Bell Laboratories Record

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The Decoder

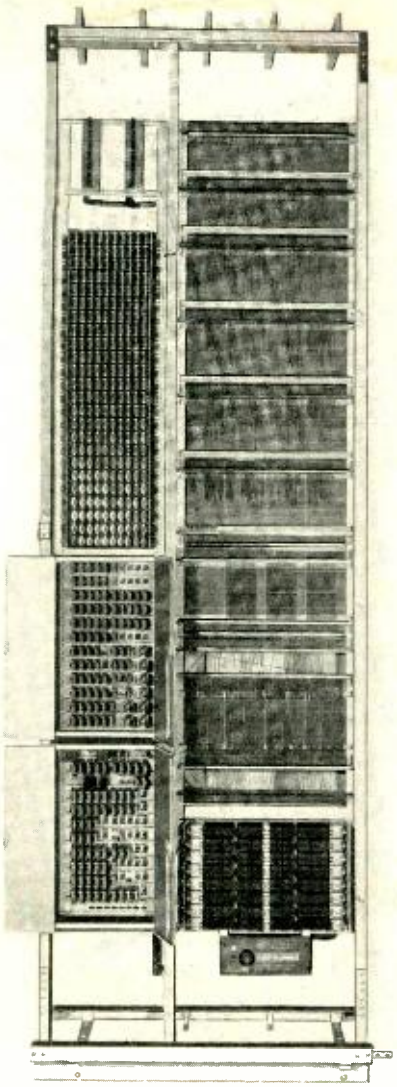
By R. RAYMOND
Systems Development Department

TELEPHONE numbers in all larger cities have two parts: an office name, and a subscriber's number. In manual exchanges, after the operator has heard the number you want, she selects from the many outgoing trunks in front of her one running to that particular office and then gives the number to the operator at that office who completes the call. In dial-type offices the sender, which has been called the brains* of the "panel" system, performs the work of these two operators. It has no difficulty in handling the second part of the number by itself, but to locate the proper office it requires help. For this it may now turn to the decoder, a new piece of equipment designed to replace the translator frames and pulse machines used heretofore. Carrying out the simile, the decoder could be called the memory of the panel system. It serves as a sort of card index to which the sender refers for the information it requires regarding the routing and procedure for each call.

In the large areas using panel equipment, each subscriber's number requires seven or eight dialing operations: three to locate the central office, and the remaining four or five to locate the individual line within that office area. The decoder is not at all concerned with these last four numbers which through relays in the sender cause apparatus located in the called office to select successively the group of two thousand that includes the subscriber being called, then the five hundred, the hundred, the ten, and finally the individual line. The method is not unlike the one you use to locate a friend when you walk down his street till you reach the building he is in, then up to the proper floor, down the corridor to the right office, and finally in to the individual desk he occupies.

This simple and straightforward method does not prove practical, however, for locating the called office because office names depend on the location of the office or on other factors that are in no way related to the terminating position of their trunks in the switching equipment.

* *A Mechanical Brain*, BELL LABORATORIES RECORD, *November*, 1926, *p.* 78.



The decoder itself is a collection of from three hundred to four hundred relays with a cross-connection rack; it has no power-driven apparatus

The Whitehall and Washington Heights offices, for instance, have a similarity in name, as both begin with "W", although there may be no similarity whatever in the position of their cable terminals in the switching equipment of the Chelsea office. Other factors too, such as whether the called office is a manual or panel office, are independent of the office name but must be considered in sending the call. In addition the equipment to locate the office trunks needs to be in use a shorter time than the equipment for calling the number, and all these factors make it a practical necessity to have a translating device as a separate unit. Only six decoders are used for as many as four hundred senders.

With a three-letter code to indicate the office there are 512 combinations that may be dialled, of which about four hundred are suitable for office names. The sender records the three sets of impulses sent out when the subscriber dials the office letters and then turns to the decoder and allows it to decode these signals and, as a result of the information it gains thereby, to pick out the proper trunk. After this the sender proceeds with the selection of the called number.

Suppose an Ambassador subscriber wishes to call Bell Telephone Laboratories, Chelsea 1000. As soon as the dial has been pulled three times to register the office code, 2-4-3, (C-H-E) the sender attaches itself to any one of the decoders that is not then in use. This requires the simultaneous connection of about fifty wires followed by the operation of a combination of relays in the decoder corresponding to the code 2-4-3. The action of this relay combination then operates a relay in the decoder known as a route relay of which there is one for each outgoing route to another central office or to an operator.

