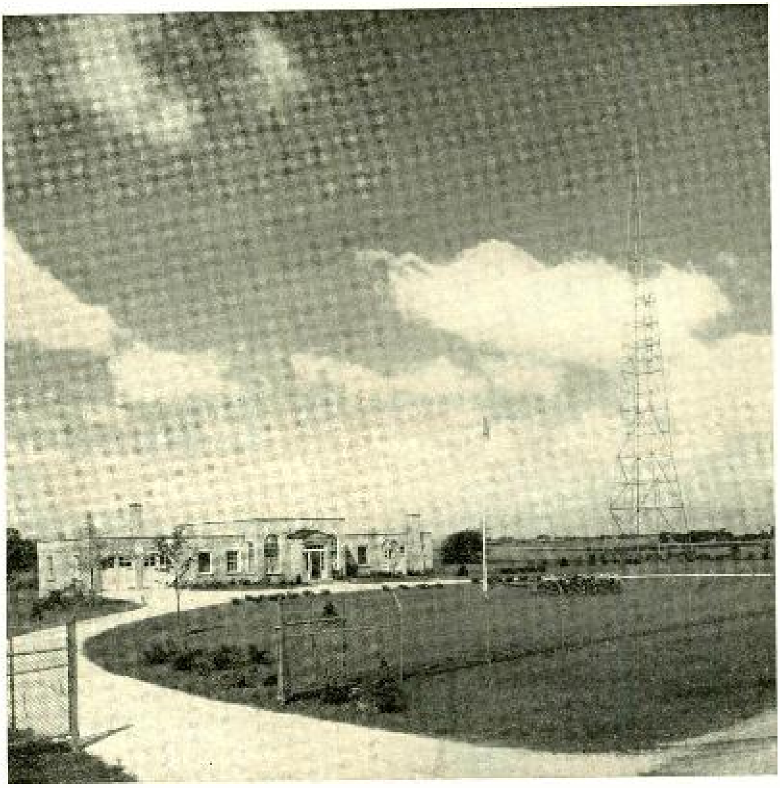
BELL LABORATORIES RECORD



Transmitting station and antenna of WMBI, owned and operated by the Moody Bible Institute of Chicago, and equipped with a five-kilowatt Western Electric transmitter

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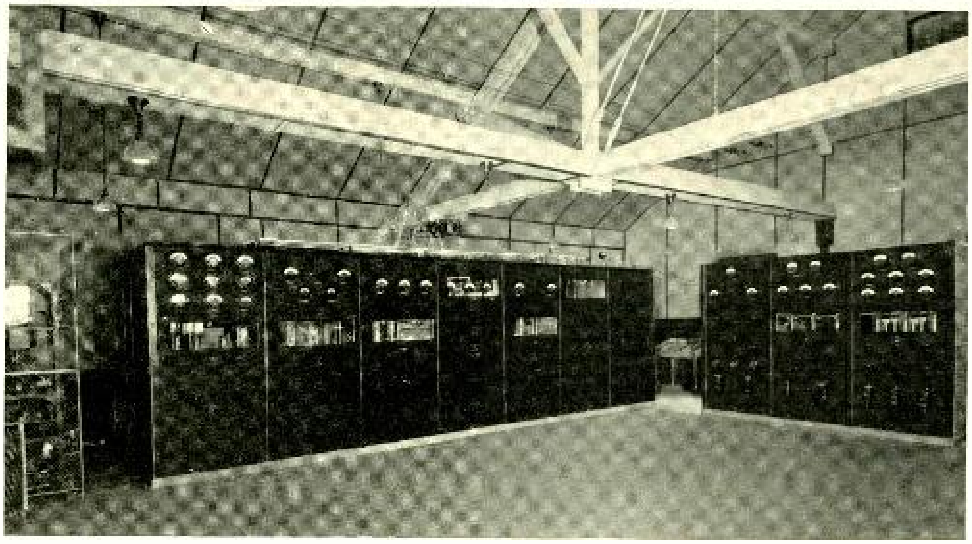

Improvements in Radio Broadcasting Transmitters

By A. W. KISHPAUGH
Radio Development

RADIO receivers, common and now almost necessary adjuncts of a modern residence, have been improved steadily since the early days of broadcasting. With the major trends of these improvements nearly everyone is familiar—at least in a general sort of way. With the broadcast transmitter, however, and with the betterments that have been made in it, there is perhaps no such widespread acquaintance. Transmitters are the "back-stage" of the radio theatre and very few have occasion to become familiar with them. That they also have been carried to greater perfection by the advancing sweep of popularity is perhaps more taken for granted than known as a definite fact.

The requirements for high quality reproduction are that the essential audible frequencies in the original sound be transmitted and reproduced without distortion and in their correct relative magnitudes. The human ear is so constructed that it hears as sound all frequencies from about 20 to nearly 20,000 cycles providing they are of proper intensity. This audible field, restricted both in frequency and intensity, is shown in Figure 1. As may be seen from this graph, tones of the same sound pressure are not equally audible over the whole frequency range. At both the upper and lower ends, sound must be of much greater pressure to be detected than in the central region. Satisfactory reproduction of most ordinary sounds does not require the transmission of this entire range of frequencies, though too much curtailment of it cannot be tolerated.

The performance of recent radio broadcasting transmitters and receivers is indicated in Figure 2 in comparison with the similar performance of earlier equipment. Here (1) is the audio frequency characteristic of the present Western Electric 50 kw broadcasting transmitter, (2) is that of the 500 watt transmitter of 1924, and (3) and (4) are characteristics of typical radio receivers of the present time and of 1926, respectively. Although there has been some change in the transmitter characteristics it is not marked, and receivers have not yet equalled the performance of the 1924 transmitter. It is evident that the faithfulness of reproduction still depends largely upon the performance of the receiver.

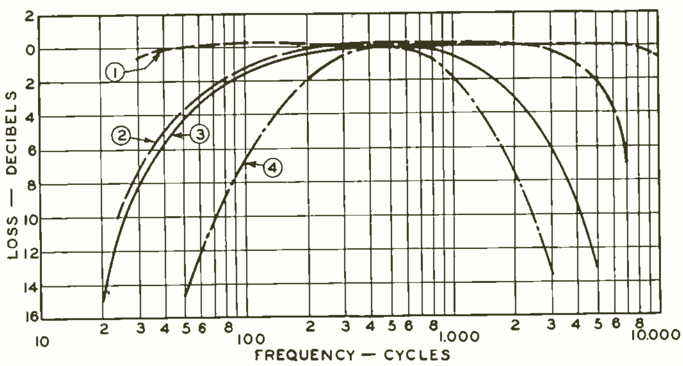

Fig. 2—*Overall characteristics of radio transmitters and receivers.* (1) *W. E.* 50 *kw transmitter,* (2) 500-*watt transmitter of* 1924, (3) *and* (4) *typical receivers*

Transmitter development has reached a stage where the apparatus may be designed to transmit almost any required range of frequencies. The limits are the available space in the ether and the economics of the situation. With broadcast receivers, the need for selectivity enters as an additional factor. The receiver must select between carriers separated by only 10,000 cycles, and it becomes more difficult to prevent interference between programs on adjacent channels as the receiver is made to pass a greater range of the higher audio frequencies. Since both sidebands are broadcast, voice frequencies above 5000 cycles begin to overlap those of the next assignment, so that 5000 cycles is the practical limit of reproduction to be hoped for under present conditions.

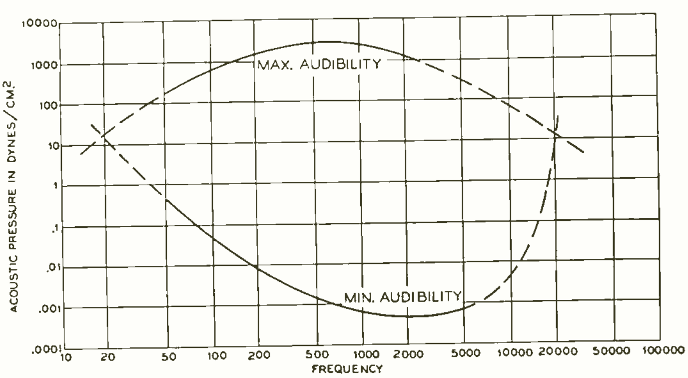

Fig. 1—*Ability to hear is limited both in frequency and intensity*

Although the modern transmitter, because of this fact, cannot effectively employ a much broader band of frequencies than was done some years ago, a considerable part of the evident improvement in reception during the past five years must, nevertheless, be credited to developments in the transmitting art. The benefits are reflected chiefly in the greater freedom from noise and interference now enjoyed in the reception of broadcast programs. Improvements in modern receivers have also done a great deal, but they alone could not have effected all that has been accomplished.

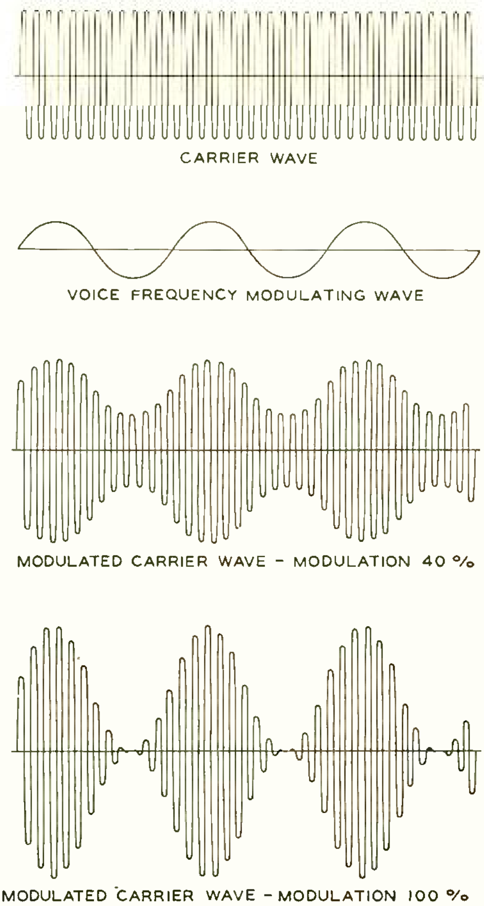

Fig. 3—Diagramatic representation of 40% and 100% modulation

Even though a program may be entirely satisfactory so far as range of reproduced frequencies is concerned, it may be very unsatisfactory because of noise in one form or another. The major achievement of the best modern transmitters, exemplified by the 50 kw Western Electric transmitter shown in the headpiece, is the reduction of the interference from disturbing noises. To a large extent this has been accomplished by increasing the output of the transmitter, by employing complete modulation, by the elimination of harmonics, and by accurate frequency control.

The use of greater power at the transmitter reduces the effect of noise, first because it increases the ratio of signal strength to stray noise level, and second because it requires less amplification at the receiver, and thereby eliminates noises which greater amplification would make audible. Although the radiation of more power is usually economically desirable because it increases the number of listeners, the overall reduction in noise in programs when the power of a station is augmented makes increased power desirable entirely regardless of the greater economy due to the larger number of listeners served.

Of possibly greater effectiveness in reducing noise than augmented capacity is the increased modulation obtained in the new Western Electric transmitters. The transmitted wave of a broadcast program is a carrier at a frequency between 550,000 and 1,500,000 cycles—varied in amplitude at voice frequency by the speech current. The amount the carrier current is increased and decreased by the voice current is defined as the degree of modulation. In the earlier sets, modulation was limited to about 40% and a carrier wave so modulated is shown in the center of Figure 3. The new 50 kilowatt Western Electric set, as well as the one and five, permits modulation to 100%—producing a modulated wave similar to that shown at the bottom of the illustration.

The effectiveness of increased modulation in reducing interference by noise is particularly great as a certain amount of the noise brought in by the receiver is "beat in" by the carrier. Any electrical disturbance whose frequency differs from the carrier by an audible amount will beat with it in the receiver to produce an audible signal or noise upon detection. This noise is proportional to the carrier power so that a minimum carrier to produce the desired useful signal entails minimum noise. For a given carrier power with 40% modulation the sideband power is less than one-quarter of what it is with 100% modulation. This means that the ratio of speech-to-noise level at the receiver is more than twice as great for 100% modulation as for 40%, and clearly indicates the importance of this feature of the modern transmitters.

Freedom from interference between broadcasting stations is as essential for good reception as freedom from noise, and improvement in this respect has not been lacking. Modern transmitters have contributed to this through very accurate control of the frequency of transmission. With broadcasting channels only 10,000 cycles apart it is essential that the carrier frequency be held very closely to its assigned value. If this is not done, there may be interference between adjacent channels, and noise and annoyance to those listening in will result. Such interference is of two types: either a beat note of a frequency equal to the difference between the two adjacent carriers, or cross-talk between the two programs. With a 1,000 and a 1,010 kilocycle carrier, for example, a two-tenths percent increase in the lower frequency and a similar decrease in the upper will produce a beat note of about 6000 cycles. Cross-talk may also occur with relatively small deviations in frequency. Federal regulations require the assigned carrier frequency to be maintained within 500 cycles. This is a variation of only five hundredths of one percent with a 1,000 kilocycle carrier, and not only is it difficult to maintain such constancy by manual adjustment, but it is difficult to measure and thus detect

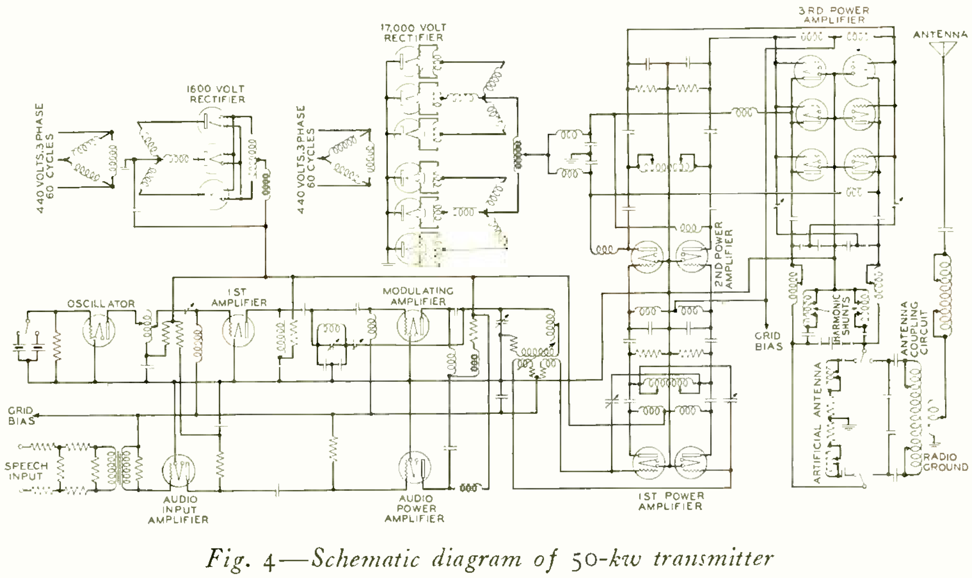

Fig. 4—Schematic diagram of 50-kw transmitter

such small deviations when they occur. The problem has been very satisfactorily met by the use of piezo-electric crystals to control the carrier frequency as has already been described in the RECORD.*

Another accomplishment that contributes to no small extent to the reduction of interference is the more complete elimination of radio-frequency harmonics. The greater use of the wavelengths shorter than the ordinary broadcast bands — i.e. below 200 meters — makes the harmonics of all the broadcast bands much more objectionable than they have been heretofore. In addition, of course, the second harmonics of the lower broadcast bands, from 550 to 750 kilocycles, actually cause interference with the higher frequency bands in the range from 1000 to 1500 kilocycles.

It is not practicable to employ high frequency amplifiers that will minimize the generation of harmonics, largely because such a design would require operating all the tubes at a very low output and at considerably reduced efficiencies, and even though it were practicable it is not likely that the minimum possible would be sufficiently low. The practical way is to make no particular restriction to the generation of harmonics in the tubes themselves and then to reduce the harmonics before they reach the antenna or are otherwise radiated. The harmonics are discriminated against at several points in the transmitter and particularly between the last power stage and the antenna. In the 50 kw transmitter of the Western Electric Company all circuits are completely shielded by copper enclosures to prevent the radiation of harmonics directly from tuning coils and leads, and where the transmission line, which feeds the antenna, emerges from the transmitter enclosure special circuits are employed to keep harmonic voltages from it. So effective are these precautions that the effective radiation of second harmonics is less than .00001 per cent of the carrier power.

The Western Electric transmitters of today, in addition to transmitting the range of frequencies required for satisfactory programs, thus show decidedly increased capabilities over the transmitters of a few years ago. Freedom from noise and interference has been afforded to a great extent in radio broadcast reception by the employment of greater power at the transmitters, more complete modulation, and accurate frequency control. By the reduction of noise originating both within and without the receiver, and by the prevention of interference with adjacent broadcasting bands, a much better grade of reception is secured and the illusion of the actual presence of the entertainment being broadcast is more nearly attained.

