INSTALLING AND OPERATING INSTRUCTIONS

FOR

TYPE 32A1 P-A-X

OPERATING BULLETIN 32A1

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AUTOMATIC ELECTRIC COMPANY
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TABLE OF CONTENTS

	PAGE NO.
General	1
Ringing Methods	1
Numbering	1
Method of Operation	1
Installation	2
Switchboard Location	2
Power Equipment	2
Telephones	2
Connections at Switchboard	3
Designation of Switchboard Apparatus	3
Operating Instructions	3
Ordering Apparatus and Parts	6
Circuit Explanation	6
Initiation of a Call	6
Line Finder Start	6
Searching for a Calling Line	6
Line Finder Encounters Calling Line	6
Generating the Dial and Busy Tones	7
Dialing	7
Testing the Called Line	8
Called Line Tests Busy	8
Releasing from a Busy Line	8
Seizing the Called Line	8
Signalling the Called Line	9
Ring Back Tone	10
Code Ringing	10
Called Station Answers	10
Transmission	11
Releasing after Conversation has Terminated	11

STROWGER TYPE 32A1 P-A-X

1 - General

The Strowger Type 32A1 P-A-X provides full-automatic, isolated private branch exchange service. It has a capacity of ten lines and two intercommunicating paths (connecting links).

One station (telephone) may be connected to each line when individual line service is desired. The number of stations may be increased beyond ten, however, by connecting two stations per line. Care is required in assigning two stations per line as no facilities are provided for signaling between two telephones on the same line.

2 - Ringing Methods

Automatic ringing is generally employed when individual lines are used, or where the second station on a line is operated as an extension set.

Dial-controlled ringing is employed for two-party lines. Code signalling is used to identify the two stations---a long ring for one station, and a short ring for the other. A long ring is produced by dialing an "8," and a short ring by dialing a "2." These long and short rings may be repeated as often as desired.

3 - Numbering

With automatic ringing the lines are assigned numbers as follows:

Line 1	Tele. No. 1	Line 6	Tele. No. 6
" 2	" " 2	" 7	" " 7
" 3	" " 3	" 8	" " 8
" 4	" " 4	" 9	" " 9
" 5	" " 5	" 0	" " 0

With dial-controlled ringing, a ringing digit (8 or 2) is suffixed to the line numbers (listed in the preceding paragraph) to designate the stations; for example, if 38 is dialed, the two telephones on line No. 3 are given one long ring to indicate that the first station is wanted. Similarly, dialing 32 will signal the telephones with a short ring to indicate the second station.

4 - Method of Operation

A call is made by first lifting the handset and placing it to the ear. Dial tone will be heard if an intercommunicating path is available. If both intercommunicating paths are in use, there will be no dial tone, and the handset should be replaced for a few moments.

When dial tone is received, the desired line number is dialed. If dial-controlled ringing is employed, the ringing code suffix should then be dialed. This suffix may be repeated as often as desired, but the line number should not be repeated without first replacing and again lifting the handset.

When automatic ringing is employed, ring-back tone (a faint "burring" sound) will be heard at the calling telephone if the dialed line is

idle, thus indicating that the called station is being signalled. When dial-controlled ringing is used, ring-back tone will not be received since ringing occurs while the dial is rotating back to normal.

The called station answers by lifting the handset. Disconnection is accomplished by replacing the handsets at both telephones. If the called station is in use, "busy" tone (a fairly rapid "buzz-buzz" sound) will be transmitted to the calling telephone, and the connection is released when the calling person abandons the call.

In case an error is made in dialing, the handset should be replaced to release the connection, and the call then re-established.

5 - Installation

(a)- Switchboard Location

The switchboard should be located as near the center of the wire distribution as practicable. It may be mounted on a wall or column, or on the top of a table. A reasonably dry location, comparatively free from dust and fumes is desirable. Two short angle-steel pieces serve as feet when the switchboard is located on a table, and as hinged wall brackets when the switchboard is mounted on a wall.

(b)- Power Equipment

Fig. 1 is a single line diagram showing three arrangements of power supply. When a storage battery is employed, the cells should be connected in accordance with the instructions supplied by the battery manufacturer, and the charging rate adjusted to compensate for the current used during ordinary traffic.

