Make required incoming line connections and straps between KTU's.



When you read the required job knowledges and tasks included in your job training standard, this question may have occurred to you: why must the telephone installer repairman concern himself with the installation of rubber covered cables? One answer to the question is that in remote areas or in cases of emergency when telephone linemen and cable splicers are not available, it may become your responsibility to restore damaged lines or construct a temporary telephone system. In such instances, the use of rubber cable could be the answer to your problem. For example, disrupted service, due to a break in an existing open wire or cable lead, can be quickly restored to a degree, by bridging the break with rubber cable. Another example, in most cases where flood, fire, or enemy action have destroyed telephone lines on an air base or lines between airbases or other service commands, temporary communication systems can be quickly installed with rubber cable assemblies, field wire, and tactical switchboard equipment. It goes without saying that in such instances, the entire success or failure of an important Air Force mission could lie in your ability to quickly establish communication lines.

The construction methods used in building rubber cable lines are in general very similar to those used in building field wire lines. There are four construction methods used in placing rubber cable lines: ground surface, buried, self-supported aerial and messenger-supported aerial lines. This chapter will discuss in detail the construction practices involved in placing ground surface lines and present a general description of the practices involved in the three other types of line construction, as applied to the following cable assemblies: CX-1065/G, CX-1606/G, and CX-1512/U. If you have not had an opportunity to work with rubber cable, a brief description of these cable assemblies is in order.

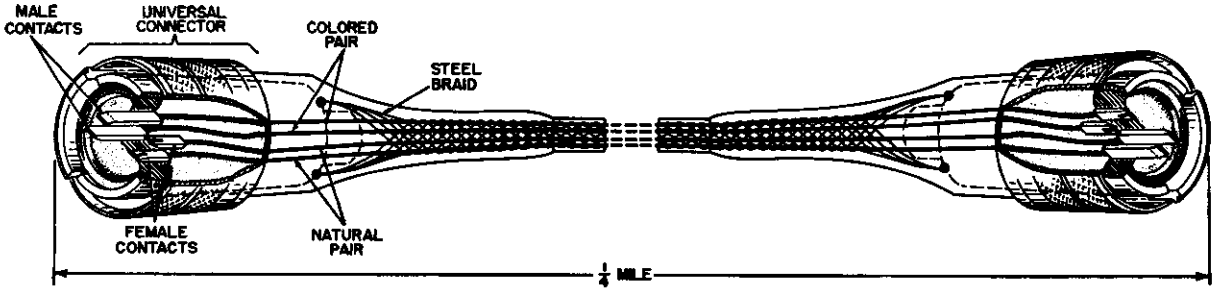


Figure 7-1. CX-1065/G Cable Assembly

Cable Assembly CX-1065/G, Telephone cable assemblies CX-1606/G and CX-1512/U, and Telephone Loading Coils Assembly CU-260/G may be used to form a four-wire transmission line to link stations of a military carrier telephone communications

system. The assemblies may be used in any climate. Basically, the cable assemblies are sections of spiral-four cable, WF-8/G, with universal connectors attached on each end. The CX-1065/G is approximately one quarter mile in length. The exact length will be found stamped on a metal band attached near the connector. The cable contains four conductors (2 pair). One pair of conductors is connected between the male contacts of the connector on one end and the female contacts of the connector on the opposite end. A steel braid runs the full length of the cable and is attached to the connectors on each end. Assembly CX-1606/G is made the same as the CX-1065/G assembly with the exception of its length. The CX-1606/G assembly is approximately one-hundred feet long. The remaining telephone cable assembly, CX-1512/U, consists of twelve feet of cable with a connector at one end only and is used for connection to equipment not provided with connectors. The CU-260/G telephone loading coil assembly is provided for use with systems using four-channel carrier. This coil assembly is connected into the cable lines at the junction of two CX-1065/G assemblies.

CONSTRUCTION PLANNING

Regardless of the purpose for which rubber cable is used, either as an expedient in restoring interrupted service or to fulfill the requirements for a complete system, planning is the first step.

For purpose of simplification, the planning stage of this installation job may be divided into two parts: advance planning and detailed planning.

ADVANCE PLANNING

Advance planning is generally accomplished by higher level personnel and the information passed on to the crew installing the cable. The factors included in advance planning are:

1. The number of circuits involved.
2. The available time allowed for providing the circuits.
3. The quality of circuits required.
4. The length and type of line.
5. The proposed line route.

In determining the line route, several items must be considered. Areas such as forests, swamps, jungle, very rocky ground, deep ravines, steep grades or large streams should be avoided if possible. If aerial construction is used the ground should be suitable for digging pole and anchor holes. The route should be accessible from roads needed in transporting line materials. In some instances, the tactical situation may require concealment of the cable lines. The possibility of physical damage to the cable should also be considered.

DETAILED PLANNING

Once advance planning is complete, it is necessary that more detailed plans be developed. The information accumulated during advance planning is put to use along with additional observations. These plans are usually formulated by personnel involved in the actual construction of the line. Such factors as a detailed route survey, equipment and materials survey, and manpower requirements are considered in detail planning.

The detailed route survey establishes the most practical way of following the proposed route; it provides a basis for completing the construction details and sets up landmarks to guide construction teams. The route survey is normally accomplished by a party that performs the following tasks:

1. Selects the most favorable line route in accordance with the proposed line route.
2. Clears away minor obstructions.
3. Observes and records landmarks, locations and compass directions.
4. Takes notes of important findings that will aid the construction team.
5. Designates the route with visible markers such as driven stakes and tree blazes.
6. Marks the location of pole and anchor holes if layout is not performed by a separate layout team.
7. Measures the route with reasonable accuracy by placing stakes that show the distance to some reference point.

The notes taken during this survey should be detailed enough to provide a basis for estimating the required materials and supplying information in overcoming special problems. The notes may be recorded on the line route map, particularly notes dealing with detours and special construction requirements.

Obviously, from the information provided by the route survey, estimates can be made as to manpower and materials required. The quantity of cable can be determined from the route measurements made. Allowances should be made for errors in measurement and slack -- about 20 percent excess of the total line will do the job. Cable support materials can be estimated from the number of overhead crossings required and the possibility of using existing pole lines and trees. Manpower requirements are determined from: (a) the type of construction used, (b) number of cables involved, (c) length of line, and (d) the urgency need. Manpower requirements for the construction of rubber cable lines is influenced by many factors, the foremost of which is how well the crew leader organizes and plans the job. Therefore, let us digress from the explanation of line construction and examine the role of the crew leader on such a project.

There are very few other assignments in this career field where the crew leader can better exhibit his ability to organize his crew and work. Speed is often an important factor when building rubber cable lines. The crew leader must organize his men and job so that the work is accomplished quickly. There are, of course, many variables that enter into such a project, such as, terrain to be covered, number of men available and type of construction used. A good crew leader will use imagination and ingenuity in organizing the job. Depending upon the number of men available, he may separate his crew into teams, each assigned with a particular task. For example, a supply team, a cable laying team, and a testing and policing team may be used. The supply team can transport materials such as support materials for overhead crossings to the locations where they are to be used. In the case of long lines, the transport team can keep the teams laying the cable supplied with full reels of cable and pick up the empty reels. The cable laying team can pay out the cable and construct the required crossings. The testing and policing team can test, tag, and anchor the cable.

Many variations for the utilization of manpower are possible, depending of course on the situation encountered. It should be apparent to you, how vital this portion of your job planning is. Normal telephone installer repairmen crews will obviously be lacking in men for such a project as described above. Therefore, if the situation should arise, where you and your crew are involved in a large number of such projects requiring additional manpower, inform your supervisor of the situation. It may be necessary for him to make adjustments in the unit manning document to provide larger crews. If such is the case, your supervisor will want to know the number of manhours required for performing certain work units involved in the project. Consequently, it is suggested that when you assume the duties of a crew leader, you analyze each operation and keep a record of the time spent on each unit of work for a number of jobs. Thus

you will establish an average time for each work unit and will be prepared to have the information ready for your supervisor. This procedure will apply to all phases of the installer repairman's job assignments, not only to cable installations.

CONSTRUCTION OF GROUND SURFACE LINES

Getting back to the installation of cables, after the planning is complete, materials on hand, and crew members assigned, construction can get under way.

TESTING

Before the cable assemblies and loading coils are transported to their installation locations, it is good practice to test them. Considerable time is lost if an installed assembly has to be recovered or replaced. Test each cable assembly for opens, shorts, crosses and grounds. The steel braid should also be tested for continuity. These tests may be accomplished with the TS-26 test set, with a head-set, or with telephone receiver and battery. Insulation resistance tests between each conductor and the other conductors and between the conductors and the steel braid should also be made. Insulation resistance testing may be new to you. If so, technical orders number 31W3-1-20, part 4 and technical order 31W1-2G-121 explain the process. Test the loading coil assemblies in the same manner with the exception of the steel braid.

HANDLING RUBBER CABLE

During the loading, transporting, and installing of rubber cable, there are certain procedures that must be taken to safeguard the cable from damage:

1. Avoid excessive pulls or jerks on the cable.
2. Avoid kinking the cable.
3. Do not roll full reels of cable over surfaces where hard projections, such as stones or stumps may come in contact with the cable.
4. Avoid damage to connectors -- keep covers in place until the connections are made.
5. Do not pull the cable across sharp edges or corners.
6. Do not crush the cable.

PAYING OUT GROUND SURFACE CABLES

Surface lines are usually laid (by the cable laying team) from a reel unit mounted on a truck. Under favorable conditions it is possible for one team to place 5 miles of cable in one hour. The procedure used is as follows:

1. Load the vehicle with full reels of cable and loading coils as required.
2. Place first reel on the reel unit and unreel the end of the cable and fasten it to a stake, pole or tree. Leave enough cable beyond the point of attachment to reach the terminal or repeater equipment. Where two cable sections join, leave about 20 feet of slack.
3. Lay the cable straight from the back of the truck. Start the truck slowly and accelerate gradually. Control the rotation of the reel so that the cable is payed out under slight tension.
4. Signal the driver to slow down as the bottom layer of cable starts to unwind from the reel. Signal a stop while there are still a few turns of cable on the reel.
5. Unreel the remaining cable by hand and remove the inner end of the cable.
6. Leave loading coil assembly at end of cable section, if required, and proceed with subsequent reels.

