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GENERAL SYSTEM

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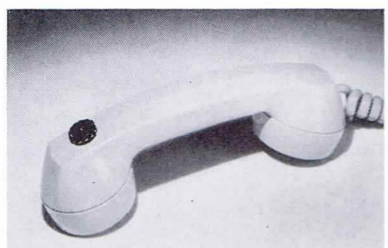

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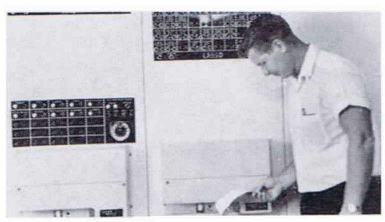

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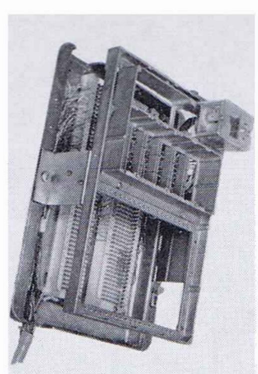

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**COVER ILLUSTRATION**—Lifting the housing from Automatic Electric's new Starlite® Telephone exposes a straight-line ringer which increases the versatility and mobility of this popular design. This change, which eliminates the wall mounted ringer box, was accomplished without changing the external appearance of the telephone. A current-limiting resistor block placed at a conventional 110-volt wall outlet supplies 5 milliwatts of current—all that is needed for the electroluminescent dial light. A new five-conductor dial light—line cord combination replaces the two cords formerly used.

# Starlite® Telephone with Internal Ringer

By John B. Gerosa
*Automatic Electric Laboratories, Inc.*

and Jerry L. Schoemann
*Automatic Electric Company*

Figure 1. Starlite telephone with internal ringer can be used alone or as an extension in any part of the house or office. External appearance is unchanged except for dial-light control, which is located on the right rear corner instead of at the front-center of the base.

**The Starlite® Telephone, originally designed for use as an extension requiring no signaling device, is now to be equipped with an internal ringer to increase its versatility and simplify installation. The appearance of the new instrument, called the 182A Starlite Telephone, is practically unchanged (Figure 1), but the internal components and the inside of the housing have been redesigned to accommodate the new, compact ringer assembly and a standardized printed-wiring transmission unit.**

In 1960, Automatic Electric Company introduced the Starlite® telephone to complement the existing line of residential telephone offerings. The new telephone was designed for use as an extension without an internal ringer, and the designers created a compact instrument with a pleasing appearance. The design was well accepted by customers—so well, in fact, that the Starlite telephone became a universal instrument that is now being used either alone or as an extension in any part of the house. Where a signal was needed, an external ringer box has been provided and screwed to the wall. Now a trend toward pre-wired homes with jacks that allow telephones to be moved from room to room has created a need for an internal signaling device for the Starlite telephone.

Consequently, a straight-line ringer has been designed for mounting inside the Starlite telephone, to increase its versatility, and to simplify installation. This new straight-line ringer (Figure 2) requires about one-third less space than the Type 45 ringer.

## Ringer

The single-gong, single-coil ringer responds to ringing frequencies over the range from 20 to 30 cycles. This ringer, working with a resonator, produces a pleasing sound suitable for residential or business use. A bias-spring adjustment is provided to eliminate bell-tapping, and a three-point, rubber grommet mounting absorbs vibration. The ringer is secured to the new molded plastic baseplate by three self-tapping screws. A special, encapsulated, ringer capacitor with two spade-type terminals is screwed to the transmission network.

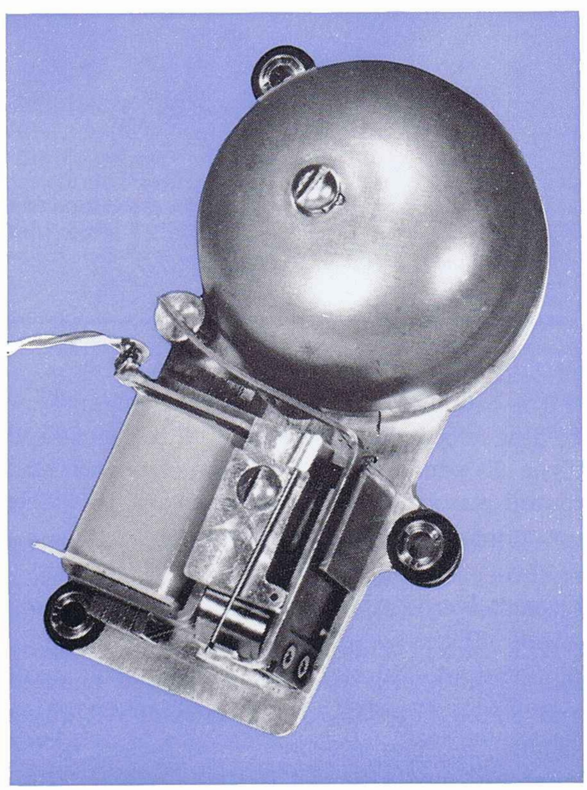
## Component Arrangement and Redesign

A complete rearrangement of the internal components of the Starlite telephone has taken place to provide space for the ringer (see Figures 3 and 4). The new design uses a molded plastic baseplate, a printed-wiring transmission network, a spring-loaded hookswitch arm and actuator assembly, a newly designed "split" hookswitch pileup, a three-position slide switch for the dial light, and the miniature straight-line ringer. All components are either secured with self-tapping screws, or simply snapped into position.

### *Transmission Unit*

The new printed-wiring transmission network requires less space than a "potted" unit. It employs resistors, capacitors, and varistors that can be replaced with a side-cutter and a soldering iron, whereas potted transmission units must be discarded if defective.

Figure 2. Single-gong, single-coil ringer requires about one-third less space than the Type 45 ringer used in most Automatic Electric telephones.



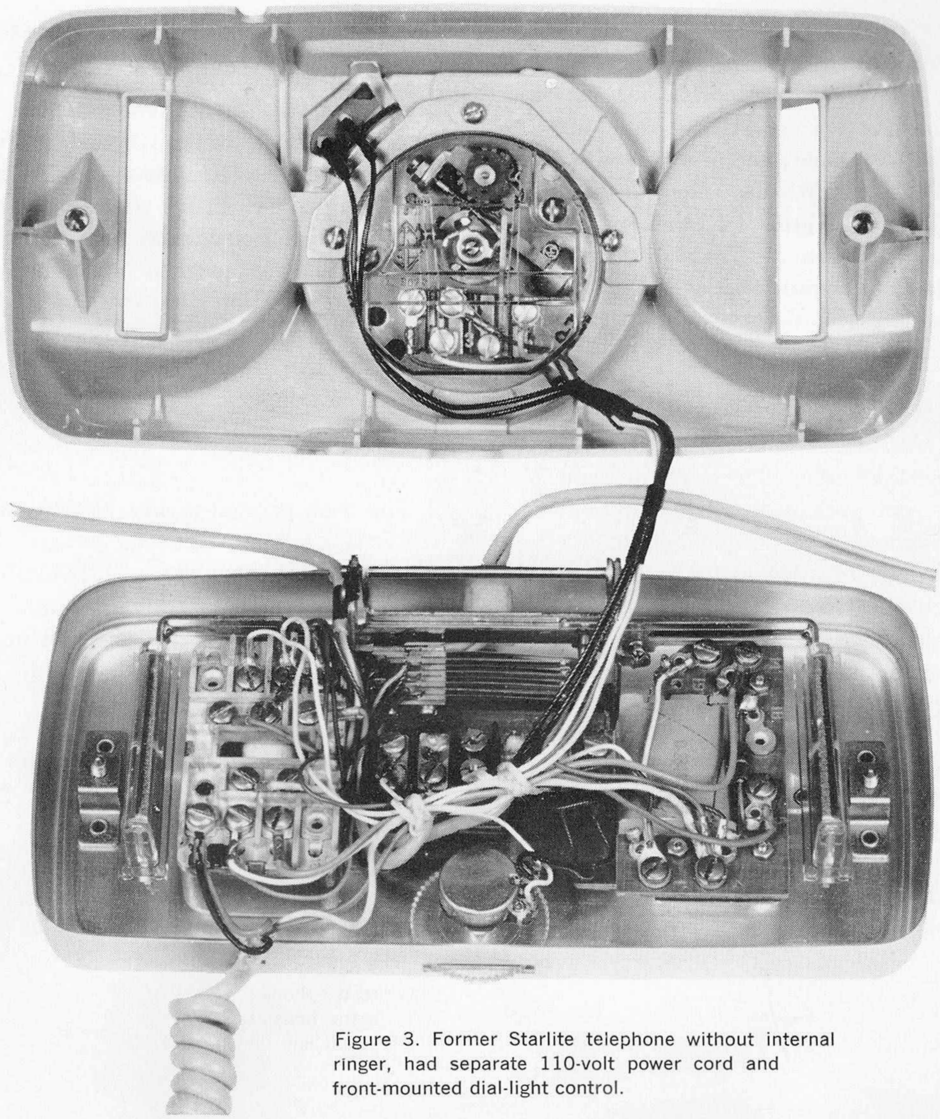


Figure 3. Former Starlite telephone without internal ringer, had separate 110-volt power cord and front-mounted dial-light control.

The new network is also standard in our Type 80 desk telephone, Type 90-M wall telephone and Type 95 panel telephone. This is another step toward standardization of components to enable operating companies to reduce inventories.

*Current-Limiting Resistor Block*

The current-limiting resistor block, formerly located within the telephone, has been removed and placed in a plug at the 110-volt AC outlet (Figure 5); two insulated wires tacked to the baseboard supply current to the telephone terminal block. A new five-conductor line cord replaces both the three-conductor line cord and the six-foot 110-volt power cord formerly used.

The new plug consists of two special 47,000-ohm resistors and two 1-amp. fuses, potted in an epoxy material. One resistor and one fuse, wired in series, are placed across each side of the 110-volt AC line. With this method, the current output of the plug cannot, under any circumstances, exceed five milliamps, even if the two plug terminals are shorted together. This limitation of current insures complete safety to all telephone

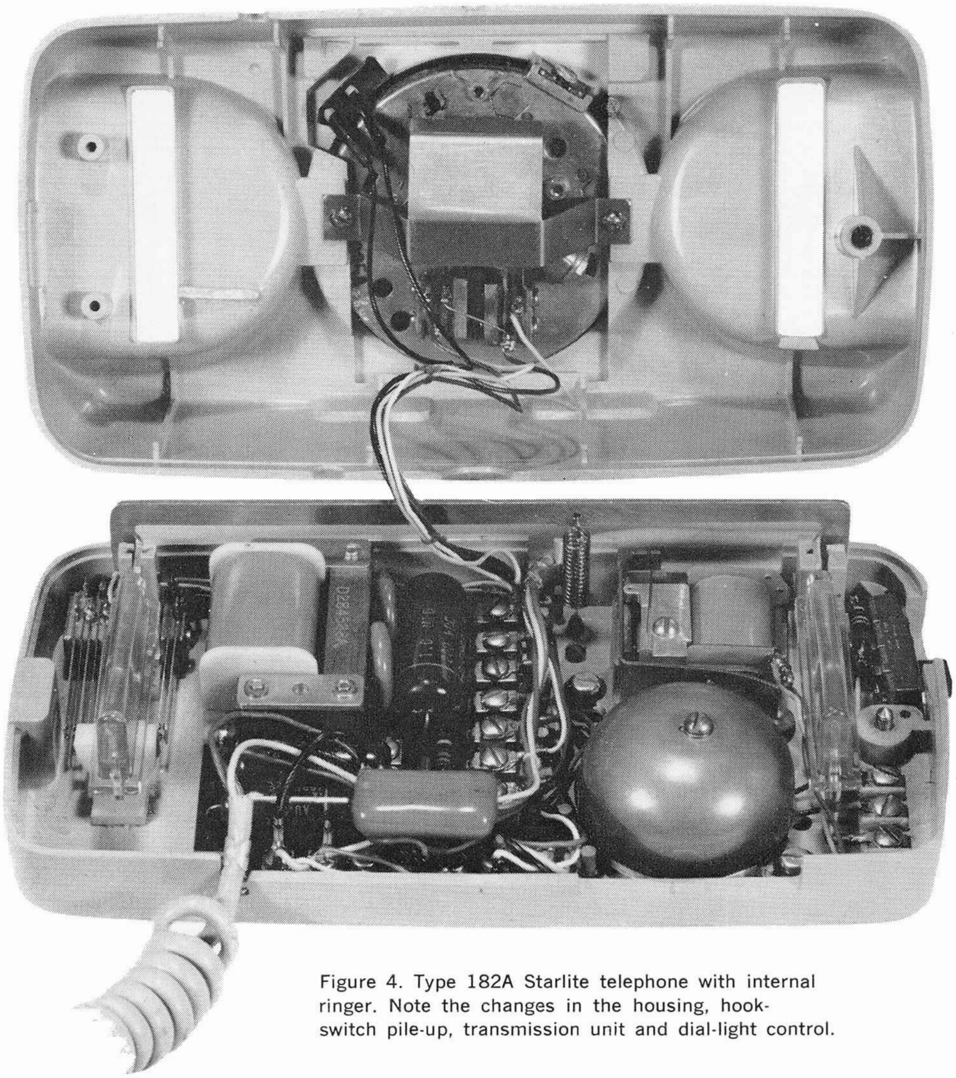


Figure 4. Type 182A Starlite telephone with internal ringer. Note the changes in the housing, hook-switch pile-up, transmission unit and dial-light control.

subscribers. It is possible to power more than one Starlite telephone dial-light from one current-limiting resistor plug by wiring the light leads in parallel.

*Lighted Dial*

The Type 54 dial, square number plate, and light assembly used on the original Starlite telephone are retained. The plastic dust-cover and wire shield formerly used is replaced with a metal stamping which acts both as a wire-shield and a dial mounting bracket.

The rheostat control for the dial light is replaced with a three-position slide switch, providing off, dim, and bright positions.