Returning to the conception of the decoder as a card index, this particular route relay is the card for Chelsea Office or code 2-4-3 and if it were

a printed card, it would contain the following information:

1. There is such an office and the Ambassador subscribers are allowed to dial it.

2. There is a group of trunks direct from Ambassador to Chelsea which are to be reached by choosing the third brush and the first group on the district selector frame and then the second brush and the eighth group on the office selector frame.

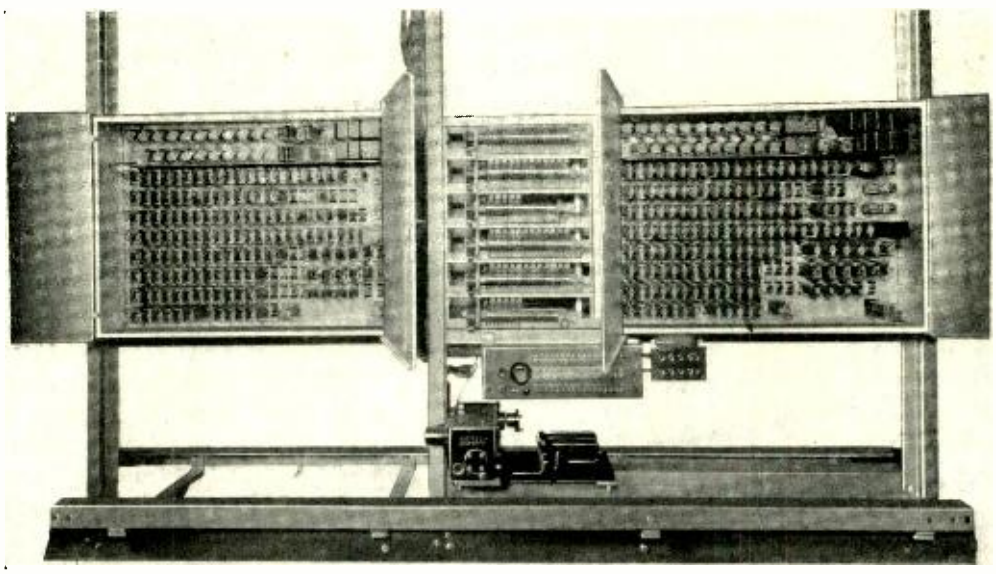
3. As Chelsea is a manual office, the sender must transmit the called number to it by impulses of a kind to display the number (in this case 1000) on lamps before the operator.

4. The office selector frame is very near the sender (both in Ambassador Office) and therefore in operating the office selector, the sender must add a certain resistance to the circuit to make the relays operate properly. But Chelsea is so far away that no resistance should be added when transmitting impulses to it.

5. Chelsea has no party lines, but it has numbers between 10,000 and 10,499. Since the sender cannot tell whether the subscriber is going to call 1,000 or 10,000, it must wait a few seconds to give him time to dial a fifth numerical digit before signalling the Chelsea operator. But if the subscriber calls Chelsea 2000, it is not necessary for the sender to wait this time since there are no such numbers as 20,000 and no party line stations such as 2000-J.

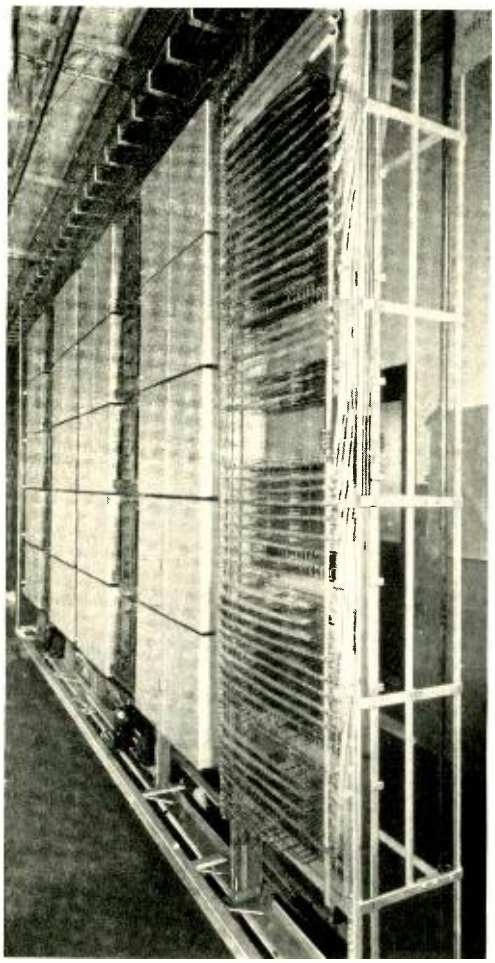
6. The sender must notify the district selector to supply repeating-coil transmission, and if the call is answered to operate the Ambassador subcriber's message register.

