GENERAL MAINTENANCE OF P-A-X's

Technical bulletin 565

AUTOMATIC ELECTRIC
GENERAL SYSTEM
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

Factory, development laboratories, and general office at Northlake, Illinois, U.S.A.

AUTOMATIC ELECTRIC COMPANY is an organization of designing, engineering, and manufacturing specialists in the fields of communication, electrical control, and allied arts. For more than sixty years the company has been known throughout the world as the originator and parent manufacturer of the Strowger Automatic Telephone System. Today Strowger-type equipment serves over 75% of the world's automatic telephones. The same experience and technique that have grown out of the work of Automatic Electric engineers in the field of telephone communication are also being successfully applied on an ever-increasing scale to the solution of electrical control problems in business and industry.

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Strowger Automatic Telephone Systems—Complete automatic central-office equipment for exchange areas of any size, from small towns to the largest metropolitan networks.

Community Automatic Exchanges—Unattended automatic units for small rural or suburban areas, with facilities for switching into attended exchanges.

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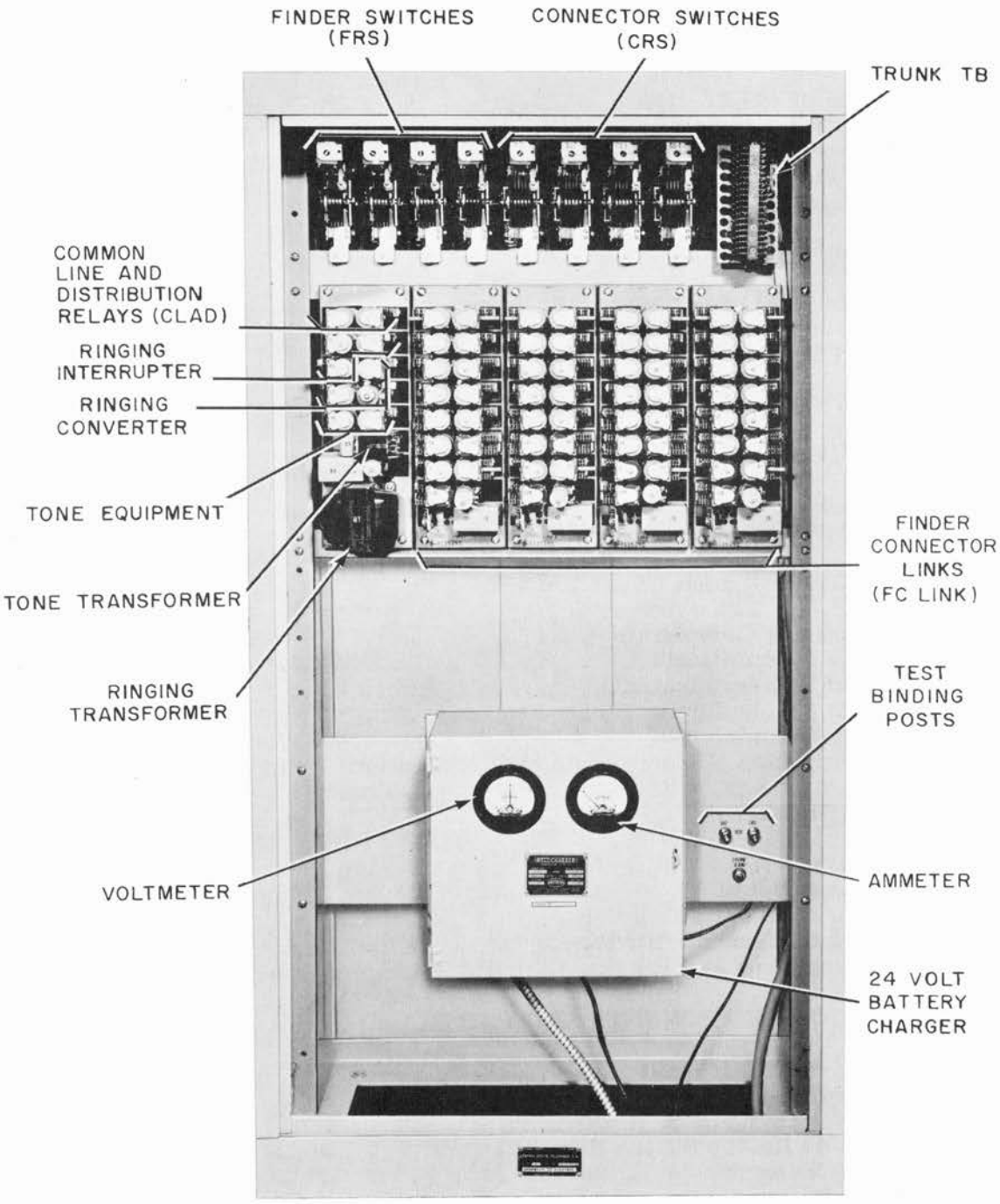


Figure 1. Typical rotary-type P-A-X.

GENERAL MAINTENANCE OF P-A-X's

1. INTRODUCTION

All Private Automatic Exchanges (P-A-X) manufactured by Automatic Electric Company are ruggedly constructed (figure 1), designed for long use, and require very little attention. A small amount of maintenance is required at regular intervals to forestall possible service interruptions. Minor defects can be detected and corrected before they develop into a service complaint. This publication is directed primarily toward personnel who maintain the rotary switch and relay switching components of the P-A-X.

1.1 Scope of Publication

This publication includes maintenance instructions for all components of all P-A-X's. Instructions for cleaning, adjusting, removing, and repairing relays and rotary switches are applicable to a majority of the components and therefore are given only once. For detailed theory of operation of your P-A-X, refer to the technical bulletin supplied with the equipment.

1.2 P-A-X Equipment

An isolated dial telephone system consists of three distinct components as shown on figure 2.

a. The first component is the station equipment which is designated as the "A" equipment.

b. The second component is the P-A-X equipment which is designated as the "B" equipment.

c. The third component is the building wiring which is designated as the "C" equipment.

1.3 Station Equipment

The telephone, designated as the "A" equipment in figure 2, is represented in figure 3.

With the handset on its cradle, the hookswitch places the ringer and its associated capacitor in series across the line, or from one side of the line to ground when party line service is required. The capacitor blocks the flow of the d-c switchboard battery in the ringer coils to prevent a shorted or "permanent" line. However, the P-A-X ringing converter supplies a 20-cycle signaling source which flows through the capacitor to operate the station ringer and signal the called party. This ringing current is supplied over the (+) side of the line, through the ringer coils and capacitor, to either ground at the instrument or back over the (-) side of the line to the P-A-X (-) battery and ground through the ringing relay. Removal of the handset causes the hookswitch to open the ringer circuit, and the ringing cut-off relay of the P-A-X conversation link operates to stop the ringing.

To make a call, remove the handset. This places the dial pulse springs in series with the

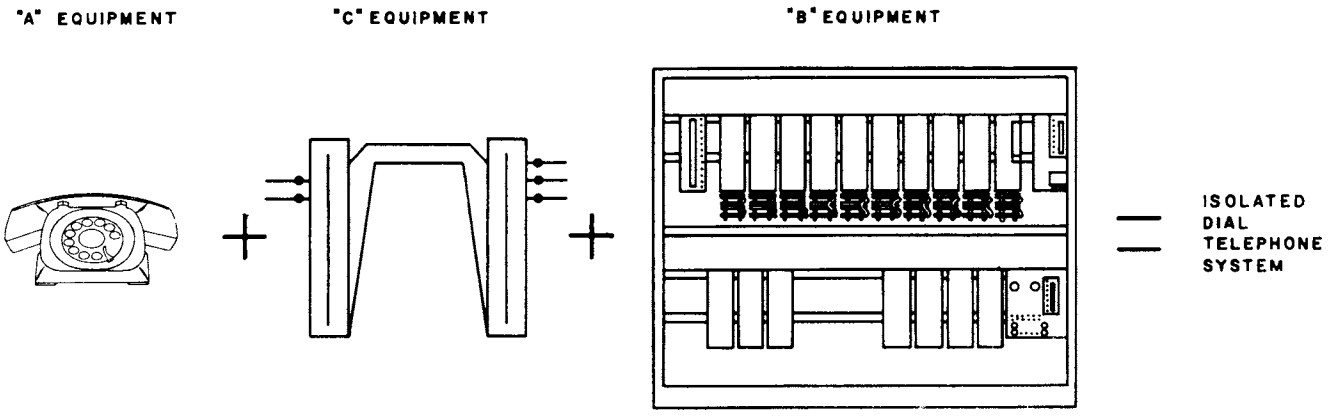


Figure 2. Isolated dial telephone system.

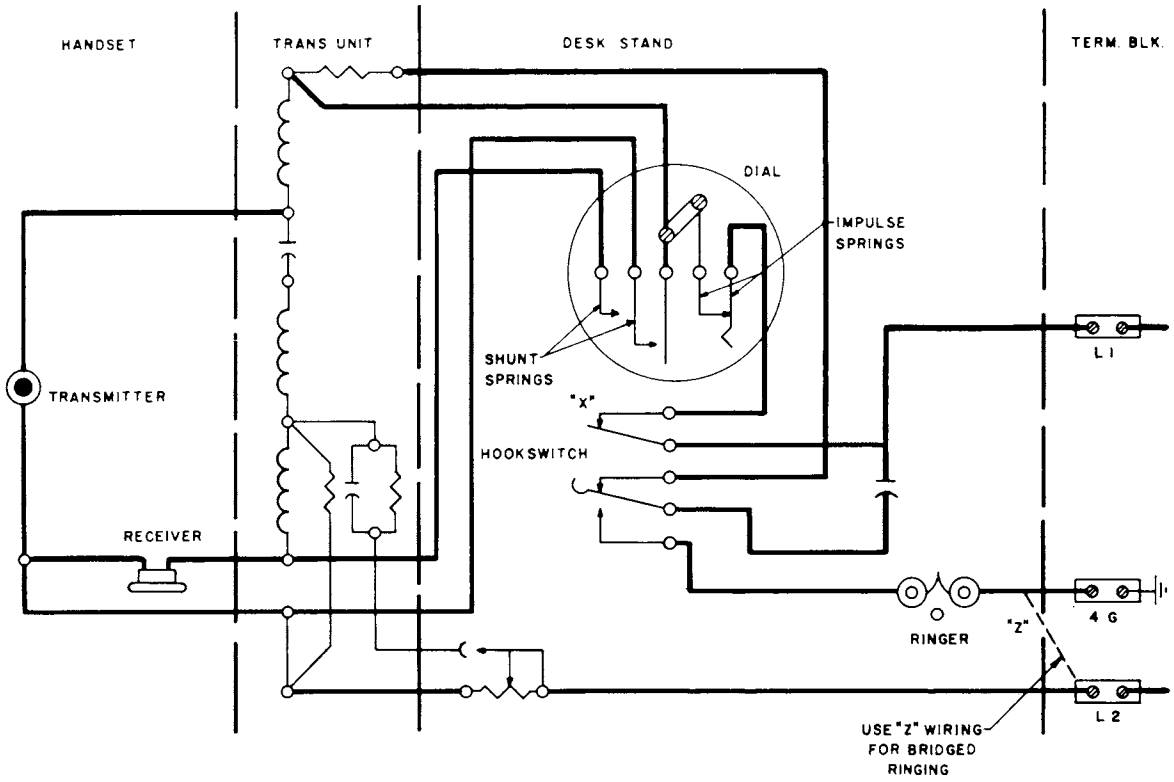


Figure 3. Typical wiring diagram of a telephone set.

transmitter across the line to the P-A-X, completing a d-c loop. The switchboard equipment is seized, dial tone is heard, and the desired number can be dialed. While in its off-normal position, the dial shunting springs will short-circuit the transmitter to prevent dial clicks in the receiver and also to prevent the variable resistance of the transmitter from affecting the dial pulses.

The dial pulse springs interrupt the circuit to the P-A-X a number of times equal to the digit dialed to select the desired party. The equipment is released when the handset is restored. This is the general operation of the telephone. A detailed wiring diagram is located inside the assembly and, with it, each wire can be traced and identified. No special tools are required for repair except a screwdriver and a pair of dial pliers.

1.4 The P-A-X

The P-A-X designated the "B" equipment in figure 2, consists of the following three interrelated components to form a switchboard (see figure 4).

1.4.1 The individual line equipment.

This group of identical units, required for each telephone line, consists of line relays. The two wires from each telephone terminate in the switchboard at a line relay. When a subscriber closes the circuit to the line relay by lifting his handset, the relay operates and starts the linefinder hunting for an idle connector. In some P-A-X's, a lineswitch is used in place of a line relay and linefinder. In this instance, the subscriber lifts his handset and closes the circuit to a lineswitch. The lineswitch operates automatically and connects the calling line to an idle connector trunk. A lineswitch is required for each station. The functions of a lineswitch are:

a. To extend the line through to an idle connector trunk.

b. To busy the line at the connector bank terminals to incoming calls immediately upon operation of the lineswitch relay.

c. To restore itself to normal when the connector is released.

The type 27 plunger lineswitch used in some P-A-X's consists of a line relay and an operating coil which activates an armature carrying a plunger. Details of the type 27 lineswitch are fully described in bulletin 805, copies of which will be furnished upon request from Automatic Electric Sales Corporation.

1.4.2 Conversation links.

The conversation links consist of linefinders and connectors. The number of each depends

on the size of the P-A-X. The linefinder and its associated connector form a linefinder-connector link (conversation path).

a. The linefinder. Some P-A-X's use a rotary type linefinder while others use a Strowger type. When a linefinder is seized, it hunts for and connects an idle connector to the calling party line. At this point, circuit operation causes the distributor switch to advance its wipers ahead to the next idle link. The mechanical components of a Strowger linefinder include a shaft, and a ratchet mechanism for raising and rotating the shaft. Its electrical components include control relays, vertical and rotary stepping magnets, and a magnet which releases the ratchet mechanism.

b. The connector. Under guidance of the calling party, the connector functions as an operator via the telephone dial. Connectors used in P-A-X's are the Strowger type and in some cases the rotary switch type. The Strowger type connector's mechanical components include a shaft, a ratchet mechanism for raising and rotating the shaft, and two sets of wipers (termed the line and control wipers). Its electrical components include several control relays, vertical and rotary stepping magnets, and a magnet which releases the ratchet mechanism. The bank contacts at the bottom of the connector are the terminals of the telephone lines which the connector serves. Each contact is multipled to each connector bank so that all connectors can have access to any of the telephone lines. In response to dial pulses, the connector raises its wipers to the dialed level and across to the dialed level contact which is the called party's line. When the connector is released, the switch shaft is restored to its normal position. The connector functions are:

(1) Upon seizure, to hold equipment behind and busy out the calling party's line.

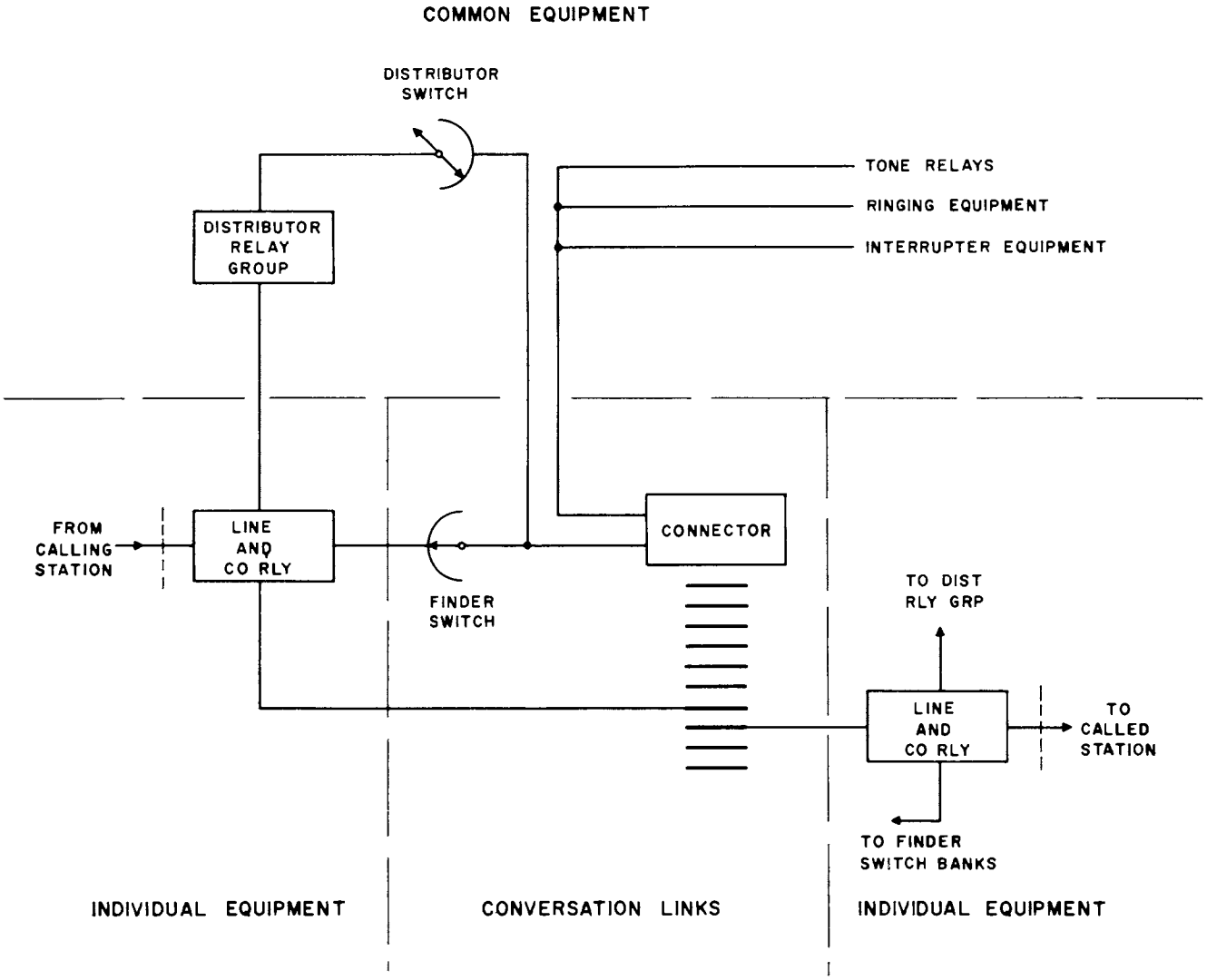


Figure 4. Schematic of a dial system.

