# REFERENCE

# 1A

# KEY TELEPHONE SYSTEM

## 1. GENERAL

**1.01** This section provides identification, installation and maintenance information for the 1A Key Telephone System.

**1.02** Information in this section was formerly contained in Section 518-110-100, which is hereby canceled.

## 2. IDENTIFICATION

**2.01** The main components of a 1A Key Telephone System are key telephone sets and/or nonkey telephone sets (with separately mounted keys) used in conjunction with the appropriate key telephone units. The complete system also includes power supplies, cabling, distribution terminals, adapters, fasteners, and mounting facilities such as apparatus mountings or equipment cabinets.

**2.02** The 1A Key Telephone System provides the following service features:

- Holding on CO, Centrex, or PBX Lines
- Visual and audible line signals
- Intercommunicating
- Conferencing
- Cutoff, exclusion, and selective privacy
- Private lines

**2.03** The 1A system line circuit operates and holds on line battery. In addition to tip and ring conductors required between stations and apparatus serving the installation, a balance and hold lead must be provided to stations arranged for hold. Local power from transformers, rectifiers, building or PBX batteries, central office cable pairs, etc, is required to provide auxiliary service features such as visual and audible signals, intercommunicating, automatic time-out, etc.

**2.04** Incoming signals are indicated audibly and/or visually. They may be steady or intermittent in operation. When a call is answered, relay operation silences the audible signal and changes the flashing line lamp, if provided, to a steady busy lamp. A ***common time-out feature*** is provided which releases locked-in relays and extinguishes incoming signal indication if the call is not answered within approximately 30 seconds and if no other line in the system is busy. The overall time-out interval varies from an extremely short (or no) interval up to 30 seconds depending on whether the thermal control element has had sufficient time to cool following its last operation.

**2.05** Key telephone units (KTUs Fig. 1 and 2) are individual circuit packages which provide switching and control functions and are arranged for mounting in standard equipment cabinets or apparatus mountings.

**2.06** Table A lists the 1A-type KTUs and the features they provide.

### OPERATING FEATURES

#### A. Hold

**2.07** Permits holding a CO, Centrex, or PBX line while using another line at the station. Hold circuit characteristics are explained as follows: Depressing the HOLD key releases L relay causing H relay in the line circuit to operate and lock up on line current.

#### B. Audible Signals

**2.08** The ringer may be connected to an individual line or wired as a common ringer for a group of lines. A bell or buzzer may be used as the audible signal for one or more groups of stations.

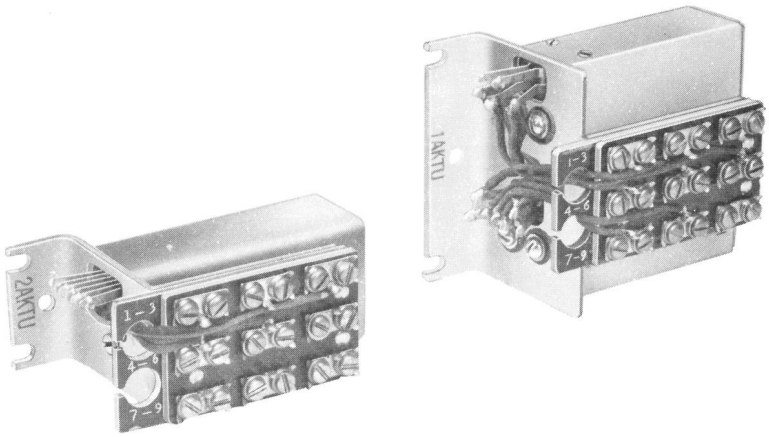



Fig. 1—Angle Bracket Key Telephone Units

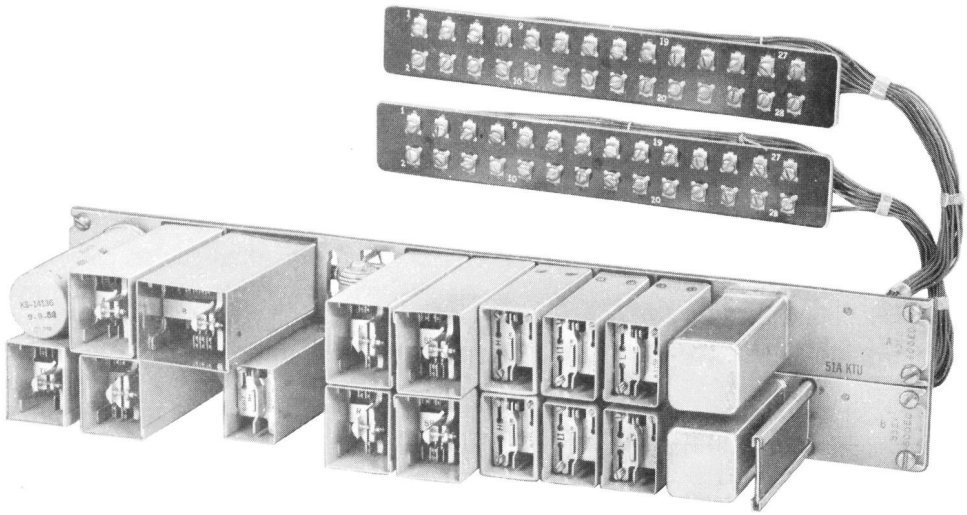



Fig. 2—51A (MD) Key Telephone Unit

**2.09** Use of a diode matrix block can provide flexibility in associating several key telephone system lines with one or more common audible signals. Matrix units consist of two electrical groupings: lines and ringers. Small clip-type mounting terminals are furnished in multiple combinations on the face of the unit. Pig tailed diodes (446F) are hand inserted by the installer at appropriate electrical crosspoints to associate any line(s) with any ringer(s) connected through the unit.