*Rotary or Touch-Calling Dial*

The new Starlite design accepts either the conventional rotary dial or the new touch-calling unit; field conversion of a rotary dial version to touch-calling can be accomplished readily at any time, thus allowing the operating company to minimize its inventory of parts and telephones. Provision is also made for the incorporation of "message waiting" features.

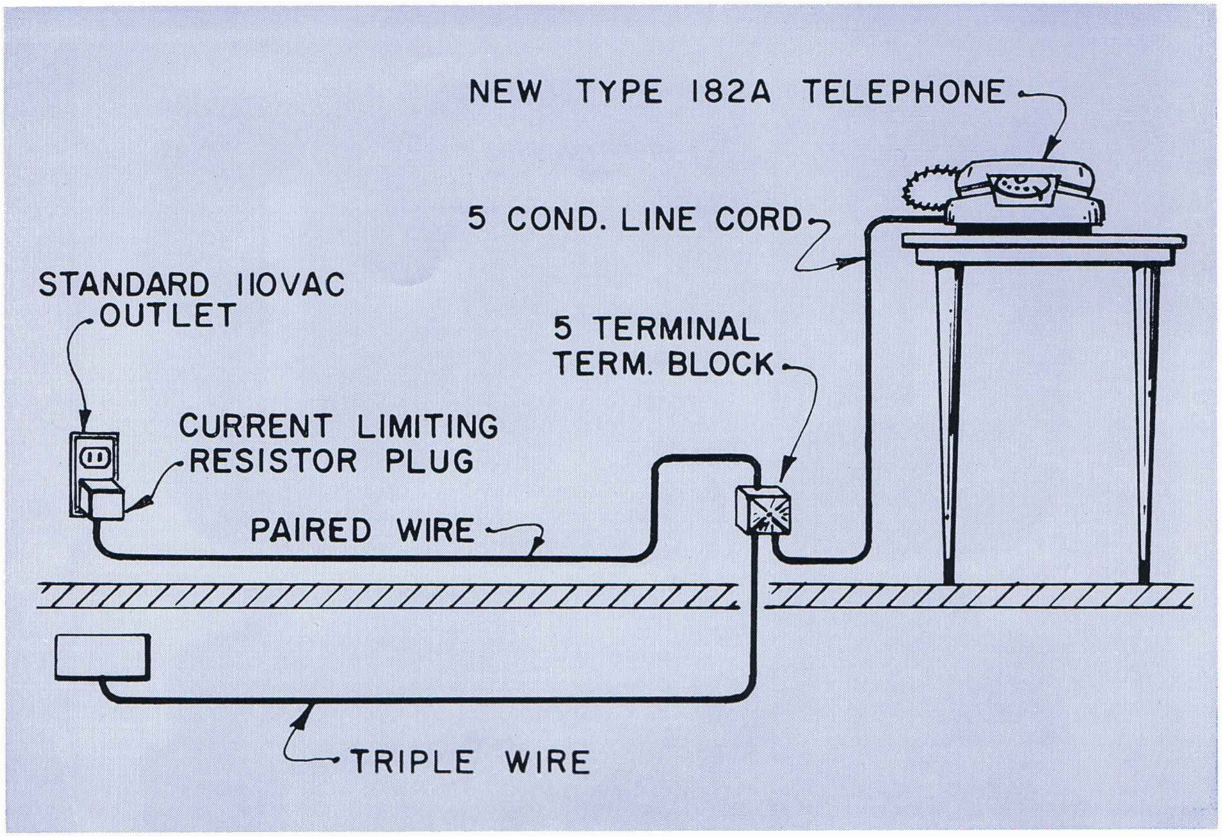



Figure 5. Installation diagram for Starlite telephone with internal ringer. The current-limiting resistor plug placed at the 110-volt AC outlet permits use of a single cord from terminal block to telephone.

*Hookswitch*

To provide space for the internal ringer, the hookswitch has been relocated from its former central position. By providing a two-stack pile-up and a wedge-type actuator, the necessary operating force is reduced from that required for the previous one-stack pile-up. With the present trend toward lighter handsets to reduce subscriber fatigue, the problem of off-hook conditions has been on the increase. The decrease in operating force needed to actuate the hookswitch is expected to reduce the posibility of ROH (receiver off-hook) trouble. The two-stack pile-up arrangement also substantially reduces the amount of adjustment required, because a two-surface actuating cam provides an inherent make-before-break sequence.

The hookswitch bracket is supported by a molded post which is an integral part of the plastic baseplate. The split post is designed to accurately position the hookswitch bracket and actuator with reference to the hookswitch pile-up. A similar post on the opposite side of the baseplate eliminates hookswitch binding, by providing adequate clearance to compensate for dimensional variations in the plastic baseplate resulting from changes in temperature or moisture conditions.

The split hookswitch pile-up straddles the split plastic post and is secured to the baseplate by means of one self-tapping screw. Two brass pins keyed to the plastic posts provide bearing surface for the hookswitch bracket and prevent wear of the plastic.

The hookswitch bracket assembly is spring-loaded and is held in position by the centrally exerted tension of the hookswitch return spring. Removal of the hookswitch bracket assembly is accomplished by removing the return spring.

Plastic buffers, which project through the housing for actuation of the hookswitch by the handset, were formerly pinned to the hookswitch arm; this made replacement of these buffers difficult if damage occured. The new hookswitch bracket is designed so that the plastic buffers can be snapped into position and removed easily.

The spring pile-up actuator, made from an acetal material possessing good wear characteristics and dimensional stability, is press-fitted to the hookswitch bracket. A notch in the bracket locates the actuator in position by compressing its plastic material when it is being assembled and then allowing the plastic to expand after it has been located.

This new hookswitch arrangement has been thoroughly life-tested in our laboratories; no appreciable wear was found after 1.5 million operations.

*Baseplate*

The baseplate of the new Starlite telephone is molded ABS (acrylonitrile-butadiene-styrene-copolymer), a high-impact-strength plastic. The new Starlite telephone is, in fact, the first telephone manufactured in the United States that utilizes plastic for the baseplate and component mounting. The hard, smooth surface of ABS material is highly resistant to scratches and stains, as proved by past experience with this material on our telephone housings.

A new method of attaching the Starlite telephone housing to the baseplate saves the service man's time, and takes less internal space. A projecting tongue on one end of the housing fits into a hole on the top rim of the baseplate. One screw at the opposite end of the baseplate replaces the two screws formerly required.

To effect a standardization of parts, all of the plastic baseplates are a neutral gray color, simulating the anodized aluminum baseplate previously used.

The one-piece cork pad which formerly covered a large portion of the aluminum baseplate is replaced by two narrow cork strips positioned at each end of the new molded baseplate. The new Starlite is more stable than the former design, because the reduced area of the pad increases the force exerted per square inch of its surface.

*Housing*

The Starlite telephone housing retains its outward styling, but incorporates several internal changes. A projection is provided to accommodate the new latch-in feature. To facilitate the assembly of the new housing to the baseplate, a special cam in the housing depresses the hookswitch. The dial opening is enlarged to provide the clearance necessary for the new touch-calling unit. Two mounting pads are added to adapt the new housing to Starlite telephones with aluminum baseplates; an adapter bracket, and three screws, will also be provided.

## Design Features

The 182A Starlite telephone retains all features offered by the previous design, such as:

1. Light weight for easy lifting — yet enough weight for stability.
2. Projecting edges on the dial plate for easy gripping.
3. A unique electroluminescent dial light that provides a soft and pleasing greenish light over the entire face of the dial.
4. Adjustable dial brightness; a three-position switch provides off, dim, and bright positions.
5. "Walking handset" that returns easily to the correct position on the cradle.

The main reason for the development of the 182A was the requirement for a Starlite telephone with an internal ringer. As a by-product, however, several features benefit the telephone operating company:

1. The handset assembly and printed-wiring transmission network are the same as those used on the Types 80, 90M, and 95 telephones. This allows operating companies to standardize on replacement parts. The transmission network and a separate induction coil were formerly special components used only in the Starlite and Type 880 telephones.

2. Internal components that can be easily replaced are provided. Components are secured with self-tapping screws; they were formerly eyeletted to the base.

3. Marred or damaged housings can be replaced easily. Housing replacement formerly required the removal of all dial leads connected to the transmission network. The new design, because of an enlarged dial opening, allows the repair-

man to remove the dial mounting screws, slide the dial through the housing opening, substitute the new housing, and remount the dial. Dial leads need not be disconnected from the transmission network.

4. A new, internal, miniature, straight-line ringer eliminates the cost involved in installing the external ringer box and ringer for one- and two-party service. The new miniature ringer offers a melodious ring suitable for both residential and business use.

5. The new housing has been designed to accept either the conventional rotary dial presently used, or the newly designed touch-calling unit. Conversion requires only the removal of the rotary dial and the substitution of the new touch-calling unit and its associated adapter plate.

## Summary

The new Starlite telephone reflects the continuing effort of Automatic Electric to offer its customers the utmost in telephone design and service as the state of the art advances. The new unit can be adapted to provide the "message waiting" feature, or Touch-Calling; field conversion of the telephone to touch-calling may be accomplished readily at any time. The full versatility of this design has not yet been utilized; we can look for continued expansion of its capabilities in the future.

**JERRY L. SCHOEMANN** graduated from Marquette University with a degree in Mechanical Engineering. He joined Automatic Electric in June, 1959 on the "co-op" training program, and upon becoming a full-time employee was assigned to the Product Design Laboratory. He is now a Product Analyst in AE's Product Planning Department. Mr. Schoemann is a member of American Society of Mechanical Engineers.

**JOHN B. GEROSA** graduated with a degree in Industrial Engineering from the University of Illinois, and joined Automatic Electric in 1962. In January, 1963, he was assigned to the Product Design Laboratory where he is engaged in the design and application of subscriber-station equipment. Mr. Gerosa is a member of American Institute of Industrial Engineers.

# Sound-Booster Handset

## Contains its Own Amplifier

Figure 1. The volume control knob is the only feature that suggests that this handset contains a complete amplifier for the hard-of-hearing subscriber.

By Victor G. Burger
*Automatic Electric Laboratories, Inc.*

**A new Automatic Electric telephone handset containing an amplifier, for users who are hard of hearing, looks identical to the familiar standard unit except for a small knob mounted above the receiver. The handset can be used with any model or color of AE telephone that incorporates the self-compensated network. This article describes the physical and electrical characteristics of the new handset and outlines its capabilities.**

A number of years ago, Automatic Electric created a special model of the Type 80 desk telephone that incorporated an amplifier in the receiver circuit. This feature has been invaluable to people who are hard-of-hearing, and subscribers are now requesting it in other styles of telephone instruments. Since new techniques have permitted miniaturization of the amplifier circuit, it has now been incorporated into the handset. The new unit, called the Type 820 Sound-Booster Handset, is intended for use on any telephone with the self-compensated network, on 0- to 1,300-ohm conductor loops, and with 48- to 52-volt central-office battery.

The only visible difference between the familiar Type 810 handset and the new Type 820 is a volume-control knob numbered from 0 to 9, located on the outer side of the handset, directly above the receiver capsule (Figure 1). Placement of the volume control knob behind the receiver capsule allows adjustment of signal levels by thumb or forefinger, and keeps the volume control out of the way when change of setting is not needed.

### Amplifier Construction

The amplifier board in the new handset (Figure 2) is a one-piece assembly containing all of the amplifier components except the volume control. The board is made of semi-flexible, .055" CIMCLAD® material with a one-ounce copper foil, that is preformed to an eight inch radius. The thin copper conductors are gold plated prior to component mounting to facilitate soldering and retard tarnish.

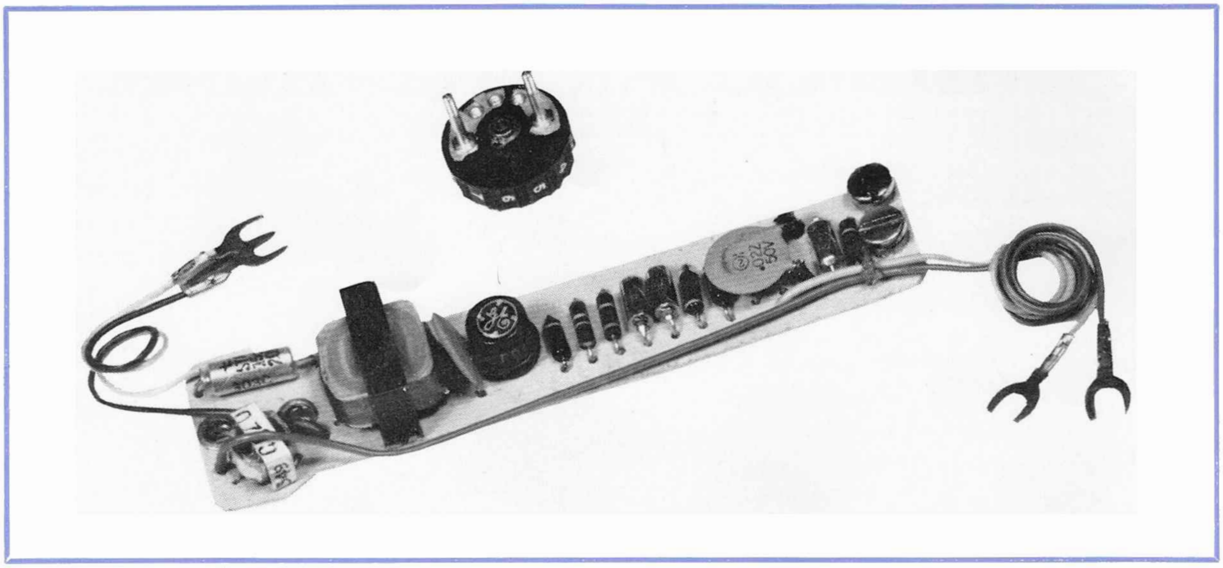


Figure 2. All amplifier components except the volume control are mounted on a semi-flexible board measuring only 3⅞ by ¾ inches. (Shown actual size.)

The entire assembly is inserted through the receiver-capsule cavity (Figure 3), and is mounted in place by the two potentiometer mounting studs, which also serve as electrical connectors. When in place, the board extends approximately one-half inch past the longitudinal mid-point of the handset. With this configuration, sufficient space is allowed for the mounting of another piece of equipment within the transmitter cavity — such as a long-line transmitter amplifier.

