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A New Type of Toll Switchboard

By L. F. PORTER

THE story of the toll switchboard is largely the story of development in signalling methods and circuits. In the early days of telephony when the numbers of subscribers and circuits were small, interurban or toll connections were handled on practically the same basis as connections between different subscribers in the same locality. In those days it was customary to call the attention of the subscriber or the operator by means of alternating current from a hand-operated magneto generator. Somewhat later the generator at the subscriber's telephone was superseded by the use of signals in the switchboard operated from a common battery in the central office. Even earlier than this the operator's use of the hand-generator was displaced by a machine delivering 16 2/3-cycle alternating current so that the operator had only to connect to the proper line and press a key in order to operate either the bell at the subscriber's telephone or a signal at a distant switchboard.

In order to use the outside plant more efficiently, circuits were introduced by which telegraph signals could be sent over the same wires simultaneously with telephone conversations. As telegraphy involved frequencies of the order of 16 cycles, it was necessary on these "composite" circuits to have some means of signalling from which the telegraph operation would be mutually independent. For this purpose a frequency of 135 cycles was chosen as high enough to be separable from the telegraph currents, and low enough to be separable from the telephonic currents.

To insure that ringing current of appropriate frequency should be applied, a conversion unit known as a "composite ringer" was developed. Receiving 16 2/3-cycle current from the switchboard, this unit would emit toward the line a 135-cycle current. Vice versa, a 135-cycle current from the toll line would cause a 16 2/3-cycle current to be applied to the central-office equipment.

With the advent of long repeatered circuits it was necessary, where the 135-cycle signalling system was used, to relay this signalling current

Figure 1—A typical installation: "Outward" part of the No. 3 toll switchboard at Reading, Pennsylvania

mechanically at most repeater stations, since the repeaters could not readily be made efficient enough at this frequency. Because of this another system has been developed in which the signalling is at 1000 cycles, a frequency which passes directly through all the repeaters and requires signalling apparatus only at the terminal offices of the long-distance circuit. A corresponding type of "composite" ringer operates between 1000-cycle signalling current at the line side and 20-cycle* signalling current on the switchboard side. Both of these types of composite ringers are installed as part of the terminal and test-board equipment of the circuit, being thus connected between the line itself and the toll switchboard.

* *The 16 2/3-cycle current has been replaced by the present standard 20-cycle signalling current.*

Manipulation of cords and keys in setting up connections has changed since the days when toll lines were handled by subscribers' operators. First came the toll operator—a specialist in the more complicated technique of building up long circuits, locating the persons wanted, and timing conversations. This operator—and her co-workers—had access to all subscribers' lines through an extension of the multiple into their sections of the board.

When local subscribers' circuits were converted to the common-battery system it was of course necessary to arrange the toll operator's cord circuits so that in making connection to the local subscriber through the multiple the necessary current for his transmitter would be provided from the central office battery through that part of the operator's cord circuit which was used for connection to his line. As signalling from subscriber to operator was now by direct current, means had to be provided in the operator's cord circuit to translate the signals into lamp indications. Signals from other offices would still come in as alternating current, for which different relays were required. In many instances it was necessary to have several different types of cord circuit in order to meet service requirements.

Such switchboards are characterized by the entire multiple of local subscribers appearing in front of the toll-line operators. These switchboards* are economical in smaller cities where traffic does not warrant a separate toll board. In contradistinction, another type of toll board** provides connection with subscribers' lines through trunks to the local central office. This arrangement is a necessity in cities served by more than

*Specifically the Nos. 1D, 2, 9C and 11.
**Known as the No. 1 Toll Board.

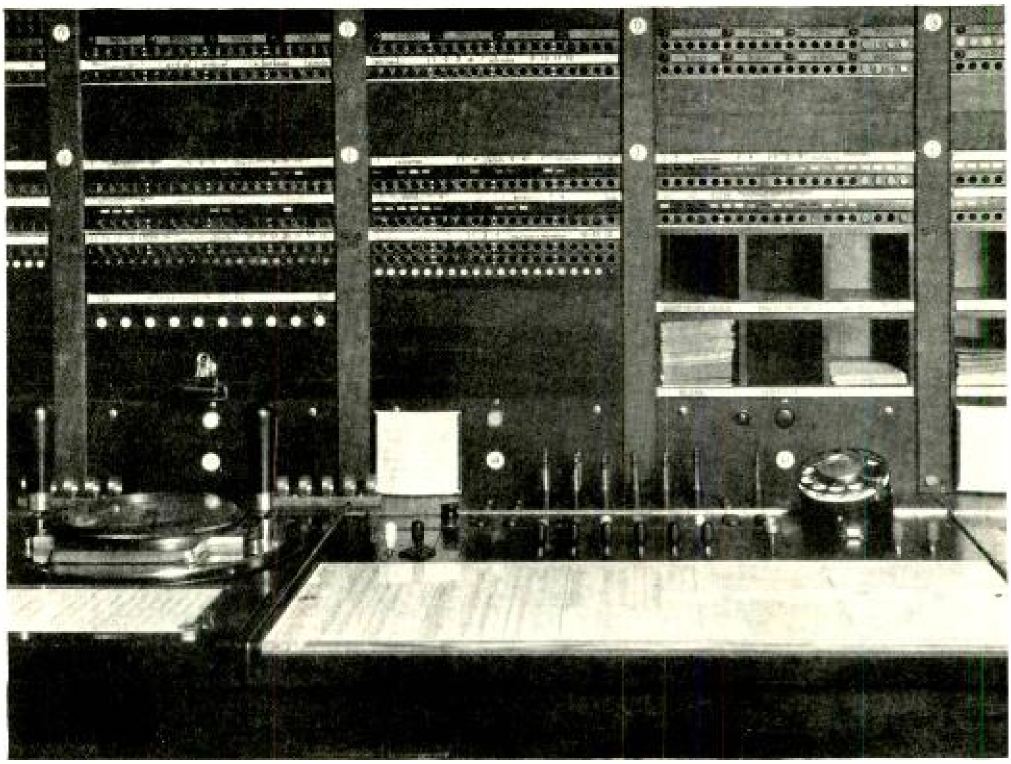


Figure 2—A toll operator's workplace: an outward position at the Reading toll board. Key-shelf equipment, left to right: calculagraph, positional ringing key, dialing key, splitting key, supervisor's holding key, six talking-monitoring keys and their associated pairs of cords, coin-control cord with "collect" and "refund" keys; dial; position transfer key; messenger call key. As calls are recorded as well as completed at this part of the board, the lowest group of jacks on Panel 64 are incoming trunks from the local office; the next two levels are outgoing toll lines with their visual busy signals. Above are outgoing trunks to the local office

one central office; it also assists in promoting economy by grouping at one point the toll traffic of an area as extensive as may be desired.

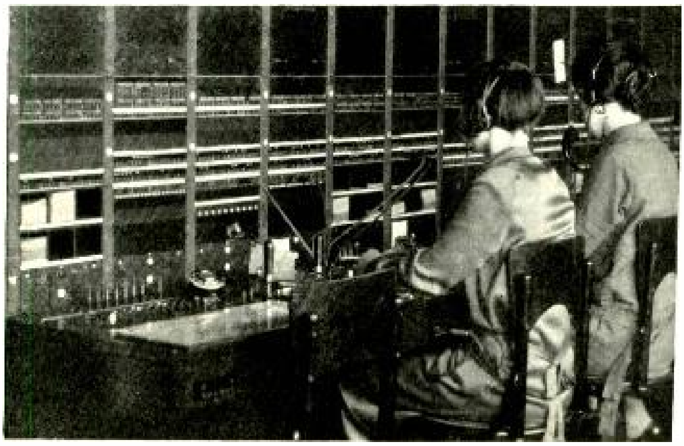


Figure 3—Another view of the position shown in Figure 2

When a connection is established, current—both talking and ringing—is supplied to the subscriber's line from the local office. At that point the subscriber's signals are transferred to the trunk for the information, ultimately, of the toll operator. Toll-line circuits are practically the same in this switchboard as in the other types. Here also the matter of making "terminating" and "through" connections requires different types of cord circuits in the toll switchboard because it is necessary to make the toll end of the cord responsive to alternating-current signalling and to make the local end of the cord responsive to direct-current signals from the toll switching trunk.

With the coming of machine switching, it became desirable to enable toll operators to dial local subscribers. Additional relays for the dial circuit added to the congestion in the rear of the switchboard. Traffic requirements, too, were changing. All in all, a new switchboard, designed in accordance with modern ideas, seemed desirable. Boards of this type, known as the No. 3, are now in satisfactory operation in Lansing, Michigan; Reading, Pennsylvania; Miami, Florida; and elsewhere. The new Cleveland toll board, one of the largest in the country, and now in process of installation, will be of this type.

To make clear one point of view from which the new board was designed it is helpful to recall that incoming signals are of two kinds; *supervisory* signals, made when the line is connected to a cord circuit and *line* signals, made when the line is not so connected. Obviously the relay equipment for the line signals must be associated with the line; less obviously, the equipment for supervisory signals may be associated with *either* the line or the cord circuit. In subscribers' boards, where the lines far outnumber the cords, it has always been economical to place supervisory equipment in the less numerous cord circuits. But in toll boards, there are sixty per cent more cords than lines, so a saving can be made by placing as much as possible of the equipment in the line circuit. Still further savings then follow. A single set of relays will now respond to both line and supervisory signals, instead of one set for each kind of signals. As has been said, conversion units were used on those lines where signalling was as at 135 or 1000 cycles, and the signalling relays on individual cords were made responsive to 20-cycle or direct current, according to whether the cord was intended to be connected to toll lines or to trunks. In the No. 3 board, with conversion units in all lines, the cords contain no signalling relays, and their circuits are all alike, so they can be used indiscriminately to connect to trunks or toll lines. Operation of the ringing key sends direct current over one conductor of the cord; this operates a relay in the line or trunk circuit to send out signalling current of appropriate frequency.

Maintenance of signalling equipment is facilitated by certain advances in design incorporated in the No. 3 switchboard. Since a given signalling relay has to function with only the particular trunk or line to which it is permanently connected, it can be adjusted for a narrower range of conditions than it would have to meet were it to be connected indiscriminately to any line or trunk. A narrower range of input conditions permits a less precise adjustment, with accompanying savings in the time required to make the adjustment.

In addition to connecting toll and trunk lines with each other through pairs of cords, the toll operator must from time to time connect her telephone circuit to any cord circuit to talk and listen, or to listen only. She must ring on any front or back cord. She may need to "split" any cord circuit—that is, cut off either front or back cord from her own telephone set and from the other cord. She should be able to dial local subscribers when there are machine-switching offices in the local area. Inward operators will need to signal the outward and through boards. In earlier systems the functions described in the preceding sentences were performed by keys in each cord or toll-line circuit. Since most of these operations are performed only when the opera-

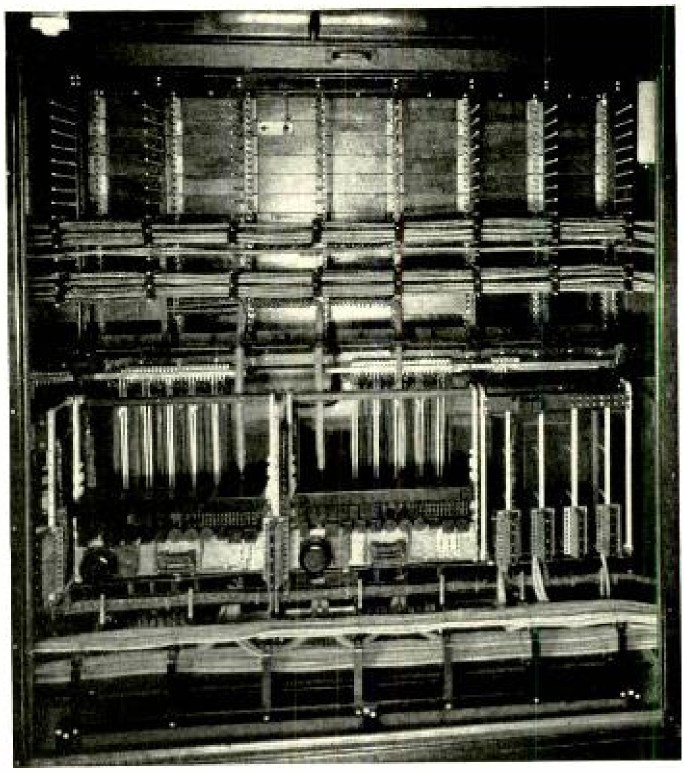


Figure 4—A typical rear view: inward section of No. 3 toll board at Reading. One sees mostly cables and cords, inevitably part of any switchboard. Cord-circuit apparatus is limited to that mounted on three plates in each position, a notable characteristic of the No. 3 board

tor's telephone is connected with the cord, apparatus has been economized by associating several functions in a "positional" circuit. These are talking, splitting and transferring, and (when desired) dialing. Associated with each cord-pair are only the ringing* and the talking-monitoring keys. When the latter is thrown to "Talk" it cuts in the positional circuit in readiness for the operator to talk; other functions of this circuit are under control of appropriate keys.

When a toll call is delayed at the distant end, an operator at that point may call back the originating office. This call, answered at the inward board, must be transferred to the outward board, where the original ticket is being held. For this purpose there was provided for each line at the inward board a push-button which lighted a line-lamp at the outward board. Evidently this button would be used only when a cord was connected to the line. The relay in the line circuit which performs this function is now controlled by a key in the positional circuit. Operating the key in one direction signals the outward board; operating it in the other direction signals the "through" board when the call is to be switched to a toll line leading to another office.

In order to prevent functional interference between cord circuits those of the No. 3 board are arranged so that, if the listening key is operated on one cord, the operator can not connect a second cord to her positional circuit. A later system enables the operator to talk over two or more cords by operating the key of one cord to "Talk" and the keys of the other cords to the "monitor" position. The other functions of her positional circuit are unimpaired as regards the cord of which the "Talk" key is thrown.

So a new type of switchboard appears in Bell System service. Its design promotes economy in several ways: notably by associating certain relay-groups with lines and trunks instead of with the more numerous cord circuits, and by associating toll-line transfer arrangements with the positional circuit instead of with the toll-line multiple. Design of this system has eliminated most of the relays which once congested the rear of the switchboard; result: a simpler, cleaner switchboard which is better adapted to manufacturing and stocking. Maintenance has been facilitated by lessening congestion behind the board and by locating most of the relays on racks in the terminal room. Finally, the board is prepared to accept without difficulty further developments which have been and will be accompaniments of the unfolding art of telephony.

