November 1958

Bell Laboratories RECORD

Studying Tomorrow's Communications

Experimental Transistorized Telephone

Measuring Time in Central Offices

"Ready-Access" Distribution Terminal

New AMA Translator for No. 5 Crossbar

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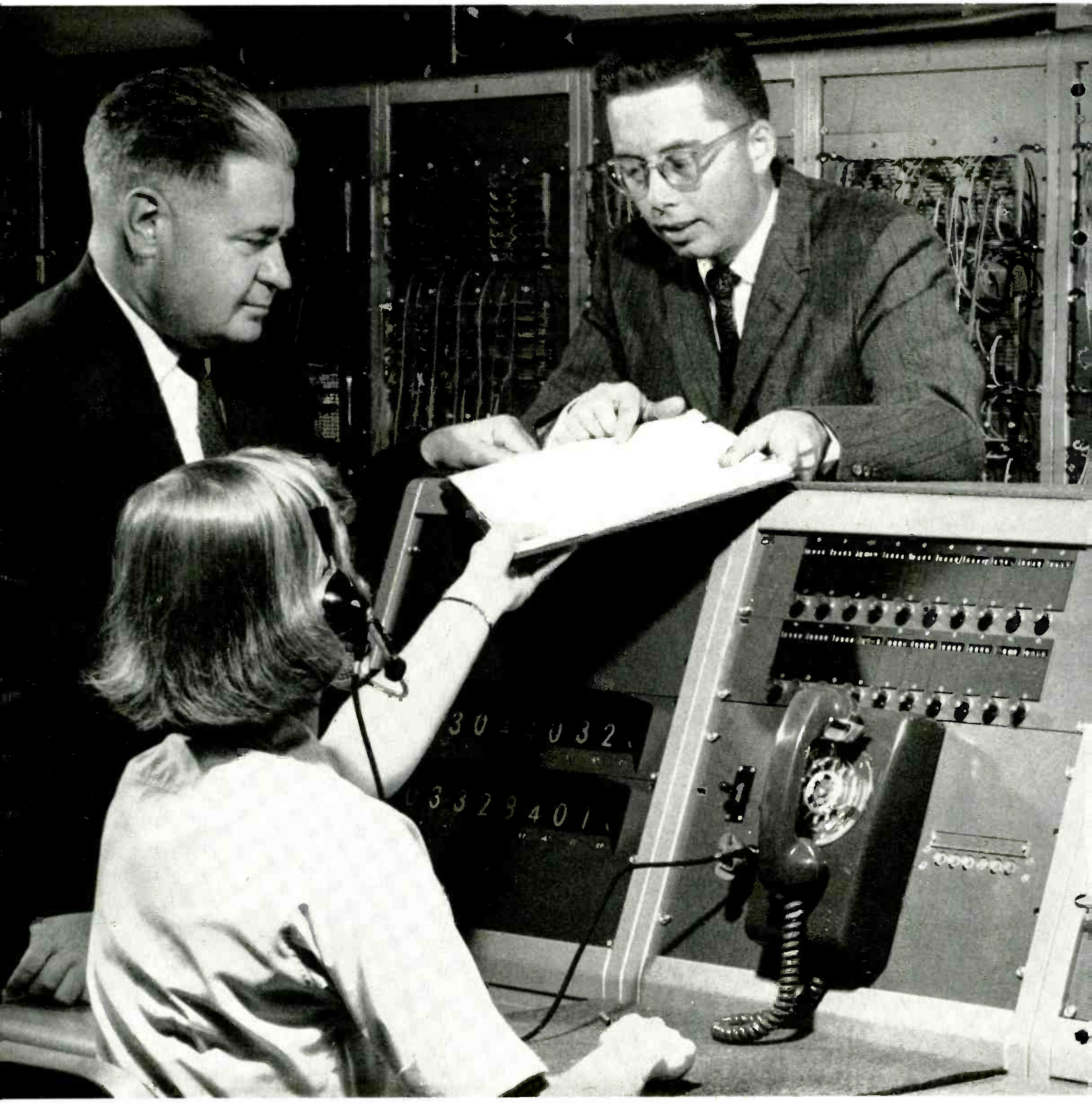
Contents

Cover *Early design of the "ready-access" type terminal described in the article beginning on page 411. Although design and operating procedures have been modified, photograph illustrates ease of connecting drop wires.*



Console operators can act as circuit elements in simulator. Data obtained by Virginia Hansen are examined by R. R. Riesz, left, and author.

Part of the engineering effort that goes into any new communications service must be devoted to discovering if this service will be satisfactory to its ultimate user. For this purpose, Bell Laboratories has designed a machine — called Sibyl — to ascertain a user's reactions to a new device by simulating its functions for him.

H. D. Irvin

STUDYING TOMORROW'S COMMUNICATIONS . . . TODAY

When the inhabitants of Ancient Greece wanted to know something about the future, they sought advice from the sibyls. These were certain women supposed to be inspired by Apollo to the powers of prognostication. Reports of their predictions were set down in the Sibylline Books, whose addenda were called the Sibylline Oracles. From this phase of Greek history comes the name of the new "forecasting" facility developed by Bell Laboratories for the study of human factors in engineering communication systems — the Sibyl Laboratory. Our Sibyl predicts how people will get on with a new communication service before we develop that service.

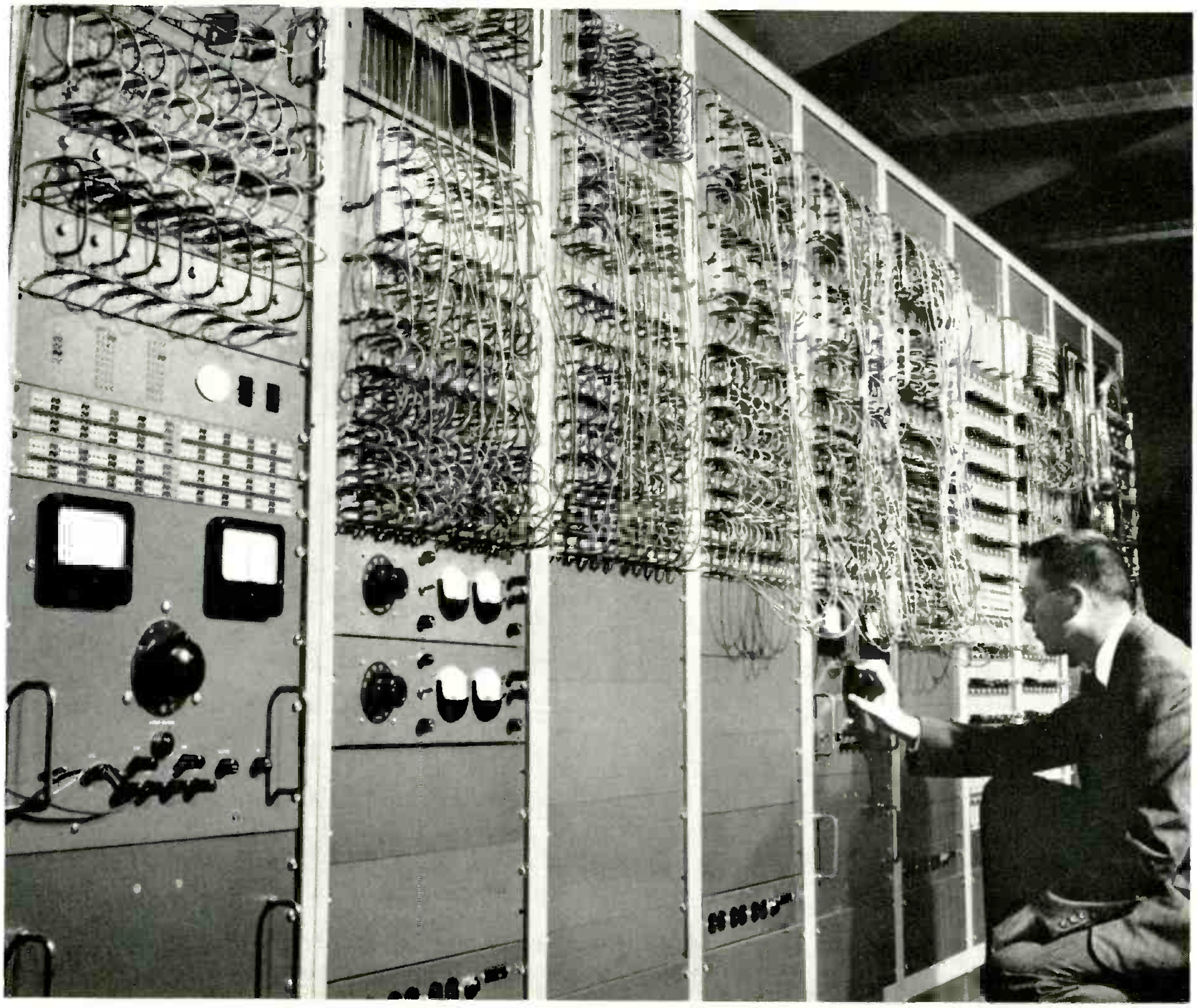
Sibyl works by intercepting the telephone lines of test users so that it may give them simulated services in their normal work environment. At the same time, Sibyl automatically collects objective data on the performance of the man-machine system while, of course, preserving the privacy of the actual conversations.

Any new communication service or equipment offered by the Bell System must be "engineered" for dependability and economy. But it must also be made as utilitarian and as convenient to the user as is possible. These human-factor requirements are becoming more and more important in this era of modern merchandising with its increasing complexity and, even more important, its variety of new services and equipment.

Method of Simulation

To find out dependably how a user will react to a proposed new service, we must give him experience with the service. Neither asking people how they *think* they will react, nor using our own opinions for this purpose, have proven reliable (RECORD, *May*, 1954). Relationships between men and machines are complex and require scientific study based on real experience. We must not only know how much people are going to like a product or a service, but we must be able to measure how they use it.

At first, it would appear that to obtain this information, we need to build and install the new device before we can test it on the user. But such an expensive procedure can be circumvented by applying a method of simulation developed at Bell Laboratories (RECORD, *July*, 1958). Simulation, in this sense, can perhaps be best described as the technique of producing a function of a machine by any means short of building the actual machine or device. In other



First stage of development of this Sibyl Laboratory resulted in start of collection for library of telephone habits. Here, H. D. Irvin makes final adjustment on panels wired for a specific program.

words, simulation is an empirical way to arrive at specifications for a system in terms of what is best for the user. The purpose of simulation is to determine if a device is worth developing, and, if so, what features should be included in it and how they should be arranged.

Previously, this method of operation required a different simulated set-up to be built for each new apparatus to be studied. Now, with Sibyl, many tests can be made through the use of a single machine — one that can simulate the functions of a wide variety of communications services and devices at the same time it collects data on their operation.

For most applications Sibyl does three things: (1) It gives the test subject the *use* of the proposed device, either in a special test room or at his normal work location. (2) It acts as an "invisible" observer and supervises, unobtrusively the operation of the experimental system — this is usually done in greater detail than is feasible with conventional service-appraisal equipment. (3) It picks out and records what information it needs to help us choose those features best suited for the proposed device.

Design and construction of the first stage of Sibyl was begun in 1956, and preliminary operations were started early this year. The general purpose features of this first stage result from the method of programing a test—a method that uses electro-mechanical switching apparatus to record digital data. In future stages, an "open-ended" feature will permit the addition of analog equipment and wide-band transmission facilities, as well as expanded switching functions.

The Sibyl Laboratory contains three principal sections of equipment. The first of these is the main machine. This is essentially an array of relay racks containing the switching elements (constructed in small modular units) and jack fields through which the program under test is wired. This machine is programed to simulate the functions of a proposed service or device, and to collect data on the service automatically. It may merely collect its information without disturbing switching operations, or it may alter the information to aid in the switching operations. In neither case, however, will the user be aware that Sibyl is conducting an experiment. One rack of the main machine connects Sibyl to the telephone lines under observation, and the remainder serve for simulation and data collecting. Three strip-chart recorders for monitoring operations of equipment or for the recording of overflow data are included in the main machine.

The second section of Sibyl is the data-recording equipment. This automatically records what the users are doing with the system. Privacy of conversation of course is preserved. Two recording "stations" are available, each consisting of an electric typewriter and a tabulating card punch. Data are recorded through a combination of these, plus direct-writing recorders, magnetic-tape recorders and paper-tape punches. The combinations are chosen according to the type of analysis to be performed. For example, use of the tabulating cards allows immediate analysis of the data on the IBM 704 computer at the Murray Hill location of Bell Laboratories. The data-recording section can handle up to 10,000 calls per day in service-appraisal experiments, although it is anticipated that submitted loads will never approach this figure.

Operator Consoles

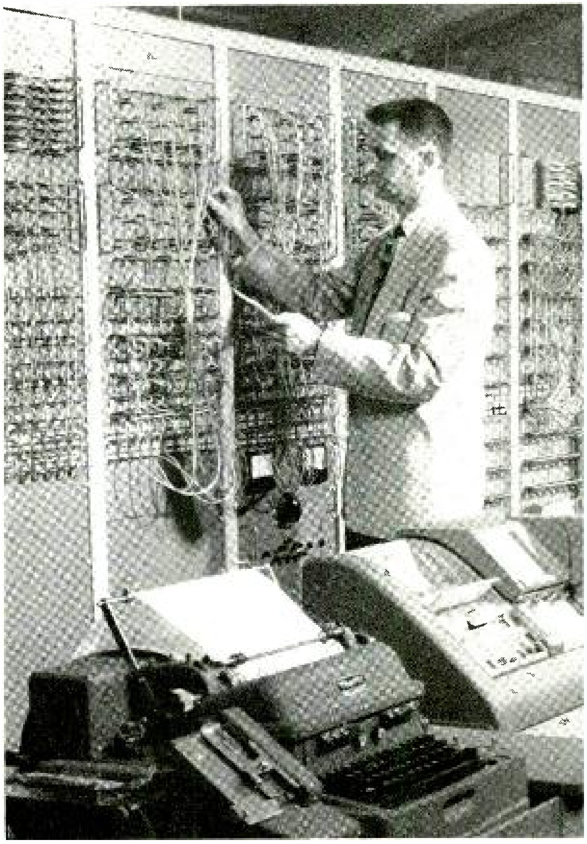
The third section of Sibyl is a pair of operator consoles. These allow the experimenting team to observe, unobtrusively, the behavior of the simulated system. They also permit a human operator to be used as a circuit element in the simulator. In an early "voice-dialing" experiment, for example, a silent operator responded to spoken telephone numbers, thus acting as a voice-to-dial-pulse translator (RECORD, *July*, 1958).

Ordinarily, the console has two major functions. From its displays of coded numbers, it (1) supervises what goes on in the main machine, and (2) permits instantaneous observations of data still in storage and occasionally of data not to be recorded. In the case of some unanticipated action by the user (such as his jiggling the switch-hook), the Sibyl experimenters may want to find out what he is doing. The console allows them to do this without disturbing him.

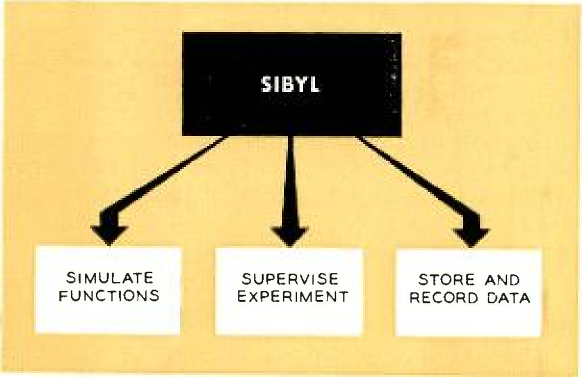
Sibyl communicates with the equipment undergoing evaluation by means of tone-multiplex telemetering. In this method, oscillators at the transmitting end of the communication link generate tones at frequencies of from 500 to 3,000 cycles. The receiving end has detectors which operate relays as the tones are turned on and off. The desired information is interpreted from these actions. As an example, in the interests of future handset design we may wish to know in what general position the user holds his handset. A transducer at the remote terminal might change this position into an electrical signal — in this case discrete tones. These tones would be transmitted over the wires to Sibyl where they would be translated into a form that could be easily recorded on an electric typewriter.

Typical Test

The study of a telephone equipped for push-button keying would be an example of the application of Sibyl to a problem involving human factors in communications. In this study, we would want to compare the performance of a group of people using the rotary dial with that of the same, or a similar group, using push-buttons. Both of these groups will perform the test in their regular office environment. In the search for the best design, we will probably try out several types of push-button arrangements.



In its present phase, Sibyl can serve two entirely separate simulation studies at one time. While part of study crew oversees completion of one experiment, F. R. Misiewicz programs a new study.



The triumvirate of duties of Sibyl give an "all-purpose" character to this simulating machine.

For this test, Sibyl will be programed to collect data on a group of people using the rotary dial by observing their performance over some period of time. In effect, this portion of the experiment amounts to "automatic service appraisal". The data collected will include relevant information such as dialing speed and errors.

Part of the group will then be supplied with the push-button instrument. The rest of the users will retain their dial telephones and become a "control" group. For the push-button users, Sibyl will *simulate* a push-button telephone exchange. In effect, it will become a link between the telephones and the exchange. Each telephone placed on test user's desk will have the realistic appearance of the contemplated design for a push-button set. But, other than electrical contacts actuated by the push-button keys, the set will contain no special signaling equipment. Instead, the desk instrument will be connected to a telemetering transmitter near the set, but out of sight and out of the way.

As the push-buttons are depressed by the user, the keyed information is transmitted to Sibyl and is stored there. In addition, the information is translated into dial pulses which will be passed immediately to the local exchange, which will make the indicated connection. The desired information on the behavior of both the user and the system will be recorded automatically, as was that for the control group using rotary dials. Instantaneous observation of the state of the system will be available at any time through displays mounted on the console.

