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Ionized Regions in the Atmosphere

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WITH the first transmission of radio signals across the Atlantic, a phenomenon was demonstrated which previously had been considered impossible. Electromagnetic waves of all kinds travel in straight lines unless deviated by some unusual condition, and so it had been considered impossible to transmit radio signals over long distances, because of the curvature of the earth. Success of the transatlantic transmission showed however that unless there were other elements entering into the transmission conditions than those previously considered, the theory of straight-line travel was wrong. Attempts were made to account for success of the transmission on the basis of atmospheric refraction, dispersion, and the effect of a conducting ground, but none of these explanations was entirely satisfactory. In the meantime it was suggested that the cause might be reflection* from an ionized region in the atmosphere. This suggestion was first made over twenty years ago, but it is within the last few years that the ionized zone has been shown as the real cause of the transatlantic success.

To determine the existence of reflection from such an ionized medium, efforts were made to observe it by the most direct method possible. For such observations radio waves were transmitted from the Laboratories' experimental station at Deal, New Jersey, to a receiving laboratory forty-seven miles away, near Mineola, Long Island. If there were a reflecting layer in the upper atmosphere, a second path for the waves would be available, much longer than the direct path along the ground, and signals traveling over the reflected path symbolized in Figure 1 would take longer to arrive than those using the direct course. Hence reception of primary signals and then, a trifle

* *When a wave enters a medium in which its velocity of propagation varies from point to point, its direction of advance becomes curved. If the change of velocity is rapid enough, the curvature is so abrupt that the effect is much the same as that of reflection from the surface of the medium. It is often convenient to speak of this phenomenon as reflection, although it is really one of refraction. How radio waves are supposed to be bent was shown graphically on pages 349-353 of the* RECORD *for June, 1927.*

later, of auxiliary signals would be evidence for the existence of such a reflecting layer. From the time interval between original and auxiliary

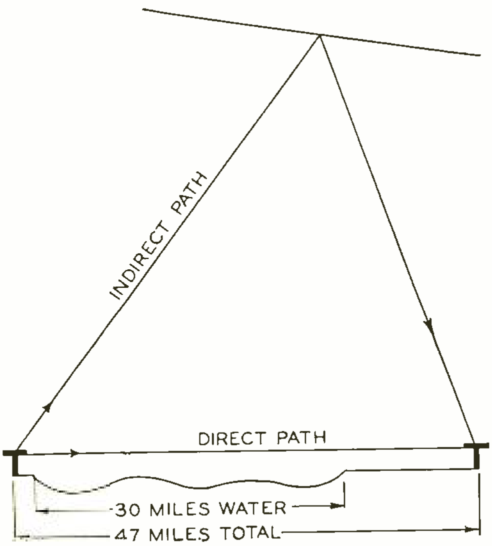

Figure 1

signals the difference in length of the paths could be computed.

Signals of the type shown in Figure 2 (A) were transmitted. High-frequency power was radiated for periods of approximately 0.001 second at intervals of about 1/60 of a second. Signals similar to Figure 2 (B) were received with a sharply tuned set, and were recorded by an oscillograph. When there were two paths for transmission of the wave—a path with reflection from an overhead layer in addition to the direct path along the ground—two signals were received for each group of waves transmitted, as represented in Figure 2 (C). This is strong evidence for the existence of the postulated zone of ionization. Drawings of the oscillograms of actual received signals are shown in Figure 3.

Even more than two paths were sometimes observed. Some of the paths would occur as represented in Figure 4, where paths B, C and D have one, two and three reflections respectively from the reflecting layer. The diagram at the right of the drawing shows the type of signal to be expected under such circumstances. As many as four signals may be received for each signal sent. Oscillograms in which signals arrived by several different paths are represented by Figure 5.

The theory of the reflecting layer requires the presence of free electrons. When an electromagnetic wave traverses this reflecting region the unattached electrons are moved by the influence of the wave and absorb energy from it. On account of their mass and charge and the presence of the earth's magnetic field the electrons in their movements reradiate the absorbed energy slightly out of phase with the passing wave; in doing so they change the effective velocity within the refracting zone. This variation in effective velocity is, of course, the cause of refraction.

The electrons in this reflecting layer are supposed to come from two

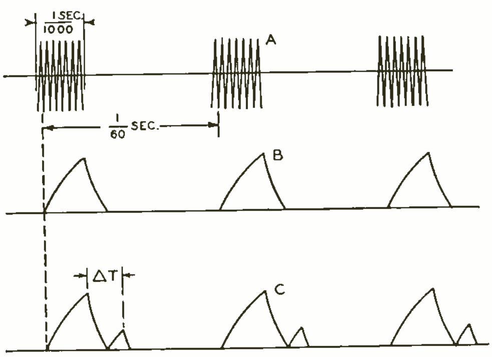

Figure 2

sources. There is good reason for believing that electrons may be shot out of the sun and reach the earth. Other electrons are freed by ultra-violet light from the sun, which, on reaching the atmosphere, knocks off electrons from molecules of its gases. It appears from our experiments that the free electrons in the ionized regions of the atmosphere are produced by both of these causes; electrons from the sun spots are received both day and night, since their paths are bent by the earth's magnetic field, while ionization of the air molecules takes place on the sunlit side of the earth.

The free electrons do more, however, than refract or reflect the waves. When an electron absorbs energy from a passing wave and executes an oscillatory or circular motion in the atmosphere in its absorbing and radiating process, continuance is insured only as long as nothing gets in the way. If there are many gas molecules around, the moving electron may strike one and lose a large part or all of its energy, or it may be deflected in such a way that the energy remaining is radiated at random, no longer contributing to the passing radio wave. In such a case the free electron must absorb more radiation before it can contribute further to the passing wave. The presence of gas molecules in the region where the free electrons occur thus causes absorption of energy from the wave. Under these circumstances the wave may be so reduced in intensity that it is worthless for radio purposes.

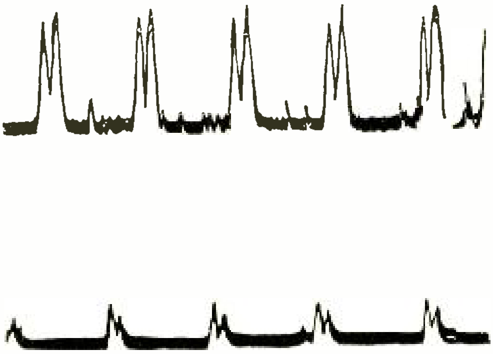

Figure 3

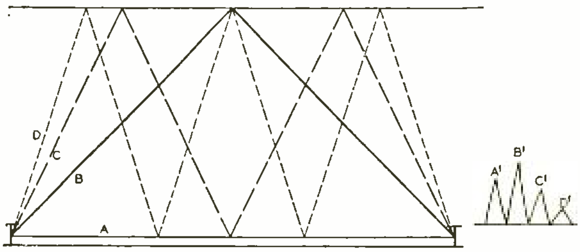

Figure 4

It has been shown in a paper by Nichols and Schelleng* that the frequency of collision with molecules is related to the magnitude of absorption. If the gas molecules are relatively close together—if the air is dense—a free electron can scarcely move under the influence of a passing wave since the gas molecules block its way, and so neither absorption nor reflection occurs. If the gas molecules become less numerous the free electrons can move more readily. At a certain air density therefore maximum absorption occurs, because at that stage it is certain that practically all the electrons lose their energy by collision with gas molecules before they have had a chance to radiate again any appreciable part of it. As the density of the gas is still further reduced the molecules become so far apart that the electrons can execute a great number of oscillations before losing their energy by collisions.

* *Bell System Technical Journal, April,* 1925.

Density of the air thus determines location of the zones at which waves are absorbed.

Atmospheric density is greatest at the earth's surface, and rapidly becomes less as the altitude increases. At a height of about fifty miles the density is reduced to the value causing the greatest absorption, and about twenty-five miles higher is so much less that the electrons can execute their oscillations with only rare loss of energy to the gas molecules in collisions; reflection, or more properly refraction, can therefore occur. That region where the air density is suitable for absorption is called the "absorbing region," while the zone higher up in which refraction occurs is called the "refracting region."

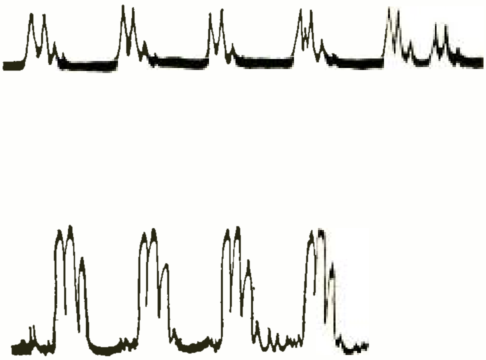

Figure 5

When an electromagnetic wave travels between two points separated by a considerable distance, on account of the earth's curvature a wave received at a distant point must have travelled up to the refracting region, and there have been turned downward to strike the earth at the receiving station. The wave must therefore have passed through the absorbing region twice. On the way up, if many free electrons are present in the absorption region the energy of the wave may have been so cut down that little is left to be reflected, and after reflection it will be cut down further on the return to earth. Long distance radio communication can therefore be secured only by means of those waves which can make two or more passages through the absorbing zone without undue attenuation.