### C. Visual Signals

**2.10** Visual signals are furnished as illuminated buttons in multiline telephone sets and

**TABLE A**
**ANGLE BRACKET KTU'S**

| ORDERING GUIDE KTU | FEATURES OR OPTIONS | | QUANTITY |
|---|---|---|---|
| 1A<br>1B<br>1C (MD) | Hold circuit | Standard<br>For 555 PBX line | 1 per line |
| 2A<br>3A | Battery feed coil (14 to 26 volts)<br>Intercom signaling circuit | | 1 per intercom |
| 5A | Auxiliary hold circuit | | 1 per line |
| 6B<br>6C | Supervisory and busy lamp circuit | Standard<br>For 555 PBX line | |
| 7A | Private line circuit | | |
| 8A<br>8C | Terminal panel assembly | Blank<br>For U-type relays | As required |
| 10A | Automatic exclusion circuit | | 1 per line |
| 11A | Ringing feed lamp circuit | | 1 per central office generator feed |
| 12B | Dry cell battery feed coil (4-1/2 volts) | | 1 per intercom |
| 13C | 2-way automatic signaling intercom circuit | | |
| 14A<br>15D | Ringup relay circuit | Manual area<br>Dial area | 1 per line |
| 16A | Common audible signal control circuit | | 1 per group of common aud signal |
| 17B<br>17C (MD) | Switching relay circuit | | As required |
| 18D<br>18E | Busy and supervisory relay circuit | Standard<br>For 555 PBX line | 1 per line |
| 19B | Flashing circuit | | 1 per 6 lines |
| 20A | Common audible control circuit manual | | 1 per group of common aud signal |
| 21A | Fusing unit | | 1 per 6 fuses |
| 22 type | Resistor units for dc lamp supply | | As required |
| 23A | Noise suppression circuit | | 1 per system |
| 24A | Telephone set induction coil unit | | 1 per station |
| 25B | Automatic cutoff control circuit | | 1 per line |
| 26B | Automatic cutoff circuit | | 1 per line |
| 27A | Capacitor circuit 4 uf | | 1 per line |
| 28A | Equalizing resistor circuit | | 1 per station |
| 29A | Cut-through relay | | |

**TABLE A (Cont)**

**ANGLE BRACKET KTU'S**

| ORDERING GUIDE KTU | FEATURES OR OPTIONS | | QUANTITY |
|---|---|---|---|
| 30A | Time-out circuit | | As required |
| 31A | Battery feed relay | | 1 per intercom |
| 32A | Equalizer unit | | 1 per station |
| 33A | Wink circuit (used with 17B KTU) | | 1 per 5 lines |
| 34A | Make-busy circuit (CO or PBX trunk group) | | 1 per line or group of lines |
| **STRIP-MOUNTED KTUS** | | | |
| 51A* | Two CO, Centrex or PBX line circuits with common equipment for up to 6 lines | | As required |
| 52A* | CO, Centrex or PBX line circuit | | 1 per line |
| 53A* | Tie line circuit | Automatic | 2 per line (1 at originating and 1 at terminating end) |
| 54A* | | Ringdown | |
| 55A* | Station line circuits | | 1 per line |
| 56A | Off-premises extension station circuit | | |
| 57A* | 9-station dial-selective signaling intercom circuit | | 1 per system |
| **PACKAGE UNITS†** | | | |
| 50A* | Two CO, Centrex or PBX line circuits with common equipment, manual intercom with line lamps | | As required |
| 50B* | Three CO, Centrex or PBX line circuits with common equipment, manual intercom with line lamps | | As required |
| 50C* | Four CO, Centrex or PBX line circuits with common equipment, manual intercom with line lamps | | As required |

* Manufacture discontinued.

† Mounts in a 4-plate apparatus cabinet per ED-91472-70.

separately mounted keys or in separate lamp indicators as follows:

- Flashing lamp, locked-in or nonlocked-in line lamp, signifying an incoming call
- Steady lamp indicating line busy or, in some cases, hold
- Winking signal—line on hold

### D. Make-Busy and Key Circuit

**2.11** This arrangement is not usually considered to be fundamental to key telephone system service. It provides a means for busying out a CO, Centrex, or PBX line (or a group of lines) to incoming off-hour traffic. Outgoing traffic is not affected. It connects to CO, Centrex, or PBX circuits which provide the make-busy feature. A

separate control pair is required for each line or group of lines to be made busy.

### E. Manual Intercom

**2.12** The intercommunicating feature enables two or more stations to be connected to a common talking line, usually on the same premises. A person may communicate with other persons at one or more stations connected in the system without the use of a CO, Centrex, or PBX line.

**2.13** The intercommunicating line may be provided with a line and busy lamp and associated key telephone units.

**2.14** Generally associated with the talking line are pushbutton and buzzer signaling devices among stations. The signaling buttons may be part of the key telephone set or may be externally mounted 1-, 4-, 8-, or 12-key button assemblies, or combinations of these keys. The buzzer may be mounted either externally or within the set.

### F. Automatic Intercom

**2.15** An intercommunicating circuit arranged to signal automatically from one station to the other by operation of the switch hook and to signal manually in the other direction, is referred to as a ***one-way automatic intercommunicating line.*** When the same type line is arranged to signal automatically from either end it is referred to as a ***two-way automatic intercommunicating line.***

### G. Conferencing

**2.16** Two PBX lines may be bridged for conferencing purposes under control of an exclusion key or nonlocking key at a key station. This can be accomplished without returning the handset on-hook and without the assistance of an operator. When the station is equipped with a speakerphone feature, a nonlocking key arrangement should be used to control the bridging circuit.

### H. Manual Cutoff and Exclusion

**2.17** The cutoff and exclusion features are similar and differ only in the manner in which they are provided. Both of these features are controlled by the operation of a mechanical device as follows:

(a) ***Cutoff:*** The turnbutton key must be operated manually to disconnect or to reconnect various circuit arrangements such as an extension ringer.