In areas where the terrain is such that motor vehicles cannot travel, surface lines can be laid out by hand. Two men can carry a reel unit on an axle; however when square axles are used, this becomes a difficult task. Rope slings placed on the round sections of the shaft and used as handles, may overcome this difficulty. Another method of laying cable by hand is to remove the entire length of cable from a reel and lay it in three or four piles of figure 8s, each of reasonable size and weight for one man to carry. The last man in the file carrying the piles of cable, pays his cable out first, the man just ahead, then pays his cable out and so on until the entire section is payed out.

Where it is necessary to lay the cable over swampy ground and across streams, follow the precautions and procedures outlined below:

1. Be sure that the end caps are in place on the cable connectors when the cable is to be carried through mud or wet grass.
2. If possible, position the cable so that connectors may be supported above the water or mud level.
3. Cable may be laid on the bottom of streams and other bodies of water if the bottom is solid and there is no danger of damage from current flow, navigation, or sharp stones. Weights may be attached to the cable if necessary to hold it in position. Even though the universal connections are water tight, it is not good practice to position them under water. This obviously can lead to difficulty in cable maintenance.
4. Place anchorages on both sides of a stream crossing. Where overhead crossings must be made, the cable laying team should follow the procedure outlined below:
   (a) Unreel enough cable at the first support (called the near pole) to allow for the vertical runs on the supports at both sides of the crossing. Allow extra cable, or slack, for easy handling.
   (b) Tie the unreeled cable temporarily to the base of the support, so that it will not be drawn out as the truck proceeds.

NOTE: Do not place connectors in aerial spans crossing highways or other traffic routes. Where the cable remaining on the reel is too short to complete the crossing span, coil the remainder of this cable at the base of the near pole and join on a new assembly (section) of cable.

Where railroad crossings are necessary, remove the ballast (the stone or gravel around the ties) under the rails and alongside one of the ties; pass the cable alongside the tie and cover it by replacing the ballast. Bury the cable in a trench on each side of the rail crossing for several feet, to protect it from physical damage.

ANCHORING AND TESTING THE CABLE RUN

As the cable laying team progresses, the cable testing and policing team should follow. This team will install the necessary anchors and ties for securing the cable and aid in testing the cable run after each assembly or section is connected. Remember that this procedure is only one suggested method; you may find a different arrangement of teams more suitable.

Prior to starting their work, this team should place the cable pairs "upon test", that is, connect them into either a test set, switchboard, or telephone, so that the team will be in communication with the wire chief or testman. He will conduct tests for opens, shorts, crosses, grounds, and make loop resistance readings after each cable section is connected in place. This procedure throws out the need for carrying test equipment along the entire cable route. After connecting a new section of cable in place the team may call, by means of a field telephone, the testman and request him to perform the required tests. Upon receiving an "OK", the team continues on and prepares the next section for connection.

This team should be well supplied with stakes, cable clamps, field wire or marlin, and the tools for driving stakes. These items are required in securing or anchoring the cable run. The cable run should be anchored as follows:

1. At points where any substantial change of line direction is made.
2. On steep slopes.
3. On each side of crossings over deep ditches or gullies.
4. On each side of crossings made through culverts or under railroad tracks.

The anchorages used may be stakes, trees, or any other device that is strong enough to withstand the expected pull. Drive stakes well into the ground and slanted slightly toward the expected pull. Attach the cable to the anchorage, with cable clamps, shown in figure 7-2. Basket hitches, shown in figure 7-3, may be used if clamps are not available. In cases where it is not possible to loop the cable clamp, bail over the anchorage, use a piece of field wire or marlin to secure the bail to the anchor as indicated in figure 7-8. Be sure that the clamps or hitches are placed so that they resist the pull on the cable. If there is pull in both directions, use two clamps or hitches, one in each direction, and leave a small amount of slack between the clamps or ties.

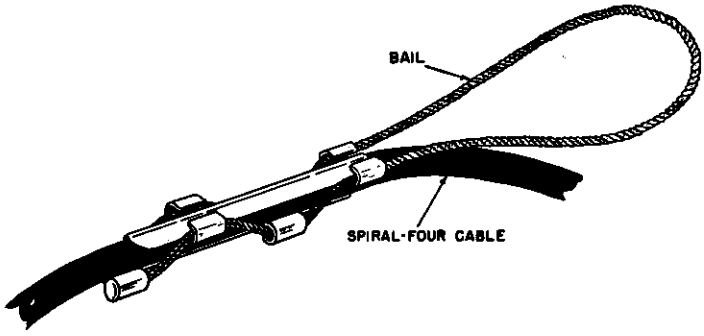


Figure 7-2. Cable Clamp

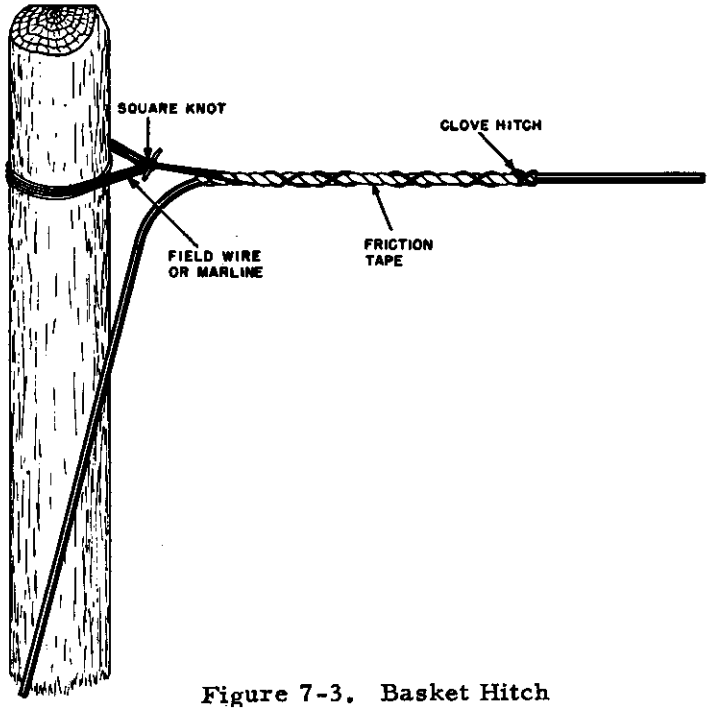


Figure 7-3. Basket Hitch

The only materials required in making a basket hitch are a seven or eight foot piece of single insulated conductor field wire or marlin and friction tape. Make the hitch as follows:

1. Apply a layer of friction tape over the cable where the hitch is to be located.
2. Double the piece of field wire or marlin to locate the center.
3. Start the attachment by making a clove hitch over the far end of the taped area.
4. Weave five or six cross overs on to the cable.
5. Bring the ends together and make two full turns of both ends of the field wire around the anchorage.
6. Finish the hitch by taking one of the ends over the standing part of the field wire and the other under; bring both ends around and tie them with a square knot. Figure 7-3 illustrates the completed hitch.

As the testing and policing team progress in testing and anchoring the cable, they should at the same time place cable tags. Special waterproof tags are available for this purpose and are placed at the far end connector of each length of cable. The following information is written on each tag: (1) the number of the cable assembly in the line, (2) the line number, and (3) the actual length of the cable assembly.

Before this testing and policing that we are talking about in this chapter goes too far down the cable line, it would be well to explain how the cable assembles are connected together. The steps in making connections are:

1. Remove the end caps from the connectors.
2. Grasp one connector in each hand with the thumb over the button.
3. Push the connectors together firmly until segments of one connector fit into the spaces between the segments of the other connector.
4. Slide the couples toward each other until the threads on the inside of the couple engage the threads on the segments. Use the hands only and twist the couples in opposite directions until the connection is tight.

CROSSINGS

The procedure to follow at crossings has been explained. The job of completing a crossing can be accomplished by the testing and policing team, by the men assigned to the cable laying team, or in cases where a number of crossings are involved, a team may be specifically assigned to this task alone. Regardless, there are standard practices that should be followed when completing a crossing. Overhead crossings are made by stringing the cable between trees, poles or other supports. If satisfactory clearances can be obtained, the cable may be strung, self-supported (without messenger). The clearances required are:

18 feet--over main traffic arteries and paved roads.
14 feet--over secondary roads and at other points where vehicles may travel.
8 feet--over walk ways or foot paths.

If existing supports are available and will provide the required clearance, make self-supported crossings as outlined below:

1. Transfer half of the slack left during the cable laying operation to the other side of the crossing.
2. Raise the cable at one support to a position high enough to gain the necessary clearance and attach it to a drive hook with either a cable clamp or basket hitch.
3. Place a second clamp to support the vertical run.
4. Raise the other end of the cable and pass it over the drive hook on the second support.

5. A man stationed on the ground some distance back from the base of the support may apply tension by hand to bring the cable up to the proper sag.

6. Place a cable clamp or basket hitch on the cable and attach it to the drive hook.

Another method of raising a cable for an overhead crossing is illustrated in Figure 7-4.