Cards for other codes might contain information that the called office was a full mechanical one requiring a different kind of impulses to transmit the number. They might carry information that there was no office selector in the route or that the office selector was of the two-wire



One sender unit of two senders which is assembled, wired, and tested in the factory and then mounted on the frame with four others by the assembler

variety requiring somewhat different treatment from the local three-wire office selector. They might include the note that there were no direct trunks to the called office, and that it must be reached through a tandem office. Some of them might convey the fact that the office concerned may be



Two sender frames including twenty senders, and one connector frame in the trial installation in Brooklyn

dialed by one class of Ambassador subscriber but not by another class. When the route relay operates, its contacts, which are interchangeably cross-connected, cause other relays in the decoder to operate, which ground a certain selection of the wires connected to windings of relays in the sender. The combination of these relays which are thus operated, records in the sender all that it needs to know to connect the calling subscriber to Chelsea Office. The connection between sender and decoder is then broken.

This is in brief what the decoders do for every call registered in the senders: they take the office code, decode it and return full information to the sender. This requires about three-tenths of a second, and if supplied with a steady stream of calls, one decoder will handle 12,000 an hour. In practice, the calls do not come in a perfectly steady stream and to attempt to handle them at that rate would cause excessive delays to some of them. It is proposed, however, when the maximum equipment of six decoders is provided, to load them during the busy hour at nearly 8,000 calls per decoder. If one of the six should be out of service due to trouble, the load could still be handled without noticeable delays.

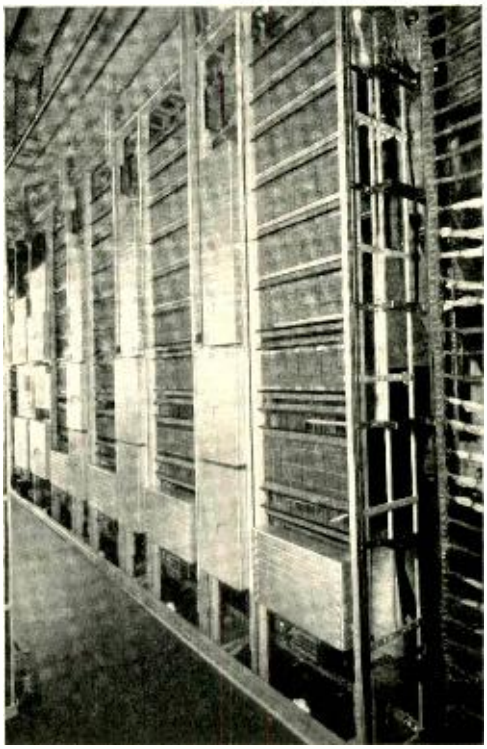
When handling calls at this rate, a decoder which develops trouble, such as a break or cross in its wiring or a dirty relay contact, could misroute or fail to route a great many calls in a short time unless precautions were taken to prevent it. A so-called second trial feature is incorporated in the design of the decoder and sender to prevent even one call from going astray due to such a fault. A system of alarms is provided to call the attention of the maintenance force to any faults arising in the decoders or the connectors which serve as the link between them and the senders

and to assist in locating such faults.

In handling each call, the decoder automatically tests all the wires connecting it with the sender, and if a fault exists it refuses to proceed. It will also fail to proceed if there is any fault within the decoder itself. A time-measuring device allows the decoder a certain short time to complete its work on every call and if it does not do so in that time, it sends a signal to the sender to make a second trial. This means to disconnect from the decoder and try again with another decoder. If the second trial is unsuccessful, the fault must be in or near the sender, not in the decoder, and the sender sticks without making a third trial. This feature practically eliminates lost calls due to troubles in the decoders or in that part of the connector which is near the decoders.

With the old-type senders, the decoding was done by means of translator frames and pulse machines. Each sender had a panel-type selector on the translator frame which was run up to a certain level depending upon the office code dialed. At that level, it connected the sender by six wires to the commutators of the motor-driven pulse machine, which sent six sets of pulses in turn over the six wires, operating a selection of thirty-six relays in the sender.

The essential differences between the pulse machine and decoder principles of operation are two. First, the pulse machine sender has an individual clutch-driven selector to record the office code, whereas the decoder sender transmits the code by grounding a selection of leads to relays in a common decoder. Secondly, the pulse machine operates relays in the sender in successive batches by pulses of current of short duration,



Three decoders of the trial installation and at the extreme left the decoder test frame

whereas the decoder operates relays in the senders all together by currents of more ample duration. The decoder equipment has no moving apparatus except relays and these are all furnished operating currents far in excess of their needs in respect to both volume and duration. The decoder is proving successful in its trial installation in the Ambassador Office, Brooklyn, where it has been in service since the first of September, 1927.