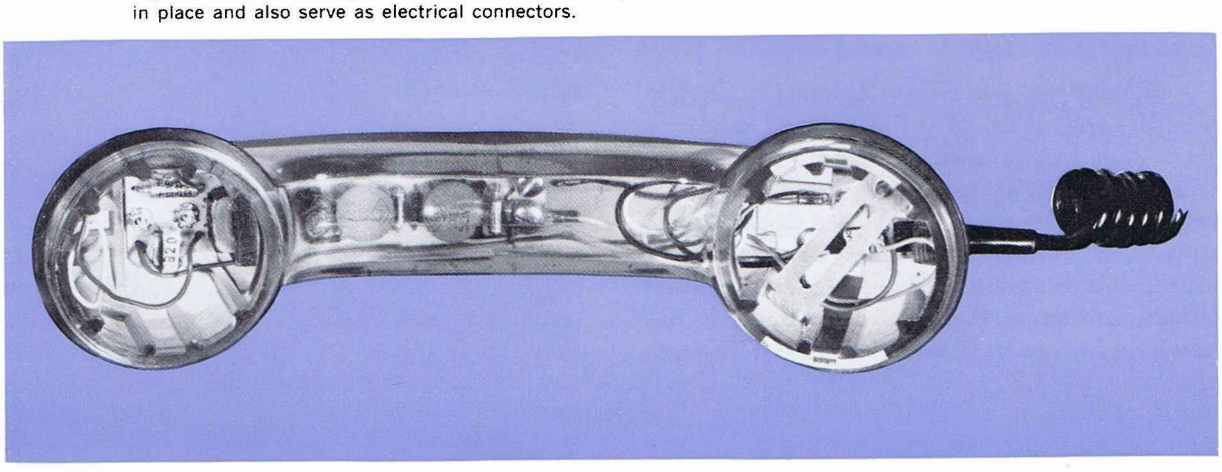
The "Sound-Booster" amplifier is connected between the receiver terminals of the network and the receiver unit (Figure 4).

Power to operate the amplifier is obtained by diverting a small portion of the direct current from the transmitter. The base resistors R2 and R3 limit the amplifier current to approximately two milliamperes on long loops and eight milliamperes on short loops. The varying transmitter speech current is filtered by inductor L1 and capacitor C6. Four miniature silicon diodes — CR1 to CR4 — maintain correct polarity to the amplifier, regardless of the voltage polarity across the transmitter.

## Silicon Varistor

The modified 810 receiver for the 820 handset (D-51029-A) uses, as a click-reducer, a small

Figure 3. Two mounting studs in the receiver cavity (left) hold the potentiometer and the amplifier in place and also serve as electrical connectors.



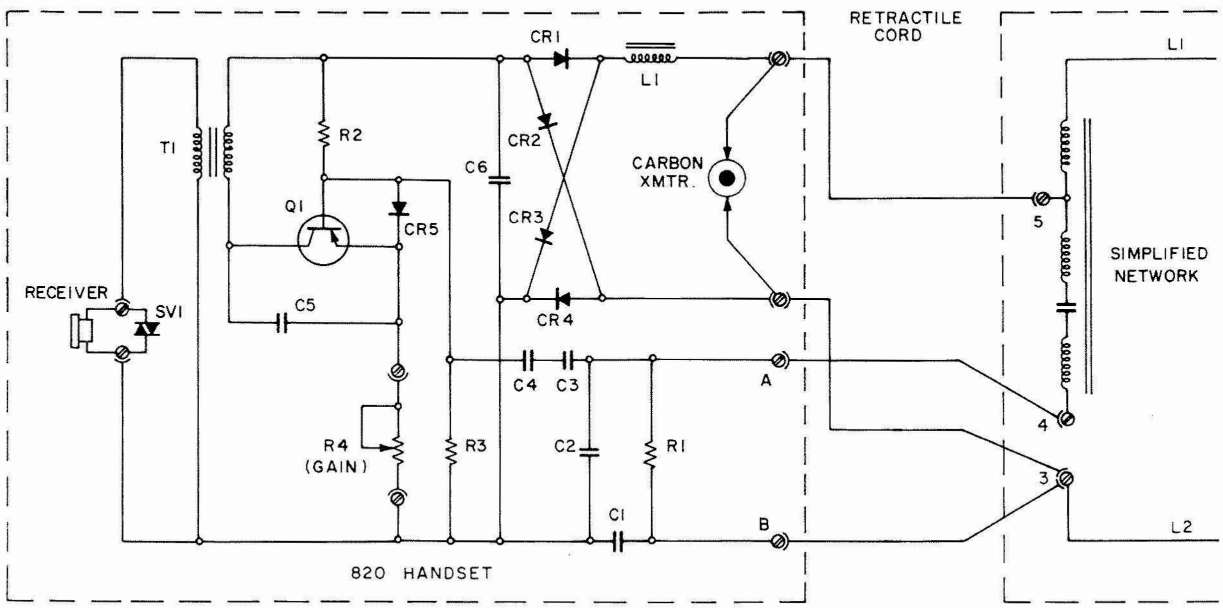



Figure 4. Diagram of the 820 Sound-Booster Handset, showing its relationship to the transmission network.

internally mounted Type SV1 silicon varistor, which is to become standard on all Automatic Electric receivers, superseding the externally mounted copper oxide varistor now used on the standard 810 receiver (D-51024-A). The small size of the silicon varistor as well as its electrical characteristics, make it superior to the copper-oxide type for ordinary use as well as for the sound-booster application.

At normal sound levels, the voltage across the receiver and a copper-oxide click reducer is low enough to avoid clipping of speech signals; at higher signal voltage, however, this type of varistor causes partial conduction, and consequent clipping of signals. Because of the broad or shallow knee characteristics of the copper-oxide varistor (see Figure 5), this clipping conduction causes non-linear distortion within the normal additional amplified range of 15 to 30 db. Further increase of input levels yields a negligible increase in sound output, because of the limiting effect of this type of varistor.

Unlike the copper-oxide varistor, however, the silicon device has a very sharp knee or sudden conduction point, and up to this point it is not affected by the higher voltage levels. The silicon click reducer does not clip the speech signals, and does a better job of limiting the maximum acoustic output from the receiver.

## Performance

A single PNP germanium transistor in a common-emitter configuration provides approximately 28 db gain for the received signal. The amplifier input impedance, between terminals A and B, is suitable for direct coupling to the telephone network. Resistor R1 and capacitor C2 stabilizes this input impedance, and along with C5, suppresses high-frequency radio or TV signals that might cause interference with the speech signals.

With the volume-control potentiometer R4 set at 9 (shorted), the amplifier operates at full gain; at other settings of the volume control, gain is reduced. Also, with R4 in series with the emitter, circuit stability is provided and differences caused by variations in component characteristics are minimized. With the volume control set at 0 or 1, the performance of the handset is essentially the same as that of the regular Type 810 handset; consequently, the amplifier does not have to be switched out of the circuit when used by people with normal hearing.

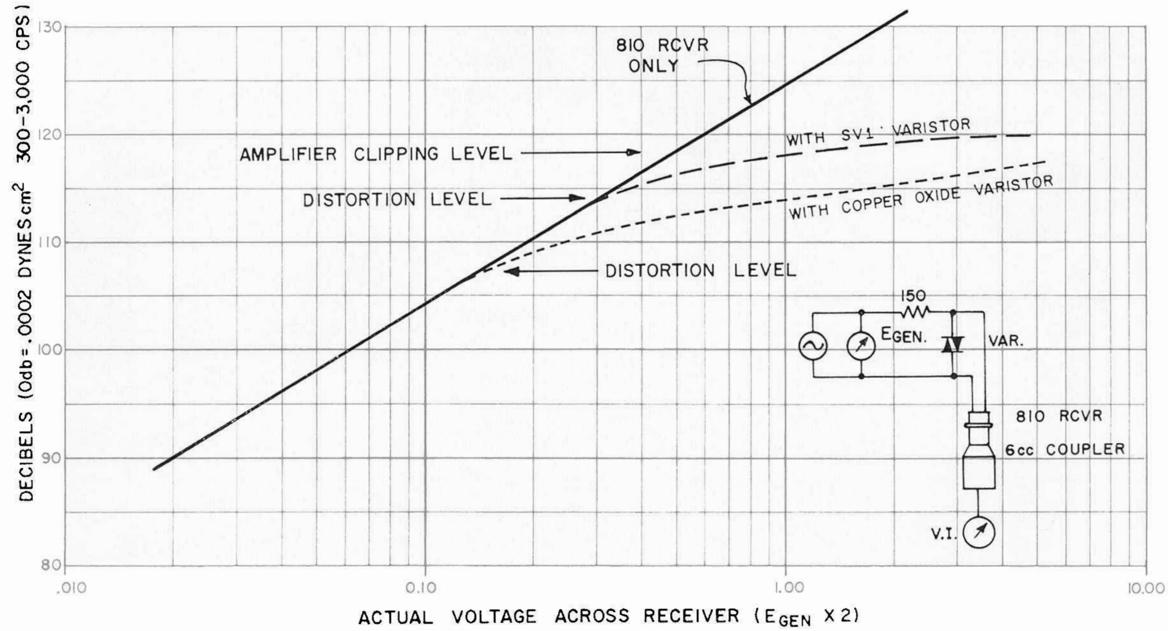
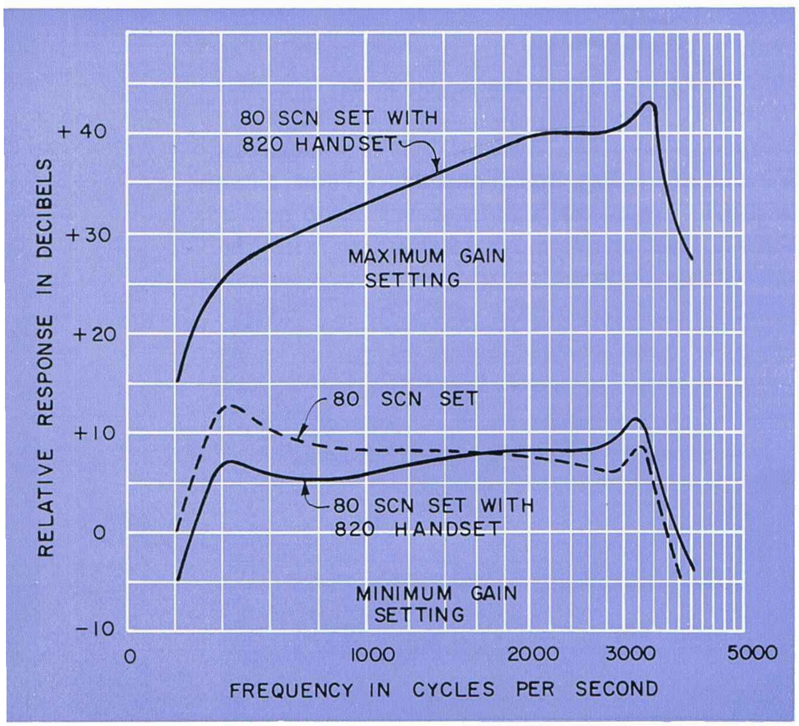



Figure 5. The graph shows the limiting characteristics of the SV1 varistor compared with those of the copper-oxide type. Not only is the point of noticeable distortion level higher than for the copper-oxide varistor but it also has a smaller ratio of distortion level point to maximum limit output. The inset diagram is the equivalent secondary driving impedance of output transformer T2 and the modified 810 receiver used in the 820 Handset (when loaded into a 6 cc coupler and measured with the condenser microphone and sound pressure meter).




Frequency-response curves (Figures 6) show the performance on a two-mile loop of 26-gauge non-loaded cable. Increase of gain causes an increase in the high frequencies where most hearing deficiencies occur. However, at maximum output, the sound levels will not injure the user's ear; signal levels are limited by the overload characteristics of the amplifier and by the click-reducing characteristics of the silicon varistor across the receiver.

Oscillation, or singing, does not occur in these handsets if they are well sealed against the user's ear; however, at full gain settings they will sing if both the transmitter and receiver ends of the handset are open acoustically.

Since the amplifier is powered from the transmitter, the line current or d-c resistance of the telephone is unchanged, because of the slight

Figure 6. Frequency response curves for the Type 80 Self-Compensated Network with and without the 820 Handset.

residual varistor regulation. Therefore, unlike the 80T telephone, no penalty is imposed on the supervision limit of loops on which the 820 Sound-Booster Handset is used. The higher power supplied to this handset provides for approximately 12 db more gain, as well as a 10 db higher output level than the 80T supplies.

Since the transmitter resistance and voltage supplied is higher in the Type 80 SCN (self-compensated network) telephone than in the Type 80 with the manually-compensated network, the 820 handset is not recommended for use with the latter.

The 820 handset is not designed to overcome transmission difficulties on long, limiting cable loops, or in noisy locations. Its use for such purposes would enhance the side-tone levels, resulting in the degradation, rather than improvement, of transmission performance. Corrective measures for such transmission difficulties should be obtained through proper transmission engineering and design techniques.

## Conclusion

Introduction of the Type 820 Sound-Booster Handset provides operating companies with a virtually unlimited number of combinations of telephone type, and color, whenever the hard-of-hearing feature is desired. Its simplicity, permitting installation without additional mounting hardware, and easy replacement of handsets in the field, will be appreciated.

**VICTOR G. BURGER** graduated in Industrial Electronics at the Masaryk Technical Institute in Praque, Czechoslovakia in 1951. He joined Automatic Electric Laboratories in 1958 and in 1959 was assigned to the Telephone Components and Transmission Group. As an Associate Engineer, Mr. Burger has participated in the design and development of components and transmission circuits, and is now engaged in the design and development of new circuits and components for future long-range telephone set equipment.