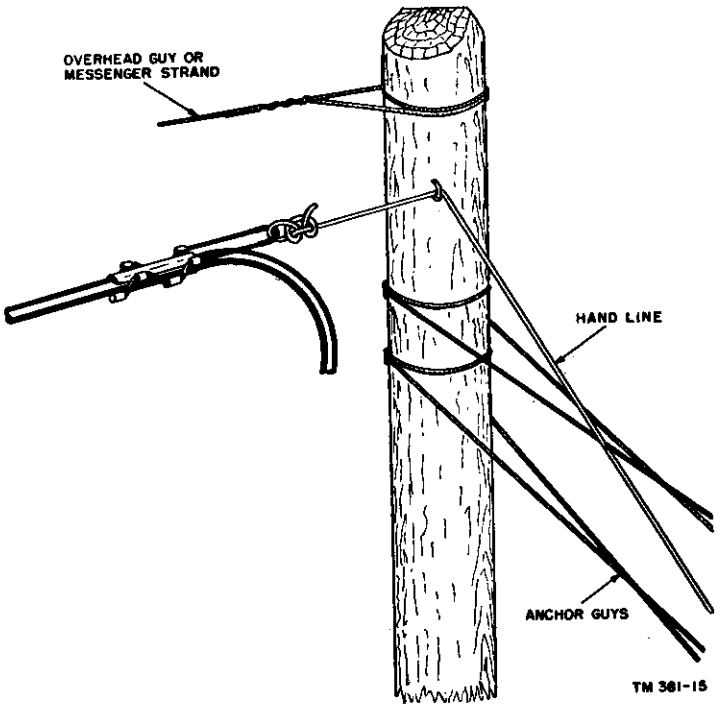


Figure 7-4. Use of Handline for Raising Cable

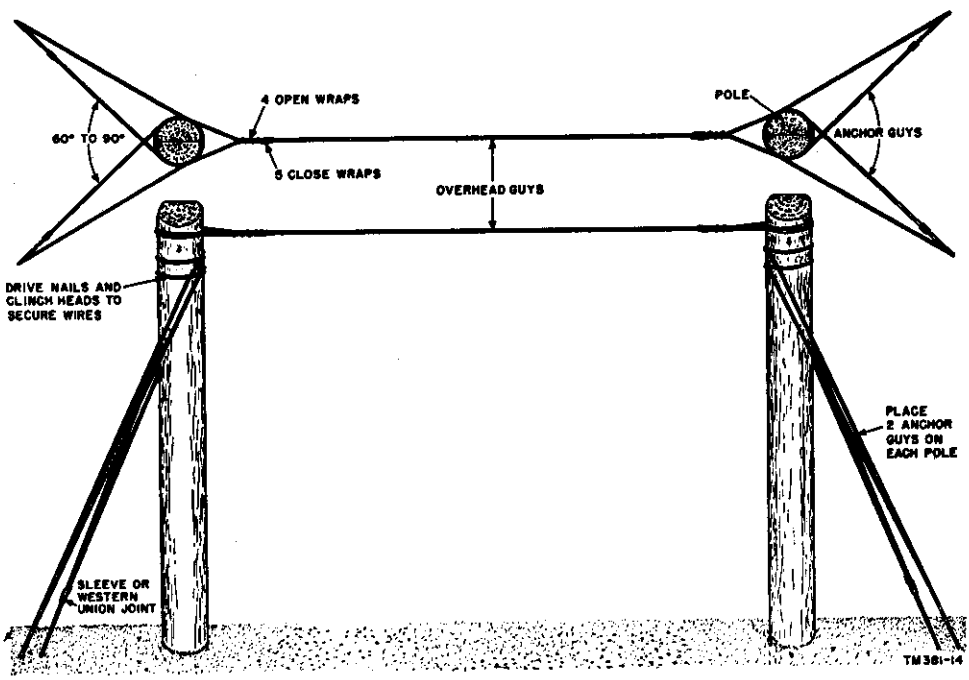


Figure 7-5. Guying Overhead Crossings

If supports are not available you may use standard poles, native poles, trees, sectional metal poles, or lance poles for supports. Erect and guy the crossing supports as illustrated in Figure 7-5. In situations where it is necessary to construct overhead crossings having span lengths of 300 to 500 feet, the cable should be supported from a messenger strand with cable hangers as illustrated in Figure 7-6. Cable rings may be used in place of hangers if hangers are not available.

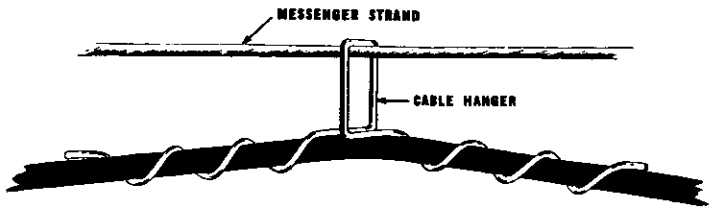


Figure 7-6. Use of Cable Hanger

Crossings are also made by burying the cable. This method often proves to be the least difficult to use, especially where nonsurfaced roads are involved. Dig the trench at least 6 inches deep and extend it far enough on either side of the road to protect the cable from vehicles. After the cable is laid in the trench, backfill and tamp the trench. Restore the road surface as well as circumstances will permit.

AERIAL AND BURIED CABLE LINE CONSTRUCTION

To this point the chapter has discussed the methods used in constructing ground surface rubber cable lines. This, of course, is only one method. It is, however, one of the fastest methods and in addition, requires little special equipment to accomplish.

Other methods used in constructing rubber cable lines are: buried cable lines, self-supported aerial lines, and messenger supported aerial lines.

BURIED CABLE LINES

Long buried cable runs are usually plowed in with the LC-61 cable plow. Cables are placed deep enough to protect them from activity disturbances on the ground surface. Soft ground and stony soil require the cable to be placed deeper than in ordinary hard ground. The LC-61 plow may be used in two different ways. One method is to lay the cable out on the ground along the desired route and feed the cable through the front sheave and guide of the plow. As the plow advances, the cable will be picked up and buried. The other method is to pay out and plow in the cable from reels mounted directly on the plow. Where cable lines are buried, it is important that the location of the connectors be marked in a reasonably permanent manner. For more complete information, on the use of the LC-61 plow, consult T.O. 31S1-3LC61.

SELF-SUPPORTED AERIAL CABLE LINES

Self-supported aerial cable lines can be installed quickly and with little difficulty, in cases where existing pole lines or other means of support are available. The cable is attached to the poles or trees by means of basket hitches, cable clamps and drive hooks, or cable hangers and drive hooks. The procedures employed when constructing overhead crossings will in general apply to this type of construction. The length of spans should be between 100 and 200 feet. One precaution that must be taken when using this type of construction is to allow the proper amount of sag in the spans. Allowable

sags are based on tensions of 100 pounds at 60°F. The chart in figure 7-7, shows sags for various span lengths of self-supported spiral-four cable carried on poles in medium loading areas. Lines using trees for supports require additional sag, unless the floating suspension method is used. Figure 7-8 illustrates floating suspension construction.

Minimum sags for self-supported spiral-four cables on pole lines (medium loading areas)					
Span length (ft.)	Sag (in.)				
	0°F.	30°F.	60°F.	90°F.	120°F.
100	13	12	11	11	10
125	19	18	17	16	15
150	28	26	25	24	23
175	40	38	37	35	34
200	68	66	64	62	61
250	139	137	136	134	132
300	224	222	221	219	217

Figure 7-7. Minimum Sags

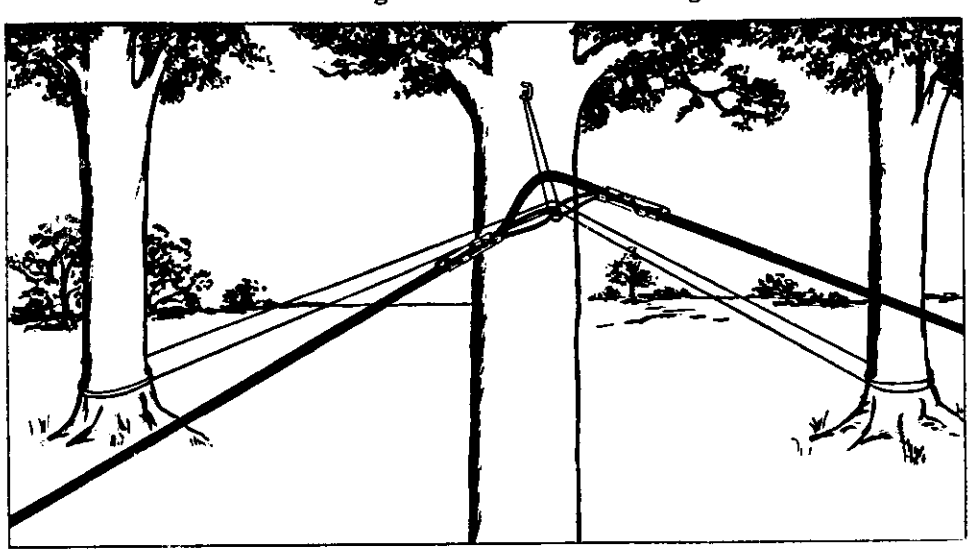


Figure 7-8. Floating Suspension

MESSENGER SUPPORTED CABLE LINES

This type of construction is generally used when aerial span lengths exceed 300 feet. Spans as long as 500 feet can be made with messenger supported construction. A messenger strand correctly sagged is strung between poles of suitable height, which are properly guyed. The cable is secured to the messenger by means of cable hangers, cable rings or by lashing. Figure 7-9 illustrates this type of construction at an overhead crossing and T.O. 31W3-1-112 covers the procedures used for placing the messenger strand.

CABLE LINE CONNECTIONS

Once the overall cable line is in place, properly anchored or guyed, and tested "OK", the next step is to make connections to the equipment installed. This is a relatively simple task, in that some equipment includes connectors, made to fit into the

cable assembly connectors. In cases where such connectors are not provided, the assembly CX-1512/0 will do the job. When connecting cables to equipment, remember that it is good practice to bury the cable where building entrances are made.