**A recent modification; some of the earlier boards have ringing keys in the positional circuit.*

Iron Crystals

By L. W. McKEEHAN

A LITTLE knowledge, at least if action must be based upon it, is a dangerous thing. That, comparatively speaking, is perhaps the state of our knowledge as to the magnetic behavior of iron. Many able experimenters have studied and described what happens when iron, or other "ferromagnetic" materials, are operated on by magnetic fields, but their attention was largely focussed upon a few sorts of iron which are "desirable" for particular uses. One cannot intelligently desire what is unknown; and since there is always the chance that a new magnetic iron (as peculiar in its way as permalloy) is awaiting discovery we must add to our knowledge about the magnetic behavior of iron before we can say that an ideally desirable set of magnetic properties is possible or tell where to look for it.

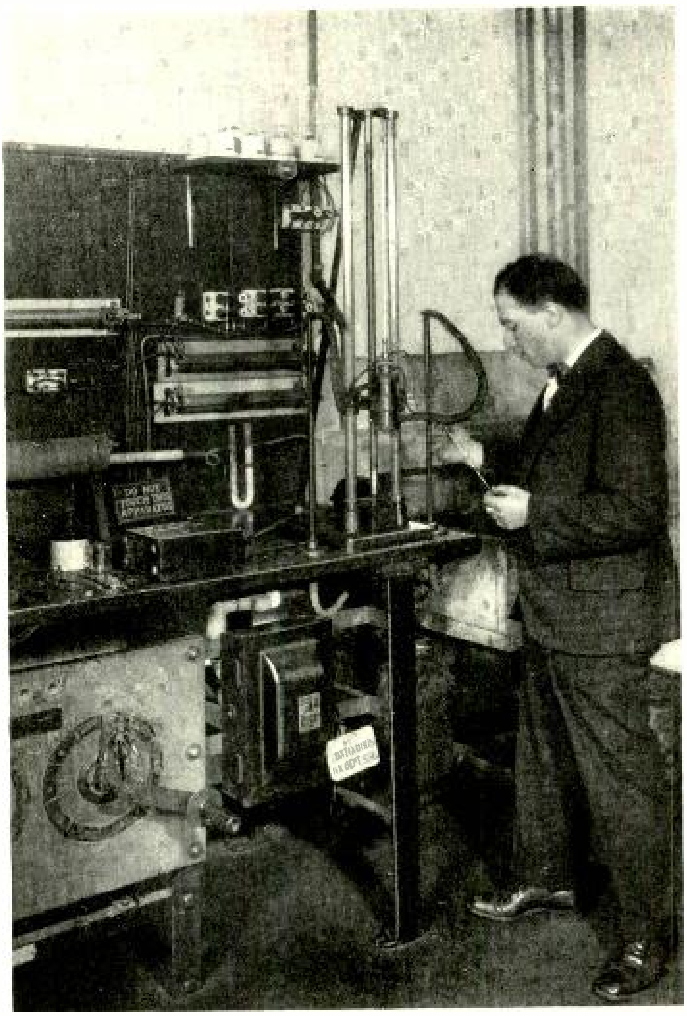


Figure 1—P. P. Cioffi examining single-crystal wire grown in apparatus shown at his left

All this preamble is by way of explanation of the interest of our Bell Laboratories in making large iron crystals and in studying their magnetic behavior. The crystals themselves *may* be useful but the knowledge they yield is *sure* to be. We are not, however, spending time on these matters without strong hopes of turning up something interesting. Other investigations have shown already that large iron crystals have attractive magnetic properties, in particular that of low hysteresis loss. Since hysteresis is so fundamental in ferro magnetism, and so embarrassing on its own account, our

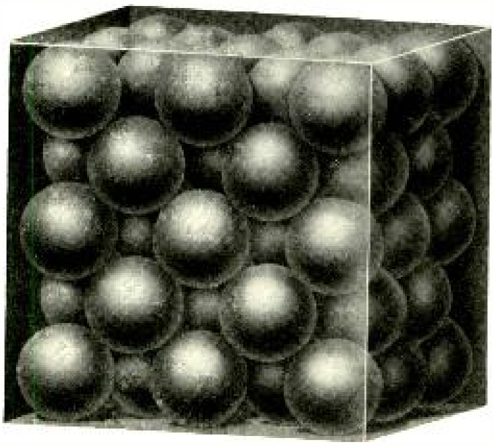


Figure 2—The arrangement of atoms in γ-iron, the form stable above 900 degrees centigrade. The faces of the cube shown are of the crystallographic form [100]

concern in this subject is natural enough.

Like every other magnetic material except magnetic iron oxide (lodestone) large iron crystals have to be made before they can be studied; we do not find them growing wild. To be sure, some large enough to work with have been found in silicon-steel sheets or have popped up unexpectedly in heavy ingots. Such haphazard crystals are not of the right shape for easy magnetic examination; and in drawing conclusions from them there is always the fear that the act of making them the right shape has played hob with their magnetic properties.

A straightforward way of tackling the job is to take a piece of iron of preferred size and shape and to form one crystal from the many which actually compose it. There are two ways of doing this, one old and one new. The old way is due originally to Professor Albert Sauveur of Harvard University. The details depend upon the experimenter but the essentials are: (1) that the iron be annealed so as to give it a nearly uniform grain-size, with grains not too coarse and not too irregular in shape; (2) that the piece be over-strained, not too much nor too little; and (3) that the temperature be raised slowly enough and high enough so that one grain (perhaps not one of those originally present) will grow so large as to occupy the whole of the strained portion. The control of the various steps is not easy and even when the greatest care is taken the experimenters report that failures outnumber successes.

The new way was devised by the writer and the details of its application were perfected by P. P. Cioffi.

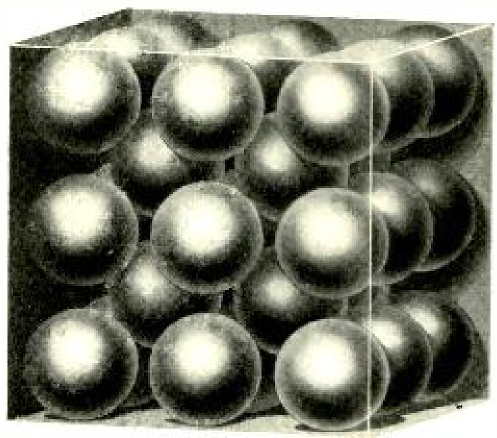


Figure 3—The arrangement of atoms in α-iron, the form stable below 900 degrees centigrade. The faces of the cube shown are of the crystallographic form [100]

The essentials are: (1) that the iron be heated much above 900° C; and (2) that it be cooled progressively and not too fast in such a way that at every moment the part cooling through 900° C is a very thin layer in a region of steep temperature gradient. These conditions are met by moving a hot spot steadily along a vertically supported rod or wire. In the latest design of apparatus the heating is provided by an electric current carried by the millimeter wire in which the crystal is to appear. The contacts through which the heating current enters and leaves the piece are rigidly connected and are carried by a lead-screw like that of a lathe or boring mill. Since the hot part of the wire is weak mechanically and reactive chemically, it must be specially protected against mechanical and chemical reagents.

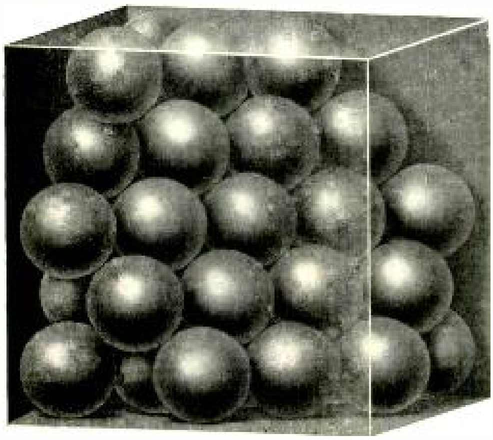


Figure 4—Arrangement of atoms in γ-iron on a plane of the form [111]. The cube shown in Figure 2 has been cut off to expose such a plane

We think we know why these two ways work. In the old method the second operation leaves the metal principally composed of strained crystals which are at every temperature less stable than unstrained crystals. If then a bit of unstrained crystal exists, as is almost certain to be the case, it will at some stage of heating begin to grow by taking over atoms from the strained crystals in its neighborhood and rearranging them to suit its own structure. It can go on growing until it has rearranged all the atoms in the piece or until it meets another growing crystal over which it has no advantage. In this competition the similarity of the original grains, the exact degree of over-strain and the rate of heating all affect the prob-

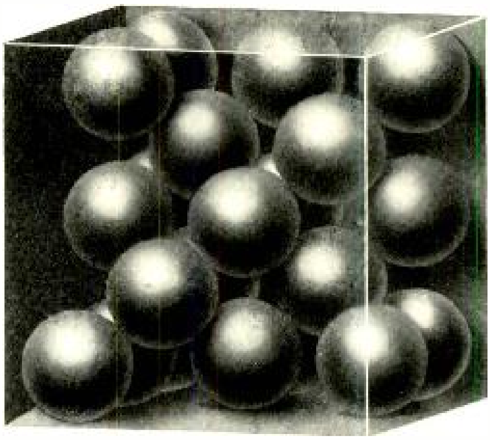


Figure 5—Arrangement of atoms in α-iron on a plane of the form [211]. The cube shown in Figure 3 has been cut off to expose such a plane

ability that one crystal may make a clean sweep.

The new method works because iron has two crystal structures, one stable above about 900° C, the other stable at lower temperatures. The former is called γ-iron and has a face-centered cubic structure, the latter, α-iron, a body-centered cubic structure. One structure starts to change into the other as soon as the temperature drops below the transformation temperature. If then a crystal of α-iron exists on the cold side of the 900° layer it can grow by taking up atoms as fast as they are supplied to

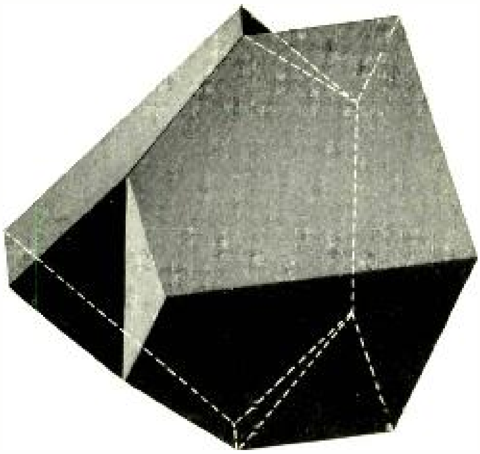


Figure 6—The arrangement of twins in γ-iron. The half-cubes are shown, the common plane being of the form [111]

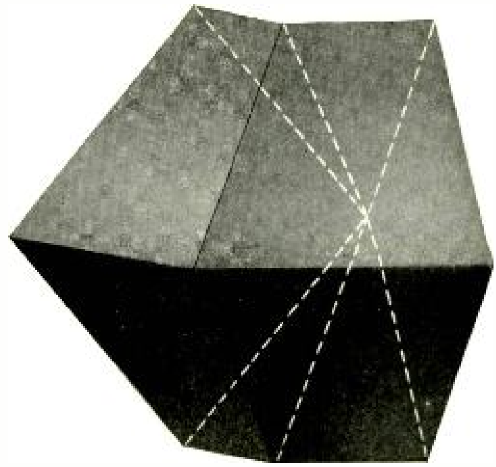


Figure 7—The arrangement of twins in α-iron. Two half-cubes are shown, the common plane being of the form [211]

it by γ-crystals on the hot side of the moving boundary. Since the volume within which steady conditions are important is smaller in the new method, it is not surprising that success in it is less dependent upon the purity and previous history of the iron. We find, for instance, that the carbon content does not have to be kept so low and that previous annealing is unnecessary.

Our experimental troubles arise from the mechanical and chemical weakness already mentioned. Small forces steadily applied may cause serious bending and side-slipping in the γ-crystal region, and while the α-crystal often grows right through these imperfections the irregular shape which results makes it impossible to apply the same magnetic and mechanical forces to every part of the α-crystal in the later tests. Sudden jerks and twists have another bad effect. They encourage the appearance of new crystals or at least of faults in crystal structure, such as twinning. The hot iron is readily attacked by oxygen, so that it must be surrounded by some neutral or reducing atmosphere. Hydrogen seems the best of these, but hydrogen readily penetrates hot iron and does not all come out again when the iron cools. Luckily the crystals can be heated in vacuum (below 900° C, of course) to drive out absorbed or locally liberated gases so that the effect these produce upon the magnetic and other properties of the freshly-grown crystals can be estimated.

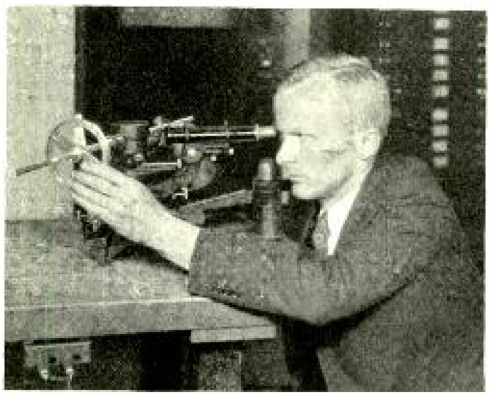


Figure 8—D. D. Foster using the optical goniometer to fix the orientation of a single-crystal wire

The contacts for the electrical current which we use for local heating of the wire have also to be designed with care. These contacts must slide along the wire with little friction, must be gas-tight and must also help to keep the ends of the wire cool. A scheme that works well is to use mercury contacts, the mercury filling two cups each with a hole in the bottom just big enough to let the wire pass. The blocks in which the cups are cut are cooled partly by water passed through them and partly by the hydrogen kept flowing gently through the space around the hot part of the wire.

The wires that have passed through the new crystal-growing process are bright and smooth, with no signs upon them to advertise their conversion. A short dip in dilute nitric acid brings out the crystal structure, for the bright planes which best resist the acid are arranged in each crystal parallel to the sides of a cube, and the edges of this cube—the "axes" of the crystal—point in different directions in each. A simple form of goniometer is used to find the directions of these edges, which are, of course, normal to the reflecting surfaces left by the etching, and the position of the wire axis with respect to the crystal axes is thus determined. D. D. Foster has conducted these optical measurements and with the advice and assistance of R. M. Bozorth and F. E. Haworth, has also taken X-ray pictures of some specimens.

