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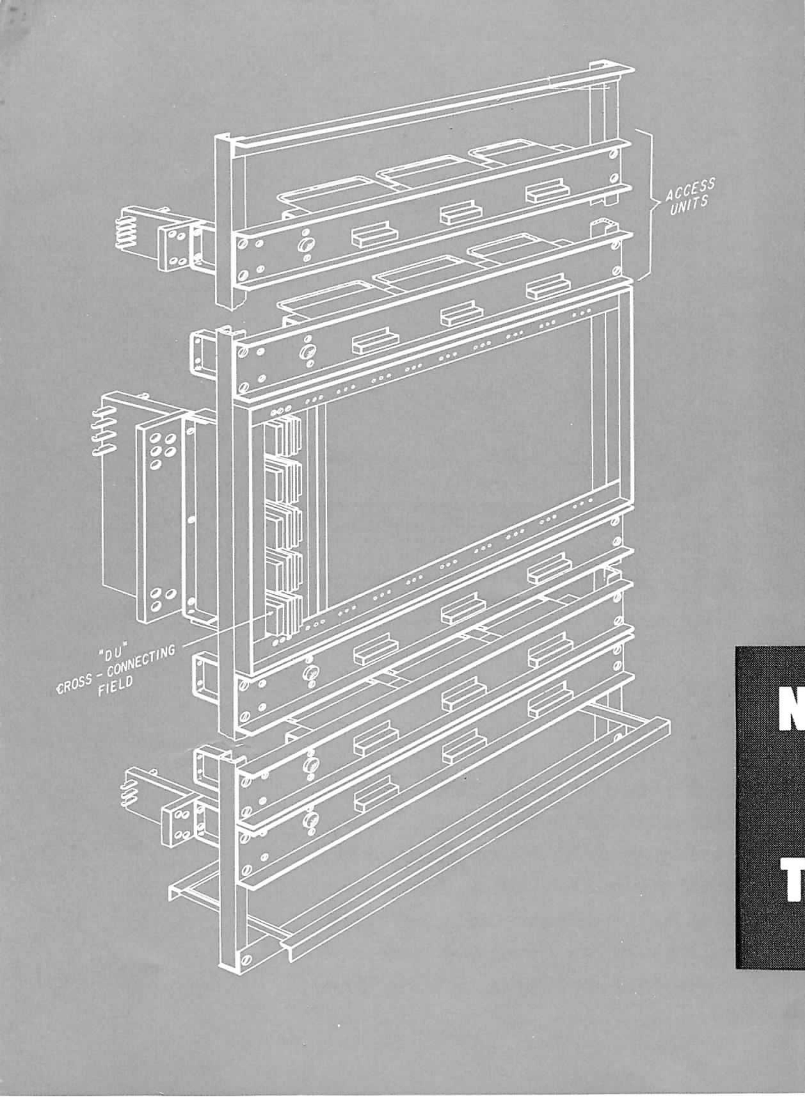


New Versatile Detector *for* Type 59 SATT Systems

By R. O. Stoehr and B. Sherstiuk

Figure 1. Type 59 SATT Detector

For automatic ticketing of toll calls, the one item of information which is not readily available on each call is the number of the *calling* party. The *called* number is derived from the pulses dialed; the date and time of the call, and its length, are easily determined by a timing device; but automatic identification of the calling party is a problem which has required extensive study and development.

The problem has been by-passed, in some systems, by having the calling subscriber dial *his own* number; this is called "Dialed Number Identification" (DNI). Normally, verification facilities are then provided, to prevent dishonesty. In other systems, an operator enters the connection to request the number of the calling party, and "keys" it into the ticketing storage equipment; this is called "Checking Operator" (CKO) operation.

The ultimate method of identification, however, is "Automatic Number Identification" (ANI), which uses an automatic unit to identify and record the number of the calling party without any conscious action on his part. In Type "A" SATT offices (frequency per group), the equipment on each line comprises only a pair of relay springs, a neon lamp, and a resistor. In Type "B" and "BD" SATT offices (frequency per terminal) detection has been accomplished by means of Detrel relays, one of which must be assigned to each station.

The Type 59 SATT Detector (Figure 1) described in this article, was developed to provide, in frequency-per-terminal offices, the advantages of the frequency-per-group Detector used in the largest Type "A" SATT systems. It provides automatic detection, economically, for frequency-per-terminal offices, large and small, having up to ten parties per line.

Detection of a calling station is carried on through the control lead of the established connection. Since this lead is also used for busy testing, and for holding the switch train, the signal employed for automatic number identification must, of course, be different from the potentials (exchange battery and ground) normally appearing on the control lead—and must not interfere with its functions. In SATT systems, this signal is provided by +60v. battery, which, when added to the 50v. exchange battery, provides a firing voltage for a neon lamp, and subsequently actuates the marking device.

Party Lines — TPL and TPS

Party lines present a problem. For universal application the Detector should be able to serve terminal-per-line (TPL) as well as terminal-per-station (TPS) lines. Under the TPL plan, all stations of a party line are assigned to the same connector terminal; their directory numbers differ in only one digit (which corresponds to the station number of the subscriber). The Detector need only identify the line; the station number is identified thru the Ticketer.

Under the TPS system, each station on a party line is assigned an individual connector terminal; thus, the directory numbers of the stations on the same line may differ widely. It is therefore necessary that each station be equipped for individual detection. Also, since the control lead of a party line is common to all stations, signals on the control lead will appear on all control-lead connector terminals associated with this line. This requires that the Detector complete the circuit to the identification equipment of the calling station *only*.

The TPS system may be either "frequency per group," or "frequency per terminal." In frequency-per-group offices, each connector serves only one group of stations (such as those with 25-cycle ringers). Since the specific party on the calling line is identified by the Ticketer, the Detector can be made to recognize signals only in the connector groups which serve these parties. In frequency-per-terminal offices, on the other hand, no connector station grouping exists; the Detrel Detector, which has been used in such offices, requires the addition of a relay per terminal. The new Type 59 SATT Detector can use relatively inexpensive terminal equipment similar to that of the Type "A" Detector, but will also provide service for frequency-per-terminal offices.

Design

It is apparent that if the Detector is to be universally applied, it must have considerable inherent flexibility. For this reason it is divided into its basic components, which can be combined to provide the facilities or features required in any specific case. For such universal application, the basic unit must be small enough for the smaller office, but not so small that excessive duplication would be required in the larger office. Too large a unit would require profuse multiple wiring; for example, if one common cross-connecting field were made to provide the full complement of 10,000 terminals, it would have to be used also for an office of 1500 terminals. On the other hand, a smaller field would lend itself more readily to expansion, and would not involve a large initial outlay on each installation. It was therefore decided that the basic unit would have a capacity of 3,000 terminals.

Since the Detector lends itself to logical subdivision, it is constructed as two distinct units as illustrated in Figure 1:

The Access Unit, which contains all the individual terminal equipment, including the "MC" (thousands and hundreds) Cross-connecting Field associated with each connector hundred-group.