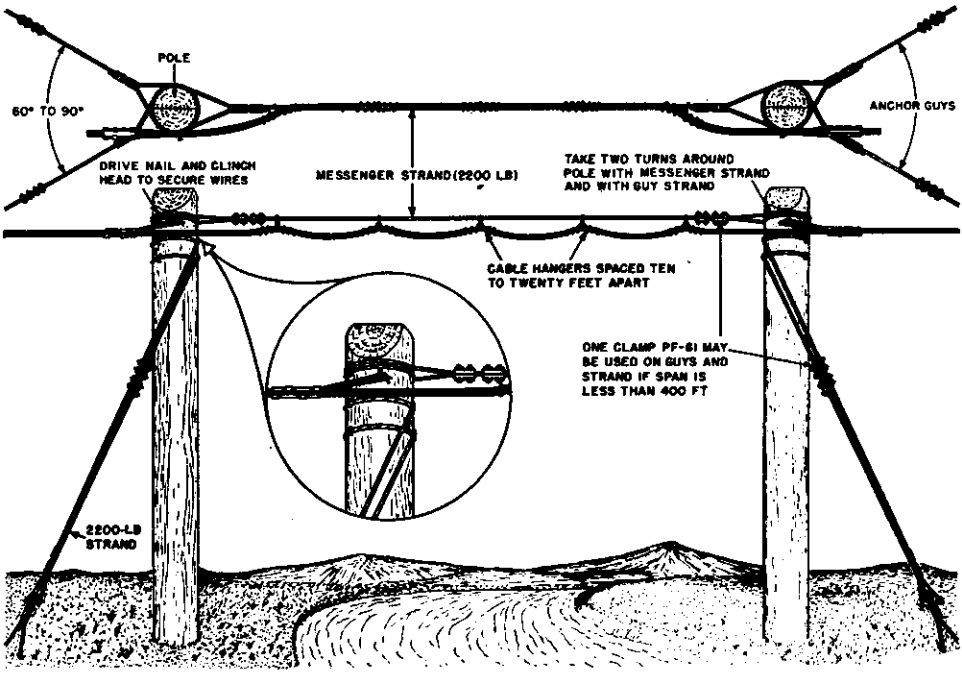


Figure 7-9. Messenger Supported Cable Lines

When connections to open wire lines are required, prepare a cable stub by splicing a few feet of insulated paired wire (W-69-A) to each pair of cable conductors. Place bridle rings on the underside or in back of the open wire dead end cross arm, spaced at 8 or 10 inch intervals from the pole to a point midway between the two open wire pairs. Thread the insulated wires and the end of the cable stub through these bridle rings until the splice is adjacent to the last ring. Terminate the twisted-pair wires on the open wire with bridging connectors as shown in Figure 7-10.

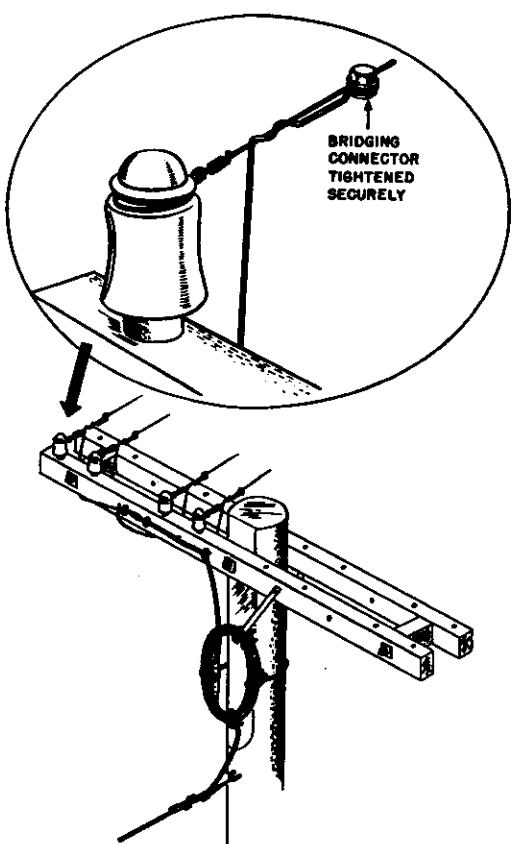


Figure 7-10. Connections to Open Wire

MAINTENANCE OF CABLE LINES

Ground surface cable lines, though quickly and easily installed, require particular preventive maintenance attention as they are subject to more damaging elements than buried or aerial constructed lines.

1. The entire length of cable line should be examined periodically and carefully. This is especially true at sharp curves or turns in the route and at points where the cable appears to be under stress. Be alert for stone bruises, abrasions, cuts and sections that may have been crushed.
2. Inspect all anchorages. Be sure they are secure and that the connections to them are in good condition. Check the insulation at all anchorages.
3. Check all connector locations carefully.
4. Repair all minor damages.
5. Replace cable assemblies in which the conductors are damaged.

Aerial cable lines inspections should include:
1. The condition of all supports, supporting ties, guys and messenger strands.
2. The cable under cable clamps or basket hitches.
3. The adequacy of ground clearances.

In general, faults may be located with a high percent of accuracy by taking loop resistance measurements. In the case of intermittent troubles and where suitable testing apparatus is not available, it may be necessary to resort to the "cut and try" method of trouble location. Your experience in shooting trouble on normal substation installations should enable you to cope with most any situation encountered on spiral-four cable lines. There is, however, one condition that is sometimes overlooked by crews when locating faults on long cable lines. In instances where the trouble crew is directed by the wire chief or test man to a location of trouble in miles distant from the wire head, the crew may not take into account the amount of cable wound on reels and rolls of slack, often left at crossings and under ground dips. When the defective section is located, your best bet is to replace the damaged section and return it to supply for repair. However, good judgment is necessary. If the damage is slight and can be repaired on the spot in less time than it would take to replace the section, make the necessary repairs.

Materials are available for making field splices in the CX-1065/G cable assembly. The procedure for making this field splice is described in the following paragraphs and illustration. However, for more prompt restoration of service, section replacement is advised.

FIELD SPLICING PROCEDURE

The field splice described below has adequate tensile strength and does not require devices to take the tension off the splice. Perform the operations below in the order that they are given.

a. Preparation for Splice. Remove the defective portion, cutting the ends of the cable square. Cut off any protruding steel cable braid wires.

> CAUTION: Handle the sharp ends of the steel cable braid wires carefully to avoid injury to the hands.

(1) Slide one 9/16-inch diameter copper sleeve over each cable end (A, figure 7-11).
(2) Slide one end cap, wide opening last, over each cable end.
(3) Slide one cable grip assembly, brass sleeve portion last, over each cable end.

NOTE: It may be necessary to enlarge the ends of each grip. If so, collapse each grip lengthwise and slide it, looped end first, over the handle of a pair of side cutting pliers, pushing and twisting the grip up the handle. This will widen the looped end of the grip and make it easier to slide it over the end of the cable.

(4) Designate one cable as cable No. 1 and the other as cable No. 2. Remove 12 inches of outer jacket, cable braid, and stabilizing tape from cable No. 1 and 3 inches from cable No. 2 as instructed below:
   (a) Carefully cut two circular rings about three-fourths of an inch apart through the outer jacket down to the steel cable braid (B, figure 7-11).
   (b) Slit the outer jacket, between the ringed cuts, on opposite sides of the cable.
   (c) Remove the outer jacket, between the ringed cuts, with a pair of pliers.
   (d) Cut the wires of the exposed cable braid, with a pair of diagonal cutting pliers, as close to the outer jacket (nearest the end of the cable) as possible. Be careful not to damage or cut the inner jacket.
   (e) Separate the strands of the cut wire braid and cut the steel wires close to the outer jacket, carefully trimming any wires protruding from the cut end.
   (f) Loosen the stabilizing tape (located between the steel cable braid and the inner jacket), with a twisting motion. Cut the tape close to the outer jacket.
   (g) Pull the outer jacket toward the splicing end of the cable. The outer jacket, steel braid, and stabilizing tape will now slide off the inner jacket as a unit.

(5) Remove the inner jacket from both cable No. 1 and cable No. 2 as instructed below (C, figure 7-11).

   (a) Cut a nick around the inner jacket, 1 1/2 inches from the end of the outer jacket; be careful to cut only part way through the inner jacket. Flex the inner jacket and conductors until the jacket separates at the nick.
   (b) Make a longitudinal cut through the inner jacket, at the end of the cable, approximately 1/4-inch long. Be sure that two conductors are on each side of the cut.
   (c) Grasp the inner jacket, on each side of the cut, with side cutting pliers and pull outward. The inner jacket will now peel away from the insulated conductors.
   (d) Cut the polyethylene core close to the end of the inner jacket (D, figure 7-11).

(6) Slide one flanged collar, flanged end last, over the inner jacket on each cable end.

(7) Slide one neoprene plug, narrow end last, over the inner jacket on each cable end.

(8) Push each plug and flanged collar toward the outer jacket until the stem of the collar is completely under the cable stabilizing tape.

(9) Slide the cable grip assembly on cable No. 1 until the end of the brass sleeve portion is close to the end of the outer jacket (E, figure 7-11).

(10) Slide the conduit assembly over the end of cable No. 1, until the end of the conduit assembly is seated on the neoprene plug.

(11) Screw the end cap onto the conduit as far as possible.

NOTE: When screwing on the cap it may be necessary to release the hold of the cable grip assembly by sliding it towards the conduit assembly.

(12) Pull the insulated conductors taut and cut them to a length of 1 3/4 inches from the end of the conduit assembly.

b. Splicing Conductors.

(1) Slide an insulating sleeve assembly over each conductor of cable No. 1 (F, figure 7-11).
(2) Strip 3/8 inch of insulation from the end of each conductor protruding from the conduit assembly.
(3) Insert each conductor into a splicing sleeve. Make two crimps on each sleeve, over the conductor, with the outer crimping recess of the crimping tool.
(4) Cut the insulated conductors of cable No. 2 to a length of 1 1/2 inches, measured from the end of the inner jacket.
(5) Strip 3/8 inch of insulation from each conductor.
(6) Splice together conductors having the same colors as instructed in (a) through (d) below:
   (a) Select one conductor, having the same color, from each cable.
   (b) Insert the skinned conductor of cable No. 2 into the end of the splicing sleeve on the conductor in cable No. 1 until the insulation touches the sleeve. Crimp the sleeve in two places, over the conductor, using the outer recess of the crimping tool.
   (c) Center the insulating sleeve assembly over the conductor splice. Make one crimp, with the middle crimping recess of the crimping tool, in the middle portion of each copper sleeve located at the ends of the insulating sleeve assembly.
   (d) Repeat the procedure given in (a) through (c) above for the remaining conductors. Be sure that conductors having the same color are spliced together.

c. Assembling Splicing Conduit

(1) Unscrew the end cap from the conduit assembly on cable No. 1.
(2) Slide the conduit assembly over the spliced conductors, seating the end of the conduit on the neoprene plug at cable No. 2.
(3) Screw the end cap tightly onto the conduit at cable No. 2 until all threads are covered (G, figure 7-11).
(4) Bend the insulated conductors of cable No. 1 into an S shape and push them into the conduit assembly, until the neoprene plug of cable No. 1 is seated in the conduit.
(5) Screw the end cap of cable No. 1 tightly onto the conduit until all threads are covered. If necessary, release the hold of the cable grip assembly by sliding it toward the conduit assembly.