The X-ray data show that the optical method, while not very accurate, is good enough for inspection purposes, either for judging the success of a crystal-growing experiment or for selecting a crystal to be given more particular study. We are not yet sure that any special orientation of the crystal axis is either preferred or prohibited. F. F. Lucas has checked our conclusions as to crystal sizes and as to the nature of some of their ac-

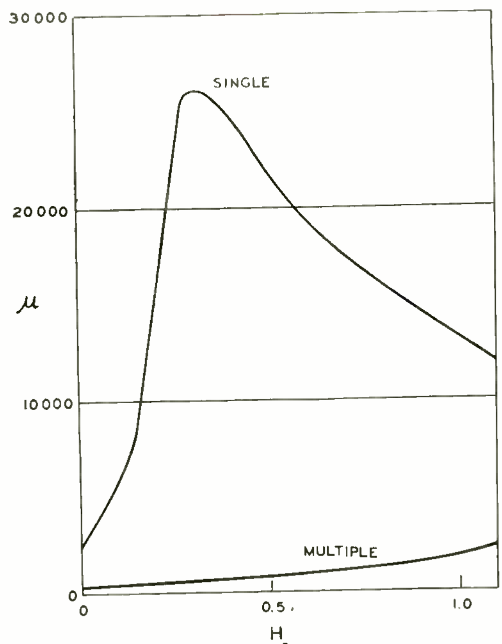


Figure 10—Permeability curves

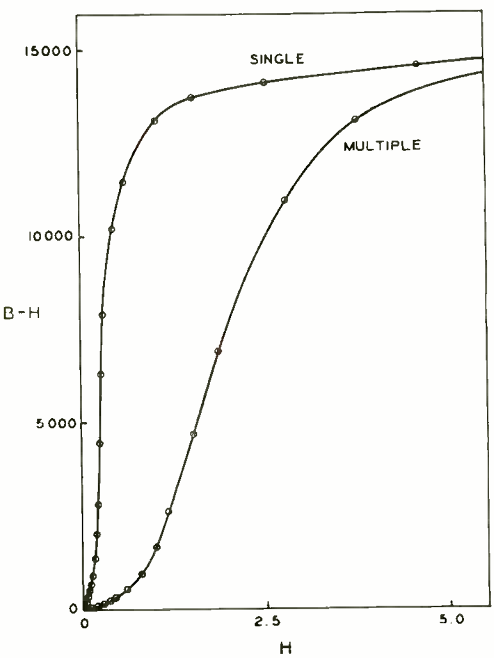


Figure 9—Magnetization curves

cidental imperfections by visual and photographic study under the microscope.

The magnetic behavior of freshly grown and of "degassed" iron crystals is, according to measurements by R. H. Raguse, qualitatively like that of polycrystalline iron, but the magnetic forces necessary to reach the interesting points of magnetization curves and hysteresis loops are less for the single crystals. This is more easily seen by looking at the diagrams than by reading the numerical data. Magnetostriction, as already known, depends in amount and even in sign upon the position of the crystal axes with respect to the wire axis along which the magnetic force always acts and nearly along which the resultant magnetization must also lie. The few magnetostriction curves so far obtained by P. P. Cioffi are different for differently oriented crystals. Magnetization curves are not so sensitive to changes in crystal position, and our experiments are not yet complete enough to give safe results on this point.

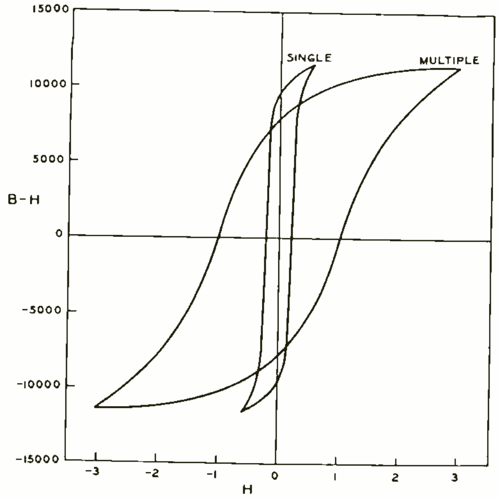


Figure 11—*Hysteresis loops*

While spending most effort on the new method we are not neglecting the chance that the old method may give importantly different results. In order to supply comparable samples D. D. Foster is therefore applying Professor Sauveur's method to wires identical in preparation with those used in our progressive process.

When we get a clear picture of how a single crystal of iron goes about changing its state of magnetization and what happens to its dimensions in the process we may hope to have a very fair start toward telling how a few million crystals, more or less carefully packed together, succeed in doing the same thing and how best to help or to hinder them. Perhaps then we may even succeed in obtaining in the cores of relays or of coils a new set of desirable magnetic properties.

Long Waves or Short

By J. C. SCHELLENG

SEVERAL years ago measurements of radio transmission had led investigators to the belief that only long waves were useful for transmission over great distances. As a matter of fact this is true within the range of frequencies which were used at that time. Waves of 5000 meters, for example, were chosen by Bell System engineers in the first successful transatlantic telephone experiments in 1915, and in the later engineering development which culminated this year in public transatlantic telephone service.

The results of numerous transmission tests on such long waves were found to be in general accord also with reasonable theoretical predictions. Empirical rules, thus derived, proved to be very useful and were commonly applied beyond the wave lengths employed in the original experiments. Since a wave of 1000 meters was known to have a smaller range than one of 5000, it was entirely natural to assume that one of 100 meters would have too small a range for long-distance communication. As for those between 15 and 50 meters, they were quite naturally relegated to the field of academic experiment.

As radio developed, however, its engineers learned that short waves are useful and can be employed for long distance communication (in fact, they may *sometimes* travel completely around the world and back to the transmitter). The pendulum of popular approval meanwhile swung from long waves to very short waves.

Between long and short radio waves—between low and high radio-frequencies—it is not easy to draw a sharp line. We can probably avoid disagreement by calling "long" all waves more than 1000 meters and by designating as "short" all those less than 100 meters and refraining from classifying those in the no-man's land in between. This division is reasonable also because there seems to be a fairly definite difference in the mechanisms of propagation.

Whichever frequency range we may be considering, the electrical properties of the earth are not in themselves sufficient to explain why radio waves follow its curvature. It has become necessary to assume an

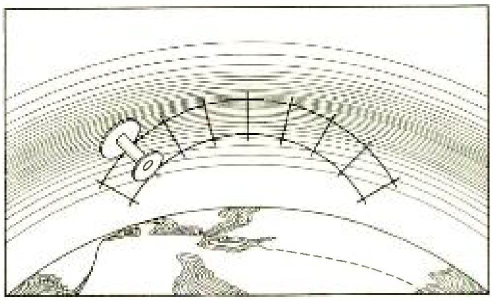
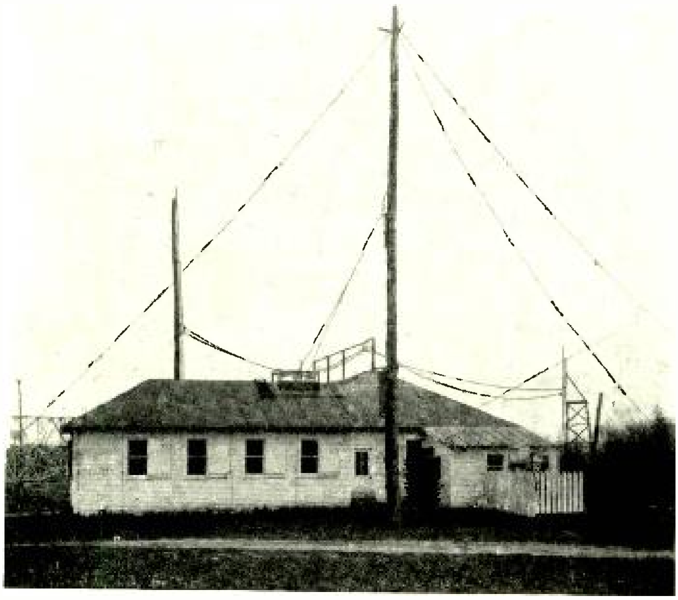


Figure 1—A graphic analogy of how waves are refracted on passing through a medium in which their velocity is not uniform. The common axle symbolizes a wave front. Where there are more ions, the wave travels faster; this is symbolized by a larger wheel. Since the wheels are of different diameters, the combination describes a curved path, symbolizing the curved path of the ray

ionized region in the atmosphere, from fifty to a few hundred kilometers overhead. This means that the rarefied upper atmosphere is supposed to be laden with unattached electrically charged particles, that is, free ions and electrons. For this belief evidence is not by any means confined to radio data—the assumption was first made to explain certain phenomena of terrestial magnetism. Furthermore, measurements of ionization in the lower atmosphere and the very existence of the aurora borealis, give a direct indication of what is to be expected at great altitudes. Laboratory researches have also indicated that electrons and alpha rays from the sun as well as its ultraviolet light should result in great numbers of ions in this upper atmosphere. The most important of these agencies very likely is the ultraviolet radiation. Since the region of the earth's atmosphere which is exposed to that radiation follows the sun's rays from east to west the condition of the upper layers changes correspondingly. And also at any time the density of free ions and electrons will vary gradually from a maximum in the upper layers to a negligible minimum lower down.



Our laboratory at Deal, New Jersey, for short-wave transmission. Antennas can be seen attached to the pole in the foreground and to the structure at the left. At the right can be seen a turntable for investigations into directive antennas

Returning now to observed radio phenomena, long waves travel great distances without becoming so weak that they are ineffective for communication. The signals are ordinarily steady and the variations in their transmission are usually only diurnal.

As the wavelength is decreased, absorption increases and this results in a decreased range of transmission. At broadcasting frequencies, for example, which correspond to wavelengths below those called "long", the daytime range is hundreds rather than the thousands of miles which longer waves would travel.

As we proceed to shorter wavelengths other complications are encountered. The earth's magnetic field in conjunction with free electrons should produce critical phenomena centering about 250 meters. This is a region where high attenuation and unreliable transmission are to be expected. The magnetic field, of course, should have an effect throughout the whole wavelength range though not in so marked a degree. Our experimental information bearing on the effect of the magnetic field is unfortunately rather meager.

The essence of the experimental facts of short-wave transmission as we have come to know them is this: Using waves shorter than fifty meters, there is found for any geographical distance an ill-defined wavelength for which the daytime results are on the average as good as those at night. Shorter waves are apt to be inferior during the night while longer excel. On the other hand, during the day the longer waves tend to fail and the shorter waves become of greater use. For example, this dividing wavelength in the case of transmission to England during the winter is about twenty-five meters. Seventeen meters fails completely during the night but can be used during the day. On the other hand, fifty meters yields a strong signal at night but cannot be detected during daylight hours.

One of the interesting peculiarities of short waves is that at the same time that a station is heard at a distance of thousands of miles, the signal may be completely inaudible at points less distant than one hundred miles. The wave apparently skips over the region near the sending station. It descends at a more remote point. This limiting range is called the skip distance. Within this region only a small signal is received. Very little is transmitted directly along the earth because the ground absorbs short waves so strongly. In fact absorption is found within a few wavelengths of the transmitting antenna and at a distance of fifty miles the direct signal has ordinarily been completely eliminated.

It is a fact that a small erratic signal is often found within the skip distance. This may be due to a small signal received from overhead. Some of this signal has probably travelled all the way around the earth. Another explanation which seems plausible is that it is the result of diffuse

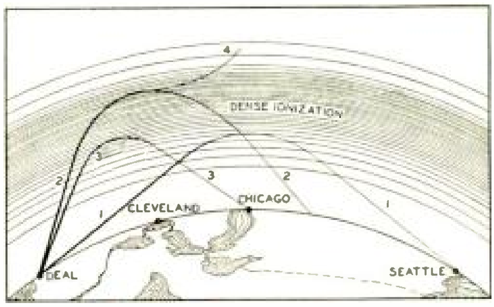


Figure 2—This drawing and Figure 3 illustrate contrasting theories of the skip effect. Here is visualized what might happen to rays of a single wave-length. The ray (1) which makes the smallest angle with the earth's surface is refracted so as to come to earth at Seattle; ray 3, at a greater angle, comes down at Chicago; ray 2 is at an angle so great that it must pass nearly through the ionized layer before it is turned earthward again. However, if it has passed the level of maximum ionization, it will keep right on going, as shown at 4

reflection from points beyond the skip distance. Since the ocean, and to some extent the land, are fairly good reflectors, the waves probably skip out a thousand miles or so and are reflected from the ocean waves or from irregular land back to points within the skip distance. This would result in erratic reception, particularly in the case of reflection by the sea.

The skip distance increases with frequency. If we increase the latter a frequency is reached for which the wave will be lost at all distances even by day. This limiting frequency corresponds to a wave which is probably of the order of ten meters and represents the lower limit of the long distance radio wavelength spectrum.

But there is a less rosy side to the short-wave picture. Short waves are much more temperamental than long waves. The day-to-day variations for short waves are large and while reception may be nearly perfect today, tomorrow the signal may be very weak. In addition transmission suffers from a kind of nervousness known as "fading". This is a more or less rapid fluctuation of signal strength. It produces distortion in telephone signals which in extreme cases become unintelligible.

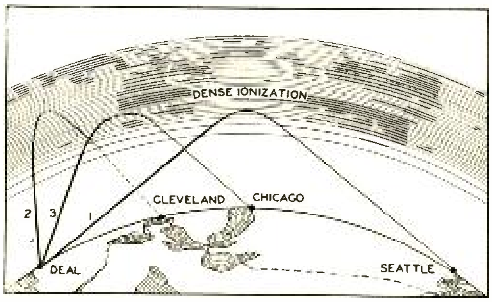


Figure 3—This illustrates the second theory of skip phenomenon. A falling-off in signals at a nearby point—such as Cleveland—is explained by the longer path of ray 2 through the ionized region; and also by the much more intense ionization at the turning point of ray 2 than at the turning point of the other rays

Viewing the whole range of radio transmission, the following facts stand out to invite or to defy theoretical explanation. For long waves, attenuation increases with frequency. For short waves, on the other hand, absorption decreases with frequency. Short waves can often be received at a distance more easily than nearby, for they skip overhead and return to earth at a more remote point. Short waves fade while long waves are steady.

The most probable explanation of the increase of absorption with frequency for long waves seems to be that long waves in passing along the earth are guided by the conducting earth and by the conducting layer in the upper atmosphere, the region in between being without appreciable ionization. This action can be compared to the guiding of a wave by a pair of wires. In the words of Heaviside: "* * * the waves will, so to speak, catch onto it (conducting layer) more or less. Then the guidance will be by the sea on one side and by the upper layer on the other".

At low frequencies, as we have said, the attentuation increases with frequency, while the exact opposite is true at very high frequencies. Since this is one of the fundamental differences between long and short wave propagation the reason for this reversal is of great interest.