The "DU" *(tens and units) Cross-connecting Field,* designed to be common to all Access Units. Since the basic unit is 3,000 terminals, the DU Field also has this number of terminals, and is an integral part of thirty 100-terminal units of access equipment.

The rack layout is designed so that the 3,000 terminal DU field is mounted near the center of the equipment rack, with as many as 30 units of access equipment mounted above and below. For very small offices, it should be possible to provide 2,000 terminals on a rack 9 feet high.

To apply these principles, within the limits of cost and size that we had set for ourselves, we have used printed-wiring boards for the individual equipment units, and have interconnected them with their associated MC fields by means of patching leads with "Taper Tab" terminals. These mechanical terminals provide connections which are very firm yet can be quite readily changed; they require no soldering.

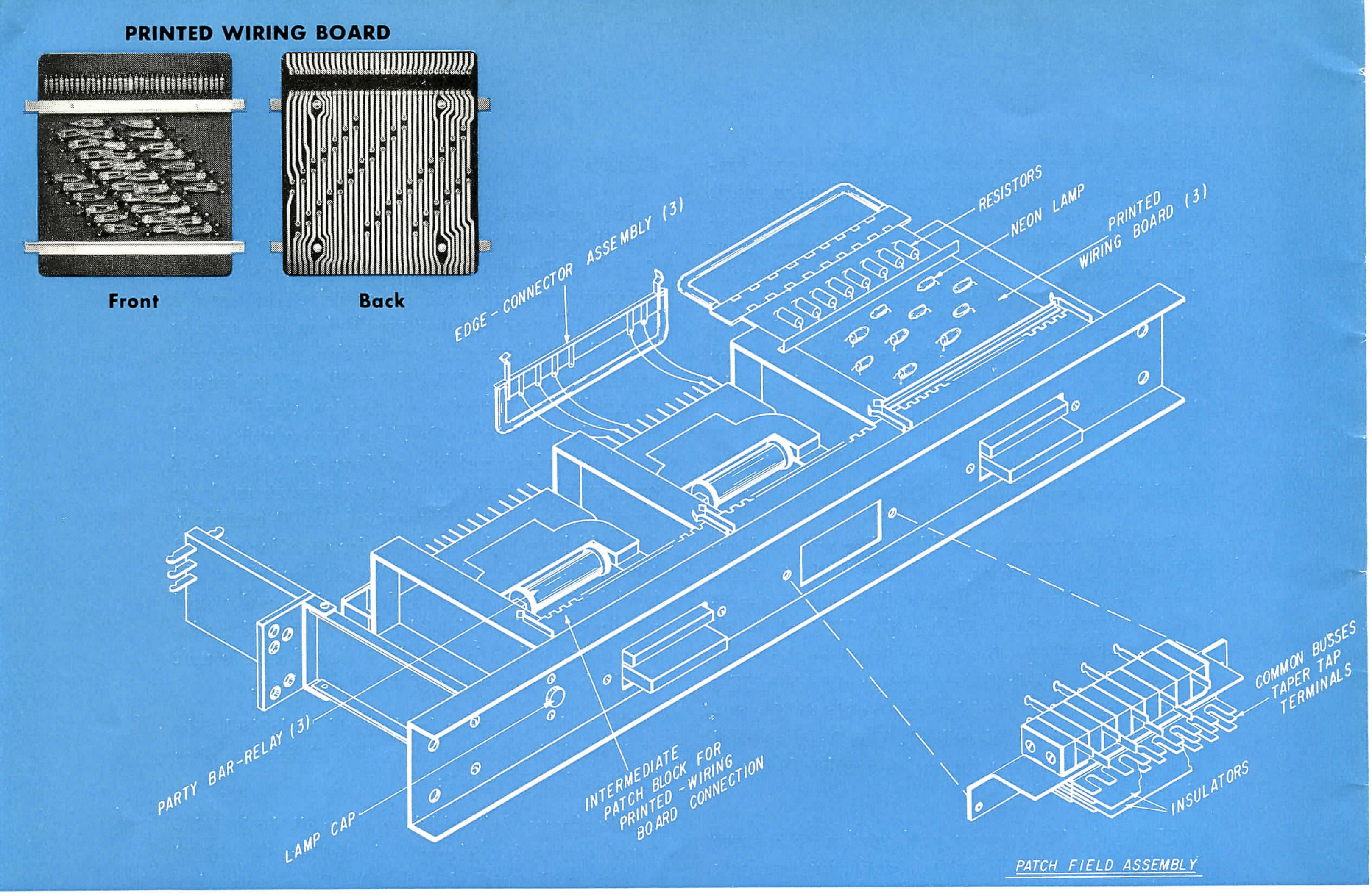


Figure 2. Detector Access Equipment and Printed Wiring Board

Detector Access Unit (Figure 2)

Access Units are designed around the Automatic Electric Bar-relay, which has 35 pairs of springs. One pair of springs is assigned to each party; thus, three party Bar-relays, side by side, form the basis of an Access Unit serving a connector hundred-line group. Associated with each relay is a printed-wiring board, an intermediate patch-block, and an MC patch-field assembly.

The printed-wiring boards are interchangeable, plug-in-units, each containing 34 neon lamps and 34 resistors. The resistors are fastened directly to the board, while the lamps are mounted on stand-off terminals to permit easy replacement of the lamps without the necessity of unsoldering the lamp leads from the printed board. Each printed-wiring board is inserted from the rear of the Unit; it is plugged into the intermediate patch-block directly over the associated party Bar-relay, and rests on the relay mounting. Connections between the relay and the board are made by means of a handle assembly containing an "edge-connector" that engages terminals on the rear edge of the board. This connector also carries the installer's wiring from the LIDF.

The MC patch field consists of a series of common buses, each containing 16 Taper-Tab terminals. As many of these buses are assembled into a field as may be required for a particular office; for example, a four-party office would require a bus for each party, a "no-detect" bus, a party "O" bus, and a spare—a total of seven buses, which are separated by clear plastic insulators, designed to prevent shorting of the patch cords on adjacent buses.

Each terminal of the intermediate block (except for those necessary to provide outgoing leads for the MC patch field) represents a particular station, which must be connected to the proper party-bus of the MC field. To minimize errors in making these connections, patch cords of different colors are used for the different parties (and for the MC field outgoing leads); e.g., if blue represents party 1, all connections to the party 1 bus will be made by means of blue patch-cords. The design of this Access Unit permits high equipment density, thus saving valuable space.

DU Cross-connecting Fields (Figure 3)

The "DU" field is an assembly of one hundred patching-blocks—twenty vertical rows of five each. Each block consists of a number of individual terminals and a small common patch field, similar to the MC patch field. Each of the common buses of the patch field represents a party, and as many of these buses are provided as required.

Each patching block represents a particular connector terminal of the one-hundred group (hence, there are 100 patching blocks). Referring to the DU illustration, Figure 3, the upper left-hand patching-block represents terminal 11 of all the access equipments associated with that particular DU field. The next block below represents terminal 12 of all the units, and so on down and across the field for a total of one-hundred blocks.