(6) Remove the slack from each cable grip assembly by working it along the cable, away from the conduit assembly, until it lies even and snug.

(7) Crimp the copper sleeve (H, figure 7-11) over the end of each cable grip by pinching the sleeve with a pair of lineman's square-jawed pliers. Bend over the flattened portion of the crimped sleeve (I, figure 7-11).

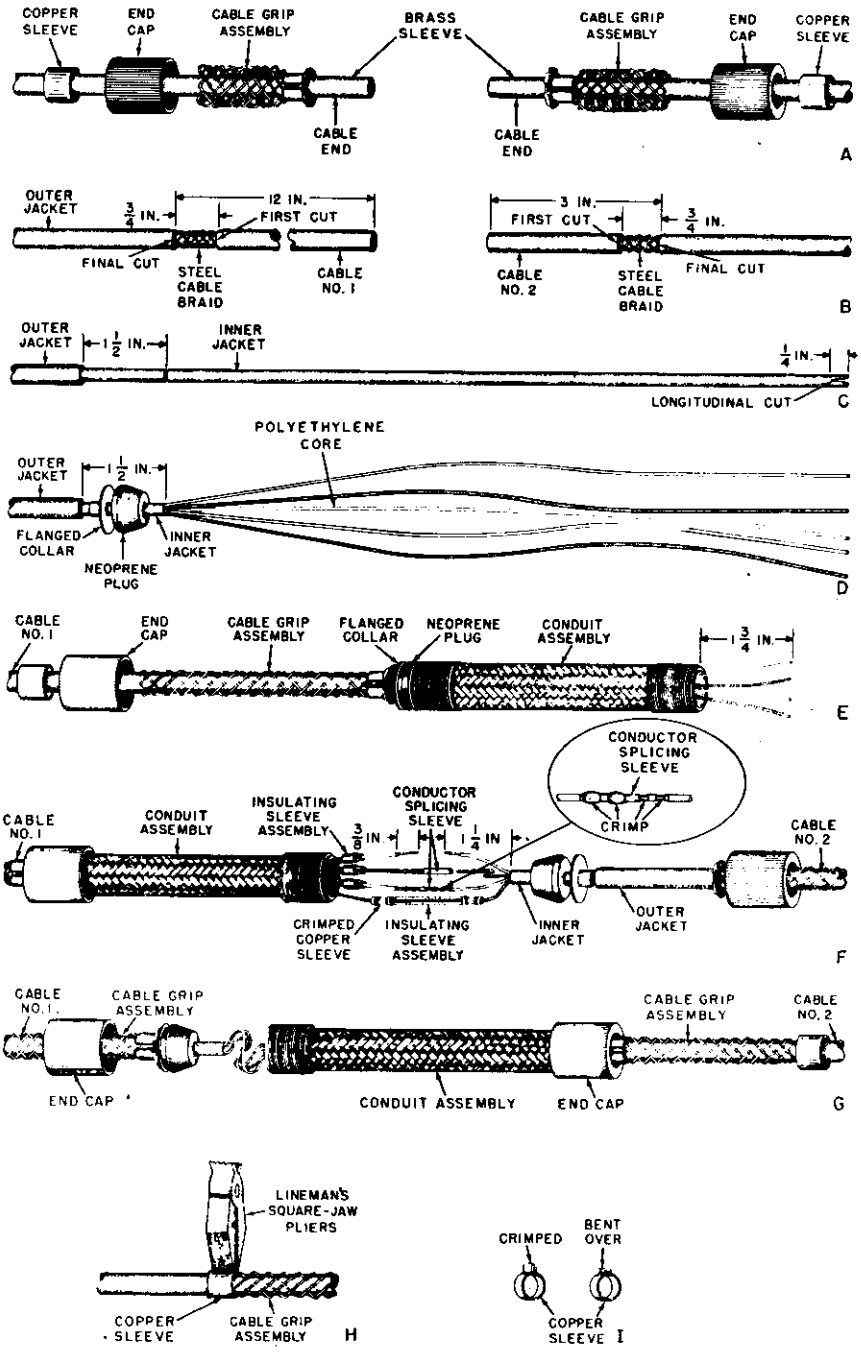


Figure 7-11. Field Splice of CX-1065/G Cable Assembly

SUMMARY

Rubber cable assembly CX-1065/G and telephone cable assemblies CX-1512/U and CX-1606/G are used to establish communication circuits for tactical telephone and telegraph equipment. The cable assembly may also be used as a temporary means of restoring breaks in existing lines.

Various construction methods are employed in placing the cable assemblies. These are designated as ground surface construction, aerial self-supported construction, aerial messenger supported construction, and buried construction. Usually lines may be installed more rapidly and with less special equipment by means of the ground surface method than by the other methods. Such construction, however, results in a less permanent type of installation and consequently requires more maintenance. Faults in the cable lines can be detected and located in much the same manner as troubles found in any outside plant telephone lines.

The real key in rapidly constructing rubber cable lines, lies in the over-all job planning. Team work is "of the essence". The crew leader must exercise good judgment, imagination, and ingenuity in planning the job and guiding the crew throughout the entire installation. The following chapter, "Duties of the Crew Leader", contains many sound suggestions that may be applied to the management of men and teams of men involved in building rubber cable lines.

REFERENCES

TO 31W1-2G-121	Cable Assembly CX-1065/G, Telephone Cable Assembly CX-1606/G and CX-1512/U, and Telephone Loading Coil Assembly CU-260/G.
TO 31W1-3RL26-1	Reel Units RL-26-A, RL-26-B and RL-26-C.
TO 31-3-26	Field Expedients for Wire and Radio.
TO 31S1-3LC61-1	Plow LC-61 (Cable).

REVIEW QUESTIONS

1. How long is the CX-1065/G cable assembly?
2. What factors are considered when planning a proposed spiral-four cable route?
3. Why must a detailed route survey be made?
4. In a system using four-channel carrier, where are the loading coils placed?
5. In swampy areas, where vehicles cannot pass through, how is cable payed out?
6. Where should cable connectors be placed in swampy areas?
7. What procedure is used to alleviate the need of placing connectors in a self-supported aerial span?
8. How and where should ground surface lines be anchored?
9. What are the required vertical clearances at overhead crossings for spiral-four cables?

10. What portions of a ground surface cable line should be buried?

11. How are preventive maintenance inspections of rubber cable lines made?

12. How is the basket hitch made?

13. When are basket hitches used?

14. Explain how aerial messenger supported crossings are made.

15. Explain the procedure for testing a cable section.

WORK PROBLEMS

PROBLEM 1. Planning Rubber Cable Lines.

Training Equipment: Area map, paper and pencil.

References: TO 31W1-2G-121 and TO 31W-1-9

Work Procedures: Prepare a detailed rubber cable line route map between two points suggested by your supervisor. Plan and indicate on the map the locations of overhead and buried crossings and line direction changes. Develop itemized list of tools, materials, and number of men required to make the installation. Prepare an account of how the men will be utilized when making the installation. Submit completed map and plans to your supervisor for critique and approval.

PROBLEM 2. Layout of cable.

Training Equipment: Test set, cable, reel unit, vehicle, and hand tools.

References: TO 31W1-26-121 and TO 31W-1-9

Work Procedures: Lay cable out along desired line route.

PROBLEM 3. Construction of Crossings.

Training Equipment: Digging tools, hand tools, climbing equipment, drive hooks, cable clamps, marlin and/or field wire, and supports.

References: TO 31W1-2G-121 and TO 31W-1-9

Work Procedures: Construct overhead and buried crossings.

PROBLEM 4. Policing of cable.

Training Equipment: Test set, tags, stakes, marlin and/or field wires, hand tools and climbing equipment.

References: TO 31W1-2G-121 and TO 31W-1-9

Work Procedures: Test, anchor, and tag cable.

PROBLEM 5. Service Restoration.

Training Equipment: Climbing equipment, hand tools, test set, cable assembly or section, drive hooks and cable clamps or marlin.

References: TO 31W1-2G-121 and TO 31W-1-9

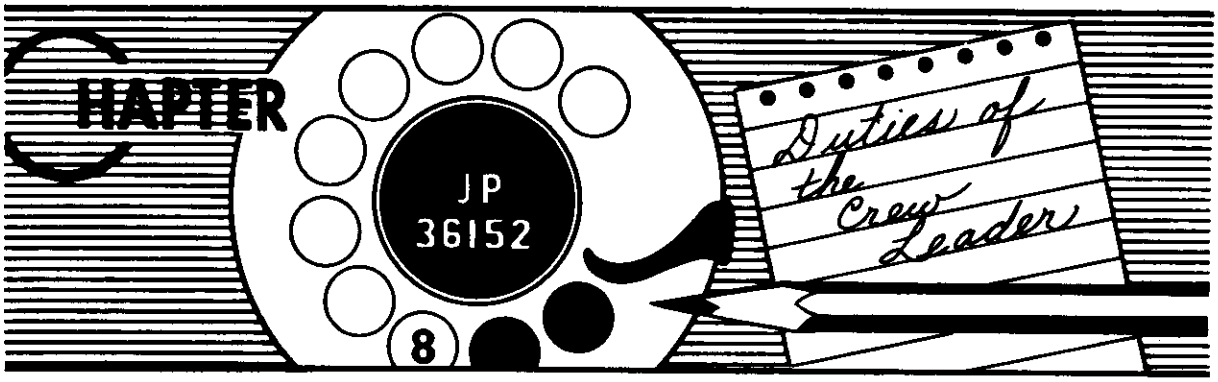
Work Procedures: Make temporary rubber cable installation to bridge circuits around breaks in permanent leads.