Two No. 14 B. & S. gauge B.R.C. wires are required between the switchboard and the storage battery or the battery eliminator, whichever is provided. When a storage battery is employed, No. 14 B.R.C. wire should also be used to connect the charging equipment to the battery.

The battery eliminator, or the storage battery and associated charging equipment, may be housed in a combination cabinet with the switchboard or may be located adjacent to the switchboard at a distance not exceeding 25 feet.

(c)- Telephones

For desk sets, the line wires and the telephone stand cord should be connected to the ringer box in accordance with the circuit labels attached to the base of the telephone and to the inside of the ringer cover.

For wall sets, the line wires should be connected in accordance with the circuit label attached to the inside of the cover of the set.

Two wires (one pair) are required from the switchboard for each line. The lines should not exceed a loop resistance of 200 ohms, exclusive of the telephone and line relay resistances. The installation of the telephones and wiring should be done in accordance with specification 5104 - Building Wiring for Private Dial Systems---a copy of which may be had upon request.

(d)- Connections at Switchboard

The lines from the telephones should be connected to the terminal block located at the rear of the switchboard. The power supply leads should be connected to the fuse block also located at the rear of the switchboard.

Layouts of the terminal and fuse blocks are shown in Fig. 2.

(e) Designation of Switchboard Apparatus

The relays, switches and other apparatus in the switchboard are stenciled by name or number so that they may be readily located. The circuit sketch in Fig. 2 is designated in a similar manner.

6 - Operating Instructions

In order to forestall possible interruptions in the service, it is desirable to make occasional checks to determine that the equipment is functioning properly. Such tests and inspections can be performed most effectively if a simple system of routines is established. The routines recommended, and the approximate time intervals at which they may be performed, are suggested in the following table.

(a)	Test Charge Alarm Signal	Monthly
(b)	Inspection of Storage Battery	Monthly
(c)	Inspection of Charging Equipment	Monthly
(d)	Inspection of Battery Eliminator	Monthly
(e)	Clean Switchboard	Monthly
(f)	Test Switching Equipment	Monthly
(g)	Lubrication of Rotary Switch Mechanism	Semi-Annually
(h)	Inspection of Telephones	Annually
(i)	Check Adjustments	Annually

(a) Charge Alarm Signal

When a rectifier is used for charging a storage battery, the alarm springs on the rectifier can be wired to a bell or buzzer to serve as an alarm when the commercial current is disrupted. To test this charge alarm signal, open the commercial current supply to the rectifier.

(b) Inspection of Storage Battery

When a storage battery is used, the electrolyte level in the cells should be maintained one-half inch above the tops of the plates by adding distilled water. The water should be handled in clean glass or earthenware vessels. Additional sulphuric acid should not be placed in the cells.

The state of charge can be determined by observing the positions of the indicator balls located at the positive end of the middle cell of each 3-cell unit. The lower, or white, ball will sink when the cell is approximately 25 percent discharged, and the upper, or green, ball when the cell is approximately 75 percent discharged.

The storage battery is usually operated on a "trickle" or full float, charge basis, i.e.. the charging current is applied continuously. It may be operated on a semi-float basis, the charging being automatically started whenever a call is initiated and continuing until the battery is fully charged. When the semi-float method is used, the charge-start lead

should be connected to the terminal marked "CHG. ST." on the terminal block located at the rear of the switchboard.

When the full float method is used, the charging rate should be adjusted to approximate that of the average discharge rate for twenty-four hours. This charging rate should be low enough to cause the lower (white) ball to fall during the day time, and still high enough to cause white ball to float near the top at the end of the night, or light, load period.

Both overcharging and undercharging are harmful if continued over a long period. To guard against both, the gravity of the electrolyte should be permitted to fall slightly over a four to eight week period, and the battery then given an equalizing charge to bring it back to a fully charged condition.

(c) Inspection of Charging Equipment

(1) Full-Wave Rectifier

When a rectifier is provided, inspect for fuse plugs and bulbs loose in the sockets; see that both bulbs are glowing; and inspect for possible loose connections in the wiring. Two spare rectifier bulbs should be kept on hand. The charging rate should be adjusted in accordance with the instructions supplied with the rectifier.

(2) Direct Current Charging Unit

When a direct-current charging unit is provided, inspect for fuse plugs loose in the sockets, and for possible loose connections in the wiring. The charging rate should be adjusted in accordance with the instructions supplied with this unit.