The experiments appear to support the hypothesis that free electrons are produced in the absorbing region of the atmosphere by ultraviolet light from the sun, making absorption thus a daylight phenomenon. It is not equivalent for all radio waves, but varies with the wavelength. At 15 to 20 meters it is very small, is fairly great for wavelengths around 100 meters, and is a maximum just over 214 meters; beyond this point it seems to become much less.

The free electrons present in the refracting region at night appear to be those which arrive from the sun. There are also some "hold-over" electrons formed during the day and remaining uncombined with the positive gas ions. The electrons from the sun appear to be more numerous or at least more influential, for the data show that the refracting region moves up and down in a manner not compatible with other hypotheses. The apparent height of the refracting region at night is from 150 to 400 miles. During the day, the larger part of the free electrons in the refracting region are caused by ultraviolet light from the sun. Since this light produces free electrons at altitudes as low as 16 miles, the apparent height of the refracting region is much lower by day than by night.

From our observations, we have concluded that the refracting region does not remain in any position, but moves up and down. A rise of six miles per minute and a fall of twenty-five miles per minute were observed. This rapid movement of the refracting region at night appears to be the cause of rapid fading of those wavelengths which travel well at night. If the reflecting or refracting layer were fixed and the frequency of the transmitting station fixed also, fading would not occur, but because the refracting region is moving, fading is produced.

Another effect is bad quality of received signals under certain conditions, as has been proved by Bown, Martin and Potter.* When the reflected wave as received is of the same order of magnitude as the wave which comes along the ground and when frequency of the transmitting station is not constant, the signals arriving at any receiving station over two paths will actually be of different frequencies. Travelling over different paths, two or more waves arriving simultaneously will have left the transmitting station at different times and if the carrier-frequency of the station is not constant the waves will be of different frequencies. If the two waves are of the same order of magnitude a beat note will result. For the large number of frequencies in a modulated wave, the correspondingly large number of beat notes results in noise which overshadows the speech or music being received. Experimental demonstration of this phenomenon is shown in Figure 6. Power of constant amplitude but of varying frequency was radiated from the transmitting station during the transmitting intervals; at the receiving station, the beats between the waves arriving over the two paths produced the distortion shown. Any transmitting station therefore operating with variable frequency may be expected to produce bad quality at all receiving stations to which there is more than one path of transmission. It is for this reason that the greatest care is taken in the design of modern broadcast stations to prevent variation of the carrier frequency during the course of an audio wave.

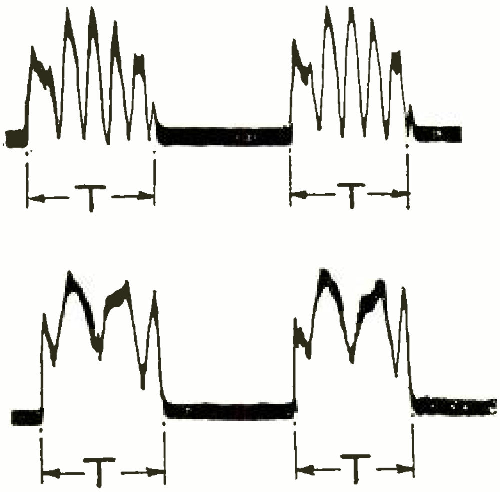

Figure 6—A wave of varying frequency, when received over two paths, gives rise to the beat notes indicated

* *I. R. E. Proceedings, February,* 1926.

New Specifications for Raw Materials

By J. R. TOWNSEND
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STUDIES of the properties of materials have been made in the past, but with the increasing complexity of the telephone plant these studies have had to be carried forward to greater detail in order to set up more precise standards of quality. Furthermore, the growth of the Bell System requires vast quantities of materials, and much depends upon the steady flow of materials of the proper quality and uniformity into the manufacturing plants.

The raw materials used in telephone apparatus are controlled by specifications which depend upon the basic physical qualities of the material and the requirements of manufacture. Within the last few years a new series of specifications has been inaugurated by the Laboratories to cover those raw-material requirements that are of engineering concern. More than a score of these specifications have been issued; they cover such diverse materials as wax, duralumin, powdered permalloy, silk, cable sheath, lubricating oil, and sheet brass. The new specification series is designated as "LRM," that is "Laboratory Raw Material" specifications. It is intended that all the important materials used in telephone apparatus shall be covered ultimately by such specifications. They serve to collect, and state precisely, all the engineering information necessary to secure material of the proper quality. The Western Electric Company uses this engineering information in the preparation of purchase specifications.

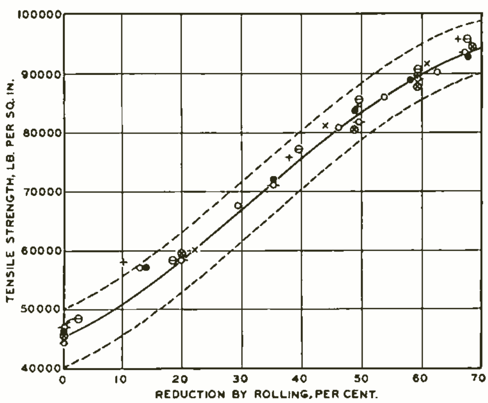

Fig. 1—How rolling increases the tensile strength of brass sheet. The points symbolize tests on different thicknesses

In preparing "LRM" specifications considerable care is taken to see that the quality of the material is correct from an engineering standpoint. Economic considerations such as sources of supply and commercial grades are also considered. The requirements are submitted to the Western Electric Company in order that questions of mutual interest in the production of telephone apparatus may be considered, and that the requirements after study from a commercial viewpoint will be entirely acceptable to all concerned. In important cases a joint study is made of raw materials covering the manufacturing history and physical properties as a basis for specification work.

A striking instance of such an in-

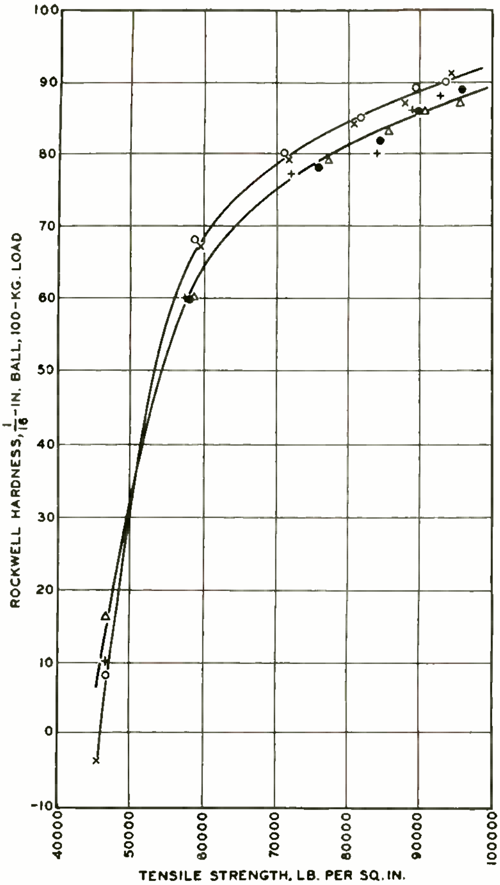

Fig. 2—That a relation exists between tensile strength and Rockwell hardness numbers is indicated by the narrow distribution of points. The curves are for sheets above and below 0.040 *in. thick*

vestigation is that made by the Western Electric Company, the Northern Electric Company, the American Brass Company and the Laboratories which led up to the new specifications for non-ferrous sheet metals These materials — brass, phosphor bronze, nickel silver, and the like — are widely used in all sorts of apparatus. They must be capable of fabrication in various ways to produce apparatus parts having resistance to wear, bending, torsion, vibration, corrosion, and so forth. Some of the essential physical properties desired — ductility, tensile and compression strengths, hardness, elastic and endurance limits — can be measured with great accuracy. Some can be correlated with others, as for example endurance limit with tensile strength and again hardness with tensile strength. A complete tensile test will give many of the essential mechanical properties of sheet metals. However, for the inspection of raw materials, this test leaves much to be desired: a piece has to be cut from the stock, milled to size, and destroyed by the test itself. The test for hardness can be made on the raw stock, and is not destructive. If then a satisfactory test of hardness could be found, and correlated with the results of tensile tests, much time and expense would be saved.

One measure of the desirability of a testing method is its reproducibility — that is, whether or not it can be depended upon when applied by different observers using different instruments. This point is particularly important in inspection testing, where the work is done in separate places.