Differential Equations and Law

By THORNTON C. FRY
Research Department

MATHEMATICIANS and lawyers both find it necessary to define curves. Mathematicians sometimes do it by the use of differential equations and sometimes by the use of algebraic equations. Lawyers always use differential equations. That is one difference between the two professions. Another is the charge they make for their services; but that is beyond the scope of this article, which is intended to explain how the differential equations used by mathematicians (and by lawyers) succeed in defining curves.

I own a certain building lot. The boundary of this lot is a curve. From a strictly logical standpoint it would be possible to prescribe that boundary by giving the latitude and longitude of every point on it. It is true that there are an infinity of points and we could not handily make a table which lists them all, but we might think up some other scheme that would accomplish the same end. We might say, for instance, that along one side of my lot the sum formed by adding the longitude to half the latitude was equal to 115 degrees. We could even save space by letting x represent longitude and y latitude and writing the equation

$$x + \tfrac{1}{2}y = 115. \qquad (1)$$

This algebraic equation would accomplish the same end as a table and would be much simpler to construct.

The lawyers who drew the deed to my lot, however, did not see fit to define its boundary in any such way. Instead they first announced that there was a marble "monument" buried in the ground at one corner of it, and then said "beginning at this monument proceed so many feet in a certain direction, then so many more feet in another direction, and so on until the monument is again reached." This is a differential equation all written out in words — and it is, in addition, a "boundary value."

Now these two methods of prescribing the curve in question are equally precise but they are essentially different. For example, the first method is of such a character that it is possible to decide at once whether a particular point is or is not on the curve without reference to any other point whatsoever. All that is necessary is to substitute its latitude and longitude in the equation (1) and this is identical in principle with looking them up in our hypothetical table of boundary points. The second method, on the other hand, is of such a nature that this cannot be done. To find whether a particular point is or is not on the boundary it is necessary to start from the monument and walk in the prescribed direction until either we reach the point in question, or else are quite sure we never shall. In doing this, however, we obviously locate many other points of the boundary which are quite likely to be of no immediate interest.

Mathematicians sometimes define

curves in this way. In other words, they sometimes talk about direction as well as latitude and longitude; and just as they use the letters x and y as abbreviations for latitude and longitude, they use y′ as an abbreviation for direction. Take, for example, the "differential equation"

$$y' = x + y. \qquad (2)$$

It has nothing to do with the boundary of any lot, but it may serve to illustrate the mathematician's point of view. Suppose we are located at a point for which the latitude is 5 ($x = 5$) and the longitude 4 ($y = 4$). Then this equation tells us that y′ must be 9; in other words, it tells us that we should travel away from this point in the "direction 9", whatever that may mean.*

Suppose we obey the command and start out in this direction. Our latitude and longitude immediately change; that is, the x and y which must be substituted in equation (2) are no longer 5 and 4, but are somewhat different and therefore give a somewhat different direction y′. Let us change our direction to conform to this new command and proceed. Again our latitude and longitude change and because they have changed the command given by equation (2) also changes. We can imagine ourselves, however, traveling in a constantly changing direction in such a way that at all times we instantaneously obey the command of equation (2). If we do this we shall follow a curved path which is said, in mathematical language, to "obey the differential equation (2)".

It is obvious then that equation (2) has done for this curve exactly what the lawyers did for the boundary of my lot; it has told us in what direction we must travel in order to follow along a certain curve.

Shifting our point of view somewhat, it may be interesting to think of ourselves taking various positions in the plane, and nothing that equation (2) assigns to each of these points a definite direction. If we were to take up position after position, we might note the direction in which we were commanded to proceed, and lay down an arrow to indicate it, thus producing an array of arrows somewhat like those shown in Figure 1.

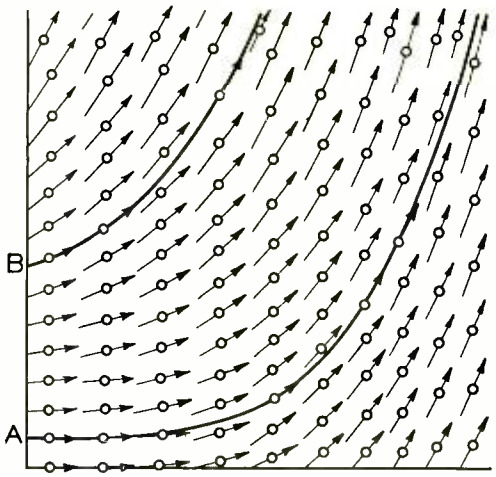


Figure 1

In looking at this figure each arrow tends to carry the eye to the arrow next ahead of it, in such a way as to associate the arrows into groups. By beginning at any point A and connecting the arrows of such a group together, a curve is produced which has, at each of the points to which arrows are affixed, the direction required by (2).