(b) ***Exclusion:*** The exclusion key is part of the switch hook assembly; it is operated manually by pulling the plunger up and restored automatically when the handset is replaced on-hook. This excludes extensions or other stations having access to the same line.

### I. Automatic Cutoff and Exclusion

**2.18** The circuit functions of automatic cutoff and exclusion are based on the station supervisory relay operation.

**2.19** ***Exclusion:*** A main station may be arranged to exclude automatically one or more secondary stations regardless of whether or not the stations are in use.

### J. Private Lines

**2.20** A private line is a metallic circuit between two stations which may or may not be on the same premises. It is used when two customers desire direct communication with each other without the need for routing the call through a CO, Centrex, or PBX switch train. The kind of private line service provided is determined by the type of terminating equipment used.

**2.21** A private line arranged so that either end can be manually signaled by the other is referred to as a ***ringdown private line.***

**2.22** A private line, arranged for signaling automatically from either end when the handset is lifted, is referred to as an ***automatic tie line.***

**2.23** A private line, arranged for signaling in one direction automatically and in the other manually, is referred to as a ***station line circuit.*** This circuit differs from the ringdown private line in that the station end requires no line circuit or other additional equipment.

## 3. INSTALLATION

### PLANNING

**3.01** Fig. 3 shows a typical key telephone system installation.

#### A. Limitations

**3.02** Key telephone system line circuits are designed for use on CO, Centrex, or PBX lines only.

**3.03** Because of the hold feature, line circuits should not be installed on party lines.

**3.04** Refer to Division 500, section entitled, Ringing Bridge Limitations for maximum number of ringing bridges permitted per line.

**3.05** Table B lists approximate maximum distances between the 9- to 11-volt ac supply and the key telephone units.

**3.06** Table C gives the approximate maximum cable length between key telephone units and signal lamps.

**3.07** Table D shows the types of lamps most often required.

**3.08** When more than thirty-six 51A lamps or more than thirty G2 lamps are fed from a J86731A or D power plant or 393B transformer, two circuits must be provided. Each circuit must be equipped with a 2-amp fuse.

### INSTALLING

#### A. Mounting

**3.09** The angle bracket key telephone units are generally mounted in 105-type apparatus boxes (Fig. 4); however, they may be mounted in various cabinets or relay racks by using mounting bars. Strip mounted key telephone units are usually mounted in a 4-plate cabinet (Fig. 5).

**3.10** Mount cabinets, apparatus mountings, relay racks, or apparatus boxes as described in Division 463, section entitled, Equipment Cabinets and Apparatus Mountings, Identification.

#### B. Wiring

**3.11** See appropriate sections for information on:

(a) Selecting, placing, and fastening of wire and cable.

(b) Selecting A and/or B-type connector cables and/or adapters.

(c) Connections for installation of the particular key telephone system.

(d) Wiring of connecting blocks and terminals.

**3.12** The use of connector cables and plug-ended key telephone sets is recommended wherever practicable.

**3.13** The use of the proper 3-way bridging adapter makes it possible to have two key stations on one adapter or to extend cabling from one station to another.

**3.14** For speakerphone connections using connector cables, see appropriate section in Division 461 on 148- and 149-type adapters.

**3.15** Where possible, connecting blocks and connector cables should preferably be placed on walls adjacent to desks.

**3.16** Key cables may terminate beneath screw terminals of individual key telephone units, or on connecting blocks furnished in packaged units. They may also terminate at separate distribution terminals.

**3.17** Place the distribution terminal in a convenient and accessible location. If possible, centralization of the terminal with respect to station cables served from it is desirable.