(d) Inspection of Battery Eliminator

When a battery eliminator is provided, inspect the fuse plugs, rectifier bulbs, and the 60-watt lamp for looseness in the sockets; see that rectifier bulbs and the 60-watt lamp are glowing; and inspect for possible loose connections in the wiring. Two spare rectifier bulbs should be kept on hand.

The permissible voltage regulation of the Type 32A1 P-A-X is from 21.5 volts minimum to 26.5 volts maximum. Adjust the direct-current voltage in accordance with the instructions supplied with the battery eliminator.

(e) Cleaning Switchboard

Cleanliness and freedom from dust are essential for the proper operation of telephone equipment. Accordingly, the dust covers should be left on at all times except when inspecting the individual parts. The exterior of the switchboard should be cleaned with a dry cloth.

(f) Test Switching Equipment

(1) Ringing and Talking Test

Lift the handset of any telephone and observe whether dial tone is heard. Call any telephone line and note whether ring-back tone is received. Then talk with the called person to determine whether the transmission is satisfactory. Replace the handsets of both telephones.

(2) Busy Test

Lift the handset of any telephone and dial the number of that telephone. Busy tone should be heard. Without replacing the handset perform test (6).

(3) Second Intercommunicating Path Test

Repeat tests (1) and (2) from another telephone.

The operation of the combined line and cut-off relays may be checked as follows:

(4) Short-circuit the terminals of a line at the terminal block. The associated line and cut-off relay should operate, and a line-finder should rotate to the line under test.

(5) If a line-finder does not rotate, remove the "short" and inspect the line relay. If it is operated, there is a "permanent" condition on the line. A handset accidentally blocked off the cradle may be the cause of the permanent.

(6) If no unstandard condition is observed at the telephone, disconnect the line wires from the terminal block. If the relay restores, the fault is outside the switchboard; if not, the fault is in the switchboard.

(g) Lubrication of Rotary Switch Mechanism

All bearing surfaces should be lubricated, care being taken to avoid applying too much lubricant. The oil should be applied by means of a No. 22 B. & S. gauge, bare, copper wire or the small end of a toothpick. The quantity of oil adhering to such a wire or toothpick when dipped approximately one-half inch into the lubricant constitutes one drop.

One drop of spindle oil (specification 5231) should be applied to the bearings of the motor-magnet armature and the wiper shaft. Three drops of switch lubricant (specification 5232) should be applied to the ratchet teeth.

(h) Inspection of Telephones

The following procedure should be observed when making an inspection of the telephones.

(1) Test the speed of the dial by dialing the digit "0." Approximately one second should be required for the return of the dial.

(2) Frayed and worn receiver and desk stand cords should be replaced.

(3) A transmission test should be made over each telephone, by talking with another person, noting how well his voice is heard and inquiring how well he hears the voice of the person making the test. Unsatisfactory receivers or transmitters should be replaced, and the defective units returned for repair.

7 - Ordering Apparatus and Parts

When ordering additional telephones, parts, etc., always list the name or description, and if possible the piece number.

8 - Circuit Explanation

A schematic circuit diagram is shown in Fig. 2. The circuit explanation is as follows:

Initiation of a Call

When the handset at the calling telephone is lifted, a circuit is established through the telephone loop, relay L-5 (which is common to all line relays) and the 1100-ohm winding of relay A03. This causes A-3 to operate sufficiently to close its make contacts designated "X," but not enough to operate its break contacts. Relay A-3 operating partially, connects "-" battery to the control C bank contact of the line finders, thereby "marking" the calling line, and preparing a circuit to cause the complete operation of relay A-3 when the line finder engages the calling line.

Line Finder Start

Relay L-5 completes a circuit through relay E in series with the 40-ohm winding of the connector magnet A-4, causing E to operate. The connector magnet does not operate when connected in series with E.

Relay E closes a circuit to the 40-ohm winding of the line finder magnet A-2; and disconnects the finder start lead (Outg. St.) from the succeeding finder-connectors, to prevent them from searching for the "marked" line.

Magnet A-2 closes a circuit to the upper 125-ohm winding of relay A, causing A to operate. It also prepares the pawl and ratchet mechanism fo advancing the line-finder wipers one step.