What kinds of data are obtained in such a test? Certain standard information — called "protocol" information — includes such items as the date, time and originator of the call. Other data would include such items as: was the call answered? was the line busy? was the dialing correct? This information is further broken down into the quantitative data of the duration of events — dialing and holding time, time until answered, interval between the pressing of two successive buttons (or the dialing of each digit on the rotary dial). These data would be compared and the results be taken into account in the design of push-button sets.

This information gives designers the answers to a number of important questions. They will learn the types of errors most often made, and whether faster dialers make more mistakes than slower dialers. They will determine if certain people are "error prone." In our example, the designers will learn how long it takes to acquire a given level of proficiency in using push buttons. Furthermore, they will learn if people are likely to use their telephones more often if the instrument is equipped for push-button operation.

Tests of the future may include user's reactions to such proposed devices as the repertory dialer, new kinds of telephone directories, and devices which allow users to send written and spoken messages simultaneously. Even user's reactions to a new style, such as that of the dial-in-handset phone, may come under the scrutiny of the Sibyl Laboratory. A likely candidate for an early program is an office trial of our example — push-button keying. Sibyl will furnish a relatively economical and thorough study of this system. Furthermore, all the equipment, with the exception of the shells and dials of the desk sets, will be salvageable and available for later studies of almost any type.

General Tasks

Because of the variety of tasks for which this simulation device was intended, Sibyl is extremely general. Therefore, such factors as low first cost and rapid programing time have been sacrificed to some degree. Initial experience, however, has shown the programing time to be faster than was expected; this is true even for moderately complex systems.

The present input equipment of Sibyl limits studies of experimental devices to 24 remote locations at any one time. Except for very complex simulated systems, future stages of the input facilities will permit extending to 100 the number of users on a single test. The flexibility of the main machine is such that capacity and complexity may be "traded" over a rather wide range.

Because of Sibyl's open-ended feature, additions to its units which may be required from time to time can be added as new experiments are carried out. Eventually, however, Sibyl could be expanded to the point where it becomes a machine which can simulate a very wide variety of proposed communication services that might conceivably be offered by the Bell System in the future. From then on, proposed communication services could be simulated quickly, and at minimum cost to the Laboratories.

Telephone systems of the future may operate on considerably less power than is presently required. To prepare for the advent of such systems, station engineers at Bell Laboratories have developed a new transistorized telephone which is more efficient than, yet equal in transmission performance to, the widely accepted 500 set.

A. Busala

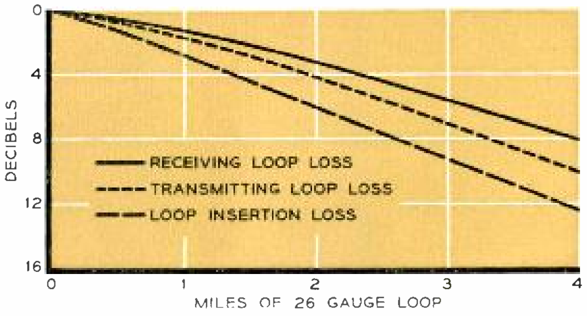
An Experimental Transistorized Telephone

The transistor is rapidly becoming one of the most dynamic forces in the design of modern communication systems. As evidence of this, an experimental electronic switching system has been developed at Bell Laboratories, based largely on the favorable size and power characteristics of the transistor (RECORD, *October,* 1958). Naturally, such a system is expected to have far-reaching ramifications throughout the rest of the telephone plant. And one of the most important items of communication equipment which would be affected thereby is the telephone itself.

To provide a telephone that will give high-quality service to the customer and that will operate within the parameters of a low-power telephone system, station development engineers at the Laboratories have developed an entirely new, transistorized telephone set. This experimental set represents a radical change from the conventional telephone, and will be used in the field trials of the electronic switching system. Some of its features are the result of system requirements, while others are improvements made possible by the use of new devices — principally the transistor.

In the experimental electronic switching system, economic as well as engineering considerations call for a station set that draws substantially less direct current than that supplied to present sets. Also, the telephone set used in conjunction with an electronic switching network must require far less power for ringing than the 90-volt, 20-cycle signal used by the conventional telephone bell.

This requirement, and some of the other important parameters of the new transistorized telephone, are compared with those of the 500 set in the table on page 405. The parameters in this table are dictated by the characteristics of the switching system. But the comparison with the 500 set has additional significance in that the design goal for the new telephone was to equal or improve on the performance of the well established 500 set.



Curves showing variations in transmitting and receiving characteristics with increasing length of loop. Part of the loop insertion loss is compensated by the equalization arrangement in the set.

For attracting attention to an incoming call, the new electronic telephone uses the "tone ringer" (RECORD, *February*, 1957) instead of the conventional bell. The tone ringer is a transistorized sound generator operated by a low-voltage signal in the voice-frequency range. This signal from the central office excites a frequency-selective resonant circuit which in turn drives a transistor amplifier. The output of this amplifier is then converted into an audible tone by the use of a small loudspeaker.

The tone-ringer circuit used in the transistorized set differs somewhat from the earlier version described in the RECORD, but it performs in substantially the same manner and has the same general characteristics.

In addition to its suitably low power requirements, the tone ringer has three other fundamental advantages: (1) its sound output is superior to that of the conventional bell-type ringers in attention-attracting qualities and in acceptance by the public; (2) the ringing signal is in the voltage and frequency range of speech and therefore does not impose additional requirements on the transmission system; and (3) the tone ringer can provide full-selective ringing for eight-party circuits. That is, each user on an eight-party line hears only his own ringer.

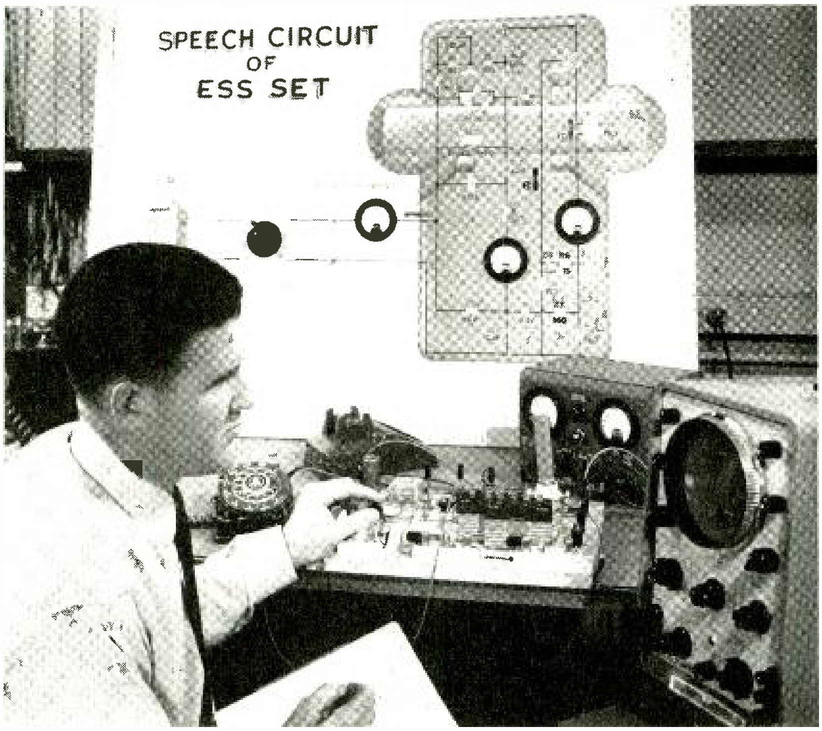
Full-selective ringing as arranged here does not require a ground connection at the customer's location. The absence of a ground connection improves transmission by reducing circuit noise.

The speech circuit, shown in detail on page 406, is a conventional "anti-sidetone" circuit and its response characteristic is very similar to that of the 500 set. Anti-sidetone speech circuits, which have been used in telephones for many years, are arranged to reduce the sound level of the user's own voice as heard through the telephone receiver. In its simplest form, the anti-sidetone circuit consists of a transmitter, a receiver and a balancing network, connected to each other and to the transmission line by a transformer, called the "induction coil."

A simplified schematic of this form of the anti-sidetone circuit appears at the bottom of the illustration on page 406. When the impedance of the balancing network exactly matches that of the line incoming to the telephone, the transmitter and receiver are "conjugate." This means that there is no direct transmission of energy (sidetone) from transmitter to receiver.

The two most important parts of the speech circuit of any telephone set are the transmitter and the receiver. The carbon transmitter in all telephones is a modulator of the direct current flowing through it. In the transistor set, however, the output of the transmitter is so much lower than the output in a conventional set that it must be amplified. The transmitter of the simplified anti-sidetone circuit therefore actually consists of a transistor amplifier driven by a small carbon microphone.

The output impedance of this transistor is nor-



N. C. Hazell makes measurements of click levels in a model of the new transistorized telephone set. The test apparatus is so arranged as to supply various transient voltages ("clicks") to the speech circuit.

COMPARISON OF SOME IMPORTANT PARAMETERS

Parameter	500 Set	Low-current Set
Range of direct current:		
During talking	25-190 milliamperes	8.5-13 milliamperes
During ringing	0	0.7 milliampere
Average central office power:		
During talking	3.0 watts	0.5 watt
During ringing	0.6 watt	0.035 watt
Ringing signal	90 volts at 20 cps	2 volts at voice frequencies

mally very high — of the order of megohms — which is practically infinite compared with the other impedances in the circuit. Thus, to obtain the desired value of over-all impedance, it is necessary to introduce some shunt (negative) feedback, which has the effect of reducing the output impedance of the transistor amplifier. This is done in the new telephone by feeding back a fraction of the output voltage, across a resistor to the base of the transistor.

The receiver of the transistor telephone is of the same type as, but has twice the impedance of, the U-1 receiver used in the 500 set. It also has a different "click-reducer" arrangement. "Clicks" are extra loud tones that might be produced in the receiver by surges of voltage in the line. The particular configuration of the reducer insures a symmetrical limiting of the clicks despite a small dc bias (0.4 volt) which exists across the receiver.

The voltage that actually serves to limit the clicks is the 0.7-volt "knee" of the forward characteristic of the diodes that make up the reducer. With this protection across the receiver, the maximum effective acoustic pressure that transients can produce in the ear is 5 db below the level of the loudest clicks obtainable in a 500 set. And even the loudest clicks in the 500 set have been found to be generally tolerable.

The balancing network, which is the essential element in eliminating sidetone, gives good sidetone balance for practically all conditions in the wire loops between telephones and central offices. Measurements in the field have shown that the transistorized set generally suppresses sidetone as well as the 500 set, despite an increase in transmitting level.

One of the interesting features of the new low-current set is "loop equalization." This is an automatic adjustment, in the telephone, of the transmitting and receiving level. Essentially, loop equalization compensates, at least in part, for the losses present in the line, or loop, from the central office. These losses of course vary with the length and characteristics of the line. A similar though slightly different compensating arrangement is also built into the 500 set.

Equalization in transmitting is accomplished by increasing the direct current in the carbon transmitter in proportion to the increase in the length of the loop. This increase tends to compensate for the loop losses because the sensitivity of the microphone is approximately proportional to the square of the input current. And in a transistor circuit, it is possible to control this current automatically.

Briefly, the increase in transmitter current with increasing loop resistance is obtained as follows. The total direct current drawn by the set divides into three parts. One of these currents is a biasing current for the transistor. The other two currents combine at one point in the speech circuit and their sum is regulated by the transistor. Of these two currents, one flows through a very non-linear path, and therefore varies quite rapidly with variations in voltage, decreasing as the loop resistance increases. In the process of regulating the total of the two currents, the transistor must increase its own emitter current. The latter is also the transmitter current.

The accompanying set of curves shows the resulting transmitting characteristic — the sound level transmitted to the central office from the station set as the loop length is varied. For example on a long loop, the transmitting losses (the middle curve) are less than the insertion losses due to the loop (the dashed line) by approximately 3 db.

The rapidly varying current, mentioned previously, is also used for equalization in receiving. The impedance of a silicon-carbide varistor in the receiving circuit, which effectively shunts the receiver, is a function of the current through it. On a short loop, where the rapidly varying current is relatively large, the varistor has a low impedance and reduces sensitivity of the receiver.

On a long loop, the same current is very small and the impedance of the varistor is not low enough to represent an appreciable receiving loss. The receiving characteristic, which gives the receiving level at the set with variations in loop length, is also shown as one of the accompanying group of curves.

A transistorized circuit is in general susceptible to damage by transient surges of voltage, and the low-current set is well protected against any such difficulty. The conventional blocks in the lightning protector take care of the longitudinal voltages which appear from both sides of the line to ground (RECORD, *August,* 1956). In the new transistor set, a diode varistor is also included in the lightning-protection arrangement. This diode is connected in a way that will keep the voltage appearing at the terminals of the set from exceeding the breakdown voltage of the diode — approximately 60 volts.

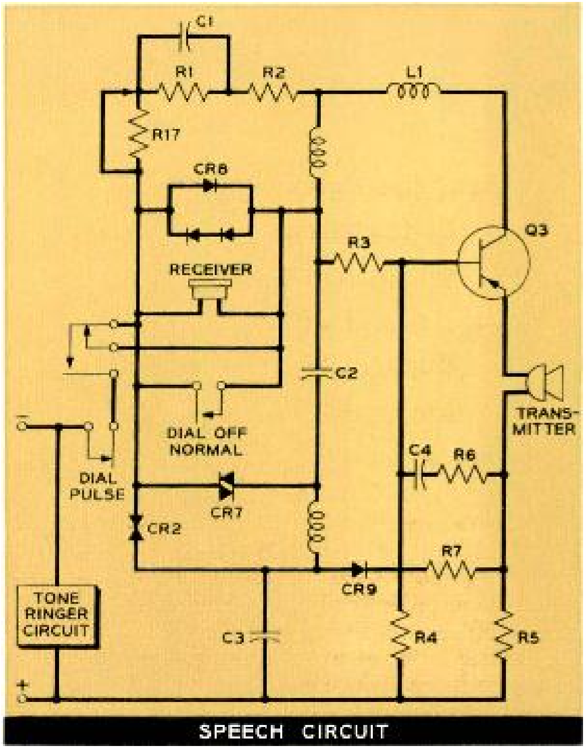
In the speech circuit, a double diode provides additional protection against transients. This unit is made of two diodes connected "back-to-back," each with a breakdown voltage of 8 volts. The double diode protects the transistor by holding under 8 volts the sum of the voltage across the receiver and the voltage across a portion of the induction coil. At the same time, it helps the click suppressor in reducing clicks in the receiver. In normal operation, the diode does not conduct, because the voltage across it is less than 8 volts.

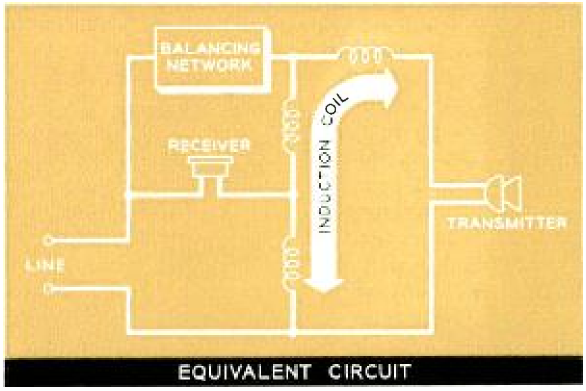
The dialing function in the experimental electronic switching system will be performed in the conventional way — with dc pulses. The new telephones, therefore, will be equipped with rotary dials. The electronic office is capable of greater speed, however, so the dials will send 20 pulses per second instead of the standard 10 pps.

One of the basic requirements for a telephone set is a high degree of reliability. Because of its location on the customer's premises, any maintenance is costly. To keep this cost down, the maintenance objective for telephone sets is 20 years of trouble-free service. This was of special interest in the transistorized set because the circuit has more components than the 500 set, and some of these components are of types whose degree of reliability has not at present been fully ascertained.

With this in mind, a small field trial of about 300 telephones of this new design was conducted at Crystal Lake, Illinois, during 1956-1957. In these sets, some of the more expensive components (a transistor and a diode) were used in common by both the speech circuit and the tone ringer by means of a transfer contact operated by the switch hook.

The set for the electronic switching trial will not feature this joint use of components, however. Which of these two arrangements will be more desirable in the final design for production will depend on both economic and engineering information gained from the system trial.





A schematic of the speech circuit, top, and a greatly simplified schematic showing main functional components of such anti-sidetone arrangements.

Field trials, and the changes and improvements that they inevitably bring about, are normal steps in the perfection of Bell System apparatus. Combined with the fundamental principles of design formulated by engineers at Bell Laboratories, these changes and improvements will someday produce a practicable, proven transistor telephone — the telephone set of the future.

Modern telephone central offices require numerous measurements of time values: chronological time, time intervals and programs of time sequences. More than thirty different timing devices have been developed for many activities ranging from maintenance to customer billing

R. F. Ewald and E. P. Williams

Measuring Time in Central Offices

Time is directly or indirectly involved in almost every phase of telephone operations, and in many instances it must be accurately measured. For this reason it has been necessary to develop numerous timing devices.

Perhaps the most familiar of these measurements is the length of the conversation interval. When the customer is billed for timed calls, the time that the conversation begins and the time it ends are recorded either manually or automatically to determine the correct charge. In telephone offices, however, there are many other timing devices not apparent to the casual observer. Without these devices it would be difficult to provide efficient and economical telephone service.

Practically every step through complex telephone switching and transmission equipment depends upon a controlled chronological sequence of operations. Many of the actual steps in connecting a circuit for a telephone call, for example, are completed with relays, which are designed to operate in milliseconds. Other functions require timing values ranging from several seconds to many minutes, for which special timers or clocks are necessary.