Absorption of wireless waves is due in great measure to energy losses in the upper atmosphere. Free ions in the electrostatic field of a wave will be set into motion. The kinetic energy of this motion is drawn from the wave. As long as the ion does not suffer collision with molecules of the air, there is no dissipation of energy. But collisions do occur and obviously result in the conversion of this energy of vibration into disordered translational energy. In other words, the temperature of the gas is very slightly increased. The wave thus has lost some of its energy—it is attenuated. Now it makes a great difference how many collisions the ion encounters. Two different types of phenomena are to be expected, depending upon whether the collision frequency is

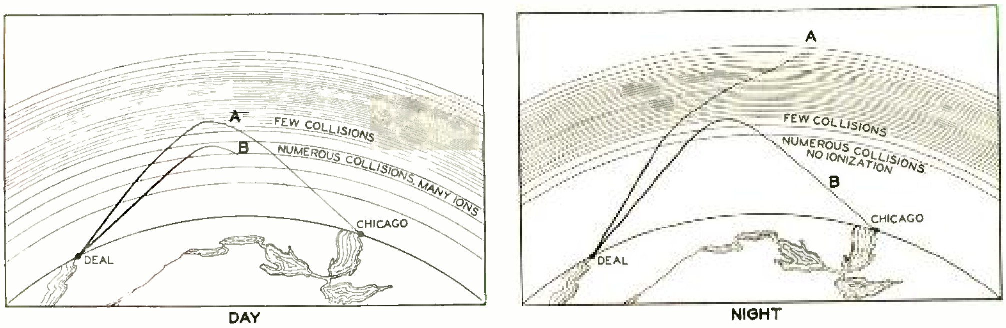


Figure 4—Why transmission differs between day and night. During the day, wave A, of say twenty-five meters, is refracted to reach Chicago. Wave B, of say one hundred meters, is so much more attenuated, due to its lower frequency, that it never reaches its goal. At night, however, the ions in the lower atmosphere have disappeared, and wave A never returns to earth, as explained in Figure 2. Wave B however is no longer strongly absorbed and now reaches Chicago

greater or less than the angular frequency of the wave. In the first case the frequency of the electric field is so low compared to the frequency of collisions, that the medium obeys Ohm's law. By this we mean that the convection current resulting from the drift of ions under the influence of an electric field is proportional to the field, is in phase with it, and is independent of frequency. Under these conditions it is found theoretically that attenuation should increase with frequency. This, we have already noticed, is precisely what is found for waves longer than 1000 meters; for frequencies, that is, less than 300 kilocycles.

At the other extreme, the frequency of the wave is high compared to the rate at which ions are colliding with neutral molecules. An ion can cause dissipation only in proportion to the kinetic energy which it possesses as a result of its oscillatory motion. It can cause the dissipation of an amount of energy proportional to this at each collision. The higher the frequency, the smaller is the amplitude of vibration of the electron. The alternations then occur so rapidly that the electron does not at any time acquire velocity as high as it does for lower frequencies. Its kinetic energy and the loss of energy due to collisions are correspondingly less. Absorption, therefore, would be expected to fall off with decreasing wavelength in somewhat the same way that has been found by experiment.

This is the explanation why a fifty-meter wave is useless between this country and England in the daytime when ionization is more intense in the lower reaches of the atmosphere where collisions are more numerous than at greater altitudes. It gives a reasonable explanation for the success of 20-meter waves at the same time.

So much for absorption. Now why do these waves return from the ionized upper atmosphere? Free ions act in such a way toward a wave as in effect to decrease the refractive index of the medium. To use an analogy familiar to the electrical engineer, ions, due to their mass, add an inductive admittance in parallel with the normal capacitive admittance of the medium which reduces the effective value of the latter. In other words, the effective dielectric constant and therefore the refractive index, become less than unity. In this way the velocity (phase velocity) of the wave is increased and optical refraction results. The wave is deflected away from the region of ionization and back to earth. Now it requires a greater degree of ionization to turn a short wave back than a long one. It follows that for a given angle of emergence from the ground, the shorter wave not only can go higher, but must do so if it is to return ultimately to earth. If the wave is short enough there may not be sufficient ionization to hold it down. In that case it may escape from the earth as do waves of visible light.

Another way of explaining the failure of short waves within the skip distance is that the shorter waves do not escape, but are absorbed. Since they are not bent back to earth as readily as the longer ones, they are forced to travel a greater distance in the ionized region and are therefore absorbed in spite of the fact that at any point in their path their absorption is less than it would be for longer waves.

Fading has received various explanations which are more or less plausible. It is likely that several of these are needed to explain the complicated phenomena which are found. Signals may be received over several separate paths; the wave may be broken up into components due to double refraction as a result of the earth's magnetic field; irregularities in the atmosphere may produce fluctuations resembling twinkling of the stars or shadow bands during an eclipse. Speculation finds in this subject a fertile field. This much, however, is certain regardless of the mechanism which we may suggest. The existence of fading can be explained only by a *changing* physical condition in the upper atmosphere.

A probable reason why long waves do not suffer such rapid fluctuations is that there is less likelihood of reception over several paths. Again, the wave length is probably long in comparison with the dimensions of the irregularities of the medium. Furthermore, the probabilities of interference-effects increase with the number of wave lengths included in the transmission path. At 5000 meters the distance between New York and London is 1000 wave lengths; at 25 meters it equals 200,000 wave lengths.

Short-wave transmission, therefore, is not unlike the "little girl who had a little curl"—it may be very good and it may be horrid. Again like the little girl, short wave technique is growing up. The troublesome effects from which we now suffer will undoubtedly be greatly reduced by further development work.

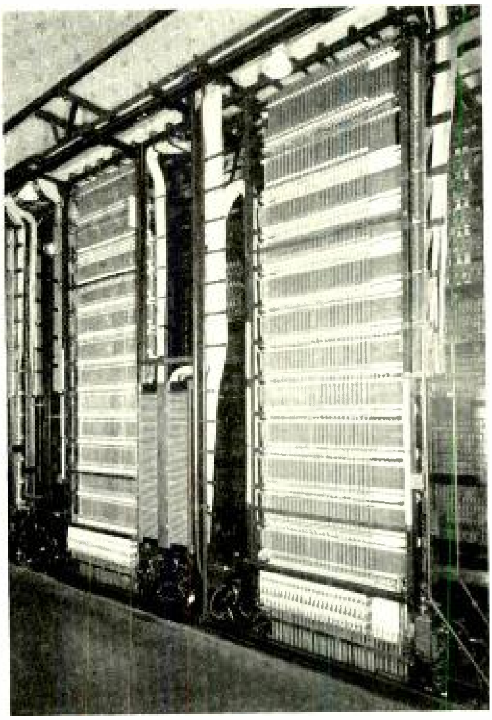
Light Finish in Central Offices

By E. J. JOHNSON

FOR some time past, it has been recognized by telephone engineers generally that a satisfactory bright or light-reflecting paint on the iron framework and apparatus of central offices would do much to increase the attractiveness and better the lighting of terminal and apparatus rooms. This in turn would pay dividends in improved maintenance conditions and in the cheerful effect on the central office personnel.

The finish used up to the present time on iron framework is black, consisting of a primer coat of steel gray protective paint, and a finishing coat of black asphaltum paint, both coats applied by brush and air dried. Finish on apparatus is also black, being generally baked japan or black lacquer. But plans have now been completed, and as soon as manufacturing arrangements can be made and merchandise stocks now on hand satisfactorily disposed of, central offices will begin to blossom forth in spick and span coats of bright, silver-like aluminum paint and varnish.

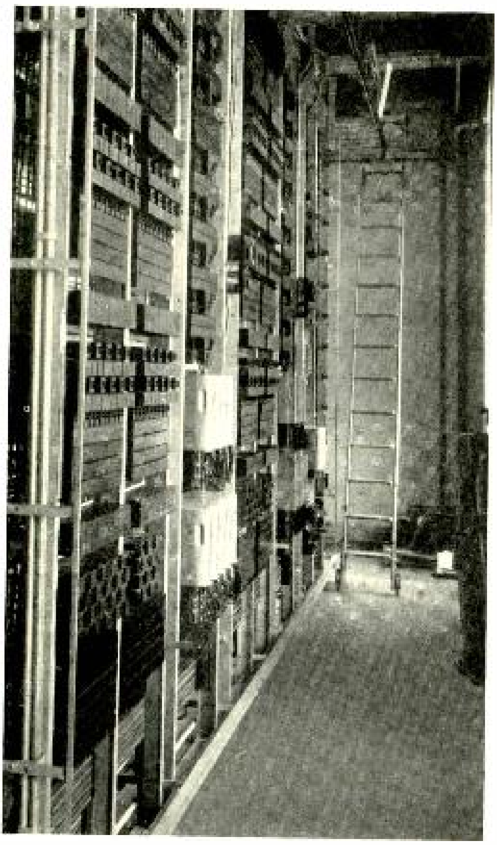
On the new basis, all ironwork such as frames and racks, cable racks and superstructure, as well as all the various kinds of apparatus: relay and repeater covers, repeating coils and condensers, will be given an aluminum finish to replace the black finishes which are now in use. Mounting plates, both drilled and punched, conduit and all screws, nuts and bolts will be galvanized. Switchboard cable will remain gray as at present. Power machines and related equipment will for the present remain black on account of oil, but since power equipment is usually housed in separate quarters, the appearance of the apparatus and terminal rooms will not be affected. No change will be made in



Light and dark finishes harmonize in this typical machine-switching installation

the mahogany finish of switchboard and desk units, and the use of black hardware will continue.

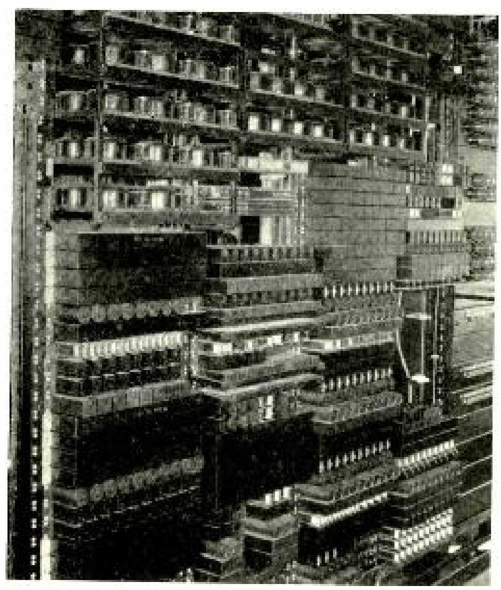
The new standard finish for use on the iron framework of central-office equipments of all classes will be known as the No. 55 aluminum finish. It is made of polished aluminum powder suspended in a quick-drying vehicle. A single coat is sprayed on the ironwork after it has been thoroughly cleared of grease, loose scale and rust. It dries rapidly and the framework can be handled almost immediately. The resulting finish is hard, smooth and bright, has good rust resisting properties, and can



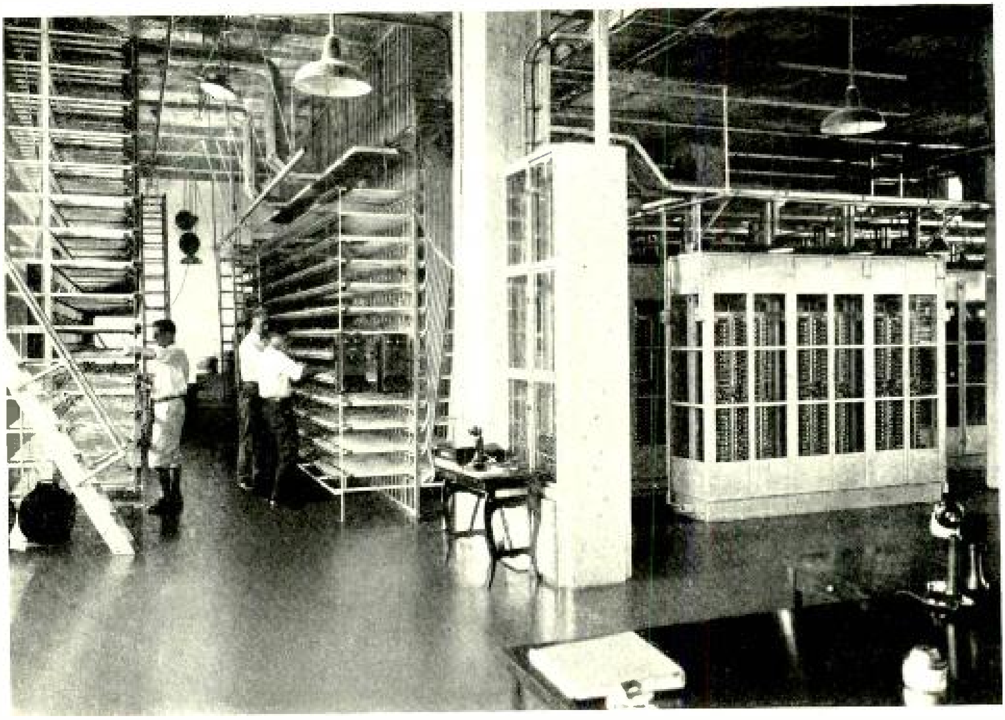
Quite common in step-by-step offices is this combination of light-colored frames and black apparatus

stand satisfactorily the handling to which ironwork is subjected through the factory and on the road. If it becomes scratched, marred or soiled, it can be touched up without having to repaint the entire surface and in a short time the repair blends with the rest of the surface and cannot be detected. Finally, in addition to the improved appearance and light-reflecting properties already mentioned, this finish costs less than the black asphaltum finish.

Apparatus too must have its light-colored finish, since it must harmonize with the framework and contribute its share to the tone of the office. It presents a somewhat more difficult problem than ironwork, in that many of its units require a finish which will stand up under handling not only during manufacture and installation but also throughout twenty years' handling by maintenance men —the approximate life of a central office. Many kinds of light-colored finishes were investigated and finally a finish was developed by our Chemical Laboratory expressly to meet our needs. General investigation was con-



The galvanized mounting-plates in the foreground harmonize with a nearly-all-black assembly; a combination common in nearly all central offices



Light-finished equipment in the step-by-step office at Orlando, Florida

ducted by C. D. Hocker, and laboratory experiments by W. G. Knox.

Three new aluminum finishes have been developed for use on apparatus of practically every sort. The first,—a single coat of baked aluminum varnish—will be used on apparatus requiring very little maintenance, such as the covers of 94-type repeating coils. The second, consisting of two coats of baked aluminum varnish, will be used on apparatus where heavy wear and much handling is expected, such as individual relay covers and the can covers of repeater units.