Searching for a Calling Line

Relay A opens the circuit to the line finder magnet. When the magnet is de-energized, its armature and pawl, restoring to normal under the power of the restoring spring, step the wipers to the next set of bank contacts; and the circuit to the upper 125-ohm winding of A is opened.

Line Finder Encounters Calling Line

Relay A releasing, again completes the circuit to the line finder magnet; whereupon, the magnet re-establishes the circuit to A. This alternate performance of the magnet and relay A will be repeated until the control wiper C of the line finder encounters "-" battery. A circuit is then established through the lower 125-ohm winding of A, 50-ohm winding of D and the 250-ohm winding of A-3. Positive battery from the same source is also connected to the control normal lead CN terminating in the connector banks, to busy the calling line against intrusion.

Relay A-3 now operates completely and disconnects its 1100-ohm winding from the "-" side of the line and relay L-5 from the "+" side of the line, permitting L-5 to release. This opens the circuit to relay E. Relay E, however, is slow acting and remains operated for a short interval.

Relay A is held operated through its lower winding, keeping the circuit to the finder magnet open and stopping the stepping motion of the finder. The current through the 50-ohm winding of D causes its armature to operate sufficiently to close the make contact "X," causing B to operate. Relay B extends the "-" side of the calling line to the upper 125-ohm winding of A, and completes a circuit to the 200-ohm winding of D, causing D to operate.

Relay D disconnects its 50-ohm winding, and extends the "+" side of the line to the lower winding of A. Battery is now supplied to the calling telephone loop, through the windings of A. Relay D also connects "+" battery to the 250-ohm winding of A-3 to keep A-3 operated during the remaining period of the connection; connects "+" battery to the tone start lead (Tone St.) to start the dial and busy tones; and connects dial tone, through the eleventh (home) bank contact of connector level "+L" and a .005 M.F. condenser, to the "+" side of the calling line to indicate that dialing may proceed.

Relay E restoring shortly after D has operated, prepares a circuit to relay E of the succeeding finder-connectors so that other calls may be served while the call under discussion is still in progress.

Generating the Dial and Busy Tones

When D operates, "+" battery is connected to the tone start lead (Tone St.) A circuit is completed to the upper 250-ohm winding of relay S-5 in series with the 100-ohm winding of R-5. Relay S-5 short-circuits its upper 250-ohm winding, restores, removes the shunt, and again operates. This buzzer action continues as long as "+" battery is maintained on the Tone St. lead. The current through the upper winding fluctuates between maximum and zero each time S-5 operates, and in this manner, an alternating current is induced into the lower 250-ohm winding. This tone is impressed upon the Dial Tone lead, and is connected to the "+" side of the calling line, through a .005 M.F. condenser.

When "+" battery is connected to the Tone St. lead, the circuit of M-5 is also closed. Relay M-5 connects the tone generated by S-5 to the Busy Tone lead; and short-circuits its own 500-ohm winding and restores. This removes the shunt from the 500-ohm winding and M-5 again operates. Relay M-5 is slow both to operate and to release, which action causes the tone connected to the Busy Tone lead to be periodically interrupted.

In the event that storage battery charging equipment is so arranged that the charging is started each time a call is initiated, the circuit to the charge start equipment is completed when "+" battery is connected to the tone St. lead.

Dialing

Each time a digit is dialed, the current through the calling station loop and relay A is interrupted and then closed, once for each impulse; that is, if the digit "6" is dialed, relay A alternately releases and operates six times. Upon restoring, A opens the circuit to B, but since "B" is of the slow release type, it remains operated during the impulsing periods. When relay A releases momentarily, a circuit is completed to the 40-ohm winding of the connector magnet A-4. A circuit from the same "+" battery

source is also established to the 250-ohm winding of relay C. This causes relay C to operate in multiple with the connector magnet on the first impulse, but since C is slow acting, it remains operated during the rest of the impulses of the series.

Magnet A-4, in following the dial pulses, causes the wipers to be rotated, step-by-step, to the bank contacts corresponding to the dialed digit. On the first step, dial tone is disconnected.

Relay C operating on the first impulse, short-circuits the break contact of G in the pulsing circuit so that this circuit will not open should G operate while the wipers are being stepped over busy line contacts.

Testing the Called Line

Within a few seconds after the dialing operations, either ringing tone or busy tone will be heard, thus indicating the progress of the call.