The unique design of the DU field makes it readily accessible for necessary changes as they arise. Changes are easily made, because each terminal and party is plainly identified, and the Taper-Tab patch-cords need simply be moved to the proper terminals—without use of a soldering iron. Plastic ducts for wiring eliminate the necessity of untying and replacing cables, and assure a neat-appearing unit, regardless of the number of cable additions.

Ease of Installation

For initial installation, the equipment is completely wired, and all equipment (except for the printed-wiring boards) is assembled. The installer need only provide the multiple cables between DU fields on adjacent racks, the cables from the MC and DU Party Bar-relays, the access cables from the LIDF, and the miscellaneous power and signal cables. All installer cables terminate on terminal blocks—no wiring to relays or patching-blocks is required. The printed wiring boards are shipped separately, and are inserted into the access equipments after the cabling has been completed.

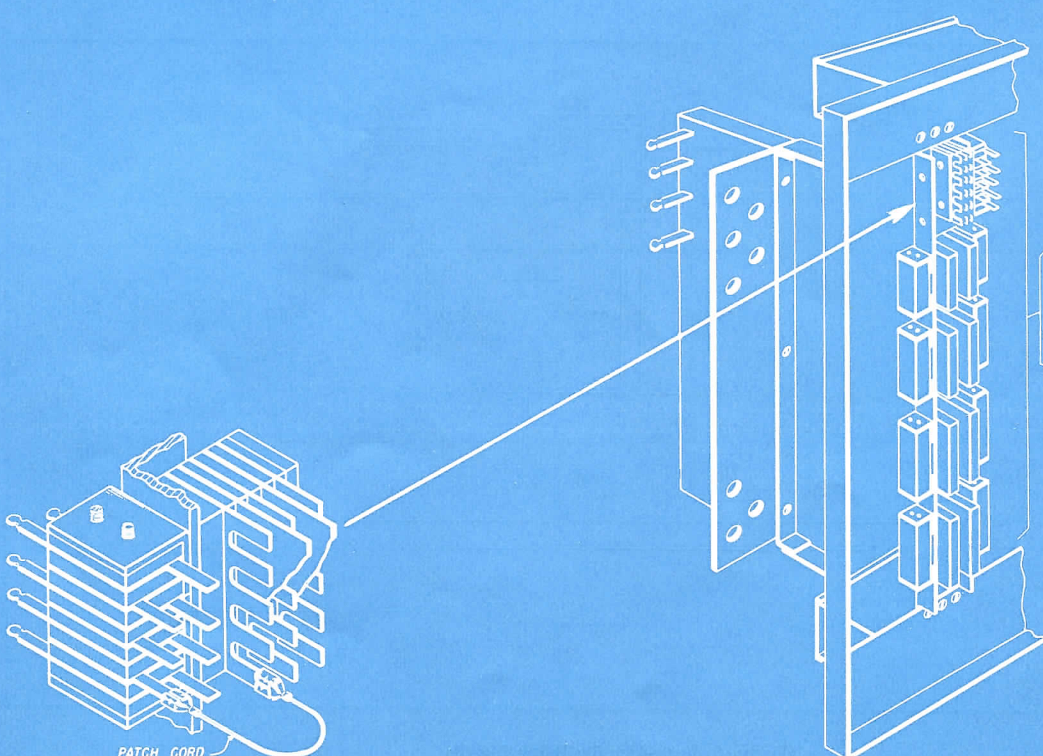


Figure 3. DU Cross-connecting Fields

Each Access Unit is connected to the "DU" cross-connecting field on the same rack by means of a 100-conductor, color-coded, plastic cable. Terminal 11 of each Access Unit is cabled to a terminal in patching-block 11; terminal 12 is cabled to a terminal in 12, etc. Thus, the same terminal number on every Access Unit is represented as an individual terminal within the same patching-block; or, all terminals 11 of all Access Units are represented on one patching-block known as block 11, all terminals 12 of all Access Units are represented on another block known as block 12, etc.

Patching between the individual terminals and the party buses in any one patching-block is accomplished with colored patch cords, as on the Access Units.

Party-Identity Relay Circuits (Figure 4)

Each party group in the office will require one party relay to recognize party marking provided by the Ticketer, at least one MC party Bar-relay to associate the respective MC party buses with MC register relay circuits, and at least one set of three DU relays to associate the respective DU party buses with D and U register relay circuits. Each contact of the MC party Bar-relay is connected to its respective party bus in different access groups. Since 35 contacts are available on the MC party Bar-relays, one relay can serve 35 access groups. If the Detector is to serve more than 35 connector groups, additional MC party Bar-relays can be provided, as required.

Digit-Register Relays Circuits

MC and Office Code Register Relays (Figure 5)

When +60v battery is connected to a control lead, 110 volts is impressed across the neon lamp, the series resistor and the MC relay circuit. With most of the voltage dropped across the resistor and lamp, the remaining voltage is not sufficient to operate a standard relay.

The Type "A" SATT Detector uses a sensitive relay for this purpose, but this relay is quite costly. In the Type 59 Detector we have used the NPN general-purpose type transistor, which is well suited for this application, and compares very favorably in cost. It has a 30v absolute maximum collector-to-emitter voltage rating; to provide current within this voltage limit, a Zener diode is provided, to derive 28v ± 5% from the standard exchange battery as shown in Figure 9 (page 152).

Diode D1 is provided to protect the transistor from negative surges on the control lead. Diode D2 protects the transistor from inductive surges from