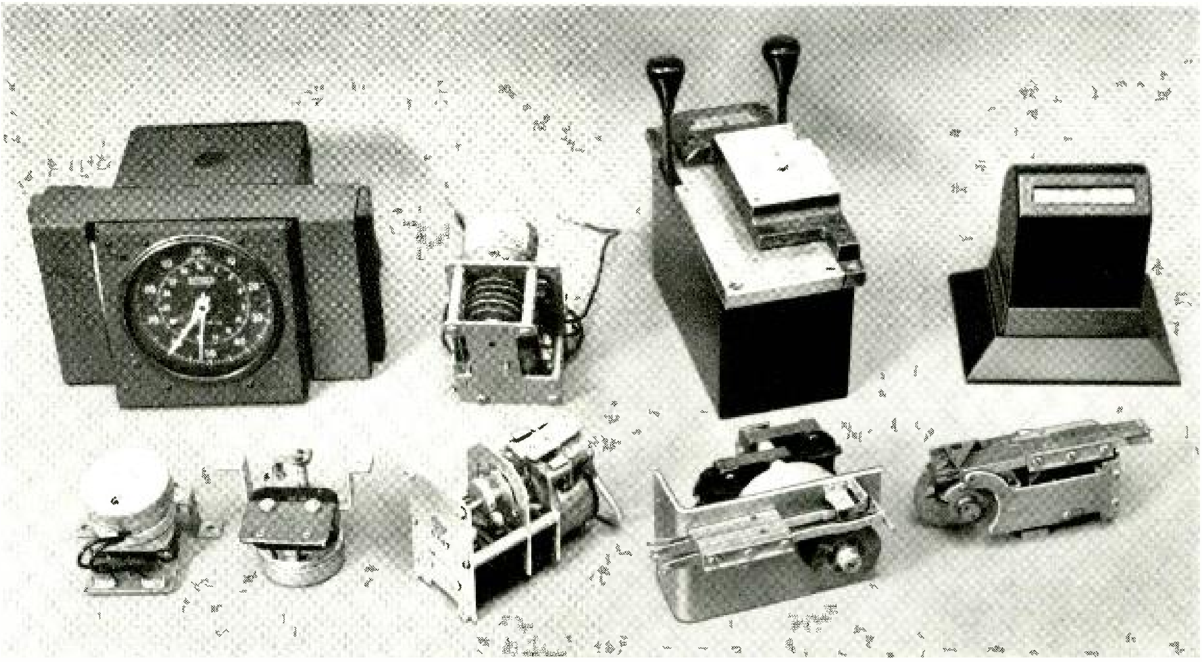
Today there are more than thirty different types of timing devices used in telephone central offices, of which only a few will be discussed here. These few, however, illustrate the significance of timing in the Bell System and emphasize the careful attention given to this problem.

It will be helpful to discuss timing devices under the four broad categories of clocks, interval timers, cycle timers and program timers. These categories may be explained as follows:

- Clocks, of course, are used to indicate actual times and elapsed-time intervals.
- Interval timers measure time from start to finish of an event and reset to normal to recount a subsequent interval of time.
- Cycle timers are used to indicate continuously a specific time interval.
- Program timers measure time chronologically to insure the repetition of an event at desired uniform intervals.

In the category of clocks, a good example is the recently improved operator's switchboard unit. One of these clocks is located between each pair of telephone operators so that either may conveniently read it to note the starting and stopping times of calls, particularly short-distance toll calls. Because switchboard space is at a premium, compactness consistent with a neat appearance was important in its design.

This switchboard clock is of the direct-reading type — using numbered drums instead of hands and numbers on a clock face. It is driven by a small synchronous motor which rotates a "sec-



Various types of timers, illustrating wide range of such devices needed in telephone central offices. Units are grouped under categories of clocks, interval timers, cycle timers and program timers.

onds" drum continuously, and this drum in turn steps four other drums for the minute and hour indications at the appropriate intervals. The case has a dull black finish and is adjustable in position — design features that make for eye comfort of the operator by minimizing light reflecttions from both the case and the plastic window through which the drums are read. The clock is designed to be mounted on a flat surface of the switchboard. Two other designs are available, one to be recessed into the switchboard and the other to be mounted on a vertical panel.

"Reminder" Unit

Under the second heading — interval timers — a newly developed "initial-period reminder" unit is worthy of mention. Often a customer wishes to talk only for the first charging period and to be notified of its termination. The new timer aids the operator in providing this information. When the conversation begins, the operator plugs into one of three jacks — for 3, 4 or 5 minutes, depending on the length of the initial charge interval for the particular call, and thereby starts the timing of the charge interval. A few seconds before the end of the interval, the timing unit operates a light which flashes to alert the operator, after which, at the end of the interval, the light changes to a steady condition. At this time, the operator informs the customer that his initial interval is completed, and he can terminate or extend his conversation as he chooses.

As in many timers, this unit has a synchronous ac motor and a group of cams. The motor rotates the control cam precisely once per minute, and this cam is geared to separate cams for 3, 4 and 5 minutes, each of which closes its associated timing contacts. Use of the faster revolving (one minute) cam results in greater accuracy than could be obtained by directly timing the longer intervals with more slowly rotating cams.

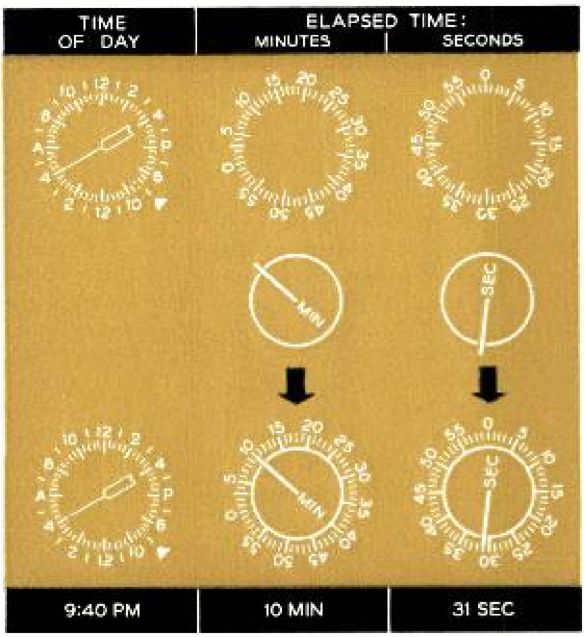
Timer for Service Observing

Another type of interval timer of the "stop-watch" variety is used in central offices to study how efficiently telephone lines and switching equipment are being used. For this purpose, time intervals are measured for various telephone-call operations: time for dialing, time to complete the connection and so on. These apply to both customer and operator usage of equipment. For this "service observing" function, a special stop clock has been developed. Like the switchboard clock, this unit has been designed with considerable attention to eye comfort and ease of operation. The clock has three pointers; two are white and one is red. One white pointer is arranged to rotate continuously at a rate of one revolution per 100 seconds to facilitate time records. The red pointer totalizes the number of these revolutions. The other white pointer is the actual "stop-watch" indicator — it starts with the other two but can be stopped at any position and restarted.

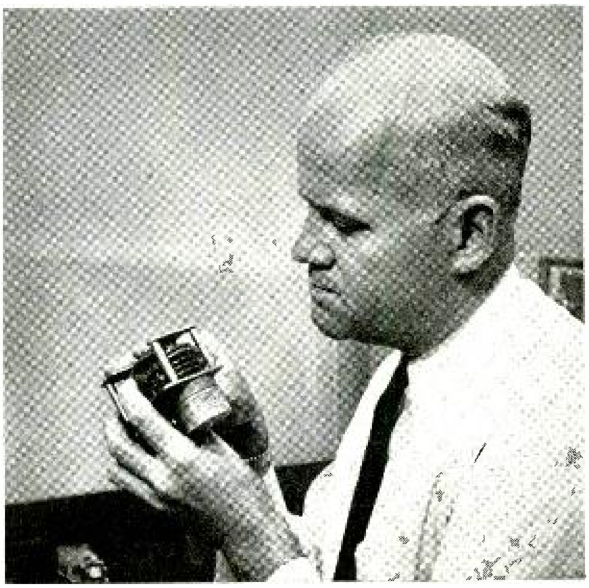
The service observer uses a special hand-held control switch to control this stop clock. One position of the rotary knob starts the "stop" pointer, and another rotary position stops it. When restarted, this pointer "catches" the other continuously rotating pointer to allow other stop readings to be measured from the original starting time. At the end of the group of time readings, the clock is reset to zero by depressing the switchknob. This stop clock is a unit associated with the No. 12 service observing desk, which is used primarily for toll calls.

The master timer associated with Automatic Message Accounting is an example of devices in the third category, cycle timers. Its cams close several contacts in a cycle at 6-second intervals. These closures provide the time information to be punched on the paper tape used to record conversation time, and they also provide other information concerning a telephone call. Because of the importance of the timing record for the billing of telephone calls to the customer, two of these timers are used to check one another in each AMA office.

In the category of program timers, two units used in central offices will serve as illustrations. The first of these is a device which functions as a part of the equipment used for automatic testing of the insulation-resistance of telephone lines (RECORD, *October*, 1954; *October*, 1956; *November*, 1957). Lines that may give trouble, however infrequently, will often show an advance indication in the form of low insulation resistance under conditions of wet weather. Overnight, some lines may absorb moisture through a defective surface of the outdoor cable. The timer can be set to a program of testing for 15 minutes at a designated time every morning, usually beginning at 4:00 A.M. It can also be arranged, if desired, to omit the test on certain days of the week.



In a Calculagraph record, the first stampings print time of day and only the dials for elapsed time (top row); second stamping superimposes pointers (middle row) to produce the record at bottom.



R. F. Ewald inspecting the newly developed "initial-period reminder" unit, a timer which aids operators in providing information to customers.

A second program timer illustrates the use of the programing technique over shorter intervals of time. In equipment that measures traffic usage (RECORD, *July*, 1956; *March*, 1958) as an aid to the engineering of offices for maximum efficiency, it is necessary to "scan," or test as many as 3,600 circuits for busy or idle conditions every minute and a half. The timing device used for this purpose controls the program of scans, which must be accurately timed to arrive at precise measurements of traffic usage.

The Calculagraph

For the basic timing functions described at the beginning of this article, there remain the devices that produce a stamped paper record. Included in this group are the Calculagraphs — clocklike mechanisms used by operators in larger toll offices for timing long-distance calls. The printing elements for this device include three pointer-dial combinations — one for time of day, one for the elapsed time of the conversation in minutes, and the third for elapsed time in seconds. On the time-of-day indicator, the dial is stationary, and two pointers for hours and min-

E. P. Williams examining a 1A timer — this is the original automatic device used for measuring time intervals on local calls from crossbar offices.

utes rotate continuously. On the minutes and seconds indicators for elapsed time, the dials and the pointers rotate together continuously, but impressions of the dials and pointers are made separately. At the start of the conversation, the operator stamps impressions on the toll ticket — impressions that consist of the complete time-of-day stamp and the elapsed-time dials. This initial part of the record is shown in the upper row of the illustration on page 409. Then, at the end of the conversation, the operator superimposes the impression of the elapsed-time pointers on the previously made impressions of the elapsed-time dials (center of illustration). These are superimposed on the same toll ticket, and the result is the record shown in the lower part of the illustration. The combination of the two impressions shown in the drawing indicates that the conversation started at 9:40 P.M. and lasted for 10 minutes and 31 seconds.

The 1A and 2A Series

While these devices include many of the important areas of central office timing, the description would be incomplete without mention of a group of timers that were designed some years ago. The 1A type timer is the original automatic device for measuring a 4- or 5-minute charging interval for local calls from crossbar offices. It is used for message-rate service. A similar unit was developed for timing calls from coin telephones, and others were developed for routine testing. The 1A timers will record the times of telephone calls of indefinite length in any multiple of the standard charge interval. A maximum of twenty of these timers are associated with a common drive, and each timer is arranged to be individually driven by a common synchronous motor.

In some areas with various classes of service, the talking interval varies from 3 to 4 or 5 minutes. For this purpose, the 2-type timer was designed to close a chatterless contact every 15 seconds. By summation of these basic 15-second intervals, the total conversation interval can be recorded on message registers from which the proper charges are obtained.

Another function of timers is to provide a guarding or monitoring action, and the 3A timer (RECORD, *September*, 1953) used in connection with automatic ticketing in step-by-step systems is an example. This timer provides contact closures at 12-, 22- and 32-second intervals and is restored to normal to repeat the checking cycle. If the identifier or sender circuits are held longer than these allowable intervals, the timer indicates a trouble condition and an alarm is sounded to call a maintenance man to correct the difficulty. The timer was designed as a plug-in unit to facilitate maintenance.

This brief review of certain central office timing devices has, of necessity, omitted many other types, but those discussed here give an idea of the important role that accurate timing plays in the Bell System.

One of the principal advantages of polyethylene-insulated conductors is high resistance to moisture. By exploiting this advantage, engineers at Bell Laboratories have developed a simple, efficient and economical terminal arrangement for connecting customers' telephone sets to cable pairs from the local central office.

P. P. Koliss

A NEW "READY-ACCESS" DISTRIBUTION TERMINAL

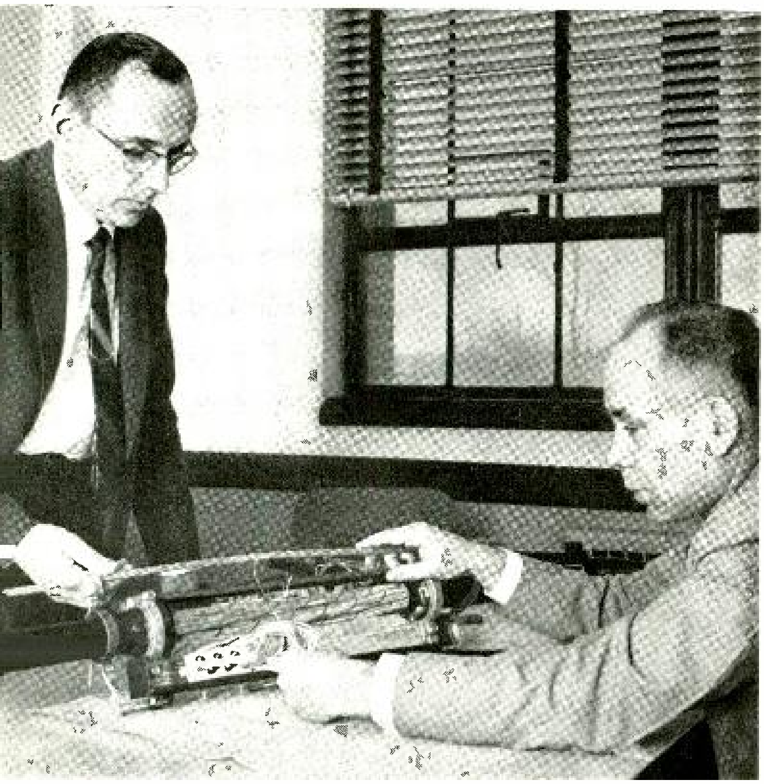
The far-flung Bell System telephone network can be divided roughly into three major divisions: switching centers, the outside plant and station equipment. The outside plant represents about 36 per cent of the capital investment of the System and consists mainly of wires and terminals.

This vast and intricate system of wires — the telephone cable plant — is made up of a variety of sizes and types of cables, each designed for a specific transmission job. The one thing that all of these cables have in common, however, is some type of insulation. Insulating the metal conductor in a wire or cable is necessary regardless of its environment — undersea, underground, or suspended in the air on telephone poles.

One of the best and most economical insulators is paper, in either strip or pulp form. Paper, however, is of little value in protecting the conductor against the effects of environment, so a jacket or sheath of weather-resistant material — a lead alloy, rubber, or polyethylene — must be put on over the group of paper-insulated conductors. Prior to World War II, all telephone cables were made with a lead-alloy sheath, but shortly after the war polyethylene became a strong competitor as a sheathing material. At the present time, a large percentage of the cable being manufactured has plastic covering.

About 400,000 sheath-miles of paper-insulated cable are currently in use as "exchange" cable. These cables contain the pairs of voice conductors that extend from the telephone central office to a "distribution terminal" near the customer's premises. Distribution terminals are the points of access to the wire pairs in the exchange cable, and from these terminals "drop wires" connect the customer's premises to a cable pair from the local central office.

For many years, an important consideration in the design of distribution terminals has been the need for hermetically sealing the paper-insulated conductors to protect the paper from moisture, but this situation recently has been changed. Cable engineers and chemists at Bell Laboratories and at the Western Electric Company have developed the materials and methods for making practical and economical polyethylene-insulated conductors (PIC Cable). And the proven effectiveness of polyethylene insulation has made it possible to explore entirely new concepts in the design of distribution terminals. The principal factor in this new approach is the imperviousness



Author (left) explaining features of new terminal to A. Logan of Western Electric. A model of the terminal assembled to a cable strand is on the desk.

of the polyethylene to any atmospheric moisture.

As a result, engineers at the Laboratories have been able to develop a completely new type of terminal arrangement. Unlike its predecessors, designed for use with paper-insulated cables, the new distribution terminal does not have the customary qualities of moisture-tight and gas-tight construction. It is, rather, a simple, weather-protective housing that can be quickly installed and that provides ready access to all the circuit pairs inside the cable.

On aerial cable, distribution terminals are usually located on the telephone pole or underneath the cable-support strand at a point near the pole. The strand is a steel cable that serves as a supporting member for the exchange cable. Exchange cable is lashed to the support strand by steel wire.