**3.18** Tag or otherwise identify all cables at distribution terminals or on key telephone units.

**3.19** Use distinctive colors of 24-gauge BG or BW wire for strapping and cross-connecting key telephone units:

- Red for battery leads
- Black for ground leads

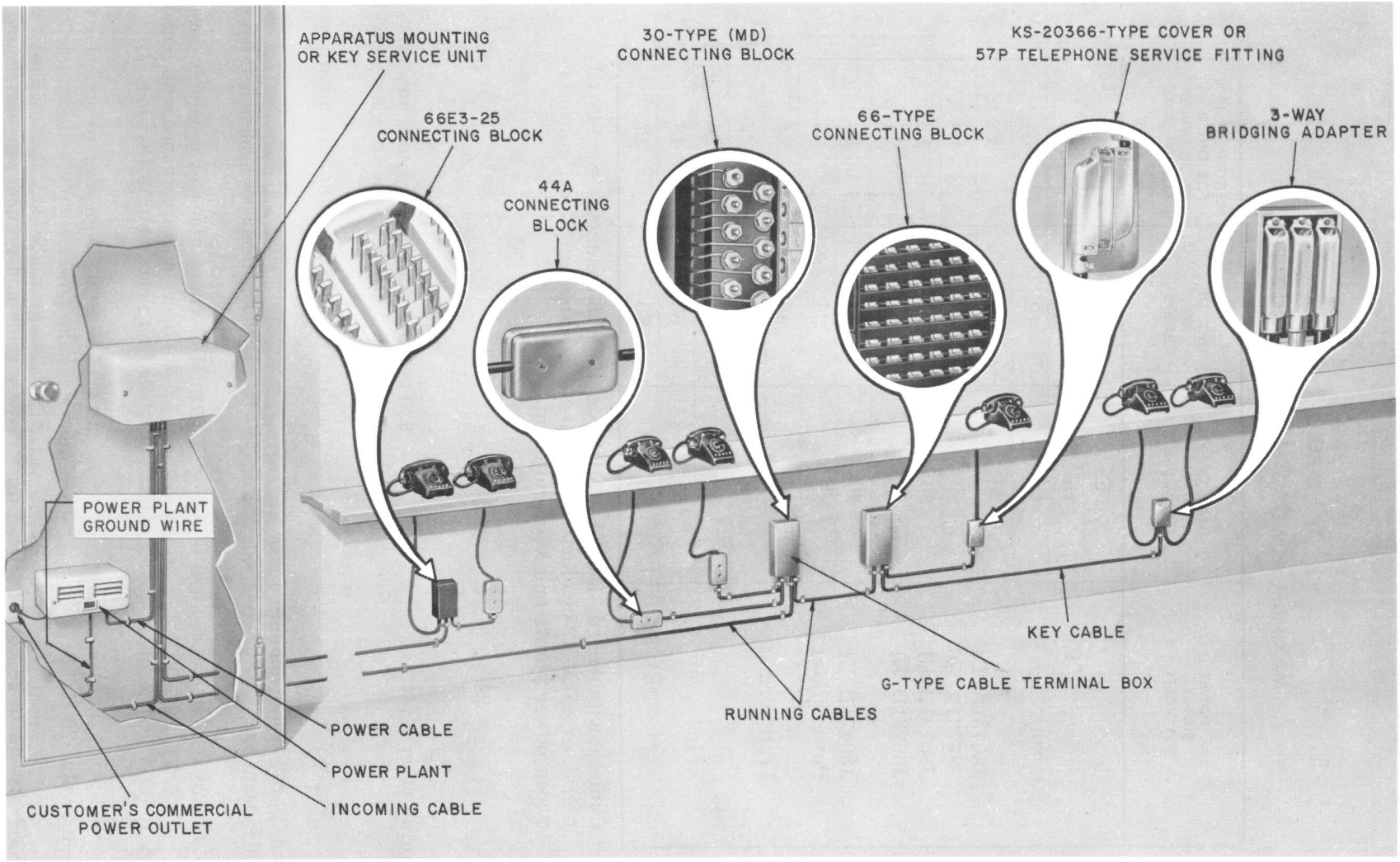



**Fig. 3—Typical Key Telephone System Installation**

**TABLE B**

**MAXIMUM POWER CABLE LENGTH AC SUPPLY**

| AC POWER SUPPLY 9-11 VOLTS | NO. OF 51A LAMPS | NO. OF G2 LAMPS | LENGTH OF RUN FOR ONE PAIR OF 20-GAUGE* COPPER WIRES |
|---|---|---|---|
| | | | FEET |
| J86731A, L4<br>J86731A, L6<br>J86731B, L1<br>J86731D, L1<br>or<br>J86471D, L1<br>Power Plant<br>393B<br>Transformer | 5 | 4 | 315 |
| | 10 | 8 | 155 |
| | 15 | 12 | 104 |
| | 20 | 16 | 78 |
| | 25 | 20 | 62 |
| | 30 | 24 | 52 |
| | 35 | 28 | 44 |
| | 40 | 32 | 39 |
| | 45 | 36 | 35 |
| | 50 | 40 | 24 |
| | 55 | 44 | 22 |
| | 60 | 48 | 20 |
| | 65 | 52 | 18 |
| | 70 | 56 | 17 |

* Cable (switchboard, 1450CL (MD), or 450M 6-conductor or 1451CL (MD), or 451M 12-conductor) is a 20-gauge cable suitable for use between power plants and key equipment.

- Green for all other leads

**C. Power**

**3.20** The basic power requirements for a key telephone system are:

- Relay—14 to 26 volts dc
- Lamp—9 to 11 volts ac or 14 to 50 volts dc
- Ringer—105 volts, 20 Hz
- Buzzer or bells—14 to 28 volts dc or 15 to 25 volts ac

**3.21** More than one key telephone system can be fed by the same power plant provided that:

(a) The power plant has adequate current capacity.

(b) Each key telephone system is fused separately.

**3.22** Determine the power supply arrangement to be used in accordance with section entitled Power Unit Selection (518 Division).

**3.23** Use a 20-gauge wire, or equivalent, between lamp power supply and key telephone units. Fig. 6 shows a J86731A, List 4 power plant with power cable and ground wire terminated. Ground the power supply in accordance with section entitled

**TABLE C**

**MAXIMUM CABLE LENGTH AC SUPPLY**

| NO. OF LAMPS PER PAIR | LENGTH OF RUN FOR ONE PAIR OF 24-GAUGE CABLE |
|---|---|
| | FEET |
| 1 | 470 |
| 2 | 235 |
| 3 | 155 |
| 4 | 115 |
| 5 | 90 |
| 6 | 75 |
| 7 | 65 |
| 8 | 55 |
| 9 | 50 |
| 10 | 45 |
| 11 | 40 |
| 12 | 35 |
| 13 | 35 |
| 14 | 30 |
| 15 | 30 |
| 16 | 25 |
| 17 | 25 |
| 18 | 25 |
| 19 | 25 |
| 20 | 20 |

*Note:* Not more than 20 lamps may be connected to any one line or intercommunicating circuit.

Key Telephone System, Grounding and Special Protection Requirements (518 Division)

**3.24** A generator resistance lamp unit should be used when the 105-volt 20 Hz supply is from the central office or PBX. An 11A key telephone unit (ringing lamp unit) can be used when the 105-volt 20 Hz is supplied from a J86731A, List 4 or 5 (107B frequency generator), or a J86731C, List 1 or 2 power plant [107C (MD) frequency generator].

**3.25** Upon completion of a system installation, check that all features of the system operate properly at each station.

**3.26** Check that all stations are equipped with the correct designation cards and strips.

**3.27** On systems using commercial power, disconnect the power cord and check that outgoing calls can be made on all lines.

**3.28** Before leaving the job, be sure that the customer fully understands the method of operation of the system and its limitations during power interruptions.