# High-Speed Large-Capacity Supervisory and Telemetering System for Electric Utilities

By George W. Potenza
*Automatic Electric Laboratories, Inc.*

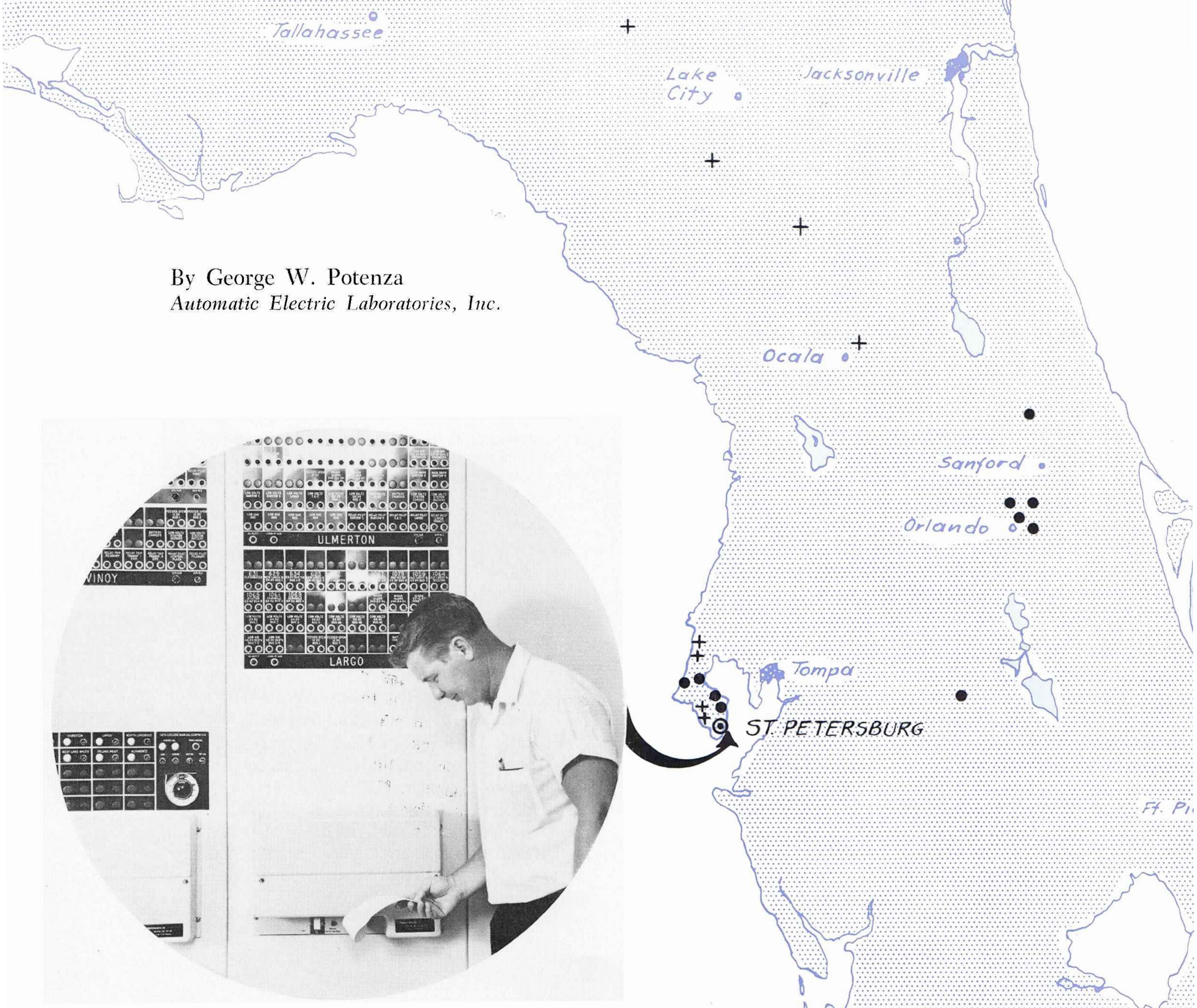



Figure 1. This map of Florida shows the load dispatch office (master station) and the substations of the Florida Power Corporation at which Automatic Electric's Conitel 1000 equipment is located. Recording and display of status and variables associated with circuit-breakers, control voltages, and transmission-line loading is provided by the Conitel 1000 equipment. Florida Power Corporation serves 32 of Florida's 67 counties, a sector containing 20,600 square miles with 325,000 residential, commercial, and industrial consumers. The inset shows an operator at the display panel of the master station in St. Petersburg. Black dots indicate completed substation equipment and black crosses show the locations of substation control equipment under construction.

**Failure in an electric power network can cause extensive damage to equipment throughout the system. To provide fast communication of alarms from remote areas to a master station, as well as of measurements from transducers, Automatic Electric has developed its Conitel 1000 Wired-Program Supervisory Control and Telemetering System.* This article describes the application of this system to the network of the Florida Power Corporation, with special emphasis on the scanning and reporting of alarms and data.**

In the electric power industry, a failure in the network lines, transformers, or controls can quickly spread from the original fault to connected equipment, causing extensive damage, personal injury, and interruptions of service. Automatic Electric's Conitel 1000 Wired-Program Supervisory Control and Telemetering System has been applied, without the control functions, in an installation which was designed for the Florida Power Corporation (Figure 1), to provide fast communication of fault information to a master station at St. Petersburg, where corrective measures can be initiated by a dispatcher.

Modern power systems are designed to minimize the probability of failures, and to minimize damage to equipment, and interruptions to service when inevitable failures do occur. An important feature of these systems is "protective relaying",** which causes the prompt removal of any element from the power system when that element's failure threatens to disrupt the equilibrium of the system. Circuit-breakers (Figure 2) disconnect the faulty elements when they are called upon to do so by the relaying equipment.

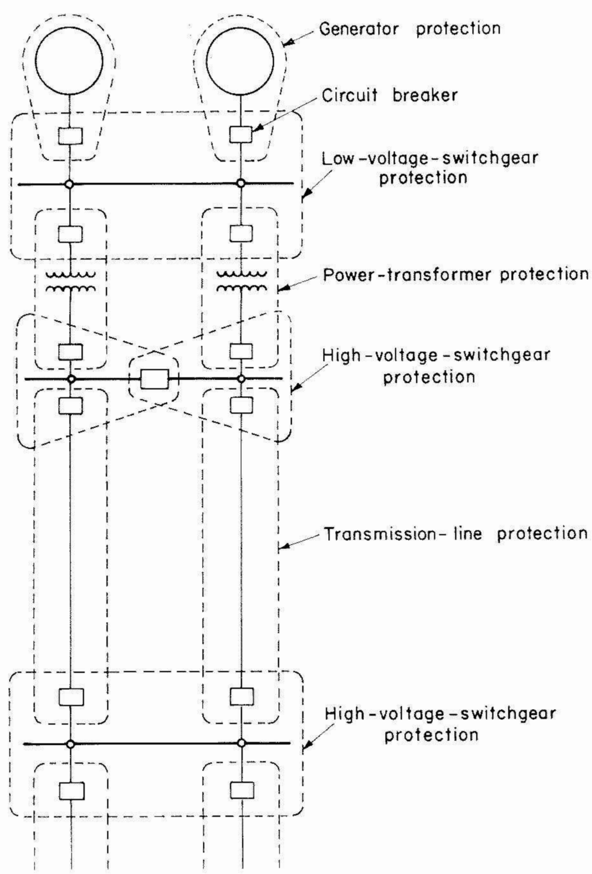
The protective relays are completely automatic in their operation, and are effective almost instantly. However, since they must necessarily be located close to the point being monitored — which may be many miles from the dispatcher — valuable minutes may be lost before the dispatcher becomes aware of the changes which have occurred within the power system. It is here that the features of the Conitel 1000 system can offer valuable service.

*"*A Wired-Program Supervisory Control and Telemetering System*", *F. C. Giarrizzo, Automatic Electric Technical Journal, Vol. 9, No. 4, October, 1964.*

**"*The Art and Science of Protective Relaying*", *C. Russel Mason, John Wiley and Sons, New York, 1956.*

Conitel 1000 makes it possible to report the condition of all circuit-breakers, and the associated system parameters, directly to the dispatcher, who is in a position to recognize trouble and take immediate corrective action. The speed of the system is such that, within approximately two seconds after a circuit-breaker trips at any substation, the dispatcher receives a visual indication, accompanied by an audible signal and alarm printout (Figure 3). Three seconds later he receives another sequence of indications, signaling an attempted automatic reclosure of the circuit-breaker. Should the breaker trip again, due to a continuing fault, a second sequence of indications is initiated. This history, or event recording, provides the dispatcher with a printed log of events for each trip-and-reclosure segment of operations at a particular substation. Analysis of the printed record permits him to diagnose the problems and take action to clear or transfer a particular section of the transmission line.

Figure 2. A diagram of an electric power system illustrating protective relaying. Dotted lines indicate zones of protection; any failure occurring within a given zone will cause opening of all circuit breakers within that zone.



Two basic classes of information are handled by the Conitel 1000 system: *supervision* of the status of circuit-breakers and alarms, and *telemetering* of the actual value of important system parameters (voltage, etc.). In the Florida Power Corporation application, the supervisory function is given priority.

## Supervision

The basic method of operation of the Conitel 1000 system is "half-duplex"; that is, transmissions between master and substations are one-way rather than simultaneous. Each status-point, as well as each data-point, is assigned a three-digit address, with a maximum of 1000 such point-addresses in the system. Substations are not addressed as such — only their points. Therefore, the 1000 available addresses can be assigned to stations in any combination, as required.

The master station continually sends point-address messages that are received by all of the substations and decoded; the output of one decoder only is activated, however, since a given address is assigned to a single point. For example, if the point addressed represents a watt transducer, a three-digit message is returned from the substation to indicate the magnitude of the wattage being measured. When received at the master station, the data is routed to a "telemetering printer"; status information is further routed to indicating lamps and simultaneously to an "alarm printer".

### *Poll-Points*

Rapid system-scan is made possible through the use of "poll-points." A poll-point is a point, or address, that has associated with it a group of substation alarms or circuit-breakers. A change in state of any associated device causes the poll point to "raise a flag" in the system scan. This flag is detected by the master station, which then scans all indication points associated with this poll-point. A further reduction in the normal system-scan interval results from functional grouping of alarms; that is, alarms which may be occasioned by a common fault are grouped with the same poll point so they will be reported during the same time interval.

When any status-point changes from the "no alarm" to the "alarm" state, the corresponding poll-point encoder will be set. Then, when this poll-point is interrogated, its condition will be transmitted to the master station, which in turn will interrogate all status-points (whether on or off) associated with the set poll-point. When all of its status-points have returned to normal, the poll-point encoder will be reset.

Scan messages are normally generated by a three-decade counter which is incremented once for each step in the scan. To allow for deviations from the normal sequential generation of messages, a "jump" (or skip) feature is provided. Thus, an increment-count command is always superseded by the presence of a jump request, which forces a particular scan message into the counter. Using this "wired program" technique, the counter is programmed to jump from poll-point to poll-point when no alarms are present (normal scan).

### *Storage of Scan Replies*

Each time that a new count (scan address) is formed, one correed within a 10 x 100 matrix will be activated to perform the required gating function. A single correed may select as many as three alarms, each digit of the three-part address representing a single alarm-point.

Circuit-breaker status and alarm indications are stored in a correed register. The indications are then available to their individual display lamps on the display panel (see Figure 3).

The last-reported status of each substation poll-point is stored in a separate correed register. Depending upon the particular poll-point status, the counter is instructed to access the next appropriate address as follows: if no alarms are associated with a poll-point, "jump to next poll-point"; if one or more alarms are associated with a poll-point, "index to the particular group of addresses that contains the alarm".

## Telemetering

In addition to alarm records and indications, the Conitel 1000 gathers data and measurements from transducers throughout the power system. This information, in the form of measurements in watts, vars, volts, or amps, is accumulated once each hour on demand of the dispatcher, and telemetered to the master station. By pressing a button, the dispatcher can also obtain the readings from any remote station he selects.

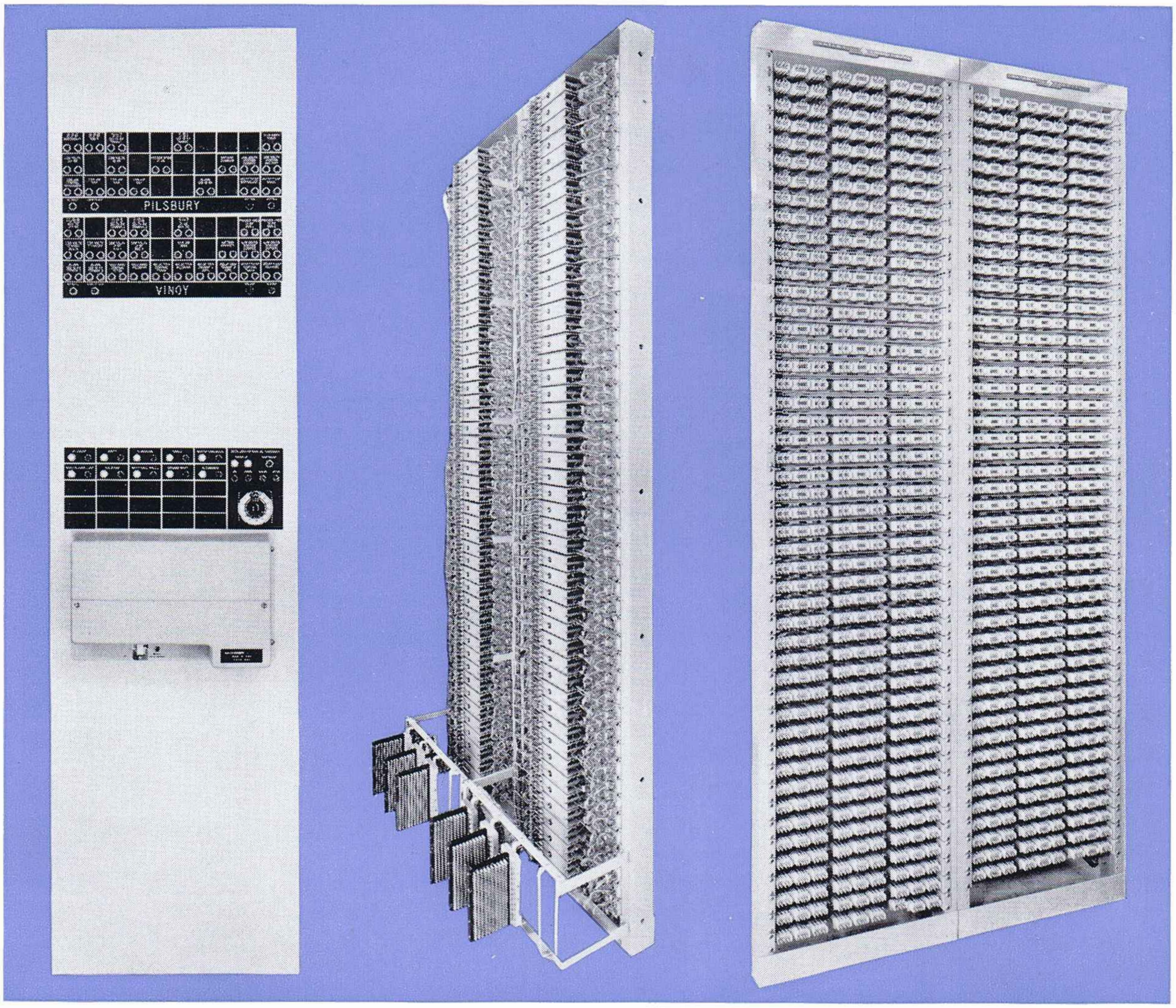



Figure 3. (Left) Display panel divided according to substations, each section having lamps for indication of alarms at a particular remote station. The status of each point is displayed by means of two lamps, one green for "alarm" and one red to indicate a "no alarm" status. A telemetering printer mounted at the bottom of the panel can write up to seventeen 16-column lines per second, permitting print-out of telemetered information without delaying other system operations.