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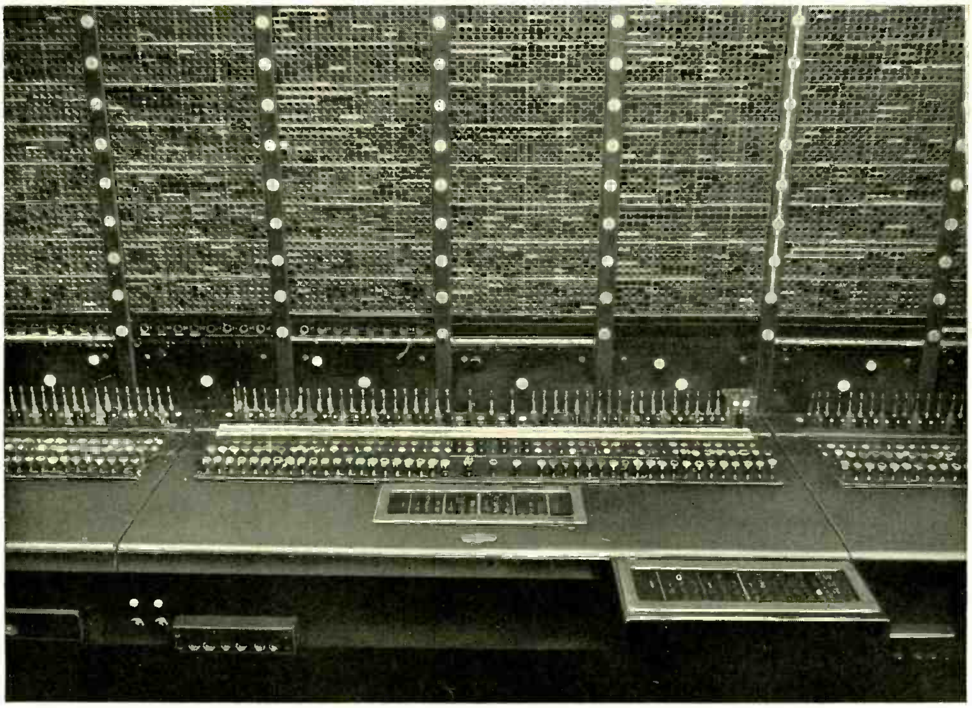
* BELL LABORATORIES RECORD, *Sept.* 1928, *p.* 24.



Key-Display Type Call Indicators

By S. T. CURRAN
Telephone Apparatus Development

TWO operators are ordinarily required to complete a call in any of the larger manual areas. One, the "A" operator, receiving the number from the calling subscriber, makes connection to a trunk to the office serving the subscriber called. At this office a "B" operator, obtaining the number from the "A" operator, completes the connection by plugging into the desired subscriber's line. Calls from a dial to a manual office cannot follow this procedure, and so the call indicator was developed as the connecting link between mechanism and operator. A summary of the various call-indicator systems, running from the carriage-call type to the automatic display type, has already appeared in the RECORD.* The present article deals more particularly with one of these systems, the key-display type. Although this form has now been superseded by further developments, it is still widely used in the Bell System and is, therefore, of considerable interest in a consideration of this method of telephone operation.

Certain positions at the "B" board of a manual office are used for the reception of calls from dial offices. In the front part of the keyshelf of these

* *December*, 1929, *page* 171.

positions is set a call-indicator which presents to the operator a rectangular glass plate divided into six sections by five transverse white lines. Each of the four middle sections contains the ten digits from zero to nine inclusive, arranged as shown in the headpiece. One digit in each of these four sections lights for every call and the four illuminated digits indicate the number wanted. In the last section on the right are the four letters, W, R, J, and M, required for party lines. In the first section on the left is a star and the number "1." For all calls not having party-line letters the star usually lights, and for those numbers in the ten-thousands group, requiring five digits, the "1" is illuminated.

Trunks from dial offices to these call-indicator positions terminate in

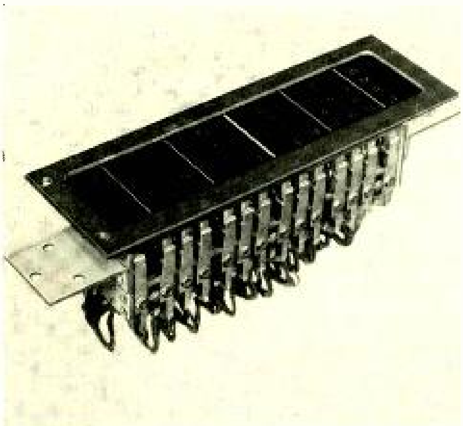


Fig. 2—Some of the forty-six spring sockets are evident in this view of the call indicator removed from a keyshelf

single-ended cords. In front of the plug of each cord, and in line with it, is an assignment lamp, a disconnect lamp, a display key, and in some cases a teamwork display key arranged in the order named. When a number has been dialed requiring completion at a manual office, a trunk is selected which terminates at a call-indicator position, and the assignment lamp of that trunk lights. The operator then presses the proper display key which causes the called number to be displayed on the indicator.

As soon as the operator reads the complete number, she attempts to complete the connection in the multiple. If the number is not busy, which she determines by touching the tip of the plug to the sleeve of the jack, she plugs into the proper jack. If it is busy she connects the trunk with a "busy-back" jack which gives a busy signal to the calling party. Should the line be out of order, she connects the trunk to the trouble operator who informs the person calling.

Disconnection of a call completed through a call indicator position is controlled by the calling subscriber. When he disconnects, the disconnect lamp in front of the operator lights, and the operator takes down the connection. The dial equipment of the originating office is automatically disconnected when the calling party hangs up.

The call-indicator consists of forty-six small switchboard lamps, one for each digit on the display plate, mounted in spring sockets arranged in four rows. The construction may be partially seen in Figure 2. Located above these lamps is a thick phenolfibre block having rows of holes corresponding to the lamps below. On the upper side of this block is an opaque glass number plate with translucent characters over each hole. Above the number plate is a thick sheet of clear glass held in place by a flat metal escutcheon plate. Mounting brackets have been provided at the ends in order to permit the indicator to be mounted ith the surface of the keyshelf.

The call-indicator described above is known as the No. 1 type. There are, however, several other types—the same in general construction and method of operating but differing somewhat due to the particular uses to which they are applied.

As there is only one indicator per position, provision must be made for the possibility of failure. This is accomplished by the No. 2 type indicator—similar to the No. 1 except that it is enclosed in a mahogany box and equipped with a multiple plug which engages with a jack mounted in the lock rail of the keyshelf. The jack is connected with an emergency control circuit so as to be ready for use should the regular indicator be out of order.

For tandem offices, where both the subscriber's number and the office code must be shown, the No. 3 type indicator has been developed. This is virtually two No. 1 indicators mounted under the same plate but one of them has a display plate having only three groups of digits and is used for giving the office designations (Figure 3).

A No. 4 type has been developed for use as the emergency indicator to go with the No. 3 which it resembles except for the method of mounting. It is related to the No. 3 exactly as the No. 2 is to the No. 1.

In some tandem offices the keyshelves are so arranged that it is not possible to mount the No. 3 indicator. The 5-A and 10-A indicators are used under such conditions, mounted end to end. The 10-A, which displays the office code, is mounted at the left and the 5-A, which displays the subscriber's number, at the right. The 5-A is similar to the No. 1-A except for the mounting arrangements and the 10-A is similar to the office-code part of the No. 3 except equipped with mounting arrangement similar to the 5-A.

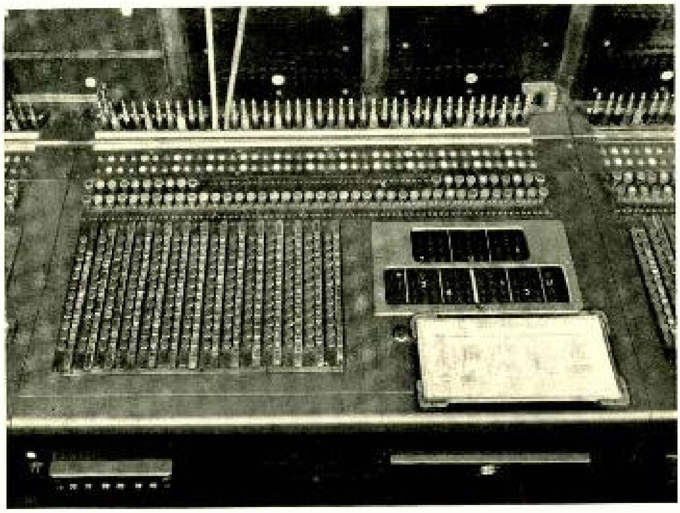


Fig. 3—A No. 3 call indicator is used for tandem offices where the office code as well as the number must be given

Call indicators are widely used in cities like New York, Chicago, Los Angeles, and many others where there are both manual and dial offices. The call indicator serves as a memorandum pad on which the dial sender writes the number wanted for the information of the manual operator. The number on this call-indicator pad, written rapidly and legibly, is instantly erased when the operator inserts the plug into the proper jack or operates another display key, and a clean sheet is left for the next number.

Automatic Prevention of Trouble by Decoders

By RODERICK K. McALPINE
Local Systems Development

THE decoder* has been compared to a card index to which the sender refers on each call after the desired office has been indicated by the dialing of the office code. From this index the sender learns how to locate the proper group of inter-office trunks and, having reached the proper office, how to proceed in connecting the subscriber to the number he wants. The analogy to a card index may even be broadened to include some of the intelligence and ability of an operator. If an operator who is handling calls becomes ill and no longer capable of completing connections without serious danger of error, she does not attempt to carry on her work further, but notifies her supervisor, who assigns another operator to her work. Similarly, each decoder watches itself very closely for symptoms of inability to give the sender correct information on any call, and upon discovering a sign of weakness, refuses to act and refers the call to another decoder. This ability of self-watchfulness combined with a high reliability by design makes the chance of misconnections due to decoder trouble negligible.

In normal operation a decoder needs only about three-tenths of a second to complete its part of a call, and so if a decoder does not release within a second or two, as measured by a timing device, the sender is signaled that something is wrong and that it should obtain its required information from a different decoder. The desired information will then be obtained from another decoder. The trouble condition first encountered will merely cause an inappreciable delay; the subscriber will not even suspect any irregularity in the functioning of his dial equipment.

A decoder consists of between three and four hundred relays and their inter-connections. The correct translating of the signals received from the sender requires that certain of these relays operate and all others remain non-operated, and that there be no dirty contacts, broken wires, or crosses which can cause trouble. Signals are received from and sent to senders over forty-eight wires. Since the decoder receives information by finding ground on different combinations of some of these wires and replies by grounding other wires, as illustrated in Figure 1, the correct routing of each call requires that no wire be broken, crossed with any other wire, or unintentionally grounded. To insure that all of these conditions in the decoder and the connecting wires are as they should be, a variety of distinct tests is required. Any of these tests which discovers trouble of any kind need only prevent the release of the decoder to prevent its giving wrong information, for after a second or two the timing device mentioned above will signal the sender to disregard any information that may

*Bell Laboratories Record, *pp. 273-277, May,* 1928.

have been received and to use a different decoder for the call.

Seventeen of the forty-eight connecting wires are used for transmitting information from the sender to the decoder. To make sure that these wires are in good condition, two tests are made. The first searches for broken wires by operating a relay in the decoder over each wire from ground in the sender. Since only a few of the seventeen wires are grounded by the sender on any call, the remaining wires are connected together at the sender in order to make the continuity test and supplied with ground over a separate wire from the decoder until this test is completed. The second test looks for both crosses and false grounds by seeing that none of the relays which were operated by ground from the decoder remain falsely operated when the applied ground is removed. These tests, which require only about a hundredth of a second, are automatically repeated for each different call on the first attempt. If either of the above tests indicates trouble, the decoder will refuse to release, allowing the timing device to signal the sender to try again with a different decoder.

The remaining thirty-one connecting wires are used for transmitting information back from the decoder to the sender. In operation, some of these are grounded by the decoder and the others left ungrounded, the combination depending on the information to be transmitted. At the sender end, each of these wires is connected to battery through the winding of a relay, and the current which flows through the grounded wires operates the proper relays to record the information sent back by the decoder. For each call, therefore, the wires to be grounded must be tested for continuity, and those to be left ungrounded must be tested for false grounds.

To check for continuity of the wires which are grounded by the decoder, "continuity" relays are inserted and the release of the decoder is made de-

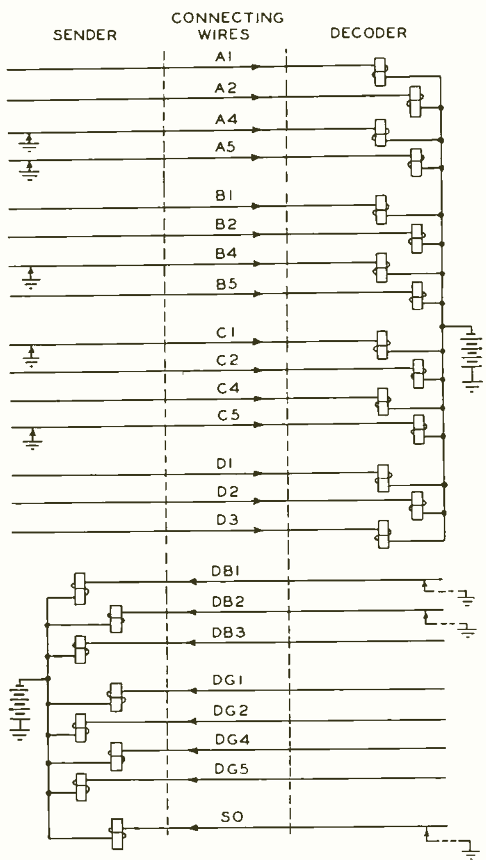


Fig. 1—How information regarding a call from Ambassador to Windsor is sent over the wires between sender and decoder. The upper 12 wires tell the decoder that the code dialed is 946, corresponding to WINdsor and the next three that the calling subscriber has message rate service in a certain district. The remaining 8 wires, tell the sender that trunks to Windsor are to be found in the first group on the third bank of the district frame. 23 other wires which are not shown, give the sender exact information regarding the procedure necessary on a call to Windsor

pendent on the operation of all of them as will be explained later. If one of these wires is broken, the continuity relay associated with it will not operate, and the decoder, therefore, will fail to release, and a second

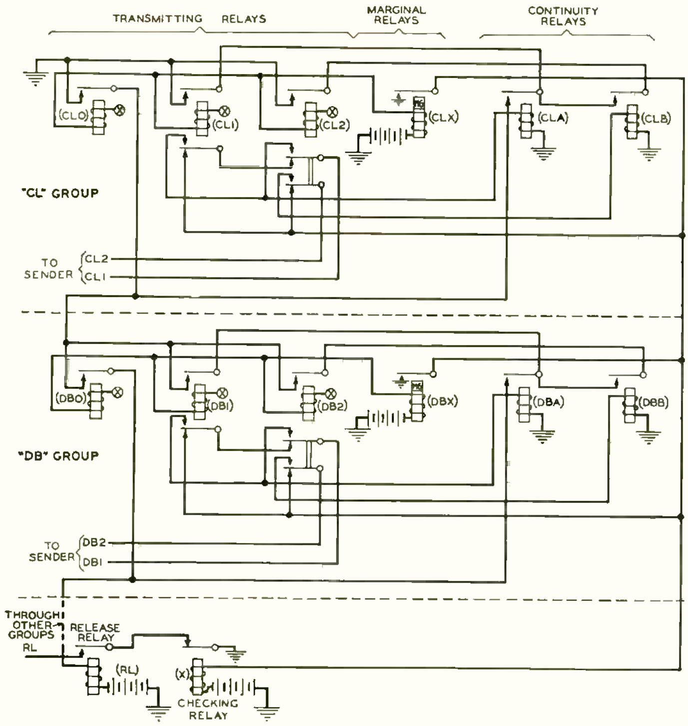


Fig. 2—A portion of two of the six groups of transmitting relays are shown here with their associated marginal and continuity relays

trial will immediately be made.

To check for false grounds, all wires that should be left ungrounded are connected together to battery through the winding of a checking relay. In case a false ground exists, the checking relay operates and prevents the release of the decoder. Should one of the wires supposed to be ungrounded be crossed with one of the intentionally grounded wires, the checking relay would also operate and prevent the release of the decoder.

A part of the decoder consists of six groups of "transmitting" relays. Each relay grounds a different combination of wires to the sender, there being one transmitting relay, but never more than one, operated in each group for any call. Closely associated with the transmitting relays are the continuity relays, one of which should operate for every wire grounded by a transmitting relay. To secure an indication that at least one transmitting relay has operated in each of the six groups, and that the proper continuity relays have operated, a chain circuit is arranged through contacts on all of the transmitting and continuity relays in the six groups. If at least one transmitting relay and the associated continuity relays operate in each group, the chain circuit will be closed and a release relay in series with it will operate, releasing the decoder. Otherwise the release relay will not operate, and the decoder will block and wait for the timing device to signal the sender.

To test for the false operation of two transmitting relays in a group, a marginal relay is connected in series with the relays of each group, so that the current which operates the relays of the group also tends to operate the marginal relay. If only one relay in a group is energized, the current which flows is not enough to operate the marginal relay, and the call proceeds.

If a second relay is energized, however, sufficient current flows to operate the marginal relay, which blocks the translation and causes the sender to pick a different decoder.

Figure 2, which shows portions of two typical groups of transmitting relays with their associated marginal and continuity relays, illustrates five of the foregoing tests. Wires CL1 and CL2, which are two of the thirty-one wires by which information is transmitted to the sender, are connected by operation of the transmitting relays to ground through the windings of continuity relays (CLA) and (CLB) respectively, which, should the wires be open, fail to operate. As previously stated, one transmitting relay but never more than one operates on every call. The chain circuit, which controls the operation of relay (RL), and thereby the release of the decoder, will be closed only when a transmitting relay and the proper continuity relays operate. If relay (CL1) operates, relay (CLA) should also operate; if the (CL2) relay operates, then both relays (CLA) and (CLB) must operate in order to close the chain circuit. In case of any failure of this circuit to close, due to the non-operation of a transmitting relay or to an open circuit in one of the grounded wires, the (RL) relay will not operate and the translation will not be recorded in the sender.

Wires which are not grounded are connected through back contacts of the transmitting relays to the winding of the (X) relay. If any of these wires should be falsely grounded or crossed with a grounded wire, the (X) relay would operate and prevent the RL lead from being grounded, thereby preventing the release of the decoder.

Should any two transmitting relays in the same group operate, sufficient current would flow in the battery supply wire of the group to operate the marginal relay, such as relay (CLX) in the sketch, which in turn operates the (X) relay, so that the decoder will not release.