***In any key system where common audible signals are provided by means of locally furnished power, interruption of this power supply will render ALL visual and audible signals inoperative during the period of power failure. Standby power provisions and/or the use of appropriate power failure switching equipment and/or connection***

**TABLE D**

**TYPE OF LAMPS MOST OFTEN REQUIRED**

| SIGNAL LAMP SUPPLY | LAMP IN TELEPHONE SET | LAMP TYPE INDICATOR AND/OR 101-TYPE KEY UNIT |
|---|---|---|
| 10 volts ac | 51A | G2 |
| 14 to 26 volts dc* | 51A | A3 |
| 47 to 50 volts dc* | 51A | K2 |

* With internal resistance of the power supply in series with the line circuit relay.

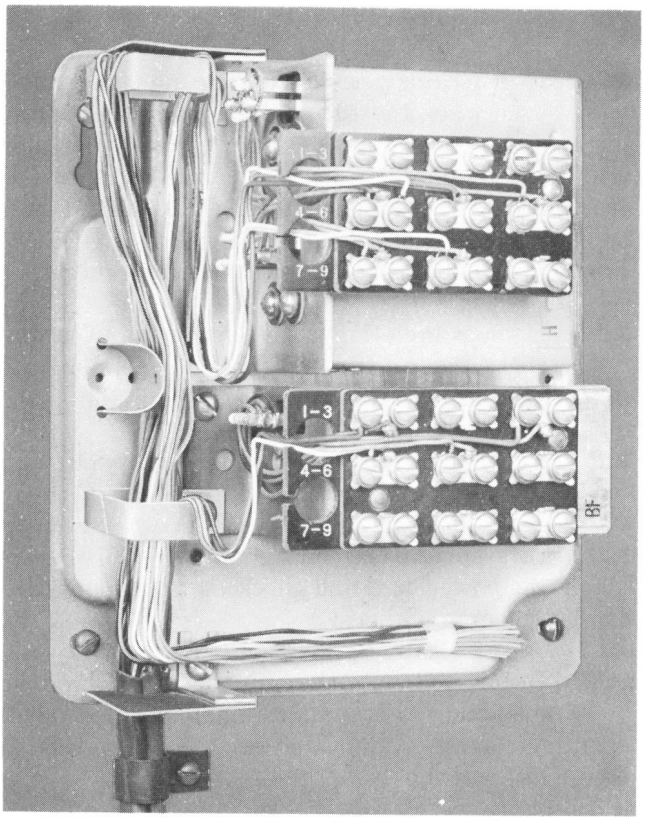



**Fig. 4—105-Type Apparatus Box Equipped With Angle Bracket Type Key Telephone Units**

***of line ringers where necessary, will minimize customer inconvenience during interruption of the normal source of power to the installation. This of course does not limit the customer from making outgoing calls at any time.***

## 4. MAINTENANCE

### A. Relays

**4.01** Key telephone system apparatus is designed and manufactured to tolerances and specifications which insure reliable operation and good service with extended useful life. Improper or careless handling of this equipment can result in costly damage. This is particularly true of wire spring relay apparatus. Inspect carefully for:

- Transposed (crossed) contact springs
- Broken actuating cards
- Slipped coverplates
- Jammed cards
- Cracked plastic parts
- Improper position of contact spring

**4.02** When necessary, relays shall be tested and adjusted in accordance with information contained in related subsections of Division 040 of the Plant Series. Relay operating requirements for specific relays used in various system circuits are listed in the circuit requirement tables. These tables are associated with the various SD drawings concerned.

**4.03** The 4A (MD) and 4B cover clips shown in Fig. 7 and 8, respectively, are used to minimize displacement of core plates and contact springs of wire spring relays during shipping and handling. Clips of early manufacture are shown in Fig. 7 (A) and 9 (A); those of later manufacture in Fig. 7 (B) and 9 (B). They are interchangeable.

**4.04** To place clips:

(1) Slide the clip over the lower end of the cover enough to engage the tang.

(2) Press the upper end of the clip over the cover until the tang engages with a snap.

**4.05** To remove clips:

(1) Hold clip with left hand. Disengage the top tang and slide clip up and off. [See Fig. 9 (A) and (B).]

**4.06** Check position of the plastic cover after placing or removing the 4A (MD) or 4B clip.

**4.07** To minimize damage or misplacement of cards due to mishandling in transit, 4A (MD) or 4B clips may also be applied to relays returned to the storeroom.

### B. Nonpolarized Electrolytic Capacitor

**4.08** A polarized electrolytic KS-14136 capacitor had been used in the early manufacture of some 23A and 51A key telephone units. This