(2) To start and stop the switchboard common equipment as required.

(3) To return a busy tone to the calling party when the dialed line is busy.

(4) To ring the called party's telephone and return ring-back tone to the calling party.

(5) To stop ringing when the called party answers and supply talking battery for both parties.

(6) To release after the calling party has restored his handset.

(7) To prepare the release alarm signal if the mechanism fails to restore properly.

1.4.3 Common equipment.

a. Distributor group. The distributor group is a switch consisting of control relays for the linefinders and a rotary switch. The distributor switch preselects and assigns dialing links successively to incoming calls. Only one distributor switch is needed. After a previously assigned link has been seized, it immediately allots the next idle link for another incoming call. The distributor switch passes over bank contacts of busy links. When all links are in use, the distributor switch rotates to its home position ready to advance immediately to the bank contacts of the first link to become idle.

b. Master switch. When a plunger type lineswitch is used in place of line relays and linefinders, the common equipment consists of a master switch instead of the distributor group. The position of the plungers of each group of lineswitches is controlled by a mechanism termed a master switch. The control is through the movement of the plunger guide shaft. The prime function of the control is to keep the plunger of all idle lineswitches resting opposite the bank contacts of an idle trunk. Each time a trunk is engaged, the master switch immediately moves all the remaining idle lineswitch plungers to a position opposite an idle trunk. The plunger type lineswitch is thus preselecting in operation; that is, the idle trunk is selected prior to a call.

c. Ringing converter. A portion of the P-A-X power supply is converted into an a-c source for operating the telephone ringers via the connectors.

d. Ringing interrupters. An a-c source is interrupted and delivered to the connectors for ringing the called telephone lines.

e. The tone relay and interrupter. A portion of the P-A-X power supply is converted into a steady dial tone or interrupted busy tone and is supplied to the calling party via the connector as required.

f. Supervisory alarm equipment. The signal lamps and associated relays of the P-A-X supervisory alarm system are found on the individual apparatus shelves which they supervise. A buzzer provides a general alarm to all shelf units. The supervisory alarm equipment operates as follows:

(1) Power-supply shelf. A glowing red lamp indicates a blown fuse. A glowing white lamp indicates the failure of the charging equipment to deliver current to the storage battery (if any) when the charge control relay operates.

(2) Lineswitch shelf. A glowing red lamp indicates a blown fuse. A glowing white lamp indicates that all lineswitch trunk outlets are busy.

(3) Connector shelf. A glowing red lamp indicates a blown fuse. A glowing green lamp indicates the failure of a connector to release.

g. The power control panel. The power control panel ordinarily includes a voltmeter for determining the potential of the power supply, an ammeter for determining the load on the switchboard, a charge and discharge fuse, and a number of alarm fuses.

h. Power supply. Normally a battery eliminator is used and is supplied with the P-A-X when specified. This apparatus draws alternating current from a standard 110 volt a-c outlet (or from a 220 volt, a-c outlet) and converts it to direct current. In some cases, a battery is used (dry cells or wet cells). When wet cells are used, a battery charger should be used with the battery and is supplied when specified.

1.5 Building Wiring

The building wiring, designated as the "C" equipment of figure 2, consists of all facilities used to connect the station equipment to the P-A-X. This portion of the telephone system, that is any electrical circuit, should be kept dry.

2. TOOLS AND TEST MATERIAL

This section lists the tools and materials required for maintaining a P-A-X. The manufacturer's part number is stamped on most of the tools to help identification. Technical bulletin 540 lists all maintenance tools and contains tool illustrations which are referenced below.

2.1 Tools

The tools generally required to properly maintain P-A-X equipment are listed below:

TABLE A: P-A-X EQUIPMENT TOOLS

A. E. Co. Number	Item	Use
H-14768	Armature Adjuster	Relays with short-lever armatures.
H-88502-1	Armature Adjuster	Relays with long-lever armatures.
H-88504-1	Spring Adjuster	Relays with stationary springs.
H-88504-2	Spring Adjuster	Relays with moving springs.
H-882553-1	Contact Cleaner	Cleaning relay contacts.
H-882568-2	Lamp Extractor	Removing switchboard lamps.
H-883114-1	Lamp Cap Extractor	Removing lamp caps.
H-14315-1	Fuse Repair Kit	Repair of alarm-indicating fuses.
H-46795-1	Thickness Gages	Residual screw adjustment.
H-16339-1	Test Lamp	For 48v dc continuity tests.
H-880922-1	Inspection Lamp	Gaging of relay contacts.
H-50619	Long Nose Pliers	General usage.
H-22945	Diagonal Cutting Pliers	General usage.
H-50620	Duckbill Pliers	Rotary switch interrupter and wiper adjusting.
H-16290-7	Dial Pliers	Spring adjusting.
H-21766	Offset Screwdriver	Air gap adjustment.
H-24664	Screwdriver	General usage.
H-7062	Open-end Wrench	Residual screw locknut.
H-7063	Open-end Wrench	For adjusting rotary switches.
TL-117	Soldering Iron	General usage.
H-56628-4	Cleaning Tool	Rotary switch banks.
H-16590-1	Cleaning Tool	Strowger switch banks.
H-26917	Dial Escutcheon Tool	Dial disassembly.
H-74573-1	Ground Cord	Verifying open d-c circuits.

2.2 Maintenance Materials

The most commonly used maintenance materials required for general maintenance of a P-A-X are as follows:

TABLE B: P-A-X MAINTENANCE MATERIALS

A. E. Co. Number	Item	Use
H-880843-1	No. 4 Sable Brush	Lubrication.
———	1/2" Camel's Hair Brush	Relay dusting.
———	Cheesecloth	Cleaning exterior
D-542539-B	Oiled Sleeving	Switch bank cleaning
———	Orange Stick	General.
	Solder	General repair.
———	Tape, TL-83, 3/4"	General taping.
———	Twine 8 and 11 Play	Cable repair.
H-88844-1	Bank Cleaning Brush	Strowger switch banks.

2.3 Hand Test Telephone

The basic hand test telephone designed for station repairmen is the A. E. Co. No. L-965. The L-965-A2 (figure 5) hand test telephone is the basic L-965 with a test cord and two test clips attached that can be snapped onto line wires, terminal screws, and ground connections (such as a cable-terminal box), etc. The L-965-A0 hand test telephone is equipped with a test plug which can be inserted into Strowger switch test jacks.

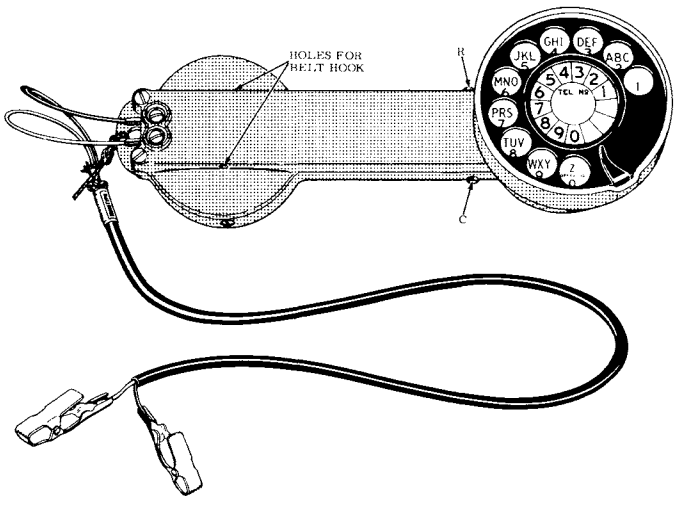


Figure 5. Hand test telephone.

3. LUBRICATION

The purpose of lubrication is to provide a film of lubricant between fixed and moving or two moving surfaces to reduce friction and wear. Avoid excessive lubrication, since too much lubricant can be just as harmful as not enough. Remove any excess lubricant by wiping. All components that require periodic lubrication are listed in technical bulletin 505.

4. PREVENTIVE MAINTENANCE

Preventive maintenance consists of a series of routine inspections which provides insurance against operational failures and major repairs. These routine inspections are a systematic series of operations performed on equipment at regular intervals. They are designed to eliminate major breakdowns and unwanted interruptions in service and to keep the equipment operating at top efficiency. The inportance of preventive maintenance cannot be overemphasized. Preventive maintenance differs from repair in that it is intended to prevent breakdowns, and therefore, eliminate the need for repair. On the other hand, the prime purpose for trouble shooting and repair is to locate and correct existing faults.

4.1 Maintenance Procedures

Most of the electrical and mechanical parts used in P-A-X systems (equipment) require routine maintenance, but differ in the amount and kind required. The age of the equipment and the conditions under which it must operate govern the frequency of maintenance tests and inspections. An accurate fault statistics file will show whether preventive maintenance is applied properly. A person performing maintenance on P-A-X equipment should become thoroughly familiar with the indications of normal functioning so that he can recognize the first signs of defective equipment. To detect minor defects and signs of worn, damaged, or corroded parts which may later cause trouble, a visual periodic inspection should be made. Although these minor defects may not have interfered with the performance of the equipment, correcting them before they lead to major breakdowns saves valuable time and effort. Periodic inspection consists of observing all parts of the equipment during operation. It is advisable to inspect for the following conditions:

a. Overheating. Look for discoloration, blistering, or bulging of the parts or surfaces of a cover, leakage of insulating compound, and oxidation of metal contact surfaces.

b. Placement. See that leads and cabling are in their original positions, that insulation has not become damaged, and that soldered connections are in good condition.

c. Cleanliness. Examine carefully all recesses in the unit for accumulation of dust, especially between the connecting terminals. Parts, connections, and joints should be free of dust and other foreign matter.

d. Tightness. Any connection or mounting that appears to be loose should be checked. Screws, nuts, and bolts should not be tightened carelessly (fittings tightened beyond the pressure for which they are designed will be damaged or broken). Do not confuse the adjusting screws with mounting screws. Perform cleaning operations carefully, in order not to damage the equipment or change its adjustment.

e. Lubrication. Observe the amount of lubricant on all moving parts requiring lubrication.

4.2 Performing Preventive Maintenance

4.2.1 Inspection.

Inspect all units regularly to prevent needless interruptions in service.

Check:

a. Relay coils and rotary switch coils for discoloration, blistering, and bulging.

b. Transformer and choke coils for discoloration, blistering, and bulging.

c. Contacts for oxidation, pitting, dirt, dust, and lint. In high humidity locations, look for fungus growth and mildew.

d. Covers, cables, leads, and individual parts to see that they are in their original positions, securely fastened, and are not frayed or broken.

4.2.2 General office care.

a. Keep dirt, dust, and moisture out of the P-A-X room. Dust and dirt cause excessive equipment failures, since it eventually filters into the working parts. Moisture and humidity also cause equipment failures through rust and corrosion of metal parts, or electrolysis and insulation leakage in electrical apparatus. Keep all parts of the room as clean as possible. Linoleum or similar floor covering is desirable. Keep it lightly waxed and clean it at regular intervals with a mop dampened lightly with water. For rooms without floor covering, use a push broom and sweeping compound. Remove accumulated dust and

dirt from the equipment with a clean, lint-free cloth. Use a camel's hair brush to remove dust from relays or switch assemblies where space is limited.

b. Ventilation. Outside air drawn into the P-A-X room must be passed through filters. Only filtered, dust-free air should be circulated in the room. Seal all windows, unnecessary doors or other openings to prevent entrance of dirt-bearing, unfiltered air. Inspect the air filters frequently. The use of air conditioning eliminates the need for outside ventilation.

c. Humidity. When high humidity prevails, the equipment must be protected from moisture damage. Relative humidity, an expression for the moisture content of the air, is the ratio of moisture actually present in a given volume of air compared to the maximum which the air can evaporate and hold. Heating the air increases its capacity to evaporate and hold moisture and, therefore, reduces the relative humidity. When air cools, its capacity to hold moisture is reduced, causing its relative humidity to rise. If warm moist air comes in contact with cold equipment, the sudden cooling causes it to deposit its moisture in the form of dew. To avoid moisture troubles, keep the relative humidity below 60% and never above 70%. Use hygrometers, one indoors and one outdoors, to provide accurate readings of humidity conditions.

d. Air conditioning. A unit type air conditioner, using a refrigerated cooling system, provides the most effective protection against high humidity. Air from the P-A-X room is circulated over the cooling coils, giving up its moisture, and is returned to the room through a dust filter. The resultant dry, dust-free, and cooled air insures the best equipment performance. For the very small P-A-X's, there is available a unit type chemical dehumidifier which will reduce the content of moisture in the air without the use of a refrigerated cooling system.

e. Battery. Wipe the battery jars, connections and surrounding parts with a dry cloth. If the terminals or connections are corroded, scrape clean, wash them with soda solution (one pound of bicarbonate of soda to a gallon of water), dry, and coat them with a thin layer of vaseline. Add distilled water to the batteries as required to maintain the proper electrolyte level within the cells. See the manufacturer's literature for complete details of battery care.

f. Relay contacts. Clean dirty relay contacts with a fast drying fluid, such as alcohol or chlorothene, before being polished. Carbon tetrachloride is not recommended. Clean the contacts with contact cleaning tool H-882553-1 or a similar cleaner. Never use a rough-surfaced object for contact cleaning as it will remove contact material. Do not use cloth or paper as a substitute for the contact cleaner, since both have insulating lint on the contact surface. Clean or polish the contacts by holding adjacent contacts together and running the cleaner between them several times.

g. Rotary switch contacts. Rotary switch bank contacts are designed so as not to require any lubrication or cleaning for the life of the switch. In the event that it becomes necessary to replace a wiper assembly, the bank contacts should be cleaned as a preventive measure before replacing the assembly. Use bank cleaning tool H-56628-4 with an oiled sleeving. Rotate the tool between the rows of the bank contacts. Clean the outside of the two outside rows by gently pressing the tool toward the center of the bank while rotating the tool. After cleaning, lubricate the wiper tips.

h. Cleaning and oiling of Strowger switches. Busy out the link associated with the connector during cleaning or oiling. Clean and oil the bearings, shaft, and the vertical and rotary teeth at least once a year. Use lubricating material supplied with the installation. Clean the release magnet coil core and armature. Brush off the connector bank contacts with bank cleaning brush H-88844-1 or 2. Clean and oil Strowger switches once a year with cleaning tools H-16590-1 or 2 and the oiled webbing supplied with the P-A-X. Do not damage the bank insulators and switch wipers. Keep bank collars in place and bank nuts tight. The banks must not drop down on their bank rods.

4.2.3 The building wiring.

The following is a list of suggested wire maintenance practices.

a. Do not make temporary repairs. Replace defective material.

b. Terminal box connections must be tight. Wire insulation should be brought up to the terminal lug to prevent shorts with an adjacent wire.

c. Label terminal box strips to identify the circuit contained therein. Note changes so others can find the trouble.

d. Splices should be made and taped carefully. Poorly made splices cause trouble. Avoid splicing building wires placed in conduit runs.

e. Spare pairs should be included in conduit runs to facilitate additions or replacements in the existing system.

f. Protect the exposed sections against damage, especially at the instrument terminal block.

g. Leave enough slack at each end of a twisted wire pair to eliminate the need for splicing when the telephone is relocated.

4.2.4 Telephone maintenance.

Telephones receive hard use and should be checked once a year. When possible, replace the regular telephone with a spare telephone, clean the entire unit, and replace defective parts. Replacing telephones for a bench check is good preventive maintenance.

a. The dial. Faulty dials cause two complaints: one from the party using it and one from the party wrongly signaled. Dials must operate properly at all times. Although they give no trouble from normal usage, they can become dry and "sticky," requiring cleaning, oiling, and minor adjustments. Dial maintenance procedures are outlined below. Consult technical bulletin 527 or standard adjustment sheet 805 for further information.

(1) Remove the dial from the telephone. Remove the escutcheon ring, finger plate, and number plate.

(2) Clean the spring contacts with fast-drying liquid, such as chlorothene.

(3) Remove the accumulated lint from the gear teeth.