Called Line Tests Busy

When the connector wipers reach the bank contacts associated with the called line, the control wiper C encounters "+" battery. A circuit is completed to the winding of G, causing this relay to operate. Relay G opens part of an incomplete circuit to the 100-ohm winding of H to prevent H from operating in the event the called line is later freed; and connects busy tone, through a .005 M.F. condenser, to the "+" side of the calling line.

Relay C restoring shortly after impulsing has ceased, opens the connector magnet circuit to prevent possible further stepping action; and also switches the winding of G from the control wiper G to "+" battery at a break contact of H, to hold G operated until disconnection occurs.

Releasing from a Busy Line

Upon hearing the busy tone, the calling person replaces the handset. This opens the telephone loop circuit, permitting A to restore. Relay A opens the circuit to B, allowing B to release shortly thereafter.

Relay B opens the circuits to the 200-ohm winding of D and the winding of G, permitting both D and G to restore; and connects "+" battery to contacts 1 to 10 inclusive of connector bank level A, completing a homing circuit to magnet A4. The magnet alternately operates, opening the homing circuit; and then releases, re-establishing this circuit; thereby, advancing the connector wipers until they reach the eleventh position.

Relay D opens the circuit to the 250-ohm winding of A-3 associated with the calling line, permitting this relay to release and restore the line to normal. Relay D also disconnects "+" battery from the Tone St. lead, causing tone relays S-5 and M-5 to cease operating.

Seizing the Called Line

In the event the called line is idle, C restoring after impulsing has ceased, closes a circuit through the 100-ohm winding of H, the control wiper C of the connector, and the 250-ohm winding of line relay A-3 associated

with the called line. This causes relay A-3 to operate completely and clear the line of attachments.

The current flowing through the 100-ohm winding of H, in series with the 250-ohm winding of A-3, is just sufficient to cause H to close its make contacts designated "X." The "+" battery potential connected to the control normal C.N. of the called line, through the 100-ohm winding of H, busies the called line against intrusion by other calls. Relay H completes a circuit to its 500-ohm winding and operates completely.

Relay H fully operated, opens the circuits to relay C and magnet A-4 so that any subsequent operation of the dial at the calling telephone will cause no further stepping of the connector. Relay H also connects direct "+" battery to the control wiper C to guard the called line; connects "+" battery, through the 100-ohm winding of F, to the "-" side of the called line; connects the interrupted generator lead (Int. Gen.) to the "+" side of the called line; and connects "+" battery to the generator start lead (Gen. St.)

Signalling the Called Line

Ground on the GEN ST. lead completes a circuit to U-5; T-5; and the #1 winding of N-5 in series with the #2 winding of N-5. U-5 operates with a large amplitude for starting; prepares a short circuit to U-5; and closes the circuit to the 8-7 winding of W-5. T-5 operates; removes the short circuit from resistance "A5" and closes the short circuit to U-5. U-5 restores; removes its short circuit; opens the circuit to the 8-7 winding of W-5; and the momentum of the weighted reed, on restoring, causes the circuit to the 5-6 winding of W-5 to be closed momentarily. U-5 is energized in series with resistance "A5" and operates with normal amplitude, short circuits its winding and closes the circuit to the 8-7 winding of W-5. U-5 restores again closes the circuit to the 5-6 winding of W-5. U-5 continues to vibrate as long as ground remains on the GEN. ST. lead. The 8-7 and the 5-6 windings of the W-5 are in opposite direction and an alternating field is therefore generated which induces an alternating current of approximately 25 cycles per second in the 1-2-3-4 winding of W-5.

Assuming that the P-A-X is arranged for automatic ringing "X" wiring, relay N-5 also operates when "+" battery is connected to the Gen. St. lead, and sets its weighted spring into vibration. This intermittently closes a circuit to the 500-ohm winding of relay R-5; however, because of the slow-to-operate characteristics of R-5, it does not operate until the weighted spring of N-5 has nearly come to rest.

Relay R-5 sets its own weighted spring into vibration; thereby intermittently closing a circuit to the winding of P-5. Relay P-5 is also slow-to-operate, and accordingly does not operate until the weighted spring of R-5 has almost ceased vibrating.