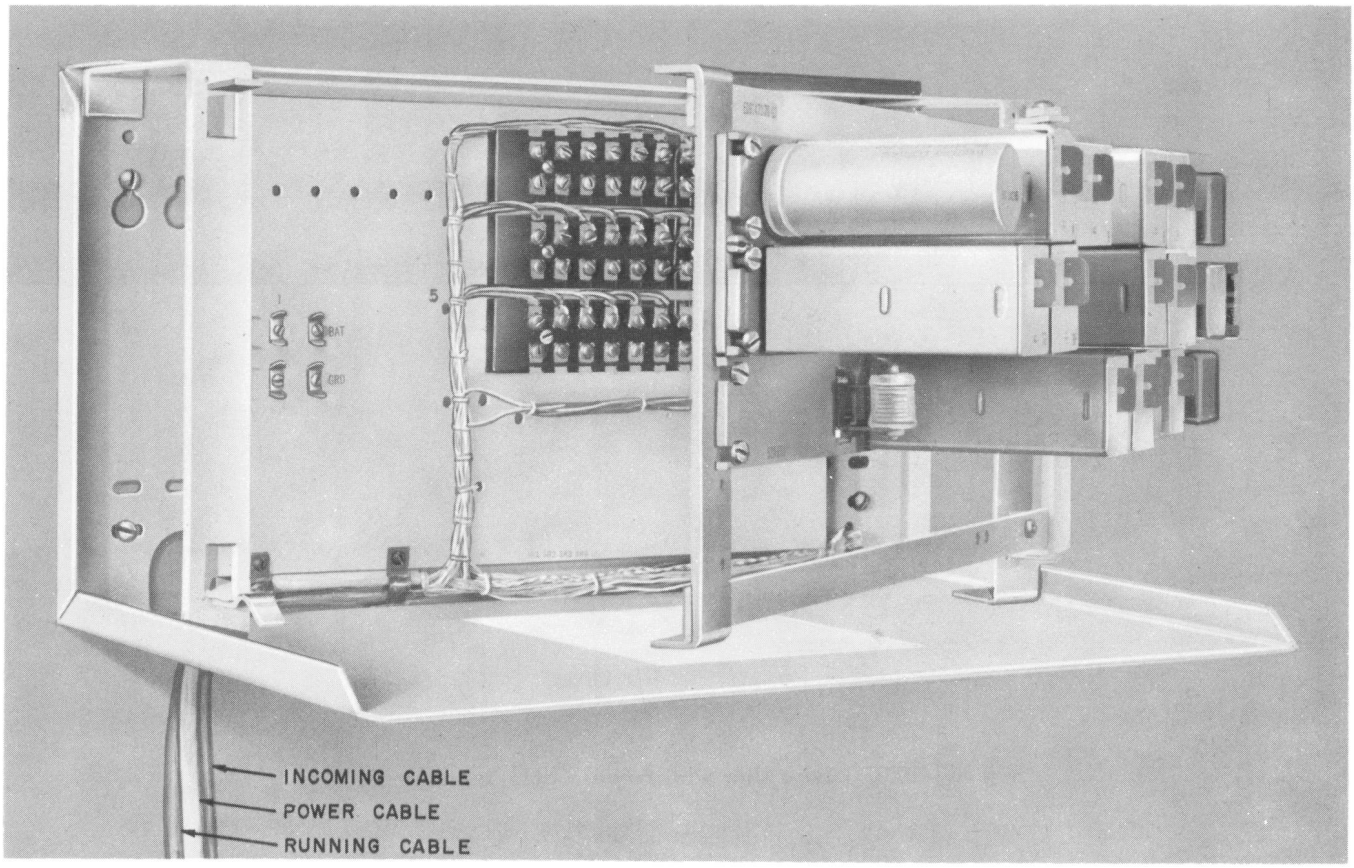



**Fig. 5—Strip Mounted 50-Type (MD) Key Telephone Units Mounted in a 4-Plate Cabinet**

capacitor has been replaced by a nonpolarized KS-16485 capacitor.

**4.09** For a time, the Western Electric Company modified KS-14136 polarized capacitors. Modified capacitors are marked with a red "P" stenciled under the KS number at end of the capacitor.


***Do not modify the KS-14136 capacitor in the field.***

**4.10** The KS-16485 capacitor, while 1/2-inch longer, is the same diameter as the KS-14136 capacitor and mounts interchangeably with it.

**4.11** Replace KS-14136 polarized electrolytic capacitors in all unmodified 23A and 51A key telephone units. This should be done at the most opportune time, and can be done as follows:

(1) Disconnect battery from the working circuit.

(2) Discharge KS-14136 capacitor by momentarily shorting terminals with an insulated-handle screwdriver or equivalent tool.

(3) Disconnect leads from capacitor and remove from mounting.

(4) Mount replacement KS-16485 capacitor in its place and reterminate leads.

(5) Solder all connections.


***Since the KS-16485 capacitor is nonpolarized, it is not necessary to determine polarity before reterminating disconnected wires.***