PROBLEM 6. Rubber Cable Maintenance.

Training Equipment: Test set, climbing equipment, hand tools, and marlin or field wire.

References: TO 31W1-2G-121 and TO 31W-1-9

Work Procedures: Make a preventive maintenance inspection of rubber cable installation. Detect, locate and repair faults in rubber cable installation.



The United States Air Force does not make a habit of giving something for nothing. You will find this especially true as you progress up the telephone installer repairman career ladder. With each promotion and pay increase you will find that you must shoulder more responsibilities. For example, your job training standard indicates that the 5-level man must be able to lead a crew when working in such areas as installation and repair of intercommunicating systems. In other words, the Air Force is looking for men to lead their telephone installer crews. Now is the time to prepare yourself for the day when you will be considered by the supervisor for this position.

Generally, the requirements of this position may be grouped into two categories: technical know-how and leadership. From your study and experience as a 36132 you should be fairly well qualified in the detailed technical requirements. It may be well, however, to brush up on some of the broader technical aspects required by the position of crew leader.

CREW DIRECTION and JOB ASSIGNMENTS

In addition to normal job planning, the good crew leader gives careful consideration to such factors as the experience of his men and the urgency of the job. Let us fit these factors to situations that you may encounter on the job.

Suppose, as the leader of a five man crew, that you receive an assignment to construct a field wire telephone system. More than ample time is allowed for the job and all necessary tools and equipment are on hand. Two of the crew members are well qualified and experienced in building field wire lines; the other two crew members have no experience in this area. In such a situation the crew leader should have two objectives: first, to build the lines and install the equipment efficiently and according to specifications; second, to accomplish as much training as possible for the unskilled members of the crew. The logical thing to do is to assign one experienced man and one inexperienced man together as a working team. Now with the crew paired together into two teams, divide the work as evenly as possible between them. When making this division of work, consider the number of overhead and underground crossings involved, type of terrain, and the length of the line. Insofar as possible assign the same type and amount of work to each team. Once the work is started, keep in close touch with both teams and inspect the quality of work as the job progresses. Make sure that all wire splices are correctly made and taped; check the wire ties and mechanical protection of the line; be quick to compliment the men on work well done, and be tactful in pointing out mistakes. Make certain, however, that all mistakes are pointed out to the men making the errors; remember our two original objectives. If you are in doubt over some particular specification or work procedure, don't bluff your way through - admit your short comings and check the applicable technical order.

Be alert to any unsafe conditions that exist and make certain that the crew follows safe working procedures throughout the job. Consider any suggestions made by the crew

members and put the good ones into effect. Pitch in and help the teams over the rough parts of the job.

You understand, of course, that all jobs cannot be accomplished in such a manner. In emergency cases or when the work must be completed in the shortest possible time, it may be advantageous to make different arrangements. One possible arrangement might be to assign the inexperienced men to less complicated tasks and let the skilled men progress as fast as possible. In either case make certain that all members of the crew know your objectives. If you are pressed for time, tell your crews so that the experienced men will understand why their work load is greater. If you are endeavoring to accomplish training in addition to completing the job, also tell the crew so they may work together toward common objectives.

This same procedure may be used when making job assignments on other types of installations. Jobs requiring the use of rubber covered cable may be handled in about the same way as field wire installation. When making normal station installations the work may be divided between inside and outside wiring or between conduit work and wiring. When installing inter-com systems, part of the crew may be assigned to wire or cable placement and the remainder of the crew to the installation of terminals and equipment. Regardless of the type of installation, always remember to divide the work as evenly as possible among the men, aid your men in learning new skills, and treat the men in the same manner as you would expect a crew leader to treat you.

TRAINING THE CREW

Training individual crew members is one of the more important duties of the crew leader. In any organization, there is always need for training. Men with considerable job experience, must be trained in new methods and on new equipment. Men with lesser experience need training in the areas where they lack experience so that they may become qualified in all phases of the job. The new men, of course, must be trained to carry, eventually, their full share of the work load. In any case, training should be carried on not only to improve the crew but also to provide every man with the feeling that he is growing in his job. This helps build good morale.

Probably the most effective way to train your men is by supervised on the job training. The procedure is fairly simple. First, you must recognize the type and amount of training needed (set a goal); next prepare the learner, get him in the mood to learn. He must be interested and willing. Now, you are ready to present the training; to do this effectively, a plan is necessary. When making your training plan, think the complete project through, make sure the project is presented in a logical sequence, be ready with answers to the "why," "when," and "how" questions that the trainee is bound to ask you. Generally it is best to start with the easier operations and progress to the more difficult. Then, when the training period is complete, follow up and make certain that the trainee has attained the goals that you originally set.

It is not necessary for the crew leader to handle the actual presentation of the training; he may delegate this job to another crew member. Make certain, however, that the man you delegate is fully qualified both technically and in the methods of presenting the lesson.

Suppose that the following situation exists. During a routine inspection of the crew's tools you discover that one man does not know how to sharpen his climbers. You decide on the spot, that some instruction is needed. Now, it is always best to consider just how the instruction will be accomplished, who will be the trainer, when the training will take place, and what equipment will be required. The next step, then, is to think through the step by step procedure used in sharpening gaffs. It might be wise to read through the

procedure in the applicable technical order to refresh your memory. You now prepare the trainee; this can be accomplished by pointing out the dangers involved in using gaffs not properly cared for. In presenting the lesson to the trainee, go through a complete procedure step by step, explaining the "why" of each operation. Now let the student attempt the job; stand by and watch closely. Be quick to praise his correct operations and tactful in correcting his mistakes; a man needs encouragement when learning. When the job is finished point out any improvements that could be made. Follow up your instruction with later checks on the condition of the trainee's gaffs.

In some cases, particularly when new equipment is introduced to the crew, it may be beneficial to assign your crew members to factory or technical schools.

THE CREW LEADER and SAFETY

Safety is everyone's responsibility regardless of rank. However, the crew leader in addition to making certain that his crew follows safe on-the-job practices, must also see to the crew's safety training. At this point it might be well to review some of the general safety precautions that must be observed while performing on the job.

1. Report to the proper authority all unsafe or potentially unsafe conditions.

2. Keep all unauthorized personnel from the work area.

3. Wear all items of protective clothing required by safety regulations.

4. When working in hazardous areas, station a guard in a location where he may issue warnings to safeguard the working crew or those outside the working area.

5. Unless required by the job, do not walk or stand under work aloft. Wear protective head gear at all times while stationed under work aloft.

6. Be alert to recognize a dangerous situation: Report any dangerous situation for which safe practices have not been planned in advance. Exercise unusual care when working in the vicinity of power wires and equipment; when working near traffic or heavy moving equipment; or when working on or about facilities weakened by explosion or severe weather conditions.

7. Keep clear of all ropes or lines under strain.

8. Observe all safety regulations while being transported to and from the job.

9. Know the purpose of each job and the safe practices for that job.

10. Plan each job in advance so that the safe practices may be followed and the work done efficiently.

11. Obey instructions.

12. Use the correct materials, tools and equipment for each job.

13. Avoid actions which may be dangerous to others.

14. Protect the eyes from injury by wearing goggles when performing work near tree branches and loose wires or when performing any chopping or cutting which might cause flying particles.

15. Wear rubber gloves for all work involving electrical hazards.

16. Keep the body and clothing clear of all moving equipment.

17. Be sure that temporary construction is strong enough to prevent accidents.

18. Handle and use all tools in accordance with safe job practices.

The telephone installer is often required to perform his job under hazardous conditions after and even during severe storms. A point to remember is that any storm or similar action that can knock a drop out of service, may have weakened other parts of the line. For example, power wires may be down and in contact with telephone facilities, which could place dangerous voltages on the wire you must work with. Poles may be weakened and break when work is started. Down guys may be weakened or broken. Therefore, remember to make a thorough inspection and eliminate any hazards or suspected hazards prior to starting the job.

There are many special safety precautions that must be taken in addition to the foregoing general safety practices such as are necessary when performing work near power and light wires, when using climbing equipment, when using ladders, hand tools, etc. It is your responsibility to know and practice these special precautions. Technical Order 31W3-1-13 which contains these special precautions, is a reference that every outside plant communications man should study.

SAFETY TRAINING

Every wire communications section should conduct a continuous safety training program. The program like any other training program, must be interesting, in detail, and cover all phases of the subject. Generally, arrangements for such a safety training program are not your responsibility. Your supervisor, however, may request your assistance in preparing and presenting such training. Probably the most difficult part in conducting a safety training program is to make it interesting to the crew members. An interesting program requires both ingenuity and imagination on the part of the person developing and conducting the same. Commercial telephone companies often conduct their programs by holding a meeting once a month for all crew members. During the meeting safety practices are discussed, demonstrations are observed, accidents are discussed, and rescue and first aid procedures are practiced by the crew members. The Air Force has definite safety programs established, but they are not so detailed that the crew leader cannot vary and project new ideas into the program to keep it from becoming stale and disinteresting to his crew.

One safety operation that always proves interesting to a group is rescue from a pole. Details of the procedure may be studied by the group and demonstrations made. Finally, the rescue may be practiced by individual crew members. It might be added that rescue from a pole is not only an interesting subject for safety instruction sessions but a procedure that all telephone installers should know.

RESCUE FROM POLE

In an electric shock accident, quick rescue and application of artificial respiration (when breathing has stopped) are extremely important. Proceed as here described, taking all precautions to protect the rescuers from electric shock. In some cases, the injured person may remain in contact with the wire because of his inability to let go of the live conductor, or because he is unconscious. Unless it is definitely known that contact with power circuits has been broken or that the cause of the trouble is not electric shock, assume that all wires on the pole carry dangerous voltages.