Relay P-5 disconnects direct "+" battery from the ringing lead (Int. Gen.), and connects thereto grounded ringing current. Relay P-5 also opens the circuit to N-5, and connects a short around the 500-ohm winding of N-5, which causes N-5 to be slow to restore. When N-5 restores, after the operation of P-5, it opens the circuit to R-5, permitting R-5 to restore. Relay R-5 is slow to restore, and on restoring opens the circuit to P-5, which

likewise is slow to release. Relay P-5 removes the shunt from the 500-ohm winding of N-5, connects "+" battery to the 500-ohm winding of N-5, causing N-5 to reoperate; and disconnects ringing current from the Int. Gen. lead.

With the reoperation of N-5, the foregoing sequence of operations of relays N-5, R-5 and P-5 is repeated as long as "+" battery is connected to the Gen. St. lead. In this manner, the ringing current is periodically interrupted to cause the bell at the called telephone to ring intermittently.

When P-5 operates, a circuit is completed from "+" battery, superimposed by ringing current, through the called station ringer (in series with a condenser) and the 100-ohm winding of F to "-" battery. The copper slug over one end of the core prevents F from operating from alternating current.

Ring Back Tone

A portion of the interrupted ringing current passes through the .005 M.F. condenser to the "+" side of the calling line during the ringing period; indicating to the calling person that the called station is being signalled.

Code Ringing

In case code ringing is employed, the wiring designated "X" in the schematic circuit diagram is removed, and the wiring designated "Y" provided. Ringing of the called station is then controlled by the dial impulses. Dialing the suffixed digit "8" produces a long ring; and the digit "2," a short ring.

Relay A follows the impulses of the ringing digit, and each time it restores, it momentarily opens the circuit to B and closes a circuit to C. Relay C completes a circuit to the winding of G, causing G to operate; disconnects "+" battery from the "+" side of the called line; and connects thereto ringing current.

Relay N-5 is not operated in this case when "+" battery is connected to the Gen. St. lead. The ringing circuit is in other respects similar to that previously described.

Relay C remaining operated during the impulsing period, produces a ringing period which includes the impulsing period and the releasing time of C. When C restores, the circuit to G is opened. Relay C also disconnects ringing current from the "+" side of the called line and reconnects "+" battery, in preparation of the ring-cut-off circuit.

Called Station Answers

When the called station answers, a loop is closed through that telephone, thus providing a direct-current circuit from "+" battery (either direct or through the two 78-ohm secondary windings of the ringing transformer W-5) connected to the Int. Gen. lead, through the called telephone, and the 100-ohm winding of F to "-" battery. Relay F is operated sufficiently to close its make contact designated "X," irrespective of whether the called station answers during the ringing or silent interval. This completes a circuit to the 400-ohm winding of F. Relay F disconnects "+"

battery from the Tone St. lead to stop generation of the dial and busy tones; disconnects "+" battery from the Gen. St. lead to stop generation of interrupted ringing current. Relay F also disconnects the Int. Gen. lead from the "+" side of the called line; connects "+" battery, through the lower 125-ohm winding of A to the "+" side of the called line; disconnects the 100-ohm winding of F from the "-" side of the called line; and connects the upper 125-ohm winding of A to the "-" side of the called line. This transfer of the called line to relay A also extends the calling line through to the called line.

Transmission

Transmission battery is now supplied to both telephones through the two 125-ohm windings of relay A.

Releasing after Conversation has Terminated

Connection is maintained during conversation under control of relay A; therefore, as long as current is flowing through either the calling or called telephone loops, relay A remains operated.

At the termination of conversation, when the handsets at both telephones have been restored, the circuit to relay A is opened, permitting it to restore. This opens the circuit to B which restores shortly afterwards.

Relay B opens the circuits to the 200-ohm winding of D, the 400-ohm winding of F, and the 500-ohm winding of H, permitting these relays to restore. Relay B also prepares a "homing" circuit for the connector.

Relay D opens the circuit to the 250-ohm winding of A-3 associated with the calling line, permitting A-3 to release; and disconnects "+" battery from the control bank contact (C.N.) associated with the calling line, so that the calling line will not test busy to incoming calls.

Relay A-3 associated with the calling line connects "-" battery, through its 1100-ohm winding, to the "-" side of the calling line; and connects "+" battery, through the 100-ohm winding of common relay L-5, to the "+" side of the line; thereby restoring the calling line to normal.