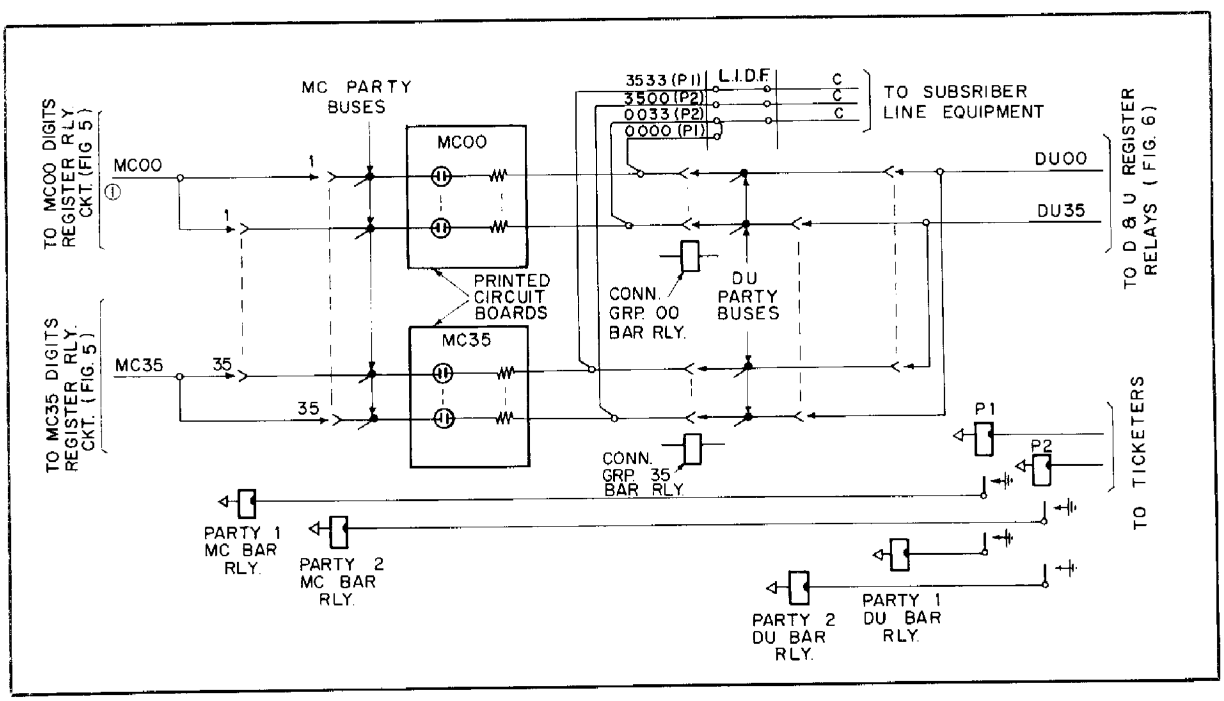


Figure 4. Party-Identity Relay Circuits

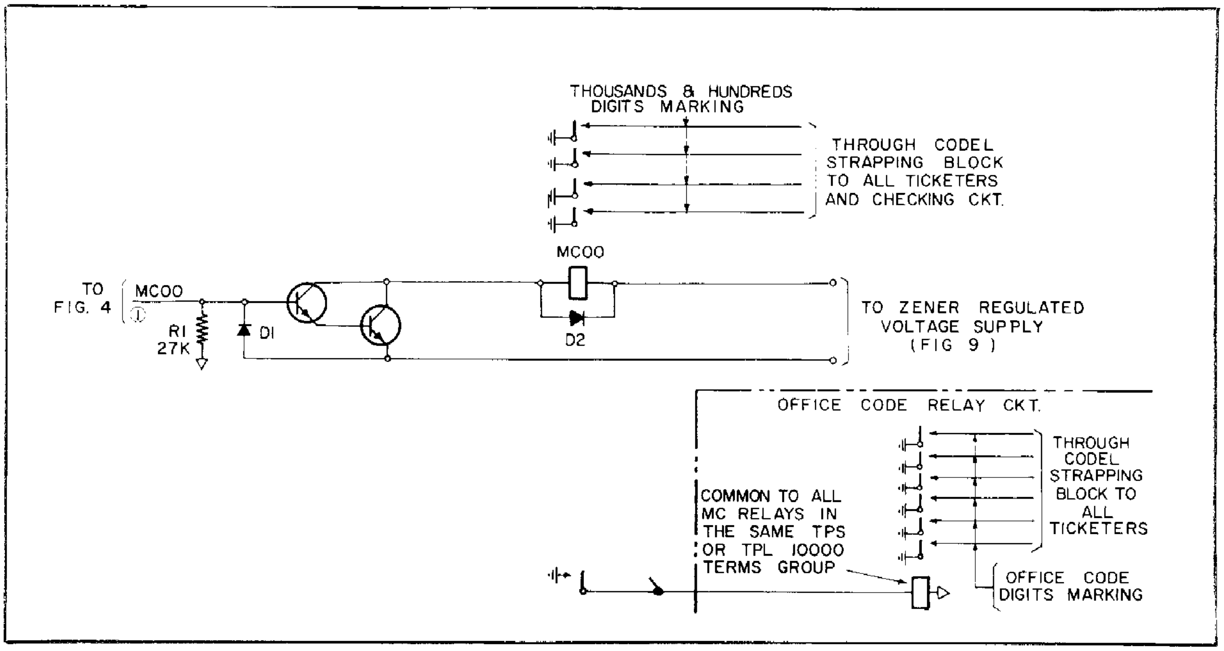


Figure 5. MC and Office Code Register Relays Circuits

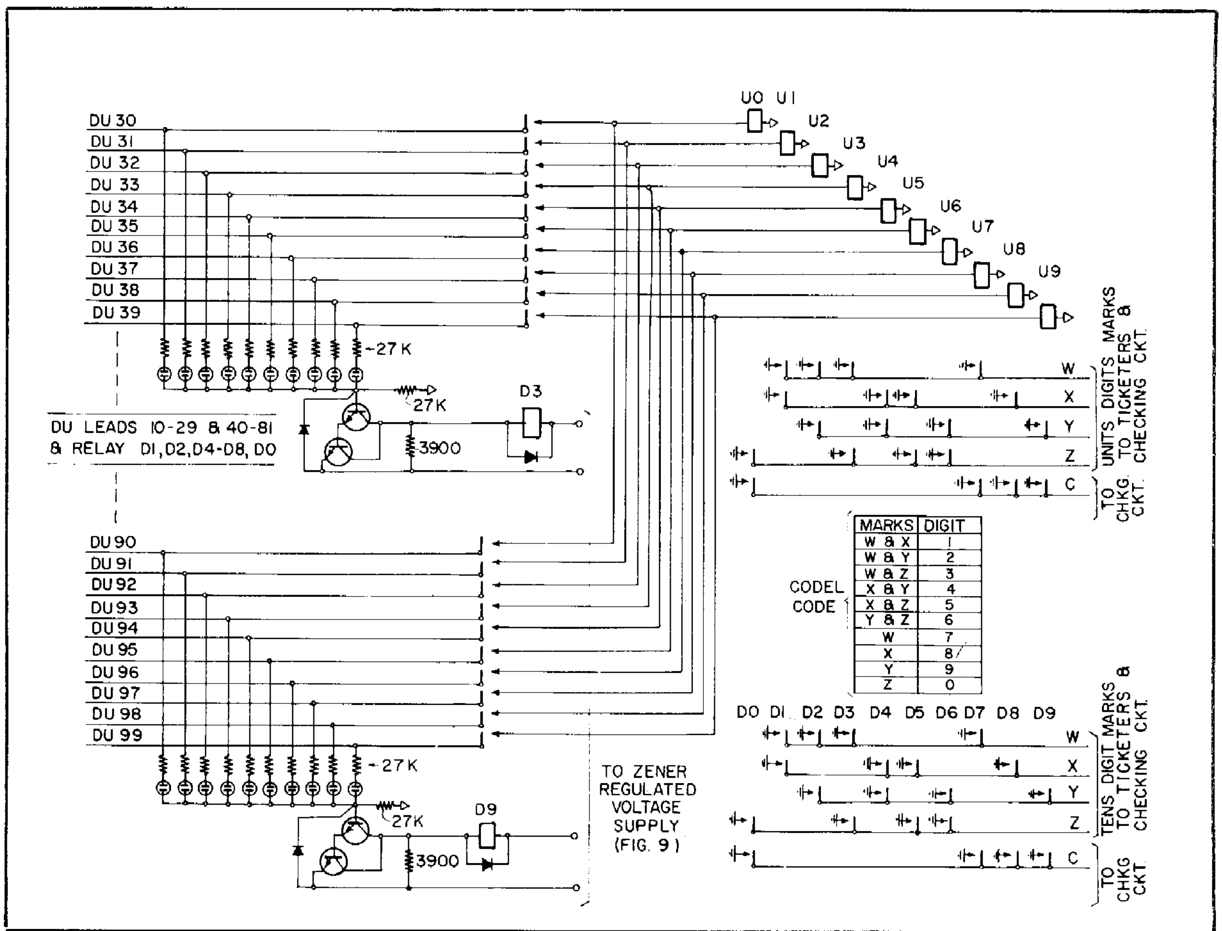


Figure 6. D and U Register Relays Circuits

the MC relay. Resistor R1 provides bias for transistors which are in a non-conductive state; thus it limits their collector-to-emitter leakage.

In a terminal-per-station office, the office-code relay registers the ABC digits, and the MC relay registers the thousands and hundreds digits of the directory number. However, in a terminal-per-line office the office-code relay registers the AB digits of the office code, and the MC relay registers the C digit and the thousands digit. MC and office-code relays are provided as required, i.e., one MC circuit per connector group, and one office-code relay circuit per office code.

"D" and "U" Register Relays Circuits (Figure 6)

Each "D" relay is connected through neon lamps and resistors to ten DU leads which have common tens digits (the lamps and resistors are, of course, provided to prevent control leads from being tied together). The D-digit register-relay circuit is the same as the MC register-relay circuit, except for the 3900-ohm resistor which is provided to pre-energize the relay and thus speed up its operation.

In terminal-per-station and terminal-per-line "frequency first" offices, the "D" relay registers the tens digit of the directory number, and the "U" relay registers the units digit. In terminal-per-station "frequency last" offices, the "D" and "U" relays register the hundreds and tens digits of the directory number, respectively. "D" and "U" relays are part of the office common equipment and only one set of each is normally provided.

Control Equipment

The control equipment provides the following facilities: overall time-out of the detection cycle, Zener-regulated voltage supply for the transistors, "2 out of 5" checking circuit for terminal digits, and controls for the Detector battery supply; busy and idle Detector markings; "complete-," "incomplete-" and "no-detection" markings, peg-count meters, alarm circuits, etc.

Supervisory Facilities (Figure 8)

Supervisory facilities consist of terminal-digits supervisory, connector-group supervisory, and alarm lamp circuits. Each neon lamp and resistor in the connector-group supervisory circuit is associated with a particular connector group. In operation, the neon lamp associated with the connector group will light. If a fault occurs, the lamp will remain lighted, subject to manual reset. Similarly, the terminal-digit supervisory circuit will provide indication as to the terminal-digit marking involved at the time a fault occurred.

Circuit Operation

Basically the operation is simple. When the Ticketer is assigned to the Detector, the Ticketer extends a party marking to the Detector and switches the control lead from ground to +60v battery. The respective MC party Bar-relays operate, and close all MC register-relay circuits to the particular party group buses. The +60v battery is extended over the control lead of the switch train and through the LIDF to the terminals of the neon lamps associated with the calling line. The neon lamp connected to the MC register-relay circuit "fires" and becomes conductive. The MC register relay operates, marks the thousands and hundreds digits, and closes the circuit to its associated connector-group Bar-relays, and to the office-code relay. The office-code relay operates and marks the office-code digits.