In addition to the six groups of relays, there are a number of relays, any one of which, if it should be falsely operated at the moment the decoder is connected to a sender, would release the decoder prematurely and route calls incorrectly. Such relays are guarded by a sensitive relay in their battery supply wire, which operates and starts the timing device whenever one of these relays becomes energized. If one of these relays becomes falsely operated and remains so for two seconds, the timer will cause the decoder to test busy so that it cannot be used until the trouble is cleared.

A dirty contact or broken wire anywhere in the decoder, which affects the translation in progress but does not cause any of the specific effects mentioned above, will yet halt the sequence of operations by preventing the operation of the transmitting relays so that the decoder will fail to release, allowing the timing device to signal the sender to pick a different decoder.

Almost any trouble condition in the decoder that might cause a wrong number will, due to this automatic trouble prevention scheme, prevent the decoder from releasing until, after one or two seconds, the sender is notified that it should select a different decoder. Thus, the combination of decoder and sender senses a mistake before it is made and proceeds to route the call correctly after eliminating the defective decoder.

Flutter Effect in Loading Coils

By F. J. GIVEN
Telephone Apparatus Development

WHENEVER additional communication channels, either telephone or telegraph, are superimposed on lines carrying an ordinary telephone channel, new and exacting restrictions are placed on the transmission apparatus of the system. In particular, certain properties of ferro-magnetic materials used in the cores of loading and repeating coils may be a source of interference among the various channels, unless these properties are correctly controlled in the design and manufacture of the coils.

One such property common to all coils having cores of magnetic material whether of iron, silicon steel, or permalloy is the nonlinearity and nonreversibility of the magnetization characteristic. Figure 1 shows a typical magnetization curve plotted on an arbitrary scale. From this it may be seen that the magnetic flux is not proportional to the magnetomotive force; that a given magnetomotive force may produce different amounts of flux depending upon the direction of application of the force and upon the preceding magnetic cycle or state.

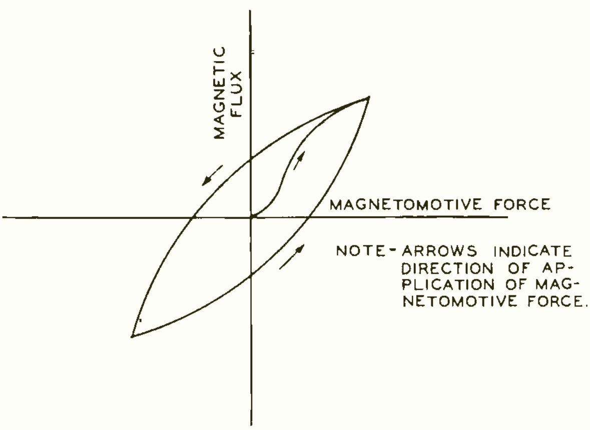


Fig. 1—For any one value of magnetizing force there are two values (except for very high fields) of flux, depending on whether the field is increasing or decreasing algebraically

In a line transmitting currents of one frequency band, this fundamental property of the core material of the repeating or loading coils produces harmonics of the frequencies of the transmitted band. These harmonics are perhaps only a small fraction of the strength of the fundamental and consequently, in a system carrying only one message channel, they are not ordinarily noticeable, not only because of their small magnitude but also because many of the harmonics are reduced to even lower magnitude by filtering action of lines or repeaters.

In multi-channel systems, however, where the coils are carrying currents of several frequency bands, the effect of this property of the core material is to add to the harmonics of each band, other frequencies which are the sums and differences of the fundamental of that band and the fundamental and harmonics of the other bands.

Some of these extraneous frequencies bear approximately the same magnitude relationships to the fundamental bands as do the harmonics. At many points of a system carrying more than one message channel, however, the message currents are of quite different relative strengths due to attenuation of the line and because the messages are flowing in opposite directions. Some of the added modulation products may consequently be of the same order of magnitude as the currents of one of the message channels, with the result that their presence may produce interference of a serious nature between channels. In loading and repeating coils used in multiple channel systems, these effects are of prime importance and must be so controlled in the design as to minimize this interference.

Through usage, these effects, although of common origin, have acquired different names depending upon the particular types of message channels in which they occur and also on the effects they produce. They are generally referred to as "modulation" when produced by loading or repeating coils and manifested in carrier systems superimposed on an ordinary telephone channel. Here they appear as additional and unwanted frequencies giving rise to noise or cross-talk.

They are referred to as "telegraph thump" when produced at the terminals of a line carrying low frequency telegraph and an ordinary telephone channel. Because of imperfect filtering of the composite set some of the low frequency telegraph currents pass to the repeating coils and by a modulatory action produce audible frequencies. These appear as a thumping noise in the telephone channel.

They are referred to as "flutter" when produced by the loading coils in a line transmitting low-frequency telegraph in addition to the ordinary telephone channel. Here they are perceptible as an intermittent lowering of the transmission efficiency of the line. It is with this manifestation of these effects occurring in loading coils that this article is concerned.

Figure 2 shows a typical arrangement of a "ground-return" telegraph system that is used for simultaneous transmission of low-frequency telegraph and telephone channels, on open wire lines. The "ground-return" telegraph must of course pass over any loaded entrance cables that may occur in the open-wire line. The telegraph currents here are large in order to

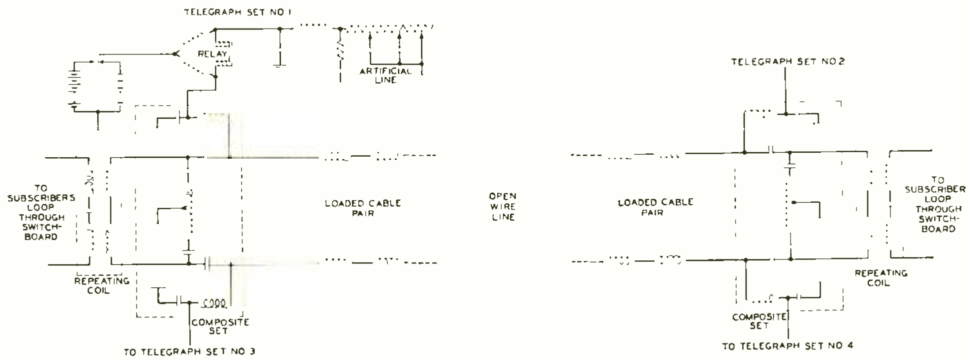


Fig. 2—Composite sets allow a single pair of wires to be used for sending telegraph messages as well as for telephone use

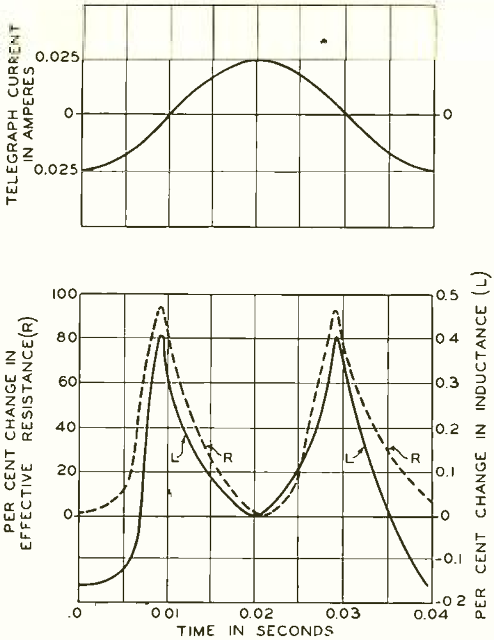


Fig. 3—A single cycle of telegraph current causes two peaks in the inductance and resistance values of a line

ride over extraneous induced current and accordingly are perhaps fifty times larger than the voice currents. Another scheme used embodies a "metallic" return which is commonly employed on cable circuits. Here, because induction effects are comparatively small, the telegraph currents used are only about twice as great as the telephone currents.

In either case, although more pronounced in the "grounded" circuit, the flutter effect in the loading coils is of importance. Although in the open wire-cable system the "flutter" effect per coil is greater, the fact that there are fewer coils than in a complete cable circuit means that the overall effect in each system tends to be of the same order of magnitude. If not controlled the effect would be much like that which would occur if a person were talking through a speaking tube that was being alternately opened and partially closed by a number of valves at various points along its length at a rate equal to twice that of the signals of the telegraph key. In a telephone transmission line, the loading coils may be regarded as the valves which are actuated electrically by the superimposed telegraph currents. Successful transmission of telephone currents while the telegraph circuits are operating is possible if proper care is exercised in design and in the choice of

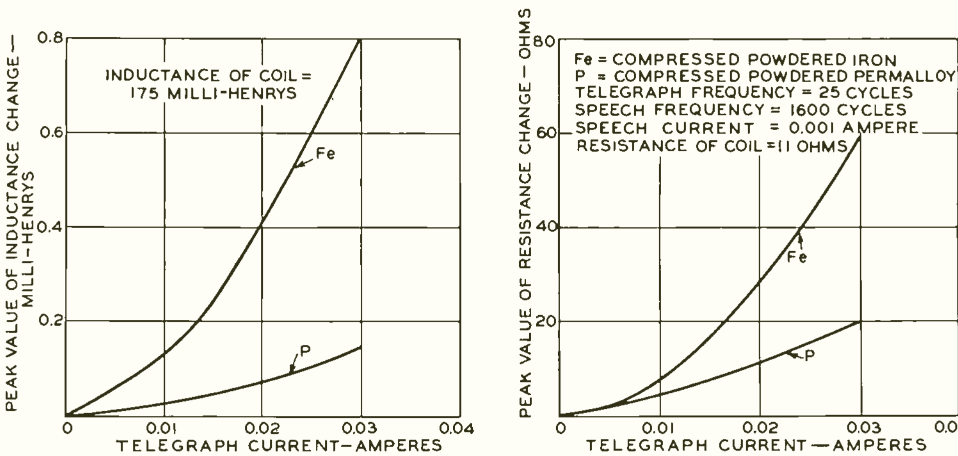


Fig. 4—For a given average value of telephone current the flutter effect increases as shown with an increase in the telegraph current. This increase is distinctly less for permalloy than for iron cores

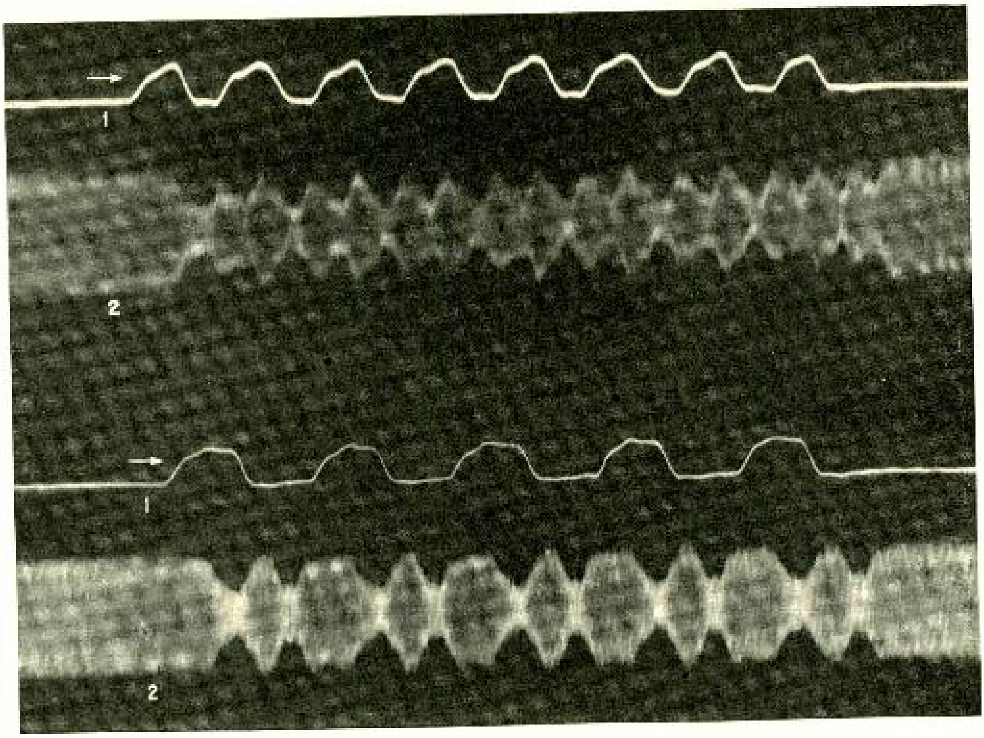


Fig. 5—Were it not for the flutter effect of the telegraph signal, the telephone wave would be regular in amplitude as at both ends of the oscillogram

high grade magnetic materials for the loading coils.

Fundamentally the flutter effect can be traced back as previously mentioned to that undesirable property in all magnetic materials technically called "hysteresis." This might be explained as a disinclination to change from an existing magnetic state. When magnetic materials are subjected to cyclic magnetization, energy called "hysteresis loss" is expended to overcome this disinclination. The hysteresis loss incurred by the telephone current is increased markedly by action of the telegraph current. If there were no hysteresis loss in the cores of loading coils, as would be the case if air were used as the core material, there would be no flutter effect. Air-core coils, however, would be much too expensive for practical use. It is quite economical and practical to engineer the layout of telephone transmission systems and to choose the materials in the design of the loading coils so as to render the flutter imperceptible to the average telephone user.

If the flutter effect of an individual loading coil is examined in detail, it will be found that the resistance and inductance change in accord with the pulsations of the telegraph current, the resistance change being far more significant. When these coils are inserted at approximately 1.1 mile intervals along the cable transmission line, the summation of these individual effects produces rapid fluctuations in the attenuation of the transmission line. Electrically, this corresponds to the valve action in the speaking tube analogy referred to earlier.

On account of the complexity of

the computation of these effects of an individual coil from the fundamental magnetic properties of the coil, it is much easier to measure the flutter effect. Methods have been developed, which will be described in a later article, that facilitate obtaining data showing the variation of resistance and inductance instantaneously with the telegraph current under any conditions of frequency and current strength desired. Figure 3 shows how the resistance and inductance of a coil vary throughout the period of one cycle of telegraph current. It will be noticed that the variations in inductance and resistance have half the period of the telegraph wave. The peak or maximum values are of particular interest since they produce the maximum effects on the line attenuation. The effect on the peak values of inductance and resistance changes of varying the strength of the telegraph current is shown in Figure 4. It will be noted that for any given strength of telephone signal, the flutter effect is worse for strong telegraph currents than for weak ones.

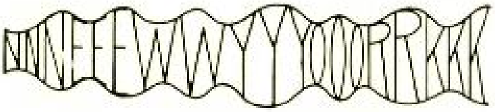


Fig. 6—The effect shown in Figure 5 might cause the word "New York" to fluctuate in volume as analogized here

Figure 5 shows a group of oscillograms illustrating pictorially the flutter effect on a telephone current received over a loaded cable circuit. To make this picture show the effect more plainly, it was taken on a line in which the flutter effects had been made greater than permissible for commercial transmission. In the case shown almost a five to one, or 14 db, variation in strength of the received telephone current is found. This would render some syllables of the received speech almost inaudible and would make understanding difficult. Figure 6 shows in cartoon fashion how the name "New York" would sound as received over a line with a large flutter effect.

The importance of the flutter effect is perhaps becoming less and less each year. Other factors are coming into play which are leading to the use of through cables and in turn to the use of separate pairs for the telegraph and telephone channel, particularly for long distances. Both these tendencies will for the future in effect relegate the "flutter" effect into the background. Nevertheless, a great deal of the present plant is laid out for dual operation and it seems probable that for some time to come at least on the short circuits, the effect must be given careful consideration. In future design of loading coils, which will employ new magnetic materials as they become available, the "flutter" effect will be used as one of the yard sticks with which to measure their suitability and usefulness.

Multiplying the Subscriber's Line

By V. I. CRUSER
Equipment Development

IN many business establishments the volume of telephone calls requires the use of more than one telephone. Incoming calls arrive over several lines, either directly from the central office or through the establishment's private branch exchange. The individual termination of these lines in separate telephone instruments might not provide the best service, for during the business day certain of these telephones would be left temporarily unattended and incoming calls would be answered, generally after some delay, by nearby employees.

To meet these service conditions when only a few lines and telephones are required, the telephone companies have made much use of circuits, known as station wiring plans, which permit access to more than one line by each employee. But a study of the problems arising when a larger number of lines and instruments are involved, indicated that it would be possible to design a more satisfactory telephone arrangement, affording more convenient and attractive station equipment, quicker answers on incoming calls, and signalling and switching means superior to those used with the wiring plans.

The development work subsequently undertaken has resulted in the "No. 100 Key Equipment—Multiple Line." This station system is designed for use where it is desired to have a number of telephone lines with suitable lamp signals accessible to one or more telephone sets. By operating a key associated with the line, any one of a number of employees can originate, answer and hold calls on any one of the lines appearing before him. Lamp signals and buzzers are provided to indicate incoming calls. The equipment is suitable for operation with both dial and manual systems.