Cable terminals are used at an average of 20 per mile of exchange cable. These terminals play a major role in both the construction and the efficient use of the telephone-cable plant. In terms of dollars, one fourth of the total (installed) cost of aerial exchange cable having paper-insulated conductors is represented by cable-terminals.

Another important economic consideration in cable plant which uses paper-insulated cable is the high cost of re-arranging cable pairs after installation. This type of cable uses hermetically sealed distribution terminals. To keep down the cost of re-arranging cable pairs, it has been the general practice of the Operating Telephone Companies to terminate a given cable pair, at the time of installation, at more than one terminal point along the cable. This arrangement — called "multipling" — provides some future flexibility and permits better use of the cable pairs.

In new cable plant of this type, it is very important that terminal pairs be installed not only at locations where a present demand for service exists, but also at locations where future service is likely. On a working cable, the cost of adding terminals is approximately three times the cost of splicing additional distribution terminals into new, unenergized cable.

In spite of multipling, however, the addition of new customers in unanticipated locations or in unexpected numbers sometimes requires revision of the existing facilities. Consequently, a certain amount of the terminal work done each year involves placing new terminals on working cables and rearranging cable pairs at old terminals to make unused cable pairs available at locations with heavy traffic.

These problems in the installation, use and maintenance of exchange cable plant are almost entirely obviated by the new ready-access terminals. The design of the new terminals takes full advantage of the superior moisture-resistant and dielectric characteristics of polyethylene in three ways: (1) low manufacturing cost, (2) ease of installation and (3) more efficient use of the cable plant. The new terminal, shown in the photograph at the left, consists essentially of a baseplate assembly on which up to four 6-pair terminal blocks can be installed, a snap-on cover molded of neoprene, the terminal blocks, and the drop-wire connections.

Installing New Terminal

To install the new terminal, the workman fastens the metal base-plate assembly to the cable-support strand about ten inches from the pole, and removes approximately 14 inches of the polyethylene sheath from the section of the cable between the cable clamps. He then slits the cable sheath to make four tabs at each end of the opening, places clamps underneath the aluminum portion of the sheath, and fastens the cable sheath to the base-plate assembly by tightening the corrugated, die-cast clamps, as the installer in the cover photograph is doing.

Adjacent to the cable clamps, he makes a drip collar of B sealing tape to prevent water from reaching the open core. The "nozzles" that extend from each end of the cover have numbered grooves in them at one-tenth inch intervals, so that they may be cut off to fit any of the more than 20 different sizes of cable used in the exchange-cable plant. After the workman slips the cover into place, he fastens the three wire clips on the bottom and the two wire clips on the end.

Unlike former standard distribution terminals, this new unit is not multiplied on preselected cable pairs. Instead, it is spliced to assigned cable pairs at the time the customer's drop wire is installed. The leads from the terminal block can be connected to the cable without the use of equipment for identifying the pairs, because the new polyethylene insulation on the conductors is furnished in colors which permit the pairs to be identified by color-code combinations.

Installation Has Many Advantages

This installation procedure offers the maximum flexibility and greatest potential use of the cable plant as it is installed, and it will reduce rearrangements to a minimum. Since the average number of drop wires per distribution terminal for the entire Bell System is about four, only one six-pair terminal block is supplied with the ready-access cable terminal. By contrast, an average of 16 pairs per terminal are supplied for multipling purposes with the N- and T-type terminals used with paper-insulated cables (RECORD, *November*, 1954).

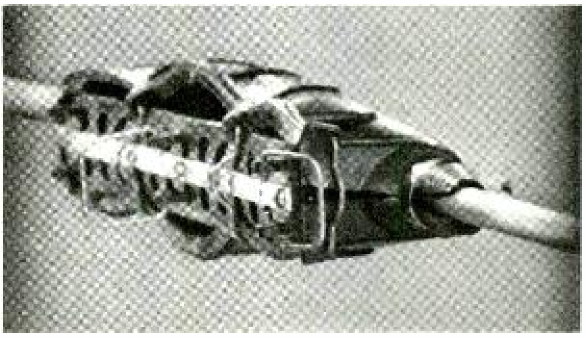
In the course of developing this new terminal, many accelerated laboratory tests were performed to evaluate the proposed ready-access design. Among these was a wind-tunnel check to determine the effectiveness of the simple clip arrangement for fastening the cover to the base assembly. An assembly terminal was subjected to wind velocities up to 200 mph in each of six different directions, without dislodging or damaging the test sample. The photograph (right) shows the condition of the terminal under test while it was being subjected to a 200-mph wind in a direction perpendicular to the base assembly. The cover did not completely reseat itself on the base after the wind velocity was reduced to zero, but on tests up to and including 100 mph, the cover remained firmly seated.

Another group of tests was devised to evaluate the physical properties of the molded neoprene cover. Since the installation of drop wires is an all-weather operation, the cover material must be flexible enough at low temperatures to permit bending to remove it from the base. Ice-coating tests were made to be sure that the cover could be opened under very adverse conditions without damage. Ultraviolet light and ozone tests were also an important part of the program for evaluating the plastic used for the cover prior to the final selection of a material that would insure long service-life.

Two of the most important test installations used for long-range evaluation of the new terminals are still in service. The first of these tests — carried out at the test location of the Outside Plant Department in Chester, New Jersey — has been in progress for three years, and involves periodic measurements of the electrical characteristics of polyethylene-insulated distribution cable equipped with ready-access terminals. This test is designed to determine the effect that moisture has on polyethylene insulation and how this might affect transmission over telephone circuits.

The second series of tests is being carried out at Willimantic, Conn., in cooperation with the Southern New England Telephone Company. The original terminals used in field-trials were installed in the Willimantic area — a region of high lightning-incidence — to obtain information on the dielectric performance of the new cable-terminal arrangement in the presence of lightning (without protectors). This test has been in progress for two years. All of these tests have indicated that both the mechanical and electrical performance are most satisfactory.

To make the new terminals as universally adaptable as possible for the anticipated widespread use of polyethylene-insulated cable, they are being manufactured in several sizes and types. The designs cover terminals for use in both the straight and "branch" cable conditions, and provide for a range of cable sizes up to 2.2 inches in diameter. Volume production of some of the terminal units began in 1956, with the other sizes currently in production.



Testing the new terminal at University of Maryland wind tunnel. A 200-mph wind is coming from left, perpendicular to plane of base plate.

Joining Armor Wire For Transoceanic Telephone Cable

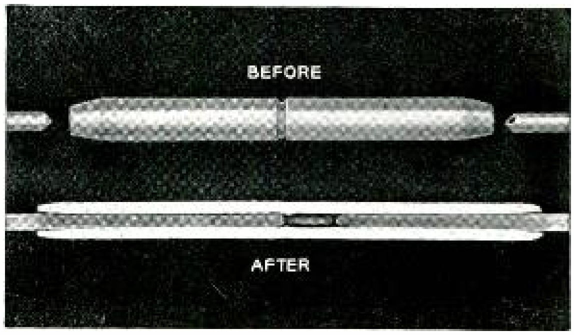
The armor of transoceanic telephone cables provides the necessary strength to permit cable to be laid in ocean depths and subsequently to be picked up again if necessary for repair operations. In addition, the armor provides protection against damage that might result from a number of causes including handling, abrasion, anchors and trawlers. Since submarine telephone cables are made in continuous lengths of about 38 miles (one repeater section), the three-mile lengths in which the armor wire is supplied must be joined together during cable manufacture so they can be continuously applied to the cable at the armoring machines. Joints in the several armor wires surrounding the cable are staggered to avoid multiple armor wire joints at cable cross section.

In the past, these armor wires have been joined by electric butt welding. It was known, however, that the intense heat generated during welding operation annealed the high-strength armor wires in the vicinity of the weld so as to reduce the wire strength to approximately one half its original value. This loss in strength did not seriously affect the safety margins of the cable until it became necessary to consider placing such cable in ocean depths in excess of 2,500 fathoms. At these greater depths, the loss in joint strength becomes a matter of concern.

Standard Bell System rolling tool with galvanized steel sleeve and wire held between the rollers.

To obtain increased safety margin for the transoceanic cable, it was necessary to develop wire-joining techniques which would provide joints having a strength equivalent to that of the armor wire itself. For this purpose, a galvanized steel sleeve similar to those used for joining high-strength telephone line wire was developed.

The sleeve application procedure consists of inserting an armor wire into each end of the sleeve up to a midpoint separator. With the wires held in position, the sleeve is fed into the small groove between rollers of a standard Bell System rolling tool as shown in the illustration at the left. Rotating the tool crank forces the sleeve between the rollers. This reduces the outside diameter of the sleeve and results in a swaging or binding action between the wire and inner surface of the sleeve. Sleeves before and after rolling are shown in the illustration above. The rolled sleeve has been sectioned longitudinally to show the intimate contact obtained between sleeve and wire. Extensive elongation of the sleeve provides some measure of forces resulting from the rolling process, and may be gauged by the separation of wire ends which were virtually butted together before rolling.



Armor wire shown before and after it was fitted into the sleeve; sectioned view reveals tight fit.

To prevent the sleeve from snagging during the armoring process as it passes over small roller guides, through guide holes, and through closing dies at the armoring machines, a gradual taper is provided at each end of the sleeve. The inside surface of the sleeve is coated with a spray of Nichrome to improve the friction or lock between the sleeve and the wire.

To check the performance of the rolling tool and the quality of workmanship, a qualifying joint is required from each tool and workman on each shift. Test results of these armor sleeve joints during the past months indicate that the sleeve joint made by this new wire-joining method is essentially as strong as the armor wire itself.

G. Garbacz
Outside Plant
Development Department

Engineers at Bell Laboratories are constantly trying to improve the quality and maintain the low cost of telephone service. This effort is exemplified by a recent redesign of the AMA translator for No. 5 crossbar that has doubled the line capacity of the frame, yet made it smaller and no more difficult to maintain efficiently.

G. S. Bishop

A NEW AMA TRANSLATOR FOR No. 5 CROSSBAR

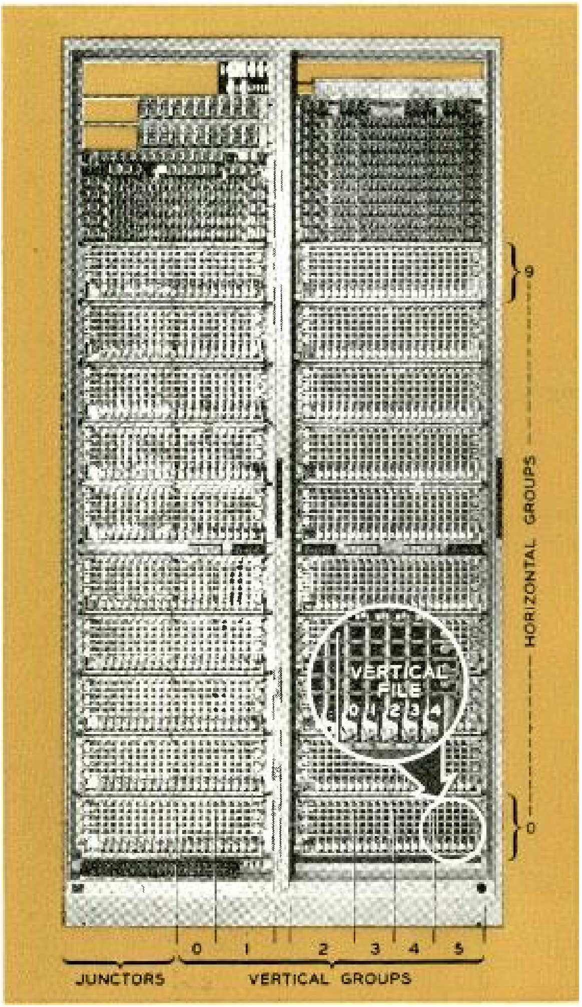
A translator, strictly speaking, is a person who converts information in one language into the same information in a different language. This same procedure, done mechanically or electrically, is often required in the telephone plant. Conversion arrangements are particularly necessary in systems which use Automatic Message Accounting (AMA). From various switching machines that are essentially communication systems, AMA — essentially a recording mechanism — must receive information it can immediately understand and use.

Reconciling this difference between the kind of information required for efficient communication and the kind of information needed for AMA has been the basis for many unique developments at Bell Laboratories over the past ten years. In the No. 5 crossbar system, an AMA translator was developed as an integral part of the over-all switching plan. The purpose of this translator is to furnish billing information to the AMA equipment.

If you are a customer served by a No. 5 crossbar office, your line appears on one vertical of a crossbar switch on a line-link frame. This vertical and those of other customers are arranged in groups of fifty, called vertical groups. There are four to twelve vertical groups on each line-link frame, and up to sixty line-link frames in each office. Each vertical group is further subdivided into ten horizontal groups, and each horizontal group contains five line-verticals. These five line-verticals are called vertical files. The pattern of line verticals in each vertical group is shown in the illustration on page 416.

On a call, a "marker" — the circuit which directs a call through the office — must identify the location of the calling-line vertical. This is done in terms of line-link frame, vertical group, horizontal group and vertical-file numbers. The calling-line location and the number dialed are used by the marker to set up the talking connection. After the connection has been initiated, the calling-line location and the dialed number are sent to the AMA equipment. Here, the AMA machines make a record of the call for billing purposes. The common-control frames of the AMA equipment that receive the originating line-location and the numbers of the called party are called transverters.

Charges for telephone calls are made against the directory number, not against the line location. There is, however, an effectively arbitrary relationship, fixed by assignment, between line



Photograph of line-link frame with lines added to show arrangement of vertical groups (VG), *horizontal groups* (HG) *and vertical files* (VF).

locations and directory numbers. The two most important reasons for this are: (1) flexibility in the assignment of directory numbers to customers, and (2) even distribution of traffic over all of the line-link frames in the No. 5 crossbar office. The function of the translator is to convert the line location to the directory number. The AMA transverter refers the received line-location to an AMA translator, which quickly returns the corresponding directory number. A translator is, in effect, a card file that can be kept up to date with the day-to-day changes in directory numbers and line locations.

The original translator, as mentioned earlier, was developed about ten years ago, and was designed to serve 1,000 line locations — or, looking at it another way — to identify 1,000 directory numbers. The equipment is mounted on a single frame 11 feet, 6 inches high and about 44 inches wide. During the ten years since the original development, many new types of apparatus such as wire-spring relays, new terminal strips, and solderless wrapped connections have also been developed. By using these devices and techniques along with some redesign of the translator circuits, engineers at the Laboratories have designed a new AMA translator for 2,000 lines.

In addition to being smaller (about 34 inches wide) than the original, the new translator has several other advantages. The most important of these are savings in equipment and installation and the use of common maintenance tools used on other frames, most of which are also arranged for solderless wrapped connections. The circuit for the new translator is essentially the same as the original except that it uses new relays and other apparatus, and has been expanded to the 2,000-line capacity.

Doubling the capacity of the basic circuit (RECORD, *February*, 1951), while at the same time reducing the physical size, presented some interesting problems. Before discussing these problems, however, it would be well to review the original circuit and compare it, in rather general terms, with the new arrangement. The sketch on the next page will be helpful here, since it shows the (original) equipment separated into four parts.

At the top is a connector. This consists mainly of a set of two multicontact relays for each associated AMA transverter. One set of these relays at a time is operated on a request for translation. These connector relays then close the conductor paths that transmit information between the translator and the transverter.

The new frame has four wire-spring, multicontact relays for each transverter. These provide the same number of contacts as the two flat-spring multicontact relays on the old frame, and save about thirty per cent in mounting space. Two terminal strips for each transverter have been added at the very top. These will permit connection of leads from switchboard cables on the front of the frame, whereas most of them were previously connected on the rear. Front-of-frame connection is particularly important since the width of the wiring aisle has recently been reduced to 22 inches.

The next portion of the circuit is the "relay tree." This consists of a few general-purpose relays and a relatively large number of multicontact relays. The relay tree, in effect, takes the line-location information received over fifty wires and spreads it out through a network of contacts and wires so that each of the 2,000 line-locations is identified on a single terminal of a multi-terminal field.

The new frame, quite logically, needed twice as many relay contacts to expand from 1,000 to 2,000 line-locations. This required eighty wire-spring, multicontact relays as compared to twenty of the flat-spring type on the old frame. On the new translator frame, the relay tree and connector fill the entire upper half of the frame.

The third part of the translator is the control circuit. This consists mainly of general-purpose relays, flat-type resistors, and capacitors and gas tubes. The three main functions of control are (1) to insure that only one transverter is connected at a time, (2) to check for troubles and (3) to furnish a surge of oscillating current to the line-location terminal when a translation is to be made. On the new frame, the control equipment is combined with the general-purpose relays of the relay tree to make up a compact unit that fits on four mounting plates.

The lower half of both the old and the new frames is the "ring" translator. This makes the actual conversion from line location to directory number. It consists of two terminal fields separated by five shelves of inductor coils, five plates of cold-cathode gas tubes, and a large number of loosely run wires called "jumpers."

Both of the terminal fields have 2,000 terminals, each representing one line location. These terminals are arranged and designated in groups of fifty to correspond to the pattern of line verticals on the line-link frames. It is important to point out here that the terminal positions are identical in each field. This is essential for easy installation and removal of jumpers when making changes in line-assignments.

The coil shelves are located between the two terminal fields. From top to bottom, they are designated "office," "thousands," "hundreds," "tens," and "units." On the equipment, these shelves are marked, respectively, OFF, TH, HN, T and U. The shelf designated "office" has eight coils associated with the office codes — the two letters and first numerical of the directory number. Each of the four lower shelves has ten coils corresponding to the individual digits within each place of the four-place directory number.