Relay H disconnects "+" battery from the control bank contact (C.N.) associated with the called line, so that the line will not test busy to incoming calls; and opens the circuit to the 250-ohm winding of A-3 of the called line, allowing A-3 to restore. Relay H also completes a circuit from "+" battery on the first ten contacts of connector bank level A, to the 40-ohm magnet winding A-4. This interrupter circuit causes the magnet to rotate the connector wipers to the eleventh ("home") position.

Relay A-3 associated with the called line releasing, restores the called line to normal.

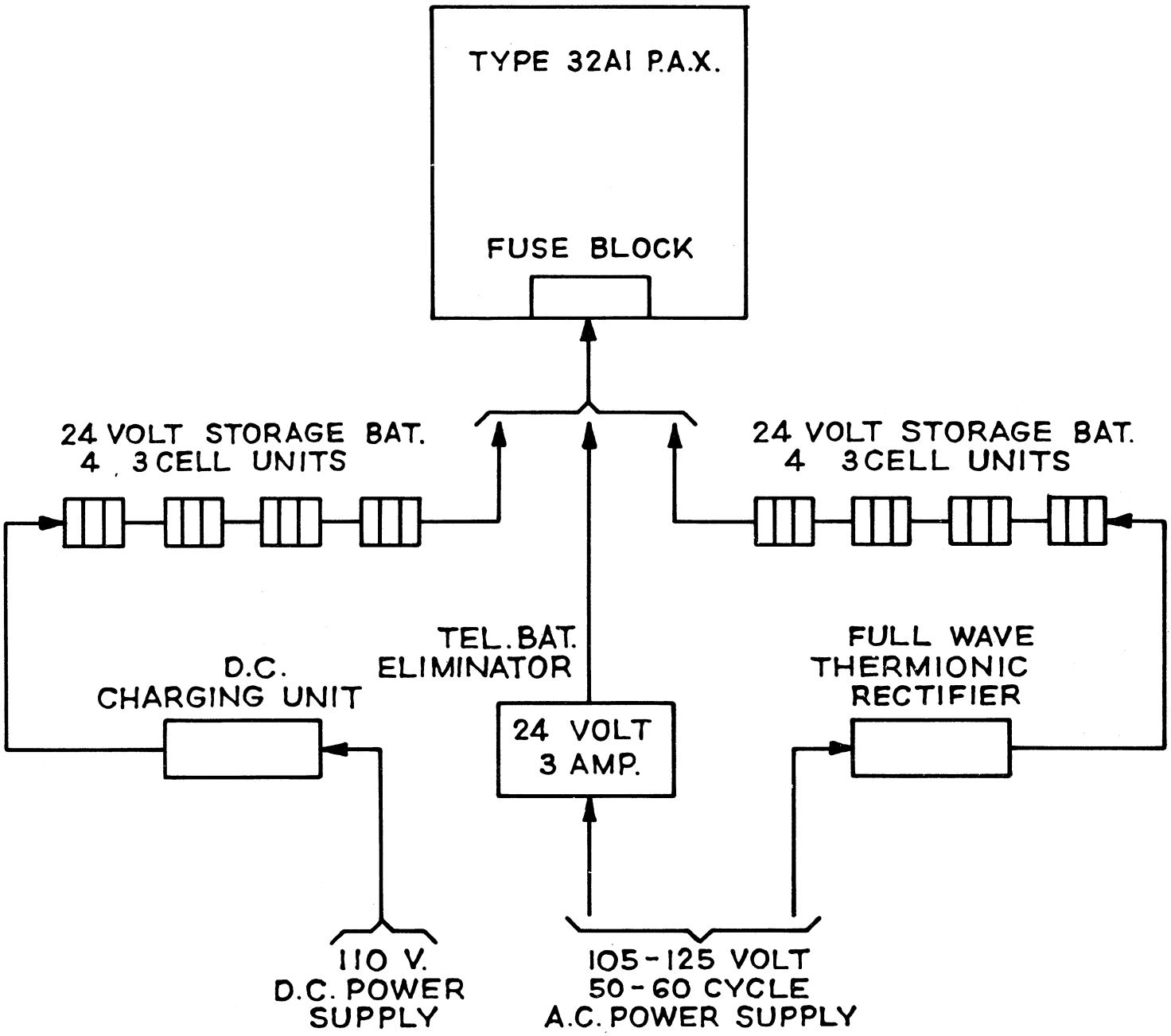

FIG. 1 ALTERNATIVE POWER ARRANGEMENTS AVAILABLE WITH TYPE 32AI P-A-X.