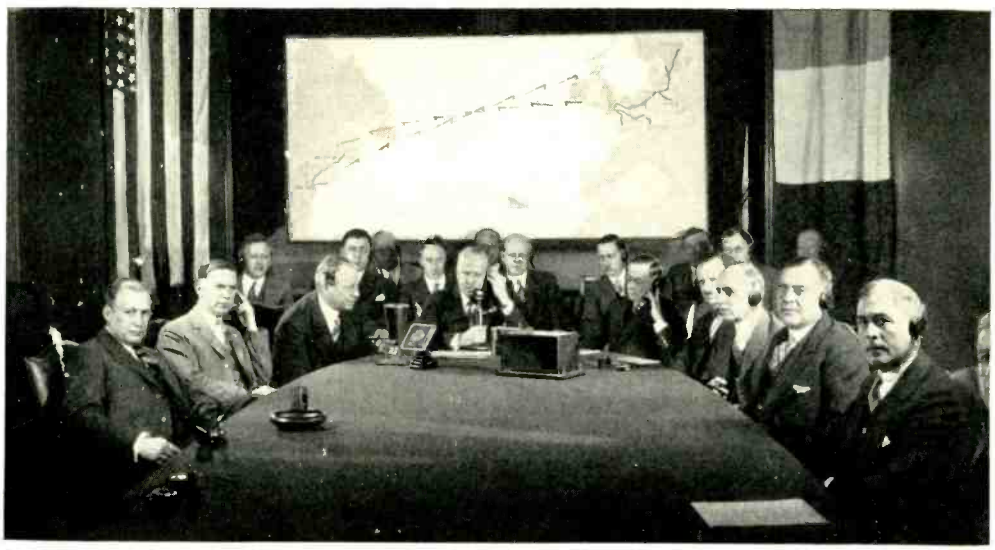
If the number of arrows is greatly increased the number of points at which the curve satisfies (2) is also greatly increased. In fact, by making

* *What it means is that we should travel in such a direction that the longitude changes nine times as fast as the latitude.*

the arrows more and more numerous it is possible, in theory at least, to approach a limiting curve, the direction of which satisfies the differential equation at every point. It is, in other words, the path along which we have imagined ourselves to have walked.

If, however, we were to start from a different point B, a different curve would be obtained. Obviously this new curve, like the old one, obeys (2); both are therefore "solutions" of it. We could find many other such curves by starting from still other points. It follows, then, that a differential equation defines, not one curve, but many. Indeed, we could show that their number is infinite.

We have now been led to the two most fundamental facts about differential equations: that they define, not curves, but families of curves; and that they define them by telling, not positions of points, but directions of advance. To sort out a single one of these curves it is necessary to specify a point of beginning, or "boundary value", just as, in describing the boundary of my lot, it was necessary to say "Begin at the marble monument". Had these words been omitted my home might be in California or Timbuktu, so far as anyone could determine from the deed.



NEW YORK TALKS WITH PARIS

Those pictured at the New York end of the circuit are: A. W. Page and C. P. Cooper, Vice-presidents of the American Telephone and Telegraph Company; W. Wilson of the Laboratories; Bancroft Gherardi, Vice-president, A. T. & T.; R. A. Heising, John Mills and R. H. Wilson of the Laboratories; President Gifford; H. D. Arnold, B. W. Kendall and H. W. Everitt, of the Laboratories; John J. Carty, Vice-president, and E. H. Colpitts, Assistant Vice-president of A. T. & T.; B. B. Webb and A. M. Curtis of the Laboratories; F. B. Jewett, Vice-president, A. T. & T. and President of the Laboratories; T. G. Miller, General Manager, Long Lines; O. E. Buckley of the Laboratories, and E. B. Craft, Executive Vice-president of the Laboratories

Telephone Service Opened with Paris

INAUGURATING telephone service between the United States and France, a group of telephone executives and engineers on March 28 gathered at 195 Broadway, New York, and talked with another group in Paris. Reminiscent of the first radio-telephone transmission to Paris in 1915, twelve of the men concerned were present in New York and one was in Paris.

Group at the Paris terminal

Conversations took place between President Gifford and M. Maurice Bukonowski, Minister of Commerce and Industry for France; between Mr. Gifford and General Pershing, then in Paris; between General Carty and M. H. Milon, Chief Engineer and Director of Telephones, Ministry of Posts and Telegraphs; between General Carty and H. E. Shreeve, and between B. B. Webb and Mr. Shreeve. In 1915; Mr. Webb was one of the talkers at Arlington, and Mr. Shreeve a listener at Paris; one of the first phrases to be understood in 1915 — "and now, Shreeve, good night" — was part of their 1928 conversation.