This equipment is particularly adapted to business offices where any one of a group of employees doing work of the same character may satisfactorily dispose of a call originally directed to another who is absent. A typical example of this is an insurance office, which employees leave on business during certain portions of the day. The equipment is useful also in

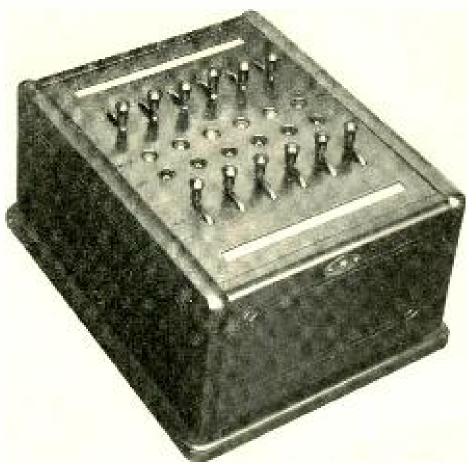


Fig. 1—A six-line double-sided keybox for Multiple Line Key Equipment, showing the single assembling screw

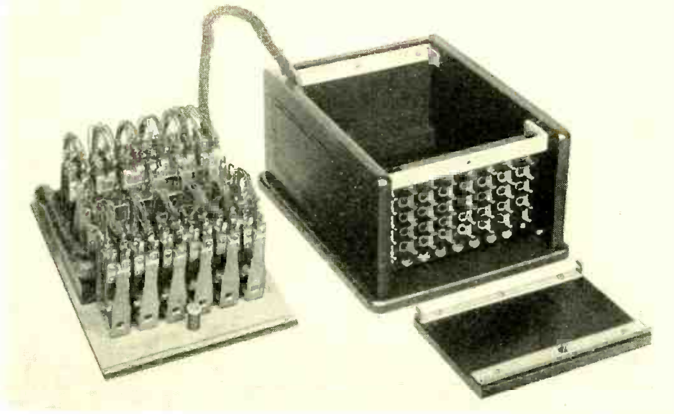


Fig. 2—When the assembling screw of the keybox is loosened, the terminal plate, and key and lamp connections, are readily available

By double-sided keyboxes with two users for each group, as many as twelve persons may be enabled to answer any particular one of the lines.

While only a single telephone-station circuit is common to all of the lines in one or more single-sided keyboxes on the same desk, more than one person may have access to the lines by connecting more than one telephone instrument to the same telephone circuit. Only one of these, of course, can use the system at one time. For a group of double-sided keyboxes, a separate telephone circuit is furnished on each side so that two persons may use the system indepen-

enabling an office clerk to answer calls for employees not at their desks, by grouping before the clerk all the lines in a particular department.

Equipment for the system may be divided into two major parts: the keyboxes, in which are mounted the keys and lamps controlling the lines, and the relay equipment. Keyboxes are usually conveniently located on the user's desk; relay equipment can be concentrated in a more remote location.

Keyboxes are made in two types: the "single-sided", to be operated from one side only, and the "double-sided", with a duplicate set of keys so that it can be operated from opposite sides. Each of these types is made in two capacities—for three lines and for six. This, however, sets no limitation on the number of lines that can be made to appear before each user, for, by placing keyboxes side by side on the same desk, the user's telephone can be made common to any number of lines. These same lines can be connected in multiple to other keyboxes—to give each line an appearance on as many as six desks.

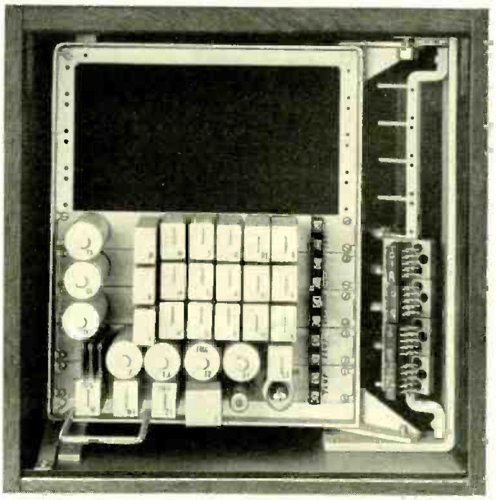


Fig. 3—Relay equipment for a three-line single-sided system. The three upper transverse mounting plates, the relays mounted on them, and their terminal strips at the right, are the three line-circuit units; below is the timing and buzzer unit

dently. As with the single-sided keybox, more than one person on each side of a double-sided keybox may have access to the system through duplicate telephone instruments on each telephone circuit.

To call attention to an awaiting incoming call, and to mark a busy line, small amber and green lights respectively are used at each appearance of the line. On an incoming call the "line" lamp lights and a buzzer sounds. The call is answered by moving the associated key to its "talk" position, an operation which extinguishes all line lamps, connects the telephone at the operated appearance to the line and lights all associated "busy" lamps to indicate at other appearances that the line is in use. An outgoing call similarly lights all "busy" lamps associated with the line in use. At the completion of the conversation, the key may be pushed back, restoring the circuit to normal, or advanced to the "hold" position, where it releases the telephone connection, but holds the line connection with the exchange and leaves the "busy" lamps lighted.

Although the keyboxes are made in two styles and two sizes, the design features are the same for all. The keys and lamps are assembled as a unit on a sheet steel plate which is mounted at the top of a wooden casing (Figure 1). To hide all mounting-screw heads, a top faceplate is attached to the key and lamp mounting plate by two screws from the underside. All local and incoming leads are connected to a terminal plate at one end of the box, which can be exposed by detaching a removable panel. So that the key and lamp assembly may be stocked and wired as a unit separate from the wooden casing, the terminal plate is also made removable, and is fastened

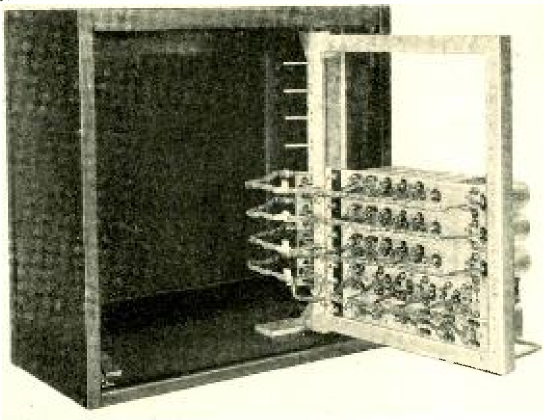


Fig. 4—Opening the relay gate makes the wiring available

in the casing before the incoming wiring is connected on the subscriber's premises. The box is regularly made of mahogany with a dull rubbed walnut finish, and the top faceplate is given a harmonizing old brass finish.

One of the most important design features of the keybox is that whereby loosening a single screw in the wooden end panel enables removing both the panel and the key and lamp assembly from the casing. The wiring from the keys and lamps to the terminal plate, which remains in the casing when the box is in service, is long enough to allow the key and lamp assembly to be laid outside the box with all connections at the keys and lamps fully exposed for testing and maintenance attention (Figure 2).

The relay equipment for the Multiple Line Key Equipment has been designed on the unit basis, in accordance with the recent tendency in equipment development. Each unit, complete in itself, is wired to a terminal strip in the factory so that it can be installed with a minimum of soldering. For small installations of, for example, six to twelve lines, the units are of a single-circuit type: one unit is required for each circuit to be equipped. These units are designed to be mounted on a hinged relay gate in their containing cabinet (Figure 3), so that both the wiring and the apparatus sides are readily accessible. Each terminal strip is mounted opposite its associated mounting plate and the handmade cable connecting them is made sufficiently long to flex as the gate is swung (Figure 4). After the units are mounted in the cabinet, the incoming wiring is connected to the terminal strip. Like the keyboxes, the apparatus cabinet is made with a dull rubbed mahogany-walnut finish.

A maximum of six line circuit units, and one timing and buzzer unit common to the six lines, can be placed in the cabinet. When the operator rings the line, the buzzer furnishes an audible signal. The timing circuit, use of which is optional, controls the line lamp, extinguishing it at a definite time after ringing has ceased and preventing the line lamp from remaining lighted for long periods of time when the keyboxes are unattended. The lighted period is made long enough, however, to permit finding the lighted lamp without looking up immediately on hearing the buzzer. To reduce the size of the equipment to a minimum, the chain of slow-operate relays in the timing circuit is made to operate four times instead of but once to secure the desired time interval, and is thus reduced to a quarter the size otherwise required. Where this optional automatic timing feature is not furnished, a manually operated switch cuts off the battery supply from all the line lamps when the keyboxes are unattended. When the switch is "ON" the line lamps remain lighted until the call is answered by operating the associated line key.

For larger installations than that described, equipment units are designed to be mounted on a small relay rack. Here the line unit is arranged for ten circuits instead of for only one, and a single timing circuit is made common to all ten lines instead of to six.

Development of the No. 100 Key Equipment, in the convenience it affords and the attractive appearance it presents, marks another step in the Bell System's efforts to give "service from the subscriber's viewpoint."

Acoustical Characteristics of Movie Screens

By H. F. HOPKINS
Transmission Instruments Research

IN its pioneer stages the sound-picture system was used chiefly to provide a synchronized musical accompaniment for the picture. The loud speakers, as a result, were frequently placed in the orchestra pit to give the effect of the presence of an actual orchestra. With improvement in technique, however, the reproduction of dialog became more general; the accompaniment feature decreased in importance until now a sound-picture is usually understood to mean a talking picture—a dramatic screen entertainment reproducing the voice as well as the scene. To produce the proper effect under these new conditions, a different location for the loud speakers was necessary since the sound should appear to come from the speaker's mouths and thus from the screen itself. Behind the screen seemed the most suitable place. This change brought an added difficulty into the reproduction, however, due to the partial obstruction of the sound by the screen.

To determine how serious the obstruction was, required acoustical tests which the Laboratories was well equipped to make. The frequency response of loud speakers has been the subject of many studies as already described in the RECORD.* To make similar tests with a screen in front of the loud speaker, and to compare the resultant sound received to that without the screen in place was, therefore, a comparatively simple matter. This has been done to a large extent as a matter of routine in determining whether certain screens will be satisfactory for sound-picture reproductions.

A screen may be expected to transmit sound in three ways. It may vibrate as a diaphragm driven by the sound from the horn and in turn produce new waves which will be heard by the observers. Also the original sound may be transmitted through air passages in the screen itself, which is a second method. The third is by wave propagation with the screen material as the conducting medium. Because of the physical properties of the screen, however, the power transmitted by this last method is much smaller than for the other two so that for practical purposes it may be neglected.

From a knowledge of the tension to which a screen may be stretched and of the density of the material, it might be expected that the natural frequency of the screen as a whole would be low. At this natural frequency the screen would transmit efficiently but for higher frequencies, where the mass reaction becomes large, the greater portion of the driving force would be consumed in accelerating the screen and little would remain for moving the air load. This natural frequency, however, is ordinarily below the frequency band used in sound-pictures. The transmission

* BELL LABORATORIES RECORD, *May*, 1929, *p.* 347.

efficiency of speech vibrations, therefore, would be highest at the lower frequencies and would decrease as the frequency increases. Furthermore over the range of frequencies involved, the screen is far from a simple vibrating system. Irregularities occur, therefore, in the sound transmitted although they may be small compared to the total effect.

Transmission through air passages in the material proves to be much

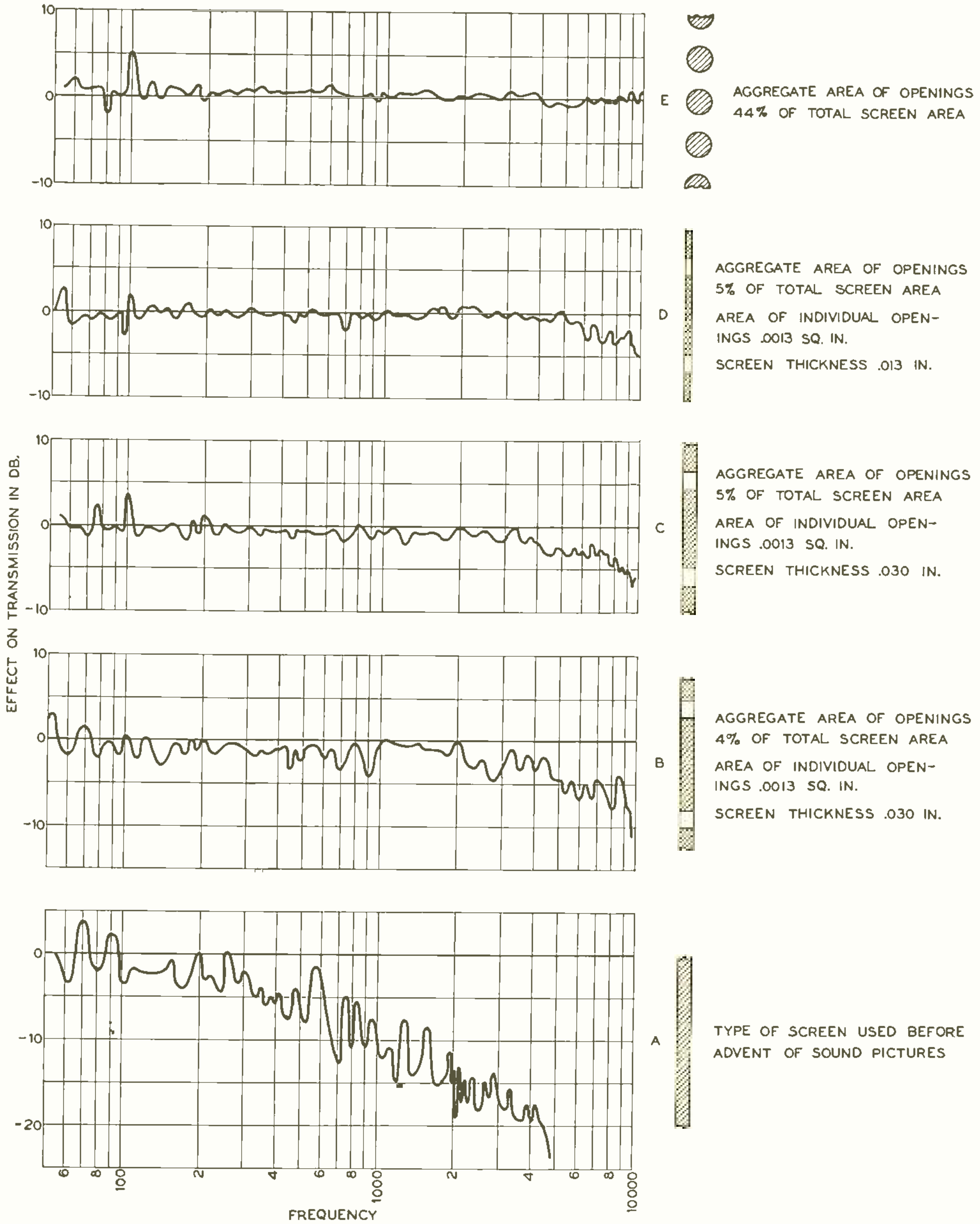


Fig. 1—Transmission characteristics of modern movie screens with punched openings compared to the earlier solid type

more satisfactory. Two factors are of primary importance. The aggregate area of the openings in the screen must be adequate to give the proper air load for sound radiation into the theater, and the dimension of the holes, principally the ratio of diameter to the thickness of the fabric should be sufficiently large to reduce the mass reaction to a satisfactory value. The effect of too high a mass reaction is to produce an attenuation that increases with frequency; while an improper air load produces a general decrease in the efficiency of transmission. If these factors are considered in the design, screens may be made which have very satisfactory transmission characteristics.

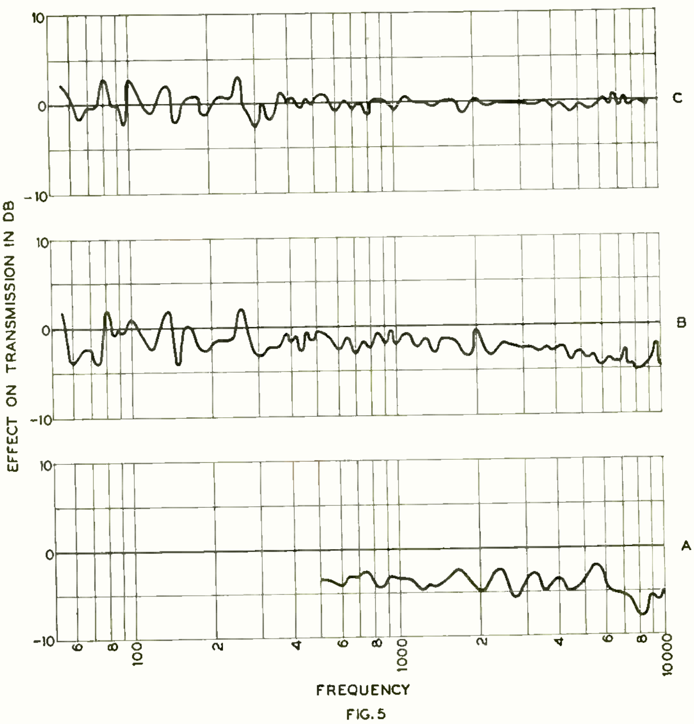


Fig. 2—Transmission characteristics of screens which allow the mesh opening of the weave to transmit the sound

Before the advent of sound-pictures the screens were heavy and not porous. Sound could be transmitted only by diaphragm action. The result is shown at "A" of Figure 1. There is a rapidly increasing loss with increasing frequency, and the irregularities mentioned above are plainly evident. Since a loss of three db means that only about half of the power is transmitted the seriousness of the loss indicated is obvious.

Curve "E" shows the other extreme where the major part of the energy is transmitted through openings in the screen. For this screen the openings constituted about 44% of the screen area, and it will be observed that there is practically no attenuation of the sound, and that the irregularities, except at the very low frequencies where the data are perhaps less reliable, have been considerably reduced.

Although such a screen is entirely satisfactory for the transmission of sound it is lacking in the desirable optical characteristics. Light is not reflected from the openings so that the total light reflected is reduced in direct proportion to the total area of the aperture. The tendency therefore is to provide smaller and more widely spaced openings, as a result of which sound transmission may be partly due to diaphragm action. Curve "B" shows a characteristic screen of this type. The screen is like that of "A" but punched in it are holes .040″ in diameter which comprise about 4% of the total area. The screen thickness is .030 inches. The drooping of the curve at the high frequencies due to mass reactance, is plainly evident although not nearly so pronounced as in "A." There is also a noticeable loss over the entire range compared with "E."

Curve "C" shows the effect of increasing the open area by 25%—using holes of the same size but with less separation. Although the dropping off at higher frequencies is still evident, the loss over the entire band is appreciably decreased.