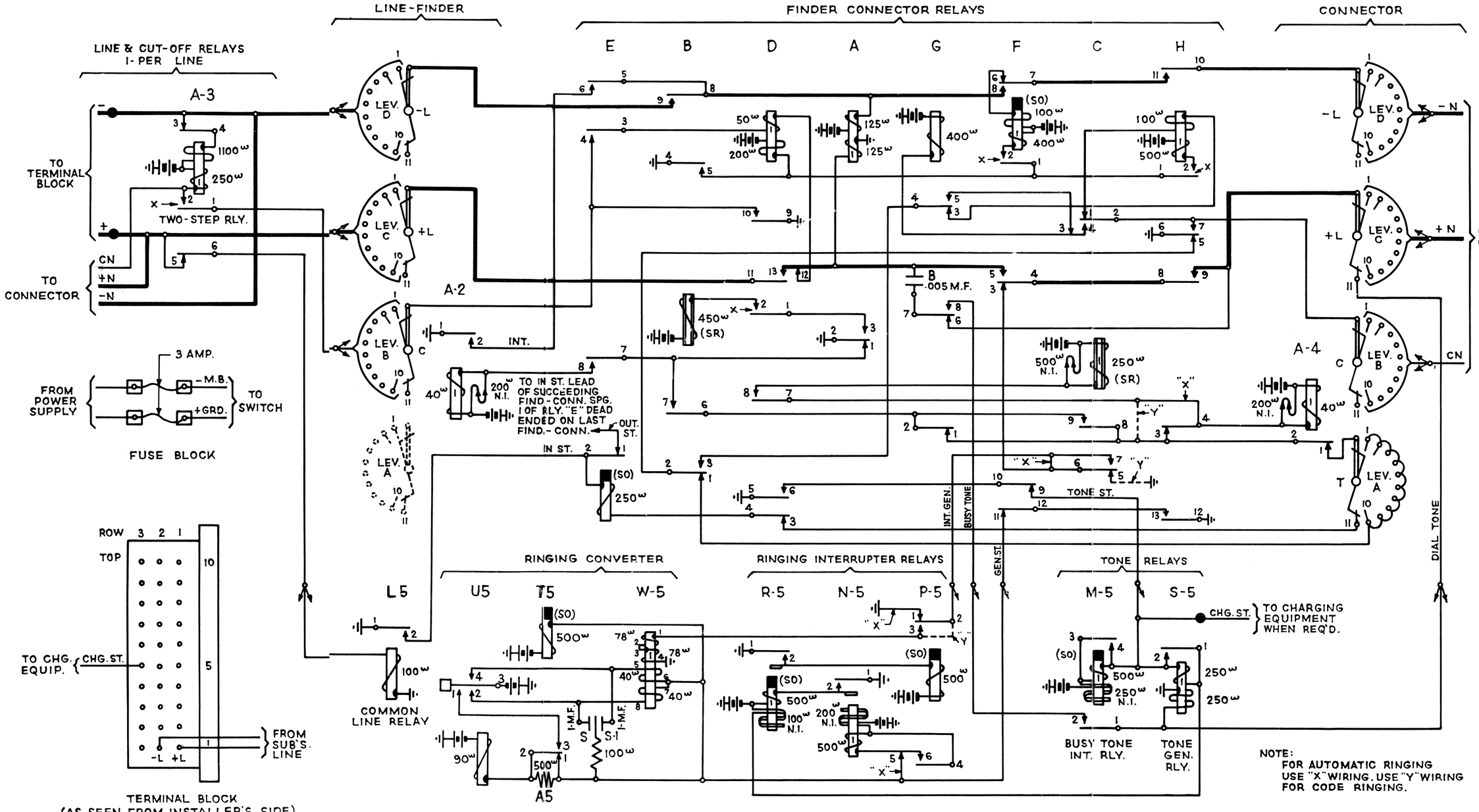

FIG. 2 SCHEMATIC CIRCUIT DIAGRAM OF THE TYPE 32A1 P.A.X.