(4) Oil the parts as suggested in technical bulletin 527 or standard adjustment sheet 805, using the oil supplied with installation. A sluggish governor should be disassembled and its bearings oiled. It is not recommended that this be done in the field. If necessary, be sure the governor-bearing screw is adjusted and locked in a position that eliminates excessive end play without bind.

(5) Reassemble and test. Adjust the governor to obtain the correct speed of 10 pulses per second. In other words, the dial should restore in approximately one second if the number "0" has been dialed. A corrected dial may be used as a comparison.

(6) Clean and adjust the shunt and pulse springs (see figure 3). To clean, use the contact cleaner H-882553-1, and to adjust use the dial pliers H-16290-7. Shunt springs are closed while the dial is off normal. The cam does not open the pulse springs until its final half revolution.

b. The ringer. Check for loose parts. Adjust the gongs to improve tone. See that the bias spring is in place. Check for loose or shorted connections.

c. The hookswitch. Clean and oil for smooth operation. Clean the spring contacts with cleaner H-882553-1. A "sticky" hookswitch delays answering and initiating calls. Poor contact pressure causes noisy conversation. Check and adjust the springs during routine inspections. NOTE: The springs marked "X" on the wiring diagram (figure 3) should be adjusted to open first and close last to prevent clicks in the receiver when the hookswitch is operated. Replace other telephone components if defective.

5. STATION SUBSCRIBER COMPLAINTS

5.1 Classes of Complaints

Classification of station subscriber complaints is the first step in correcting trouble. Complaints can be divided into four groups.

5.1.1 Class 1 complaints.

a. Description: Those reported by or affecting only one station.

b. Example: Station 6 in figure 6. Cannot receive calls; cannot initiate calls; gets wrong number, etc.

c. Analysis: The fault is within that position of the system set aside for the exclusive use of station 6. No portion that is set aside for other stations or commonly used by all stations need be considered.

5.1.2 Class 2 complaints.

a. Description: Those reported by or affecting all stations within a particular area of the organization's plant.

b. Example: Stations 7, 8, and 9 of figure 6. Noisy conversations and cannot seize the P-A-X equipment.

c. Analysis: The fault is within that portion of the system used by only these three

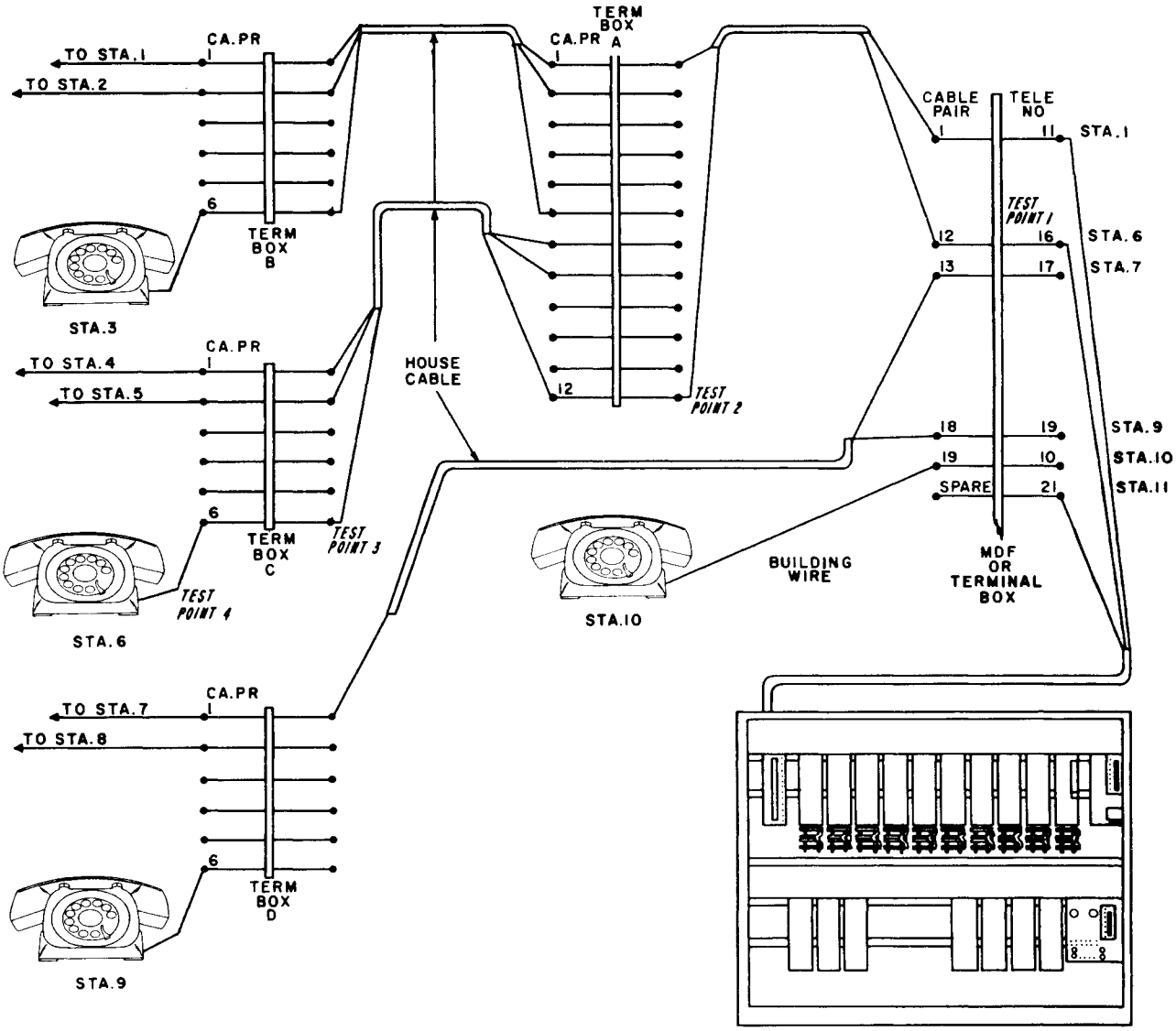


Figure 6. Schematic diagram of a key telephone system.

stations. No portion that is used by other stations or commonly used by all stations need be considered.

5.1.3 Class 3 complaints.

a. Description: Those reported by and affecting all stations part of the time.

b. Example: All 10 stations of figure 6 report that at times the called party cannot be signaled; at times no dial tone is received, at times no busy tone is received.

c. Analysis: The fault lies within that portion of the system that is used by all stations. However, since the trouble is not present all of the time, it is probably caused by equipment used only part of the time.

5.1.4 Class 4 complaints.

a. Description: Those reported by and affecting all stations all of the time.

b. Example: All 10 stations of figure 6. No dial tone is received; no station bells can be rung, no busy tone received.

c. Analysis: The fault is within that portion of the system used by all stations; it is caused by equipment used at all times.

5.2 Class 1 Complaints

This type of complaint is caused by trouble that is located within any one of the three dial systems' components. According to section 5.1.1, this could be the complaining party's telephone, his pair of building wiring, or his line relay equipment in the switchboard.

Testing procedure: The instrument's terminal block and all building and main terminal boxes are used as test points. Here, the system's components and sections of the "C" component may be separated and individually tested.

Step 1. Separate the complaining party's individual P-A-X equipment (line relay) from his other individual equipment at the main terminal box or test point 1 (see figure 6). Connect a spare telephone and initiate and receive calls from this point. Satisfactory results eliminate this unit as the source of trouble. Reconnect the original circuit, or correct line relay faults.

Step 2. Disconnect the complaining party's telephone at the instrument terminal block or test point 4. Connect a spare telephone and initiate and receive calls from this point. Since satisfactory results eliminate the building wires as the source of trouble, the telephone itself must be at fault. Correct the fault in the instrument and reconnect the original circuit.

Step 3. When the above mentioned tests fail, proceed as follows: Disconnect the complaining party's building wiring lead at test point 2. Repeat step 1 (above) looking toward the P-A-X from this point. Satisfactory results eliminate this portion of the building wiring lead as the source of trouble. Unsatisfactory results require the repair of this portion of the building lead. Reconnect the original circuit. If necessary, repeat (step 3) above at test point 3 and/or other test points until the defective portion of the building wiring has been isolated. Repair, test, and reconnect the original circuit.

5.3 Class 2 Complaints

This type of complaint is caused by a defect in that portion of the complete system that is used by the complaining stations only. According to section 5.1.2, the defect is within that isolated length of home cable serving these stations.

Testing procedures: Connections at terminal box D and the main terminal box are used as test points. Here, this piece of equipment may be separated from the rest of the system's equipment (see figure 6).

Step 1. Disconnect one end of this cable from the switchboard at the main terminal box. Disconnect the other end of this cable from the telephones at terminal box D.

Step 2. Test the line wires for grounds, and the pairs for shorts with an ohmmeter.

Step 3. Clear grounds and/or shorts in the house cable.

5.4 Class 3 Complaints

This type of complaint is caused by a fault in the equipment that is used by all stations only part of the time. Accordingly, this could be a faulty P-A-X conversation link.

Testing procedure: Each conversation link must be given an operating test.

Step 1. Connect a spare telephone to the line equipment at the main terminal box.

When available, use spare line equipment as represented by station 11 of figure 6.

Step 2. Test the conversation links until the faulty one is located. Its operation under test indicates the cause of the complaint.

Step 3. "Busy out" the conversation link until the defect is corrected.

5.5 Class 4 Complaints

This type of complaint is caused by a defect in some portion of the complete system that is used by all stations for every call. According to section 5.1.4, this is the P-A-X common equipment.

Testing procedure: Common equipment consists of the link distribution and all power and supervisory relays for supplying the tones and ringing current to the conversation links.

Step 1. Check for low voltage supply to the P-A-X and for blown fuses.

Step 2. Connect a spare telephone to the line equipment at the main terminal box. If possible, reserve the line equipment, such as station 11 of figure 6, for testing purposes.

Step 3. Set up calls while observing the operation of various units of the common equipment. Repeat as often as necessary until the faulty portion is located.

Step 4. Correct the difficulty.

5.6 Investigation of Complaints and Correction

Three steps in correcting a station subscriber's complaint are:

a. Classify the complaint.

b. Locate the fault in the system.

c. Correct the fault.

Use sections 5.1 through 5.5 as guides for steps a and b. The balance of this bulletin is devoted to step c. Refer to the complete schematic of your exchange when investigating station subscriber complaints.

5.6.1 The plunger lineswitch.

To investigate a station subscriber's complaint, test the lineswitch operation when checking Class 1 complaints (review sections 5.1 through 5.5). Should a lineswitch need attention, check one of the following:

a. The station subscriber complains that he can receive, but cannot initiate calls.

Proceed as follows:

(1) Test the station's lineswitch by placing the plug of the hand test telephone between relay B springs 3-5.

(2) If relay A does not operate, check the operating circuit of relay A with the use of the test lamp (see section 6.3).

(3) If relay B does not operate, check the operating circuit of relay B with the use of the test lamp (see section 6.3).

(4) Clean the contacts with contact cleaner as explained in section 4.2.2f or adjust the springs per section 8.2 as required.

b. The station subscriber complains that he can initiate, but cannot receive calls. Proceed as follows:

(1) Test the operation of the lineswitch by placing (+) battery on the connector bank lead C, with the use of a ground cord, to cause the small or BCO bridge cut-off armature of relay B of the associated lineswitch to operate. (This is how the lineswitch operates when its station is called.)

(2) If relay B does not operate through its 1200-ohm winding, check it for an open operating circuit with the use of a test lamp connected to (-) battery.

(3) Clean the contacts with contact cleaner or adjust springs as required.

5.6.2 The line relay.

To investigate a station subscriber's complaint, test the line relay operation when checking Class 1 complaints (review sections 5.1.1 and 5.2). Should a line relay need attention, check one of the following:

a. The station subscriber complains that he can receive, but cannot initiate calls. Proceed as follows:

(1) Place the plug of the hand test telephone between line relay L springs 5-7.

(2) If the line relay does not operate, check its operating circuit with the use of a test lamp connected to (-) battery, and proceed contact by contact until the trouble point is located (section 6.3).

(3) Clean contacts, or adjust springs as required (sections 4.2.2f and 8.2).

b. The station subscriber complains that he can receive, but not initiate calls. Proceed as follows:

(1) Test the line relay by placing the plug of the hand test telephone between springs 5-7.

(2) Note that the line relay closes its "X" contacts, but the group relay equipment fails to start.

(3) With the use of the test lamp connected to (-) battery, check the start circuit of the group relay equipment (section 6.3).

(4) Clean contacts, or adjust springs as required (sections 4.2.2f and 8.2).

c. The station subscriber complains that he can initiate, but cannot receive calls. Proceed as follows:

(1) Place (+) battery on the connector bank lead C with a ground cord to operate its associated line relay.

(2) If the line relay does not operate, check for an open lead.

(3) With the ground cord at one end of the lead, place the test lamp connected to (-) battery at the other end. If the lamp does not glow, the lead is open.

(4) Replace the open lead.

5.6.3 The master switch.

To investigate a station subscriber's complaint, test the operation of this switch when checking Class 4 complaints involving the distribution of connector switch trunks (review sections 5.1.4 and 5.5). Should a master switch need attention, check one of the following:

a. The station subscriber complains that he hears interference from other stations during call. Proceed as follows:

(1) Place the plug of the hand test telephone between relay B springs 3-5 of an unused lineswitch and release it several times.

(2) Assume that the master switch does not operate. The lineswitch remains opposite trunk No. 1.

(3) With the aid of a test lamp, check the operating circuit of the solenoid; also check if the trip relay has operated.

(4) Clean the contacts or adjust the springs as required (sections 4.2.2f and 8.2).

b. The station subscriber complains that there is an intermittent all-trunks-busy condition on the P-A-X. Proceed as follows:

(1) Place the plug of the hand test telephone between relay B springs 3-5 of an unused lineswitch and release it several times.

(2) Assume that the master switch skips idle trunks.

(3) Check the release timing of the start relay or locking magnet.

(4) Adjust the residual screw (section 8.3).

5.6.4 The distributor equipment.

To investigate a station subscriber's complaint, test the operation of this equipment when checking Class 4 complaints involving conversation link seizure and selection (review sections 5.1.4 and 5.5). Should this equipment need attention, refer to one of the following:

a. The P-A-X is out of service. No station can initiate calls. Proceed as follows:

(1) Short the test jacks 1-2 of the group relays. This equipment should operate to select and operate the linefinders in sequence until the short is removed.

(2) Assume that this equipment operates, but the linefinder is not seized.

(3) Check for an open start circuit in the linefinder with the aid of a test lamp connected to (-) battery (section 6.3).

(4) Clean the contacts or adjust the springs as required (sections 4.2.2f and 8.2).

b. The P-A-X is out of service. No station can initiate calls.

(1) Place the hand test telephone into test jacks 3-4 of the group relays. This equipment will seize a preselected linefinder-connector link, or a linefinder-selector link, depending on the system your P-A-X uses.

(2) If relay B in the linefinder operates, but it does not step vertical, check for an open VERT (vertical) circuit or an open INT (interrupter) circuit in this equipment.

(3) Checking for an open vertical and interrupter circuit may be done by the use of a test lamp or ground cord (sections 6.3 and 6.4).

(4) Clean the contacts or adjust the springs as required (sections 4.2.2f and 8.2).

5.6.5 The linefinder switch.

To investigate a station subscriber's complaints, test the operation of the linefinders when checking Class 3 complaints involving conversation link seizure and operation (review sections 5.1.3 and 5.4). Before working on a faulty linefinder, it should be busied out. To busy out a linefinder, operate the red lever of the busy key. Should a linefinder need attention, refer to one of the following:

a. The station subscriber complains that at times he waits for dial tone. Test all linefinders by placing the plug of the hand test telephone between test jacks 3-4 of the group relay equipment. This equipment will then seize a preselected linefinder-connector link or linefinder-selector link. Dial tone is heard and calls may be made. By releasing and reseizing this equipment several times, all linefinders may be tested. Proceed as follows:

(1) While testing the linefinders, it is noted that one switch does not find the proper level.

(2) Possible cause: An open test circuit to the vertical bank and wiper.

(3) Clean and oil vertical banks and wiper. Adjust wiper.

(4) While testing the linefinder, it is noted that one switch does not find the proper rotary level contact.

(5) Clean and oil the bank contacts and wiper. Adjust the wiper.

b. The station subscriber complains that at times he waits for dial tone. Test linefinders as in section 5.6.5a above. Proceed as follows:

(1) While testing the linefinders, note that one switch may fail to step vertical.

(2) Check for an open vertical circuit with the use of a test lamp or ground cord (sections 6.3 and 6.4).

(3) Clean the contacts and adjust the springs as required (sections 4.2.2f and 8.2).

c. The station subscriber complains that at times he waits for dial tone. Test linefinders as in section 5.6.5a above. Proceed as follows:

(1) When testing linefinders, it is noted that one switch finds the line but drops its connection; i.e., it does not hold an established connection between the line relay and the next succeeding switch.

(2) Possible cause: An open locking circuit for the switch-through relay of the linefinder.

(3) Test the open circuit with the use of a test lamp or ground cord (sections 6.3 and 6.4).

(4) Clean the contacts and adjust the springs as required (sections 4.2.2f and 8.2).