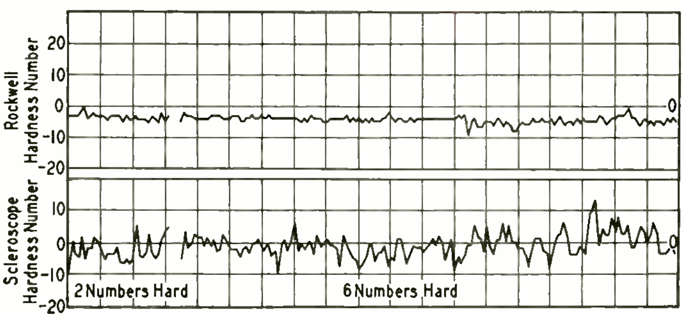

Fig. 3—Variation between readings by two independent observers. The smoother curves for the Rockwell instrument indicate its superior uniformity

The method of attack on the problem of non-ferrous metals was to have the Brass Company prepare sample lots of sheet metal, as, for example, sheet brass, rolled to various thicknesses and hardnesses. The rolling was done in a commercial manner, but very careful data were obtained of the actual conditions surrounding the manufacture of the metal. Complete physical tests were made in the Laboratories upon these samples, and the data were sent to all collaborators. These tests confirmed what had long been felt, that the scleroscope test of hardness as formerly specified did not give sufficiently precise results when used under inspection conditions. This test has therefore been eliminated from our specifications. A close agreement however was found between the Rockwell hardness numbers and tensile strength. This is evident from the uniformity with which the points of Figure 2 lie along one or other of the smooth curves. Furthermore, Rockwell hardness numbers as determined on five different instruments showed that the various inspection results of producer and consumer could be expected to agree.

With the data from the laboratory tests and from previous work and from experience with actual shipments of material, requirements were drawn up for non-ferrous sheet metals. It was determined that at the present time the best means of specifying the quality of these metals is the tensile test. In the new specifications this is given as the basic test and the Rockwell hardness test is used for inspection since it is non-destructive and easy to apply. In case of doubt as to whether the material fulfills the requirements, a tensile test is made. The Rockwell test is specified for all thicknesses of sheet brass down to 0.020 inch. For thinner material, a tensile test is always made since the Rockwell test is unsatisfactory here.

As part of its responsibility in the design of apparatus, the Laboratories select appropriate raw materials, whose quality they define in terms of precise tests. This care, exemplified in the specifications for non-ferrous sheet metals, is one of the Laboratories' contributions to uninterrupted telephone service.

An Appreciation of Achievement

"The outstanding experimental result of the year has come from a continuation by Davisson and Germer of the (electron) scattering experiments using a single crystal of nickel. . . . It should be noted that these electron scattering experiments involve a difficult technique; and, because of the several independent variables, the amount of data required is very great. It seems safe to predict that these preliminary results may make a new era in atomic physics. . . ."

—From the report of the Committee on Progress in Physical Optics in the Journal of the Optical Society for January, 1928.

The Use of Codes in Electrical Communication

By J. L. HOGG
Research Department

THE subject of codes is of fundamental importance in many forms of electrical communication. Even the sounds of speech may be considered as the characters of a code into which we are taught from childhood to translate our thoughts.

Proper choice of the variations of electric current which are arbitrarily assigned to represent the symbols of speech and writing aids greatly in realizing the full transmitting efficiency of any particular system. It does not always happen, however, that the communication engineer is at liberty to substitute one code, which might theoretically be better, for another already in use. It would scarcely be practicable, for instance, to undertake to alter the code commonly designated as speech although it is perfectly true, as will be brought out later, that codes are known which, with given line facilities, will transmit words a great deal faster than they can be transmitted by the voice. Much more meaning is conveyed by the voice, however, than is represented by the words alone. Manner of speaking, inflections, and pauses for emphasis, frequently tell more in a fraction of a minute than would hundreds of words.

Leaving speech as something which it would scarcely repay us to attempt to alter, at least for the present, we shall see upon a little inspection that in the matter of artificial codes there is much room for choice. This brings us at once into the domain of the telegraph.

Unlike the sounds of speech, telegraph code characters may be selected at will with only efficiency as a criterion. To originate code signals, a mechanism produces abrupt changes in the voltage applied to the sending end of the line. In the case of the familiar Morse code, the units are distinguishable from one another by their varying duration. In the Continental form of this code, there are three standard time intervals, the lengths of which are as 1 :3 :5. Application of one pole of the battery to the line for these different intervals communicates what are called the m a r k i n g units, the dots and dashes. Removal of the battery or the application of the other pole to the line sends out the spacing units, the letter spaces and word spaces.

In telegraph communication, it is necessary to transmit fifty-odd characters. The time taken to put on the line the longest character of the Continental code is twenty-three times a dot length. To put the shortest character on the line four dot lengths are required, one unit of time for the dot itself and three for the letter space to follow.

One may now venture the guess that this particular code is rather wasteful of line time. Any change in the characters would be desirable which would shorten to the minimum the time required to put onto the line the character of average length. One apparently plausible method is to use a variety of sending battery voltages—these to be allocated in a definite manner among the code characters—instead of relying solely upon different durations to effect discrimination. There is a fairly definite limit, however, to the number of discrete voltages that can be employed in practice, the most important consideration, perhaps, being that it obviously increases the complexity of both sending and receiving apparatus.

Having once decided upon the combinations of current pulses which are to form a code, the possibility obviously presents itself (provided these combinations are of different length) of assigning them among the letters and other characters so that those used most frequently will also be those requiring the shortest time to send. Studies have been made of the relative frequencies with which the various letters occur in the English and other languages. With the

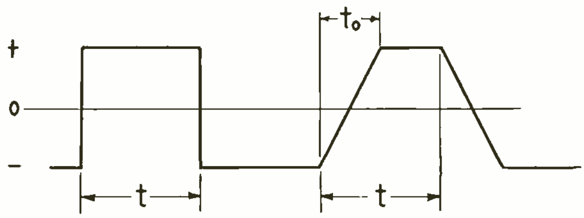

Figure 1 *Figure* 2

For simplicity in this and the other drawings straight lines are used which show the principal part of the sluggishness in current change though true representations would show the corners decidedly rounded

results of such an analysis at hand, it is easy to set up an economical assignment of code characters to alphabetical characters. The commonly-used codes leave little to be desired in this connection.

Choice of code characters, most economical in terms of transmission speed or line time, is not by any means so simple a problem, however. It depends in large measure upon the characteristics of the terminal and line apparatus, and practical experience is usually the best guide to the final choice.

Such a code as the Morse, the time lengths of whose characters are not all equal, is well adapted to manual sending and aural reception, but for printer operation mechanical advantages are gained by making the characters all of equal length. A common form of printing telegraph code (it is used by the system developed some years ago at our Laboratories) has a common length of five dot lengths* for each character. This provides thirty-two different current pulse combinations, a number just about doubled by providing that two of the thirty-two characters act in a manner analogous to the carriage shift keys of a typewriter. It will be apparent that the printer code effects a considerable saving in line time as compared with the Morse code. For one thing, the spaces between letters may be entirely eliminated, there being no need to provide the printer with the short rest which the ear requires. The average length of each character is also somewhat reduced.

The printer code is technically known as a two-element, five-unit code, because it employes two current values (one positive and one

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** It will be convenient to refer to the shortest marking unit as a dot, and the maximum rate at which dots can be satisfactorily received as the limiting dotting speed.*

negative) and each character is five dot lengths in duration. By employing three current values it becomes possible to shorten still further the duration of each character. The relationship which exists is so readily deduced that it may interest the reader to follow the argument.

Imagine a succession of time units, each of which is to be assigned one of the possible current values. For the two element code, each unit can have either of two current values. Hence in a series of five units, the possible number of distinct characters is 2 x 2 x 2 x 2 x 2 = thirty-two. For the three element code, the expression becomes 3 x 3 x 3 x 3, etc., and now it is necessary only to give each character a length of four units in order to secure eighty-one different characters. In fact, with a length of but three units, there will be twenty-seven distinct characters. So far as diversity is concerned, the three-element three-unit code is therefore practically equivalent to the two-element five-unit code. Since the time intervals are in the ratio 3:5, one would naturally conclude, were there no other factors to consider, that the three-element code is decidedly superior. As a matter of fact, the reverse is the case, this rather unexpected upset being due to the contribution of the vibrating relay which can be used only with a two-element code.

A simple explanation will make clear the functioning of the vibrating relay. Consider a single dot. It is formed by a sudden reversal of the battery potential which is applied to the line, and at the end of a short time interval an equally sudden return to the original potential. In response to these potential changes, a sharp current pulse is formed at the sending end, as shown in Fig. 1. Due to the charactertistics of the line, however, this pulse is no longer sharp upon its arrival at the distant end. It partakes of the shape indicated in Figure 2 which shows that the received current rises sluggishly instead of instantaneously. The time required for this sluggish rise of current is called t_o.