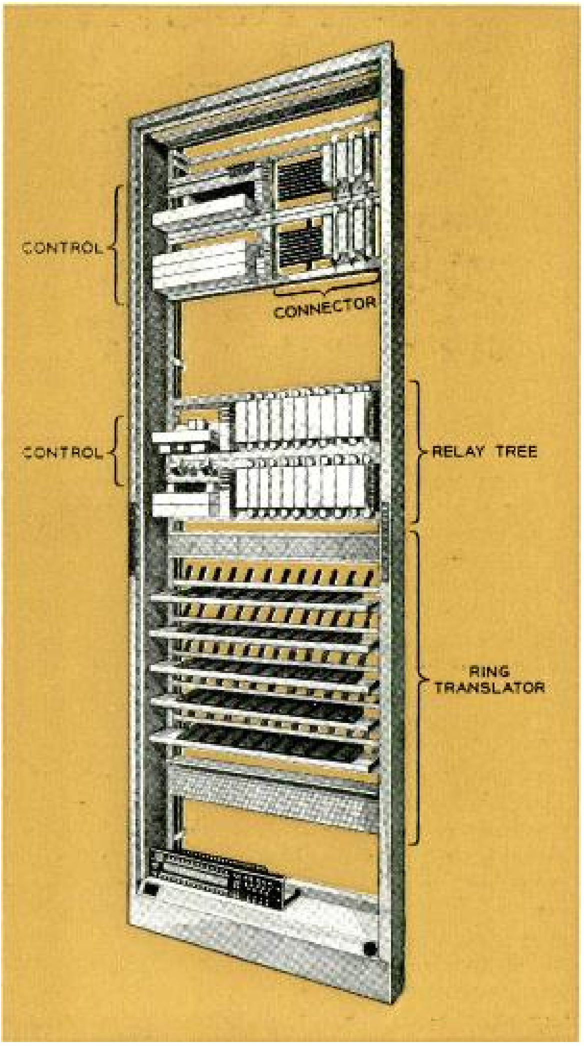
One gas tube is located on the rear directly behind each coil. These are arranged on five plates and designated exactly the same as the associated coils.

A jumper wire for each line location runs through the coils. Each wire is threaded through the OFF, TH, HN, T, and U coils corresponding to its directory number. One end is connected to the upper line-location terminal, and the other end of the jumper is connected to the lower line-location terminal. Thus, when the AMA transverter sends a line-location code to the translator, the connector, relay tree and control unit, operating together, cause a surge of oscillating current to flow through the jumper wire associated with a particular line-location.

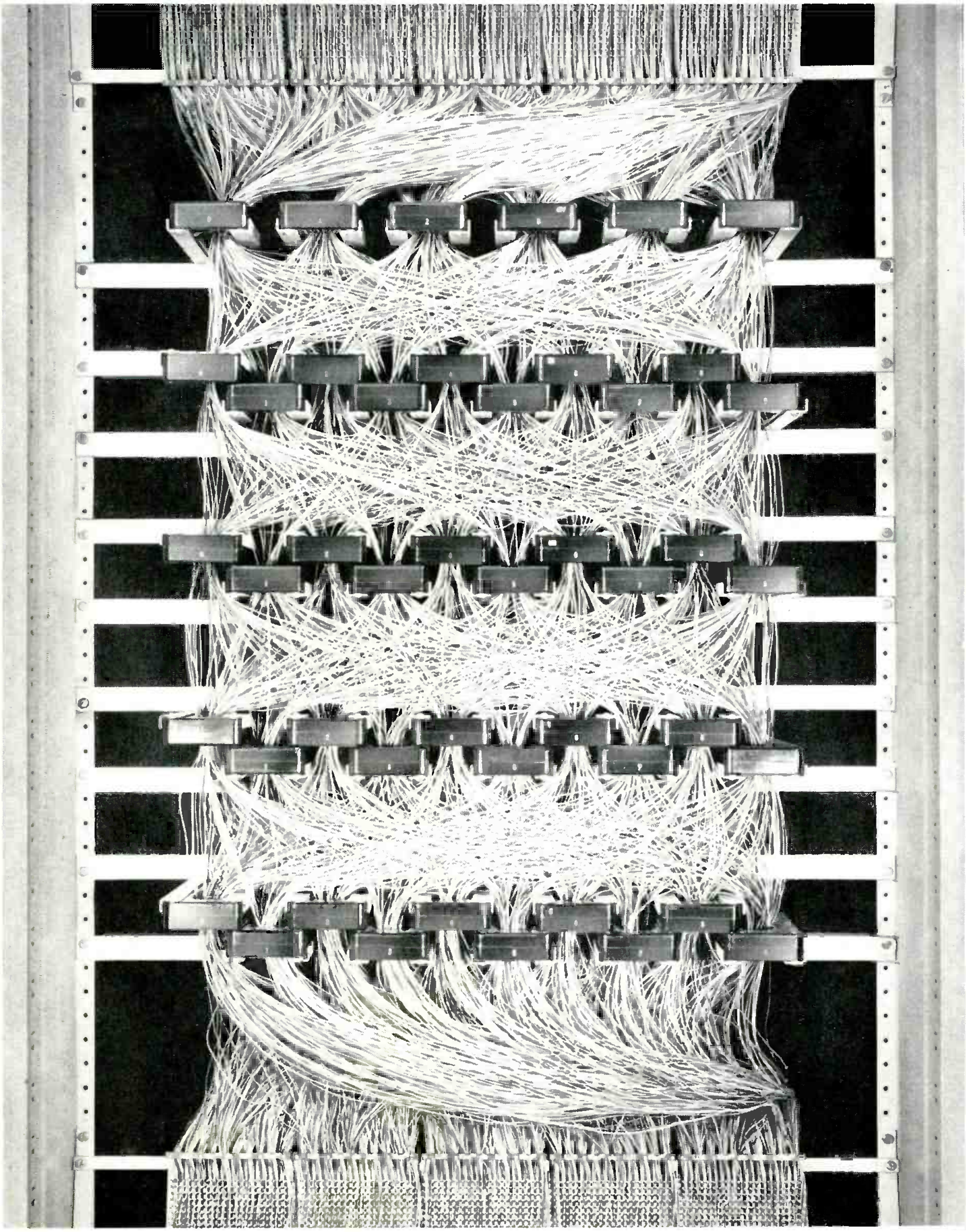
This in turn induces voltages in the windings of the coils through which the jumper has been threaded. The induced voltages in these windings, each of which is connected to the control terminal of an associated gas tube, cause the tubes to conduct current through the connector to directory-number relays in the transverter.

Expansion of the ring translator proved to be the crucial problem in the redesign of the translator. In problems of this kind, the designer must always consider the five most important factors affecting over-all system cost. (1) Operating Company and Western Electric Engineering, (2) manufacturing, (3) installation, (4) central-office space, and (5) maintenance.

An analysis of apparatus and wiring patterns indicated that it would be possible to design a 2,000-line translator with substantial savings in engineering, manufacturing, installation and floor space. A prime concern of the Operating Companies, however, is maintenance — specifically, maintenance service throughout the life of the equipment.



Sketch of original (1,000-line) translator frame, without jumpers, divided into four sections.



Experimental model of the new wiring field of the ring translator, built at Bell Laboratories to see whether 2,000 lines could be used with this arrangement. Subsequent design has gone through considerable modification, but photograph shows basic wiring scheme and use of overlapping rings.

Maintenance of translator frames consists almost entirely of rearranging jumpers to keep up with the day-to-day changes in directory numbers and line locations. On the average, each line-location jumper is changed once every three years. With about 275 working days a year, or 825 in three years, there are between two and three changes per day on each 2,000-line translator frame. The success of the new 2,000-line translator thus hinged almost entirely on working out an arrangement that would permit easy installation and removal of jumpers.

Several laboratory models of the ring translator were made using different coil spacings, terminal arrangements and types of wire. The final model is actually quite similar to the original design except for the changes necessary for expansion to 2,000 lines. For example, each of the terminal fields uses an arrangement of ten cast-resin terminal blocks, each with 200 square wire-terminals suitable for gun-wrapped connections. The original frame used plier-wrapped solderless connections.

The terminals in the new fields are also arranged in groups of fifty corresponding to the line-vertical groups on a line-link frame. The upper terminal field tilts slightly downward and the lower terminal field tilts slightly upward. The tilt puts the terminal field at an angle that makes it easier for maintenance men to read the terminal designations and also makes engaging the bit of the wrapping gun easier.

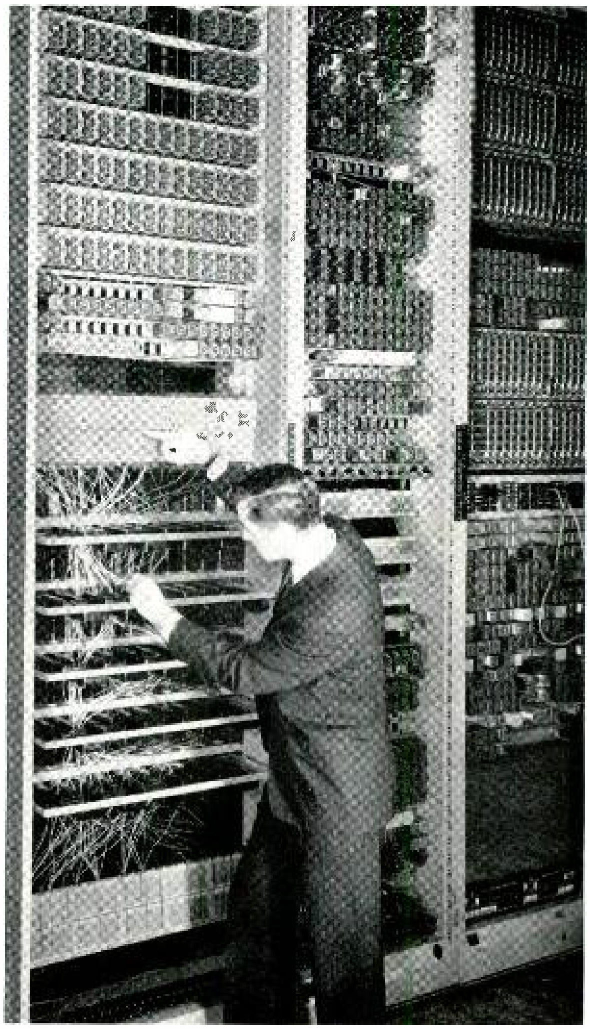
Another change in the new translator was the use of 24-gauge wire with braided cotton insulation (Type K) instead of 22-gauge wire. The change to 24-gauge wire reduced over-all crowding within the jumper field.

To relieve the pressure between adjacent jumpers and reduce the maximum "zig-zag" in the path of each jumper, several space adjustments had to be made. Increased space in several places also reduced the friction between wires and simplified the removal and replacement of wires. The space between adjacent coil shelves was increased as was the space between the terminal fields and their adjacent coil shelves. For each coil shelf the effective width was reduced by overlapping the sides of adjacent coils. This arrangement and the location of the terminal fields are shown in the photograph on the opposite page.

The expansion from 1,000 to 2,000 line locations naturally lead to some rather complex wiring arrangements. This was particularly true of the wiring on the rear of the frame, and the entire problem was further complicated by the fact that the new frame is ten inches narrower than the original translator. The wiring that connects the translator frame with the transverters is contained in vertical local cables. Each of these cables has 120 leads and serves one transverter.

Further complexity was caused by the fact that the relay tree, control unit, and upper line-location field require nearly 5,000 leads from local cables. These leads are formed in two parts, one on the left upright of the frame and one on the right upright to improve appearance and to avoid an additional congestion of wires. The wiring used for internal connections on the control unit, for the rear of the coil shelves, and for the multiple wiring on the lower terminal field is all surface-type wiring, because this method reduces shop costs.

An experimental translator frame for handling 2,000 lines has been built and tested in the laboratory. The first field installation will be at Danville, Ill., and is scheduled for completion about the middle of next year.



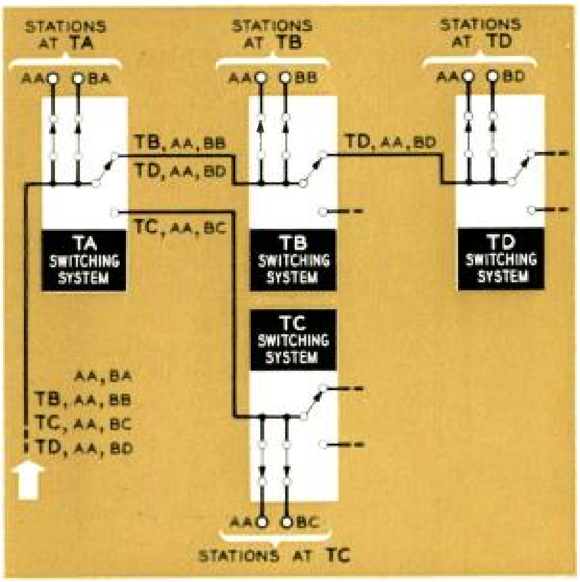
H. N. Wolf checking path of jumper in 2,000-line translator frame design at Bell Laboratories.

A new teletypewriter intersystem code makes it possible for many companies with mutual interests to intercommunicate via the automatic teletypewriter.

Teletypewriter Intersystem Operation

Fully automatic teletypewriter switching systems have been a Bell System service since 1940. These are in wide use by customers who need independent and rapid systems of communication among their many offices, which may be in widely separated sections of the United States. With this service, customers may communicate by teletypewriter message with any one of the stations on their private-line network. In addition, a customer may establish a connection to any desired number of these stations and transmit a message to them simultaneously. This latter service is called "multiple-address operation."

In the past, multiple-address operation has been confined to communications over a network provided exclusively for a particular customer. Some customers such as the airlines, however, have common interests — including reservations and operating information — which make it desirable for them to interconnect their teletypewriter systems. This service is now available to Bell System customers.



Block diagram illustrating teletypewriter intersystem operation with four different stations.

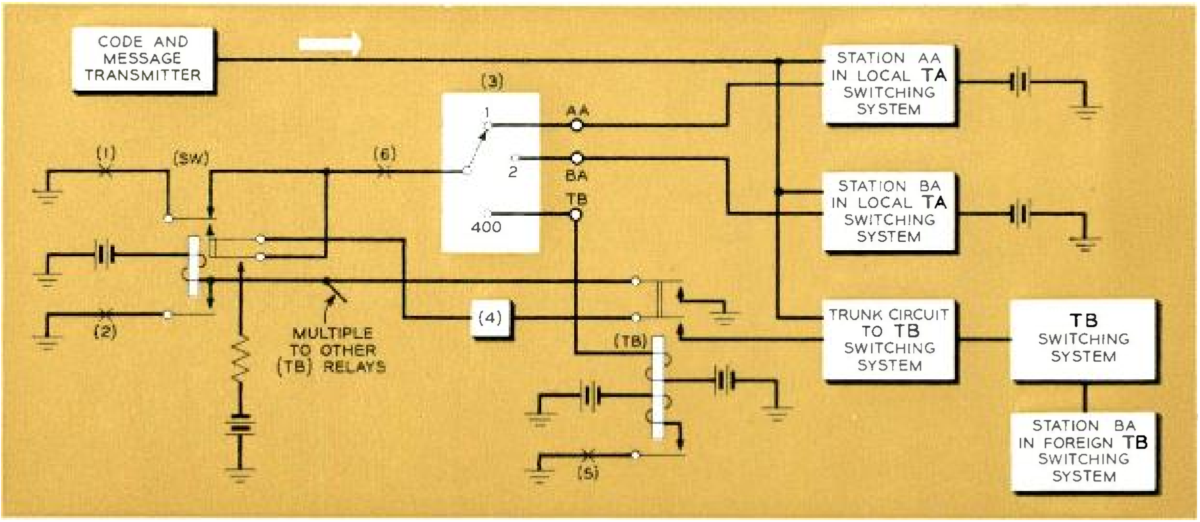
Simply providing a method of interconnecting customer's teletypewriter circuits is not sufficient for this service, since customers assign their own two-letter codes to identify the stations in their network. These codes may be duplicated by other customers. The multiple-address director circuit which selects the stations that are to receive a particular message in one customer's network cannot distinguish between identical codes in different systems. Present operating procedures, and future traffic planning which involves the assignment of station codes in different systems, made it inadvisable to require that customers change their codes to avoid duplication.

This problem was solved by a relatively simple modification of the multiple-address circuit at each switching center. With this modification, stations identified in the address format by a two-letter code may be interconnected within a particular system in the usual way until an "intersystem" code appears. This code directs the switching system to establish connections to particular stations in specified "foreign" systems.

Intersystem operation is shown by the first of the accompanying drawings. This illustrates the example of interconnection to two stations in the local system (TA) and two stations in each of three foreign systems. As indicated by the address at the left in the drawing, the following stations are to be connected to receive a particular message: in the local TA system — stations AA and BA; in the foreign system TB — stations AA and BB; in foreign system TC — stations AA and BC, and in foreign system TD — stations AA and BD.

As illustrated, the intersystem codes TB, TC, and TD are used only to obtain access to the trunk to the respective systems. Connections to the appropriate system stations are established locally. Trunking may be made in any sequence to fit in with the available facilities.

Intersystem code TC makes connection to switching system TC where local stations AA and BC are connected. On the other hand, both the intersys-



Method for establishing connections to Station AA *in local system* (TA) *and to Station* BA *in foreign system* (TB). *Connections may be made to other foreign systems with additional intersystem codes.*

tem codes TB and TD make connection to switching system TB where local stations AA and BB are connected. Since intersystem code TD has been passed on to switching center TB, this latter system makes connection to switching system TD where local stations AA and BD are connected. For simplicity, messages have been shown to originate only from switching system TA. Messages may originate at TB, TC, or TD, similarly.