Approximately at the same time as the MC party Bar-relay operates, the DU party Bar-relay also operates, and connects all DU leads to the DU party buses associated with the respective party group. When the connector-group Bar-relays operate, +60v battery appears on the DU lead which represents the last two digits of the directory number of the calling subscriber; this "fires" the neon lamp associated with that DU lead. The D relay operates, marks the tens digit, and switches the DU lead in its group to the U relay. The U relay operates from +60v on lead DU, and marks the units digit; all digits have now been registered. Unless faulty marking is recognized by the terminal-digit checking relays, a "complete detection" mark is sent to the Ticketer, causing it to release the Detector. The Detector can now serve another Ticketer; the whole cycle has been completed in some 300 milliseconds.

Detection Cycle (Figure 7)

The detection cycle can be best described by an illustration. For this purpose let us assume that the subscriber whose directory number is AR6-0033 (i.e., 276-0033) and who has Party No. 2 telephone on a 2-party line, is making a call. Figure 7 shows the essential parts of the equipment involved in the identification of this subscriber's directory number.

While the subscriber is dialing the first digit (or first two digits) into the Ticketer (the reference is primarily to the Type 59 Ticketer, but the description in general also applies to equivalent Ticketers, and to outgoing trunks), the Ticketer identifies the calling subscriber as having Party No. 2 telephone. Switch PS will be on the second bank contact, and will remain there while the detection cycle is completed. After the second digit has been dialed into the Ticketer, it calls for assignment to the Detector by operating the KA relay. Only one Ticketer can be assigned to the Detector at one time, but since the detection cycle is very fast, delays of even a few seconds will be rare even in the largest offices.

When the Ticketer has been assigned, the circuit is completed between its KB relay and the Detector KA relay. The KA relay operates, opens the first timing relay, and closes the 28v Zener-diode-regulated supply to all MC and D register-relay circuits (Figure 9). Relay KB in the Ticketer operates, closing the circuit to the Ticketer Bar-relay and relay KD. KD operates, and transfers the control lead from ground to +60v battery. The Ticketer Bar-relay operates, extends ground over lead P2 to Party No. 2 relays (Figure 4), and extends the Detector common leads into the Ticketer circuit. Relay P2 operates and closes the circuit to Party No. 2 MC Bar-relays and Party No. 2 DU Bar-relays. Party No. 2 MC Bar-relays operate, and close all MC party buses serving Party No. 2 MC register-relay circuits (Figure 5). Party No. 2 DU Bar-relays operate, and close all DU party buses serving Parties No. 2 to the "D" and "U" register-relay circuits (Figure 6). The +60v battery on the control lead holds the switch-train, marks the switches and the Ticketer busy, and finds its path through the LIDF to the terminals of the neon lamps serving the two subscribers on the line.

Since Party No. 1 MC Bar-relay is not operated, the path through the neon lamp serving Party No. 1 (276-0000) terminates at its contacts. The path through the neon lamp serving Party No. 2 (276-0033) is extended through the operated contacts of Party No. 2 MC Bar-relay to the exchange battery (—50 v.) in the MC00 relay circuit. With 110v. impressed across the lamp (in the non-conducting state the neon lamp has very high resistance, so for practical purposes the whole voltage drop may be considered to be across the lamp), the lamp "fires," and becomes conductive.