(Center and Right) Rear and front views of the correed registers that store breaker status and alarm indications.

At substations along the 69- to 240-kilovolt transmission lines, AC/DC transducers are used as the primary detection devices. These units are designed to convert an AC input to a proportional direct current in milliamps, as an output acceptable to the substation analog-to-digital converter (A/D). The watts and vars on lines and transformers and voltages on buses, can be read with an overall accuracy of plus or minus one unit-digit.

To avoid interruptions in transmission of the critical status indications (which have highest priority), one data-point reading is telemetered at the end of each scan of the poll-points. This sequence of one data-point per scan cycle is continued until all the data points have been interrogated. The telemetering sequence is provided at programmed intervals such as once each hour, or the sequence can be initiated at any time by the dispatcher, who may request all the readings or only those from one or more remote stations.

All data is telemetered as three-decimal-digit information; one address per data point is used. When information has been received and properly

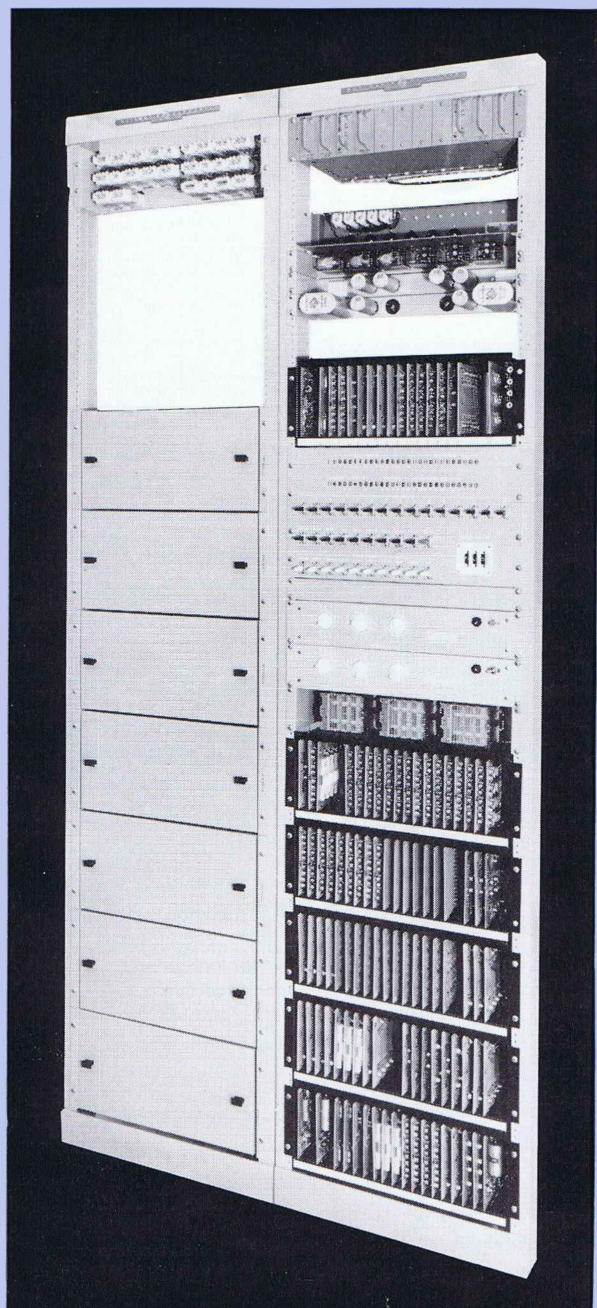
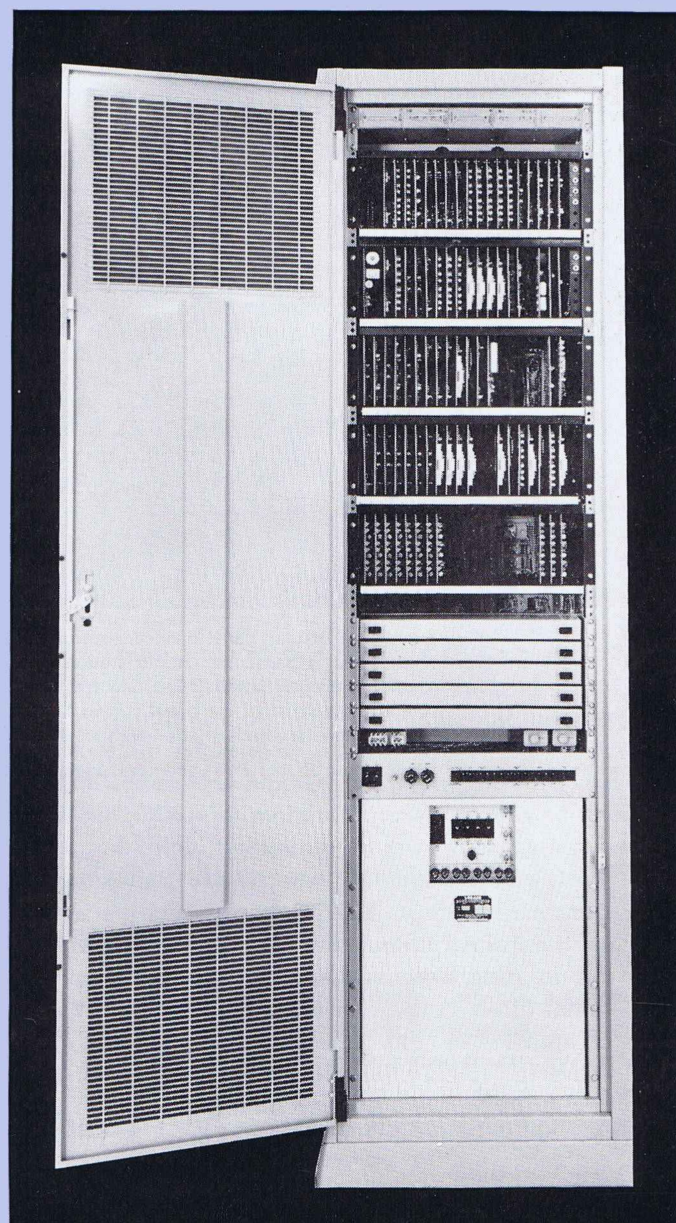


Figure 4. Master-station equipment is mounted on open-relay-racks—tone and line switching equipment at the top, maintenance panel and digital clock and calendar at the center, and system control logic and buffer storage for the telemetering logger at bottom.

Figure 5. Typical substation installation; the equipment is enclosed in a single cabinet.



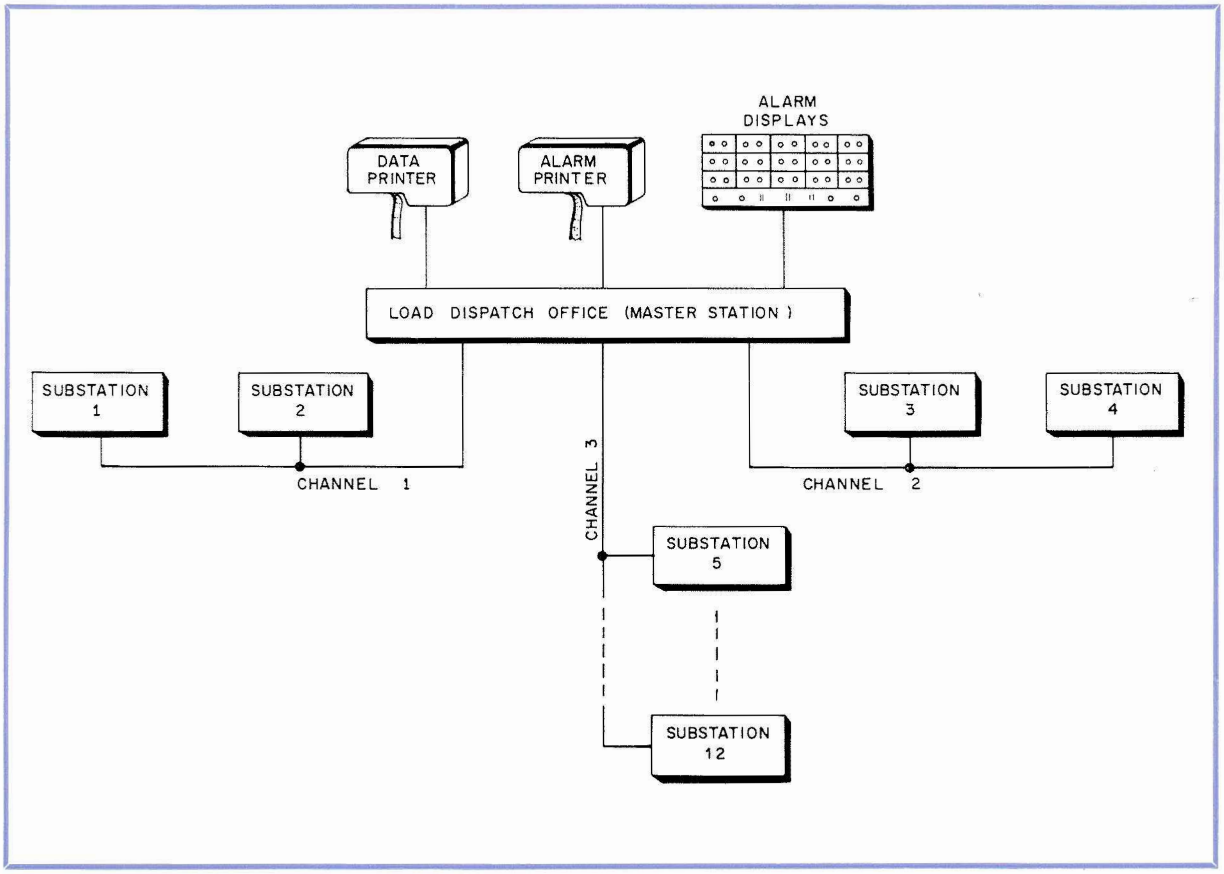



Figure 6. Substations throughout the power system's service area are supervised from the load-dispatch office at St. Petersburg. Microwave communication channels are shared with the existing "protective relaying" equipment and voice facilities.

scaled, it is stored in a buffer register so that it may be accessed by the data printers without delaying operation of the system.

*Status Indications*

The display panel is divided according to substations, each section having lamps to indicate the status of all alarms and circuit breakers at the particular station. These indications are of two general types:

1. Alarms that are common to a remote station; these are displayed by means of a single lamp per alarm.

2. Individual indications within a substation. Each point is displayed by means of two lamps — "normal" (red, according to power-system practice) and "abnormal" (green). When the status of a point changes, either to its abnormal or to its normal condition, the corresponding lamp flashes until acknowledged by a common STATION-ALARM-SILENCE button on the panel. As previously mentioned, this indication is accompanied by an automatic printout on the alarm printer.

## Packaging

With the exception of the display panels, all master-station equipment is mounted on open 19″ relay racks (Figure 4). The display panels are integrated into the existing Florida Power Corporation arrangement.

At the substations (Figure 5), enclosed steel cabinets with front and rear access doors are provided. A unique hinged-rack design was used in this application because of space limitations at the substations.

## Communications

All but two substations can be reached directly by microwave, and these two stations are reached by very short direct-wire circuits. The microwave circuits are inherently four-wire, while the direct-wire circuits are two-wire. Frequency-shift keying equipment is employed, together with "speech-plus" operation. Voice communication is a useful feature, since several of the substations are attended at least part of the time. As indicated in Figure 6, three communication-channels are used. In order to accommodate these inputs, a line-switching circuit ties only one leg at a time into the master-station.

### Prime Power Source

At the master-station, 115 VAC, 60-cycle power is used as the primary power input, with automatic transfer to an emergency source in case of power failure. The Conitel 1000 equipment at the substations operates from 130 VDC battery sources.