5.6.6 The selector.

To investigate a station subscriber's complaints, test the operation of this switch when checking Class 3 complaints involving the seizure of conversation links, dial tone, or dialing of the first digit of a station number (sections 5.1.3 and 5.4). The linefinder and selector are considered one unit, since each is wired to the other and a fault in one affects the operation of the other.

a. To test the operation of a selector, place the plug of the hand test telephone between test jacks 1-2; the switch operates. When working on a faulty selector, operate the busy key to busy out the selector. A linefinder-selector link must also be busied out at the linefinder. Busying out only the selector will lock the linefinder and the first line relay to seize it, causing a Class 1 complaint.

b. The station subscriber complains that at times he waits for dial tone.

(1) Test all the linefinder-selector links per sections 5.6.5a and 5.6.6a above.

(2) Indication of trouble: A particular linefinder finds and seizes the line, but immediately drops its associated selector. A second linefinder is seized and dial tone is heard.

(3) Look for a fault in the linefinder. Assume that not the linefinder but the selector is at fault.

(4) Test the faulty selector per section 5.6.6a above.

(5) Assume that the cause is an open operating circuit of relay B.

(6) Test the operating circuit of relay B with the test lamp or the ground cord (sections 6.3 and 6.4).

(7) Clean the contacts and adjust the springs as required (sections 4.2.2f and 8.2).

c. The station subscriber complains that at times no dial tone is received, but station number can be dialed. Proceed as follows:

(1) Test selectors per section 5.6.6a above to locate the faulty selector not supplying dial tone.

(2) When the faulty selector is seized, no dial tone is heard. Check the tone start circuit. If the tone circuit has started, then check the dial tone circuit to the (+) line.

(3) Test the tone start circuit with the use of a test lamp. The dial tone circuit is tested with the use of a receiver with a series capacitor (sections 6.3 and 6.5).

(4) Clean the contacts per section 4.2.2f. Adjust the springs per section 8.2.

d. The station subscriber complains that at times the dial tone is heard after the first digit is dialed; the dialing cannot be completed. Proceed as follows:

(1) Test all selectors per section 5.6.6a above to locate the one not responding to dial pulses.

(2) The faulty selector will not step its shaft vertical. Test the operating circuit of the vertical magnet with the use of a test lamp or a ground cord (sections 6.3 and 6.4).

(3) Clean the contacts and adjust the springs as required (sections 4.2.2f and 8.2).

e. The station subscriber complains that at times, although dial tone is removed from the line after the first digit is dialed, the call cannot be completed. Proceed as follows:

(1) Test all selectors per section 5.6.6a above to locate the faulty switch.

(2) The wipers of the faulty switch will not rotate to the first bank contacts after dialing is completed.

(3) Test for an open operating circuit of the rotary magnets with the use of a test lamp or ground cord (sections 6.3 and 6.4).

(4) Clean contacts, or adjust springs as required (sections 4.2.2f and 8.2).

f. The station subscriber complains that at times the dial tone returns after the first digit is dialed. Proceed as follows:

(1) Test all selectors per section 5.6.6a above by dialing an unused level.

(2) The faulty switch rotates its wipers to the 11th position and releases. On re-seizure, dial tone is heard.

(3) Test for an open circuit in the busy tone and ground circuit with the use of a test lamp or a receiver with a series capacitor (sections 6.3 and 6.5).

(4) Clean the contacts per section 4.2.2f; adjust the springs per section 8.2.

g. The station subscriber complains that at times ringing starts after the second digit is dialed and the wrong party is signaled. Proceed as follows:

(1) Check all selectors to find which has failed to release after a call.

(2) The faulty selector will have its wipers resting on bank contacts and all relays will be released.

(3) Check for an open operating circuit of the release magnet with the aid of the test lamp (section 6.3).

(4) Clean the contacts or adjust the springs as required (sections 4.2.2f and 8.2).

5.6.7 The connector (selector system).

To investigate a station subscriber's complaints, test the operation of this switch when checking Class 3 complaints involving station busy tone, station signaling, transmission, etc. (sections 5.1.3 and 5.4).

a. To test the operation of a connector, place the plug of the hand test telephone between test jacks 1-2. The connector is seized and dialing can follow. When working on a faulty connector, it should be busied out first. To busy out a connector, operate the red lever of the busy key. If there is no busy key on the connector, short test jacks 3 and 4. Red busy clips are supplied with the installation. Should a connector need attention, check one of the following:

b. The station subscriber complains that at times the called party in a particular hundreds group cannot be reached. Proceed as follows:

(1) Test all connectors in that particular group per section 5.6.7a above for a switch not responding to dial pulses.

(2) Note that a connector does not raise its switch shaft in response to the first series of dial pulses.

(3) Check for an open operating circuit of the vertical magnets with the aid of test lamp (section 6.3).

(4) Clean contacts, or adjust springs as required (sections 4.2.2f and 8.2).

c. The station subscriber complains that at times the called party in a particular hundreds group cannot be reached. Proceed as follows:

(1) Test all connectors in that particular group per section 5.6.7a above for a switch not responding to dial pulses.

(2) Note that a connector does not rotate its wipers across the bank contacts in response to the second series of dial pulses.

(3) Check for an open operating circuit of the rotary magnets with the aid of the test lamp (section 6.3).

(4) Clean contacts, or adjust springs as required (sections 4.2.2f and 8.2).

d. The station subscriber complains that at times no busy tone is heard when a busy line of a particular hundreds group is dialed. Proceed as follows:

(1) Test all connectors in that particular group by dialing a busy line per section 5.6.7a above.

(2) Note that no busy tone is heard after dialing a busy line number on the faulty connector.

(3) Check for an open busy tone circuit with the aid of a receiver with a series capacitor.

(4) Clean contacts, or adjust springs as required (sections 4.2.2f and 8.2).

e. The station subscriber complains that at times the called party of a particular hundreds group cannot be signaled. Proceed as follows:

(1) Test all connectors in that particular group per section 5.6.7a above by dialing any station number in the group to locate the switch not supplying "Int. Gen." to the bells of the called party.

(2) Note that when a station number is dialed on a faulty connector, the called party does not answer.

(3) Check for an open ringing circuit with the aid of a receiver with a series capacitor (section 6.5).

(4) Clean contacts, or adjust springs as required (sections 4.2.2f and 8.2).

f. The station subscriber complains that at times the called party of a particular hundreds group cannot be heard. Proceed as follows:

(1) Test all connectors in that particular group per section 5.6.7a by dialing any station number in that group until the faulty connector is located.

(2) To test the transmission trouble of the faulty connector, connect a telephone equipped with a ringer to a dead level at the connector bank block. Connect the test lamp to (-) battery.

(3) With the hand test telephone plugged into test jacks 1-2 of the faulty connector, dial the connector to the dead level. When the dead level is reached, touch the control wiper terminal with the test lamp momentarily. (This allows the wiper closing relay to operate and start the ringing circuit.)

(4) Lift the handset of the telephone connected at the dead level; while talking in one telephone, listen in the other.

(5) Check all the spring contacts of the transmission circuit.

(6) After satisfactory tests have been made on all spring contacts, check transmission capacitors. Temporarily, bridge new capacitors in multiple with switch capacitors. If the transmission trouble is cleared, replace with new capacitors.

5.6.8 The connector (connector system).

To investigate a station subscriber's complaints, test the operation of the connectors when checking Class 3 complaints (sections 5.1.3 and 5.4).

a. To test the operation of a connector, place the plug of the hand test telephone between

test jacks 1-2; the connector is seized and dialing can follow. When working on a faulty connector, busy out the connector by shorting test jacks 3-4 with red busy clips supplied with the installation. A linefinder-connector link must also be busied out at the linefinder. Busying out only the connector will lock the linefinder and the first line relay to seize it, resulting in a Class 1 complaint.

b. The station subscriber complains that at times dial tone is not heard, but dialing is possible. Proceed as follows:

(1) Test all connectors per section 5.6.8a to locate the switch not supplying dial tone.

(2) Note that when the faulty connector is seized, no dial tone is heard.

(3) Check for an open dial tone circuit with the use of a receiver with a series capacitor (section 6.5).

(4) Clean the contacts or adjust the springs as required (sections 4.2.2f and 8.2).

(5) If defective capacitor is at fault, replace with a new capacitor.

c. The station subscriber complains that at times he cannot reach the called party although the dial tone is removed from the line after the first digit is dialed. Proceed as follows:

(1) Test all connectors per section 5.6.8a to locate the connector not dialing the complete station number.

(2) Note that the faulty connector will not step its wiper across the bank contacts.

(3) Check for an open operating circuit for the rotary magnets with the aid of the test lamp (section 6.3).

(4) Clean the contacts or adjust the springs as required (sections 4.2.2f and 8.2).

d. The station subscriber complains that at times he does not hear a busy tone. Proceed as follows:

(1) Test all connectors per section 5.6.8a by dialing a busy level to find the connector not supplying busy tone.

(2) Check for an open busy tone circuit with the use of a receiver with a series capacitor (section 6.5).

(3) Clean the contacts or adjust the springs as required (sections 4.2.2f and 8.2).

e. The station subscriber complains that at times the called party cannot be signaled. Proceed as follows:

(1) Test all connectors per section 5.6.8a by dialing any station number to locate the switch not supplying ringing current.

(2) Note that when a station number is dialed on a faulty connector, the called party does not answer.

(3) Check for an open ringing circuit with the aid of a receiver with a series capacitor (section 6.5).

(4) Clean contacts, or adjust springs as required (sections 4.2.2f and 8.2).

f. The station subscriber complains that he receives a number of calls intended for other stations. Proceed as follows:

(1) Check all connectors to find the switch not released.

(2) Note that the wipers of the faulty connector will rest on the complaining party's connector bank terminals, but all relays will be released.

(3) Check for an open operating circuit of the release magnet with the use of the test lamp (section 6.3).

(4) Clean contacts, or adjust springs as required (sections 4.2.2f and 8.2).

g. The station subscriber complains that at times the Code Call equipment cannot be seized. Proceed as follows:

(1) Test all connectors per section 5.6.8a above by dialing the Code Call number, usually 70.

(2) Note that when the faulty connector is dialed, the Code Call equipment is not seized.

(3) Check for an open circuit in the cam springs.

(4) Clean the contacts per section 4.2.2f or adjust the cam springs per section 8.10.

5.6.9 Tone, charge alarm and charge control relays.

To investigate a station subscriber's complaints, test equipment operation when checking

Class 4 complaints involving the tone and the starting of the converter and interrupter.

a. The station subscriber complains that no dial tone is heard. Proceed as follows:

(1) Test the unit by seizing any selector or connector; dial tone relay should start.

(2) Note that the tone relay does not operate as a buzzer. Relay is out of adjustment.

(3) Clean the contacts. Clean between the armature and the coil core. Reduce gauging and increase the tension of spring No. 1 to improve the tone and starting.

b. The station subscriber complains that no busy tone is heard.

(1) Test the unit by seizing a selector or connector. Dial the connector or selector to a busy level.

(2) Check tone relay operation as a buzzer.

(3) Clean the contacts. Clean between the armature and the coil core. Reduce gauging and increase the tension of spring No. 1 to improve the tone and starting.

5.6.10 Ringing converter.

To investigate a station subscriber's complaints, test unit operation when checking Class 4 complaints involving no ringing current supply for P-A-X.

a. No ring-back tone is heard. No station can be signaled.

(1) Start this unit by seizing a connector, and dialing it to an idle level.

(2) Note that the converter vibrates without supplying ringing tone.

(3) Check the converter ringing contacts for adjustment.

(4) Adjust the motor contacts to close before the ringing contacts close. Bend the backstop springs with duck-bill pliers H-74611. The large contacts seldom require cleaning. Never adjust the contact screw. Equalize the ringing contact separation for smooth operation of the vibrator mechanism.

5.6.11 Ringing interrupter.

To investigate a station subscriber's complaints, test unit operation when checking Class 4 complaints involving no ringing or faulty ringing.

a. No station can be signaled. No ring-back tone is heard.

(1) Start this unit by seizing a connector and dialing it to an idle line.

(2) Note that the interrupter does not start.

(3) Check the starting circuit of the interrupter with the aid of the test lamp (section 6.3).

(4) Clean contacts, or adjust springs as required (sections 4.2.2f and 8.2).

6. TROUBLE SHOOTING

6.1 General

Trouble shooting is necessary to locate and correct the undesirable effects of wear or dirt in the P-A-X. Successful trouble shooting is based largely on the experience and training of the maintenance man. It is often helpful to keep records of common trouble reported by station users. Become familiar with the purpose of each component, and how they operate together as a system before attempting to locate and correct other than the most simple cases. Always suspect the simple case of trouble first. To familiarize yourself with the operation of the components together, use the following method for self instruction.

a. Wire two telephones to spare line equipment at the main terminal box and set up calls between them.

b. Observe the sequence of equipment operation.

c. With the circuit and explanation before you, set up calls and delay between each step to note relay operation.

d. Locate the several power shelf units and learn their functions.

e. Note relay contact follow, armature travel, and normal spring operation.

f. Repeat this procedure to gain knowledge of the equipment operation.

6.2 General Notes

a. See figure 7 for standard circuit symbols.

b. "Open contacts" mean either physically or electrically open contacts. Dirty contacts are electrically open contacts.

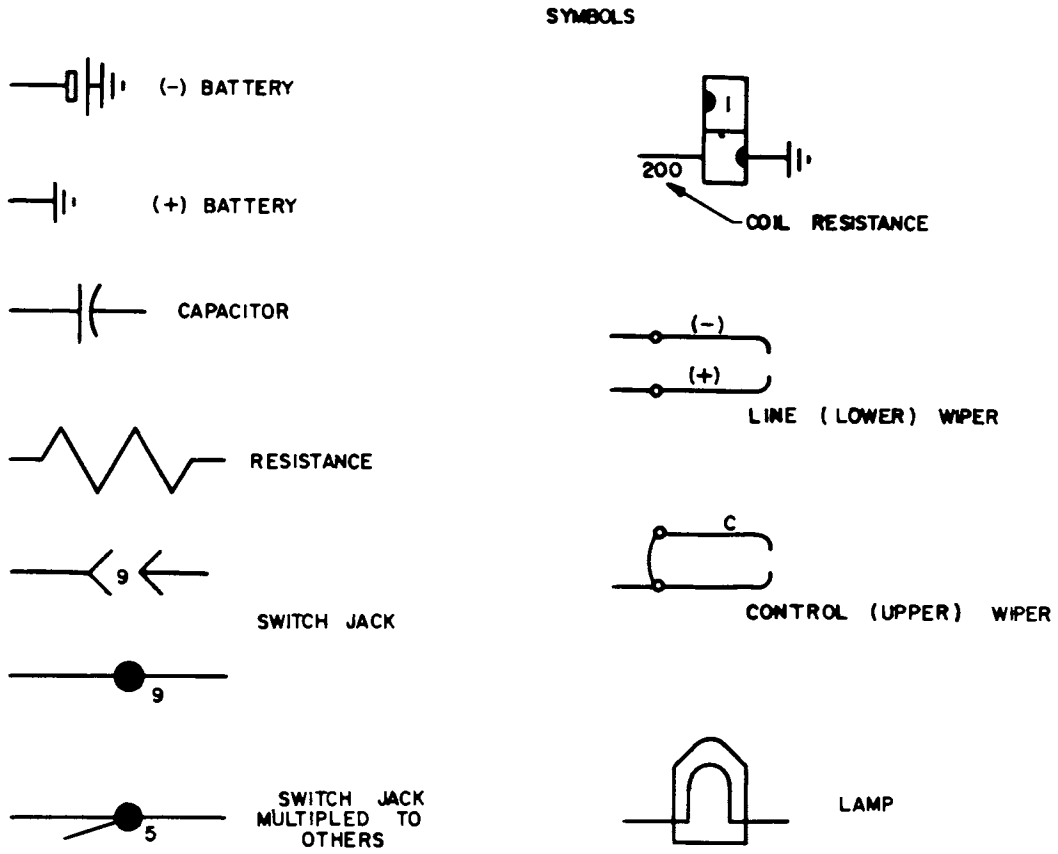


Figure 7. Standard circuit symbols.

c. Relay springs on circuit diagrams are shown in their normal position directly above and below the relay. Armature springs move towards the coil when the relay operates, and make or break contact with their associated stationary springs.

d. See figure 13 for single-armature relay spring numbering. See figure 19 for double-armature relay spring numbering.

e. Relay "X" springs close before the other relay springs move.

f. The (-) or "hot" side of the power supply uses the white and in some cases, a heavier blue wire. These leads are fused. The (+) or ground side of the power supply uses the red wire. These leads are connected to ground.

g. Read circuit drawing notes which apply to your equipment.

h. VON springs are vertical-off-normal springs that are restored by the raising of the switch shaft on Strowger switches.

i. NP springs are normal-post springs operated by their cam attached to the upper portion of the Strowger switch shaft on specified levels.

j. Cam springs are operated by their cam on the eleventh rotary step of the Strowger switch shaft unless otherwise specified.