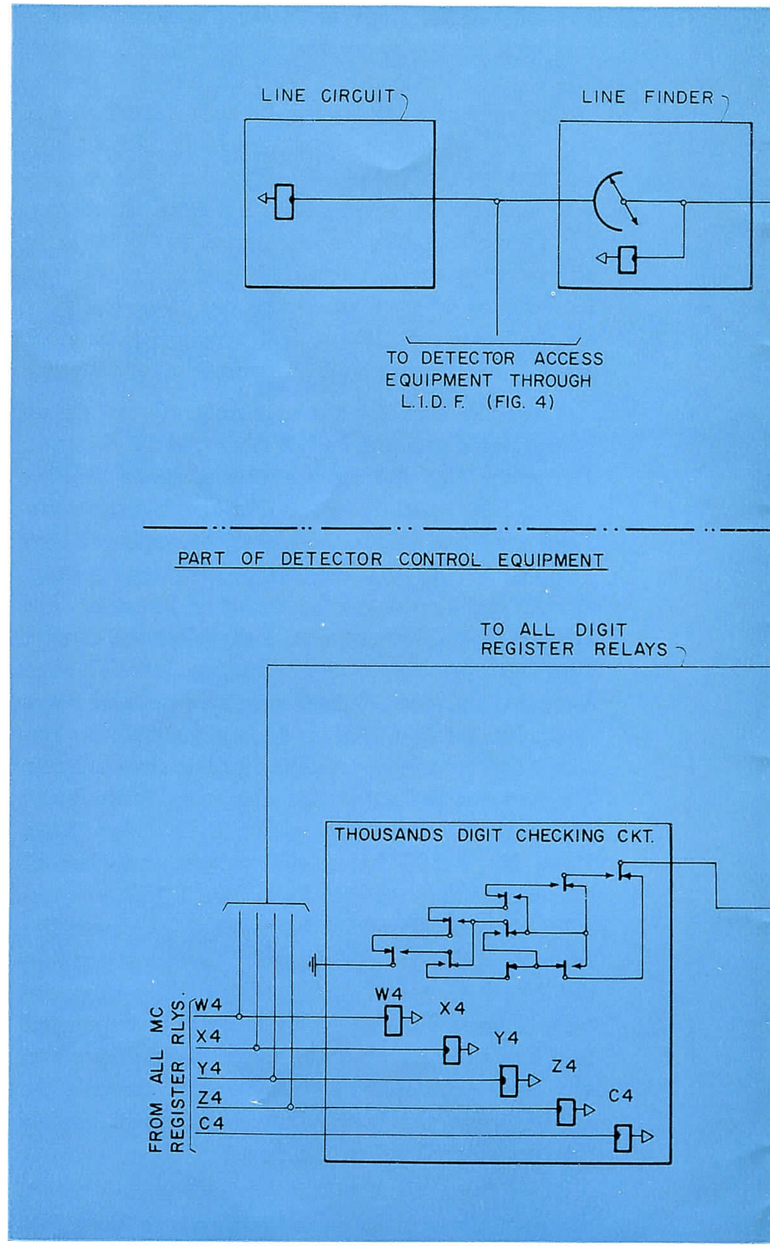
Referring to Figure 5, it will be noted that the base of each transistor is connected through an individual resistor to the negative terminal of the exchange battery. The bases are therefore normally at exchange battery potential. Approximately two volts are dropped across resistor R1 (15 ohms); thus the potential normally appearing at the emitters of the transistors is approximately two volts less negative than that at the bases. This provides a reverse bias for the transistors, which considerably reduces the leakage when 28 v. is applied between the collectors and emitters of all transistors.

When the neon lamp serving subscriber 276-0033 "fires," the bases of the transistors of MC00 relay circuit become sufficiently more positive than their emitters to switch the transistors from their non-conductive state. The transistors conduct, and the circuit is established through relay MC00. The MC00 relay operates, marks the thousands and hundreds digits to the Ticketer, closes the circuit to the connector-group Bar-relays and to the office-code relay, and closes 160 v. across its associated neon lamp in the connector-group supervisory circuit (Figure 8). The office-code relay operates and marks the office-code digit (276) to the Ticketer. The neon lamps require 135 v. ± 15% to "fire;" with 160 v. across it, the neon lamp serving connector group 00 "fires" and becomes conductive; this indicates that detection is taking place in that connector group. The connector-group Bar-relays operate, and connect all leads in their group to the DU party buses.

Similarly, on the DU side of the circuit, +60v. battery on Party No. 1 subscriber's lead will terminate at the contact of unoperated Party No. 1 DU Bar-relay. The +60 v. battery on the subscriber's lead of Party No. 2 (276-0033) is extended through operated Party No. 2 DU Bar-relay and appears on lead DU33 (Figure 6). The neon lamp associated with lead DU33 becomes conductive. The D3 relay operates in the same manner as described for the MC00 relay; when operated, it marks the tens digit (3) to the Ticketer, and closes all DU leads in its group to U relays. The 110 volts appears across U3 relay; it operates and marks the units digit to the Ticketer. (It may be noted here that ground potential may be present at this time on other DU leads in the D3 relay group, but the U relays will not operate on 50 v.).

Terminal Digits Check

All digits are transmitted to the Ticketer in the codel (binary-decimal) code shown in Figure 6. To accommodate the "2 out of 5" check, all relays that register single-mark terminal digits are arranged to provide also a second mark (which is not extended out of the Detector but terminates in the respective digit-checking relay circuit). When the digits are marked to the Ticketer, a multiple connection is also made to the checking-relay circuits. The digit-checking relay groups are arranged in sequence (thousands, hundreds, tens, and units digits groups, in that order) so that the input to a succeeding group is completed only if a satisfactory check has been made in the preceding digit-checking relay group or groups. The checking relays, when operated, also close 160 v. across their associated lamps in the terminal-digits supervisory circuit. The neon lamps light and indicate the detected terminal digit. When a satisfactory check has been made for all digits, the circuit is closed to relay CD, which operates, indicates to the Ticketer that the detection cycle has been satisfactorily completed, and closes relay KG. Relay KG operates, locks to multiple-operated relay circuits in the Detector, and opens the short-circuit on the resistor in series with the Detector KA relay. The Ticketer releases the connection to the Detector, but the Detector cannot be re-assigned until relay KG is released and the short is replaced on the series resistor.



Incomplete Detection

As mentioned above, when the Detector KA relay operates, the circuit is opened to the first timing relay. The three timing relays are slow-to-release and they release in sequence; a total delay time of some 700 milliseconds is provided before the last timing relay releases. If at this time the detection cycle has not been completed (which may be due to failure of the terminal equipment, failure of the terminal-digit marking relays to operate or to mark correct digits, or because the ticketing equipment has been accessed by a station not equipped for automatic number identification) the last of the timing relays will release, close the circuit to relay KG, and close ground to lead "Incomplete," to indicate to the Ticketer that the detection has not been satisfactorily completed. The Ticketer will then release the connection to the Detector, and the call will be routed to an operator.