By maintaining the same percentage of open area but reducing the thickness of the screen to about half the former value, and thereby increasing the ratio of diameter to thickness of holes, a further evident gain is made. There is now little or no loss over most of the band and only a very slight falling off at frequencies above 3,000 cycles. The irregularities are also greatly reduced. The acoustical characteristics of such a screen would be considered very satisfactory, and the small percent of open space — about 5% — would not materially reduce the reflection of light.

Openings in the screens discussed so far have been punched in a non-porous screen material, but many of the screens now in use are coarsely woven and meshes of the weave form the only openings for air conduction. As a result the openings are small and irregular in shape, and are apt to be partially filled by fibres from the surrounding threads. Because of this the sound transmission may be seriously affected. Figure 2 shows the characteristics of three such screens. "C" is a light netting, and while very good as a sound transmitter would be very unsatisfactory both optically and mechanically. "B" represents a rather coarse and heavy material. There is a distinct loss over the entire range as well as a more decided falling off at the higher frequencies. "A" is a still heavier material and considerable loss is evident over the plotted range.

It appears from these investigations that the design of screen is of considerable importance but that it is possible to get screens that are very satisfactory in their acoustical characteristics without appreciable impairment of their optical qualities. The interposition of a screen between the sound source and the audience is no insuperable obstacle to the proper transmission of sound if proper care is taken in selecting the screen to be used.

Apparatus for Step-By-Step Routine Tests

By A. S. DUBUAR
Local Systems Development

IN order that circuit or apparatus irregularities may be detected before they interfere with service, periodic tests are applied to central office equipment. With the dial system a vast majority of calls are completed without the aid of an operator and it is necessary, therefore, for the maintenance force to detect trouble by the aid of alarms and routine tests. When a switchman conducting a routine test observes that a piece of apparatus fails to function satisfactorily, he makes the associated circuit "busy" to prevent its use.

The frequency with which routine tests are performed is prescribed by the Telephone Company and depends on the class or importance of the equipment. Circuits, the failure of which might affect a large number of calls, are tested at frequent intervals, while other circuits of lesser importance are tested less frequently. Tests are further divided so that the more important features of apparatus are tested at shorter intervals than the less important ones. Typical of the more important tests are those on connectors.

Connectors, directed by the last two digits dialed by a subscriber, locate the line of the called subscriber and, should that line be busy, inform the person calling of the fact. If the line is idle, ringing current is applied to signal the called party. When he answers, the connector disconnects ringing and connects the two lines together for talking. Should the call have originated on a message rate line, the connector sets up a condition for operating the message register, or should the call have originated at a pay station, for collecting a coin at the completion of the call.

Testing equipment in central offices is constructed in three forms; the wagon type, the box type, and the frame type. The wagon type equip-

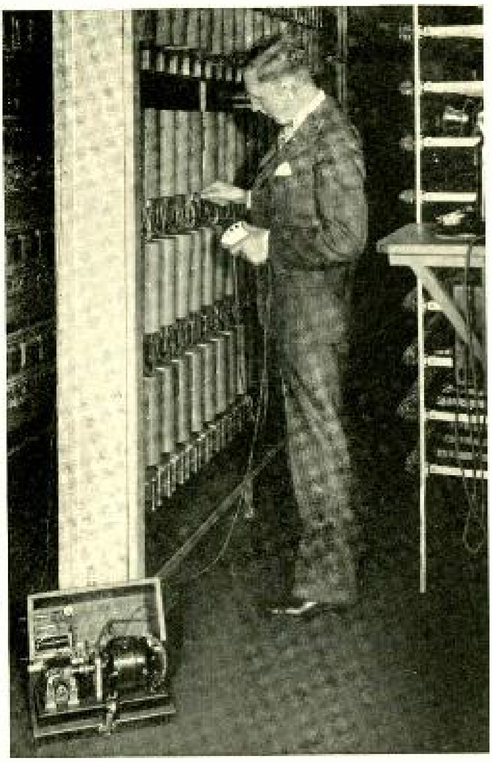


Fig. 1—C. R. Gray operating a portable interrupter machine which rests on the floor at the end of a frame

ment may easily be wheeled about the central office; the box type is much smaller and is readily carried to the place of test. The frame type is constructed on a fixed frame which is connected by means of cables to the units of the equipment to be tested.

Routine tests apply to the switches under test the operating conditions that would be encountered in normal operation. The standard local connector, for instance, is designed to follow dial pulses over a subscriber's line, the conductor resistance of which may be as much as 750 ohms, and the insulation resistance as low as 15,000 ohms. When this switch is tested to determine its ability to follow pulses these extreme limits are simulated and the test man closely observes the switch to determine its ability to function properly.

Some of the test sets, such as that used with connectors, test the switches for a number of features. With this set the switchman can test the connector for its ability to follow pulses under the conditions described above and to properly perform all of the functions for which it is designed. This set is of the wagon type and is connected to the switch under test by means of double-ended cords. Different features of the test are applied to the switch by operating keys, and progress is indicated by the lighting and extinguishing of lamps, or by tones in the switchman's receiver.

Other sets, such as the portable interrupter machine, are constructed to test only a few features of a switch. This set, shown in Figure 1, is of the box type and contains a small motor. A long cord is used to connect to the test jack of a switch under test and to a set of control keys held by the operator. These control keys consist of three buttons mounted in a housing. One button applies a maximum loop and infinite insulation resistance, another applies the minimum loop and minimum insulation resistance, and the third releases the switch. For the duration of the test the motor is applying pulses at a rate of fourteen per second with a 61 per cent open period to each pulse. These pulses are sent to the switches in trains of nine. This speed and duration of open period simulates the condition under which a switch is most likely to fail when not properly adjusted. The long cord enables the operator to leave the test set on the floor at the end of the frame and to reach the furthest switch without moving the set.

Another set is that for testing the operation of line finders, which have already been described in the RECORD.* It is of the box type and con-

* BELL LABORATORIES RECORD, *Feb.* 1929, *p.* 236.

Fig. 2—The dial hand test-set is probably the simplest of all dial test equipment

tains relays, keys, lamps, jacks, an operator's telephone circuit, a dial, and a message register and is connected by a double-ended cord with the line finder under test. By the operation of keys the maximum and minimum conditions of loop and insulation resistance may be applied so that the test may be conducted under the extreme conditions.

In operation a test line is dialed which, connected to the connector multiple, supplies tone through the connector and the train of switches to the test set so that the continuity of the circuit may be determined. The test line also simulates the answering of a call by a terminating subscriber so that the ability of the equipment to charge for a call may be tested. This is determined by a single operation of the test set register and the flashing of a lamp. The set is also arranged so that connections may be made and calls originated on particular lines.

The reverting-call switch enables a subscriber on a party line to establish a connection with another subscriber on the same party line without the aid of an operator. The set designed to test it is constructed on the frame. It can be connected to any of the reverting-call switches on that frame by means of a three conductor cord. With this set all the features of the switch are tested under the severest operating conditions.

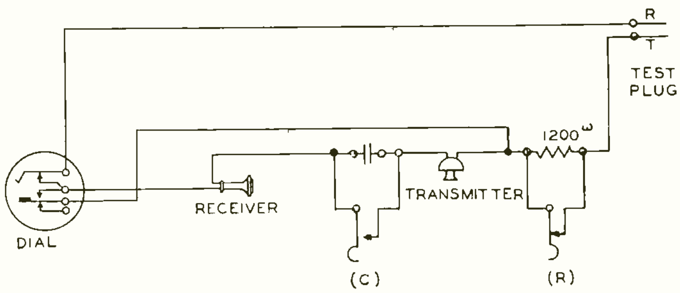


Fig. 3—Diagramatic sketch of the dial hand test-set circuit

Another piece of testing equipment is the dial hand test-set shown in Figure 2. This instrument is probably the most used test set in a step-by-step central office. Consisting of a transmitter, receiver, dial, two buttons, and cord with a test plug, it is very light and can be connected to the test jack of any switch. Any line in the multiple bank of a connector or the first idle trunk on any level of a selector multiple may be reached by dialing, and the switchman may converse over that line by means of the receiver and transmitter. This handset is so constructed that when the plug is inserted into the test jack of a unit, the tip and ring of the line is connected through a receiver and condenser so that the test man may listen in or monitor on the line without introducing interference. Should the unit be idle, he can short-circuit the condenser by operation of the key designated "C", shown in Figure 3, and dial either with zero resistance loop, if the key "R" is released, or through 1200 ohms resistance, if key "R" is depressed. This set enables the switchman to make a rapid test on any switch or to connect to any line in the central office over which he wishes to converse.

There are a number of other sets, among which are the toll test set, and the message register test set. They are all important factors in keeping the telephone plant free from defects so that high grade telephone service may always be available to the subscriber.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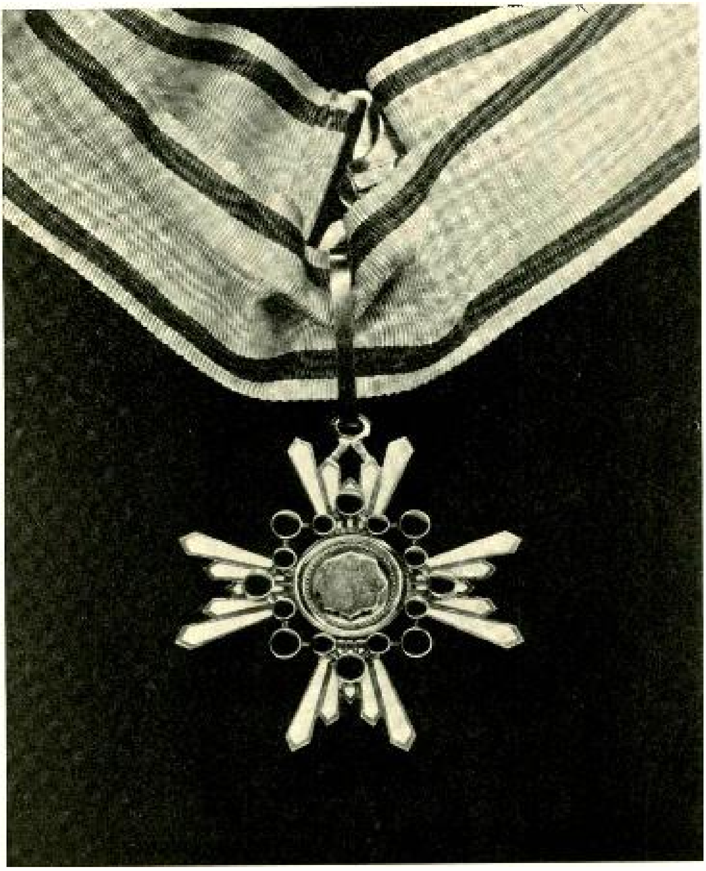
賞勲局書記官從五位伊手衡

Diploma of the Order of the Sacred Treasure, presented to Dr. Jewett on June 18

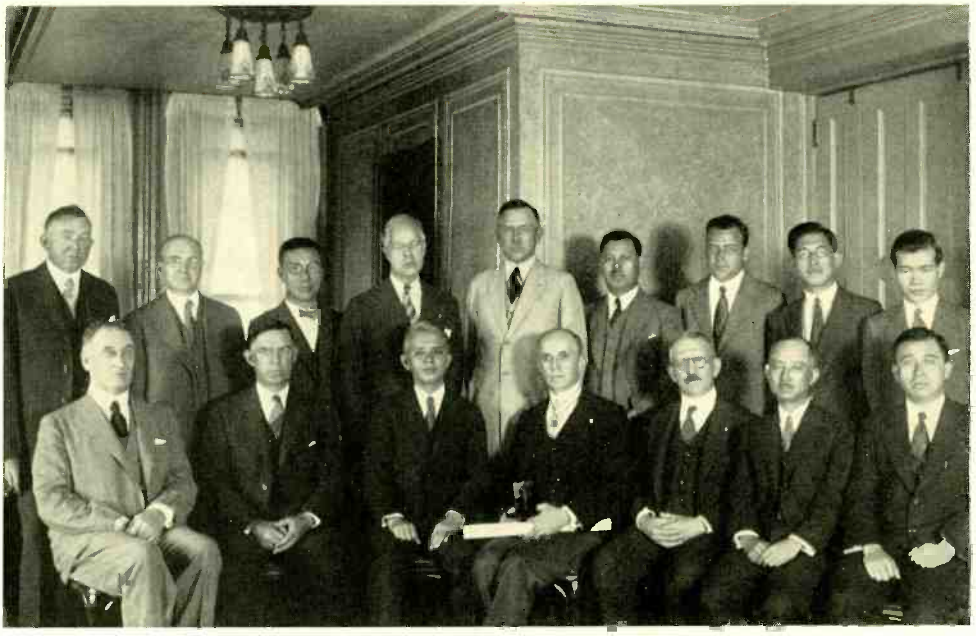
NEWS AND PICTURES

of the

MONTH



Decoration of the Sacred Treasure



In Recognition of International Services

THE Order of the Sacred Treasure has been conferred by His Majesty the Emperor of Japan upon President Frank B. Jewett in appreciation of the most valuable services in the development of the telephone and telegraph industry in Japan. At a luncheon held at the Lawyers Club on June 18, the diploma and decoration of the Order were presented to Dr. Jewett on behalf of the Emperor by Setsuzo Sawada, consul-general of Japan. Others at the luncheon were K. Ishii, consul at New York; N. Fujimura, vice consul; F. Takahashi, chancellor of the consulate; S. Tajina, director; and R. Ishida, manager of the local office of Mitsui and Company; S. Sonoda, manager of the local branch of the Yokohama Specie Bank; Mr. Charlesworth; C. P. Cooper, vice-president, and E. H. Colpitts, assistant vice-president of the American Telephone and Telegraph Company; Col. S. L. Reber of R. C. A.; Robert Ridgway, chief engineer of the Board of Transportation; Gano Dunn, president of the J. G. White Engineering Corporation; E. C. Worden, honorary secretary, and D. L. Dunbar, secretary of the Japan Society.

Dr. Jewett also holds the Order of the Rising Sun.

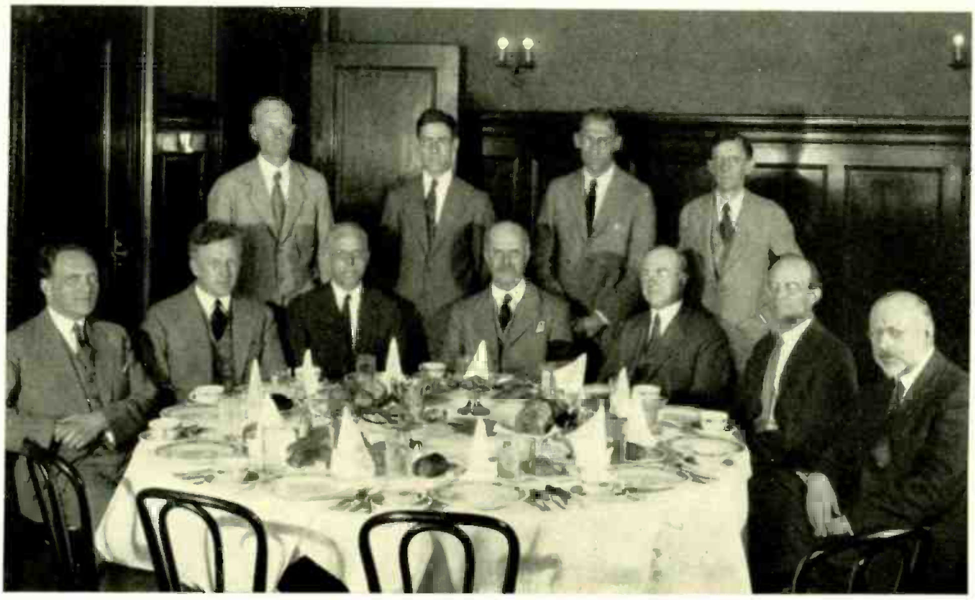
General News

A NOVEL method of broadcasting operation was announced to the press on June 11 as the result of successful tests at stations WOC at Davenport and WHO at Des Moines under the supervision of G. D. Gillett and A. B. Bailey of our Radio Development group.

Briefly, the tests consisted in operating these two transmitters simultaneously on the same carrier frequency and transmitting the same program. Installed as an adjunct to each of the 5 kw Western Electric transmitters was a crystal control oscillator developed in these Laboratories. These oscillators are of exceptional stability and the control element is isolated from the radio transmitter by three stages of amplification in order that there may be no reaction on the crystal due to modulation in the radio transmitter.