6.3 Using the Test Lamp

The test lamp, H-16339-1 or 5, is used to locate d-c circuit faults. Since a d-c circuit is traced from (+) battery through equipment to (-) battery or vice versa, the inoperative circuit has one or the other missing or stalled along the circuit path. The test lamp indicates that at a specific point in a circuit the (+) or (-) battery is or is not present.

a. For an example of locating an open d-c circuit see figure 8. Clip the test lamp on a (-) battery fuse. With the pick on relay B spring 8, a lighted lamp indicates springs 7-8 making. A similar test shows relay G springs 3-4 also making. Proceed contact by contact until the lamp does not glow. This is the trouble point. The lamp lights dimly beyond point Y since (+) battery is now being supplied through 200-ohm winding of relay H. However, a dimly-lit lamp at relay L spring 3 and a dark lamp at relay L spring 1 locates the open circuit. If the presence of (-) battery through the 200-ohm BCO winding at relay L spring 1 is to be verified, clip the test lamp to

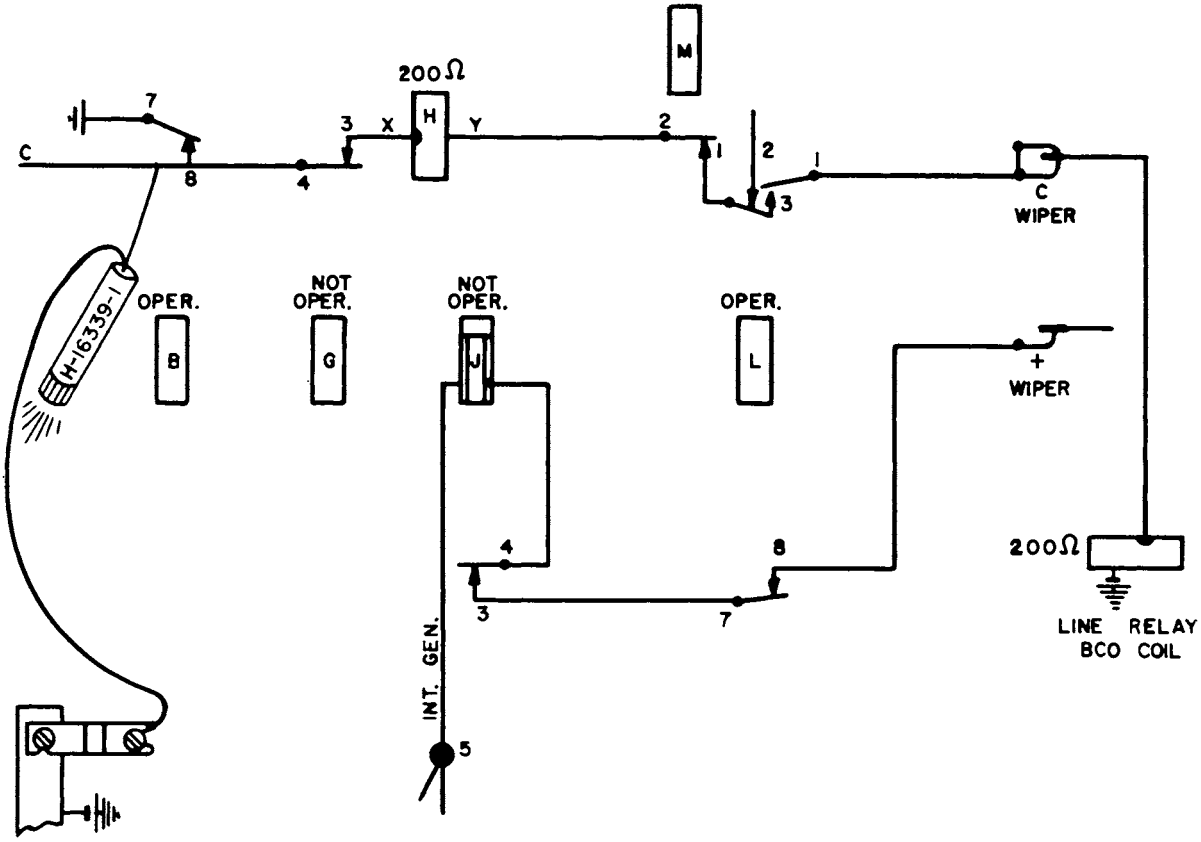


Figure 8. Locating an open d-c circuit with a test lamp.

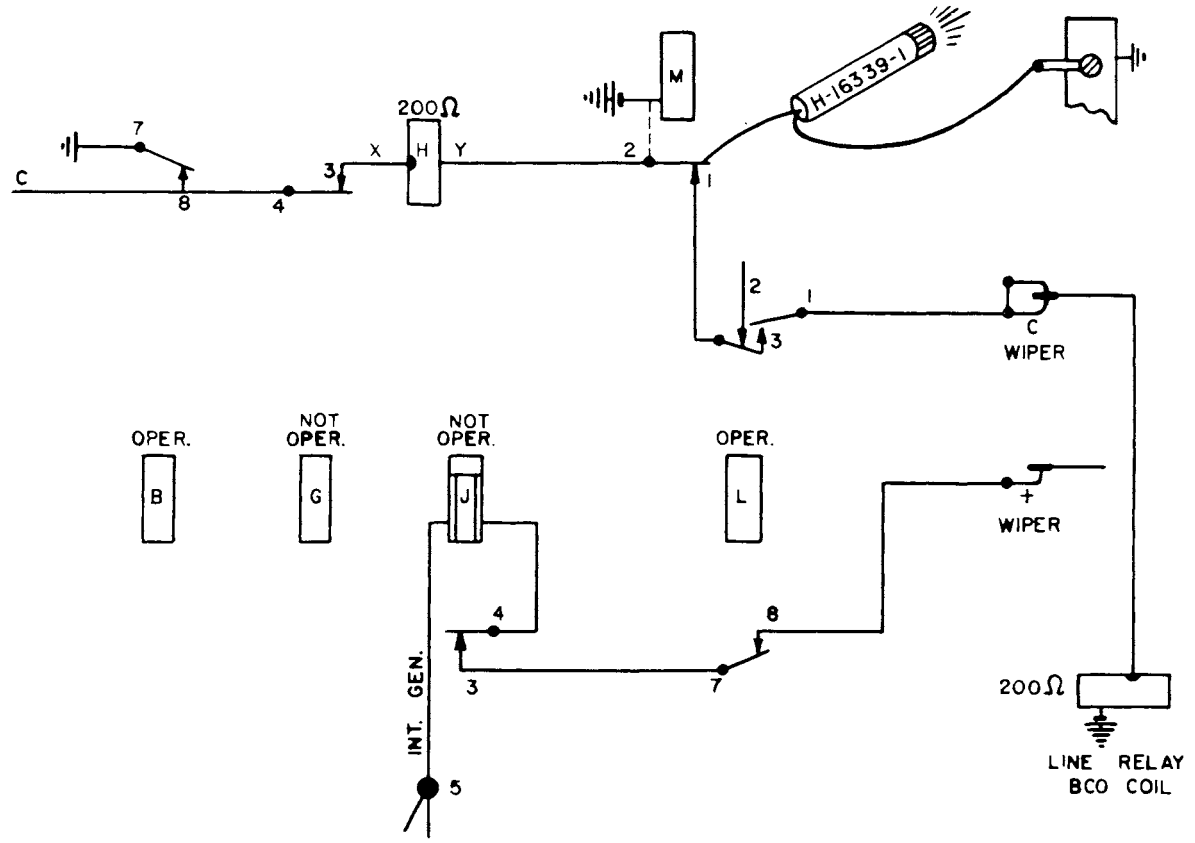


Figure 9. Locating a short in a d-c circuit.

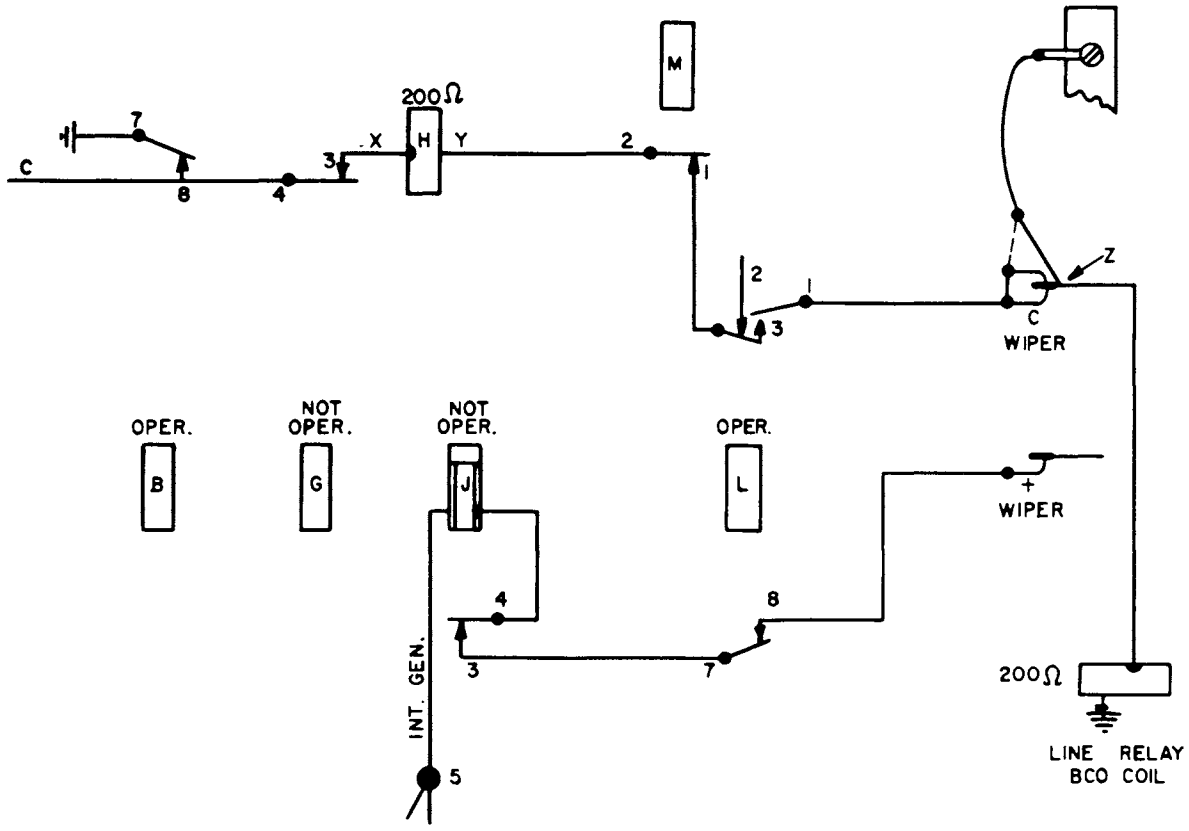


Figure 10. Verifying a break in a d-c circuit.

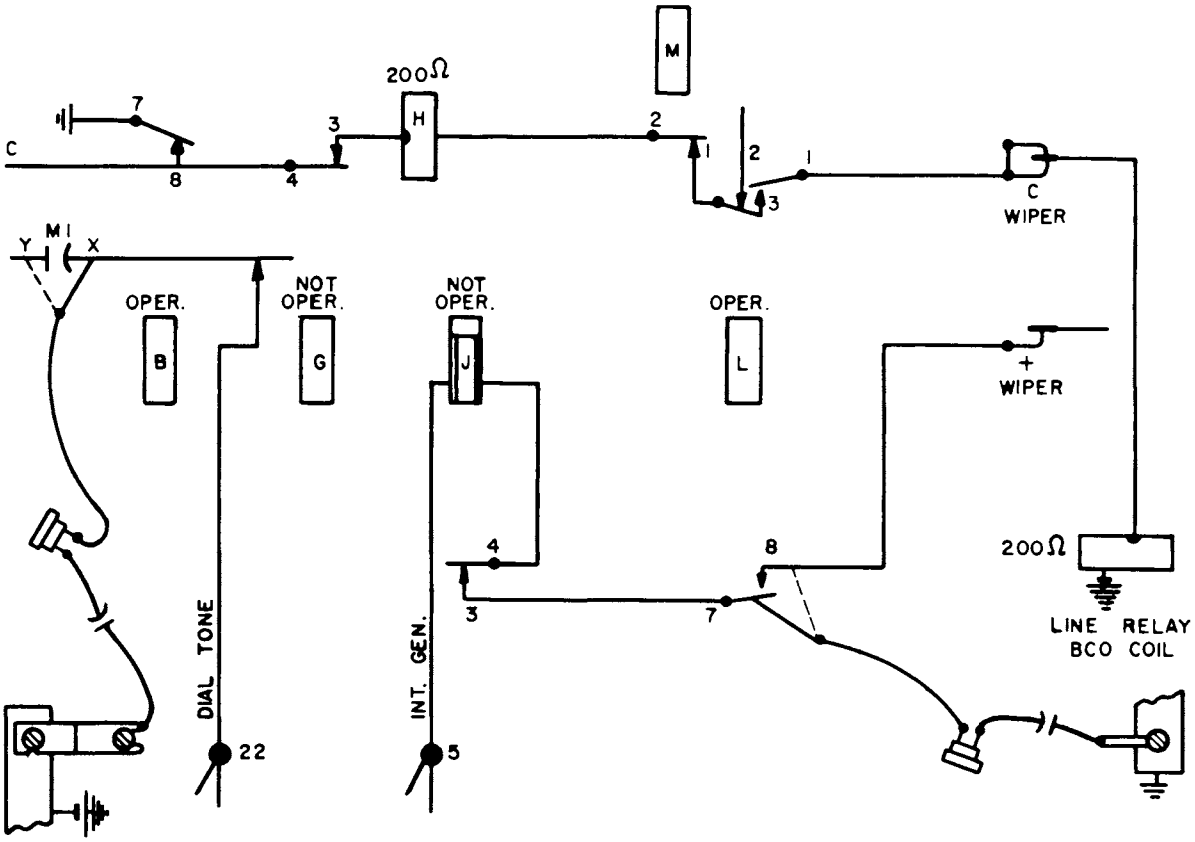


Figure 11. Locating an open a-c circuit.

(+) battery at any terminal having a red wire. Test as before. This time a dim lamp at relay L spring 1 indicates (-) battery and a dark lamp at spring 3 indicates an open circuit.

b. For an example of locating a short or foreign potential in a d-c circuit see figure 9. Clip the test lamp on a (+) battery terminal. With the pick at relay M spring 2, a lighted lamp indicates the foreign potential holding relay H operated. Separate relay M spring 1-2. A dark lamp at spring 1 indicates trouble between spring 2 and point Y. After isolating this trouble, a visual inspection will suffice.

6.4 Using the Ground Cord

The ground cord (H-74573-1) is insulated wire with a pick on one end and a clip on the other, and is used with (+) battery only.

a. For an example of verifying a break in a d-c circuit see figure 10. Assume an open circuit at Z in figure 10. This is a junction point for two P-A-X components (from conversation links, via the wipers, to the line relays, via the bank contacts). Although the test lamp will show this open, it can be verified by operating the line relay. Positive (+) battery from the bank contact operates the line relay, (+) battery from the wiper blades does not. The open circuit is located at point Z.

6.5 Testing Tone and Ringing Circuits

This arrangement tests P-A-X tone and ringing circuits. The capacitor protects the receiver and ringing machine contacts and prevents false relay operation.

a. For an example of locating an open a-c circuit see figure 11. Assume an open circuit at relay L springs 7-8. Interrupted generator will be heard at relay L spring 7 but not at spring 8, indicating the open circuit. The capacitor prevents the operation of relay J. Also, the INT. GEN. is louder at switch jack 5 than at relay L spring 7, since it is supplied through the coil of relay J. The receiver is connected to (+) or (-) battery.

b. For an example of locating an open P-A-X tone circuit see figure 11. Assume an open M1 capacitor. Tone at X will be the same as at switch jack 22. No tone at Y indicates an open M1 capacitor. The receiver is connected to (+) or (-) battery. When testing a capacitor, the tone at X is loud but with the pick at Y, the following conditions are possible.

(1) A reduction in volume, indicating a good capacitor.

(2) The same volume, indicating a shorted capacitor.

(3) No tone, indicating an open capacitor.

7. REMOVAL OF COMPONENTS AND PARTS

This section describes removal procedures required to repair a defective or inoperative component or part. The removal procedure for parts which are obviously simple to remove is not given. Prior to removal of any part for repair, take the following preparatory steps before actual work is started.

a. Arrange a clean place on a bench or table to work. Make certain that dust or dirt will not fall or be blown into the part or component that is being repaired.

b. Obtain several small, clean cardboard, wood, or metal containers to store removed parts.

c. Arrange the necessary tools and materials so that they will be readily accessible during the progress of the repair work.

7.1 Removal of Lineswitch

To remove a lineswitch, loosen the two screws which hold it to the frame. Grasp the lineswitch firmly by the frame and coils; set the plunger opposite trunks 5 or 6 and push it into the bank while removing the switch.

To mount a lineswitch, reverse the operation by inserting the plunger into trunk 5 or 6 and sliding the switch into place. Tighten the mounting screws and align the lineswitch properly.