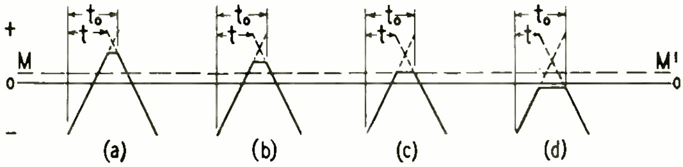


Figure 3

In Figure 3 there have been made a number of constructions showing the effect of making shorter and shorter dots. Let the height of the line MM' represent the marginal current value of the receiving relay. At (a) is shown a current pulse corresponding to a dot in which the length of the dot *t* is just less than the time of rise of the current, t_o. It well exceeds the current margin of the relay and therefore causes the receiving apparatus to respond. The same is still true in the case of the shorter dot shown at (b) while at (c) the receiving relay is merely on the point of responding; at (d) it will not respond at all so that the marking unit will fail and the spacing unit will continue.

We see then that with a code using only two current values and with line and terminal apparatus such as to yield the received currents shown in Figures 2 and 3, and with a receiving relay which operates with a negligibly small current, no code character shorter than half the time interval t_0 can be recorded. Hence, as the dotting speed is increased, the dots or shortest characters are the first to fail. Could we design the receiving apparatus so that a local source of energy would make the dots at the rate at which they are sent and then utilize the transmitted energy of each long unit merely to lock the receiving mechanism during the period necessary to form such longer units, the dotting speed of any given line could be increased. This is just what is accomplished by the vibrating relay. It usually takes the form of a mechanical oscillator, its capacity and resistance being so adjusted that its natural period of oscillation is the same as the dotting speed.

This device automatically provides for reception of the shortest units—in fact, so long as no signal is received over the line, it will mark off a continuous succession of dots—and failure to receive longer units will occur only when the received current for these longer units is not large enough to dominate the local dot-forming current. By means of this device, a dotting speed well above that indicated by half the interval t_0 can be employed.

Referring to the frequency characteristic of a telegraph line, its dotting speed is susceptible of a simple statement in terms of the upper cut-off frequency. If this cut-off is raised, the slope of the arrival curve is increased, that is, the received current builds up at a greater rate. Consequently, the higher the cut-off frequency of the line, the higher is its dotting speed. So long as the rate at which we send dots over the line does not exceed its cut-off frequency, communication can theoretically be carried on satisfactorily. In practice, because of interference and other variable factors, the dotting speed is held down to about one-half of the cut-off frequency. Since the dotting speed is seldom greater than 30 per second the cut-off frequency of a telegraph line may be placed at about 60 cycles. Thus the band of frequencies required in telegraphy is quite narrow compared to the band extending from about 200 to 2500 cycles necessary for satisfactory voice communication. Under certain conditions, use of the vibrating relay enables the practical dotting speed to be made equal to the cut-off frequency and thus the dotting speed may approach double the speed possible without the relay.

It may be of interest to point out that on account of the narrow frequency band required to transmit the telegraph code characters, the message capacity of an ordinary telephone line is much greater when used as a multiplex telegraph channel than it is when used for communication by telephone. For the latter it has a capacity of about 120 words per minute. Operated as a multiplex telegraph system without intermediate repeaters it can transmit as many as 2000 words per minute.

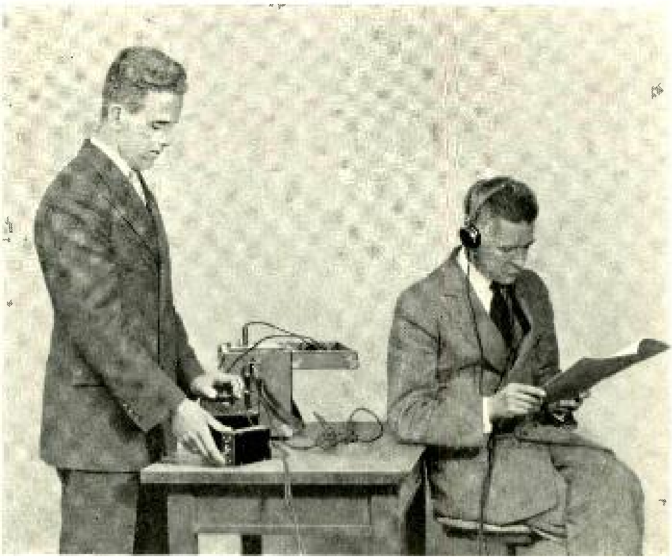
Psychology Aids in Tests of Hearing

By W. L. BETTS
Apparatus Development Department

BY the use of methods developed in these Laboratories, it is possible to make very accurate measurements of the sensitivity of the ear. The degree of accuracy is limited, not by our skill in measuring small currents, but by the ability of the listener to be sure whether he hears the test tone or not. As an aid in this direction, Western Electric audiometers have always been provided with a push-button to interrupt the tone. Should a patient's hearing seem entirely too acute, the tester cuts off the tone; the report "I still hear it" then means only one thing — that the patient has been flattering himself, to the extent of several TU.

As a further aid to tests of hearing with the audiometer, a circuit has been worked out by which the tone can be switched to either ear or to both. This device, known as the No. 42-A Test Set, brings to use several principles of psychology. For instance, does a loud tone sound in the left ear, the left eye blinks ever so slightly, although the patient may claim that all is silent as Sahara.

Conduction of sound by the bones of the skull also offers means to investigation of asserted deafness. At a more or less definite volume, sound impressed on one ear will be conducted to the other so that were a person totally deaf in one ear he could hear by bone conduction to the other when a tone of sufficient loudness was applied to the deaf ear. Not aware of this fact, a subject claiming total deafness in one ear might deny hearing anything, although the tone was loud enough to be heard by the other ear. In fact, if he wished to deceive the examiner he would be unable to do so even if he were aware of bone conduction, because he would not



How the 42-A Test Set and the 3-A Audiometer are used to detect deafness is demonstrated by J. A. Battle and W. L. Betts know the actual loudness level at which conduction occurs and so would not know when to signal.

Another effective test to avoid misrepresentation by the subject is to have the subject read aloud from a book *in* his natural voice while a tone *is* switched from ear to ear. Use is then made of two facts of psychology—that the sound of one's voice is necessary for the regulation of his voice intensity, and that one's own voice can be "drowned out" by a loud tone. A person of normal hearing in both ears will not change the volume of his voice as the tone is switched back and forth because, at all times, he has one ear with which he can hear himself talk. He will raise his voice and almost shout, however, when the tone is switched on both ears at the same time, as then his own voice is drowned out. Were the subject actually deaf in one ear he would raise his voice every time the tone was put on the one ear in which he could hear.

A similar test may also be used for a person claiming deafness in both ears. When the tone is switched on and off both ears, the voice intensity will vary with the tone if the reader is actually able to hear. If he is not, switching the sound on and off will have no effect on his reading.

Where deafness is claimed in one ear, the suggested procedure is to switch the tone at different intensities rapidly back and forth from one ear to the other. The subject of the test is supposed to signal every time he hears a sound and because of the rapid changing from ear to ear with the accompanying variation in volume a false claim soon becomes apparent. This is because to signal truthfully each time a sound is heard is an almost instantaneous act but much more time is required if one has to stop to decide in which ear the sound occurred and then to remember whether that is the ear for which he has claimed deafness. If the tones are applied at fairly rapid intervals the mind can not act quickly enough when an additional thought train is required to give the correct response.

New Languages from Old

By CLYDE R. KEITH
Research Department

MAKING a new language to order is now possible through recent work of the Research Department. To accomplish it, normal speech is "inverted," so that for every vibration a new one is produced whose frequency is equal to some selected constant frequency minus the original frequency. By the use of this inverting apparatus words spoken in English before a microphone may be reproduced on a loud speaker as a succession of totally different sounds, apparently having no relation to the original speech. These new sounds may, if desired, be translated back into English by passing them through a similar group of inverting apparatus. The fundamental processes involved in making inverted speech are not new, and it is not proposed to use such speech in competition with Esperanto, but the method illustrates in a very striking way the process of modulation and frequency conversion which is so essential to radio and carrier communication.

In forming inverted speech the modulating or inverting frequency acts somewhat as a lens does in inverting the image of an object: causing the top to appear at the lower part of the field and the bottom at the upper. The inversion might be effected about any convenient frequency but in order to have the resulting sounds at the pitch level of ordinary speech it is necessary to select a frequency only slightly above the normal speech range. The apparatus now developed uses three thousand cycles as the inverting point. Although there are frequency components in ordinary speech above this value they are eliminated by filters before the speech passes to the inverting apparatus, but this does not objectionably affect the quality of the speech.

With a normal speech range of from 100 to 2900 cycles and an inverting frequency of 3000, the resulting, or "inverted," speech also occupies the band from 100 to 2900 cycles but in a reverse order. A pure tone of the pitch of middle "C" on the piano scale which has a frequency of 256 cycles per second would become 2744 cycles or 3000 minus 256. Consequently the voice of a person talking in a low tone comes out of the "inverted" speech apparatus as a high pitched squeak, with a low grunt now and then due to the overtones in the original speech wave.

On listening to inverted speech for the first time nothing is understood. It is as unintelligible as the strangest foreign language. However, one may learn to interpret it by listening to words first spoken normally and then translated by the speech inversion equipment. "Illinois Telephone Association," for instance, when inverted sounds "Oyaneon Playafiend Acecilofin." To a considerable extent, therefore, a person could learn this inverted language; but as there are some sounds in it which the average person would have difficulty in imitating, a vocabulary would have to be made up which did not contain them.