### Summary

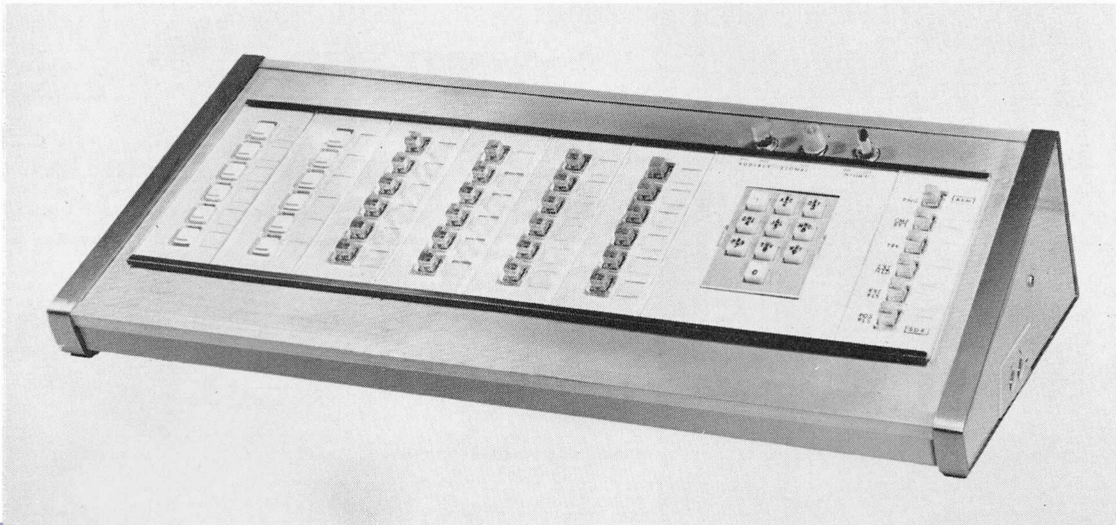
While electronic, solid-state circuits were used wherever many repetitive operations occur, certain electromechanical devices were provided to perform specific functions. For example, correeds were used for indication storage as well as for part of the switching functions.

This system incorporates most of the basic features of Conitel 1000 in an application which approaches the system's capacity. The ability to handle a large number of points, together with the high-speed, low-maintenance characteristics that are inherent in Conitel 1000, were all used to advantage in this application.

**GEORGE W. POTENZA** is a graduate of Illinois Institute of Technology. Before joining Automatic Electric Laboratories, in 1961, he was employed in the research departments of Miehle-Goss-Dexter Corporation, and American Machine & Foundry Company. Mr. Potenza is now engaged, as Staff Engineer, in the proposing and engineering of control systems in the Industrial Systems Laboratory.

# NEW PRODUCTS

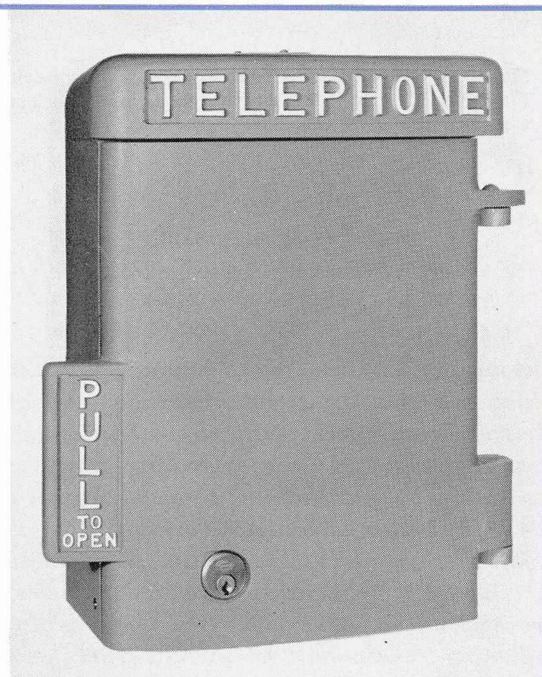
## PABX Turret is Expandable to 36 Trunks

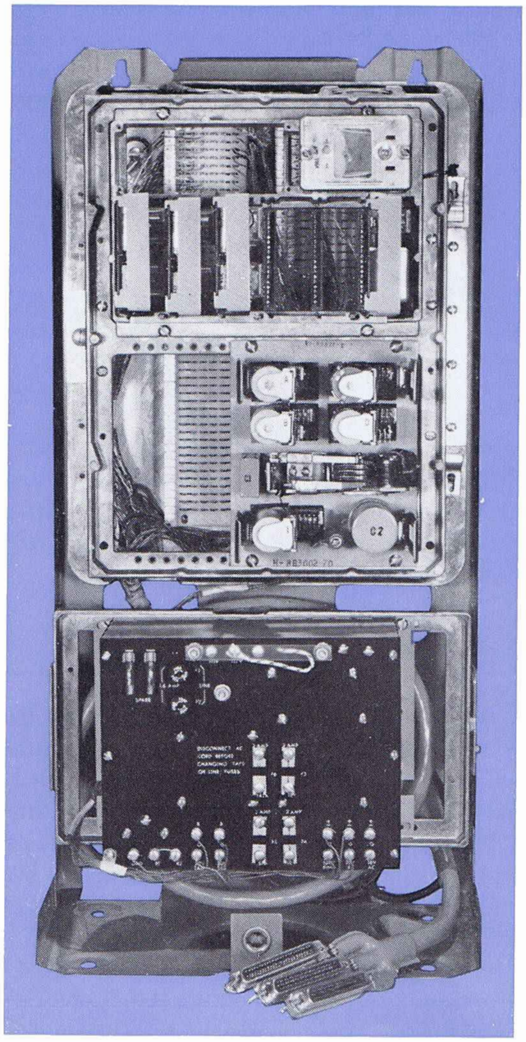


This 36-trunk turret for the Type 300 PABX provides an intermediate size between the 24-trunk desk turret and the 48-trunk floor console. Measuring 5 inches high, 10 inches deep, and 22 inches wide, the new turret is equipped for 24 trunks and is completely wired for 36 trunks. Six lamp strips, four key strips, and two dummy key strips (positions for future key strips) are provided. Additional key strips may be added by simply removing the blank key strips, plugging the new key strips into the receptacles provided, and fastening the new key strips to the mounting strips. The operation and electrical characteristics of the new turret are identical to those of the 24 trunk turret presently used with the Type 300 PABX.

## Outdoor Telephone Housing

A standard instrument such as the Automatic Electric Type 90M wall telephone is accommodated by this new weatherproof outdoor telephone housing. The box assembly consists of a weatherproof cast aluminum housing with a spring-loaded hinged door, which is held in the closed position by a magnetic latch. The door is also equipped with a weatherproof lock. Screened openings in the bottom permit the use of standard ringers mounted inside the telephone. The box, which measures 12 inches wide, 17 inches high, and 6 inches deep is dawn gray in color and can be mounted to any flat surface, or any irregular surface, such as a pole (a bracket is available for pole mounting).





# Compact Key Telephone System

## with improved installation and service features

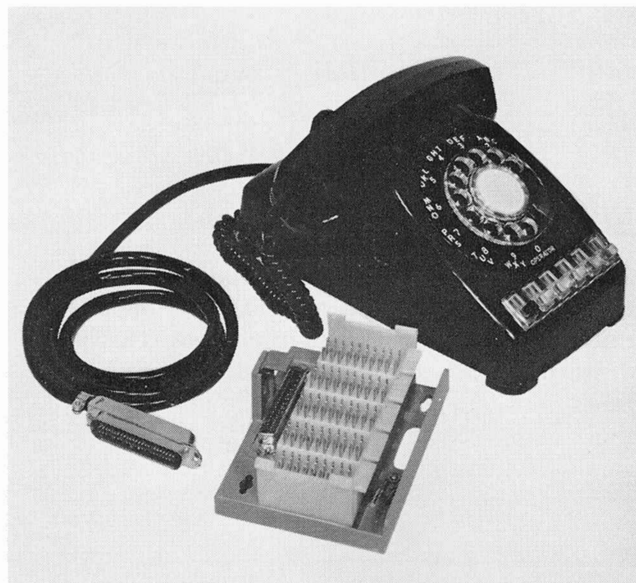


Figure 1. The 10A2 Key Telephone System, consisting of control equipment (left), and station equipment such as the Type 86 plug-ended key telephone and quick-connect terminal boxes (right), is engineered for fast installation and easy servicing.

By Robert E. Jurewicz
and George E. McLean
*Automatic Electric Laboratories, Inc.*

**Automatic Electric's key telephone equipment, which provides an attendant-less private telephone system operated by the subscriber, has been engineered to incorporate plug-in printed-wiring cards, solid-state devices, miniature relays, and plug-ended station apparatus. The result is a system that takes less space, reduces installation time, is expandable, and is easier to service. This article describes the features of the 10A2 Key Telephone System and discusses its options, circuits, and arrangements.**

In the new Automatic Electric 10A2 Key Telephone System, all components, from the telephone instrument and running cables to the individual circuit elements, are designed with plug-in connections for easy installation and adaptation to customer requirements. Printed-wiring cards, solid-state devices, miniaturized electromechanical relays, and new mounting hardware have reduced the size of the Automatic Electric Key Telephone System; factory-wired features and new quick-connect-type terminal blocks and station cabling have reduced the installation time; and plug-in cards for central-

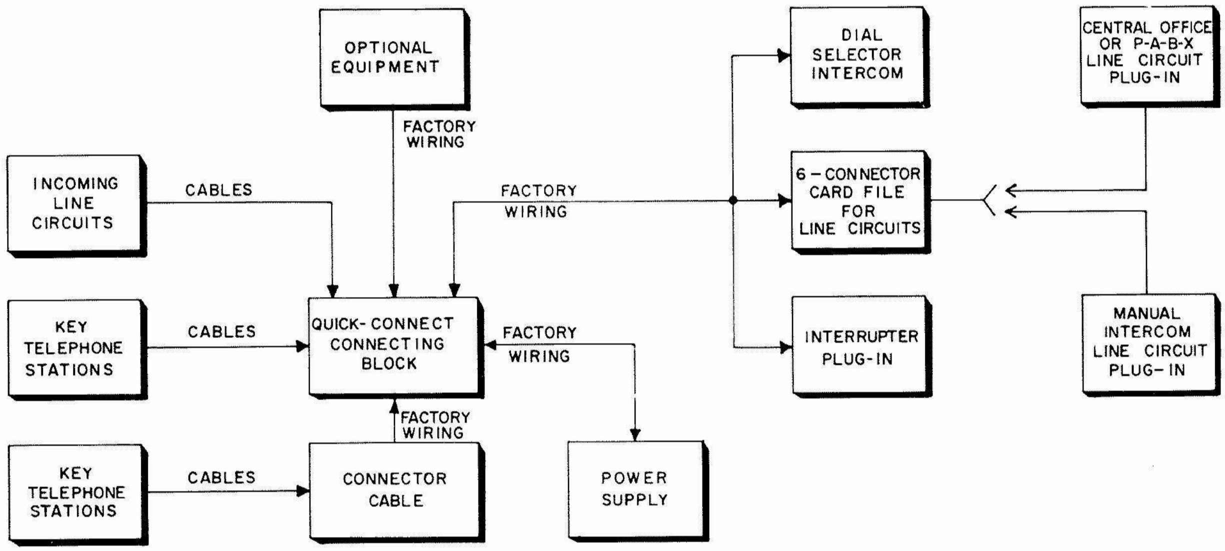



Figure 2. Interconnection of components in the 10A2 Key Telephone System.

office and manual intercommunicating line equipment have reduced capital expenditures for idle elements, and also facilitated system repair and expansion.

Briefly, the new Type 10A2 Key Telephone System is a private telephone system requiring no attendant, which the subscriber operates manually using pushbuttons, at stations such as the Type 86 or 860A key telephones. The system consists of relay equipment, power supply, and associated station apparatus (Figure 1) to provide talking channels that may connect to a public exchange office, PABX, or another key telephone system (Figure 2). The new Type 10A2 Key Telephone System provides the latest features to the customer, as well as all of the circuit features of the older Type 10A1.

## Plug-in Line Circuit

The heart of the new 10A2 Key Telephone System is a plug-in circuit consisting of a 3½″ by 5¼″ epoxy-glass printed-wiring card on which three miniature relays and solid-state circuitry is mounted (Figure 3). The plug end of the printed-wiring cards is slotted in two locations, so these cards cannot be inserted incorrectly into a receptacle.

The line circuit card provides the following features:

1. Flashing visual signal on incoming calls.
2. Audible signal for incoming calls.
3. Time-out.
4. Steady visual signal while a station of the system makes a line busy.
5. Holding lines.
6. Winking or steady visual signal to indicate a held line.
7. Wink-off release when a station of the system again seizes the line, or when the line is opened.
8. Central-office or PABX line operation during local power failures.
9. Steady audible signal for 1 to 3 seconds.
10. Signal interrupter.

Incoming signals are audible and visual and can be either steady or intermittent.

## Wiring Options

Line circuit card wiring options are provided on each circuit by a series of small wire-clip details which permit quick change of circuits as needed in field service.

The card wiring permits three distinct circuit options:

1. Visual Hold Signal, either winking or steady.
2. Ringing Signal Control—can be jump-strapped between proper wire clips for intermittent ringing or steady ringing, or for line grouping on a common audible signal.
3. Time-out of locked-in auxiliary visual and audible signals. Time-out releases locked-in re-

lays and extinguishes the incoming signal if the call is not answered. In the 10A2 line circuit, time-out control is on a per-line basis and is considered instant recycling. Factory-wired "Z" option times-out approximately 15 seconds after the first or second application of machine ringing on the line; this interval resets automatically after the third ringing cycle so that the lock-in relays will release approximately nine seconds after the last ring. Removal of the "Z" strap provides time-out of approximately 26 seconds after the initial ringing application. Subsequent ringing applied within this 26-second interval resets the timing cycle to approximately 16 seconds. This option is associated with a line having manual ring service.

A motor-driven interrupter supplies the rhythmic visual and locally derived audible signals indicating incoming calls (flashing lamps) and held calls (winking lamps). The interrupter uses a 10-volt a-c motor and has cam-actuated contacts.

The high impedance of the ringing detection circuit permits an additional ringer to be placed ahead of the circuit, if needed, without danger of pre-trip. This was not possible with either the 10A or 10A1 line circuits.