The third finish is also a two-coat process, the first coat being an insulating pigmented priming material and the second a baked aluminum varnish. It is for use on those relay covers where an insulating finish is necessary to insure that fuses will not be blown when relay springs above or below are accidentally touched with the cover.

A change in finish such as this must, in order to be practical from a merchandising standpoint, be introduced completely on all new production of iron framework and apparatus, so that ultimately it will not be necessary to make and carry two stocks of equipment differing only in the finish used. On account of manufacturing and stock conditions, the change in finish cannot be introduced on all varieties of apparatus simultaneously, but must be made by classes of apparatus on a definite time schedule. Existing stocks of black-finished apparatus and wired equipment units will be applied on additions to existing black-finished central office equipments. Merchandise stocks are in the meantime replenished with light finished apparatus, which in course of time will be furnished on additions as well as on new central-office equipment.

It might seem that the mixtures of black and aluminum-colored apparatus and ironwork which will occur on additions and on new installations during the transition period would be unsightly, but actually such mixtures are not at all objectionable. Jet black and silver gray harmonize in pleasing fashion, and color mixtures of this character actually exist now to a wide extent in all our central office equipment. For example, the picture of translator frames on page 355 illustrates a color mixture which is typical of all panel installations. Frames, cable racks, superstructure and drive mechanisms are black and the switchboard cable, clutches, clutch apparatus blanks, multiple bank assembly details and bank designation strips are light colored. The appearance of these frames will be greatly improved when all the iron framework becomes light colored, but even with the color mixtures, the frames are pleasing to the eye and the colors harmonize.

So our terminal rooms don a new dress. The cheerful and attractive light finish with its improved light-reflection properties will assist and encourage the maintenance-men in their responsible task of keeping the apparatus always in condition to render service.

Development of Light-Colored Finishes

By W. G. KNOX

ABOUT a year ago chemists of our Research Department undertook to make a study of light-colored paints which could be used on metal surfaces in central offices in place of the black finishes which had been standard for many years. Except that the new finishes should be at least as good as the old from the standpoints of protection, durability, and cost, no restrictions were made, and it was left to us to find and demonstrate suitable materials.

It was first necessary to formulate a clear picture of the general types of central-office apparatus to be finished and the service requirements peculiar to each type. Of these, two predominated. One was framework which could be retouched every few years without any particular hardship and probably would have to be retouched in any event, because it became soiled, before there was danger of the ironwork rusting. For this class, air-drying aluminum paint seemed to be a good selection.

Apparatus covers were the second class. To meet their service requirements, a finish needed to be hard, difficult to scratch or shatter by a blow, and resistant to abrasion and handling. As a corollary to hardness, the surfaces needed to be such that they would not easily soil, and preferably to be capable of being cleaned by washing. The finish should not chalk or flake on aging, and it must provide adequate protection against rusting for a long time, preferably for some twenty years.

In our search for such a finish, we soon realized our lack of much back-ground of experience. Practically all of the telephone equipment used in the Bell System is and has been for many years finished with black lacquers or black baking japans. We knew very little about light-colored finishes other than plated metals and still less about how to test a variety of possible finishes and discover the best one among them.

At the beginning of our survey, we depended very largely on the experience of outside technical men with whom we were acquainted. Manufacturers of paints and varnishes and of articles such as cash registers, automobiles, metal desk furniture, railroad cars and metal beds, gave us informally the benefit of their experience and helped us somewhat in deciding what methods should be used to pick and judge light-colored finishes. Out of these preliminary considerations, we formulated the idea that there were several promising types of light-colored finishes. As the next step, we obtained from manufacturers samples of various varnishes that we might use in making baked aluminum finishes, samples of gray baking enamels, and samples of lacquers.

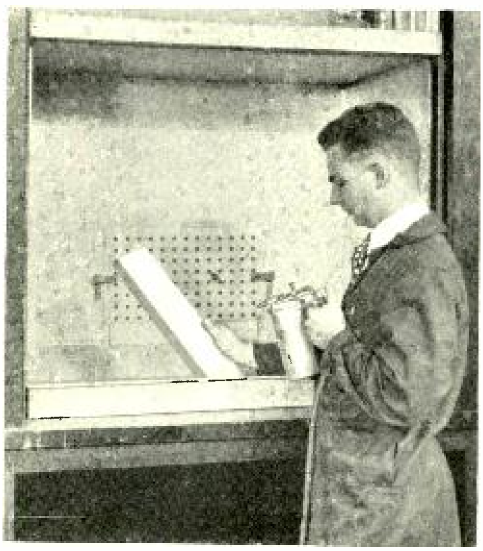
For judging the relative quality of these different finishes, rough-and-ready methods were used in the beginning to separate the sheep from the goats; tests were made on samples applied to iron or tinned iron test panels. A good sample is capable of being scratched with a knife without flaking or powdering and the little shaving or film cut off by the knife will curl slightly without breaking. Likewise, bending of the panels over mandrels of different sizes furnishes a crude but useful test by which to judge adherence of the coating. A good coating treated in this way will stand sharp bending without cracking or pulling away from its base. Similarly, a good coating will not chip or flake when the panel is struck a sharp blow.

Another test that is helpful in judging finishes is that of their inertness to solvents or to a soap solution. Results of these tests have the practical value of indicating whether or not finishes can be cleaned readily and certain tests of this kind have been

C. C. Hipkins dips a piece of aluminum-painted iron into a solution which tests its durability

demonstrated to be pretty closely indicative of the tendency of a finish to soften as a result of continued handling with the bare hands.

Since we as Bell System people must live with our product, instead of passing it along to some remote customer, we have to make everything as good as possible up to the limits set by the service which will be expected of it. Hence, the Laboratories' extensive life tests: among the most difficult to make, because by accelerated means they are expected to permit a reasonable judgment to be formed as to conditions perhaps twenty years hence. The test most commonly used is that of heating for a considerable length of time—a week or so—in an oven at a temperature a little below that of boiling water. Other tests frequently used are continued exposure to ultra-violet light, and exposure to repeated temperature changes. For our preliminary studies, we used only the heating test and noted to what extent the coating had become inadherent or had lost its appearance as a result. We used the



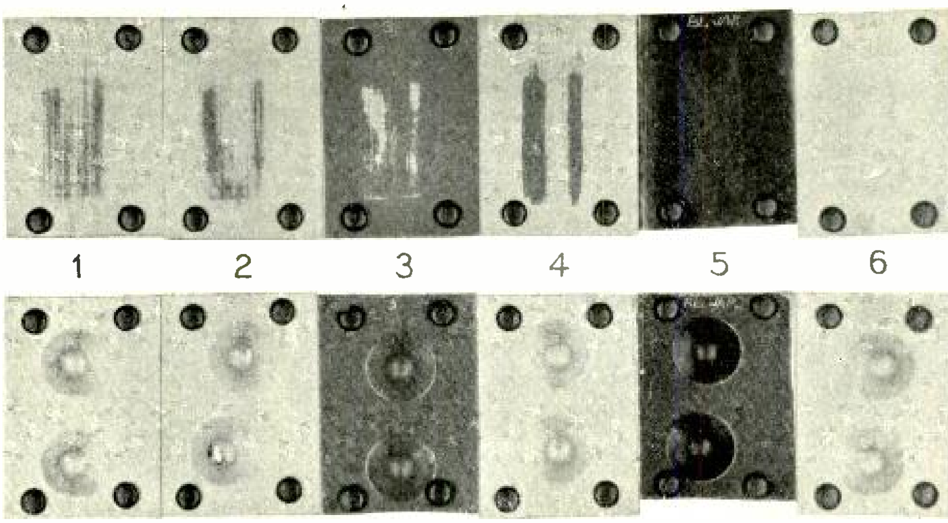
A. G. Russell spraying a relay cover with aluminum paint

mechanical testing methods already described to gain a picture of just what the oven heating had done.

Cellulose lacquers mixed with pigments are widely and satisfactorily used for finishing automobiles and furniture. However, to secure satisfactory adherence to metals, a priming coat must first be applied, followed by several coats of lacquer. Obviously this is out of the question for telephone apparatus, where the finish is required principally for protection and where cost must be kept at a minimum.

In the case of the gray pigmented enamels either of the gloss or semi-gloss variety, we are reasonably sure that if they are compounded on what the paint manufacturer calls a "short oil base" they are likely when air dried to develop a tendency to excessive hardness and consequently, brittleness, within a month or so after their application. This class of enamel, therefore, is undesirable for a large part of the apparatus which we have to consider. "Long oil" varnishes or enamels are considered to be those which have a considerable proportion of oil to the gums that are cooked with it, and generally this class of materials, either pigmented or clear, offers promise for use where flexible resilient coatings are desired. As would be expected, however, these materials when applied as coatings over metal surfaces are rather easily scratched when new because they are somewhat soft. They are greatly improved when given some accelerated drying treatment, but here again, care has to be used that the heat treatment is not extended too far, otherwise brittleness will occur.

When the investigation of these light-colored finishes was started, we were open minded as to whether gray pigmented paints or aluminum colored paints were best. If an aluminum paint could be developed which would adhere as well to metal surfaces and have as long life as the gray paints, it would be very desirable to take advantage of the superior reflecting quality of the alumi-



Results of tests of finishes: upper row, after rubbing; lower row, after ball swaging. (1) and (2), insulating primer and aluminum top coat, baked to different temperatures; (3), another insulating primer, alone; (4), the primer of (3) with an aluminum top coat, insufficiently baked; (5), standard black japan finish; (6), two coats of aluminum finish, each coat baked. (1) and (6) are the new standard finishes

num paint. This quality is due to a phenomenon known as "leafing", which has been described as follows by J. D. Edwards of the Aluminum Company of America.

"The ordinary pigment materials like zinc oxide, red lead, and white lead, are composed of particles distinctly granular in form even though they be exceedingly small. Aluminum powder is, however, essentially flake-like in character because of the stamping process used in its manufacture. When polished powder is suspended in a vehicle like varnish, a curious phenomenon can be observed. The little particles of aluminum swirl about in the liquid and many of them come to the surface of the liquid and remain there. Very quickly an almost continuous film of metallic aluminum is formed at the surface of the varnish by the little flakes of aluminum which arrange themselves in layer upon layer, much like fish scales. From the standpoint of appearance, the metallic film is almost as highly reflecting as a sheet of polished aluminum".

After supplying tests to each of the six or seven types of finishes we thought promising, the results stood out that baked aluminum-colored finishes were decidedly better than any of the others. They apparently owe this good quality to their capacity to be baked to a very hard adherent state which is resistant to the action of soap and solvents, and still to remain light colored at the end of the baking operation. Thus, a coat of a good varnish pigmented with aluminum may stand baking up to 400 degrees Fahrenheit for one and one-half hours and still be brightly aluminum colored. No other light-colored finish of the paint, varnish or japan types will stand baking at this temperature for more than a very small fraction of this time without suffering considerable discoloration.

Out of some fifteen samples of varnish for use in making aluminum baking finishes, we found three to be particularly good. These three have been approved from an engineering standpoint as "materials for use in producing light-colored finishes for central offices."

As more detailed consideration was given to using aluminum colored finishes on the various types of central-office equipment, it became evident that we needed more than one kind of baked aluminum finish. Thus, for tinned iron where rusting was not at all likely to take place on account of the tin coating, a one-coat finish appeared satisfactory. For the coating of bare iron, we have judged two coats should be applied. Certain apparatus covers are likely, while they are being removed and replaced, to touch conducting parts of circuits; hence it was desirable to have a finish of sufficiently high electrical resistance to prevent fuses being blown. A two-coat finish was worked out, of which the primer contained a non-conducting pigment. Electrical tests in this connection were made by H. G. Arlt of the General Apparatus and Physical Laboratory.

Dissipation of heat from certain pieces of apparatus presented another problem, in which we benefited from the cooperation of C. H. Greenall and others of the General Apparatus and Physical Laboratory. Radiated heat is absorbed by the inside of the cover more readily when its surface is dull black. On the other hand, heat is removed from the outside by convection, which a bright finish does not greatly impede. Satisfactory operating temperatures were realized when the inside of the cover was painted black and the outside was given the standard aluminum finish.

For the final evaluation of these finishes, careful comparative tests were made by Mr. Arlt. One test consisted of rubbing each finish with a wooden block under carefully controlled conditions of pressure, speed and the like. The "woodpecker machine" was also employed to tap the end of a switchboard plug repeatedly against each kind of finish. Ductility tests were made by pressing finished sheets into a cupped shape to see how the various finishes compared as to adherence and flexibility. Under these tests the new finishes have been found to compare favorably with the old black finishes, and promise to be quite as satisfactory as we can fairly hope a light-colored baked finish to be. Gradually, our central office equipment will practically all be finished with aluminum colored coatings; and most people have only to glance at an assembly of such apparatus to feel convinced that it does represent an improvement in appearance over the old black finishes.

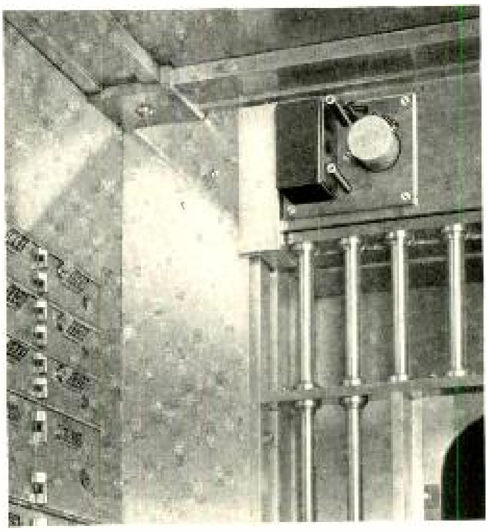
Eavesdropping on Bank Robbers

An alarm system employing a device which arose from fundamental research on telephone transmitters, first developed for war-time uses

By C. R. MOORE

THAT guarding bank vaults is a serious task appears from attempts at robbery made from time to time throughout the country. Vault engineers combat the danger by making their structures as nearly burglar-proof as possible; communication engineers, by providing equipment to send an immediate report of any attempt to break in. Now these Laboratories have contributed a new protective apparatus, a telephonic alarm with several desirable characteristics not previously available. Commonly known as the detector system, this equipment is manufactured by Western Electric for the Homes Electric Protective Company, who install and maintain it. A number of prominent financial institutions here and in Philadelphia are now equipped, among which may be mentioned the American Exchange-Irving Trust Company, the Empire City Safe Deposit Company, the Lawyers Trust Company, the Seamen's Bank for Savings, and the World Exchange Bank.