7.2 Removal of Strowger Switches

To remove a linefinder, selector, or connector, unscrew the nuts from the bank rods, permitting the banks to drop away from the switch frame. Grasp the switch with the thumb at one end of the release coil and the fingers at the opposite end; steady the switch with the other hand. The switch may then be removed by lifting it about three-quarters of an inch. Care should be taken to prevent the wipers from being damaged on the banks. To avoid damage to its parts, always lay the switch on its back. To mount a linefinder, selector, or connector, put it in place so that the slots in the switch frame engage the mounting pins on the shelf. Push the switch in and down, until it is rigidly in place. Care should be taken that the switch jack engages the shelf jack properly, and that the wipers are not damaged on the

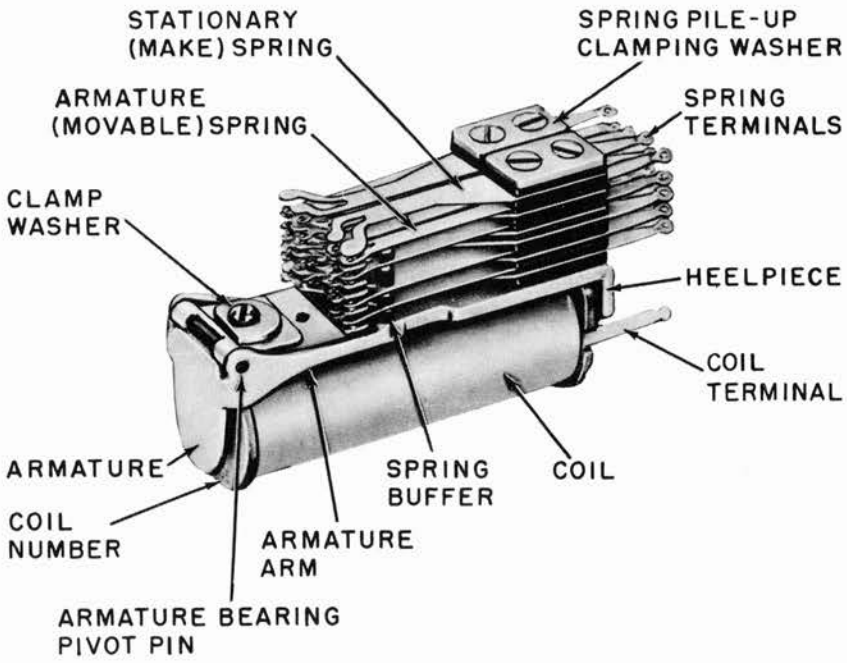


Figure 12. Type 57A relay.

banks. Place the banks in position and replace the bank-rod nuts.

7.3 Relay Removal

Defective relays that cannot be made serviceable by readjustment, by contact burnishing, or by performing minor repairs, should be replaced. Make no attempt to replace any of the springs in the spring pile-up. Relay armatures should rarely require replacement. Relay coils can be replaced, but if the relay shows wear of contacts, it is best to replace the entire relay. When replacing coils, use a new coil identical to the one being replaced. The A. E. Co. part number and sometimes the coil resistance, are stamped on the spool head. When replacing relays, unsolder the connections from the coil and the spring pile-up one at a time, and tag each wire with its terminal number. Remove the two mounting screws securing the relay to the base; remove the relay; replace with a new relay, and solder the wires to their proper terminals. Test the operation of each relay and the equipment with the replaced relay, before returning it to service. Add the circuit designation letter marked on the armature of the old relay to the new relay. Use a lettering kit or suitable brush to stamp or paint the letter(s) clearly. A new coil, a new armature, or a new heelpiece complete with factory assembled spring pile-up can be ordered as a spare part. Individual springs cannot be replaced in the field since proper pile-up alignment can only be obtained with factory squeezing fixtures. To replace these three parts, see figure 12 and the following sections.

7.3.1 Armature replacement.

Using an offset screwdriver, H-21766 (to avoid removing the relay from the relay assembly), proceed as follows to replace a relay armature:

a. Remove the screw that holds the clamp washer against the yoke.

b. Slide off the yoke and clamp washer.

c. Slide the armature out, holding one hand under the relay to catch the yoke spacer that fits between the armature and heelpiece.

d. Slide the new armature in place, holding the yoke spacer against the heelpiece until the armature is in far enough to hold the yoke spacer.

e. Replace the yoke, clamp washer and screw, and tighten the screw just enough so that there is a slight amount of play in the armature.

f. While pressing the armature against the core face, finish tightening the screw. Make the necessary adjustment of the air gap between the armature and heelpiece and adjustment of the armature lever.

7.3.2 Coil replacement.

After unsoldering and tagging all the wires connected to a relay coil, use screwdriver H-24664 to remove the screw that fastens the

coil to the heelpiece. Slide the coil toward the armature and away from the springs to remove it from the relay. Reverse these operations to assemble a new coil in a relay.

7.3.3 Heelpiece replacement.

After unsoldering and tagging all the wires connected to the relay, use screwdriver H-24664 to remove the two screws that fasten the relay heelpiece to the assembly. Proceed as follows to replace the heelpiece:

a. Remove the armature (section 7.3.1).

b. Remove the coil (section 7.3.2).

c. Fasten the coil to the new heelpiece.

d. Fasten the armature to the new heelpiece (section 7.3.1).

e. Fasten the relay to the relay assembly and rewire.

7.4 Type 45 Rotary Switch Removal

Type 45 rotary switches are mounted on brackets on the front of a relay assembly and between shelf angles.

a. To dismount from a bracket-type mounting, remove the two screws holding the switches to the brackets. Pull out the switch so that the lead wires may be unsoldered and taped. Remove the switch.

b. To dismount from a recessed mounting between two horizontal shelf angles, remove and tag all lead wires from the back. Remove the two screws holding the switch to the shelf from the front and pull out. NOTE: Use a 5/16'' ''S'' wrench H-7063 and screwdriver H-24664 unless otherwise stated.

7.4.1 Disassembly (figure 13).

a. Remove two hexagon-head screws (2) holding off-normal contact spring assembly (3) to bank assembly (13); remove clamp plate (4) and off-normal contact spring assembly (3). Do not attempt to disassemble off-normal contact spring.

b. Remove two machine screws (5) holding detent stop spring (7); remove double-holed washer (6) and detent stop spring (7).

c. Remove two machine screws (8) and hexagon head screw (8A) holding pointer arm (9) to wiper assembly (14) and bank assemblies (13); remove pointer arm (9) and two bushings (10).

d. Remove three 5/16'' hexagon-head nuts (11) and two washers (12) holding bank assembly to frame (29).

e. Pull off wiper assembly (14) and bank assembly (13) simultaneously. Separate the wiper and bank assemblies after they have cleared the frame (29). Do not attempt to disassemble the wiper or bank assemblies.

f. Remove two 5/16'' hexagon-head stud screws (15) and washers (16) holding the armature yoke (17A) to the frame (29); remove the yoke shim (18) and the armature assembly (17). The pawl spring (19) may be removed from the armature assembly (17) for replacement if necessary.

g. Remove the driving spring (20).

h. Remove the hexagon-head nut (21) and the adjusting screw (22).

i. Remove the machine screw (23) and lockwasher (24) holding the driving magnet coil (25); pull out the driving magnet coil (25) and insulating washer (26). Do not attempt to remove the shaft and hub assembly or the interrupter contact springs from the frame.

7.4.2 Reassembly.

a. Install the adjusting screw (22) and nut (21).

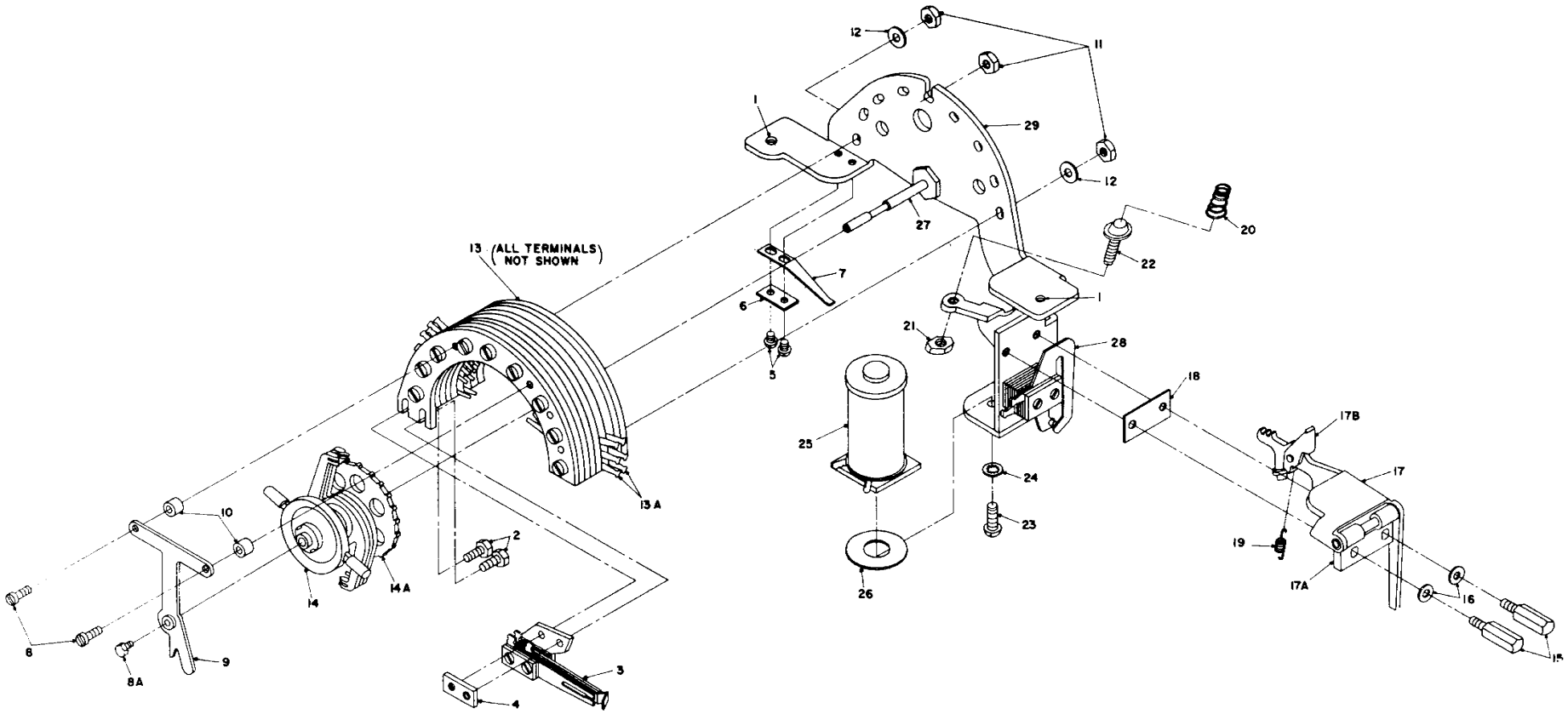
b. Fit together the wiper (14) and bank assembly (13), making sure that each pair of wiper brush springs is positioned between the two sides of the corresponding wiper.

c. Position the wiper (14) and bank assembly (13) simultaneously on the frame (29) and secure with two hexagon-head nuts (11) and their washers (12), and the third hexagon-head nut (11).

d. Position the armature yoke (17A) and yoke shim (18), and secure with two 5/16'' hexagon-head stud screws (15). Work the pawl (17B) into position on the ratchet wheel (14A).

e. Work the driving spring (20) into place between the adjusting screw (22) and the armature assembly (17).

f. Position the pointer arm (9) and two bushings (10) on the bank assembly (13) and the wiper assembly (14), and secure with two machine screws (8) and the hexagon-head screw (8A).



1. DRILLED AND TAPPED MOUNTING HOLE
2. HEXAGONAL HEAD SCREW
3. OFF NORMAL CONTACT SPRING ASSEMBLY
4. DOUBLE-HOLED WASHER
5. MACHINE SCREW
6. DOUBLE-HOLED WASHER
7. DETENT STOP SPRING
8. MACHINE SCREW
8A. HEXAGONAL HEAD SCREW
9. POINTER ARM
10. BUSHING
11. HEXAGONAL HEAD NUT
12. WASHER
13. BANK ASSEMBLY
13A. WIPER BRUSH TERMINAL
14. WIPER ASSEMBLY
14A. RATCHET WHEEL
15. HEXAGONAL HEAD STUD SCREW
16. WASHER
17. ARMATURE ASSEMBLY
17A. ARMATURE YOKE
17B. PAWL
18. YOKE SHIM
19. PAWL SPRING
20. DRIVING SPRING
21. HEXAGONAL HEAD NUT
22. ADJUSTING SCREW
23. MACHINE SCREW
24. LOCKWASHER
25. DRIVING MAGNET COIL
26. INSULATING WASHER
27. SHAFT AND HUB ASSEMBLY
28. INTERRUPTER CONTACT SPRING ASSEMBLY
29. FRAME

Figure 13. Type 45 rotary switch.

g. Position the driving magnet coil (25) and insulating washer (26) and secure with the lockwasher (24) and machine screw (23).

h. Position the double-holed washer (6) and detent stop spring (7), and secure with the two machine screws (5).

i. Position the off-normal contact spring assembly (3) and clamp plate (4), and secure with the two machine screws (2).

7.5 Lamp Removal

To remove the switchboard type lamps, lift the lamp cap with extractor H-883114-1. Next, place a lamp extractor H-882568-2 into the opening. Squeeze the extractor handles tightly and pull out the defective lamp. Place a new lamp into the extractor and push into place.

7.6 Fuse Removal

Figure 14 shows an alarm-indicating power fuse. Another fuse used is the cartridge type fuse. Cartridge type fuses are used for fusing commercial a-c power.

a. Alarm indicating power fuse.

(1) Loosen both screws that hold the fuse.

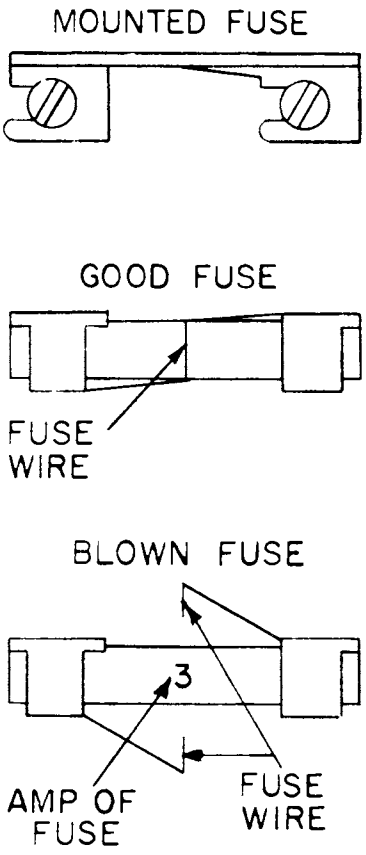


Figure 14. Alarm indicating type fuse.

(2) Slide the fuse out from under the screws.

(3) Slide a good fuse under the screws.

(4) Tighten the screws.

b. Cartridge-type fuse. Remove these fuses by gripping the center of the defective fuse with a nonconducting fuse extractor obtained locally. Grasp the handles tightly and pull forward until the fuse is free from the terminal clamps. To install a new fuse, grasp the fuse with an extractor and push the fuse into the terminal clamp.

7.7 Alarm-indicating Power Fuse Repair (Figure 14)

When the fuse wire of an alarm-indicating power fuse (abbreviated fuse) burns out, its springs move apart. One spring touches the alarm bar or stud, closing the alarm circuit. This actuates an audible or visual alarm device. The other spring of the fuse serves as an indicator to identify the blown fuse. Replace these fuses with a fuse of the same rating. The rating of each fuse is marked; the numerical 3 on the fuse indicates that it is a 3-amp fuse. These fuses may be repaired by replacing the fuse wire.

a. To repair a fuse, use fuse kit H-14315. This kit contains the necessary fuse wire, hard solder, and special flux required.

b. Place the fuse in a vise, using small blocks of wood between the vise jaws and fuse, or construct a jig of small wood blocks so arranged to hold the springs tightly against the body of the fuse.

c. Use a soldering iron capable of supplying sufficient heat. A 100 watt or 150 watt electric soldering iron should be satisfactory. Apply the soldering iron to the soldered fuse wire connections to remove excess solder and ends of blown fuse wire.

d. Use the fuse wire of the proper rating for the fuse being repaired. Pass the fuse wire through the holes in the spring (or wrap around the terminal if holeless contacts are used). Bend about 1/8" of the wire ends over each terminal. Apply a small amount of the special flux; heat the connection with the soldering iron; apply enough solder to make a good connection; remove the iron and allow the soldered connection to cool enough to harden completely before moving the fuse. Cut off the excess ends of the fuse wire.