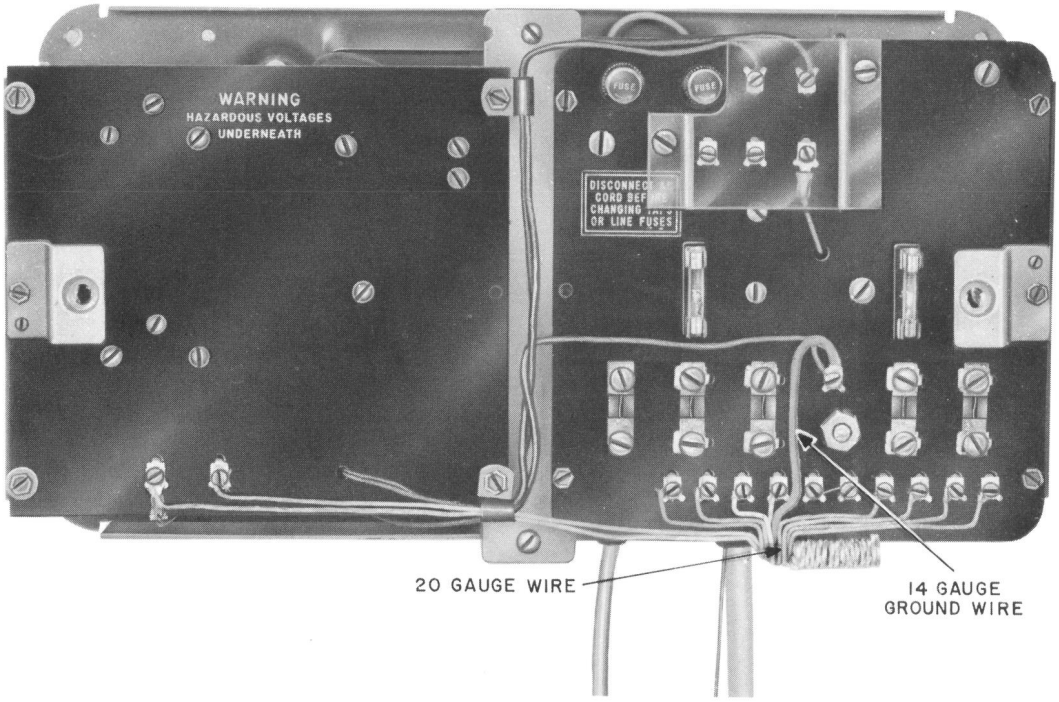



**Fig. 6—101G Power Unit with Power Cable Terminated**

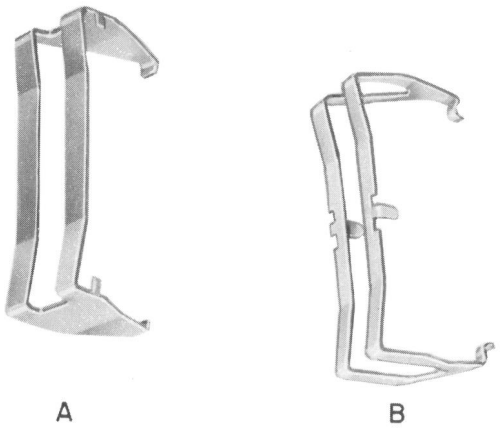



**Fig. 7—4A (MD) Cover Clips**

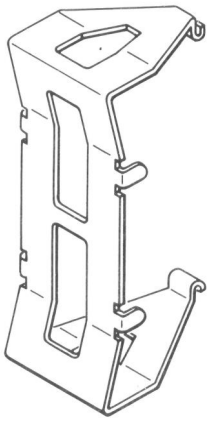


**Fig. 8—4B Cover Clip**

(6) Reconnect battery to circuit.

### C. Radio Signal Interference

**4.12** Radio signal interference may be experienced during talking or when a distant station places a hold on the line.

### D. Line Noise

**4.13** At some key telephone system installations, objectionable noise (sometimes referred to as longitudinal noise) may be heard. This noise is heard by the calling party immediately upon answer of an incoming call. This may occur when ring is applied to lines featuring a grounded ringing relay circuit (51A (MD), or 52A (MD) KTU). Noise is

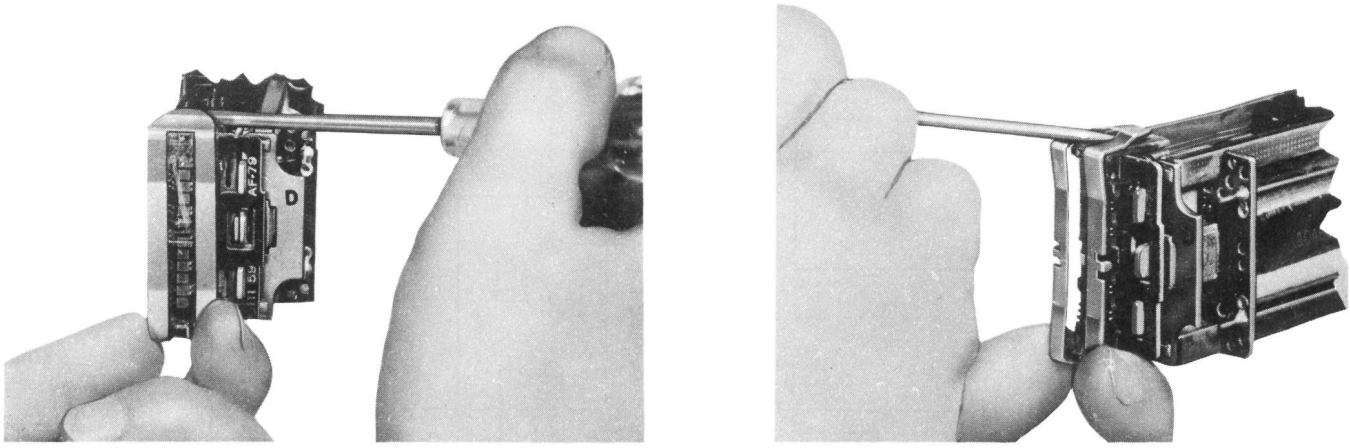



**Fig. 9—Removing 4A (MD) Cover Clip**

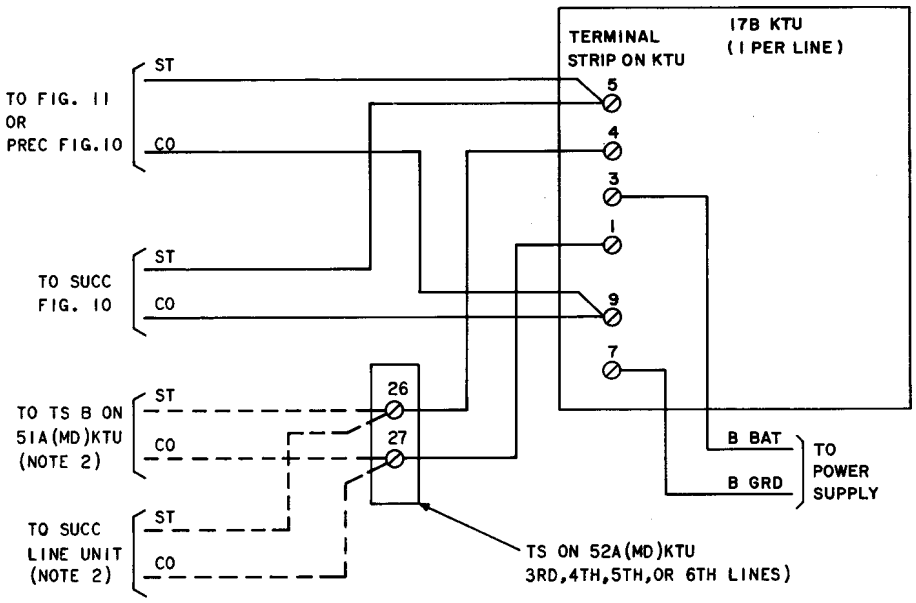
caused by temporary unbalance to ground at a time when the thermistors are at low resistance. After ringing stops (due to call being answered), thermistors should normally cool rapidly, raise resistance, and balance the line. In some areas, where an appreciable ground potential is present, a diminishing longitudinal noise may be heard during the thermistor cooling period following each ringing cycle and prior to distant stations answering. In extreme cases, this ground potential can be high enough to keep the thermistors in a low-resistance condition throughout the call, causing objectionable noise.