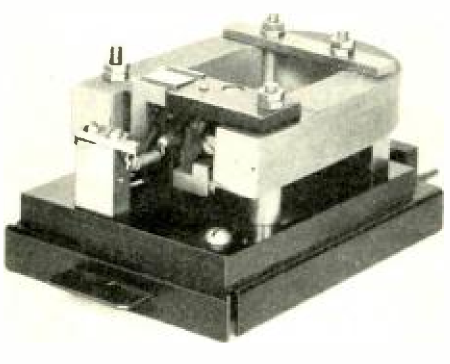
The detector system is founded on the Type H inertia microphone, developed here during the War for submarine detection. This is not a transmitter in the common meaning of the term, for it is quite insensitive to sound waves—has in fact no diaphragm suitable for receiving them. Its function is solely that of detecting and, when desired, measuring vibration in the body to which it is attached. The construction becomes apparent from a sectional drawing, while the corresponding photograph shows the appearance of the assembled button and of the several parts. Electrically the button is the same as a simple transmitter, with two electrodes separated by a space containing granular carbon. A storage battery for current supply and one side of a transformer complete the electrode circuit.



Vault of the Empire City Safe Deposit Company, Thirtieth Street and Fifth Avenue, New York, showing one of the transmitters with outer cover removed

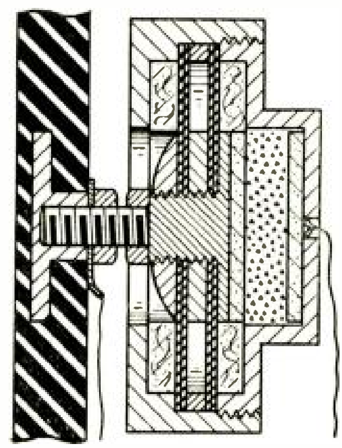
The microphone is supported by the stud, which is fastened firmly to the base, and thus attached solidly to the vault wall. When the wall is struck it vibrates, and the base vibrates also; this in turn vibrates the stud, and the electrode on its end, but the inertia reaction of the body of the button holds it back.

From the current fluctuations produced by such a blow against the vault wall a small alternating current is induced in the other side of the transformer. To convert this alternating current into the ultimate signal the Laboratories' long experience with communication problems made available a variety of means. However, there were certain considerations which materially narrowed the field of choice. To avoid false signals, the current transmitted to the central office must be little subject to interference from stray currents; this condition is much better satisfied by direct current than by the feeble alternating current from the transformer. The relay to make such a conversion is of course installed in the premises to be protected, and hence must be rugged and reliable as well as sensitive. Such



Loud-speaker relay, with the circuit chain attached

a relay has been evolved from the driving-element of one type of Western Electric loud-speaker. The lever for operating the loud-speaker diaphragm is replaced by a short chain joining the end of the armature to a stationary block on the base. When no current flows in the transformer secondary circuit this armature is stationary, and so the chain is stationary also, with constant resistance. But when current is induced by vibration of the microphone it moves the relay armature up and down, and by thus



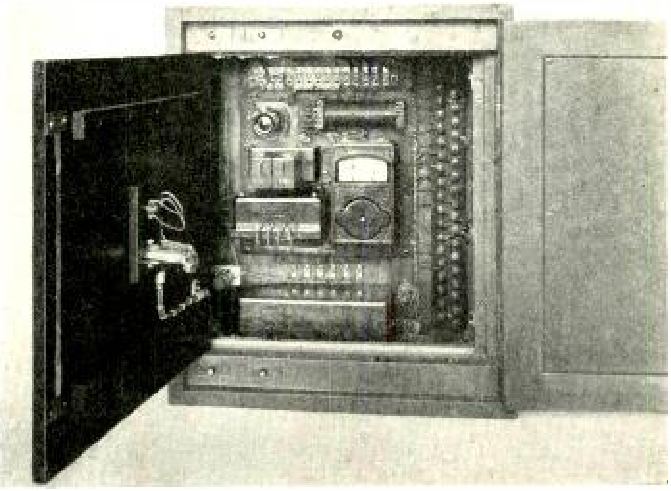
Cross section of the transmitter button and block to which it is attached. The two mica discs were used, when the button was a submarine detector, to keep the center of mass of the case within the points of support, and thereby to prevent whipping, or other motion except in response to horizontal stimuli

moving the chain increases its resistance greatly. The chain is on one side of a balanced circuit on the other side of which is a relay controlling the alarm signals; the circuit unbalance resulting from a movement of the chain increases the current flow through the alarm relay enough to pull its armature over. The contact made by the armature of this relay destroys the balance of the complementary alarm circuit and registers the signal through audible and visual alarm apparatus located in the central office. A locking relay in the alarm circuit closes upon this initial disturbance and thus registers the signal permanently, whether caused by an attack on the vault or by momentary vibration from an accidental blow. In either event, the alarm circuit is not restored until after an investigation of the situation by armed guards despatched from the Holmes Company's central office.

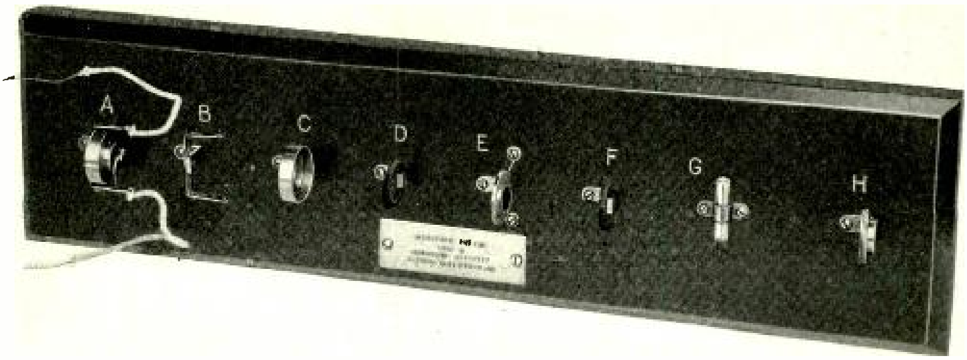
The older and most common form of protection is a series circuit, often miles in length, consisting of cable embedded within the concrete of the vault walls or of tinfoil tape mounted on insulating bases and placed against the structure. By either method the vault is completely enclosed within a protective web constituting a closed electrical circuit, constantly carrying a small current and connected to the alarm circuit extending to the central office. The distance between the cable or tinfoil conductors limits the size of the hole which might possibly be made without originating an alarm signal, but it is to be noted that this spacing is so close that it eliminates all possibility of successful attack or entry. With the detector system there are actually no points of immunity, for no matter where a blow may be struck the entire vault structure will vibrate.

The compactness of the transmitter and its equipment is apparent from the photographs—a striking contrast to the series circuit of eighteen miles of wire used recently in fitting the new vault of a prominent New York financial house. Its convenience and value are materially increased by the fact that it requires no special circuit to the alarm station, but that when attached to a standard alarm circuit it retains the full usefulness of the old equipment while adding its own protective value. Furthermore, there is no limit to the size of the room which can be guarded effectively, for by the use of two or more microphones the distance from a microphone to any possible point of attack can be kept within a safe maximum.

It is general practice to build vault doors and frames from many adjoining plates of differing properties, so alternated that a drill which penetrates one plate will break or stick in the next. This construction is just fitted for the detector system, because such drilling efforts shake a door appreciably, especially when the drill sticks. On that account an attack on the steel work of the vault will be picked up just as readily as an attack



Holmes Company's cabinet, on the bank's premises, containing supplementary parts of the alarm circuits; here the inertia button circuit is joined to lines from other protective equipment



Type H inertia button, from the Historical Museum; A, complete button with leads and the type of mounting bolt used for submarine detection installations; B, the mounting bolt; C and H, the two parts of enclosing case, whose mass makes operation possible; D and F, felt washers separating case from the supporting discs; E, mica discs, separated by a brass washer, and bearing on the right side one of the electrodes (the other electrode, not visible, is on the left side of H); G, capsule containing the carbon granules

on the concrete walls. Not even an acetylene torch, at present the cracksman's most effective tool, can escape detection, for it causes a sputtering of the molten metal strong enough to shake the wall slightly. These vibrations are picked up without difficulty.

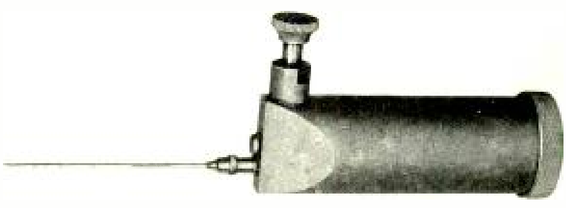
The idea of a sensitive telephonic circuit for protective purposes is not new, but hitherto such devices have depended upon picking up vibrations from the air by a sensitive transmitter. This requires that the disturbance must be radiated from the vault to the air, an energy transfer which takes place with great loss. Hence the energy to be dealt with at the transmitter diaphragm is very small, comparable in fact to that of conversation and street noises, and so an alarm is quite likely to be given by these and other meaningless sounds. By obtaining the stimuli mechanically, rather than acoustically, the inertia button is rendered unresponsive to sound waves, and its physical characteristics make it insensitive to low-frequency building vibrations, such as those caused by passing vehicles. Thus its users are spared the annoyance of false alarms from these sources. Subway trains rumble constantly a few feet from one New York vault, and its microphones are unaffected. But let a careless cleaner rap the door or wall with his broom and in about five minutes he will have visitors—guards in blue uniforms with drawn revolvers—sent to investigate the cause for the alarm.

Novel Devices for Lubrication

By W. T. PRITCHARD

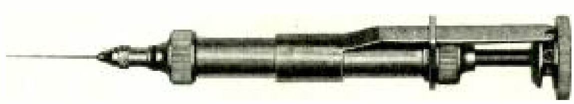
LUBRICATION, a problem in all mechanical equipment, is particularly difficult with telephone apparatus. In a machine shop or an engine room a few drops of oil if spilled may be wiped up leaving a thin protective film. That is not the situation in a telephone office. Although machine-switching frames with their many moving parts obviously require dependable lubrication, they just as obviously require that their electrical parts and friction-clutch surfaces be kept untouched by oil or grease. This demands that the lubricant be placed surely and accurately where wanted, since an excess in addition to collecting dust would be most likely to find its way to spots better without it. To avoid need of readjustments, it is necessary to lubricate without deranging the mechanisms. Other considerations are effective use of lubricant and saving of the oiler's time.

These needs have been met by three special lubricators for machine-switching apparatus, each for an individual purpose, which control the volume of oil or grease delivered. One lubricator solves a difficult problem, that of oiling the bearings of sequence switch drive shafts. These are horizontal bearings with modified oil retaining washers, used in a vertical position, very close to the frictional surfaces of the clutch discs. On that account the volume of oil delivered to each point must be controlled definitely.



Grease gun for cam-shaft bearings of the sequence switches

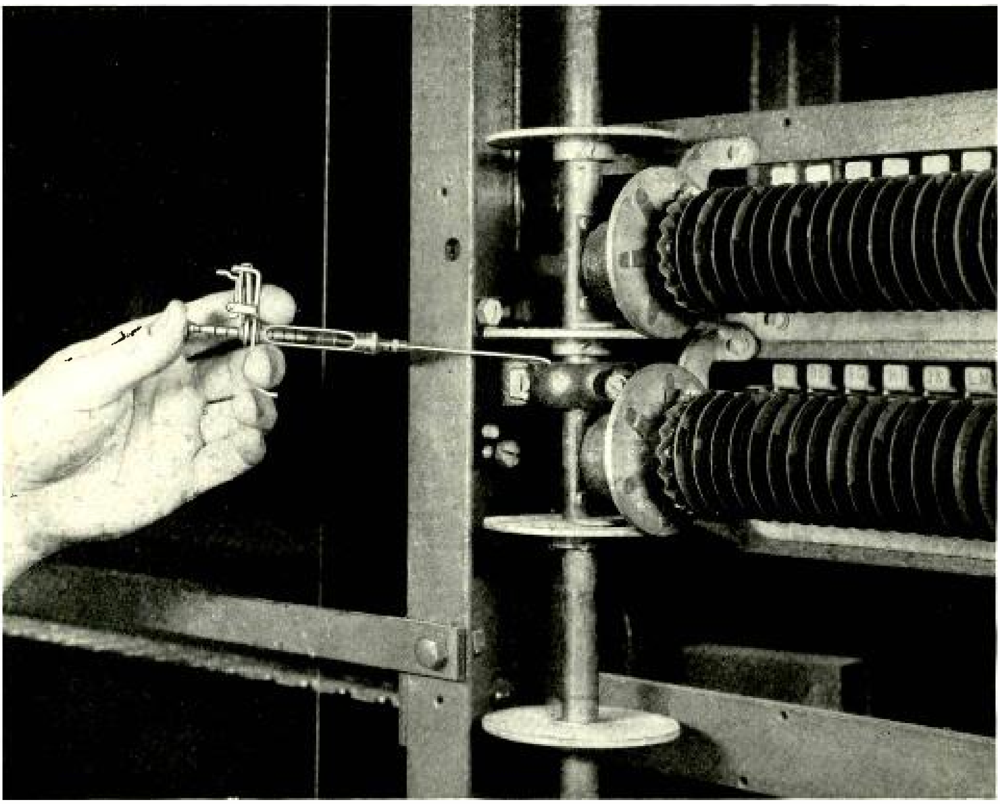
For oiling this drive shaft a type of lubricator called the No. 362 has been developed. It is a syringe, a quarter inch glass tube containing a tight-fitting plunger and bearing a long, tapering nozzle. At each bearing the oiler presses the piston forward until it is stopped by a pawl and thereby deposits nine drops of oil. He then pushes back the pawl with his thumb, transfers the nozzle to the next bearing



The single-drop oiler

and presses the piston again, and repeats this cycle until the glass barrel is empty. This procedure is permitted by eight circular grooves, on the piston, uniformly spaced. The spring pawl catches these grooves successively, and by thus restricting each plunger movement limits the oil delivered. Refilling is by suction; the eight grooves permit lubrication of the maximum number of bearings on any drive shaft at each charge. Air bubbles or impurities may be detected by inspection.

For greasing the small journal bearings supporting the cam shafts of the sequence switches without removal of the cam assemblies a small force-pump with adjoining grease reservoir has been developed. A horizontal metal cylinder fits the palm of the user's hand; on top is a button which he presses with his thumb to deliver a predetermined quantity of grease through the nozzle. A vertical cylinder encloses the plunger, an eighth inch in diameter and seven-eighths of an inch long; near the top is an opening joining it to the horizontal grease reservoir, and near the bottom a hole leading to the nozzle. The plunger when pressed down passes the upper hole, shutting it, and then forces the contained grease out through the nozzle. When released, a spring restores it to the starting position. Viscosity and fluid friction of the grease prevent its return from the nozzle, and so the air pushes in from the large cylinder enough to fill the void.