The detailed method for establishing connections is shown in the second illustration. Numbered points in the diagram refer to the following: contacts (1) close when two characters are read in the multiple-address director and open when each station or trunk circuit is connected, and contacts (2) close when the multiple-address is in the process of connecting a foreign system or trunk, and open when all connections to that trunk have been made. The 400-terminal "fan-reading" circuit (3) reads any of 400 two-character combinations which constitute a code, and the delay circuit (4) allows for the release of a formerly operated trunk relay and the operation of the next trunk relay. Number (5) in the illustration is a locking circuit that operates via other released trunk relays, and (6) is the apex of the fan-reading circuit.

This second block diagram has been arranged for the example of an address which includes station AA in the local system (TA) and station BA in a foreign system (TB). The AA station code directs the equipment to establish a connection to local station AA by means of the ground via point (1) and the fan-reading circuit (3). An intersystem code such as TB, on the other hand, causes the TB trunk relay to operate, which prepares a connection to a trunk circuit that has access to the foreign switching system identified by the TB intersystem code. The relay SW then operates to set up a connection between the TB trunk circuit and the ground via point (1). Relay SW also replaces the ground at the apex of the fan-reading circuit (6) by negative battery. This battery monitors the fan-reading circuit to permit additional intersystem codes to be recognized and acted upon.

After connection to the TB trunk circuit is established, the station code BA will be registered in the fan-reading circuit. Negative battery will not set up a connection to the local BA station because that is already terminated in negative battery. Ground at (1) will, however, make a bid to the TB trunk circuit which had previously been connected. The BA station code will then be transmitted to the TB system where a connection to that system's local BA station will be established in the normal manner. Similarly, other station codes may be transmitted to the foreign system without connecting on the corresponding local stations. Connections may also be made to other foreign systems by means of additional intersystem codes which operate relays similar to the TB relay. In these cases, however, the relays will be operated by negative battery from the fan-reading circuit because the relay SW is operated. When all connections have been made, the text of the message is transmitted to the selected stations simultaneously.

This method of intersystem operation has been installed for commercial service for the Delta, Eastern, and TWA Airlines. Other airlines may require similar service in the near future.

J. A. KRECEK
Special Systems
Development

ORGANIZATION CHANGES

H. W. Bode and J. A. Morton, Laboratories Vice Presidents; G. B. Small, Comptroller; T. J. Montigel, Treasurer

H. W. Bode, Director of Research — Physical Sciences, and J. A. Morton, Director of Device Development, have been elected Vice Presidents of Bell Laboratories, effective October 1.

Mr. Bode is now in charge of one of the two vice-presidential areas devoted to military development. He succeeds J. P. Molnar who was recently elected President of the Sandia Corporation and a Vice President of the Western Electric Company.

Mr. Morton now heads a new vice-presidential area established in recognition of the increasing volume of work in device development, including work on transistors, electron tubes, and other solid-state components.

The Board of Directors of the Laboratories also appointed G. B. Small Comptroller, succeeding the late G. T. Selby. Mr. Small has resigned as Treasurer and Assistant Secretary of the Company, and is being succeeded in these posts by T. J. Montigel, General Accounting Manager.

Mr. Bode, a member of the Laboratories since 1926, received his bachelor's and master's degrees from Ohio State University in 1924 and 1926, respectively, and his Ph.D. from Columbia University in 1935. During his early years at the Laboratories, Mr. Bode was engaged in electric filter and equalizer design. He joined the mathematics research group in 1929, and specialized in research on electrical network theory and its application to long-distance communications. After the outbreak of World War II, he turned to the development of electronic fire-control devices, and in recognition of his contributions in this field was awarded the Presidential Certificate of Merit.

Mr. Bode was placed in charge of the mathematics research group in 1944, and in 1952 became Director of Mathematical Research. He assumed the post of Director of Research — Physi-

H. W. Bode

J. A. Morton

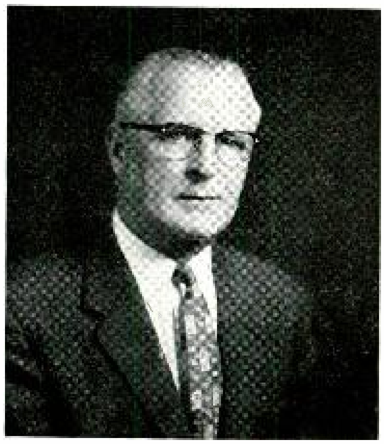
cal Sciences in October, 1955. In these posts, he has made important contributions to the evolution of applied mathematics as an effective technique for application both in industry and in the broad field of modern military problems.

The author of a book on network theory and feedback amplifier design, Mr. Bode is a Fellow of the Institute of Radio Engineers, the American Institute of Electrical Engineers and the American Physical Society, and is a member of the National Academy of Sciences and the American Mathematical Society.

Mr. Morton received his B.S. degree in Electrical Engineering from Wayne University in 1935 and the M.S. degree in Engineering from the University of Michigan in 1936. He immediately joined the Laboratories and specialized in research on coaxial cable repeaters and microwave amplifier circuits for telephone systems. During World War II, he concentrated on the development of radar receivers. During the war he turned to electron-tube development, and later designed the microwave tube which is the heart of the transcontinental radio-relay system for telephone and television transmission.

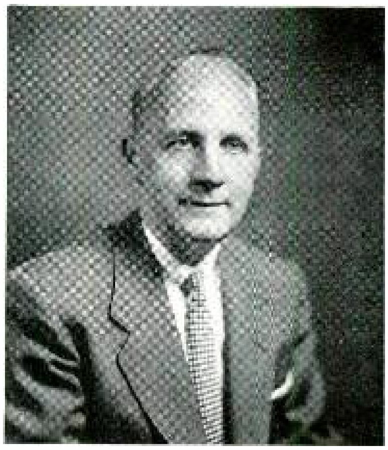
In 1948 Mr. Morton took charge of all development work on semiconductor devices, especially the transistor. In 1952 he became Assistant Director of Electronic Apparatus Development, including development of transistors and related devices, and in 1953 he was named Director of Transistor Development. In assuming his former post in 1955, Mr. Morton became responsible for the fundamental development and development for manufacture of electron tubes, solid-state devices, and electromechanical and passive devices.

Mr. Morton has been awarded the honorary Doctor of Science degree by Ohio State University (1954) and his alma mater, Wayne State University (1956). In 1948 he received an honorable mention award from Eta Kappa Nu, and in 1951 a University Alumni Award from Wayne University for "distinguished service and accomplishment in science." In 1953, at the University of Michigan Centennial, he was cited for his contributions to science. He is the author of numerous technical articles and is a Fellow of the Institute of Radio engineers and a member of the American Institute of Electrical Engineers. He is also a member of Eta Kappa Nu, Sigma Xi and the MacKenzie Honor Society.



G. B. Small

Mr. Small, the newly appointed Comptroller, is a veteran of more than 44 years of Bell System service. Before becoming Treasurer and Assistant Secretary on January 1, 1958, he had served Bell Laboratories in a number of accounting posts, including Assistant Comptroller and General Accounting Manager.



T. J. Montigel

Mr. Montigel, who replaced Mr. Small as Treasurer and Assistant Secretary, received the Bachelor of Philosophy degree from Brown University in 1930 and the Master of Business Administration degree from New York University in 1934. He began his Bell System career in 1930 with the New York Telephone Company, and since that time has specialized in accounting work. He was associated with the New York Telephone Company from 1930 until 1947, with the exception of a four-year period during World War II when he was with Bell Laboratories. In 1947, he transferred to the A.T.&T. Company, and rejoined Bell Laboratories in 1955.

Four new general department heads have been named as a result of the vice-presidential appointments. J. A. Hornbeck is Director of Electron Tube and Transistor Development, and K. G. McKay is Director of Development — Components and Solid-State Devices — both report to Mr. Morton. Reporting to W. O. Baker, Vice President for Research, are A. H. White, appointed Director of Research — Physical Sciences, and W. D. Lewis, appointed Director of Research — Communication Systems.

H. T. Friis Receives Stuart Ballantine Medal

Dr. Harald T. Friis, recently retired Director of Research in High Frequency Electronics and Guided Waves at Bell Laboratories, received the Franklin Institute's Stuart Ballantine Medal on October 15 at ceremonies in Franklin Memorial Hall, Philadelphia.

Dr. Friis was thus honored for "his many important contributions to the science of radio-communications during a lifetime of consistently productive research in this field, through which this science has been so notably advanced."

During his distinguished Bell System career, Dr. Friis contributed substantially to almost every aspect of the radio art. He has made notable contributions in such fields as vacuum-tube efficiency, ship-to-shore radio reception, long-wave and short-wave transatlantic radiotelephony, antenna design, microwave systems, waveguides, radars, and accurate methods of measuring radio signals and noise.

Dr. Friis has previously received several awards for his scientific contributions. They include the Morris Liebmann Memorial Prize by the Institute of Radio Engineers in 1939, and the Medal of Honor of the I.R.E. in 1955. In 1954, he was awarded the Danish decoration, "Knight of the Order of Dannebrog," presented by King Frederick IX, and the Valdemar Poulsen Gold Medal presented by the Danish Academy of Technical Sciences.

A native of Naestved, Denmark, Dr. Friis received the degree of Electrical Engineer from the Royal Technical College, Copenhagen, in 1916. He came to the United States in 1919 on a Fellowship from the American-Scandinavian Foundation to study at Columbia University. That year he joined the Research Division of the Western Electric Company's Engineering Department, which became Bell Telephone Laboratories in 1925.

Dr. Friis spent 38 years with the Laboratories before retiring in March 1958. He served as Director of Radio Research from 1945 until 1952 when he became Director of Research in High Frequency and Electronics.

He is a Fellow of the I.R.E. and the American Institute of Electrical Engineers. He is a member of the American Association for the Advancement of Science, the Danish Engineering Society, the Danish Academy of Technical Sciences and the American Section of the International Scientific Radio Union. Dr. Friis served on the Panel for Basic Research, Research and Development Board, Washington, D. C., and the Air Force's Scientific Advisory Board.

The Stuart Ballantine Medal is awarded for outstanding achievements in fields of communications which employ electromagnetic radiation. Included in its roster of recipients are these present or former members of the Laboratories: John Bardeen, Walter H. Brattain, Kenneth Bullington, S. A. Schelkunoff, Claude Shannon and George C. Southworth.

H. T. Friis (right) receiving the Stuart Ballantine Medal from Wynn Laurence LePage, President of the Franklin Institute, during award ceremonies.

Dr. H. S. Fletcher, left, discusses Potts Award Medal with Dr. Leopold Stokowski at award dinner.

H. S. Fletcher Receives J. H. Potts Award From Audio Engineering Society

Dr. Harvey S. Fletcher, Director of Physical Research at Bell Laboratories before his retirement in 1949, received the John H. Potts Memorial Award of the Audio Engineering Society on October 2. The Potts Award is given annually to an individual who has made outstanding contributions to the improvement of audio engineering.

Dr. Fletcher is a leader in the scientific investigation of human hearing and in the development of sound recording. Among some twenty such investigations directed by Dr. Fletcher, probably the most familiar to acoustics engineers and to "hi-fi" devotees was the determination of the response of the human ear at various frequencies. Such response characteristics are commonly known in the audio art as the "Fletcher-Munson curves."

At the same meeting, an Honorary Membership in the Society was given to Leopold Stokowski, who in the early 1930's, far ahead of other major figures in music, studied recording techniques carefully so he could work for the best possible recording quality.

In addition to Dr. Stokowski and several other musicians and scientists, an Honorary Membership in the Society was given to H. W. Bode, Vice President of the Laboratories, for his work in establishing the scientific principles of "feedback" used almost universally in audio amplifiers.

New Experimental Booth Made of Plastic Combines Privacy and Visibility

A new, experimental telephone booth illustrates the growing importance of plastics in the design of station equipment.

The experimental "Vistabooth" may some day add a space-age look to certain public telephone installations. Right now it is but one of many exploratory designs being studied to meet the demand of future telephone service.

A trial model of the new design, shown below, is made of an aluminum frame and floor with a transparent, bullet-shaped plastic dome for maximum visibility. The station equipment in the booth includes a modern coin box and a standard desk-type telephone fixed to a large semi-circular shelf. The Vistabooth, designed by D. H. King of the Station Apparatus Development Department, combines privacy and visibility and would be used in weather-protected areas like a railway concourse or a large lobby.

The new Vistabooth with the door open. Door is arranged to rotate to open or closed position.

H. Basseches, left, and R. W. Berry examine an experimental circuit sputtered onto a standard glass microscope slide. The T-shaped glass apparatus in background is the evacuated sputtering chamber.

METAL SPUTTERING

A Promising New Technique for Printed Circuitry

Recent research at Bell Laboratories in the field of cathode-metal sputtering indicates that this century-old technique may be useful in producing precision printed circuits. Entire circuits, including resistors, capacitors, and leads, may be laid down by this technique. In the metal-sputtering method, ionized molecules of gas bombard a cathode, dislodging atoms of metal which then deposit on the printed-wiring medium (generally glass or ceramics).

H. Basseches of the Solid-State Device Development Department has produced thin films of a number of high melting-point metals that are electrically interesting. Tantalum and titanium, for example, which melt at 3,000°C and 1,670°C respectively, can be laid down in films that have a resistivity high enough to be useful as resistors in printed circuits. By using the proper masking techniques, Mr. Basseches has sputtered lines and patterns of practically any desired shape and size, down to a few mils wide. The sputtered films are generally between a few hundred and a few thousand angstroms thick. In addition to pure metals, alloys such as nickel-copper and nickel-chromium can be sputtered.

R. W. Berry, of the same department, has produced "printed capacitors" by a combination of sputtering and chemical methods. A tantalum film of the proper shape and size is sputtered onto glass or ceramic and then anodically oxidized to form a dielectric film of tantalum oxide. The counter electrode, a film of gold, can then be evaporated onto the dielectric to form the capacitor "sandwich."

Copper leads, which are also sputtered on the "wiring board," connect the various components. The technique is attractive because it eliminates the present need for organic adhesives to hold the metal to the board.

In cathode sputtering, a plate of the metal to be deposited is used as a cathode. The medium on which the film is to be deposited is placed close to the cathode. After the sputtering chamber is evacuated, a suitable gas such as argon is introduced and a pressure of approximately 20 to 40 microns maintained. When a voltage is applied, ionized atoms of the gas bombard the cathode, dislodging metal atoms or clusters of atoms, which are then deposited.

In reactive sputtering, the introduction of a small, controlled amount of a reactive gas such as oxygen, nitrogen, or hydrogen sulfide into the apparatus produces films of inorganic compounds. Compounds which can be formed in this way include the oxides, nitrides, and sulfides of a number of metals.

The metal-sputtering effect — first noted in 1852 by W. R. Grove and in 1858 by J. Plücker — is a very convenient laboratory method for the production of thin films of high melting-point metals. In general, films produced by sputtering are strongly adherent. The sputtering technique also enables the thickness of the films to be controlled within close tolerances.

Bell System Aids in Supporting New TV Course in Physics

The Bell System is joining other leading corporations in giving financial support to a new college course in physics which is being televised coast to coast. This support is given in recognition of the increasing importance of science to the educated citizen.

The A.T.&T. Co.'s Long Lines Department, the Western Electric Co., and the Bell Operating Companies are all providing financial assistance. Dr. M. J. Kelly helped make arrangements for the course, and A. N. Holden of the Physical Research Department helped plan the course curriculum.

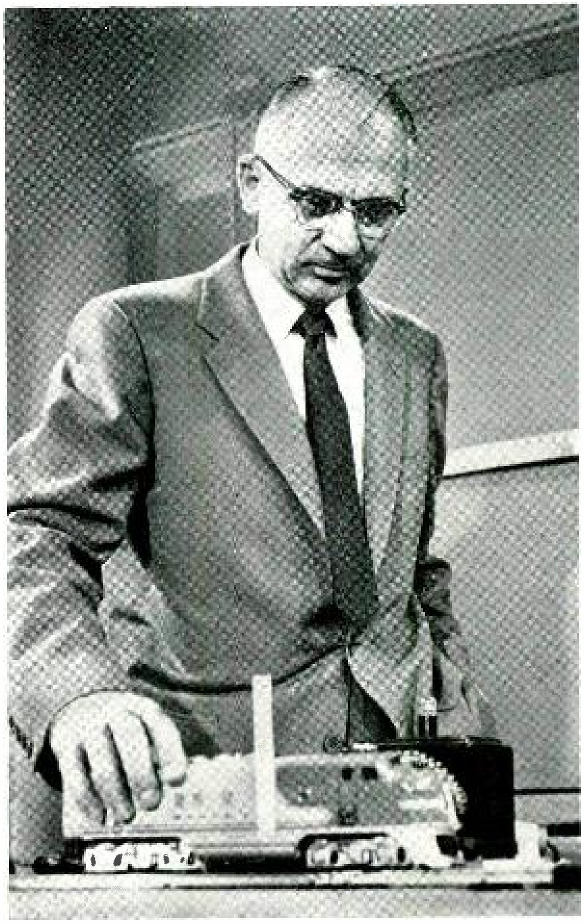
The 32-week course — "Continental Classroom" — is designed to improve science education in America's schools and to promote an adequate supply of scientists in the future. Continental Classroom will provide its students — primarily high-school science teachers — with up-to-date information concerning recent developments in physics, and with the background in the fundamentals of physics necessary to understanding these developments.

The new course started October 6 and is being telecast Monday through Friday from 6:30 to 7 a.m. in each time zone, over the National Broadcasting Company network. This marks the first time that a college course has been televised on a nationwide basis.

More than 300 colleges and universities across the country are planning to carry the course for credit. Co-sponsors with NBC are the American Association of Colleges for Teacher Education, the Fund for the Advancement of Education, and the Ford Foundation.