In all cases where the victim has received a severe shock or is unconscious, send for a medical officer as soon as possible without delaying the rescue. Also notify as soon as possible, the group responsible for the power equipment. If the cause of disability is not electric shock, conduct rescue work more deliberately than with the speed essential in electric shock cases.

PLANNING THE RESCUE

Before starting the rescue, plan quickly but carefully how the rescue can best be carried out. The more important details to be considered are:

1. Probable cause of accident: electric shock, sickness, or fainting.

2. If electric shock, the source of shock and whether or not the source of power has been removed.

WARNING

If the cause of the accident and the clearance of the shock source are not apparent, assume that the victim has been shocked and that the source has not been cleared.

3. Rescue equipment available, such as: rope, rubber gloves, pliers, tree pruner, wire cutters with handles, climbers, body belt, safety strap, and ladder.

4. Assistants to help handle rope in lowering the victim from the pole.

5. Position of the victim with respect to wires and attachments on the pole.

6. Method to be used in clearing contact between the victim and the source of shock. The victim may be freed by lifting clear, opening a switch, or cutting a wire. If a wire is to be cut, consider the possibility that the pole is unsound and may fall because of the resulting unbalanced load on it.

7. Side of the pole to be climbed and position from which the rescue work will be done.

8. Possibility of having to apply artificial respiration to the victim while he is still on the pole.

9. Point of attachment for rope to be used in lowering the victim.

10. Need for cutting wires below the victim, which might interfere with rescue work and the lowering operation.

11. Protection of the rescuer from electric shock if the pole or other equipment is wet.

12. Availability of a truck to be used, with necessary precautions such as an insulated platform. Take particular precautions under wet conditions.

13. The probable voltage of the circuit. Become familiar with types of power line construction in the area so that estimates of voltage in different types of circuits may be made.

If the victim may be in contact with circuit voltages which may exceed 15,000 volts, do not attempt rescue until the circuit is definitely broken. Rubber gloves will not withstand this voltage and the rescuer cannot be sure that ropes or wooden poles are dry enough to offer protection.

FREEING VICTIM FROM LIVE CIRCUIT CONTACTS

WARNING

Wear rubber gloves throughout all rescue operations involving the possibility of electric shock. When handling energized wires, use only one hand when possible, keeping the other hand and parts of the body clear of wires, guys, suspension strands, and other ground structures.

If the reason for the high voltage being on the telephone plant is evident, remove that contact without handling the supply conductors if at all possible. In some cases, it may be possible to clear the contact by throwing a dry handline over the telephone or supply wires and pulling them apart or pushing them apart with a dry ladder or long dry stick such as a tree pruner handle or pike pole.

WARNING

Do not use damp or green wood to separate wires. Moisture conducts electricity. Avoid standing on wet ground or in water.

If these methods cannot be used and rubber gloves are worn, the contact between the supply wires and telephone conductors may be opened by cutting the telephone wire. Use a tree pruner with a wire cutting head and a dry pull rope. If a wire cutter is not available, cut the wire with a pair of pliers.

Under extreme conditions, secondary electric circuits may be cut, provided rubber gloves are worn. Take care that cut wires do not fly back or fall, injuring the rescuers or other persons. To protect the eyes from any flash that may occur, turn your face away while cutting the wire.

WARNING

Never cut primary wires.

RESCUE PROCEDURE

Start the rescue as soon as the rescue plan has been established, and the method of clearing any power contacts has been worked out. Reach the victim as follows:

1. Select a rope in good condition (at least 3/8 inch diameter), that is long enough to permit any available assistants on the ground to lower the victim.

2. Push the loop on the end of the rescue rope under the rescuer's body belt at the back, so that it can be easily carried up the pole and removed when needed.

3. Climb the pole at the selected side and get into the proper working position behind the victim as shown in figure 8-1.

WARNING

While aloft, avoid contact with all energized equipment and with the victim's body, unless contact with the energized wire has been broken.

If there is to be any delay in lowering the victim, check for stoppage of breath. If necessary, apply artificial respiration at once; however, do not delay lowering the victim to continue artificial respiration on the pole.

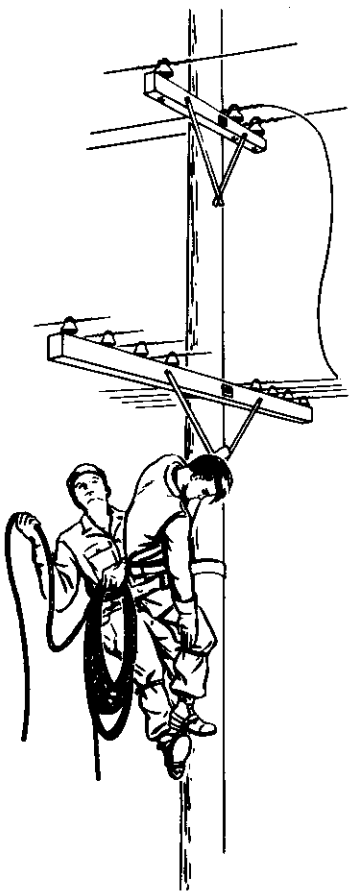


Figure 8-1
Rescue from a Pole --
Proper Working Position

4. Cut telephone wires that interfere with the lowering of the victim, being careful that they do not fall on persons below. Leave no projecting ends that might injure the victim while he is being lowered. Do not cut wires which would cause a pole to fall.

Free and lower the victim as follows:

1. Pass the rescue rope over a crossarm or other strong attachment located above the victim, as shown in figure 8-2. If working alone, make a complete turn of the rope around the crossarm or other fixture to provide some snubbing action in lowering the victim. See figure 8-3.

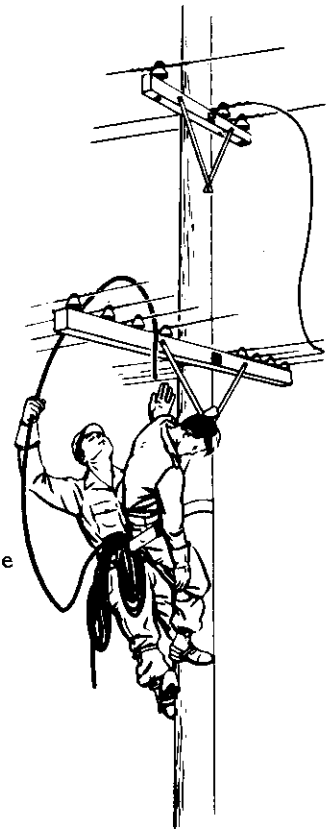


Figure 8-2
Rescue from a Pole --
Rope over Crossarm

2. When it can be done easily, double the end of the rope back on itself, and place the doubled rope around the victim's body under the arms. Tie it either at the front or back of the victim with a bowline knot. Do not take time to double the rope if it will delay the rescue. If it is necessary to move the victim to attach the rope, move him by means of his safety strap.

3. If it will make the rescue easier, pass the rope through the D rings of the victim's body belt, and depending on the case, tie the rope securely at the victim's chest or back. When the rope is attached through the D rings, exercise care in handling the victim to avoid having the belt slip over his shoulders or down over his hips, allowing him to fall.

4. After the rope has been attached to the victim, pull him toward the pole by means of the rope, or both the rope and the safety strap. See figure 8-4.

5. When lowering preparations have been completed, unsnap or cut the victim's safety strap and lower him to the ground, guiding when necessary to clear any obstacles.

6. As soon as the victim has been lowered, apply first aid.

WARNING

If the victim has stopped breathing, start artificial respiration immediately. Apply other first aid treatment after breathing has started. An assistant may be able to apply some first aid during artificial respiration, but only if it does not interfere.

POLE-TOP ARTIFICIAL RESPIRATION (ARM LIFT METHOD)

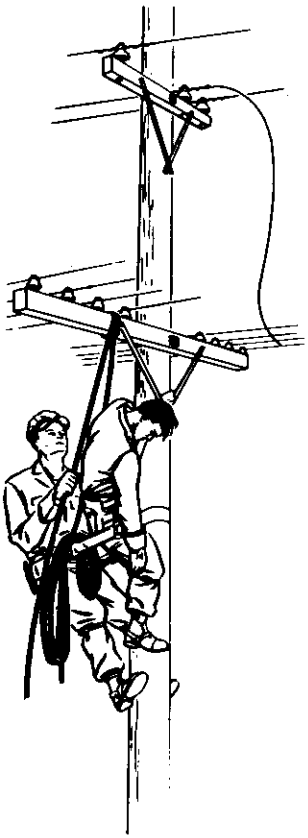


Figure 8-3
Rescue from a Pole --
Providing Snubbing Action

Where possible, a person of at least equal height and weight should apply artificial respiration, proceed as follows:

1. Reach the victim as quickly as possible and clear him of contact. Remove any tools or equipment which may be in your way from the victim's body belt. Since it is impractical to change operators on the pole, care should be taken to conserve energy while climbing the pole.

2. When the victim is hanging in his safety belt, secure your safety strap around the pole below the victim and work upward, placing the victim astride your safety belt between you and the pole, as shown in figure 8-5. Place your hands around the victim's waist with fingers together and thumbs below the lower ribs. Have the hands overlap slightly, as shown in figure 8-5.

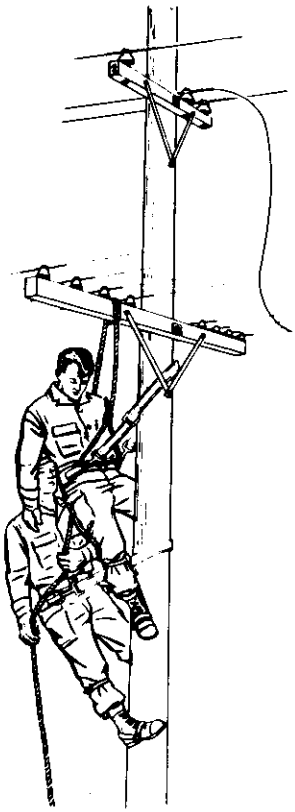


Figure 8-4
Rescue from a Pole --
Rope Passed through D Ring
of Victim's Body Belt

3. Compress the victim's abdomen while rocking the shoulders and upper body backward. Use steady, even pressure as shown in figure 8-6.