Lubricator (No. 362) being used on drive-shaft bearing of a sequence switch

This reservoir holds a supply adequate for all the sequence switches and selectors of a central office; it can be refilled from a collapsible grease tube in a few seconds.

For delivering one drop of oil to various small bearings requiring slight occasional lubrication the "Single Drop Oiler" is used. Its principal employment is for lubricating the dials. This also is a plunger-operated tube, with a threaded piston passing through a threaded collar. On the knurled head is a shoulder with eight small hemispherical indentations uniformly spaced around its periphery, are caught successively by the hemispherical point of a sliding spring pawl, which moves forward between guides, uniformly with the plunger's advance. When the oiler turns the knurled head, the point of the spring pawl is pushed up; after an eighth of a revolution the original turning force is spent, and the pawl catches the next indentation. By this means delivery is limited to one drop of oil at each operation.

A British Appreciation

. . . In looking back over the progress in radio telephony for the last twelve years, admiration must be expressed for the genius and far-sighted vision of the American Telephone and Telegraph Company and its associated Company, the Bell Telephone Laboratories, which at that time envisaged the spanning of the Atlantic telephonically and have since worked steadily and methodically at one development after another until the goal was reached. It is a striking example of the value of painstaking research, organized as it is in America on large lines, and illuminated from time to time by flashes of brilliance, which light the way from one stage of development to another.—Lieut.-Col. A. G. Lee; Post Office Electrical Engineers' Journal, April, 1927.

Research Design

By R. O. MERCNER

UPON the Research Design group devolves the task of designing the myriad sorts of special equipment required by all the divisions of the Research Department. There comes a time in almost any investigation when to make satisfactory progress some special equipment is needed. Sometimes an entirely new machine must be designed; at others, an existing type need only be remodeled to meet slightly different requirements; always, though, is there the need for some type of design work to aid the research engineer.

The chemical division is perhaps investigating the diffusion of water vapor through rubber sheets or the relations between temperature and brittleness in metals or insulating substances. All known apparatus or methods have been tried but nothing has proven satisfactory. One could scarcely hope they would for this is frontier work. In such a predicament the various research divisions turn to the Research Design group for help.

Here the task is assigned to one or more men, as seems necessary. The detailed requirements of the work are carefully discussed by the designer and the engineer. As a result of their combined efforts there emerges a new piece of apparatus for a new class of work.

The special diffusion apparatus designed by C. H. Haynes well illustrates this. The diffusion or slow seepage of a gas or vapor through solid substance is frequently a matter

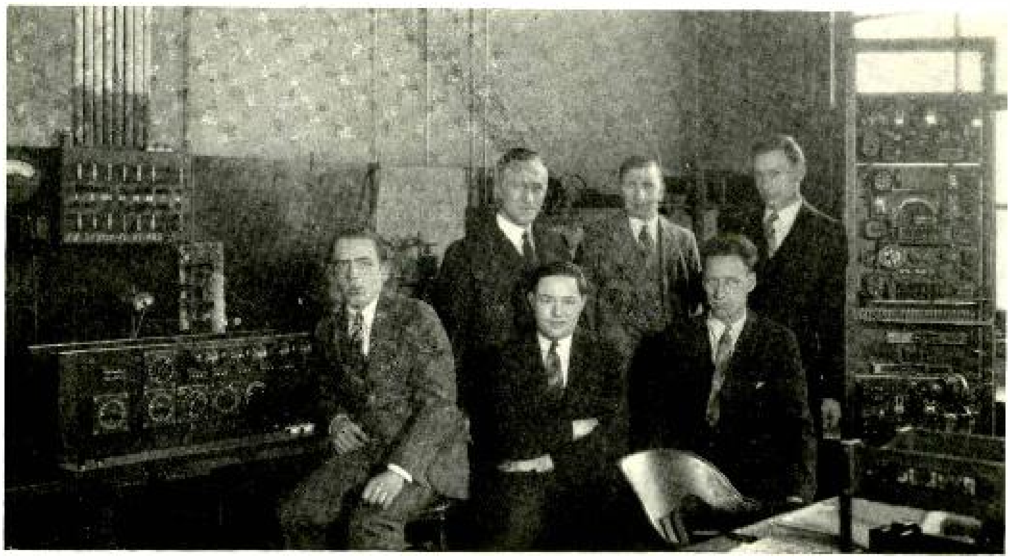


Figure 1—Wiring group of the Research Design Division. A large part of the television wiring was the work of this group. Standing, R. J. Fisher, W. F. Mayes, I. L. Hartinger (group supervisor); seated, J. A. McGrath, J. Fierst, M. L. Weber

of considerable importance. Quite a little investigating of this general phenomena had been done in the past but for the most part it was on larger pieces of material and at higher pressures than those with which this particular research was concerned. The equipment Mr. Haynes finally produced is illustrated by the cross sectional view in Figure 3.

This design avoids one of the major weaknesses in previous equipment used for this purpose: leakage of the gas or vapor around the test sample. The sample, besides being clamped tightly between pieces (M) and (R), is completely sealed with mercury

Figure 2—J. L. Mathison with brittleness-temperature apparatus

which is poured in through the hole (H). To prevent the rubber sample from buckling due to the difference in pressure on opposite sides, two alundum filter disks (A) are used. The part (C), which clamps (M) and (R) together, turns on a ball bearing to reduce friction to a minimum so that there may be no twisting action on the sample being tested.

Another design illustrating the

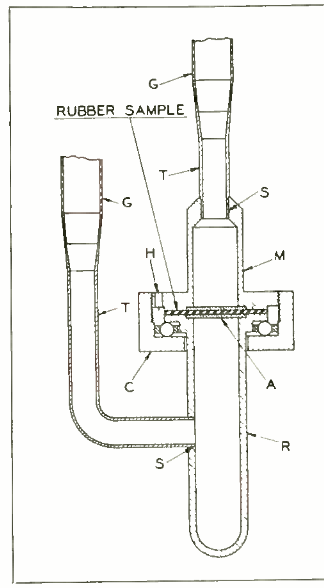


Figure 3—Cross section of vapor diffusion apparatus

work of this group was for the apparatus to determine change of brittleness with temperature. There seems to be a fairly well defined temperature below which the various insulating materials used in submarine cables become brittle and readily fracture or break. It is essential, of course, to use materials only above this temperature. No equipment was available, however, for determining this point. What work had been done was in a hand made fashion and lacked the precision of mechanical procedure. The apparatus illustrated holds a sample strip in a cold bath till a predetermined temperature is attained and then by raising the hook at the top, the specimen is lifted out and at the same moment is struck a hammer blow which bends the sample. If no fracturing occurs at the bend, the temperature is lowered further and the same procedure repeated.

The design of a distributor for high speed submarine telegraph work was another undertaking of this group. The previous designs had been for slower sending and were smaller in size. Due to this the edges of the segments on the commutator were not so accurately located as was necessary for this more refined work. The distributor consists of two commutator faces with their accurately located, silver-surfaced segments. Rotating over the surface of each commutator is a brush rigging holding the necessary contacts. The two brush

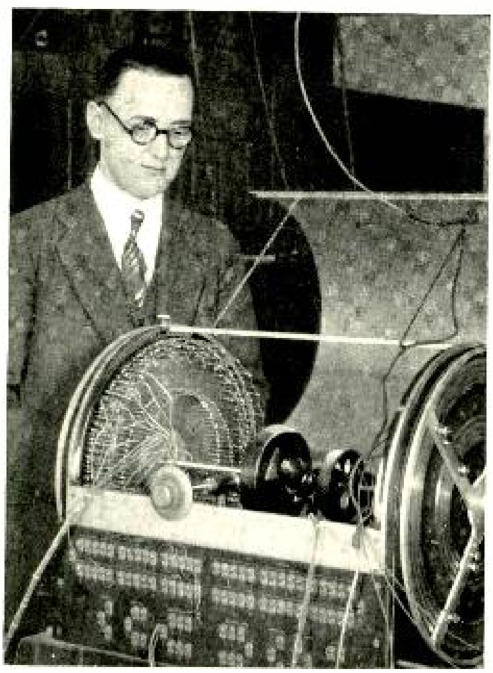


Figure 4—R. O. Mercner examining an experimental model of the multiplex cable distributor

riggings are driven in synchronism by a single motor geared through a differential to their common shaft. The differential is to enable a phase adjustment to be made between the two brushes.

Another problem occurred in the course of a detailed study of the properties of metals. A stage is reached when it is imperative to have single metallic crystals large enough to permit a determination of their various properties along different axes. Grow-

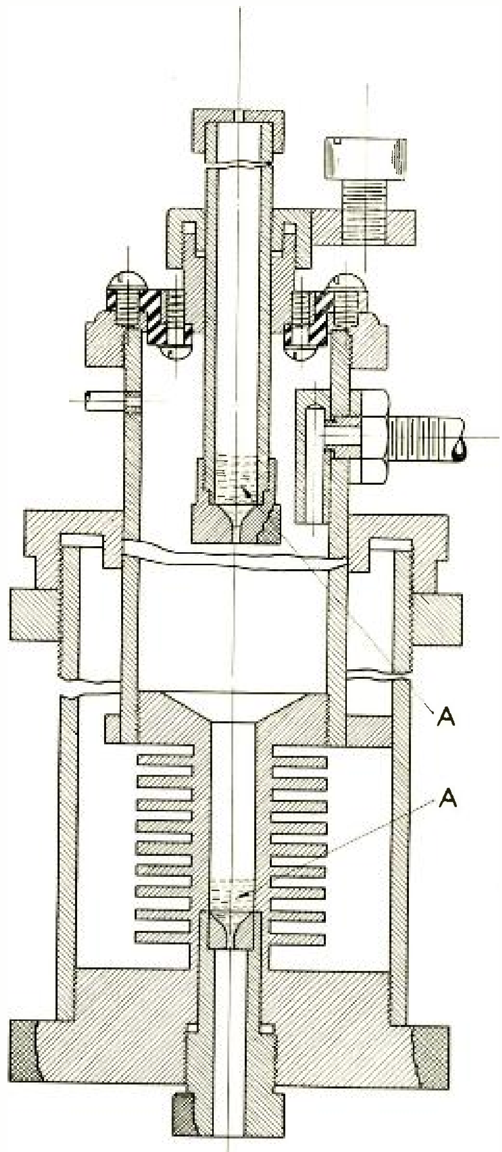


Figure 5—Cross section of crystal growing apparatus

ing large crystals is a tedious and refined process and by ordinary hand methods the largest that may be obtained are pitifully small. The problem, therefore, was turned over to the Research Design group and J. L. Mathison designed the equipment of which a cross section is shown in Figure 5.

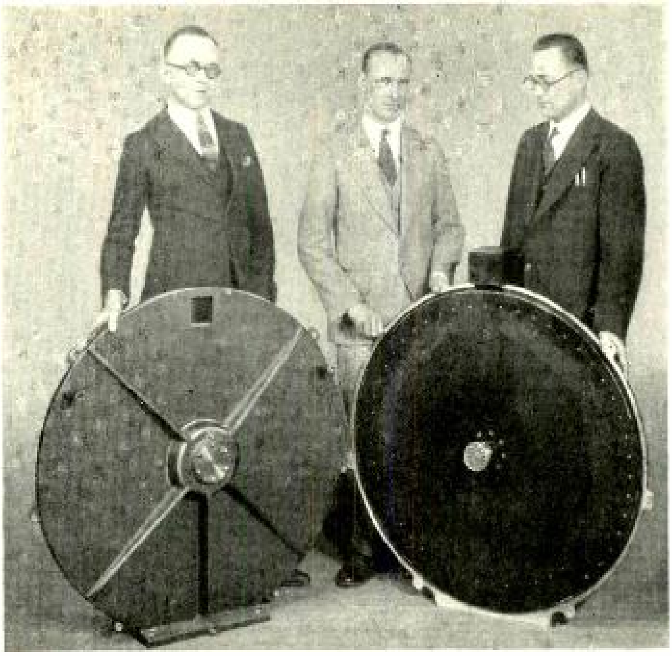


Figure 6—H. Hall, C. H. Haynes and R. O. Mercner shown with large television scanning disc

Here a pure iron wire, suspended vertically and secured at its lower end as well as at its upper, passes through the small, double cylinder shown. A mercury seal is used at the top and bottom and the inner cylinder is kept filled with hydrogen. An electric current passing through the section of the wire in the cylinder heats it to a temperature very close to its melting point. At the lower end of the cylinder the volume of mercury is large and is cooled by water circulated around the outside of the central container. The entire double cylinder is driven up at a very slow rate through a double worm reduction and lead screw. Thus the wire throughout its entire length is ultimately heated to a high temperature and then rapidly cooled in mercury. This heat cycle forms a continuous crystal. Some have been as long as thirty centimeters.

Work of recent interest was in connection with the television apparatus. One piece of equipment, designed by Mr. Haynes, was the large annular commutator with its 2500 segments, each leading to one of the small sections of the large neon tube grid used at the receiving end for large sized reproduction. A part of the same development is the scanning disk, designed by Mr. Hall, shown in the accompanying illustration. This is the large rotating disk with the spiral of small holes which, at the sending end, is used to throw the dot of light across the scene in successive rows, and at the receiving end to transmit the glow from the neon tube in exactly similar and synchronized lines to form the picture.

These few examples serve only to indicate roughly the work of this group and by no means compass its scope, which includes also development work on transmitters and receivers carried on by R. C. Winckel. Into every corner of the laboratory they are called and rare indeed is it that any major investigation does not some time require their assistance.

News of the Month

C. G. Stoll, Vice-President of Western Electric Company in charge of its manufacturing operations, has been elected a Director of Bell Telephone Laboratories to fill the vacancy caused by the resignation of J. L. Kilpatrick.

* * * *

A notable demonstration of the television system was made at the meeting of the National Academy of Science in Washington during the week of April 25. Mr. Jewett addressed the Academy on "Some Recent Advances in the Art of Distant Electrical Communication", with particular reference to the transatlantic radio telephone system. H. E. Ives described the television system, which was then shown in operation. Subsequent demonstrations were made to invited guests of the Academy and of the Telephone Company; to members of the Diplomatic Corps, and to the staff of the Patent Office. More than five thousand people attended various public demonstrations. Members of the Laboratories who participated in the demonstrations were E. F. Kingsbury, A. L. Johnsrud, J. W. Horton, H. M. Stoller, J. G. Knapp, C. R. Keith, M. W. Baldwin, R. O. Mercner and H. Hall.