### New Manual Intercommunicating Line Circuit

The new manual intercom line circuit (Figure 4) features one miniature relay, an inductor, and two resistors. The circuit requires station "A" lead control to operate the switching relay that connects an inductor across the line for local battery talking. A line-busy lamp circuit is furnished on the key telephone unit, and a spare set of transfer contacts on the relay has been wired out of the card for miscellaneous switching. Audible signaling between stations is accomplished by a separate pushbutton and buzzer.

The manual intercommunication line circuit provides the following features:

1. Talking battery for interconnected stations.
2. Busy lamps at stations, that light when the line is in use.

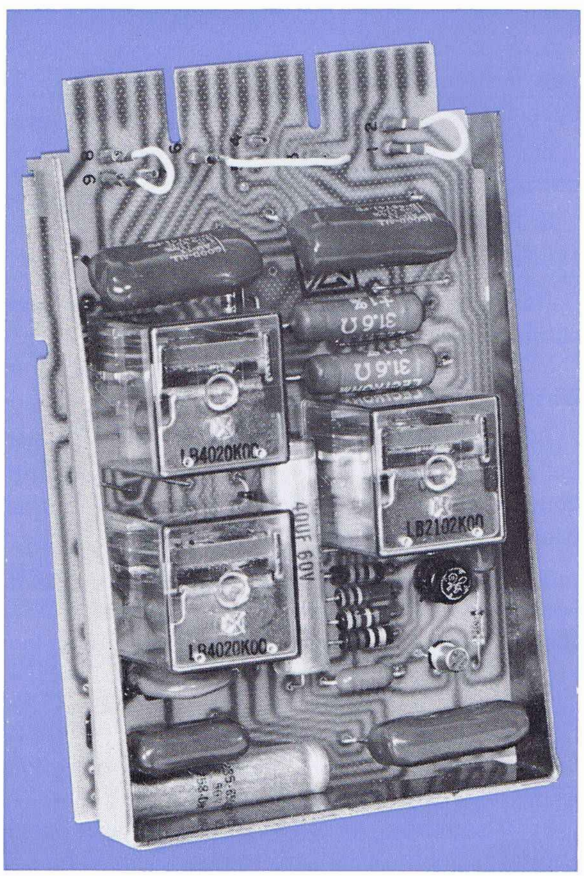



Figure 3. Plug-in line circuit card with printed wiring and solid-state components.

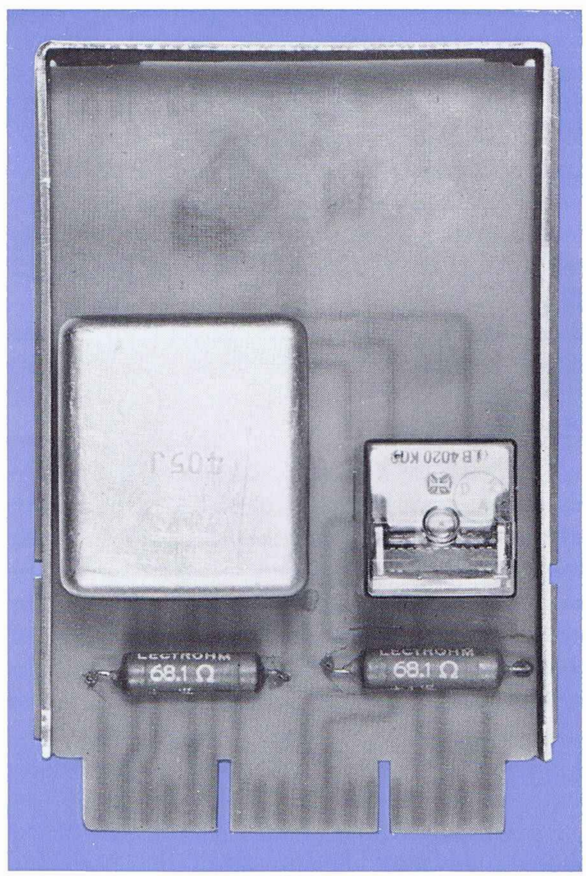



Figure 4. Manual intercommunicating line circuit card.

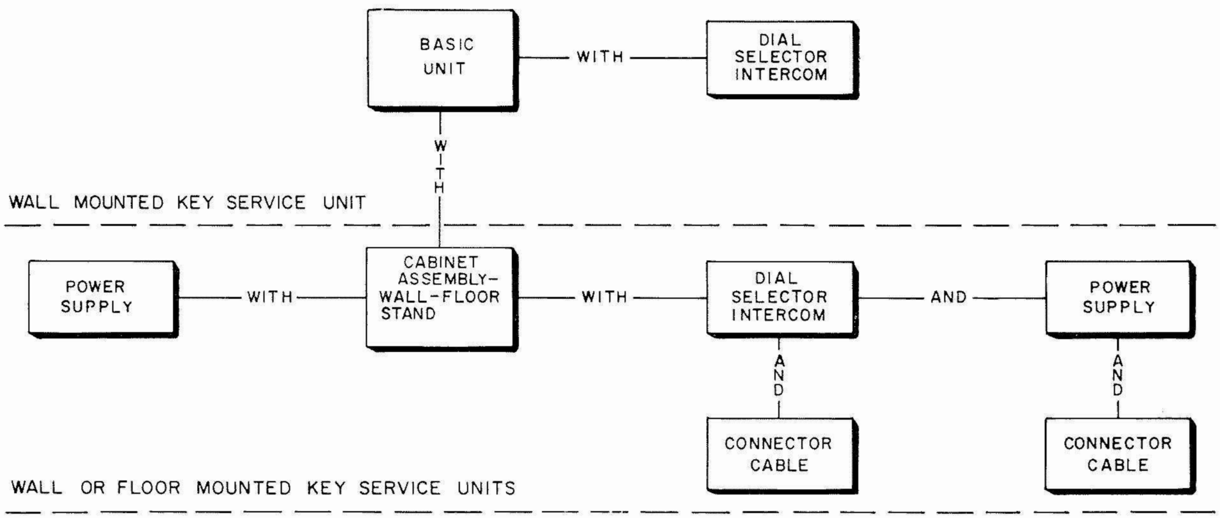



Figure 5. Eleven combinations of pre-wired key service components and two varieties of power supplies are available from the factory.

3. Intercommunicating features that permit two or more stations to be connected to common talking line, usually on the same premises, without using a central office or PABX line.

## Ten Varieties Available

Generally, the 10A2 Key Telephone System consists of a factory-wired "combination-type" package; Figure 5 shows the ten factory-equipped and pre-wired units that are available. Each key service unit can serve six line circuits, either central office, PBX, PABX, or manual intercommunication. Any number and combination of these key service units can be used to make up a key telephone system.

## Basic Key Service Unit

The basic key service unit (Figure 6) consists of:

1. Metal backboard.

2. Apparatus mounting (hinged gate) for system components.

3. Plug-in motor-driven interrupter.

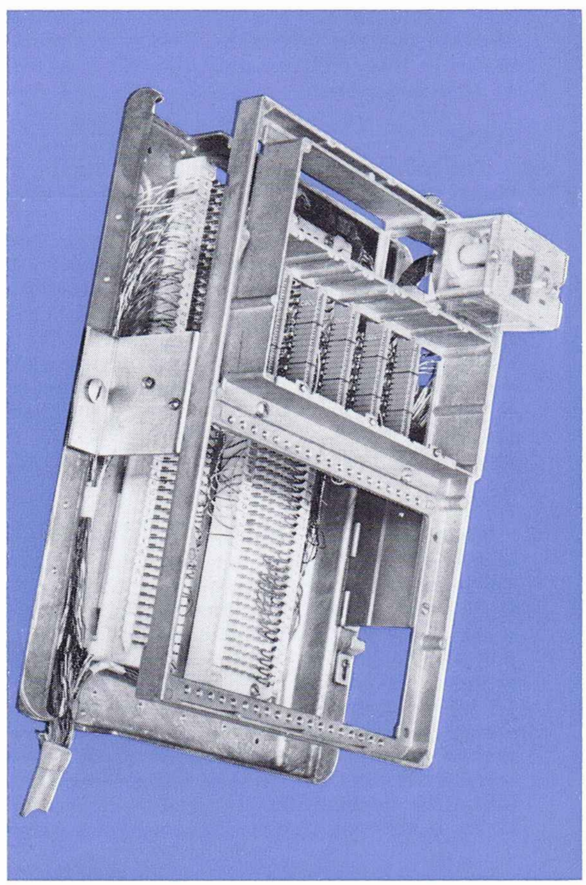
4. Printed-wiring card file having six receptacles for plug-in line cards.

5. Two "quick-connect" terminal blocks.

6. Prewired electrical components.

(Continued on page 224)

Figure 6. The basic six-line key service unit attaches to a wall and incorporates a hinged gate that permits mounting of additional equipment.



# Operation of the 10A2 Key Telephone Circuit

The progress of an incoming and an outgoing call through a central office or PABX line circuit will be traced in the following discussion to point out the unique features of the 10A2 Key Telephone System. Figure 7, a simplified schematic, may be used for reference.

*Incoming Call*

To signal a called party, ringing current over the central office T & R leads is forwarded to diode CR3 and varistor VR1 via the R3-C3 and R4-C4 network. Varistor VR1 limits the signal voltage and C6 provides a by-pass for high frequency signals. The rectifying action of CR3 allows only the positive halves of the ring signal to charge capacitor C5. These positive pulses charge C5 and discharge C2 through R12. The increased switching time provided by the discharge of C2 prevents false operation due to disconnect transients, etc. When C5 is charged sufficiently and C2 has discharged sufficiently, the current is shunted from the base of Q2. Transistor Q2 turns off and switches the cathode of diode CR2 from ground to a negative potential. Diode CR2, now forward biased, allows current flow thru the CR-2 CR1 combination. This current flow turns on transistor Q1 causing relay B to operate and completes the appropriate audible signaling circuits (table A). Current flow in relay C is insufficient to operate this relay. The ring circuit remains in this condition until the call is answered or time-out occurs.

*Answer*

The called party answers by operating the associated pick-up key and lifting the station handset. Ground on lead A causes relay A to operate, cutting off transistor Q1, and connecting lead T (CO) to lead T. The increase in current allows relay C to operate; connecting lead R (CO) to lead R; transferring lead L from lead LF to the proper visual hold circuit lead (table A); and disconnecting lead RC from the respective audible signal lead. Transistor Q1 turns off causing relay B to restore. When C5 has discharged sufficiently, the shunt is removed from the base of Q2, triggering Q2. Conversation may now take place.

*Time-Out*

Time-out occurs when an incoming call is not answered. With ground on the negative side of C5, subsequent rings do not charge C5 as fully as during the initial ring, thus reducing the discharge time of C5 and the length of the time-out period (Table B). If the calling party should abandon the call before the called party answers, C5 will discharge thru R11. When the C5 has discharged sufficiently, Q2 turns on to connect ground potential to the cathode of diode CR2, reverse-biasing CR2 to stop current-flow in the CR1-CR2 combination. Transistor Q1 turns off. Relay B restores, disconnecting resistance ground (R5) from relay C, and disconnecting the associated visual and audible signaling leads. The circuit is now at normal.

*Holding*

An incoming (or outgoing) call can be held by operating the hold key on the telephone instrument. Ground is removed from lead A causing relay A to restore; central office leads are transferred from leads T & R to the R1-R2 resistor holding loop; the shunt is removed from the base of Q1, turning on Q1, and the circuit of slow-to-release relay C is opened. Transistor Q1 turns on and operates relay B; lead T is connected to lead R; slow-to-release relay C remains operated through R5; a negative potential from the R1-R2 voltage dividing network is connected to the base of Q1 to hold Q1 on; and the lamp wink and motor interrupter circuits are completed.

Any station of the Key Telephone System that seizes this held line by operating the associated pick-up key, with the handset off hook, grounds lead A. Relay A operates, transfers the central-office conductors from the R1-R2 resistance loop to leads T & R, and connects ground potential to the base of Q1. Transistor Q1 turns off, causing relay B to restore; the interrupter circuit is opened and lead L is transferred from the lamp winking to steady visual. Conversation may now take place.

A hold circuit that is not released by a station produces a "permanent" signal at the central office, and can then be released from the central office or PABX by momentarily opening the line conductors to remove the negative bias from the base of Q1. Transistor Q1 turns off, causing relay B to restore; the interrupter circuit is opened, and relay C restores after its slow-to-release interval. The circuit is now at normal. This feature is known as "wink-off release."

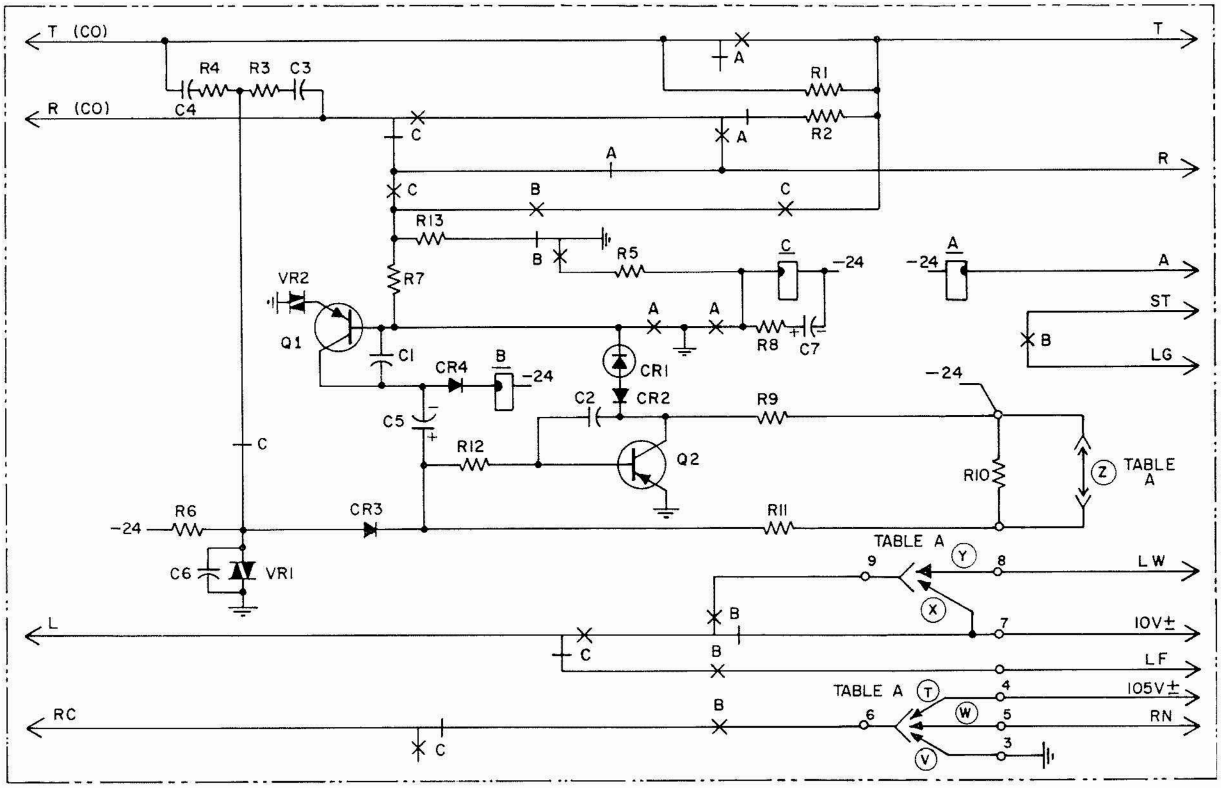
*Release*

When the PABX station disconnects, ground is removed from lead A to restore relay A; central-office conductors are disconnected from T & R; ground potential is removed from the base of Q1; and the circuit to relay C is opened. After a slow-to-release interval, relay C restores the circuit to normal.