The process is readily reversible. The "inverted" speech may be imitated before a microphone connected to the inverting apparatus which will translate it back again to English. The intelligibility of the reproduced or re-inverted speech depends only on the fidelity with which the inverted speech is imitated. In the inverting process there is practically no loss of quality so that phonograph records may be made of the inverted speech from which the sound may be picked up by an electric reproducer and re-inverted to normal English.

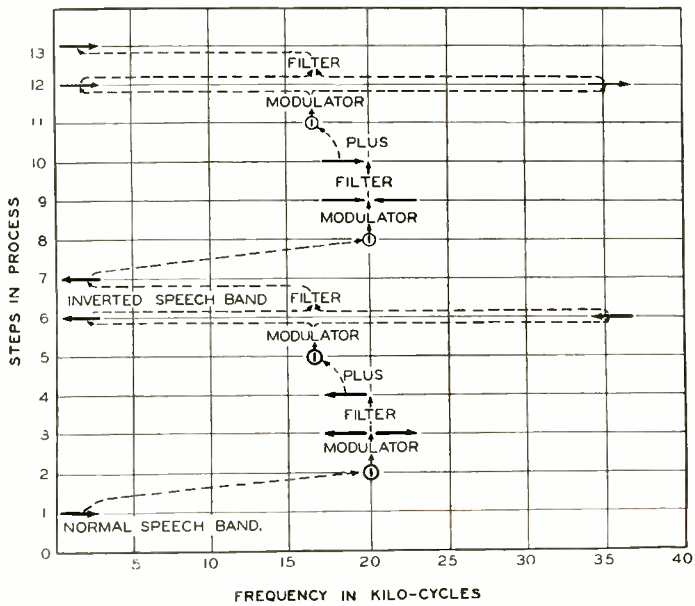


Figure 1

Records of inverted speech were first made about a year ago by J. W. Horton to illustrate the nature and use of side bands in carrier communication. Complete equipment had been arranged for a demonstration which was given in connection with a lecture by S. P. Grace at a convention of the United States Independent Telephone Association in Chicago last October. Several phonograph records were made from inverted speech produced by special laboratory apparatus which insured the best quality on the record. The records were played first to show how little resemblance the sound bore to ordinary speech. Then some of the inverted speech coming from the phonograph was picked up with a telephone transmitter and reinverted by the portable speech-inversion set. In this way the reinverted speech, or ordinary English, would come from a loud speaker at the other side of the stage. At the same time the unintelligible output of the phonograph continued and could be heard but only faintly, since it was largely masked by the readily-understood re-inverted speech from the loud speaker. To show that the reinverted speech actually came from the unintelligible sounds given off by the record, the telephone transmitter was moved away from the phonograph and as a result the translated speech stopped.

In the actual apparatus two modulating steps are used, one at twenty and the other at seventeen kilocycles, which give the same overall result that would be obtained from a single modulation at three kilocycles. In the process of modulating, certain distorting frequency components are

S. P. Grace and L. W. Davee illustrate the method of using a stage set-up of speech-inversion apparatus

unavoidably introduced which are difficult to filter out when the modulating and modulated frequencies are too nearly alike, as would be the case when a voice band of from one to twenty-nine hundred cycles modulate a three thousand cycle frequency. By allowing the voice band to modulate first a twenty kilocycle frequency the distorting frequencies are eliminated.

The inverting process may be readily followed by reference to Figure 1 which shows all the steps from the original band of voice frequencies to the inverted band and then back to the normal order. Following up the diagram step-by-step, the initial band modulates a twenty-kilocycle frequency resulting in an upper and lower side band. The upper is filtered out and the lower is then modulated by a seventeen kilocycle frequency. This again gives two side bands of which the upper is filtered leaving the lower which is in the same range as the original voice band, from one to twenty-nine hundred cycles, but in the reverse order, one hundred cycles in the original band becoming twenty-nine hundred in the inverted band and the original twenty-nine hundred cycles becoming one hundred. The steps in reinverting the inverted band to normal speech may be followed by continuing up the diagram.

In the development of the apparatus and in the making of the records used by Mr. Grace, A. G. Landeen and A. C. Keller cooperated with the author. The speech was delivered before the microphone by L. Howell Davis of the Victor Talking Machine Company, who has an exceptionally good recording voice. While at present the system for reinverting speech is used only for demonstrations, it is possible that by-products arising from a knowledge of its capabilities may prove of considerable value.

Transatlantic Telephony

"The American Telephone and Telegraph Company has officially disposed of recent rumors that transatlantic radio telephone communications are not being employed as much as might have been expected. At the close of the first year's operation the service is finding a steady and increasing use and probably will be extended. . . . The daily period of service has been extended from four and a half hours to ten and a half hours, during which excellent transmissions are obtained. . . . Improved service is bound to mean increased capacity and diminished cost. The first year's experiment may safely be taken as a prophecy that telephoning between the United States and Europe will soon become as commonplace as telephoning now is between New York and every other important American city."

Editorial, New York Sun, January 20, 1928.

From January 7, *the first day of service, to December* 20 *there were* 2173 *calls, of which about nine-tenths were completed.* 1159 *of the calls originated in America, and* 1014 *in Britain. By November the traffic for an average business day was seven and three-fourths completed calls lasting five minutes each, and each representing a cost of* $125. *By means of the transatlantic telephone service, this month there will be a joint meeting of the American Institute of Electrical Engineers, holding its Mid-Winter Convention in New York, and the Institution of Electrical Engineers, meeting in London.*

"What Are The Chances That..."

By THORNTON C. FRY
Research Department

EVERYBODY asks this question; but not everybody understands how to answer it. In fact the attempt to find answers to questions of this sort has led to an entire branch of mathematics — the Theory of Probability. Of its many aspects, this short article considers only one: the reasons for expressing measurements of probability in the form in which they are ordinarily given.

In the first place, as every one knows, to measure anything there must first be a unit of measure. Also, although one thinks of this particular fact a little less often, there must be an agreement upon a method of dividing the chosen unit before one can measure magnitudes not exactly a unit in amount. In measuring length, for example, (and the same is true of any other quantity) we must have a unit and we must agree upon a method of subdividing this unit. From a standpoint of common sense, it seems reasonable to have a scale of such a nature that when two like objects are placed end to end we shall find their combined length to be represented by just twice as great a number as the length of either one alone. Such a scale we call a "uniform scale."

The same ideas apply when we come to set up a scheme for measuring probability. Rather illogically, perhaps, we shall take up these two points in their inverse order, first discussing what we mean by a uniform scale of probability and then defining our unit of measure. An illustration will help in developing our ideas.

Imagine two men talking about Peary's trip to the North Pole, and one of them asking: "What is the chance that he got there on Sunday?" Obviously there is no point in asking this question if they know the answer, so we shall assume that they, like ourselves, are ignorant of the actual recorded day.

To this question we can not give a definite answer until we have defined our method of measuring probability, so we must do what we always do with unknown numbers: represent the desired answer by a letter, p. Next, we remember that, since we are in complete ignorance as to when Peary arrived at the North Pole, the chance of his having reached there on Monday, or Tuesday, or any other day of the week, is the same as the chance of his having reached there on Sunday. All of these then are equally likely. In other words, we have seven *equally likely* possibilities.

If we had seven *equally long* objects, the length of each being l, we could begin to construct a uniform scale of length by putting two of them end-to-end and calling the resultant length $2l$; then adding on a third and calling the new length, $3l$; and so on. We ought, therefore, by making the proper use of our equally likely things, to be able to construct a uniform scale of probability. The only difficulty appears to be that of finding a suitable analogue for "end-to-end", and this difficulty can be resolved by a very simple observation.

If we ask, "What is the chance that he arrived on either Sunday or Monday," it seems just as natural to represent the answer by $2p$ as it does to represent the combined length of two of our like objects by $2l$. This relationship of "either - or" therefore occupies the same place in our thought processes regarding probability that "end-to-end" does in geometry. It is not *necessary* that we should represent the probability of his having arrived on either Sunday or Monday by the number $2p$, but it impresses us as a very *sensible* thing to do. Similarly, we say the chance of his having arrived on either Sunday, Monday, or Tuesday should be $3p$; the chance of his having arrived between Sunday and Wednesday $4p$, and so on. Finally, after we have put all of our equally likely things "end-to-end" in this way, we arrive at the conclusion that the chance of his having arrived on some one or other of the seven days of the week is $7p$. Beyond this point we cannot go — and herein lies one very fundamental difference between measuring probability and measuring length — for some one of these things *must* have happened. There are no further possibilities, and so $7p$ must be that number which represents certainty.