H. D. Arnold, Director of Research, upon whom the degree of Doctor of Science was conferred by Wesleyan University in recognition of his leadership in industrial research

The operation of the system involves an ingenious method of monitoring which is possible only by reason of the frequency stability just mentioned. At Marengo, Iowa, a point about midway of the 190-mile distance between the two transmitters, a radio receiver was installed and tuned to both stations. The program is picked up and sent over a telephone line to Davenport where it is put on a loud speaker in the control room of station WOC. Should the carrier frequencies of the two stations be slightly different, the loudness of the signal received will vary up and down, the rapidity of the variations being a measure of the number of cycles difference between the two carriers. By a fine adjustment on the crystal oscillator of WOC the operator can make the variation in volume take place as slowly as may be desired, rates of one



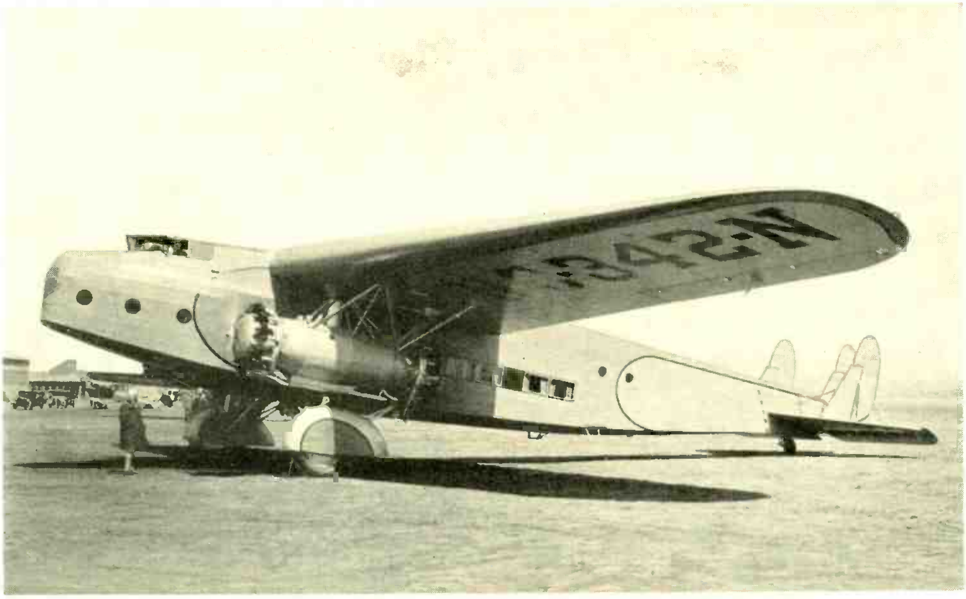
The Laboratories entertained, on June 4, Sir William Henry Bragg, Director of the Royal Institution of Great Britain, and lately recipient of the Franklin Medal. Seated: F. S. Goucher, W. Wilson, H. D. Arnold, Professor Bragg, Mr. Charlesworth, R. R. Williams, H. E. Ives. Standing: John Mills, R. M. Bozorth, L. H. Germer, C. J. Davisson

cycle in 30 seconds being quite common. This corresponds to a difference in the two carriers of one part in 30 million.

Before the inauguration of this system, WOC and WHO shared a cleared channel, each station using the channel on alternate periods. Under the proposed arrangement, authorization for which is being sought from the Federal Radio Commission, each station will operate during all broadcasting hours, transmitting a common program. Results of listening tests and field strength measurements indicate that very much better service is being given to broadcast listeners in nearly all the zones that were served by either station under the old arrangement. This is borne out by comments from listeners themselves, letters having been received from distances of more than a thousand miles away to this effect. This improvement in distant service is in addition to the reaction to listeners in the two other cities themselves, who were formerly without service from their local station during 50 per cent of the time.

Talks from California Plane to Notables in Europe

Airplane radio equipment developed in the Laboratories was used to extend Bell System transatlantic telephone service to an airplane of Western Air Express when on May 29 calls were made to a number of notable people in Europe. Cruising over Southern California, persons in the plane conversed with Premier Mussolini in Rome, Ambassador Dawes in London, and Managing Director Milch of the Lufthansa in Berlin. Twenty-nine planes of Western Air Express are now equipped with West-



An F-32 Fokker plane, one of the fleet recently purchased by the Western Air Express and all equipped with Western Electric aircraft telephone apparatus

ern Electric two-way radio telephones.

Work of Laboratories Presented in Boulder and Denver

"Miracles of modern science"—the designation is the newspapers'—were revealed to Colorado audiences by S. P. Grace during the latter part of May. On May 22 he spoke at Boulder before the Colorado Engineering Council as a feature of the Engineers' Day program at the University of Colorado. On May 28 he spoke in the municipal auditorium at Denver under the auspices of the local A.I.E.E. section. Arrangements for the visits were made by President F. B. Reid of the Mountain States Telephone and Telegraph Company. Mr. Grace as usual was accompanied by R. M. Pease who had charge of the demonstrations.

The Boulder meeting was attended by a large representation of technical and business people from all over the state. Practically the entire student body of the engineering sections of the University of Colorado attended the meeting as well as a delegation from the University of Wyoming. Mr. Grace and Mr. Pease were introduced by President George Norlin of the University.

The Denver meeting was one of the largest Mr. Grace ever addressed. Demands for admission, which was by ticket only, exceeded ten thousand. Owing to the limitations of the auditorium the audience was held down to four thousand with several hundred standing. In the demonstration of the call announcer at this meeting President Reid of the Mountain States Company operated the dial flashing the pulses over the long lines to New York City. For this demonstration G. V. Smith was in charge of the call announcer apparatus here in the Laboratories and B. McWhan lined up the toll circuits.

Greetings to Boston Banquet Sent by Airplane and Liner

A novel dinner feature was introduced at the recent Alumni Reunion Banquet of Massachusetts Institute of Technology when the assemblage listened through loud speakers to a triangular conversation between the toastmaster and two graduates located one in an airplane and the other on a transatlantic liner.

The banquet, which was attended by President Jewett and Vice-President Charlesworth, M.I.T. 1905, was held in Boston on June 7. During the dinner Mr. Desmond, the toastmaster, was notified of a telephone call. It proved to be A. R. Brooks, who was M.I.T. 1917, flying over New Jersey in one of the Laboratories' airplanes. After an exchange of greetings, in which Captain Brooks spoke for Technology men in aviation he arranged for a connection with *S.S. Leviathan*. Greetings from alumni on the high seas were then expressed by J. G. Chaffee, M.I.T. 1923. As a climax, Captain Brooks from the clouds led the diners in a Technology cheer.

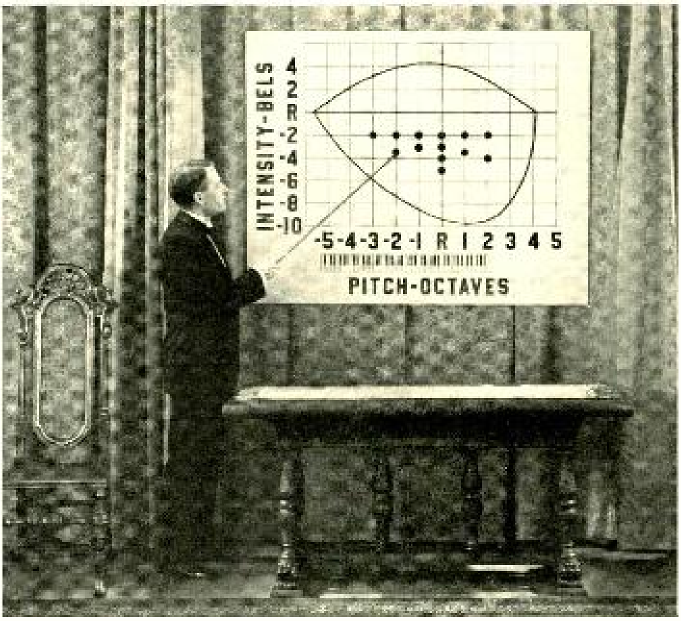
A. R. Brooks at the controls of one of the Laboratories' planes

In the plane was installed a Western Electric radio receiver and transmitter. From the plane the conversation passed by radio to and from the Laboratories' ground station at Whippany whence it proceeded by long-distance wire circuits of the American Telephone and Telegraph Company to Boston. Communication with the *Leviathan* was by the ship-to-shore radio-telephone link; the two circuits were tied together at the Long Lines office at Walker Street under the direction of Captain Brooks.

Acoustic Pitfalls Illustrated by Dr. Fletcher in Sound Film

Harvey Fletcher delivered the Presidential address at the convention of the American Federation of Organizations for the Hard of Hearing in New York. He also addressed the Federation on the physical factors involved in sound perception,employing a sound picture as an adjunct to make a number of demonstrations. This film was produced in our Sound Picture Laboratory at the instance of Electric Research Products, Inc., to demonstrate some of the common acoustical and electrical pitfalls which must be avoided if good quality is to be achieved. In the films Dr. Fletcher appears as lecturer, and the demonstrations are sound effects which accompany his talk.

One of the most interesting of these demonstrations shows how the character of the room in which sounds are produced modifies the quality of the



In this scene from the sound-film "Acoustic Principles" Harvey Fletcher indicates on a diagram the pitch and intensity of tones as they are sounded. Curved lines enclose the range of tones which the human ear can hear

sound. In general the walls reflect the sound with various degrees of efficiency, and so an auditor in the room hears the original sound echoed many times. When the room is small these echoes follow one another so rapidly that they are not heard as distinct sounds but are merged together into a reverberant effect. This is demonstrated by the ingenious method of playing a phonograph record through several reproducers; in the combined outputs some of the sound currents were delayed as much as the sound itself would have been had it been picked up after reflection from various walls.

After the film, Dr. Fletcher in person pointed out that the principles demonstrated in the film were applicable to the provision of improved hearing for the deaf. While intensity is of first importance to those who are very deaf, the other elements of good quality—faithful transmission and freedom from unwanted sounds are also to be striven for. Reverberation effects are particularly troublesome when the speaker is talking at a distance from the microphone. It is for this reason that hearing aids which are carried by the user have been largely unsuccessful in amplifying speech from a distant speaker. The best results are secured when the hall or theatre is equipped with a voice reinforcement system in which the microphone is located in the immediate neighborhood of the speaker so that what it picks up is mostly his voice and reverberation effects are at a minimum.

ADMINISTRATION

On May 15 Dr. Jewett attended a luncheon held at the Hotel Astor in connection with the fourteenth annual meeting of the National Industrial Conference Board and spoke on *The Science Motif of the Chicago World's Fair Centennial Celebration.* On the following day he visited Pennsylvania State College and addressed the Industrial Conference convening there on the subject, *The Supply of Technical Men for Industry.* He was also at the Bell System Commercial Conference at Shawnee for several days.

As a member of the Corporation of Massachusetts Institute of Technology, Dr. Jewett attended the inauguration of Dr. Karl Taylor Compton as President of the Institute. While in Cambridge he was a guest of the Class of 1903 at a dinner and also of the Alumni at their general Reunion Dinner.

H. P. CHARLESWORTH attended the Commercial Conference at Shawnee on May 26 and gave an address on the Laboratories' activities.

W. L. RICHARDS, Consulting Historian and a member of the Bell System for over fifty years, retired from service on July 1. An account of Mr. Richards' activities in his half-century of service appears in BELL LABORATORIES RECORD, October, 1928.

Our Insurance Counselor

SOME three years ago Lloyd H. Bunting of the Equitable Life Assurance Society was selected as insurance counselor in the Laboratories in connection with the Payroll Deduction Plan for life insurance premiums. He has made many friends here and still many more might have availed themselves of his years of experience in planning insurance protection had he not adhered so strictly to the principle of waiting for people to seek his services. Some, too, hesitate to approach a life-insurance agent unless they actually wish to purchase insurance.

There is, however, no obligation on anyone who consults Mr. Bunting as to insurance in general or any of its phases. Many of our people would do well to inquire whether the amount of insurance already carried by them is in correct proportion to their incomes and to the other items on their financial programs, or whether the type of insurance held would give the maximum of protection to their families in the event of any misfortune. These are questions of vital concern to everyone and ones which Mr. Bunting would gladly answer, and in strictest confidence.

Mr. Bunting may be found every afternoon in Room 144 at West Street and may be reached on extension 264 when an appointment is desired.

Departmental News

A SYMPOSIUM on Two-Way Television, consisting of three papers, was presented in abridged form before the A. I. E. E. convention in Toronto by H. E. Ives. Image transmission was treated by Dr. Ives, Frank Gray and M. W. Baldwin; synchronization by H. M. Stoller, and the acoustic system by D. G. Blattner and L. G. Bostwick.

* * * *

AN INSPECTION of the dial telephone equipment on the airplane carriers *Saratoga* and *Lexington* was made at Hampton Roads by H. A. Larlee, J. M. Hayward, B. Freile, James G. Ferguson, L. D. Plotner, and G. V. King.

* * * *

REAR-ADMIRAL PEOPLES, in charge of the supply base of the Atlantic Fleet at Brooklyn was a visitor to the Laboratories on May 22. He made an inspection tour of the building under the guidance of G. F. Fowler and accompanied by his cousin, R. E. Peoples of Local Circuit Development.

* * * *

THE FOLLOWING members of the Patent Department have visited Washington in connection with the prosecution of patents: E. W. Adams, G. F. Heuerman, E. V. Griggs, G. H. Heydt, W. C. Parnell, O. E. Rasmussen, J. W. Schmied. J. G. Roberts and G. M. Campbell both made trips to Ottawa and Wilmington.

PERSONNEL

A LUNCHEON CONFERENCE with the Massachusetts Institute of Technology cooperative students who have spent the last four months in the Laboratories was held by G. B. Thomas and R. J. Heffner during the past month. These students have two more terms at the Institute and one more training period with the Bell System, and are scheduled to receive their degree of M.S. in E.E. in 1931.

M. B. LONG attended the Washington meeting of the Physical Society.

M. L. WILSON has been elected Vice-President of the Physics Club of New York, an organization of high school teachers.

PUBLICATION

W. C. F. FARNELL gave a brief talk and demonstration of sound pictures at the Masonic Temple in Rutherford. He also attended the twenty-fifth annual meeting of the American Association of Museums at Buffalo.

A CONFERENCE of the supervisory staff of the Cleveland Public Schools was attended by John Mills, who discussed the application of telephonic devices — radio, phonograph records, sound pictures and public address systems, and television — to education in primary and secondary schools.

THE MEDAL DAY Exercises at the Franklin Institute in Philadelphia were attended by Herbert E. Ives and C. J. Davisson.

H. E. IVES was a member of the committee on arrangements for the American Physical Society meeting at Cornell University at which Sir William Bragg was a guest of honor.

K. K. DARROW sailed on the *Mauretania* for Europe, where he will devote the summer months to special studies of physics at laboratories and universities on the continent.

E. W. CONGER has been at Hawthorne on handset studies.

CHEMICAL LABORATORIES

AN ADVISORY COMMITTEE meeting of the Metal Division of the Bureau of Standards was attended by J. E. Harris and E. E. Schumacher in Washington. Mr. Harris visited Hawthorne on matters concerned with cable sheath development.

IN CONNECTION with special studies being made on hydrocarbon waxes, J. H. Ingmanson made a visit to the Standard Oil Company of Indiana at Chicago.

A. G. RUSSELL gave a recent talk before the Providence Section of the American Electroplaters' Society at Providence.

C. L. HIPPENSTEEL's work on corrosion required his presence in California and New Orleans during the latter part of April and the first of May. The trips had to do with burial tests on lead-covered drop wire.

F. C. KOCH attended a committee meeting of the American Wood Preservers Association at Philadelphia on standardizing methods of analyzing distilled creosote.

VISITS TO Norfolk, Charleston, Huntington, Altoona, Atlantic City, and Stamford were made by D. C. Smith on atmospheric dust and sulphur compound studies. He was accompanied at Norfolk, Altoona and also at Atlantic City by R. M. Burns.

R. M. BURNS, H. E. HARING and A. G. RUSSELL attended the meeting of the American Electrochemical Society at St. Louis.

L. T. SMITH attended the convention of the Society of Motion Picture Engineers in Washington.

A balance accurate to one five-hundred thousandth of a gram! It is used in the work under H. T. Reeve and is being operated by R. S. Sclater

ACOUSTICAL RESEARCH

HARVEY FLETCHER made a trip to the west coast to confer on acoustical matters with officials of Electrical Research Products, Inc., at Hollywood.

MEETINGS OF the Otological Society at Boston and the Triological Society at Atlantic City were attended by R. L. Wegel.

SUBMARINE CABLE

IN CONNECTION with their work on the transatlantic telephone cable E. T. Burton and E. M. Boardman sailed for Ireland in May.

An address on *Recent Developments in Ferromagnetics* was given by G. W. Elmen before the graduate electrical engineering students at Yale.

Laboratory Engineering

C. A. Kotterman was in Washington to inspect the scientific exhibit maintained by the Laboratories at the National Academy of Sciences.

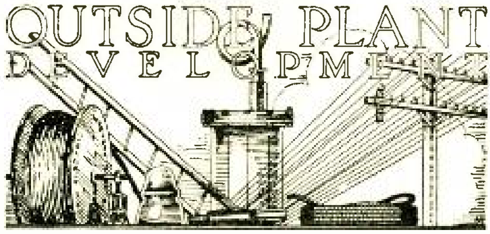
Various firms in Detroit, Toledo, Flint and Pittsburgh were visited by R. O. Mercner in connection with design and drafting facilities.

On June 23, J. J. Fennelly completed twenty years of service with the Western Electric Company and the Laboratories. As Research Service Manager Mr. Fennelly has charge of storerooms, orders for material, and messengers.

Tube Shop

On June 14 John Goetz completed thirty years of service with the Western Electric Company and the Laboratories. He entered Western Electric in this building as a packer. In 1905 he was made inspector on transmitters and receivers and for seventeen years was engaged in this work. Vacuum tube manufacture was taking on increasing importance and he was assigned to this work in 1922. Shortly after, he moved with the Tube Shop to Hudson Street. At present Mr. Goetz' work is putting together and welding elements which make up the plate assembly for vacuum tubes used in radio transmitters. He has worked on some of the largest tubes made in the Tube Shop.

John Goetz



Cable Development

G. A. Anderegg has been at Hawthorne on general cable problems.

To observe the handling of a wire-armored telephone cable which was being laid across the Hudson River F. B. Livingston made a two-days' visit to Dobbs Ferry.

J. G. Brearley completed twenty years of service with the Western Electric Company and the Laboratories on June 20.

Plant Apparatus

R. H. Colley and R. C. Eggleston attended a meeting of the American Standards Association sub-committee on Pole Dimensions held at Minneapolis. Mr. Colley also spent some time at the Forest Products Laboratory in Madison, Wisconsin, in connection with problems of timber strength and timber preservation.

C. H. Amadon was in Gulfport and Jackson, Mississippi, on matters of timber preservation.

Old poles in the Butler-Oil City pole line which recently have been given a spray-treatment were inspected by A. H. Hearn to determine the efficiency of the treatment.

L. W. Kelsay was in Philadelphia on May 15 and 16, with regard to the conversion of a standard underground cable terminal for special use on toll lines.