**4.14** Where this type of noise trouble is to be corrected, all lines in the system should be modified to minimize interference. Any of the following methods results in opening the ST lead at the time a call is answered, thereby removing ground from line.

(a) 51A (MD) and 52A (MD) key telephone units can be modified per Fig. 10 and 11.

(b) The 50-type (MD) key telephone units can be replaced by bent angle-type key telephone units per SD-69091-01.

(c) Preferably, and depending on local instructions, the 1A Key Telephone System should be replaced by a 1A1 Key Telephone System.




NOTES:
1. ADD ONE 17B KTU PER LINE. ADD STRAPPING AS SHOWN BY SOLID LINES. REMOVE STRAPPING AS SHOWN BY DOTTED LINES.
2. IF SYSTEM IS EQUIPPED WITH 53A(MD), 54A(MD), OR 55A(MD)KTU, CONNECT STRAPS FROM PUNCHINGS 26 AND 27 ON TERMINAL STRIP OF 53A(MD), 54A(MD), OR 55A(MD)KTU DIRECTLY TO PUNCHING 26 ON TERMINAL STRIPS B AND PUNCHING 27 ON TERMINAL STRIP A OF 51A(MD)KTU, RESPECTIVELY.

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**Fig. 10—Modification of Ringing Circuits on 52A (MD) Key Telephone Units Using One 17B Key Telephone Unit Per Line**

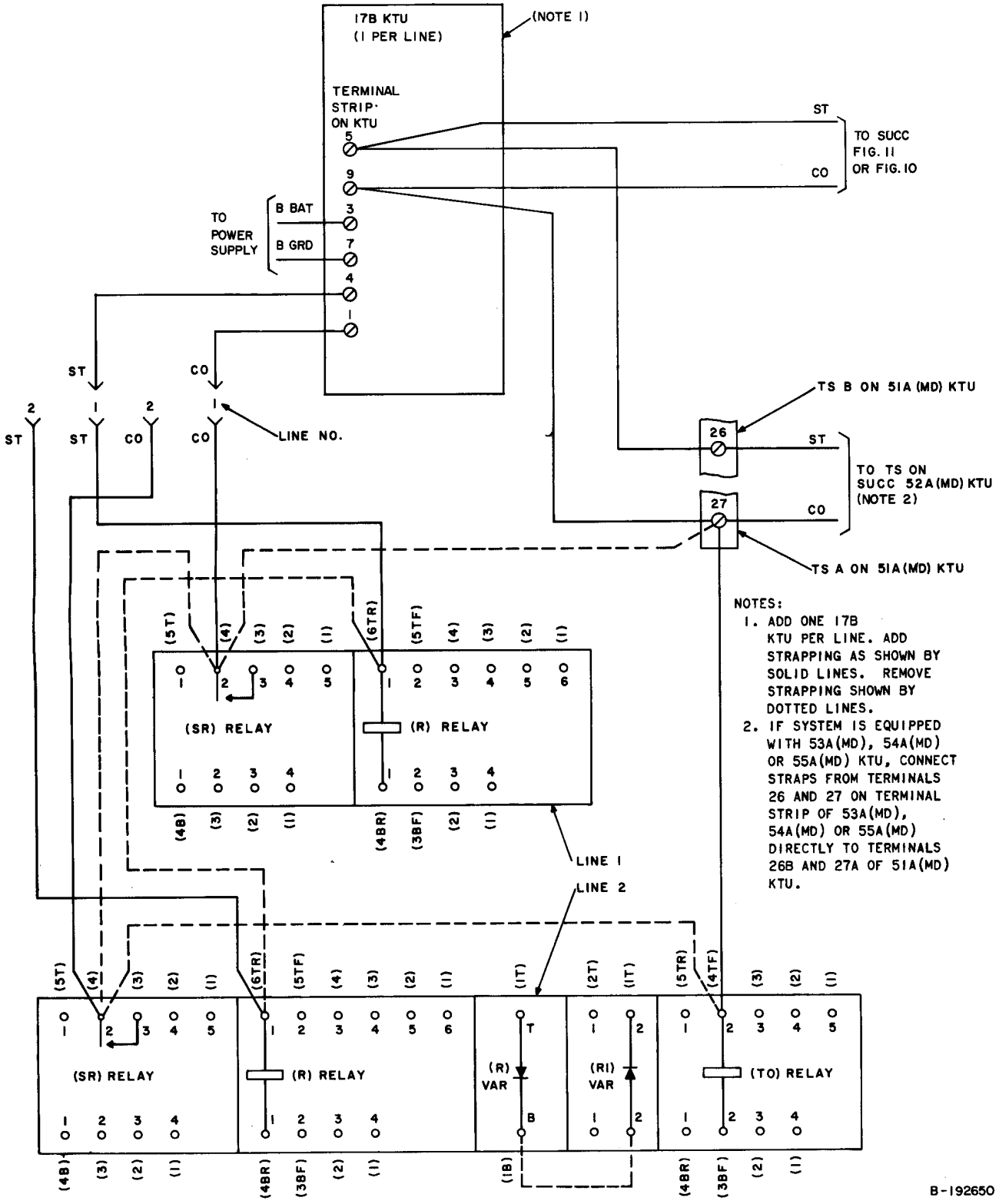


**Fig. 11—Modification of Ringing Circuits on 51A (MD) Key Telephone Units Using One 17B Key Telephone Unit Per Line**