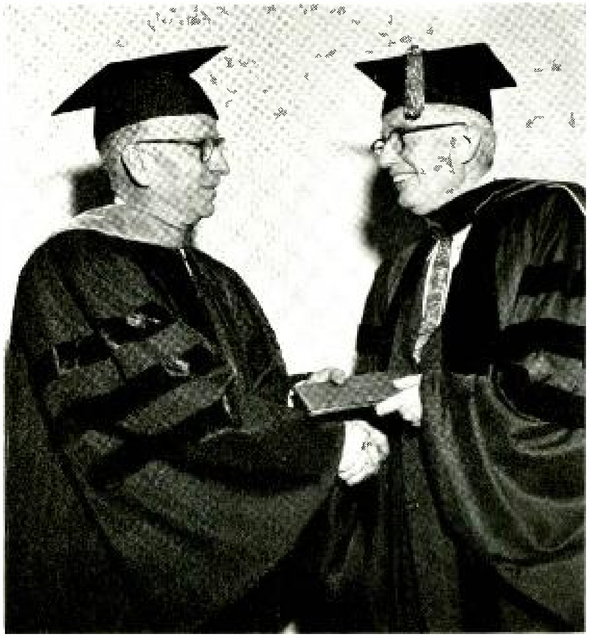
The principal instructor is Dr. Harvey E. White, Professor and Vice Chairman of the Department of Physics at the University of California in Berkeley. Other internationally known scientists, some of them members of the Laboratories staff, will participate from time to time.

During the first semester, "Continental Classroom" will cover aspects of physics that underlie atomic and nuclear physics — kinematics, light, dynamics, electricity and magnetism. In the second semester, emphasis will be on nuclear and atomic physics. Demonstrations and experiments will be an integral part of the course. The television presentation will be supplemented by periodic tests, reading assignments, problem-solving and other out-of-class activities.



Dr. H. E. White, principal instructor for "Continental Classroom," using a toy electric train in the conduct of an experiment designed to illustrate the physical law for uniform or constant velocity.

M. J. Kelly, J. B. Fisk Awarded Honorary Doctorate Degrees



M. J. Kelly, left, receiving honorary doctorate degree from C. B. Hilberry, President, Wayne State University, on occasion of the University's College of Engineering twenty-fifth anniversary.

Dr. M. J. Kelly and Dr. J. B. Fisk, Executive Vice President of the Laboratories, have recently been awarded honorary doctorate degrees — Dr. Kelly from Wayne State University and Dr. Fisk from Williams College.

The honorary Doctor of Engineering degree was awarded to Dr. Kelly in Detroit on October 17, and the presentation took place at a two-day celebration of the twenty-fifth anniversary of Wayne State University's College of Engineering. The citation accompanying Dr. Kelly's degree said, in part: "Under his guidance, creative research by individuals and teams has achieved new support through broadened public understanding; interpretations of future programs have made possible their development; educational curricula have been reshaped for the more adequate training of our scientists who are now more clearly visualized in their role in our society."

The award to Dr. Fisk was an honorary Doctor of Science degree presented on October 4 at the Williams College Fall Convocation. Dr. Fisk was cited as "a gifted physicist who served Harvard as professor and the Atomic Energy Commission as director of research before being called to the vice-presidency of the world's greatest industrial laboratory. Now deputy chairman of President Eisenhower's Science Advisory Committee. Chairman of the Western Experts at the recent Geneva conference to study the possibility of detecting violations of a possible agreement on the suspension of nuclear tests. A negotiator endowed with great firmness, tact and skill." Similarly honored at the same ceremonies were I. I. Rabi, Professor of Physics at Columbia University, G. B. Kistiakowsky, Professor of Chemistry at Harvard University, and D. E. Richmond, Professor of Mathematics at Williams College.

J. B. Fisk, second from right, with J. P. Baxter 3rd, President of Williams College, center, and other recipients of honorary degrees, G. B. Kistiakowsky, left, I. I. Rabi, and D. E. Richmond, right.

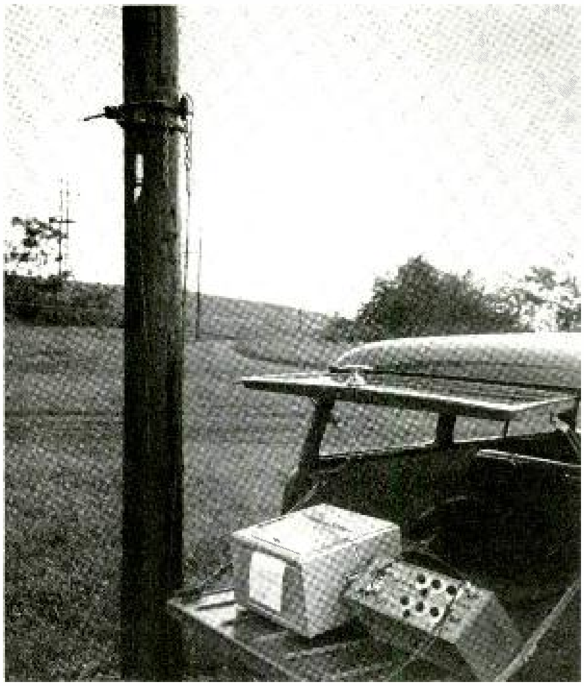
MEASURING VIBRATION ON TELEPHONE POLES

In the design of outside-plant facilities for the telephone system there has been an increasing tendency to mount a variety of apparatus on telephone poles. This situation directs the designer to consider the external effects that may be encountered by pole-mounted apparatus. In view of this, the Outside Plant Development Department of the Laboratories has conducted a series of vibration measurements on telephone poles to determine the magnitude of the shock and vibration to which new electronic equipment might be subjected when pole-mounted. These data are of particular interest where sensitive relays may be used in the equipment.

Because magnetic pick-ups are sensitive to low-frequency vibrations, they can furnish a signal to record pole motion. These devices, consisting basically of a coil and a movable magnetic slug, generate a signal proportional to the velocity at which they are vibrated. Since the pole motion can be considered to be a composite of sinusoidal elements, the output signal of the pick-up is calibrated directly in terms of deflection. This signal is fed through a dc amplifier and is recorded on a pen recorder.

In preliminary tests, outside plant engineers mounted two pick-ups — one sensitive to vertical vibrations, the other to horizontal — at right angles to each other. After the vertical and horizontal amplitudes were determined to be essentially equal, measurements were made with the pick-ups adjusted to measure only vertical vibrations. The pick-ups were mounted at several locations around the circumference and along the length of the pole.

The engineers made measurements on poles placed near major highways at locations where rough payment would offer severe ground disturbances from passing traffic. They also chose other test locations close to railroad tracks where freight, commuter and long-haul passenger trains passed at full speed. Particular emphasis was placed on determining whether the conditions encountered at any location would ever exceed those values that could cause faulty operation of the relays. Furthermore, the engineers were looking for the best location on the pole to mount electronic equipment.



Signals from pole-mounted magnetic pick-ups furnish data for "in the field" vibration studies.

Amplitudes of pole motion as large as 0.003 inch peak-to-peak were measured on poles near highways when large trailer trucks passed over pavement breaks. Only negligible motion, however, was found to result from automobile traffic. Amplitudes as high as 0.012 inch were measured near railroad tracks; these were caused by diesel commuter trains. In all cases the data indicated that the predominant frequencies were in the range of from ten to forty cycles per second.

Vibrations as severe as those measured are not likely to cause faulty operation of sensitive relays in pole-mounted equipment. In fact, relays similar to those which might be used withstood two to three times the measured maximum pole vibration and still operated reliably.

Measurements of vibrations around the circumference of a pole showed no variation in magnitude or frequency. Also, longitudinal and transverse vibrations were approximately equal in magnitude and frequency at all points on the pole. However, minimum amplitudes of vibration were recorded within four feet of the cable suspension hardware, and were found to be approximately half those further down the pole. This area, then, provides the "quietest" location for pole-mounted equipment that is sensitive to vibration.

N. O. AAMODT
Outside Plant Development

F. R. Kappel Stresses Common Goals in Talk to Telephone Pioneers

The personal progress and welfare of every telephone man and woman are directly tied up with the progress and success of the business, A.T.&T. President Frederick R. Kappel told the 33rd General Assembly Meeting of the Telephone Pioneers of America in Chicago last month. Success of the business in turn depends on all of us who are working at it.

Telephone people are individuals, with a wide variety of interests, activities and personal goals, Mr. Kappel pointed out, but "in our working lives, we have a tremendous amount in common. We share a lot of important ideas." He enumerated six:

- "We know what our job is: to give good communication service to the public. This is the responsibility we all share.
- "We know our service is tremendously important to individuals, industry, defense and the whole economy.
- "The better and more valuable we make our service, the more people will want it, and the more jobs and opportunity there will be for the men and women in the business.
- "To give good and improving service we need reasonable freedom. The business as a whole needs a fair chance to show what it can do, in the same way that individuals need a fair chance to show what they can do.
- "The success of the business depends on all of us who are working at it.
- "The personal progress and welfare of each one of us are directly tied up with the progress and success of the business.

"These fundamentals are pretty good bench marks to help us judge the meaning of events and the worth of various ideas both in and out of our business.

"Take, for example," he said, "the very simple point that the more value we build into our service the more salable it becomes, and the more jobs and opportunity the business can offer. Suppose that in all the years since the war, we had made no effort to improve our service. Today it would have fewer capabilities, it would be less attractive and it would cost more. It would be harder to sell in good times and much harder to sell in a time of recession. So I feel sure that the improvements we have made in past years are largely responsible for our being able to continue to sell more service today. Needless to say, this has helped to keep many more jobs filled than would otherwise be possible."

Taking up another of these common ideas, Mr. Kappel said that "we *do* depend on the business and the business *does* depend on us. If we fall short of our best, the business will fall short too. And if the business falls short, the public will surely and quickly find that we have failed them."

After discussing the desire to solve mutual problems and the need for unity, Mr. Kappel turned to one of our serious problems: the relationship between business and government.

"The kind of government we have very largely determines the kind of business we have. Government can help to provide a good working climate — the kind that stimulates and encourages progress — or it can set conditions that penalize success, discourage initiative and sap the strength and energy of business organizations."

Government can penalize business, he explained, by driving down earnings, perpetuating bad taxes like the telephone excise tax, interfering excessively in business operations, by making political capital out of attacks on big business, and by contributing to inflation.

"Inflation is nourished by government spending and by wage increases which add to the cost of countless products and services," Mr. Kappel said. "Yet many individuals and groups today continue to promote so-called legislative programs which promise all things to all men. However, these same programs do not at all make clear on what basis everything that is promised will be paid for. In my own opinion, they would intensify inflation, foster 'boom and bust' psychology and work a wrong on everyone.

"To achieve unity and make the most progress," he continued, "we have to work hard for answers that will serve the common interests. As telephone people *and* as citizens, we have to test our thinking in some very basic ways.

"For example, as to any political plan or program, regardless of who proposes it, I think we need to ask: Will it benefit the whole community — or just some people at the expense of others? Is it good for the long run — or will it pile up more trouble later on? Is it sincere — or just smart politics?

"How each of us answers questions like these is his affair and his alone. But I think it is vital that each of us should ask them, try to think them through, and come to the answer that best satisfies his reason and his conscience.

"Under our free enterprise system," Mr. Kappel concluded, "we have pioneered the best telephone service in the world, and this the whole world knows. The challenge now before us is to make this best even better — and to let nothing diminish our ability to do so. We have markets to serve which I am certain will continue to grow. The horizon is boundless. But to maintain our full freedom to serve — to realize all the wonderful opportunities ahead — one thing is essential. We must work together."

NEWS BRIEFS:

Dr. Kelly Appointed to Post on New York City Health Research Council

Dr. M. J. Kelly has recently been appointed a member of the New York City Health Research Council. The 47-member Council includes leaders in the fields of science, medicine, health, education and business.

The new municipal agency was formed by Mayor Robert F. Wagner to sponsor public and private research on medical problems. Programs will be administered by a new Office of Health Research in the Health Department.

Laboratories Announces Magnetically Regulated High-Voltage DC Supply

A magnetically regulated, dc power supply was described at the National Electronics Conference last month in a paper by W. J. McDaniel and T. L. Tanner of the Military Apparatus Development Department. The new unit can supply 2,300 volts at 15 to 50 milliamperes with 0.25 per cent regulation.

An outstanding feature of the power supply is the isolation of the control circuit and output-sensing circuit from the high-voltage output. These elements are isolated by placing the control-element — a self-saturating magnetic amplifier — on the low-voltage input side of the regulated supply and by adding an auxiliary winding to the magnetic amplifier for output sensing.

Silicon rectifiers in both the high-voltage output circuit and in the voltage-reference circuit assure reliability and ruggedness of the units. A conventional voltage doubler serves as the high-voltage rectifier, and there is enough capacitance in the output filter to reduce the maximum voltage ripple (RMS) to 0.5 per cent at 50 milliamperes. The reference voltage is provided by six 6-volt Zener diodes connected in a bridge circuit.

Nominal input to the power supply is 115 volts at 400 cycles. The output voltage can be maintained at the desired accuracy with variations in line voltage from 105 to 130 volts, with load current changes of 15 to 50 milliamperes, and over an ambient temperature range of −40° C to + 85° C. The circuit can be regulated to ± 0.1 per cent over a restricted temperature range with added refinements. Measured efficiency at full load is 82 per cent. The step-up transformer and the high-voltage capacitors are oil-filled, and the magnetic amplifier is cast in silica-filled epoxy resin for environmental protection.

C. C. Lawson Elected To Serve As Director Of Wire Association

C. C. Lawson of the Outside Plant Development Department has been elected a Director of the Wire Association. Mr. Lawson has been active in the affairs of the Association for many years, most recently as Program Chairman for the Electric Wire and Cable Section Meeting in Atlantic City last month. He will serve on the Board of Directors for a three-year period that began on October 13.

Laboratories People Active in N. Y. A.I.E.E. During 1958-59 Year

A number of Laboratories engineers will serve the New York Section of the American Institute of Electrical Engineers in official capacities for the year 1958-59.

W. T. Rea is Chairman of the Section. In the Communications Division, R. S. Skinner is Vice Chairman and Publicity Coordinator, W. O. Arnold is Past Chairman, C. H. Dagnall, Jr., is Secretary-Treasurer, and C. J. Vincent is Chairman of the Related Activities Committee.

In the New Jersey Division, P. T. Sproul is Treasurer, and M. G. Davis is Chairman of the Program Committee.

Contents of the September, 1958, Bell System Technical Journal

The September, 1958 BELL SYSTEM TECHNICAL JOURNAL contains the following articles:

The First Ten Years of the Transistor, by W. O. Baker.

An Experimental Switching System Using New Electronic Techniques, by A. E. Joel, Jr.

Semiconductor Circuit Design Philosophy for the Central Control of an Electronic Switching System, by B. J. Yokelson, W. B. Cagle and M. D. Underwood.

Fundamental Concepts in the Design of the Flying Spot Store, by C. W. Hoover, Jr., R. E. Staehler and R. W. Ketchledge.

A High-Speed Barrier Grid Store, by T. S. Greenwood and R. E. Staehler.

Linear Least-Squares Smoothing and Prediction with Applications, by Sidney Darlington.

Automatic Number Identification and its Application to No. 1 Crossbar Panel and Step-by-Step Offices, by D. H. Pennoyer.

TALKS

Following is a list of speakers, titles, and places of presentation for recent talks presented by members of Bell Laboratories.

AMERICAN CHEMICAL SOCIETY MEETING, Chicago, Illinois.

Anderson, O. L., *Adhesion of Metals in Air at Room Temperature.*

Becker, J. A., *Some Adsorption Properties of* C_2H_2, C_2H_4, C_2H_6, *on Single Crystal Planes of Clean Tungsten.*

Frisch, H. L., *Recent Developments in the Kinetics of Phase Transformations in Solids.*

Fuller, C. S., *Interactions Between Solutes in Germanium and Silicon Single Crystals.*

Geller, S., and Wernick, J. H., *Ternary Semiconducting Compounds and Sodium Chloride-Like Structure.*

Geller, S., see Gilleo, M. A.

Gilleo, M. A., and Geller, S., *The Magnetic Properties and Crystal Chemistry of Garnet-Structure Compounds.*

Hrostowski, H. J., *Electronic Spectra of Impurities in Silicon.*

Knox, K., *The Structure of* K_2CuF_4. *A New Kind of Distortion for Octahedral Copper (II).*

Kuebler, N. A., see Nelson, L. S.

Lowry, W. K., *Philosophical Aspects of Information—Group Operations.*

Luke, C. L., *Photometric Determination of Traces of Selenium or Tellurium in Lead or Copper.*

Lundberg, J. L., and Nelson, L. S., *Heterogeneous Flash Initiation of Thermal Reactions,* (Presented by L. S. Nelson).

Nelson, L. S., see Lundberg, J. L.

Nelson, L. S., and Kuebler, N. A., *Flash Pyrolysis Products from Polyethylene Which Contains Small Black-Body Particles.*

Reiss, H., *Influence of Solutes on Self-Diffusion in Solids.*

Smith, H. A. (Univ. of Tenn.), and Thomas, C. O., *The Separation of Mixtures of Ordinary and Heavy Water by Zone Refining.*

Thomas, C. O., and Baker, B. B. (E. I. du Pont, Inc.), *The Detection and Estimation of Air-borne Proteins by Pyrolysis to Hydrogen Cyanide.*

Thomas, C. O., and Smith, H. A. (Univ. of Tenn.), *An Investigation of Techniques for the Separation of Hydrogen and Deuterium by Gas Chromatography.*

Thomas, D. G., *The Chemistry and Semiconductivity of Zinc Oxide.*

Wernick, J. H., see Geller, S.