That is how we set up our uniform scale of probability. Now how shall we choose our unit of measure? As there is little to guide us in this matter, our choice must be more or less arbitrary, as it is in the choice of a unit of length. It has always seemed to me that the most suitable choice would be one which caused certainty to be represented by ∞, that is "infinity," for certainty is the biggest possible probability in the same sense that ∞ is the biggest possible number. Yet, curiously enough, this is about the only symbol which we cannot use for certainty. For suppose we do: then we arrive at the conclusion in our Peary illustration, that $7p = \infty$. Then p must be one-seventh of infinity and since infinity is by definition a magnitude so great that its parts are also infinite, we come to the statement that $p = \infty$ too. Thus we become involved in the absurdity that the chance of his having arrived on Sunday is represented by the same symbol as certainty, though obviously we are not at all certain that he did. We must therefore admit—and for my part the admission is always made with a feeling of regret—that this choice will not do.

Among other numbers which might possibily represent certainty there is no one which has any greater claim than the number 1 itself. Therefore it has come about, that a thing is said to have a probability $1/n$ when we are sure that either it, or one of n-1 other equally likely things, is bound to happen. In our particular illustration we put $7p$ equal to 1, and conclude that the chance p of Peary having reached the North Pole on Sunday is just one-seventh.

This, then, is the exact answer to the question, "What are the chances that——" *It is a number read from a uniform scale of probability in which the unit of measure is certainty.*

The usual definition reads: "If of n possible cases, m are favorable to the occurrence of an event, and if all cases are equally likely, the probability that the event will occurr is m/n.

As the "cases" spoken of in this definition are equally likely, the probability of any one may be represented by p. As only n are "possible"—which means that some one of them is sure to occur—we know that $np = 1$. Hence $p = 1/n$. Finally, if we consider the m "favorable" cases, their combined probability must be m/n; and as "favorable" merely means that our event always accompanies these "cases", and never happens otherwise, it follows that the probability which we seek is really m/n.

So the two definitions are equivalent after all, and we will get to the same result in the end whichever one we use. For myself, however, I like best the one to which this article has led us, for it seems to me to give us a somewhat clearer insight into what we really do when we answer the question, "What are the chances that——"

Direct Telephone Circuits

A direct circuit from New York to Tampa, Florida, 1225 *miles long, was opened December* 17. *This is in accordance with the policy of eliminating the need for switching wherever traffic justifies direct circuits. The number of such circuits between far distant cities is much greater than is supposed. Between Los Angeles and New York there are two direct circuits, each* 3412 *miles long, the longest direct circuits in the world. Between Los Angeles and Chicago there are four, each about* 2600 *miles in length. Of the longer direct circuits from New York, one runs to Dallas,* 1900 *miles; two to Havana, about* 1700 *miles each; four to Miami, about* 1400 *miles; and three to New Orleans,* 1450 *miles. The greatest wire mileage in a single group is between New York and Chicago, where there are thirty-three direct circuits whose total length is* 29,882 *circuit miles.*

Tooling-Up the Drafting Room

By W. L. HEARD

DRAFTING has been an outpost of conservatism in the adoption of modern mechanical methods. There are good reasons for this because drafting is a difficult field for short cuts. The tracing cloth on which drawings are made is not friendly to stamps or stamping methods. Special inks must be used for the sake of durability and their slow drying is discouraging to speed. However, a very effective tool for simplifying the lettering of drawings was developed a few years ago and quickly adopted by the systems and other drafting rooms in the Laboratories.

The Wrico lettering guide, as it is called, is a plate of transparent material, punched full of apparently meaningless and odd shaped holes. These holes are along a narrow strip down the center of the plate, which has parallel edges so it may be placed against the "T" square. This central strip is thinner than the rest of the plate so that its under surface will clear the tracing cloth by a small distance and thus not smear the ink when it is moved along the board. Seemingly made at hazard, these holes are actually very carefully shaped so that they may serve as guides for a special pen with which lettering may be quickly and neatly done. As an example of the method, Figure 1 shows the two successive steps by which the letter "B" is made. After the first part of the letter has been formed the guide is moved along to the hole that is used to make the second part.

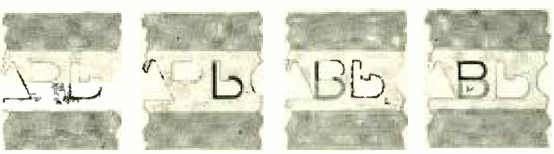


Figure 1—Method of making letter B with a standard Wrico guide

All drawings have titles and generally other lettering so that a simplified lettering system was naturally the first short-cut method to be produced. In drawings of telephone systems, however, relays in their many forms rank second only to letters in the number used. As they are much more complicated than letters, however, they require correspondingly more time to make and offer greater inducements for the use of labor saving devices. The effort was made, therefore, to adopt the principle of the Wrico guide to the making of relay symbols. After a little experimenting the guide shown as Figure 2, now known as the Wrico

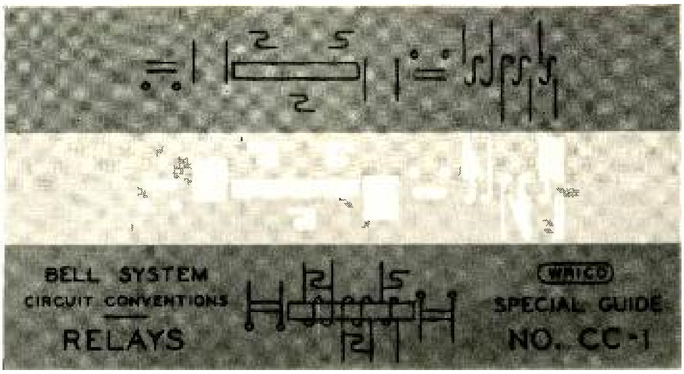


Figure 2—Wrico special guide CC-1

the great saving in time made by the use of this tool is evident. In addition there is a noticeable improvement in uniformity. Each type of relay is always made exactly the same no matter which draftsman may be doing the work.

These more mechanical methods are a convenience to all grades of draftsmen but they are peculiarly valuable to beginners for they permit them to become productive early in their training and at the same time they free the more expert for work on which their craftsmanship will find a wider field of usefulness.

Special Guide No. CC-1, was devised.

Dozens of different types of relays are indicated on systems drawings, of which a few are shown as Figure 3. Any one of these may be quickly, easily, and uniformly made by the use of this special guide. To one at all familiar with drafting methods