WIRE DEVELOPMENT

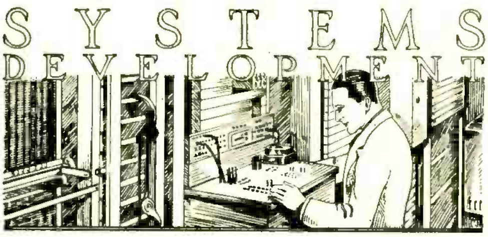
C. S. GORDON and W. S. HAYFORD were in Jamestown and Buffalo on a field trial of a new method for making sleeve joints in line wire. Mr. Gordon also visited the Seymour Smith and Sons Company plant at Oakville, Connecticut, regarding the development of methods for testing tree-pruner handles, and the Snell Auger Bit Company plant at Fiskdale, Massachusetts, in connection with developments and specifications for auger bits.

CERAMICS APPARATUS

V. B. PIKE was at Hawthorne concerning the development of cast-iron splice cases for tape-armored cable.

THE APPLICATION of a new method for waterproofing underground clay conduit was the occasion of a visit by J. M. Hardesty to Philadelphia.

S. M. SUTTON went to Chester on a field trial of prejoining sections of mitred clay conduit using the mortar-bandage conduit joint.



TWENTY-FIVE years with the Western Electric Company and the Laboratories were completed by S. B. Williams, Fundamental Development Engineer, on June 30.


S. B. Williams

His career in the telephone industry antedates his association with the Western Electric Company which began at the Clinton Street factory in Chicago in 1905. When going to high school in Dayton, Ohio, he spent three of his summer vacations working with the Central Union Telephone Company. When he completed his high school course he worked for a two-year period with the National Cash Register and then entered Ohio State University. It was following his graduation in 1905, with the degree of M.E. in E.E. and Sigma Xi honors, that he came with the Western Electric on the then-existing 'Contract Student Course.'

In 1907 he was transferred from Chicago to the Circuit Laboratory here on West Street and in 1909 was placed in charge of manual circuit development. From 1912 to 1916 he was in charge of machine switching circuit development, other than panel type semi- and full-mechanical systems. During this period the work under his direction was important in the Wilmington-Branch Brook trials of the call distributing system. In 1918 he worked with a special group engaged in radio development and submarine detection. At the termination of the war he was transferred to the newly-created Telephone Systems Engineering Department which was engaged in fundamental development studies. He was placed in charge of fundamental developments of circuits and systems in 1929. In 1926 Mr. Williams was elected to fellowship in the American Institute of Electrical Engineers.

The cut-over of a new toll office and the two new panel dial offices at Detroit on May 31 was attended by Messrs. C. White, B. W. Kendall, R. H. Miller and H. H. Lowry. The toll office incorporated a number of new features including the initial installations of both the No. 8 circuit control board and the key pulsing system to be used with toll boards. In addition to the engineers who have been out in previous months preparing the testing of these and other features, J. Meszar was in Detroit to assist in toll circuit features and Karel Lutomirski made tests on the transmission measuring apparatus associated with the circuit control board. The new toll office was successfully cut into service during the night of May 31. G. E. Bailey and A. E. Petrie spent several days at Detroit previous to cut-over to make sure the improved facilities were satisfactory.

Panel call indicator equipment of the automatic display type at Washington was studied by P. B. Fairlamb.

A. J. Pascarella went to Philadelphia to consult with Leeds & Northrup on the design of a highly insulated Wheatstone bridge.

Local Circuit Development

An inspection tour of step-by-step offices in the Smithtown, Long Island, area was made by M. C. Goddard, H. A. Sheppard, and C. P. Stocker with particular regard to unattended offices. L. T. Cox and A. R. Bertels visited Armonk, New York, for a similar purpose.

R. E. Hersey made a trip to Detroit for the first installation of toll key pulsing equipment and to attend the cut-over of the No. 3 toll board.

The cut-over of the first three panel offices at Washington was attended by H. C. Caverly.

A trip through Connecticut was made by A. B. Sperry, R. E. King, and P. L. Wright on matters relating to step-by-step tandem systems at New Haven, Hartford and Bridgeport.

J. W. Gooderham and M. E. Krom were at Beverly Hills, Massachusetts, investigating interference by the 750-A P.B.X. to radio reception.

Twenty years of service in the Bell System were completed by R. E. Peoples on June 1.

Field Studies

To investigate the sending of call-indicator signals from Boston to Providence, G. A. Hurst visited these two cities.

W. J. Lacerte was at Springfield, Massachusetts, where a trial installation is being made of two-party message rate equipment.

Toll Circuit Development

Tests of the trial installation of the new Wheatstone bridge circuit at Harrisburg and Reading have been conducted by F. B. Anderson.

A paper, *Long Distance Cable Circuits for Program Transmission*, written jointly by A. B. Clark of A. T. & T. and C. W. Green was presented at the summer convention of the A. I. E. E. at Toronto.

H. M. Pruden has returned from Buenos Aires where he spent several months in connection with the opening of the radio channel between Buenos Aires and New York.

Telegraph Development

A. M. Koerner went to Denver to

engage in field work on the prevention of static interference in open wire carrier-telegraph circuits. Later he went to El Paso to continue the same study and will probably remain until about September 1. C. B. Sutliff is in Denver cooperating in the tests.

W. C. Gunter returned from Chicago where he has been engaged in testing a trial installation of a carrier telegraph pilot channel on an open-wire carrier telegraph system between Chicago and Denver.

Special Equipment Development

J. Shea spent several days at the Boston Toll Office while arranging for the installation of a voltage regulator for the plate batteries.

A visit to Harrisburg was made by G. M. Green to arrange for the trial installation there of an improved toll line busy signal.

G. C. Bradbury was in New Haven for several days making improvements on the No. 2 information desk.

A trial installation of message register trunks in the step-by-step office at Springfield, Massachusetts, was supervised by K. C. Wilsey.

F. G. C. Volkert investigated the busy tone conditions in the No. 7 Office at Albany.

S. J. Brymer visited Forked River to arrange for the installation of additional power facilities for ship-to-shore radio-telephone receivers.

The cut-over of the first panel dial central office equipments at Washington was attended by E. J. Johnson.

Dial Equipment Development

E. J. Kane and J. G. Ferguson visited the Northern Electric Company at Montreal to discuss improvements in step-by-step equipment.

T. C. Campbell visited the Mattatuck Manufacturing Company of Waterbury, Connecticut, with O. E. Hill and W. W. McWilliams of the Western Electric Company and I. V. Williams of the Apparatus Development Department to inspect preliminary samples of the new adjustable flat-type cable clip.

Several days at the factories of the Gamewell Electric Company and Holtzer-Cabot Electric Company, Boston, were occupied by E. K. Eberhart and R. W. Harper in studying various alarm equipments with reference to the alarm systems for central offices.

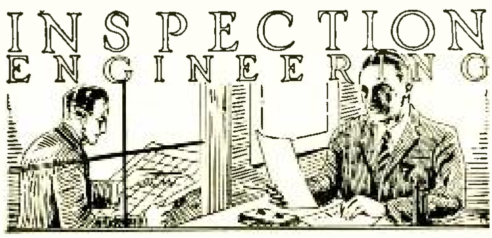
Power Development

J. H. Sole made a trip to Boston for the trial installation of an improved voltage regulator.

H. M. Spicer visited the Palmer Electric & Manufacturing Company's plant at Waltham, Massachusetts, to investigate automatic reclosing circuit breakers and a master switch for a small number of motors.

Radiator cooling units for type "R" engines were inspected by V. T. Callahan at Buffalo.

Noise measurements on power plants at Philadelphia and Stroudsburg, Pennsylvania, and Atlantic City and Ocean City, New Jersey, were made by M. A. Froberg.



G. D. Edwards, with J. L. Dow of Systems Development, attended the conference of Bell System General Plant Supervisors held at Shawnee-on-

Delaware June 4-12 under the auspices of the American Telephone and Telegraph Company. D. A. Quarles and H. T. Martin attended the sessions which dealt with outside plant and station apparatus.

Apparatus Inspection

A. F. Gilson visited the Gulfport Lumber and Creosoting Company at Gulfport and the National Lumber and Creosoting Company offices at Houston and St. Louis, to discuss pole-creosoting processes. While in Houston Mr. Gilson made a trip into the forest preserves of the latter concern to observe lumbering operations.

Quality surveys on switchboard jacks, and transformers and coils were attended respectively by J. F. Chaney and H. C. Cunningham at Kearny. S. H. Anderson attended a similar survey on protector blocks at Hawthorne.

F. I. Smith made a trip to Fanwood, New Jersey, to examine the vitrified clay conduit being installed in that vicinity on the Newark-Princeton Toll Cable.

A visit to Hawthorne was made by W. A. Boyd and W. F. Vieth to discuss inspection methods and procedures on Special Apparatus with various members of the Western Company's Manufacturing and Check Inspection organizations. Mr. Vieth also visited the Electrical Research Products, Inc., in Chicago to discuss turntable drives used with talking motion picture apparatus.

Systems Inspection

A. G. Dalton recently made a trip to Montreal to attend the bi-monthly Field Review Conference held by representatives of the Inspection Engineering Department of the Northern Electric Company and Staff Engineering and Building and Equipment organizations of the Eastern and Western areas of the Bell Telephone Company of Canada.

H. F. Kortheuer attended a quality survey conference on voice frequency carrier telegraph equipment at Kearny.

Unattended community dial offices at Bedford and Armonk were visited by H. K. Farrar to obtain information in preparation for a quality survey on test sets for use in small step-by-step central offices. T. A. Crump went to Westchester, Pennsylvania, to prepare for a similar survey on No. 11 switchboards.

D. S. Bender made trips to New Bedford and Worcester to discuss ringing-machine installations with the Telephone Company's Engineering and Plant Department people in those cities. He was also in New Haven and Boston to attend Field Review Conferences.

Matters concerned with 92-type switchboard jacks occasioned a visit by T. L. Oliver to McComb, Mississippi. Mr. Oliver also visited Charlotte to inspect a No. 3 toll switchboard installed there.

C. A. Johnson, field engineer in the Chicago territory, spent several days in New York discussing field engineering matters with various members of the department. Upon his return to Chicago, Mr. Johnson visited Evanston and Milwaukee in connection with routine inspection work.

A number of days in Fort Worth and Dallas were spent by E. J. Bonnesen in connection with power-equipment installation work. He later visited Kansas City to discuss various types of toll-cable and panel circuits.

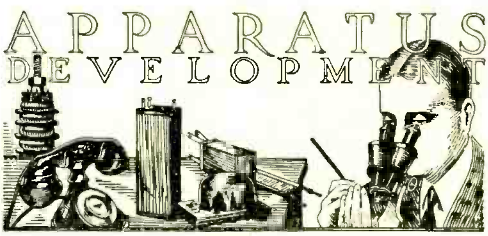
W. E. Whitworth attended Field

Review Conferences in Cincinnati and Columbus and visited Elyria, Akron and Toledo in connection with complaint investigation matters.

SPECIAL FIELD investigations called H. W. Nylund to Portland and Field Review Conferences, to Los Angeles and Seattle.

I. W. WHITESIDE, field engineer of the Philadelphia territory, visited New York to confer on field engineering matters with other members of the Department. Upon his return routine investigations took Mr. Whiteside to Harrisburg, Pittsburgh and Wilkes Barre.

R. C. KOERNIG was in Des Moines and Denver for Field Review Conferences. During his stay in the latter city Mr. Koernig visited Boulder and attended S. P. Grace's lecture.



MATERIALS DEVELOPMENT

ACCOMPANIED BY G. M. Bouton of the Research Department, C. H. Greenall spent two weeks at Hawthorne in connection with the extrusion of the Joliet-Ottawa cable.

J. R. TOWNSEND was also a visitor to Hawthorne where he discussed lead cable sheath and other materials problems with members of the Western Electric Company's engineering staff.

W. A. EVANS visited Hawthorne for a week's stay in connection with various insulating material problems.

I. L. HOPKINS visited the E. R. House Company at Unionville, Connecticut, and discussed the preparation of the material used for the handset mounting sub-base.

BASE-METAL contact work required E. Montchyk's presence in Altoona and Harrisburg during the past month.

ON MAY 22 F. F. Lucas was a guest at the Patent Department luncheon and spoke on high-power metallography and ultra-violet microscopy. At the joint chapter meeting of the American Society for Steel Treating in Newark Mr. Lucas delivered an after-dinner talk on *Impressions of Japan.*

TWENTY YEARS of service with the Western Electric Company and the Laboratories were completed by Irving C. Pettit on June 27.

MANUAL APPARATUS

PROPOSED CHANGES in coin collectors were discussed by O. A. Shann, F. A. Hoyt, and C. H. Wheeler at the Gray Telephone Pay Station Company in Hartford.

B. O. TEMPLETON spent a week in Hawthorne to discuss the details of the new wall-type handset mounting.

A TRIP to the Philadelphia Instrument Shop was made by W. J. Means and A. C. Magrath to discuss problems concerning the manufacture of the new automatic recording oscillograph.

J. FLEGAL visited the plant of the Westinghouse Electric and Manufacturing Company at Pittsburgh, on matters associated with the manufacture of copper-oxide rectifiers.

W. T. BOOTH visited the warehouses of the Electrical Research Products Company at Chicago and the Manufacturing Department at Hawthorne to discuss problems in connection with the repair of sound picture equipment. While at Hawthorne he also discussed questions of the repair of telephone apparatus; and later visited the Distributing House shops of the Western Electric Company at Kansas City, Detroit and Cleveland to make a general survey of the situation on repaired telephone apparatus.

Special Products

T. E. Shea, at Massachusetts Institute of Technology on May 23, aided in the oral examination of the honor students in electrical engineering. This examination was given by several men from different industrial organizations.

The communication systems on the U. S. S. *Tennessee* were inspected by E. O. Scriven, R. A. Miller, A. F. Price and H. C. Curl at the Brooklyn Navy Yard.

H. B. Arnold made a two-weeks' trip to Johnstown, Pennsylvania, and vicinity for the purpose of modifying the power-line carrier telephone equipment of the Associated Gas and Electric Company.

Questions in connection with the production of the small theatre reproducing equipment called G. Matejka to Hawthorne on June 2.

C. C. Towne also made a trip to Hawthorne to go over the work on the film-type call announcer.

H. Pfannenstiehl investigated a new projection machine in Philadelphia.

H. L. Walter spent two days in Washington conferring with Navy Department representatives on the design of battle telephone switchboards.

Transmission Apparatus

W. J. Shackelton attended an A. I. E. E. committee meeting which considered electrical definitions.

H. H. Glenn went to Point Breeze with several Western Electric Company engineers regarding the manufacture of lacquered wire.

Several weeks at Hawthorne were spent by J. R. Bardsley in connection with the continuous assembly of loading coil units.

R. M. Vail went to Philadelphia to calibrate the vacuum tube test set used in the Instrument Shop.

Also at Philadelphia, C. H. Young inspected several radio frequency bridges being made for the Laboratories by the Leeds & Northrup Company.

Dial Apparatus

G. W. Folkner attended conferences at Hawthorne on panel-type dial apparatus.

Abrasives for use in maintaining panel dial apparatus were discussed by W. T. Pritchard with representatives of the Pike Manufacturing Company at the Company's plant in Littleton, Vermont.

New developments on slow release step-by-step relays required C. R. Steiner's presence at Hawthorne during the past month.

The trial installation of 43-type signals at Harrisburg was inspected by W. C. Slauson.

J. R. Fry was at the Hawthorne plant in connection with developments on relays for protecting telephone circuits against interference.

June 20 marked the twentieth anniversary of J. S. Garvin's association with the Western Electric Company and the Laboratories. A. C. Magrath also has completed, during June, twenty years of service.

Radio Development

A conference in Chicago with Boeing Air Transport and other aviation officials on two-way radio-telephone communication was attended by D. K. Martin and W. C. Tinus. Mr. Tinus came east from Cheyenne, Wyoming, and joined Mr. Martin who made the trip from New York. The discussion pertained to the application of aircraft communication to liners engaged in the Chicago-Oakland and other air routes. Mr. Tinus then left for Oakland and Sacramento where he inspected the 400-watt ground transmitters installed by the Boeing Company. He was also at Los Angeles to supervise the installation of similar equipments for the Western Air Express.

R. S. BAIR visited Dayton to inspect the Western Electric 400-watt ground transmitter installed at Wright Field by the Army Signal Corps for experimental purposes.

ACCOMPANIED BY J. W. Gooderham of the Systems Development Department, H. T. Budenbom and W. M. Kellogg went to Beverly, Massachusetts, to make studies on the operation of a dial type 750-A PBX.

MEETINGS OF THE Institute of Radio Engineers and the Radio Club of America at Atlantic City were attended by J. O. Gargan, W. J. Adams, F. X. Rettenmeyer and C. B. Aiken.

O. W. TOWNER supervised the installation of a 5-kilowatt broadcasting equipment for Louis Wasmer, Inc., Spokane, Washington. While in Spokane, Mr. Towner also directed the installation of a 1-kilowatt broadcasting equipment for the Symons Broadcasting Company.

SURVEYS FOR the installation of 1-kilowatt broadcasting equipments for WKBH, Inc., La Crosse, Wisconsin, and for Wisconsin State *Journal* and the Capitol *Times*, both located at Madison, were made by B. R. Cole. For the Milwaukee *Journal* he also made a survey for speech input equipment.

THE LABORATORIES airplane fleet was at Washington on May 25 to demonstrate aircraft radio-telephony before government officials, associated with the licensing, regulation and operation of airplanes, and prominent air lines executives. The demonstration which was given at Bolling Field was run off very successfully and provided to a large and important group of aeronautical officials an intimate picture of the aircraft communication equipment and its general capabilities.