"No Detect" Paystation Restriction Service

Provisions are made in the Detector for automatic identification of all stations which have access to the Ticketing equipment. This includes not only the stations which are to have automatic number identification, but also the stations which are not to have this service (the latter category may include paystations, subscribers' stations on multiparty lines which have no provisions in their telephones for station-number identification, etc.).

In the case of paystations, all incoming leads are wired through individual lamps and resistors, and then multipled to a common read-out relay circuit, which is similar to the MC relay circuits. The read-out relay, when operated, provides a "paystation restriction" mark to the outgoing trunk circuit, which releases the Detector and returns busy tone to the calling station.

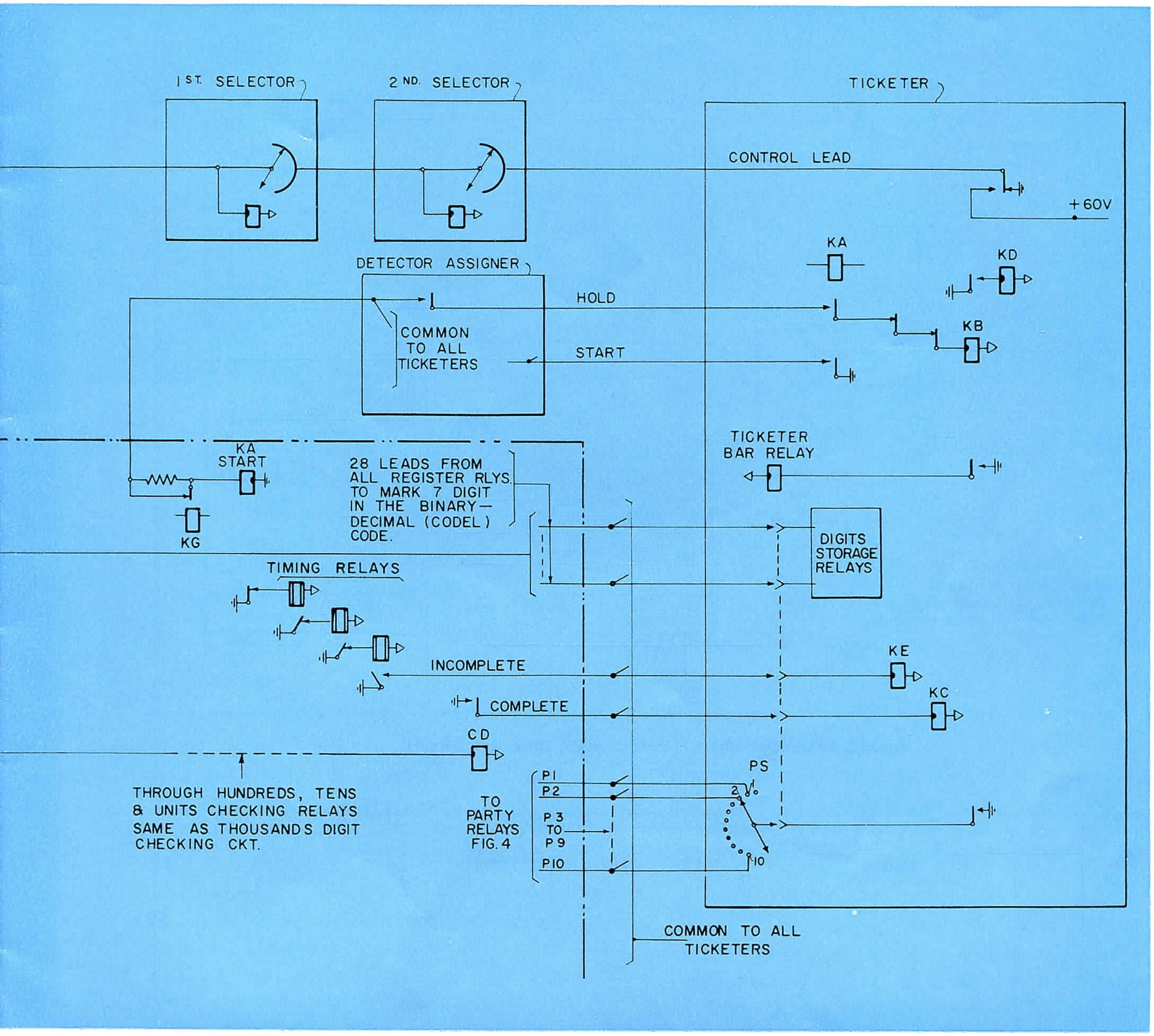


Figure 7. Overall Schematic for Equipment Involved in Detection

If some stations in a connector group are not to have automatic number identification, the leads incoming from these stations may be wired through their lamps and resistors like the others, but must be connected to the ND ("No Detect") bus. All ND buses are then multipled and connected to a "No Detect" relay circuit (similar to the MC relay circuit). When this relay operates, it provides a "No Detect" indication, which may either route the call to an operator or return busy tone to the calling subscriber.

Fault Conditions

If all stations in the office are equipped for automatic identification, failure to complete the detection cycle within the release time of the slow-to-release timing relays indicates a failure in the equipment; thus, when the last timing relay releases, the circuit is closed to the Fault relay. The Fault relay operates, locks to ground on the Reset key, closes the circuit to the Fault lamp, opens the "firing" circuit of all neon lamps, and closes the alarm-lead circuits. The neon lamps which were