In every respect, the occasion presented wide contrast to the demonstration of 1915. Instead of trying day after day to get a few words across, and being baffled over and over by interference and static, the two groups gathered at a prearranged time with well-justified confidence that their conversations would proceed without a hitch. Nor was there a delay of two days to learn by cable that Paris had understood New York; the immediate response by telephone left no doubt of the intelligibility of both transmissions.

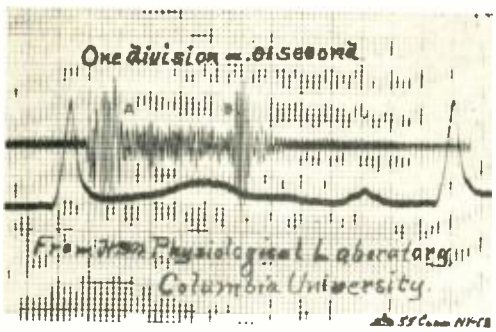
The circuits used last month were those of the regular transatlantic radio system between New York and London. At London connection was made with cable circuits recently constructed both overland and across the Channel.

Telephone service is available between American subscribers in general, and subscribers throughout Great Britain as well as in Paris and in fourteen principal cities of continental Europe. Thus the American telephone subscriber has at his elbow not only the eighteen million telephones connected to the Bell System, but 1,385,000 telephones in adjacent countries of North America and three million telephones in Europe.

Phonograph Records of Heart Sounds

By D. G. BLATTNER
Research Department

WITH the development of the electrical stethoscope* we took great pride in the fact that the most skillful physician was brought to the bedside of the most isolated patient. A striking demonstration of this was the telephotic transmission of a stethogram of a New York patient to Dr. Greer in Chicago, who correctly diagnosed the case and prescribed the proper treatment to the American Medical Association in convention in Atlantic City. Having already annihilated the lesser distances which separated the collective ears of a medical class



Combined stethogram and electrocardiogram sent by telephotography from New York to Dr. Greer in Chicago

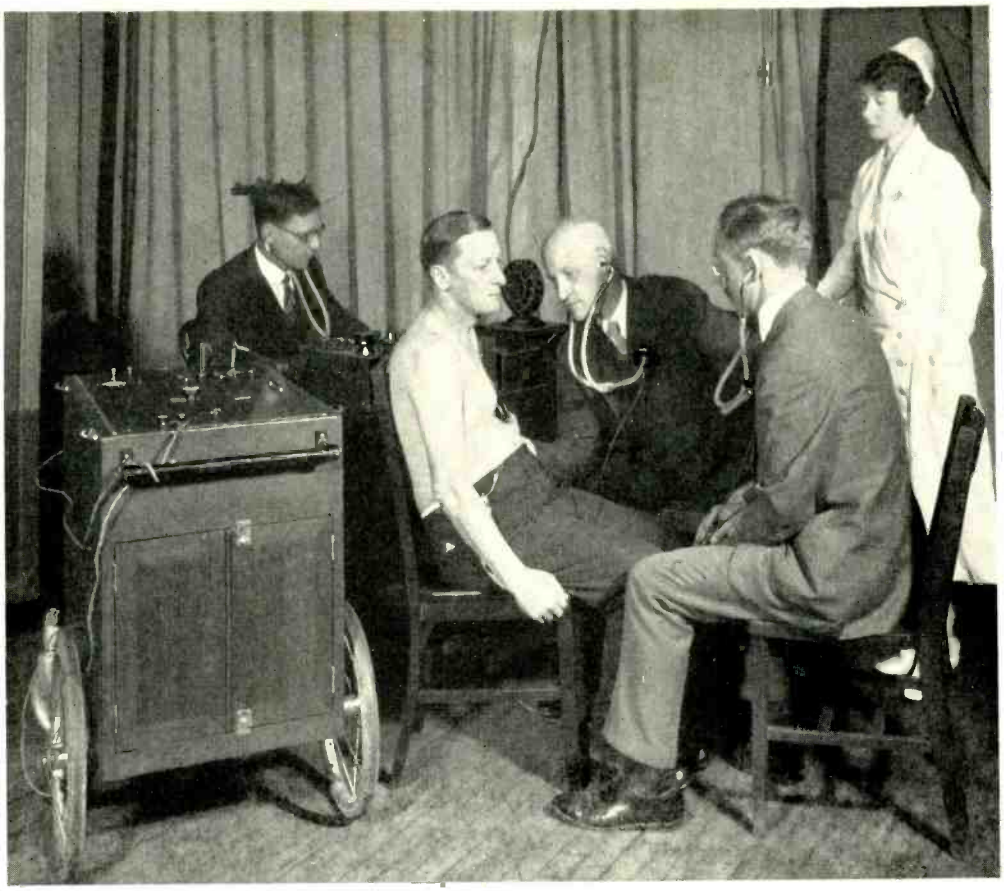
from the patient's chest — the original purpose of the electrical stethoscope — our attention turned to the annihilation of time as well, so that both student and practitioner might auscultate a patient whose case history had long since been closed. Dr. Cabot, Dr. Gamble, the Columbia Phonograph Company, and Bell Telephone Laboratories in cooperation began experimenting with the recording of various types of abnormal heart sounds* by means of the electrical stethoscope. Now, after two years of effort, a library of a dozen or so records of the more usual types of abnormalities are being released for sale through the Columbia Phonograph Company.