CAUTION: When applying the soldering iron to the terminal, do not hold the iron on the

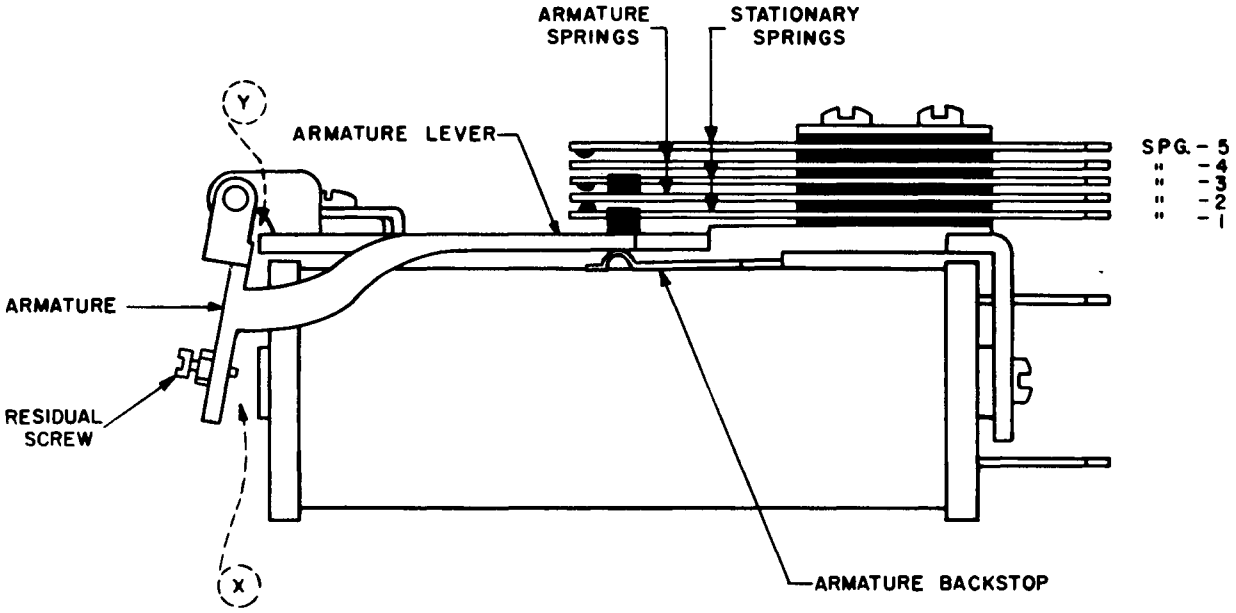


Figure 15. Residual screw adjustment.

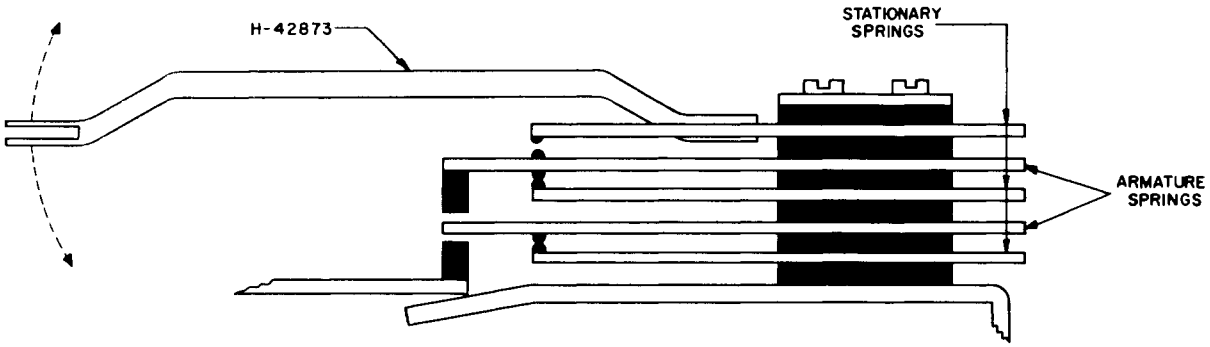


Figure 16. Spring adjustment.

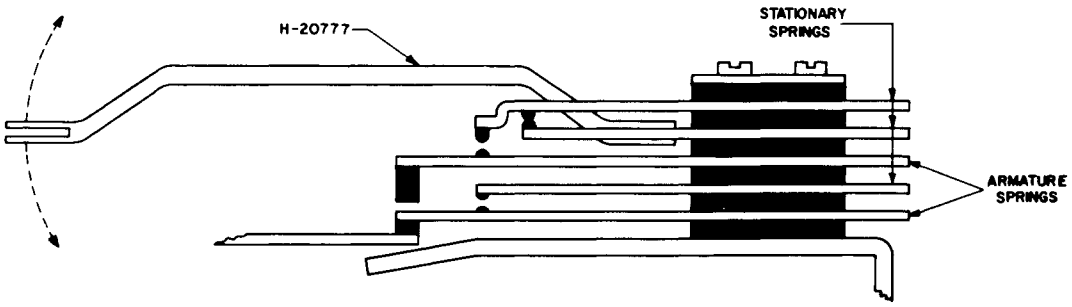


Figure 17. Make-before-break spring adjustment.

fuse wire to be soldered; otherwise it will melt. Place the solder on the terminal point to be soldered. Then touch the solder with the soldering iron tip and remove it immediately. The melted solder will flow around the connection and start cooling before the fuse wire has started to melt.

8. PERIODIC INSPECTION AND READJUSTMENT OF RELAYS AND SWITCHES

For P-A-X maintenance, it is not essential that the adjustments, as shown on the relay, switch, or standard adjustment sheets, be applied in detail. The simplified procedure outlined below is recommended. If a relay or mechanism fails to pass these simplified tests, or fails to respond to these procedures, or if there is a reason to believe that a circuit failure may be resulting from maladjustment, then the equipment should be adjusted to the detailed instructions shown on the relay, switch or standard adjustment sheets.

8.1 Relay Adjusting - General

P-A-X relays are adjusted at the factory and require only minor attention in the field. Check the following:

a. Dependable electrical connection at spring contacts. Contacts must be clean and the springs must make and break with noticeable follow. (Follow means the distance that stationary springs move after their contacts close and before their contacts open as the relay operates or releases.)

b. Correct relay release timing. Armatures and coil cores must be clean to prevent "sticky" relays (see figure 15 at point X). The heelpiece air gap must be clean (see figure 15 at point Y). Check the following sections for relay adjustment procedures.

8.2 Adjusting Relay Springs

a. Introductory notes.

(1) The adjustment of relay springs is known as "gauging." Use enough light for checking and gauging relay springs and contacts. Place a piece of white paper in such a position that the contacts will appear in a sharp outline. A. E. Co. can supply inspection lamp H-880922-1 for this purpose. CAUTION: Adjustments are made on stationary springs only. Never adjust the armature springs because this upsets the relay's operating characteristics. (See figure 15 for stationary and armature spring designation. Armature springs are moved by the armature lever when the relay operates.)

(2) Springs must be bent carefully. Use spring adjusters H-88504 or H-42873; substitute tools may damage the springs. Consult technical bulletin 540 for the proper tools. To change the position of a relay stationary spring, place the adjuster in the position as seen in figures 16 and 17 and carefully bend the spring in or out. See that they make and break with follow and are open when they should be.

(3) Repeat these two operations until the spring is correctly gauged. Using relay adjustment sheets and thickness gauge set H-46795-1, relays may be adjusted. This is the factory method and requires some experience. However, unless a relay requires a major change, the adjustment method first described is satisfactory for the relay maintenance of a small P-A-X.

b. Adjustment of twin-contact relay springs. Either contact arm may be bent to permit the associated contacts to open and close simultaneously. Make-before-break spring combinations on this type of relay must be carefully maintained. Twin contacts must be aligned before their springs are gauged.

c. Adjustment of relay "X" springs. Figure 18 springs 1B-2B represent "X" springs. These must close before any other armature springs move. Adjustments are made on spring 2B. Do not bend armature backstop (figure 15) to gauge "X" springs.

d. Special adjustment for make-before-break spring combinations. Figure 17 springs 3-4-5 represent a make-before-break combination. Tension spring 5 slightly so that spring 4 moves when contacted by 5. Adjust gauging with spring 4.

e. Clearance between the armature level bushings, armature spring bushings, and the adjacent armature springs. Figure 19 shows this clearance at point "Z". Adjust the armature backstop with adjuster H-14769 to maintain clearance between the lever and spring 2. Adjust spring 4 to maintain clearance between springs 2 and 4, etc. This clearance is perceptible except between the lever bushing and spring 2. At this point clearance is usually greater. Figure 20 shows this clearance at point "Z," but in this case, the number 1 spring is an armature instead of a stationary spring. Clearance at "Z" is accomplished by the adjustment of spring 3. Springs 1 and 2 are gauged by adjustment of spring 2. The armature lever rests on the backstop when the relay is at normal. In this case the backstop is never adjusted to correct spring gauging.

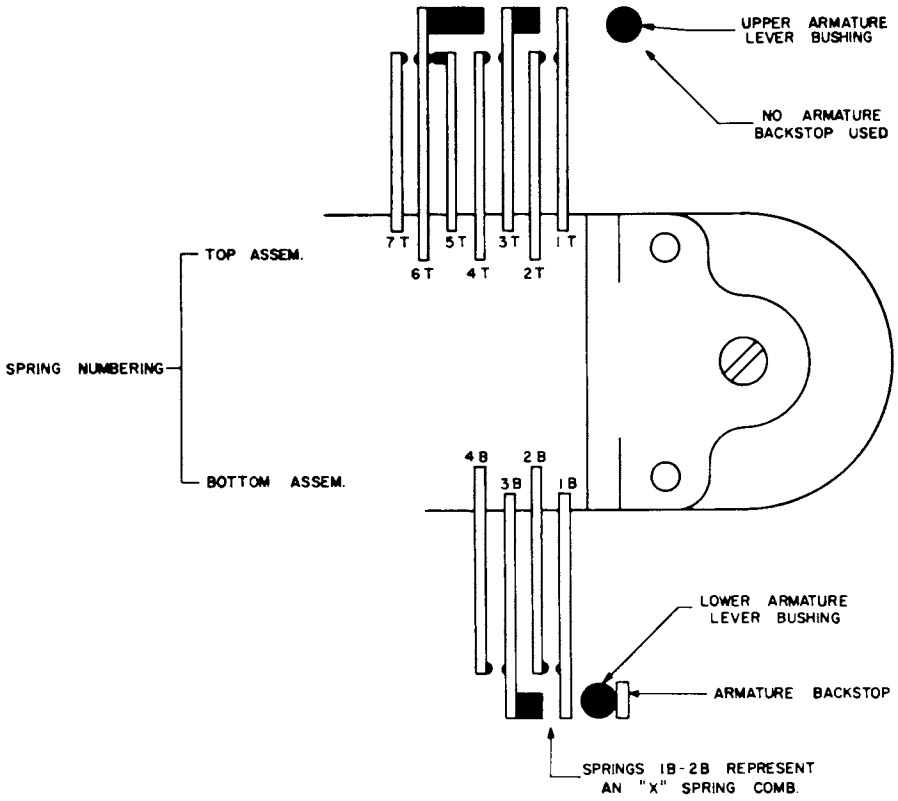


Figure 18. Adjustment of "X" contacts.

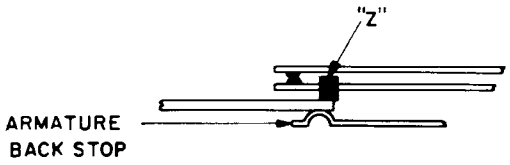


Figure 19. Armature spring adjustment.

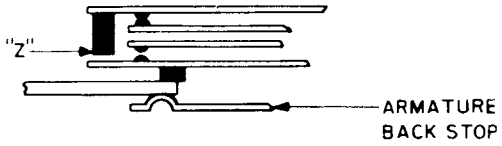


Figure 20. Clearance between armature spring and bushing.

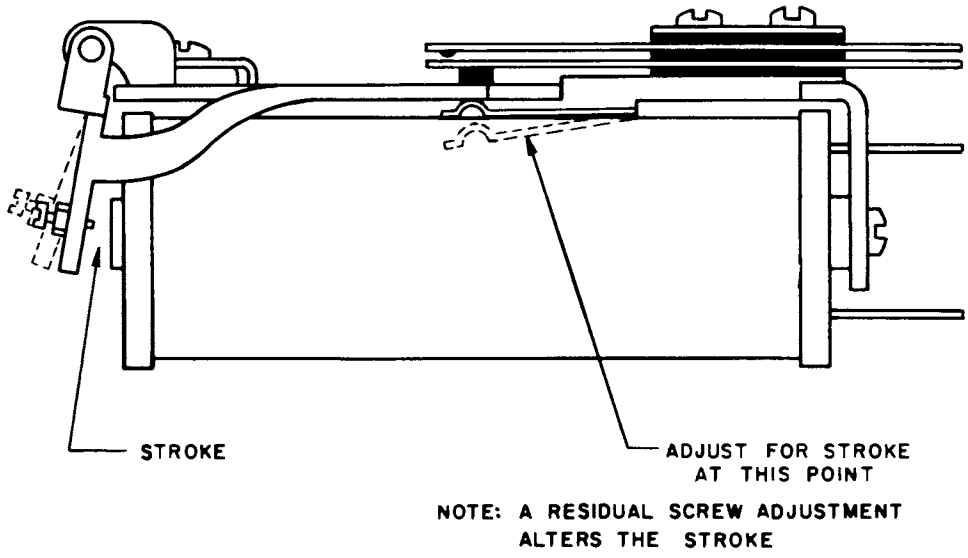


Figure 21. Armature back stop adjustment.

8.3 Residual Screw Adjustment

The armature of certain relays extend beyond the edge of the relay heelpiece. These and similar "slug relays" are designed to release a short time after their circuit is opened. This "sluggish" action is necessary and no adjustment should be attempted to overcome it. In time, however, dirt collects on the armature and the coil core to make these relays "sticky." The armature of a "sticky" relay clings to its coil core, after its circuit is opened, for a period of time exceeding even that required for a slow-to-release relay. In addition, the residual screw (see figure 15) of any relay may in time grind itself into a coil core to cause a "sticky" relay. These two conditions combine to upset relay release timing. When a relay is too slow-to-release, proceed as follows:

a. Clean face of the relay armature and coil core with a piece of cloth arranged over the contact cleaner blade. (See figure 15 at point "X".)

b. Clean between the armature and heelpiece with a suitable sized thickness gauge. (See figure 15 at point "Y".)

c. Adjust residual screw setting, and check relay spring gauging. To adjust a residual screw setting, proceed as follows:

(1) Check "residual" column on the relay adjustment sheet for correct value.

(2) Select the thickness gauge, corresponding to this figure, from set H-46795-1. Place it between the armature and the coil core so that the residual screw will pass through the opening when the relay armature is operated.

(3) Loosen the residual nut. Manually operate the relay armature and turn the residual screw until the gauge is free from bind. Retighten the residual nut. Relays with fixed residuals require only cleaning.

CAUTION: Indiscriminate changing of the residual screw setting will change the relay's operating characteristics and spring gauging.

8.4 Adjustment of the Relay Armature Lever

The armature lever (see figure 15) may be adjusted with adjuster H-88502-1 or H-14768. Hold the armature tightly against the coil core with the thumb and bend the lever slightly to the left or right. A relay armature lever may be adjusted under the following conditions:

a. When the relay springs cannot be gauged with sufficient follow.

b. When the stroke of the relays has been disturbed.

c. When installing a new armature.

8.5 Setting the Heelpiece Air Gap

An air gap (also called the "air line") between the armature and the heelpiece is .004" at point "Y" on figure 15. If this air gap is disturbed, loosen the armature-yoke mounting screw and place a .004" thickness gauge between the armature and the heelpiece. Press the three together and tighten the mounting screw. Remove and test for armature operation. Foreign material in the air gap causes an armature to bind. Clean with a thickness gauge.

8.6 Setting the Relay Armature Stroke (See Figure 21)

Some P-A-X's use the type 57 relay. The stroke for these relays is shown as the figure nearest the left border of the spring gauging column on the relay adjustment sheet. The stroke represents the amount of armature travel between the coil core and the armature residual. Adjust, using armature adjuster H-88502-1 or H-14768 and thickness gauge set H-46795-1.

Other P-A-X's use the standard class A horizontal relay. Armature stroke is required for relays having an armature spring as their No. 1 spring (see figure 20). Adjust the position of the armature backstop with adjuster H-14769.

8.7 Relay Margining

Relay margining is the proper tensioning of the relay's armature springs (see figure 15). Margining is not discussed here because it is seldom necessary in small P-A-X maintenance. Relays are properly margined at the factory by skilled personnel.

8.8 Strowger Switch Adjustments

Only minor adjustments on switch mechanisms are required in the field; and generally, periodic cleaning and oiling is sufficient. If a switch needs adjustment, proceed as follows:

a. Busy out the link associated with it.

b. Clean and oil the switch, its bank contacts, and wipers. Check wiper alignment.

c. Compare its operation with that of a similar properly functioning switch. Make whatever adjustment appears to be necessary.

8.9 Rotary Switch Adjustments

Adjust the interrupter springs with adjuster H-20179-1 or H-7066 to increase the drive springs tension of a sluggishly operating switch. The armature adjusting screw setting may be increased slightly with wrench H-23865. The adjusting screw near the armature alters wiper alignment. Do not make other adjustments unless a part replacement is necessary.

8.10 Strowger Switch Adjustments

Do not remove switch covers except when working on the switch. The cover protects the unit from dust, dirt and accidental physical damage. Use wrench H-46440-1 for tightening the shaft-restoring assembly screw and similar screws. Use wrench H-46437-1 for tightening the wiper screw. To check and adjust wipers, prevent the VON springs from operating when the shaft is raised and release the double-dog latching spring to hold the wipers in position for adjustment. Replace a damaged vertical or rotary pawl in the old armature to eliminate magnet readjustment. If the VON springs do not close, loosen and move the assembly to free the lever from binding on the switch casting. Retighten after adjustment has been made. Clean between the magnets and their cores once a year. If the cam springs do not close, change position of the cam on the switch shaft with a small screwdriver.