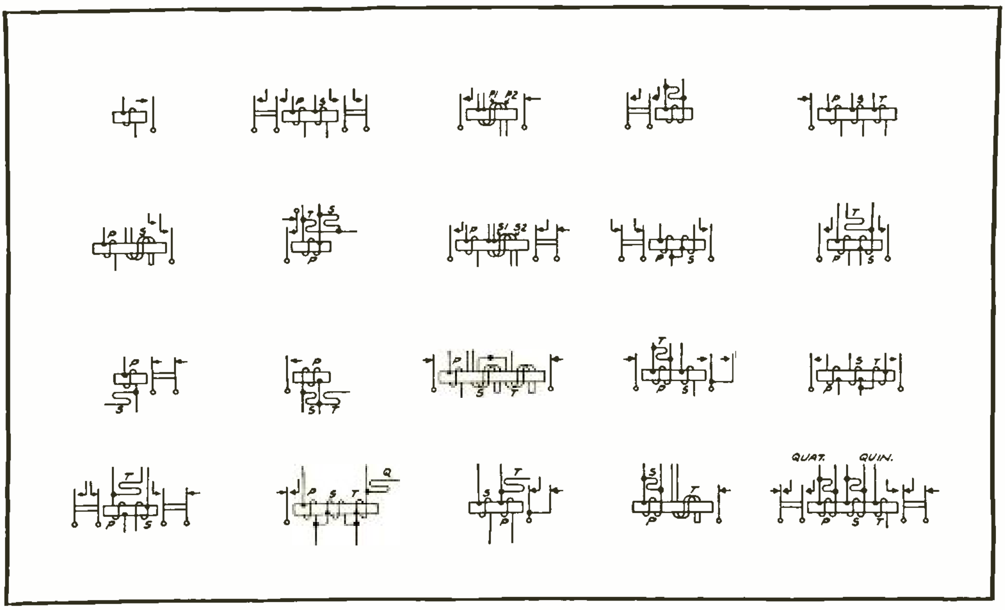
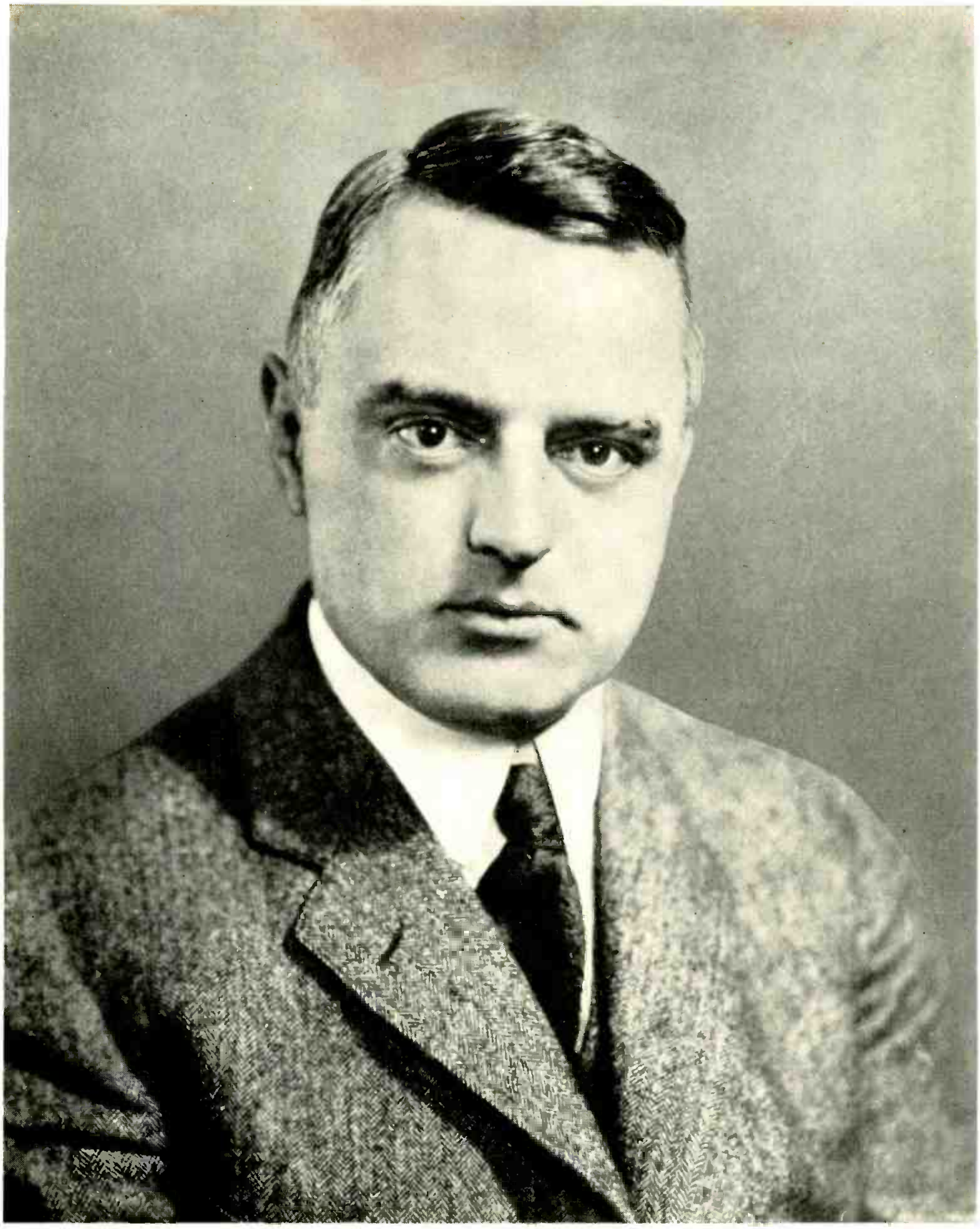


Figure 3—Typical relay symbols used on systems drawings



WILLIAM F. HOSFORD

Director, Bell Telephone Laboratories

Recently elected a Director of the Western Electric Company and its Vice-President in charge of Manufacture, Mr. Hosford was elected a Director of the Laboratories to succeed Charles G. Du Bois

News Notes

MR. JEWETT spoke at the Alumni Dinner of Massachusetts Institute of Technology held January 7 in Boston, on "Scientific Education — Do We Know What We Want and Can We Get It?"

MR. JEWETT attended the hearing of the Federal Radio Commission in Washington on January 17 and 18.

MR. CRAFT has been visiting a number of cities on the Pacific Coast. He spoke on Coordination of Researches to sections of the A. I. E. E. at Seattle, Portland, San Francisco and Los Angeles, and to the Electrical Development League at San Francisco.

J. W. HORTON spoke to the Colloquium January 9 on Frequency Measurements, and E. U. Condon January 16 on Recent Developments in Quantum Theory.

A FEATURE of the recent annual convention of the I. R. E. held in New York on January 9, 10, and 11 was an inspection trip to 3XN, our radio experimental station at Whippany, New Jersey, at which there were about four hundred members of the Institute. Following a buffet luncheon, the group inspected the new fifty-kilowatt broadcasting transmitter and also a set for measuring radio field strength, recently developed for commercial sale.

DURING 1927, the American Telephone and Telegraph Company conducted a comprehensive study of commercial aviation in its present ecnomic, commercial, and technical aspects with the conclusion that it could serve the industry by a further development of equipment and methods for communication along airways and to airships. Readily available means of communication, both wire and radio, should help to minimize the hazards of weather, of losing the course along the airway, and of collision. The problem is at first one of research and development, and the Bell Telephone Laboratories have, therefore, included in their 1928 program a substantial amount to be devoted to the advancement of safety in aviation by the application of electrical communications.

RESEARCH

C. J. DAVISSON, L. H. Germer, K. K. Darrow and E. U. Condon were members of a party of eighty-five physicists entertained January 7 at the private research laboratory of Alfred L. Loomis at Tuxedo Park. The occasion was a conference on atomic physics held in honor of Professor J. Franck of Göttingen.

D. A. MACINNES of the Rockefeller Institute visited the Laboratories January 19, and spoke informally to members of the Chemical Group.

W. E. CLEMENCY visited the Kimble Glass Company at Vineland, New Jersey, to select glass tubing for use in machines for filling transmitter buttons.

R. M. BURNS attended a meeting on corrosion held in Chicago December 6 to 8 under the auspices of the American Petroleum Institute. He also visited the Forest Products Laboratory at Madison, Wisconsin, for a discussion of wood acidity, which was continued when Dr. L. F. Hawley of that organization visited West Street.

C. A. FINLEY was at Hawthorne for about two weeks beginning January 5, instructing personnel there in methods of adjusting and testing the 1-A apparatus test set.

F. F. FARNSWORTH and C. D. Hocker attended a sub-committee meeting of the American Society for Testing Materials in Philadelphia on January 9. The meeting dealt with preparation of specifications for galvanized wire and stranded wire.

H. A. FREDERICK, D. G. Blattner, H. C. Harrison and A. C. Keller attended the monthly conference with the Victor Talking Machine Company on December 12 at Camden, New Jersey.

H. A. HENNING visited the Victor plant at Camden January 9 and 10 to investigate the extent of the special experimental records available.

J. W. HORTON spoke on "Television" to the Boston Section of the A. I. E. E. on January 11.

G. W. ELMEN has been recommended for the Elliott Cresson Gold Medal by the Franklin Institute Committee on Science and the Arts. The recommendation is "in consideration of his extended researches in the magnetic charactertistics of nickel-iron alloys resulting in the invention of permalloy."

H. E. IVES spoke on Television to a regional meeting of the A. I. E. E. at Norfolk, Virginia, on December 20. At the same meeting H. P. Charlesworth, Plant Engineer of the American Telephone and Telegraph Company, spoke on Transatlantic Telephony, C. A. Robinson, Chief Engineer of the Chesapeake and Potomac Telephone Company, spoke on Picture Transmission, and C. O. Bickelhaupt, Vice-President of the Southern Bell Company, spoke on the Progress of Communication. From Norfolk Mr. Ives went to Atlanta, Georgia, where he spoke on Television on January 23.

INSPECTION ENGINEERING

H. W. NEWLUND, who has been assisting R. C. Kamphausen in the St. Louis field territory, has been appointed Local Field Engineer at St. Louis. Mr. Kamphausen has returned to New York for a special assignment in field engineering work.

D. S. BENDER has been appointed Local Field Engineer in the territory of the Southern New England Telephone Company, with headquarters in New York. Mr. Bender takes the place of R. J. Nossaman, who will now give all his time to directing the Field Engineering forces.

J. A. ST. CLAIR, Local Field Engineer at Atlanta, recently visited Jacksonville, Miami, West Palm Beach and other Florida points in connection with regular work in his territory.

J. M. SCHAEFER, Local Field Engineer at Omaha, visited Denver, Minneapolis, and Enderlin, North Dakota, recently.

S. H. ANDERSON, and J. R. Stone of the Systems Development Department, visited several central offices in Philadelphia on December 20 with engineers of the American Telephone and Telegraph Company and of the Western Electric Company, to study the commutation on Type M generators.

Outside Plant Development

C. D. Hocker attended a meeting of the American Society for Testing Materials in Philadelphia on January 9. On January 10 and 11 Mr. Hocker and F. D. Powers visited the Bureau of Standards and the Department of Agriculture in Washington, in the interest of studies of the characteristics of rope, friction tape, rubber tape and leather.

C. S. Gordon, with engineers of the American Telephone and Telegraph Company, was in New Haven January 6, in connection with studies of drop wire attachments.

E. M. Honan attended a sectional meeting of the Rubber Committee of the American Society for Testing Materials, held in Buffalo on December 1 and 2.