His heart sounds having once been recorded, a patient may be spared even the slight fatigue of further examination for instruction purposes. More important, however, is the fact that clinical patients of every type of abnormality are not always available, so that in the past the instruction of many student physicians has been incomplete. Now not only can the instruction be more complete in regard to types of abnormality but also it can be arranged in such a way as to produce the most definite and lasting impressions.

While heart sounds were recorded on phonograph records two years ago, satisfactory reproduction from the records at that time was possible only through the use of apparatus that was costly and not widely available. Commercial phonographs would not reproduce the important low-frequency vibrations in the heart sounds, so that an electrical repro-

* BELL LABORATORIES RECORD, *Oct.*, 1925, *p.* 41.

* BELL LABORATORIES RECORD, *Dec.*, 1925, *p.* 162.



Recording the heart-sounds of a patient. Comments of the physician are recorded at the same time by means of the microphone

ducer had to be used. There was no objection to this apparatus from the standpoint of reproduction, but the electrical system with its vacuum tubes and filters was and is far too expensive for any very widespread use. In order that students and physicians all over the country could take advantage of the phonograph records of heart sounds some simple device was necessary.

This meant that a special pick-up device must be developed having suitable characteristics and yet of small enough cost so that one could be included with each group of records sold. Other requirements, aside from cost, availability, and faithfulness of reproduction, were that it must be relatively free from surface noise incidental to dragging a needle through the groove of a phonograph record. Also, the sound should pass to the ear of the user through an acoustic stethoscope so as to duplicate the tone quality that he may be accustomed to hearing in practice. The final form developed to meet these requirements is shown in the accompanying photograph. Since the heart sounds are largely of the nature of transients it is necessary that the pick-up be heavily damped if not aperiodic. This is accomplished by

means of a rubber diaphragm and by the damping action of the finger-tips which serve as the pivot of the needle arm.

In using the device the listener places one of the records on any phonograph turntable available, attaches the pick-up device to the earpieces of his acoustic stethoscope and holds it to the part of the record that may be of interest to him. Such volume adjustment as is necessary is obtained by means of the adjustable clamp shown in the picture.

While the group of records now available covers the more usual types of abnormalities of the heart it is in a sense still very incomplete. Who, for instance, can estimate the importance of having a record of the sound of a normal human heart between the periods of the cradle and the grave? or of the progressive development of a particular case of abnormality? Of what importance might not records, covering a period of time, be in determining the effectiveness of different forms of treatment for a given type of abnormality? It is probable that in years to come records of these and other sounds will be found as a regular part of each physician's library.

A student listening to heart-sounds by means of the pick-up device

Amplification Behind the Talking Movies

By H. A. DAHL

Apparatus Development Department

MUSICAL accompaniment synchronized with motion pictures but without an orchestra in the theatre was made possible a few years ago by developments in Bell Telephone Laboratories. Success greeted the first demonstration of this achievement and since then its use has become more widespread every year. The first commercial development used a disc phonograph record rotated in synchronism with the film passing through the picture-projection machine. Music picked up from the record with ordinary acoustical apparatus would not have sufficient volume to fill a theatre, so an electrical reproducer is used which enables an amplifier between it and the loud speakers to increase the feeble reproducer currents to values that will produce a volume of sound equivalent to an actual accompanying orchestra. In another development the music is recorded on a film which is run through reproducing apparatus also operated in synchronism with the picture projector, but here too the reproduction is electrical and requires considerable amplification.

Apparatus required for this amplification is one of the major parts of the equipment. The early installations used amplifiers which were available at the time and although designed for other purposes would give satisfactory amplification. Subsequent improvement in amplifying technique, however, has made improvements possible, particularly by eliminating the rather extensive batteries required by the older amplifiers, which are objectionable from the standpoint of maintenance in commercial theatre installations.