NATIONAL RESEARCH COUNCIL, CONFERENCE ON NON-CRYSTALLINE SOLIDS, Alfred University, Alfred, N. Y.

Anderson, O. L. and Dunes, G. J. (Brookhaven), *The Anomalous Properties of Vitreous Silica.*

Frisch, H. L., see Lax, M.

Lax, M., and Frisch, H. L., *Electronic Band Structure of One-Dimensional Disordered Arrays,* (Presented by Frisch, H. L.).

Slichter, W. P., *Magnetic Resonance Studies of Glasses.*

4th NATIONAL CONFERENCE ON TUBE TECHNIQUES, N. Y. C.

Craft, W. H., see Feder, D. O.

Craft, W. H., see Thomas, C. O.

Feder, D. O., and Craft, W. H., *Applications of the Atomizer Test to Electron Device Processing Problems.*

Frost, H. B., *New Methods for the Measurement of Cathode Interface Impedance.*

Pondy, P. R., *A High Temperature Ceramic—Metal Seal Made with Low Vapor Pressure Materials.*

Robinson, H. J., *Recent Developments of the Refractory Matrix Cathode.*

Thomas, C. O., and Craft, W. H., *Design and Maintenance of Systems for the Production and Utilization of Ultra Pure Water for Electron Device Processing.*

Whitcomb, D. L., *Cathode Temperature Measurements by Infrared Photography.*

White, A. D., *A Subminiature Metal—Ceramic Gas Tube.*

OTHER TALKS

Ahearn, A. J., *Mass Spectroscopy of Solids,* Michigan State University, East Lansing, Michigan, and Detroit Section, Optical Society, Detroit Michigan.

Anderson, O. L., *Adhesion of Metals in Air,* Milwaukee Section, A.S.M.E., Milwaukee, Wisconsin.

Blecher, F. H., *Recent Advances in High Frequency Circuit Design Through the Use of Diffused Types of Transistors,* Chicago Section, I.R.E., Chicago, Ill.

Darlington, Sidney, *Rockets to the Moon,* New York Chapter, Am. Rocket Soc., N. Y. C.

Doucette, E. I., *Factors Affecting the Formation of Deposited Carbon Film Resistors,* WESCON Convention, Los Angeles, Calif.

Ellis, W. C., Gibbons, D. F., and Treuting, R. G., *Growth of Metal Whiskers from the Solid*, International Conference on Crystal Growth, Cooperstown, N. Y.

Galt, J. K., see Kunzler, J. E.

Garrett, C. G. B., *Semiconductor Surfaces*, Physics Dept., Western Reserve University, Cleveland, Ohio.

Garrett, C. G. B., *Organic Semiconductors*, Cleveland Physical Society, Cleveland, Ohio.

Geils, J. W., *Research and Development in Industry Today*, Newark College of Engineering, Newark, N. J.

Gibbons, D. F., see Ellis, W. C.

Hagstrum, H. D., *Auger Ejection of Electrons from Silicon*, General Electric Laboratories, Schenectady, N. Y.

Kunzler, J. E., and Galt, J. K., *The Study of Spin Wave Energy State Occupation in Certain Ferrimagnetic Materials by Adiabatic Demagnetization Methods*, Colorimetry Conference, Chicago, Ill.

Margolis, D. P., *Heat Transfer and Vibration in Swirling Turbulent Flow*, University of California, Berkeley, Calif.

Mason, W. P., *Use of Internal Friction Regiments in Determining Dislocation, Motions, Fatigue and Fracture in Solids*, Rias Research Organization, Glen Martin Company, Baltimore, Md.

Myers, G. H., *Application of Servomechanism to Human Organ Systems*, Rockefeller Institute for Medical Research, Conference on Artificial Pacemakers and Cardiac Prosthesis, New York City.

Newhouse, R. C., *The Lunar Probe—A Review of the Problems in Propulsion and Guidance*, Fall Symposium Headquarters Engineering Group, Western Electric Co., Winston-Salem, N. C.

Pearson, G. L., *Imperfections in Crystalline Solids*, Stanford University, Stanford, Calif.

Sellers, G. A., Jr., *Digital Computers and Their Application in Weapons Systems*, Naval Reserve Composite Company 3-6, Chatham, N. J.

Treuting, R. G., see Ellis, W. C.

Winslow, F. H., *Carbonization of Synthetic Polymers*, Coal Technology, Pittsburgh Section, American Chemical Society, Pittsburgh, Pa.

Wolfe, R., *Determination of the Basic Properties of Thermoelectric Semiconductors*, Conference on Thermoelectricity, Washington, D. C.

PAPERS

Following is a list of the authors, titles, and places of publication of recent papers published by members of the Laboratories.

Anderson, E. W. and McCall, D. W., *Dielectric Constant and Loss of Polypropylene*, J. Polymer Science, Letter to the Editor, 31, pp. 241-242, August, 1958.

Batdorf, R. L., see Smits, F. M.

Chisholm, D. A., see Quate, C. F.

Doleiden, F. H., see Fuller, C. S.

Early, J. M., see Warner, R. M.

Fuller, C. S., and Doleiden, F. H., *Interaction Between Oxygen and Acceptor Elements in Si.*, J. Appl. Phys., Letter to the Editor, 29, pp. 1264-1265, August, 1958.

Fuller, C. S., and Whelan, J. M., *Diffusion, Solubility, and Electrical Behavior of Copper in Gallium Arsenide*, J. Phys. & Chem. of Solids, 6, pp. 173-177, August, 1958.

Gordon, J. P., and White, L. D., *Noise in Maser Amplifiers Theory and Experiment*, Proc. I.R.E., 46, pp. 1588-1594, Sept., 1958.

Herriott, D. R., *Polyhedral Satellite for More Accurate Measurement of Orbit Data of Earth Satellites*, J. Opt. Soc. Am., 48, pp. 667-668, Sept., 1958.

Kompfner, R., see Quate, C. F.

Loman, G. T., see Warner, R. M.

McCall, D. W., see Anderson, E. W.

Miller, R. C., see Smits, F. M.

Miller, R. C., *Some Experiments on the Sidewise Motion of 180° Domain Walls in BaTiO$_3$*, Phys. Rev., 111, pp. 736-739, August 1, 1958.

Pierce, J. R., *Innovation in Technology*, Scientific Am., 199, pp. 117-130, Sept., 1958.

Quate, C. F., Kompfner, R., and Chisholm, D. A., *The Reflex Klystron as a Negative Resistance Type Amplifier*, I.R.E. Prof. Gr. on Electron Devices, ED-5, pp. 173-179, July, 1958.

Rider, D. K., *Foil Clad Laminated in Printed Circuitry*, Metal Progress, 74, pp. 81-85, Sept., 1958.

Smits, F. M., Miller, R. C., and Batdorf, R. L., “Surface Effects on the Diffusion of Impurities in Semiconductors,” *Halbleiter und Phosphore*, F. Vieweg und Sohn, Braunschweig, Germany, pp. 329-337, 1958.

Warner, R. M., Early, J. M., and Loman, G. T., *Characteristics, Structure, and Performance of a Diffused-Base Germanium Oscillator Transistor*, I.R.E. Prof. Gr. on Electron Devices, ED-5, pp. 127-130, July, 1958.

Whelan, J. M., see Fuller, C. S.

White, L. D., see Gordon, J. P.

PATENTS

Following is a list of the inventors, titles and patent numbers of patents recently issued to members of the Laboratories.

Abbott, H. H. — *Magnetic Core Circuits* — 2,849,539.

Breed, R. N., Cesareo, O., Germanton, C. E., Roberts, R. W., Weber, L. A., and Wingardner, C. A. — *Call Data Recording Telephone System* — 2,848,543.

Cesareo, O., see Breed, R. N.

Crofutt, G. B., Jr., and Fisk, J. B. — *Party Line Station Identifying Impulse Transmitter* — 2,846,512.

Dubuar, A. S. — *Pulse Repeating with Automatic Compensation for High and Low Resistance Loops* — 2,846,509.

Dunlap, K. S. — *Magnetic Core Circuits* — 2,846,668.

Eglin, J. M. — *Composite Conductor* — 2,849,693.

Eglin, J. M. — *Reduction of Quadrature Distortion* — 2,849,537.

Favin, D. L. — *Synchronized Automatic Frequency Control System* — 2,847,572.

Fisher, J. R. — *Method for Making Ceramic Articles* — 2,847,314.

Fisk, J. B., see Crofutt, G. B.

Fox, A. G. — *Dielectric Guide for Electromagnetic Waves* — 2,849,693.

Germanton, C. E., see Breed, R. N.

Goehner, W. R. and Taris, C. M. — *Means for Erasing a Magnetic Record* — 2,846,518.

Goodall, W. M. — *Traveling Wave Amplifier* — 2,849,642.

Hamilton, J. O. and Laico, J. P. — *Reflex Klystron* — 2,847,609.

Harkless, E. T. — *Directional Coupler* — 2,848,691.

Hines, M. E. — *Electron Discharge Devices* — 2,849,644.

Holden, W. H. T., and Vroom, E. — *Stage-by-Stage All-Relay Telephone Switching System Using Voice Frequency Control* — 2,847,508.

Hussey, L. W. — *Transistor Gating Circuit* — 2,848,653.

Jurgens, W. C., and Seifert, J. A. — *Mechanical Interlock for Cabinet-Housed Apparatus-Mounting Frameworks* — 2,848,293.

Keith, C. R., Nickerson, C. A. and Taris, C. M. — *Automatic Telephone Answering System* — 2,846,505.

Klapp, C. D. — *Monostable Circuit* — 2,849,626.

Kock, W. E. — *Directional Filter* — 2,849,689.

Laico, J. P., see Hamilton, J. O.

Landgren, C. R. — *Etching Processes and Solutions* — 2,847,287.

Lewis, W. D. — *Directive Antennas* — 2,846,680.

Marino, F. C. — *Diode Test Set* — 2,847,646.

Mattingly, R. L. — *Compartmental Antenna with Hybrid Feed* — 2,848,716.

Mikulyak, R. M. — *Stereophonic Sound Transmission System* — 2,846,504.

Miller, S. E. — *High Frequency Selective Mode Transducers* — 2,848,690.

Miller, S. E. — *Non-Reciprocal Wave Transmission* — 2,849,683.

Miller, S. E. — *Non-Reciprocal Wave Transmission* — 2,849,684.

Miller, S. E. — *Non-Reciprocal Wave Transmission* — 2,849,687.

Miller, S. E. — Electromagnetic *Wave Transmission* — 2,848,696.

Mitchell, D. — *Radiant Energy Signaling System* — 2,848,545.

Moore, E. P., and Trent, R. L. — *Potential Monitoring Circuit* — 2,846,526.

Nickerson, C. A., see Keith, C. R.

Obst, C. V. — *Terminal Strip* — 2,848,704.

Pierce, J. R. — *Electromagnetic Wave Transmission* — 2,848,695.

Pierce, J. R. — *Magnetic Focusing System* — 2,847,607.

Pierce, J. R. — *Bifilar Helix Coupling Connections* — 2,846,613.

Quate, C. F., and Sullivan, J. W. — *High Frequency Apparatus* — 2,849,650.

Remeika, J. P. — *Method of Making Single Crystal Ferrites* — 2,848,310.

Ring, D. H. — *Antenna Coupling Circuits* — 2,848,714.

Roberts, R. W., see Breed, R. N.

Robertson, G. H. — *Traveling Wave Tubes* — 2,849,651.

Ruthroff, C. L. — *Amplitude Modulation Limiting Circuit* — 2,848,609.

Sandalls, G., Jr., Vibbard, E. L., and Wichman, W. T. — *Pay Station Telephone System* — 2,846,507.

Seifert, J. A., see Jurgens, W. C.

Sullivan, J. W., see Quate, C. F.

Taris, C. M., see Goehner, W. R.

Taris, C. M., see Keith, C. R.

Thomas, D. E. — *Null-Type Transistor Alpha Measuring Set* — 2,847,645.

Trent, R. L., see Moore, E. P.

Turner, E. H. — *Ferromagnetic Devices* — 2,849,686.

Vibbard, E. L., see Sandalls, G., Jr.

Vroom, E., see Holden, W. H. T.

Weber, L. A., see Breed, R. N.

Weiss, M. T. — *Non-Reciprocal Multibranch Wave Guide Component* — 2,849,685.

Wichman, W. T., see Sandalls, G.

Wingardner, C. A., see Breed, R. N.

THE AUTHORS

H. D. Irvin, a native of Jacksonville, Florida, joined the Laboratories in 1956 after receiving a B.S. degree in physics from the University of North Carolina. From 1947 to 1952, he was with the Research Division of American Enka Corporation, working on problems of instrumentation in studies of the physics of cellulose fibers. From 1952 to 1956, he was Chief Engineer of Radio Station WUNC at Chapel Hill, N. C. He was also a consultant in instrumentation to medical research and psychological testing laboratories. Since coming to Bell Laboratories, he has been concerned with problems of simulation in the human factors studies of new communication services and devices in the Human Factors Engineering department. He is a member of Phi Beta Kappa, and a senior member of the I.R.E. Mr. Irvin is the author of the article, "Studying Tomorrow's Communications . . . Today," in this issue.

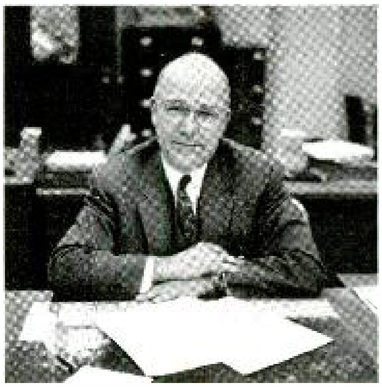

H. D. Irvin

A. Busala, a native of Rome, Italy, received a Dr. in E.E. degree from the University of Rome in 1945. After working at the S. A. Savigliano in Turin, where he was engaged in the design of electrical machinery, he came to the United States in 1948 as a participant in the Foreign Student Summer Project at the Massachusetts Institute of Technology. In 1951 he received the M.S. degree in Physics from Catholic University and spent the next two years there doing research in nuclear physics and in ultrasonics. Mr. Busala joined the Station Development Department at Bell Laboratories in 1953. He has been concerned principally with the fundamental development of transistorized telephone sets, and is the author of "An Experimental Transistorized Telephone" in this issue. He is a member of Sigma Xi.


A. Busala


R. F. Ewald

R. F. Ewald, a resident of Massapequa, N. Y., joined Bell Laboratories in 1942 as a draftsman in the Research Department, and received the Bachelor of Mechanical Engineering degree in 1950 from the Polytechnic Institute of Brooklyn. At the Laboratories, he has worked in the Switching Research Department and in the Switching Apparatus Development Department, where he was concerned with projects associated with the card translator, the card coding tool, the NIKE missile system, the automatic number identification system and central-office timers. More recently, Mr. Ewald transferred to the Special Systems Engineering Department, where he is concerned with teletypewriter station engineering. He is a member of Pi Tau Sigma. Mr. Ewald is co-author of "Measuring Time in Central Offices," in this issue.

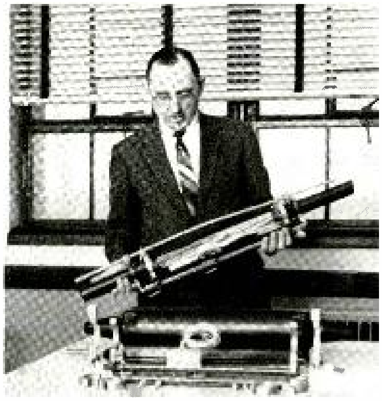

E. P. Williams

E. P. Williams, a resident of Maplewood, N. J., received the B.S. degree from the Worcester Polytechnic Institute and the M.E. degree from Cornell University. He joined the Western Electric Co. in 1923, and after transferring to the Laboratories was engaged in design work on step-by-

AUTHORS (CONTINUED)

step switching apparatus until 1932. Subsequently, Mr. Williams was concerned with various design problems of telephone ringers, panel-system apparatus, and timers, and during World War II was associated with the design of radar apparatus. Among his responsibilities since 1945, he has done additional design work on timers, and has been concerned with gyroscopes for military applications, crossbar-switch design and the analysis of wire-spring keys and connectors. At present he is in charge of a group engaged in apparatus design of various relays and the crossbar switch. He is a member of Sigma Alpha Epsilon and Tau Beta Pi. In this issue, he is co-author with R. F. Ewald of "Measuring Time in Central Offices."

P. P. Koliss, author of "A New 'Ready-Access' Distribution Terminal" in this issue, is a native of Grafton, Massachusetts. He received the B.S. and M.S. degrees in Electrical Engineering from Worcester Polytechnic Institute in 1938 and 1939 and then joined the Switching Apparatus Development Department at Bell Laboratories. During the war years, he designed apparatus for military applications. Mr. Koliss transferred to the terminal and protection apparatus group of the Outside Plant Development Department in 1949. In 1955, he was placed in charge of design for development-for-production of cords, terminals, and protection apparatus at the Point Breeze location of Bell Laboratories. He is a member of the A.I.E.E. and Sigma Xi.



P. P. Koliss

G. S. Bishop, whose home town is Elliott, Iowa, received a B.Sc. degree in Electrical Engineering from Iowa State College in 1942. He immediately joined the trial installation group at Bell Laboratories and was engaged in the production of trial models of radar systems. He entered the Marine Corps in 1943, and returned to the Switching Systems Development Department in 1946. Since then, he has taken part in the development of equipment for the No. 1, No. 4 and No. 5 crossbar systems. His current concern is the development of the "flying spot" storage element for an electronic switching system. Mr. Bishop wrote the article, "A New AMA Translator for No. 5 Crossbar," in this issue.

G. S. Bishop