Those who made the trip to Washington and discussed communication problems with those witnessing the demonstration were: O. M. Glunt, E. L. Nelson, F. M. Ryan, D. K. Martin, F. S. Bernhard and D. B. McKey. The planes were piloted by A. R. Brooks and P. D. Lucas, and mechanics W. A. Funda and C. T. Garner.

* * * *

AT THE INVITATION of the Navy Department, F. M. Ryan with L. E. Whittemore of the American Telephone and Telegraph Company accompanied the Battle Fleet to the recent naval manoeuvres off the Virginia Capes, during which President Hoover reviewed the Fleet.

Mr. Ryan boarded the *West Virginia* and Mr. Whittemore the *California* on Monday, May 19, shortly before they steamed down the Hudson. After an all-night cruise the fleet arrived off the Virginia Capes on the morning of May 20. Here Mr. Ryan joined Mr. Whittemore on the *California*. After the review, the Bell System men boarded the airplane-carrier *Saratoga* and examined the telephone systems used for communication between the vessel and planes.

STAFF

ALEXANDER THE GREAT in severing with his sword the Gordian Knot had nothing on the late Rudolf Albrecht, foreman of the tin shop a

Goodwin Rosenblum

number of years ago. In 1898 when a young man by the name of Goodwin Rosenblum came to work in the shop, Albrecht from the beginning encounttered trouble in pronouncing his first name. "From now on" he exclaimed one morning as he vainly strove to get by the 'w', "your name is John". And to countless friends and associates throughout the Bell System Goodwin Rosenblum has been 'John' ever since.

After 32 years in the present building 'John' left on May 31 for a month's vacation and retired from active duty on July 1. In this stretch of years the sheet metal department has grown from Albrecht and his lone assistant to its present force of twenty-nine men. In 1910 Rudolf Albrecht retired and it was a natural consequence that his mantle of authority should fall on the shoulders of his younger understudy. In the years that followed the youthful telephone industry was rapidly expanding and numerous new developments came into being. When the transcontinental circuit was projected the engineers told 'John' what they wanted and 'John' furnished it. A departure from the usual run of work confronted his department when the horns for the early public address system were required, but they were constructed and provided in exact accordance with the specifications. Several years later when sheet-metal work was needed in building the apparatus for transatlantic telephony by means of radio 'John's' department eminently performed its part of the task. With television, the application of sound to the 'movies', ship-to-shore telephony and the powerful transmitting and receiving apparaus for the recently opened South American circuits, it has been the same story. In fact it has become a by-word that 'John' has never been known to say 'No, it can't be done'.

The people in the Sheet Metal shop agree that 'John' can get along pretty fast, even though he walks with a cane, and he is still active and energetic despite his three-score or thereabouts of years. But 'John' himself felt he should step down and make way for a younger man—"The System is constantly growing, adding new work, and it is only natural that I should be slowing up" is the way he puts it. So, while regretting to leave the work that he has given the greater part of his life, and separate himself from his wide circle of friends in the building, he is looking forward to his well-earned leisure. Upon his departure his associates in the shop presented him with a Howard watch with a white-gold case. In addition he was given a bust-portrait of himself, hammered in copper in the form of a circular plaque. The work was artistically executed by William Paulsen of the Sheet Metal shop.

For the time being he plans to go to California where a daughter of his resides. "I had a grandfather that lived to 112 years of age," 'John' philosophically comments, "and I shouldn't be surprised if I live as long."

* * * *

THAT EXCLUSIVE COMPANY in the Plant and Shops Department, of men who have been with the Bell System a quarter of a century or more, was augmented by the addition of Fred Berger to its membership on June 29. He has worked for the Western Electric Company and the Laboratories in the present building for twenty-five years.

Starting as a tool and die-maker for the Western Electric Company, after a period of two years he was transferred to the model shop and worked for eight years there on instrument making.

He was then made assistant foreman in charge of this work and in 1928 was placed in charge of the manufacture of short-wave radio equipment in the shop. He has supervised the construction of the transmitters, receivers, rectifiers, switchboards and measuring sets for the transoceanic short-wave stations at Lawrenceville and Netcong; the ship-to-shore stations at Forked River and Deal Beach; and for the South American radio-telephone stations both in this country and in the Argentine Republic. The twenty-fifth anniversary of his association with the Bell System found him engaged on the construction of equipment for the newly planned station on the West coast which will soon send powerful short-wave signals across the Pacific.

* * * *

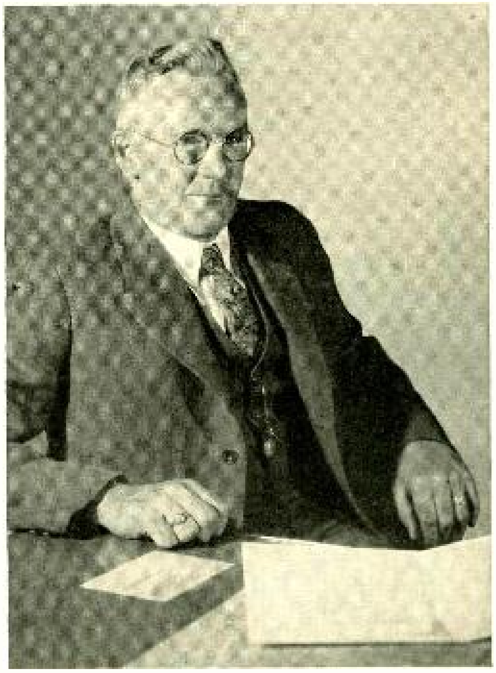
JOHN GROELING, in charge of the storeroom in the Building Shop, died at the Staten Island Hospital on May 19 after a 10-day illness. Mr. Groeling, who was 62 years old at the time of his death, had been in the Bell System nearly forty years. He was well liked by his associates in the Building Shop and the news of his death was received with much regret.

Six men from the Building Shop, with a combined service of 184 years, acted as honorary pall bearers at Mr. Groeling's funeral. These men, long associated with the deceased, were: W. C. Calmar, L. Barbieri, Sr., J. Bickler, G. Hess, A. Verrastro, and A. Wolff. The shortest service in the group was that of Mr. Hess, 26 years; the longest, Mr. Barbieri, 38 years.

Fred Berger

John Groeling

On May 28 about 120 members of the Building and Shop Department gathered in the restaurant, not, as Superintendent G. F. Morrison explains, to give a dinner in honor of W. C. Calmar, but to join with him in a final meal before his retirement from the Laboratories. Mr. Calmar after thirty-three years of service left May 31 for a month's vacation and his retirement from active duty took effect on the first of July.



W. C. Calmar

The announcement of Bill Calmar's retirement has been received with much regret not only by his immediate associates in the Building Shop but by a host of friends throughout the Laboratories. He entered the Western Electric Company in 1897, a strong-muscled youth who came to the Thames Street shop and applied for a job. The only thing open was a temporary job of pipe-fitting and he started on this work. When it was finished in three weeks, the foreman was highly impressed with the capabilities of this new employee, so instead of letting him go he was sent to install the machinery in Section B of the present building, which was then newly constructed for the manufacture of telephone apparatus. He worked on pipe-fitting and the setting up of machines until 1907 when he transferred to building engineering. He had shown, however, good executive and leadership abilities in his work in the shop, consequently when the foremanship of the pipe-fitting group became vacant a short time later Bill Calmar was agreed upon as the ideal man to fill the job. He headed the pipe-fitting group until 1917 when he was made night building superintendent during the war period when an extensive night force was working, mostly on vacuum tubes for government use. After the signing of the armistice he was named head of the Building Service in charge of policing and elevator operation. In 1923 he was promoted to general foremanship of the Building Shop in charge of his old pipe-fitting group together with all other building mechanics.

As a token of esteem, he was presented with a diamond ring with a white-gold setting by his associates in the Building and Shops department. The presentation was made by Plant Manager W. B. Sanford who eulogized Mr. Calmar's long years of service. Mr. Sanford in his talk expressed sorrow in seeing him go, and on behalf of his department and himself expressed heartfelt wishes for future years of health and happiness. He was also presented with a testimonial card signed by the members of the department attending the dinner.

Bill Calmar was a valued member of the Laboratories staff, an intelligent and capable supervisor of the work carried on in the Building Shops, and a foreman regarded with esteem and affection by the men working under him. He had a philosophy that was direct and simple: to do your job thoroughly and to have a thought in mind for the welfare and happiness of the men working with you. His thirty-three years in the Bell System stand out as an eminent fulfillment of this philosophy.

John Conge and Pasquale Levigne, who have worked as cleaners in the present building during the past twenty-four years, were retired from active duty on July 1. Mr. Conge worked in the shipping and receiving department where he was highly regarded because of his sunny and pleasant disposition and it is with much regret that Foreman J. Bryson and the men in his department see him go. Mr. Levigne was employed in the building shop and had been on sick leave for some time from injuries received in an automobile accident.

To care for increased personnel of the Laboratories five new sections of the telephone switchboard were cut into service on May 26. The additions provide 280 new lines but despite this increase, new sections, which are now in the making, will have to be installed by the end of the year if the normal rate of growth in the Laboratories personnel prevails.

Lines temporarily assigned to the 60-139 series, to meet emergency conditions, have been included in the 1600 series with the installation of the new sections. As the demand grows the numbers in the 1700 and 1800 series will be utilized. Unlike the Davis Building which has a separate PBX, the recently occupied Graybar-Varick quarters is being served through the West Street switchboard.

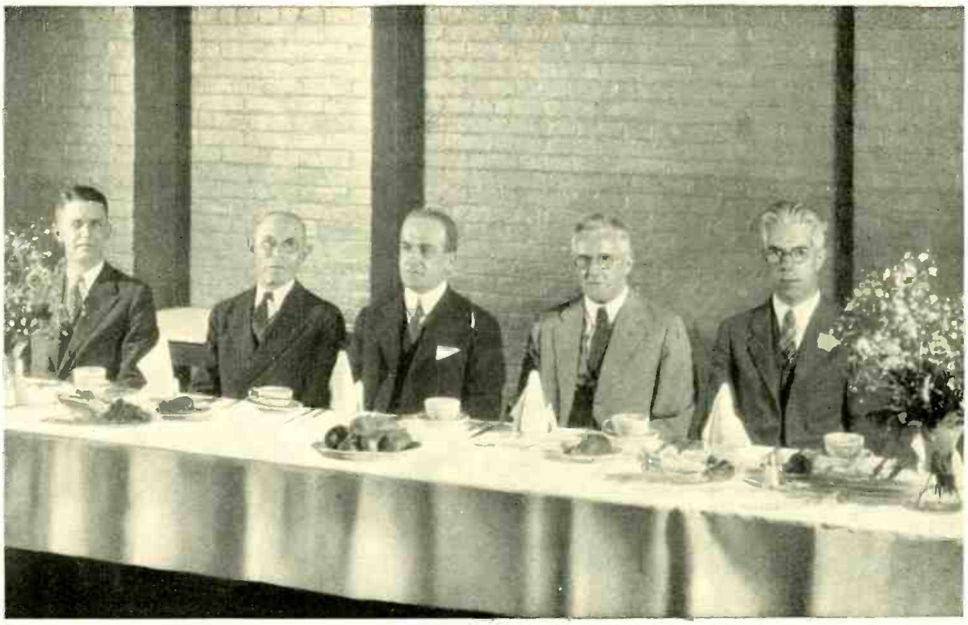
Four thousand persons in the building and 285 in the Collier Building as well as the Graybar-Varick group, are now being served through the West Street board by forty-eight young ladies ably supervised by Anna M. Menig. All operators have had at least two years' training with the New York Telephone Company before being assigned to the Laboratories' work.

CLUB NOTES

In reading over the month's program of the Hiking Club it is difficult for us on the outside, as we loll in summer hammocks and sip cooling lemonade, to escape the conclusion that from somewhere within the being of the club there must rise a spring of rare inventive genius directed to the devising of new and unusual forms of entertainment. For instance, on the Monday night of June 9 the members of the club ate a light meal at

Pasquale Levigne

John Conge



One of the tables at the Plant Department's dinner to Bill Calmar: left to right, J. G. Motley, G. Rosenblum, W. B. Sanford, Mr. Calmar, S. H. Willard

the restaurant and then bundled into a B. M. T. train for — of all places! — Steeplechase Park. Upon reaching their destination they all lined up and purchased combination tickets entitling the holder to take in everything, and with utter joy and abandon, they made a gay party of it, taking in everything. Merry-go-rounds, whips, aeroplane swings, wind tunnels, loop-the-loops and all. A slight rain fell, but the hikers out on this frolic didn't let this deter them. "Why should we let a little thing like the rain dampen our ardor?" Phyllis Barton, who led the party, asked. Yes, why should they?

Nor do the hikers let the warm weather deter them. On Saturday, June 14, they embarked upon a 10-mile hike over trails and dirt road with Kensico Quarry as their objective. The affair was climaxed with a campfire supper followed by the usual outbursts of song. On this occasion "Johnny" Barton was hostess. The following Sunday the members extended their hike to twelve miles from Hewitt to Southfields in the region about Greenwood Lake, under the leadership of Trevor Temple. One more hike was held on the Wednesday following. After work the members journeyed north to the Dyckman Street ferry and walked two miles to their campfire spot where supper was cooked, songs were sung, and laughter was unrestrained. An active life, this of the Hiking Club, with dull moments as rare as hushed notes in their campfire songs.

As THE RESULT of the doubles tournament Tennis Championship laurels in their respective classes now rest on the following players:

Class A

E. M. Tolman and K. S. Johnson.

Class B

C. D. Walker and P. G. Clark.

Supremacy in each class was only

attained after gruelling matches were hard fought every inch of the way. After defeating R. H. Wilson and H. T. Reeve in the semi-finals, the Tolman-Johnson team emerged victorious over the Elliott-Entz combination in the finals by taking the fifth and winning set.

In the Class B semi-finals Walker and Clark vanquished Donohue and Rhael in two straight sets and were matched against Jones-Boccalery. After winning the first set the Jones-Boccalery duo finally succumbed to the invincible fire of the Walker-Clark team by dropping the next three sets.

COLLOQUIUM

The Colloquium concluded its activities for the present season with the meeting on May 26, when T. C. Fry spoke on the subject *Phase Distortion.* At the previous meeting, May 12, R. M. Bozorth of the Special Research group was elected president for the 1930-31 season. R. M. Burns of the Chemical Research Department was named vice-president and L. H. Germer also of the Research Department, secretary. At this meeting F. C. Nix gave a talk on *Photo-and Electrolytic Conductivity in Non-Metallic Crystals.*

The past season was the most successful as yet enjoyed by the Colloquium. Attendance at the meetings was uniformly good, averaging nearly fifty a meeting, and the talks given were received with much interest. Outstanding on the season's program were meetings addressed by eminent authorities in physics from abroad. These speakers included G. P. Thomson of the University of Aberdeen, K. Fajans of the University of Munich, Gregor Wentzel of the University of Zurich and Otto Stern of the University of Hamburg. No definite arrangements have been made for next season but it is expected that this same policy of including occasional outside authorities on the program along with members of the Laboratories staff will be continued.

Contributors to This Issue

A. W. KISHPAUGH graduated from the University of North Dakota in 1912. After two years each with the General Electric Company and the Utah Power & Light Co., he joined the research department of the Western Electric Company. Here he was employed on radio receiving problems and on the development of radio equipment for the Army and Navy, particularly for use on aircraft. Later he was engaged in the development of apparatus and systems for the commercial applications of radio telephony and more recently in the development of broadcasting equipment. At present he is in the Apparatus Development Department in charge of broadcasting and transoceanic radio development.

R. K. McALPINE joined the Laboratories in 1925 immediately after receiving his B.S.E.E. degree from Purdue University. Since that time he has been engaged in the analysis and testing of panel system senders and associated circuits. This work has been carried on in trial decoder installation as well as in the circuit laboratory.

AFTER RECEIVING degrees of B.S. from M. I. T. and Harvard in 1918, F. J. GIVEN attended Officer's Training School, Signal Corps, at Yale University and was commissioned as a lieutenant. In 1919 he joined the Laboratories. Since that time he has been in the Apparatus Development Department engaged in design and development problems on loading coils and cases, filter coils, retardation coils, condensers, and repeating coils.

S. T. CURRAN left Cornell University in 1917, his senior year, to enlist in the Naval Reserve Flying Corp, and served overseas as an officer and airplane pilot engaged in convoy and submarine search operations. Return-

A. W. Kishpaugh

R. K. McAlpine

F. J. Given

S. T. Curran

A. S. Dubuar

H. F. Hopkins

ing to civil life in 1919 he held a position with the Army Ordinance Department appraising machinery and equipment of munition manufactures until joining the Laboratories in December, 1919. He has since been engaged in the design and development of central office apparatus.

Graduating from Newark Tech in 1917, A. S. Dubuar continued his studies at Cooper Union for three years, and then returned to Newark Tech for two more years. He left the New York Edison Company to join Bell Telephone Laboratories in 1922 and spent three years in the equipment drafting room. Since 1926 he has been with the Local Systems group engaged in the development of testing circuits for step-by-step systems.

H. F. Hopkins joined the Laboratories in 1919. After taking the Technical Assistants course, during which he was engaged in various types of work throughout the building, he transferred to the Transmission Instruments Group with which he has been associated ever since. For the last seven years he has supplemented his laboratory research with studies at Brooklyn Polytechnic School. Among the developments in which he had a part was that of the electrical stethoscope which has proved very helpful in training medical students. At present he is engaged in loud speaker development.

V. I. Cruser received the B.S. degree from Rutgers University in 1921, and joined the Installation Scheduling Department of the Western Electric Company that autumn. A year and a half later he left to become an automotive accessory designer. Returning to the Bell System in 1924, he entered the Trial Installation group of the Laboratories, and shortly afterward transferred to the Equipment Development Department. He has been interested in the design of small manual PBX's and related equipment.

V. I. Cruser