4. When firm resistance is felt in the abdomen, release the pressure gradually while rocking back to the starting position.

5. Move the arms upward and hook the elbows under the victim's armpits, as shown in figure 8-7.

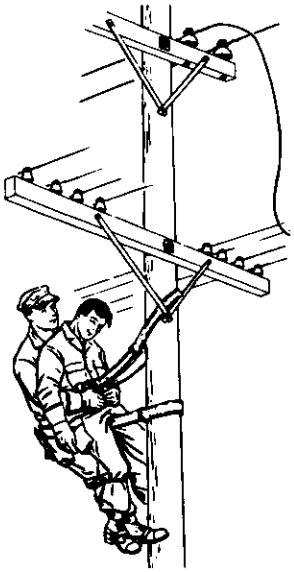


Figure 8-5 Lift Method of Artificial Respiration -- Initial Position

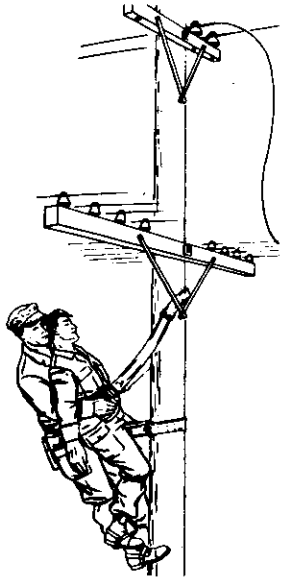


Figure 8-6 Arm Lift Method of Artificial Respiration -- Pressing the Victim's Abdomen

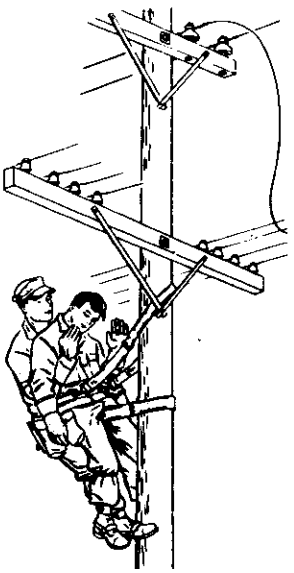


Figure 8-7 Arm Lift Method of Artificial Respiration -- Under the Victim's Armpits

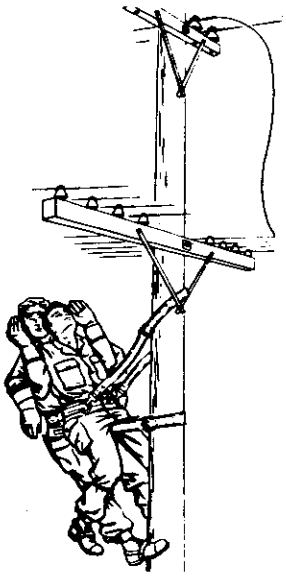


Figure 8-8 Arm Lift Method of Artificial Respiration - Final Position

WARNING

If obstructions prevent raising the victim's arms, continue respiration by repeating the abdomen compression phase described in steps 2 through 4.

6. Raise the arms upward while rocking backward from the hips until firm resistance is felt from the victim's shoulders, as shown in figure 8-8. Do not raise the victim's arms above shoulder height.

7. Rock forward to the starting position while lowering the arms.

8. Repeat the cycle at the rate of 10 to 12 times a minute.

THE CREW'S EQUIPMENT AND TOOLS

Probably one of the best ways to downgrade yourself with your crew members is to start a job with insufficient tools and materials. Neither will this practice cause your standing with your supervisor to skyrocket. Obviously, such practice hinders job progress, leads to sloppy work, and demoralizes the crew members. Complete and thorough job planning is of course the answer to this problem.

A more difficult problem sometime encountered by the crew leader is care of the crew's tools. Like safety practice, the care of hand tools and climbing equipment requires continuous attention. The expense involved in replacing tools that have become unusable due to lack of care is negligible. However, the slow down in job production and the lost time accidents that result from defective tools can become a great expense. This problem is best overcome by frequent and careful tool inspections and by training your

men in the correct methods of tool care. It is particularly important that climbing equipment be properly cared for. Body belts and safety straps, for example, should be frequently cleaned with saddle soap and oiled with Neat's Foot Oil. This prevents the leather from drying out and cracking. Never allow your crew members to store their body belts and safety straps with the climbers or other edged tools such as screw drivers, chisels, knives, etc. When inspecting climbers check the gaffs with a gaff gage. During the inspection of hand tools, look for nicks and check for proper shape and bevel of bladed tools such as screw drivers, chisels and knives. Tools with splintered or rough handles should be replaced. Loose hammer heads, sprung wrenches, and dull bits should be replaced or repaired. You do not have to be an expert on tools to recognize one that needs replacing or repairing. Sound judgment and common sense will do the job.

QUALITIES OF A GOOD LEADER

Up to this point the more important duties of the crew leader have been discussed. Now that we know the duties, we might ask how they are accomplished. Obviously, the crew leader needs help - he must get his men to work with him. To succeed in this, the desire to accomplish the mission or job must be created and developed in the men. This process of influencing other men to accomplish some particular objective is called leadership.

Contrary to the popular belief that all good leaders are born with this particular ability, leadership is an art that may be developed through learning, practice, patience, and persistence. There are no hard and fast rules or formulas that you can study which will fit every situation. This is true because you are dealing with men and their personalities differ. In other words, all men do not respond in the same way to the same treatment. Therefore, to be a good leader it is necessary to study the men in your crew to determine their reactions to different situations and types of treatment. Look into their backgrounds; learn their attitudes, beliefs, and habits.

One quality that a good leader must develop is integrity of character. This means that in dealing with your men you are perfectly honest. Your word is completely trustworthy. The ability to assume responsibilities is another important factor in leadership. You should be able to voluntarily accept responsibilities without outside pressure from your supervisor or crew; and having accepted the responsibility, you should act on it promptly.

It is necessary to develop a sense of unity within your crew. Make each man feel that he is essential to the crew. Endeavor to make your crew, not yourself, outstanding. You will find that you must work to build a crew with high morale. As you know, there are many outside factors that influence morale. However, the manner in which a crew leader conducts himself in relationship to his crew members contributes heavily to crew morale. We might say that morale is the combined effect of all of your actions in relation to the men in the crew.

Some of the leadership traits listed as most desirable by Air Force supervisors are here outlined. Check yourself against this list and try to improve your practice of any in which you may recognize a weakness.

1. A leader understands his men as individuals in spite of their previous schooling, experience, age, religion, race, or lodge.

2. A leader can, when necessary, tell a man what's coming to him without losing his temper.

3. A leader is not afraid of his position, his own boss, the instructors, any tough jobs in the offing, or honest mistakes, theirs or his.

4. A leader is easy to approach and to get away from.

5. A leader is a man you can't fool, though he may have the facility of looking away at the right time.

6. A leader knows almost all the answers, and he'll admit it when he doesn't know an answer. He should, however, know where to get the answers that he doesn't know.

7. A leader can show a man how to do a job without showing off or showing up the employee.

8. A leader is predictable.

9. A leader is honest enough that he can see through subterfuge of any kind.

10. A leader identifies himself with his men to the point that he will fight for them.

11. A leader gets a "kick" out of his work and is able to project his enthusiasm.

12. A leader believes that his work is important, If he is not sold on it, he gets out fast.

13. A leader will always listen to something important, but "remembers" an appointment when he hears drivel.

14. A leader gives the impression of trying to work himself out of his job and of trying to work his men into it.

15. A leader "gets around" but doesn't gossip.

16. A leader respects another man's pride and integrity as much as his own.

17. A leader knows the limits of his authority.

18. A leader wants his men to succeed and is personally proud when they do.

SUMMARY

This chapter has discussed some of the more important duties of the crew leader as well as the personal qualities and traits required of any good leader. No matter how proficient you become in the technical requirements of the telephone installer repairman job, you must also develop the qualities of a good leader.

Knowing and understanding what qualities are necessary in a crew leader is not enough; you must practice the actions that reflect these qualities until such actions become habit. If you are honest and fair with your crew and conscientious concerning your duties and obligations to the Air Force and your section, the men you work with will be quick to respect you. Once you gain their respect it is a simple matter to be a crew leader.

Crew training is one important part of the crew leader's job. To develop his crew, he must exercise ingenuity, imagination, and practice solid training concepts. It is particularly important for the crew's welfare that the leader carries out a continuous safety program. The Air Force has prepared many worth while publications on the subjects of leadership and safety. Such publications may be obtained from your base library. Study them and you will be a better leader for your effort.

REFERENCES

TO 31W3-1-13	Telephone Outside Plant Construction
AFM 35-15	Air Force Leadership
ATRC Manual 50-900-8	A Prescription For the Supervisor

REVIEW QUESTIONS

1. List and explain the qualities necessary for good leadership.
2. What factors should a crew leader consider when assigning crew members to a particular job?
3. Comparing your actions in relation to other members of the crew and the list of desired leadership traits listed in this chapter, make a list of those traits that you need to improve.
4. Name four elements necessary to training.

WORK PROBLEMS

Problem 1. Unsafe conditions

Training Equipment: None

References: TO 31W3-1-13

Work Procedures: List all unsafe or potentially unsafe conditions in relation to outside plant equipment in an area designated by your supervisor.

Problem 2. Care of tools and climbing equipment

Training Equipment: Hand tools and climbing equipment

References: TO 31W3-1-13

Work Procedures: Inspect tools and climbing equipment designated by your supervisor for all defects. Make recommendations to your supervisor for the repair or replacement of defective equipment.

Problem 3. Crew Training

Training Equipment: None

References: TO 31W3-1-13

Work Procedures: Develop and outline five different projects that may be used in the safety training program on your base. Submit completed projects to your supervisor.

* U. S. GOVERNMENT PRINTING OFFICE : 1959 O—491314