During the Army-Navy maneuvers off the New England coast, Mr. Jewett was a guest of the Navy aboard U. S. S. Seattle, flagship of the Atlantic Fleet. Aboard U. S. S. Texas, flagship of the cruiser squadron, was J. F. Farrington, as observer of radio communication. Also with the Fleet were F. M. Ryan and Lloyd Espenschied (D. & R.).

The Bell System Operating Conference at Absecon, New Jersey, was attended by President Jewett and Executive Vice-President Craft.

Mr. Craft addressed the Board of Directors of the Tanners' Council of America on May 18. He described the work and organization of these Laboratories, and noted some of the very tangible results derived by the Bell System from its industrial research program.

S. P. Grace has been appointed General Commercial Engineer, reporting to Vice-President Clifford. The functional activities of the Commercial Development Department, formerly headed by Mr. Grace, will be handled in the Apparatus Development Department under the direction of O. M. Glunt.

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At the American Physical Society's meeting in Washington on April 22nd and 23rd the Laboratories were represented by H. D. Arnold, J. A. Becker, K. K. Darrow, C. J. Davisson, L. H. Germer, F. S. Goucher, F. Gray, J. W. Horton, H. E. Ives and M. B. Long.

H. E. Ives presented a paper on April 29th before the American Philosophical Society at Philadelphia on "Photo-electric Photo-engraving", and was in Boston May 11th-12th, where he presented a paper on "Television" before the American Academy of Arts and Science and the students of Harvard University, respectively.

J. E. Harris represented the Laboratories at the annual meeting of the Advisory Committee on Metal Investigation held in Washington May 6th and 7th under the auspices of the Bureau of Standards.

Dr. William Mansfield Clark of the Hygienic Laboratory of Washington visited the Laboratories recently and lectured to members of the Chemical Staff on "Oxydation-Reduction Potentials".

J. M. Finch, H. N. Van Deusen and J. M. Wilson visited the Laboratories of the General Electric Company in Schenectady on May 12th, being particularly interested in insulating materials.

A. R. Kemp visited the Mellon Institute and the Robertson Asphalt Plant, when he was in Pittsburgh on April 28th. From there he went to Akron to visit the B. F. Goodrich Company and then went to Hawthorne, where he was interested in the development of submarine cable.

R. R. Williams, C. D. Hocker, F. F. Farnsworth, and C. L. Hippensteel attended the meeting of the Research Committee on Accelerated Corrosion Tests on May 18th, which was held under the auspices of the New Jersey Zinc Company at Palmerton, Pennsylvania. There they were joined on the 19th by W. G. Knox for a visit to the New Jersey Zinc Company, being particularly interested in paint-testing apparatus.

E. E. Schumacher visited the Metal Coatings Company at Philadelphia on May 13th, principally in connection with methods of spraying metals.

C. R. Moore and W. E. Orvis were at Hawthorne the latter part of April in connection with the technical features of the manufacture of the handset and of the broadcasting transmitter.

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At the meeting of the Colloquium on May 2, L. H. Germer discussed the diffraction of electrons by nickel crystals. Officers elected at this meeting for the ensuing year were: C. J. Davisson, President; O. E. Buckley, Vice-President; R. M. Bozorth, Secretary.

At its final meeting of the season, the Colloquium was addressed on May 23 by Professor Oswald Veblen of Princeton University on "The Geometry of Paths." C. J. Davisson, president for the coming year, was installed at the same meeting.

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H. S. Price recently returned from Rochester, where he made a survey for a five-kilowatt broadcasting equipment for the Stromberg-Carlson Telephone Manufacturing Company. He also inspected the broadcasting station of the Congress Square Hotel at Portland, Maine.

W. L. Tierney recently visited the broadcasting stations of the Youngstown, Ohio, Broadcasting Company and the Petroleum Telephone Company of Oil City, Pa.

J. B. Irwin demonstrated Vitaphone equipment to the staff of the Bell Telephone Company of Pennsylvania in Pittsburgh at the end of April.

R. E. KUEBLER demonstrated Vitaphone equipment and filters to the Convention of Motion Picture Engineers held in Norfolk, Va., and to the Chamber of Commerce there, staying in Norfolk April 25th to 28th. The demonstrations were given in connection with a paper on "Physical Aspects of the Vitaphone," by P. M. Rainey of Electric Research Products Company.

AT THE OPEN-AIR MASS of the Holy Name Society held in the Yankee Stadium, New York, on May 22, a No. 1 Public Address System was used to amplify the services. The system, which served an audience of seventy thousand, was installed and operated for the New York Telephone Company by G. C. Porter, R. E. Kuebler and C. F. Stephan of these Laboratories.

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F. W. TREPTOW visited Boston and Dorchester, in connection with studies of zone-registration equipment.

F. G. COLBATH made a trip to the Stromberg-Carlson factory at Rochester, New York, to discuss several questions associated with the manufacture of the No. 550-SC Private Branch Exchange switchboard.

W. L. DODGE spent a week in St. Louis discussing the recent installations of panel machine switching equipment in that city.

J. A. KRECEK AND A. J. SANIAL spent several days at Pittsburgh testing echo suppressor equipment for two-wire circuits.

O. D. ENGSTROM AND C. L. WEIS visited Houlton, Maine, where the radio receiver on the Transatlantic system is located.

J. C. BURKHOLDER has been in Canada since the middle of March in connection with the installation by Northern Electric of a high-frequency carrier-telegraph system for the Canadian National Telegraphs. This carrier system will eventually extend from Montreal to Vancouver. The portion already installed, from Montreal to Toronto, consists of ten telegraph channels in each direction, in addition to the normal telephone and telegraph channels. Four multiplex printers can be operated over each carrier telegraph channel, giving the system a total capacity of two thousand words in each direction per minute. During the next few months Mr. Burkholder will supervise the installation of the remaining parts of the system.

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DR. R. W. KING, Editor of the Bell System Technical Journal, is transferred from the American Telephone and Telegraph Company to these Laboratories and is appointed Assistant Director of Publication.

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IN ADDITION to regular Inspection Survey conferences, attended by W. A. Boyd, H. F. Kortheuer, W. C. Miller and R. M. Moody, the Inspection Department held conferences at Hawthorne on Inspection Statistics and Economy, and Rating of Manufactured Product, with the Inspection and Inspection-Development Branches of the Western Electric Company's Manufacturing Department. D. A. Quarles, H. F. Dodge, H. F. Kortheuer, W. A. Shewhart and H. G. Romig were present from the Laboratories.

R. H. HART AND D. P. FULLERTON of the Inspection Department and C. D. Hocker and E. St. John of the Outside Plant Development Department were in Bethlehem, Pennsylvania, from April 4th to 7th for the study of several questions relating to requirements on hardware manufactured by the Bethlehem Steel Company.

DURING THE FIRST WEEK in April, J. A. St. Clair, Local Engineer for the Inspection Department at Atlanta, visited New Orleans, Mobile, Tampa and St. Petersburg in connection with regular Field work in his territory. In New Orleans, Mr. St. Clair attended a two-day conference of Western Electric Company Installation Foremen of District 112.

C. D. HOCKER visited Pittsburgh, Altoona and State College, Pennsylvania, inspecting galvanized sheets on which outdoor weather tests are being made. These tests are in connection with studies being conducted by the American Society for Testing Materials. Later in April Mr. Hocker was in Philadelphia attending a meeting of the Electro-Chemical Society and on May 4th and 5th was in Phoenixville, Pennsylvania, in company with W. A. Hyde of the Outside Plant Development Department in connection with weathering tests on insulators for open wire lines.

C. H. AMADON was in Galesburg, Illinois, during the early part of April, conducting experiments in connection with the preservation of timber. The tests were made at the plant of the Chicago, Burlington and Quincy Railroad Company.

DURING THE EARLY PART OF MAY, S. C. Miller and C. H. Amadon were in Gulfport, Texarkana, Houston, Galveston, Beaumont, St. Louis and Louisville in conection with timber preservation duties.

D. & R. Notes

A test of new devices for feeding and straightening aerial cable was witnessed by H. D. Bender and representatives of six associated companies.

R. J. Kent visited Philadelphia and Dover in connection with the standardization of a reel for placing open wire, and J. A. Ratta went to Pittsburgh to discuss with the supplier changes in the construction of the new kerosene furnace.

D. F. Seacord has recently been transferred to the Transmission Development Division from the New York Telephone Company, where he had been continuously since his graduation from Yale in 1916. With the exception of three years during which he was in the Commercial Engineering Department, all of this time was spent in the General Engineering Department on transmission work. His new work will be in conection with local transmission.

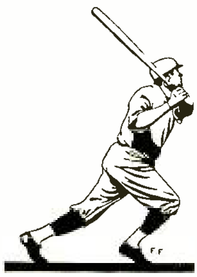
The Development and Research Bowling League, composed of eight five-man teams representing various groups, completed its season April 26th. The Clark team finished on top with 49 games won and 14 lost. The Outside Plant team, with 47 won and 16 lost, finished second, and was a strong competitor all season.

The Clark team rolled the highest single game, 934 pins. Individual honors went to R. E. Smith, high single game, 268; A. A. Heberlein, high evening score, three games 603, and A. E. Hunt, high season average, 172 in 60 games. About seventy men took part in the league games during the season.

Bell Laboratories Club

Baseball

The Bell System League opened the 1927 season on Monday evening, May 2, when the Laboratories' team met the New York Telephone Company men from Northern Manhattan. Our players were defeated by the score of 7 to 2. Our pitching ace, Kuhlman, was out of town on business, but Harrison and Gardner who carried the burden did nobly considering the batting strength opposing them. More than one hundred rooters from West Street attended this game.



During June, West Street men will play some games well worth seeing.

On the ninth, the Laboratories will meet the Western Electric Company, 195 Broadway, and on the twenty-third Western Electric Company, Hudson Street. Bus service will be available for all these games if enough people desire to attend.

The Club's Interdepartmental League played its first games on Saturday, May 7, when the Equipment team played a nine inning tie with the team representing the Toll and Circuit groups, and the Tube Shop defeated the Junior Assistants. Again this year all the games will be played at Erasmus Hall High School Field, Brooklyn. Two games will be played every Saturday, the first starting at 1:30 P. M.

L. P. Bartheld is Baseball Manager for 1927 and T. J. O'Neil is umpire.

Track Meet

The Bell Laboratories Club Track Meet will be held on Saturday afternoon, June 18, 1927, at Erasmus Hall High School. Bus service from West Street to the field will be available. All men and women of the Laboratories are eligible to enter the events. These are:

- 100 yard Dash
- 220 yard Dash
- 440 yard Dash
- ½ mile Run
- Shot Put
- 1 mile Department Relay
- Broad Jump
- Tug of War—Closed to Shop and Plant Men*
- 60 yard Dash for Women
- ¼ mile Relay for Women
- Basketball Throw for Women

Entry blanks must be filed with D. D. Haggerty, Room 164, not later than June 11, accompanied by a fee of fifty cents. Tickets of admission will be fifty cents. Tickets for the bus will be fifty cents for trip one way.

Golf

The Spring Golf Tournament will be held on two Saturdays in June at

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**By way of compensation, we suggest a slide-rule contest, closed to engineers and a speed typewriting contest, closed to women.*

the Salisbury Country Club, Garden City, Long Island, in two rounds, each consisting of eighteen holes of handicap medal play. On June 4 twenty-eight golfers will be qualified for the finals, which will be played on June 11. They will be divided into two classes, based on scores in the qualifying round. The twelve low gross scores will gain entry to Class A and the remaining sixteen net scores will make up the list for Class B.

Distribution of prizes for the qualifying round will be the same as in previous tournaments, with two prizes for the two best gross scores and two prizes for the two best net scores. In the finals each class will be awarded four prizes, and an additional prize for low gross score.

Entry blanks must be filed with D. D. Haggerty, Room 164, accompanied by an entry fee of two dollars.

The cages on the roof of Section G are now available for driving practice; all members of the Laboratories are invited to use them.

Entertainment and Dance

On Friday evening, April 22, nine hundred members and friends attended the Spring Entertainment and Dance of the Laboratories Club, held in the Grand Ballroom of the Hotel Pennsylvania. Music was furnished by Sam Lannin and his Ipana Troubadours; from 10:30 to 11:30 P. M., a program which included many radio stars from WEAF and WJZ was presented. These entertainers were the Record Boys, The Jolly Buckeye Bakers, Peter DeRose, May Breen and Phillips Carlin. After a most enjoyable hour of vocal and instrumental selections, the Troubadours entertained the guests with dance music until 2 A. M.

Brighton Beach Swimming Tickets

Tickets giving Club members all privileges at Brighton Baths on Saturdays, Sundays and holidays are now available. These tickets are one dollar for a Sunday or holiday and fifty cents for a Saturday. If presented at the season ticket entrance, accompanied by Club membership cards, they eliminate all waiting in line.

Last season one thousand Club members enjoyed the bathing at Brighton Beach, and it is expected that even more will take advantage of this opportunity during 1927. Department representatives can supply tickets in any quantity.

Swimming

The last session of the Spring Swimming Classes for Women began May 18 with full registration, and will continue until the end of June. About half the members have been swimming with the Club Classes since the beginning of the season. This winter and spring Miss Steel has been teaching the Australian crawl, side stroke, back swimming, diving and, of course, treading water and floating. Every one of the regular members is enthusiastic about these new accomplishments.

Hiking

The Hiking Club has been fortunate in having the hiking days sunny; consequently there are about twelve who, if they continue, will be eligible for the Hiking Emblem. Campfire suppers seem to be the most popular; on one of these there were twenty-nine hungry hikers. Short hikes are better attended than the long ones, but each have had a good following.

This month, the objectives are:

Saturday, June 11 the Club will go to Staten Island, for a short walk at Silver Lake Reservation.

Thursday, June 16 there will be another Campfire supper on the west shore of the Hudson. See how good food can be when cooked over an open fire.

Saturday, June 25 the trip will be from White Plains to Valhalla, about 8 miles, ending at the quarry south of Kensico Reservoir.

For further information about these hikes call Phyllis Barton or N. F. Sowers.

Vail Medal Awards

In recognition of acts involving to an unusual degree the qualities of initiative, resourcefulness, courage and endurance, six Vail medals have been awarded for 1926 by the National Committee. A gold medal was awarded to a section lineman who traversed a seventy-mile stretch of line during and after the Florida hurricane. Silver medals were awarded to three plant men for their work in restoring service after the disastrous explosion at Lake Denmark, N. J.; to an operator for services when fire destroyed the central office and but for her courage would have wiped out the town; and to the manager of a connecting company who helped to capture bank robbers. These medallists were selected from sixty-four persons to whom bronze medals were awarded by Associated Companies of the Bell System.