S. C. Miller visited manufacturing plants in Lebanon and Pittsburgh during the early part of January in connection with development work on outside plant hardware.

Patent

During the latter part of December and the earlier part of January W. G. Crawford, G. T. Morris, J. C. R. Palmer and J. W. Schmied were in Washington for the prosecution of applications for patents. During the same period J. A. Hall visited Chicago in connection with patent matters.

Laboratories motorists will be interested in learning that W. C. Kiesel has been appointed Recorder of the Borough of Florham Park, New Jersey. The office is colloquially known as Justice of the Peace.

Systems Development

O. H. Kopp, W. Whitney and L. F. Porter visited during the past month the new Main office at Cleveland, which was placed in service early in December.

W. L. Dodge, E. W. Hancock and G. A. Hurst spent several days in Boston, investigating a trial installation of new message registers.

A. F. Burns made studies of protection by high speed interrupters at Syracuse and Utica.

F. B. Anderson and T. A. Marshall observed trials of new testing methods for high insulation at Harrisburg. Shippensburg, Ligonier and Pittsburgh, on the New York-Chicago cable. In preparation for the trial, B. W. Kendall visited the Training School for the testboard men who were to carry on the test. He talked to the school, and inspected the new measuring apparatus.

H. T. Langabeer visited Buffalo to test a new model gas-engine generator set.

A. D. Knowlton visited Hawthorne for manufacturing information regarding proposed new developments of P. B. X. switchboards.

R. D. DeKay visited West Lynn, Massachusetts, and J. R. Stone, Fort Wayne, Indiana, for discussions with engineers of the General Electric Company.

C. E. Boman and R. E. Noble visited the new step-by-step and toll installation at Utica.

F. T. Forster discussed storage battery equipment with the Electric Storage Battery Company at Philadelphia.

W. L. Ross visited the Westinghouse Electric and Manufacturing Company at Pittsburgh to discuss a rectifier for use with P. B. X. boards. Then he went with L. Earl to Mercer, Pennsylvania, to conduct noise tests on an automatic power plant.

Otto Muller and his birthday cake

J. R. KIDD is representing the trial installation group at Chicago, looking after the first installation of a semi-automatic P. B. X. using line finders.

To observe the thirty-fifth anniversary of his joining the Bell System, friends of Otto Muller presented him with a cake and held a short celebration in his honor, in the Model Shop. Behind Mr. Muller and the cake is a large model which he made recently, showing a receiver and transmitter in cross section.

GENERAL STAFF

S. P. GRACE spoke on January 17 before the A. I. E. E. Section at Erie, Pennsylvania, on recent developments of the Laboratories, particularly speech inversion.

DURING January, John Mills visited several universities in the South describing to students of science the work and organization of the Laboratories and particularly discussing the problems of a graduate in starting as an engineer. He visited Duke University, University of North Carolina, North Carolina State College, and in company with Kendall Weisiger of the Southern Bell Telephone and Telegraph Company he also visited Emory University, Georgia School of Technology, and the Alabama Polytechnic Institute. At the latter institution he spoke over the radio on "How Your Radio Works."

UNDER the auspices of the New England Telephone and Telegraph Company, on January 18, P. B. Findley addressed the Boston post of the American Signal Corps Association on some of the fundamental principles of electrical communication.

The Twenty-Four Inch Cone

By G. R. LUM
Apparatus Development Department

HAVING passed the Apparatus Development Department's examinations, the new Five-Sixty Type Loud Speaking Telephone is ready to make its bow to the public and take its place in the telephone and radio world. Manufacture of its predecessor, the Five-Forty Type, will be discontinued as the newer one becomes available for sale.

With a twenty-four inch cone instead of the eighteen inch of the older type, the new speaker will reproduce the lower frequency tones somewhat more perfectly than is possible with a lesser diameter. In addition to this major improvement the driving rod has been shortened which makes it stiffer and the driving action more positive.

The soft brown color of the five-forty has been retained for the new cone but the relatively large blank surface has been relieved by a wider border which harmonizes with an eight cusped design at the center. On the whole the pattern is more graceful and pleasing than the severe and somewhat scantier design of the five-forty.

Like the older cone, the five-sixty is made with three types of terminals, the pin tips, the telephone plug, and the two-prong Hubbell plug. The power requirements are the same and in all respects the newer model may be used in place of the older one. The thirty-six inch cone described in the Record for December two years ago still proves to be a leader and the five-sixty will readily take its place as a brilliant younger brother.

The twenty-four inch cone

Club Notes

Handball

THE Club Handball tournament will be held on Tuesday and Thursday evenings, during March, at Labor Temple, under the same rules used for the last tournament. All matches will be decided by one game except the semi-finals and finals, where the victors must win two out of three games. There are to be four prizes, and in addition the team for outside competition will be chosen on the basis of showing in the tournament. Entries should be sent to D. D. Haggerty by February 25, with a fee of twenty-five cents.

Basketball

A most exciting and interesting basketball game was staged at Stuyvesant High School on Wednesday evening, December 14, between teams representing the Laboratories and the Hudson Street forces of Western Electric. Assisted by five hundred rooters from West Street, our team defeated Hudson Street by a score of 27 to 22, and thereby won undisputed title to the metropolitan championship of the Bell System. Our team started the second half with 11 points against 16 for Hudson Street, and within forty-five seconds tied the score. From then to the end it was a battle which those present cannot soon forget. Both teams played top-notch basketball throughout. O'Neil, Maurer, Gittenberger and Steinmetz starred throughout the season and finished among the first twenty in points scored.

Due to the exceptional interest shown by both players and spectators the Bell Systems League is here to stay. Plans have been made for the 1928 season, and four other branches of the System have been invited to take part in the activities of the league.

The first half of the departmental league's season ended with the Equipment team on top and undefeated. The second half began on January 17 and will end the latter part of this month. The Equipment team, which now holds the championship trophy, will play the team leading in the second half of the season for possession of the championship trophy for the coming year.

There will be no scheduled hikes this month, but those wishing to plan trips of their own can get information and assistance from Phyllis Barton, who has maps and a great store of facts about the surrounding country.

Music

The Club Quartette was the guest of Western Electric Post of the American Legion at its December 20 meeting, and rendered several selections during the dinner period and also during the open meeting which followed.

Bridge

The first half of the men's bridge tournament came to a close Monday evening, January 9, with T. V. Borland in first place and C. A. Smith and H. M. Hagland second and third respectively. The race was close from the first, and it was not until the last hand had been played on the last night that the winner was known. The second half of the season, consisting of ten nights of play, started January 23.

WOMEN'S ACTIVITIES

Golf

The women interested in golf will be glad to know that they can take lessons at the Vander-Built-In Golf Course on Forty-Second Street. Tickets are a dollar and a half per lesson, and can be secured through Marie Boman or Vivian Kilpatrick.

Another season of fun and instruction has started at the Carroll Club under Miss Stiehl's direction. Each Monday at seven and each Wednesday at five-thirty the women gather for a half hour. For a time it was doubtful whether a class could be scheduled at the Monday night period, but those who were a bit blue over the prospect are now correspondingly glad that it is going ahead. One of last season's swimmers said that never before had she learned so much in such a short time.

Bridge

Don't forget that Tuesday is bridge night, with play starting in the Rest Room at five fifteen. The Mid-Winter Tournament is just getting into swing, and Katherine Munn would like to have all her players lined up as soon as possible.

Basketball

The outside schedule of the Women's Basketball team is about half completed, with gratifying results so far. The members enthusiastically striving to keep up the record are Natalie Skinner, Lillian Kaempffe, Mandy Reinbold, Jean Hassett, Marie Boman, Margaret Brisbane, Alice Pease, Marion Grimm, Ann Barioni, Harriet Newman and Mary Zworick, and several others who come out for practice and are ready to substitute if needed. The remaining games definitely scheduled are a return game with the Vacuum Oil Company at Labor Temple on February 9, a return game with the Seaboard National Bank at the Bowling Green Association February 16, and the game all are especially awaiting, with the People's Palace in Jersey City on Tuesday, February 21, at six o'clock. To complete the season there will be a few more games booked.

Life Insurance by Payroll Deduction

Life insurance may now be carried by members of the Laboratories by means of monthly deductions from salary. This is a natural complement to the stock purchase and savings plans. Policies taken out under this arrangement will be written by the Equitable Life Assurance Society, the company chosen after a thorough investigation.

All of the Equitable's standard forms of policies are available and the regular quarterly rates will be charged although payments occur monthly. In addition to the convenient payments, the plan provides that no medical examination will be required except for policies over $10,000 *and except in instances where the health declaration makes it desirable.*

All negotiations except payment of premiums will be carried on by the individual directly with the Insurance Company. Mr. L. M. Bunting, an expert on all phases of life insurance, now occupies Room 144 *and members of the Laboratories should consider that he is available for consultation regarding their insurance problems. This consultation is entirely confidential and implies no obligation. Bearing in mind that probably as much as four-fifths of all the money men leave to their families is in the form of life insurance, the importance is obvious of obtaining the best possible advice and assistance.*