Use wrench H-46437-1 to adjust the normal post spring. If the shaft-restoring spring assembly screw is loose, align the entire shaft assembly and tighten. When the shaft is aligned, the rotary double dog drops into the groove preceding the first rotary tooth on the hub of the switch shaft. Do not make other adjustments to compensate for a switch shaft out of adjustment. If the double-dog latching spring does not latch or unlatch, move the release armature pin slightly, to correct it. The busy key lever spring tension holds the lever. Springs make and break with considerable follow. Adjust the springs with duck-bill pliers or adjuster H-7066.

9. ROUTINE TESTS

Periodic tests should be made to determine if the equipment is in need of repair or adjustment. These tests are scheduled work called routine tests. Decide how frequently routine tests need to be made by making a relay and rotary switch operation chart for your P-A-X. For example, the line relays should be tested for proper adjustment more frequently than the alarm relays.

The most economic form of maintenance results when a suitable balance is observed between fault location and routine testing. It is important that routine tests be made at relatively long intervals and with simple test equipment that does not require special supervision by a highly qualified staff. Routine testing should be carried out during periods of light traffic. Under normal operating conditions, the careful and regular testing of each piece of equipment once every second month should be sufficient to insure reliable operation. If the tests disclose that some particular fault is due to adjustment of the part in question, its readjustment should be carefully made. Most routine tests can be made by accessing the equipment via the test jacks by the use of a hand test telephone.

9.1 Alarm and Signal Equipment

a. Fuse alarms. Short circuit each fuse alarm strip with its associated bus bar and note that the proper signals operate. All fuse panels (figure 22) and individual fuse alarm contacts should be tested. When making this test, a visual inspection should be made to see that no fuses have blown and failed to give an alarm.

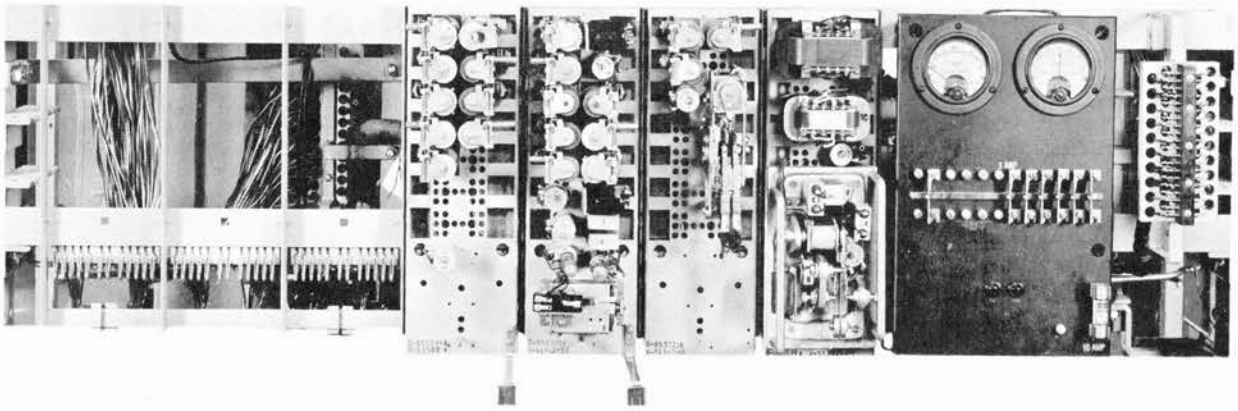


Figure 22. Typical power shelf.

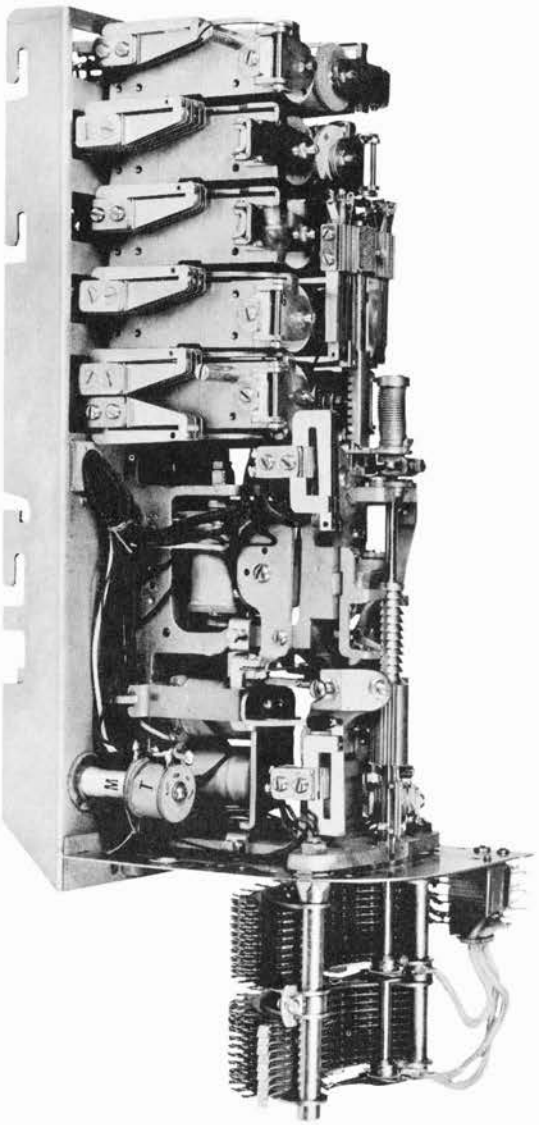


Figure 23. Typical connector.

b. Raise the shaft of a linefinder and note that the release alarm lamp lights. Repeat this test on all linefinders.

c. Hold a connector shaft off normal for a few moments. The alarm buzzer should sound. Repeat this test on all connectors. This tests the connector release failure alarm.

d. Short the test jacks 1 and 2 of the finder relay group and observe that the finder start lamp lights while the finder is searching.

e. Short both the test jacks 1 and 2 and test jacks 3 and 4 of the finder relay group and note that the specified time elapses before the "finder blocked" lamp lights.

9.2 Finder Equipment (Vertical, Rotary and Release Test)

Short the test jacks 1 and 2 of the finder relay group and note that the unoccupied finder switches step vertical and rotary to the eleventh position and release.

9.3 Operational Tests - Connector

9.3.1 Vertical and rotary test.

a. Connect test lamp H-16339-1 or 5 to (+) battery. Plug the hand test telephone into test jacks 1 and 2 of the connector under test (figure 23). The connector is seized. Listen for dial tone, and dial the connector vertical and rotary (preferably to a dead level). During rotary stepping, touch the control wiper terminal with the test lamp which is connected to (+) battery (this will operate the busy test relay). Listen for busy tone. To release the connector remove the hand test telephone from test jacks 1 and 2 and check the connector for proper release.

9.3.2 Switch-through test.

a. Connect a telephone equipped with a ringer to a dead level at the connector bank block. Connect test lamp H-16339-1 or 5 to (-) battery.

b. With a hand test telephone plugged into test jacks 1 and 2 of the connector under test, dial the connector vertical and rotary to the dead level. When the dead level is reached, touch the control wiper terminal with the test lamp, which is connected to (-) battery, momentarily (this allows the wiper closing relay to operate and start the ringing circuit).

c. Listen for ring-back tone. Lift the handset of the telephone to answer; the ringing will stop, indicating that the talking circuit is completed through the connector. While listening in one telephone, talk into the other telephone to check the transmission circuit.

d. Hang up the telephone connected at the bank block and disconnect the hand test telephone from test jacks 1 and 2. The connector will release.

9.4 Control Relays and Distributor Switch

Any faulty operation of this equipment will appear when the finders are tested, but is is also advisable, from time to time, to check the relays and rotary switches for worn, dirty, or damaged parts.

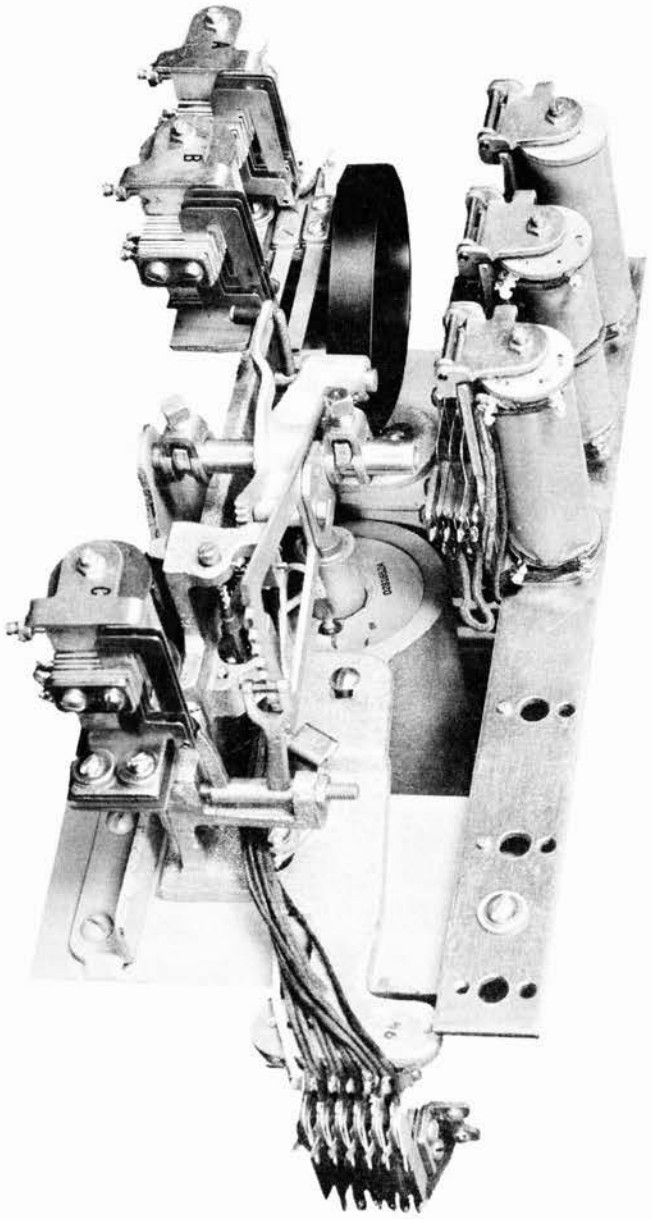


Figure 24. Master switch.

9.5 Master Switch and Lineswitch Test

This inspection should be performed as follows:

a. Operate the start relay of the master switch (figure 24) by hand and determine whether the master switch operates smoothly and at proper speed (104 to 112 cycles per minute).

b. While the master switch is rotating, manually operate the armature of the line relay of a lineswitch. The lineswitch (figure 25) should not plunge into the bank, since the positive battery which operates the pull-down coils of the lineswitch is removed while the master switch rotates.

9.6 Ringing and Tone Machine Operational Test

a. Vibrating type. Proceed as follows to perform this test:

(1) Check the frequency and voltage of the ringing current. Use an a-c frequency meter and voltmeter for this purpose. If stationary meters are not provided with the equipment, portable meters may be used by connecting them to the proper terminals on the blocks or shelves.

(2) Burnt or worn contacts will alter the voltage and frequency slightly. If not badly worn, the vibrators may be adjusted by slight movement of the weight on the vibrator reed, or by bending the contact spring back stops. Do not attempt to adjust contact spacing by turning the contact screws. Springs should be replaced if badly worn.

b. Rotary type. Proceed as follows to perform this test:

(1) Clean the machines and machine bases of oil and dust.

(2) With the machine operating, test for ringing current, busy tone, dial tone and ring-back tone by dialing from a nearby telephone.

(3) Inspect bearings for correct oiling conditions.

(4) If in doubt as to whether correct frequency and voltage is being generated,

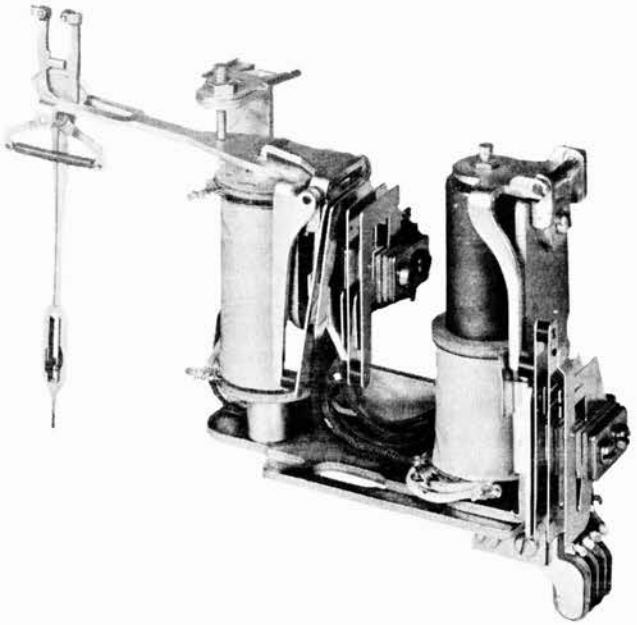


Figure 25. Lineswitch.

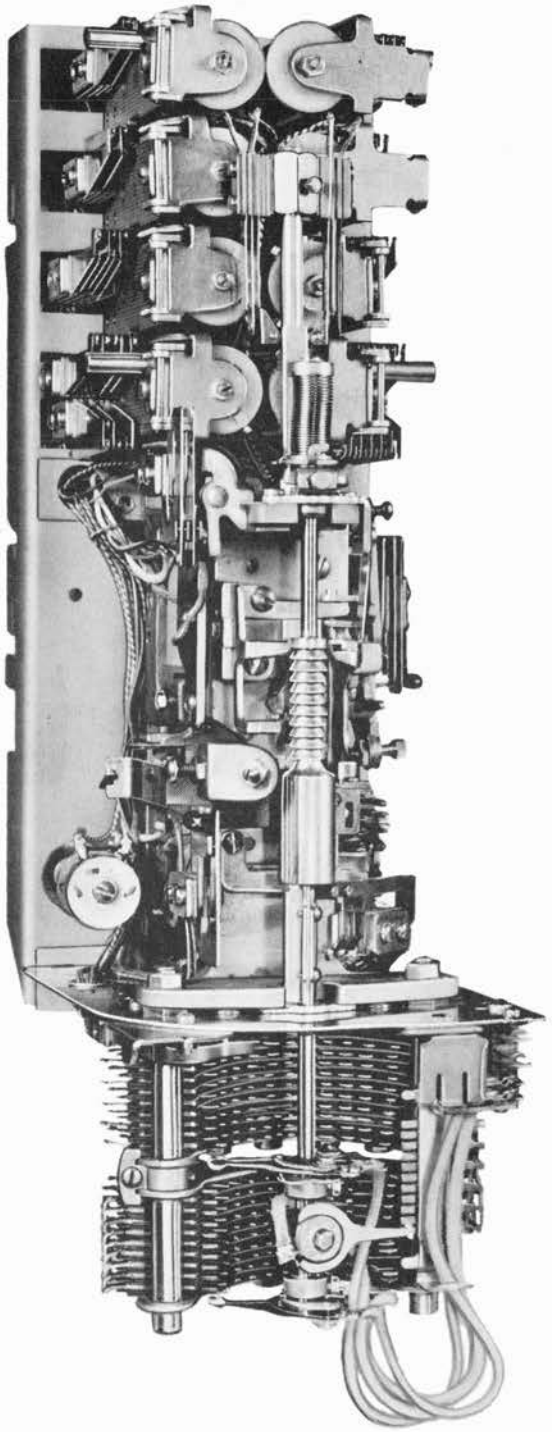


Figure 26. Typical selector.

check speed of machine against the rated speed shown on name plate. If the speed is correct, check the output with the a-c voltmeter and frequency meter.

(5) Check brushes for foreign particles and hard spots; clean brushes and commutators and replace brushes in same respective position as they were before. Clean the worm gear and wheel, interrupter springs and cams, and check the contact springs for correct contact pressure, arcing, and pitted contacts. Follow the manufacturer's instructions. On belt driven machines, inspect the belts for wear which may cause slippage and affect the ringing current frequencies.

9.7 Operational Test - Selector

a. Vertical and rotary test.

(1) Plug the hand test telephone into test jacks 1 and 2 of the selector under test (figure 26). The selector is seized. Listen for dial tone.

(2) Connect the clip of test cord H-74573-1 to (+) battery. Place the probe on selector C wiper.

(3) Dial the selector vertical; the switch cuts in to rotate its wipers to the 11th position. Busy tone is received.

(4) Remove the hand test telephone and test cord; the selector releases.

b. Switch-through test.

(1) Plug the hand test telephone into test jacks 1 and 2 of the selector under test; the selector is seized. Listen for dial tone.

(2) Dial the selector vertical; the switch cuts in and rotates its wipers. The selector switches through to the first idle trunk.

(3) Check to see that the switch-through relay is operated and the associated connector is seized.

(4) Remove the hand test telephone; the selector releases.

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