*Outgoing Call*

A PABX station initiates a call by operating a pick-up key, and lifting the handset, to ground lead A. Relay A operates, completes a circuit to the central-office conductors, connects ground potential to the base of Q1 (holding Q1 off), and closes the circuit to relay C. Relay C operates to open the visual signal circuit. Signaling or conversation may now take place.

Holding and release are as described for the incoming call.




| TABLE A | | | |
|---|---|---|---|
| FEATURE | | WRG | QUANTITY |
| TIME-OUT CONTROL | LONG TIME DELAY 26 SEC. | | 1 PER LINE |
| | SHORT TIME DELAY 16 SEC. | Z | |
| VISUAL HOLD CKT. | LAMP WINK | Y | AS REQ'D |
| | LAMP STEADY | X | |
| AUDIBLE SIGNALING | INTERRUPTED RING | W | |
| | COMMON AND CONTROL | V | |
| | STEADY RINGING | T | |

| TABLE B | | |
|---|---|---|
| TYPE-OF-RINGING | MACHINE | MANUAL |
| TIME-OUT-INTERVAL | SHORT | LONG |
| OPTION | (Z) FURNISHED | (Z) REMOVED |
| INITIAL RINGING | 15 SEC. | 26 SEC. |

Figure 7. (Above) Simplified central office or PABX line circuit. When the circuit is at normal, Q2 is conducting.

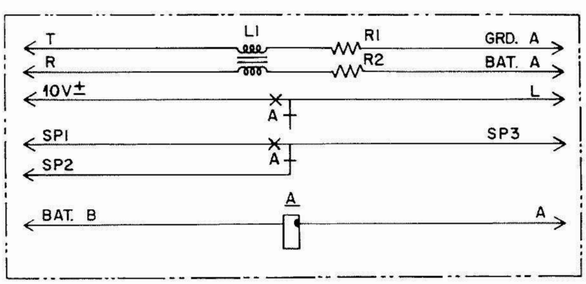



Figure 8. (Left) Schematic of manual intercommunicating line circuit.

*Local Power Failure*

Outgoing calls can be originated during periods when the local DC power supply is inoperative. The station is connected to the line in series with resistor R1, when the handset is lifted. Resistor R1 does not affect the talking circuit.

Incoming calls can be signaled by a line ringer. Common audible and separate audible signals are inoperative, since relay B cannot operate.

*Manual Intercommunicating Line Circuit*

When a pick-up key associated with one of these lines is operated, with the station handset off hook, ground on lead A (Figure 8) operates relay A; lead SP3 is transferred from SP2 to SP1; lead L connects to lead 10V±. The calling and called stations are connected to battery feed through inductor BF and resistors R1 and R2.

When the PABX station associated with this circuit disconnects, ground is removed from lead A to restore relay A; lead SP3 is transferred from SP1 to SP2; and the visual signal circuit is disconnected. The circuit is now at normal.

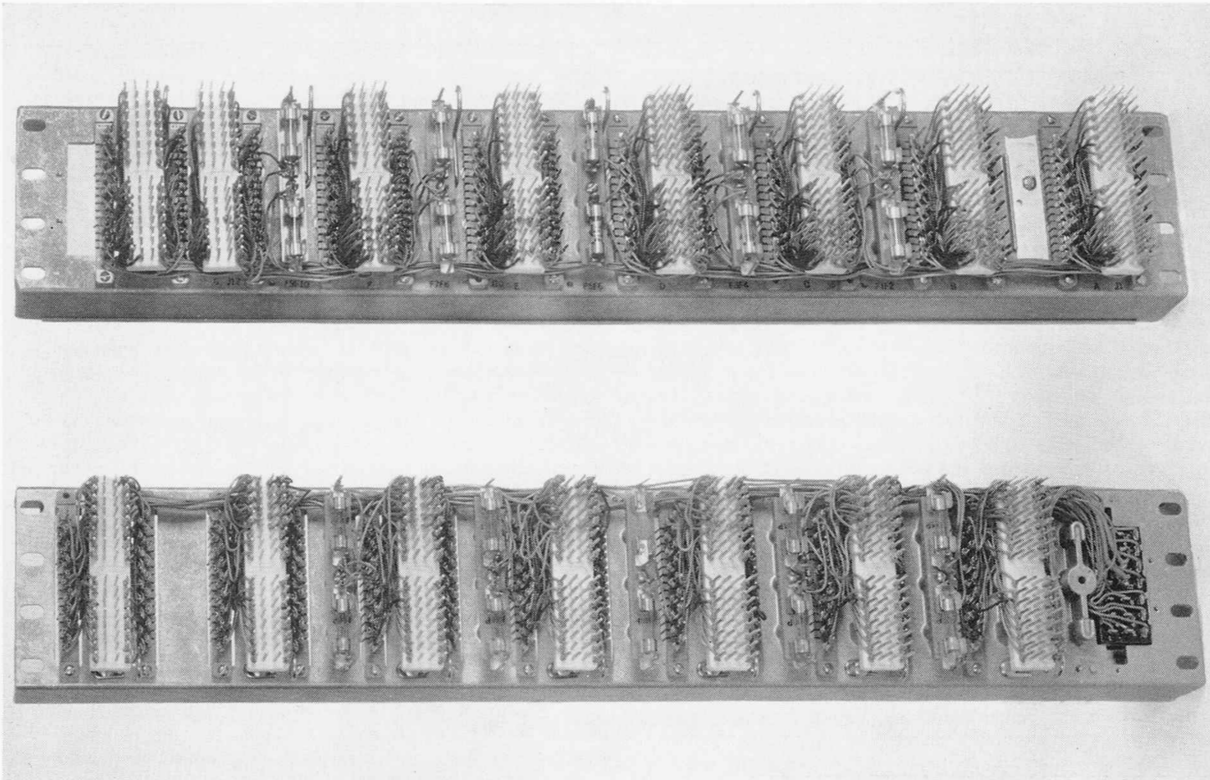


Figure 9. Rack mounted 15-line panel (top) and 13-line panel (bottom) viewed from the rear.

The basic, six-line, wall-mounted key service unit is 16¾″ high, by 13½″ wide, by 9⁵⁄₁₆″ deep. The apparatus mounting gate on the wall-mounted unit can be optionally equipped with either an internal power supply to provide a self-contained six-line Key Telephone System, or a dial selector intercom circuit. While not included as part of the basic unit, other panel-mounted Type 16A key telephone units, with standard mounting centers, are available as required.

## Cabinet Assembly

The addition of a cabinet assembly consisting of a floor stand and cover increases the space in the wall unit to allow the mounting of a power supply and dial selector intercom circuit. The cabinet assembly increases the dimensions of the key service units to 28 inches high, 14 inches wide, and 9 inches deep (See Figure 1).

## Rack-Mounted Panels

For larger key telephone installations, rack-mounted panels are available to handle either 13 or 15 line-circuit cards (Figures 9 and 10). The 13- and 15-line panels use wire-wrap terminals on the rear of the panel to terminate all wiring connections for the plug-in cards. The 15-line panel will accommodate the 15 plug-in printed circuit cards; the 13-line panel will receive 13 plug-in printed-wiring cards plus a heavy duty motor-driven interrupter, which supplies lamp flash, lamp wink, and locally derived audible signals. The manual intercom card can be plugged into various positions on the 13- or 15-line panel (when the panel is wired for this feature).

The 13- and 15-line panels will mount on any 23″ wide rack, or equivalent space. A modified Type 16A apparatus cabinet will accommodate one 13- or 15-line panel and four quick-connect terminal blocks. For installations requiring more than a single panel, the provision of an intermediate quick-connect terminal block field, or distribution frame, between the 13- and 15-line panels and the building cabling system is recommended. The use of a cross-connect distributing field facilitates additions, changes, or removal of lines or stations, to reduce installation time.

### Power Supply

The wall-mounted and floor-mounted Key Telephone System, and the larger capacity system using the 13- and 15-line panels are available with the following power supplies:

1. Filtered and non-filtered DC with 10VAC and 18VAC lamp and signaling supply.

2. Same as No. 1 with 30-cycle 105VAC ringing supply.

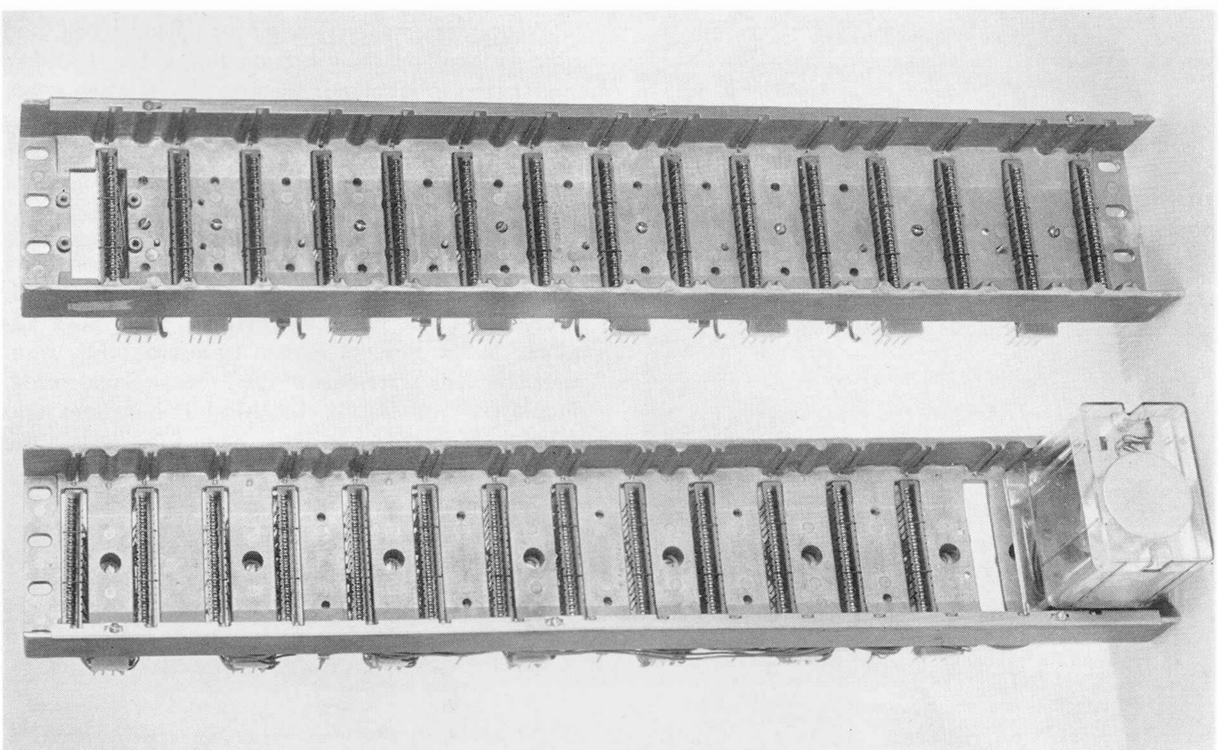
3. Same as No. 1 with 20-cycle 105 VAC ringing supply.

Items No. 1 and No. 2 can be mounted within the available 10A2 cabinet assemblies. Item No. 3 is for external mounting only.

### Conclusion

The Automatic Electric Key Telephone System is available as a complete package including telephone instruments, connectors, and switching

Figure 10. Front view of 15-line (top) and 13-line panel with interrupter (bottom) showing card receptacles.



equipment—with the plug-in concept incorporated in all equipment. As a result, the AE 10A2 Key Telephone System reduces time consuming installation problems common to the older systems. The plug-ended telephone instruments, factory wired and equipped key service units, optional plug ended cables, and solderless quick-connect terminal blocks save installation time. Plug-in line cards, which are used on an "as required" basis, minimize the operating company's initial capital equipment expenditure. The critical need for telephone communications equipment space is supplemented by the smaller size of the typical AE 10A2 installation, in comparison to the space required by older key telephone systems. These features, along with improved solid state and electromechanical circuitry, allow the Automatic Electric 10A2 Key Telephone System to economically meet and surpass present requirements.

**GEORGE E. McLEAN** joined General Telephone of California in 1951 as a central-office installer, and later worked as maintenance engineer on local, toll, and automatic toll-ticketing circuits. In October, 1959, he transferred to Automatic Electric Laboratories where he is designing local switching circuits for step-by-step central office and PABX equipment. He holds a radiotelephone operator's license, and is a member of IEEE.

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# PATENTS ISSUED-1964

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| 3,140,352 | Loewe, George R. | Amplifier And Clamp Circuit For Pulse Communication System |
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