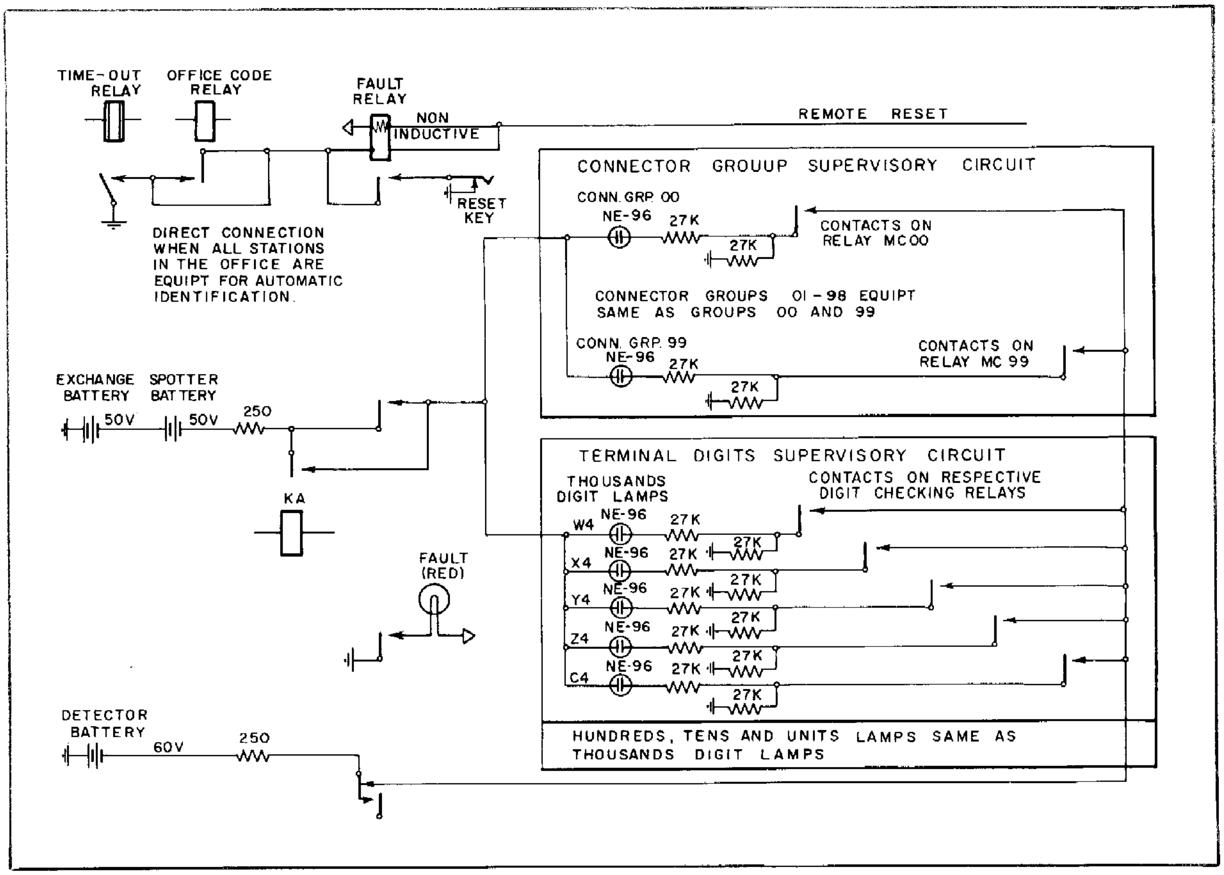


Figure 8. Connector Group and Terminal Digits Supervisory Circuits

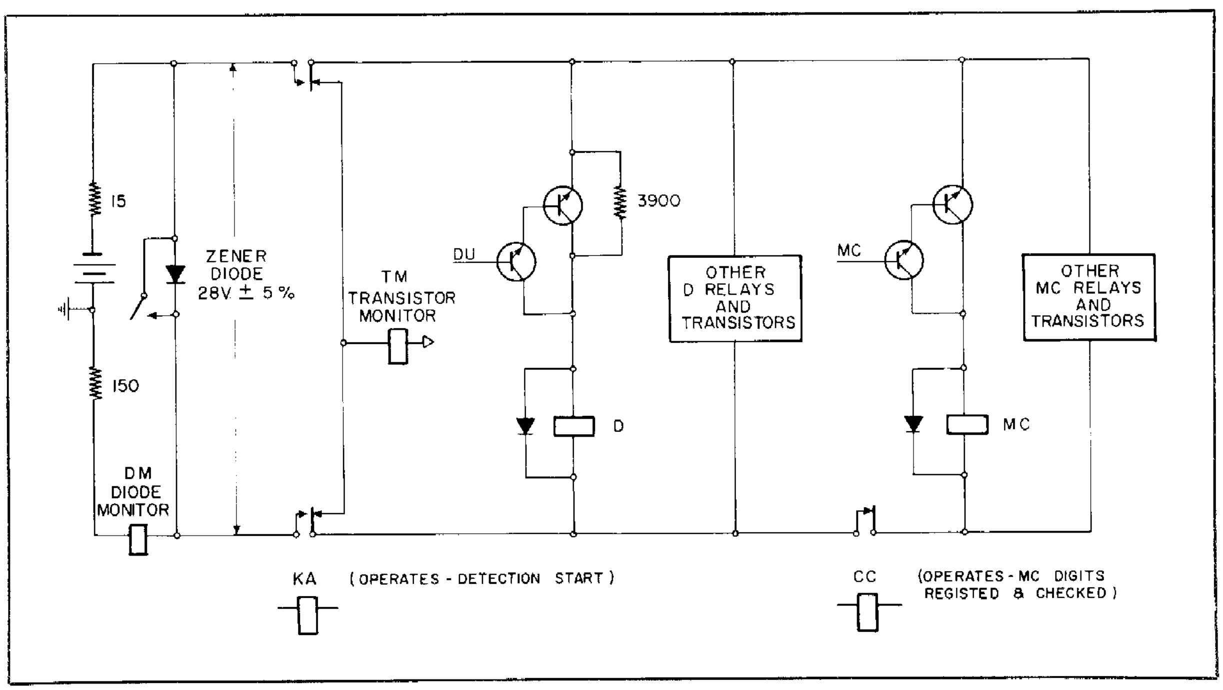


Figure 9. Zener Diode Regulated Voltage Supply for Transistor

lighted during this detection cycle will now remain connected in series with 100 v. battery, and since the sustaining voltage of these lamps is 75 v. ± 10%, they will remain lighted until the Reset key is operated. On succeeding detection cycles, absence of "firing" voltage will prevent the neon lamps from lighting.

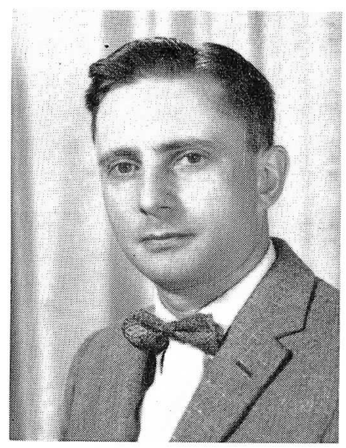
In offices where Ticketing equipment may be accessed by stations which are not equipped for automatic identification, the circuit to the Fault relay is extended through the make contact of the office-code relay. This assures that the alarm will not operate, and falsely indicate failure of the equipment, in case one of these stations accesses the ticketing equipment.

Summary

Detector equipment has been designed which will economically provide automatic detection for frequency-per-terminal offices. This equipment is suitable for smaller offices and may be readily expanded for use in larger offices. It has been miniaturized and employs up-to-date printed wiring techniques. All cross-connecting is quickly accomplished by means of patch cords which require no soldering. Parties are easily recognized and identified and changes may be made at any time with minimum disruption of service. Patch cords, or entire board assemblies, may be omitted as desired, yet quickly provided when the service is called for.

This Detector represents the utmost in simplicity of design and efficiency of operation.

RUDOLPH L. STOEHR graduated from Northwestern University in 1950, with a Bachelor of Science degree in Electrical Engineering. He began his work with Automatic Electric in Quality Control and later entered the Training School. He has held assignments in Exchange Engineering, Apparatus Engineering, and the Testing Bureau. Mr. Stoehr is now assigned to the Product Design Section of Laboratories as a Project Engineer, working on equipment and process developments.



BORIS SHERSTIUK came to Laboratories in 1956 after attending the University of Illinois, where he majored in Electrical Engineering. After two years in the Circuit Explanation Section he was transferred to the Toll Ticketing Section, where he is now engaged in circuit development work.