With the object of producing equipment which embodied exactly the features required for this service a new amplifier system was designed. This is made in units so that a suitable selection of the units may be made to obtain the proper volume of sound for the different sizes of theatres to be accommodated. These amplifiers, shown mounted on a rack in the accompanying photograph, are the 41-A, 42-A and 43-A. Power supplies required for their operation are of the simplest possible type. Only a small capacity twelve-volt battery and a 110-volt alternating current supply are necessary.

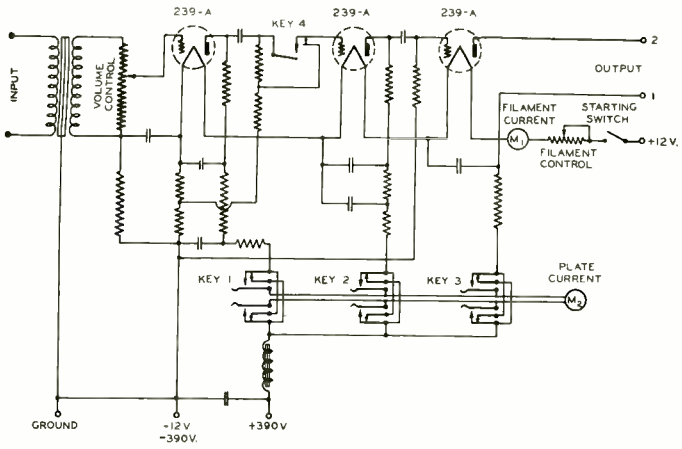
Over one-half the total amplification of the system is produced by the 41-A amplifier which raises the energy level of the reproducer to a volume suitable for the operation of a power amplifier. Essentially it is a three-stage resistance-coupled circuit using 239-A tubes in each stage.

In any high-amplification system such as this, the vacuum-tubes in the first and second stages are very sensitive to external disturbances. Slight jars or knocks or even air currents impinging on the tubes are converted into electrical impulses which are carried through the amplifier to the loud speakers, where they appear as

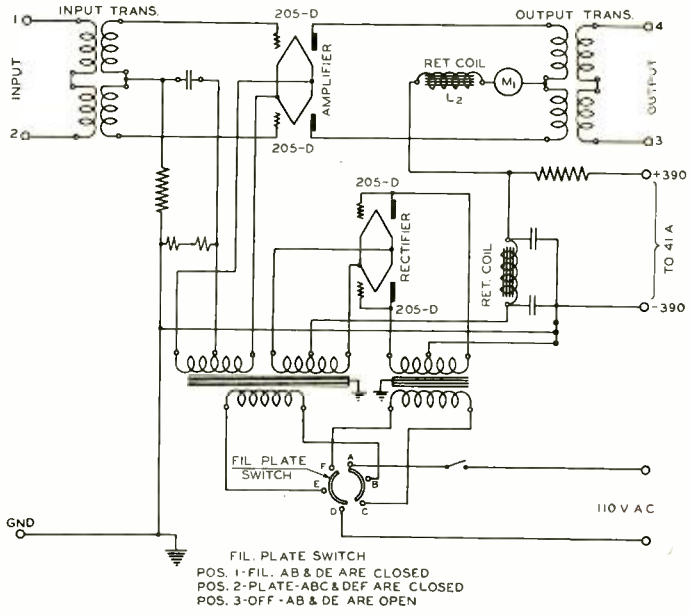
grating sounds. In the 41-A amplifier special precautions are taken to prevent this. The three vacuum-tube sockets are each mounted on a separate piece of sponge rubber which is fastened to a heavy steel plate. This plate in turn is suspended on sponge rubber mountings. The method of suspension here employed, which is called the inertia type, was evolved after an extensive series of tests. The sponge rubber beneath each tube socket prevents the higher frequency disturbances from reaching the tube, and the heavy plate suspension, because of its inertia, filters out the lower frequency disturbances.

The filaments of the three tubes, which require a quarter of an ampere current, are connected in series and supplied by a twelve-volt battery. Plate potential is obtained from the 42-A amplifier at 390 volts which is reduced by resistances in the plate circuit of each stage so that in no case is more than one hundred volts applied to the plate. In conjunction with these resistances are condensers which act as filters to smooth out more perfectly for these sensitive first stages the rectified plate supply from the 42-A amplifier.

A key turns off or on the filament current and a rheostat allows adjustment of the current strength which is read on the milliammeter provided. Plate current for each stage may be determined by pushing a key associated with each



Schematic of 41-A Amplifier



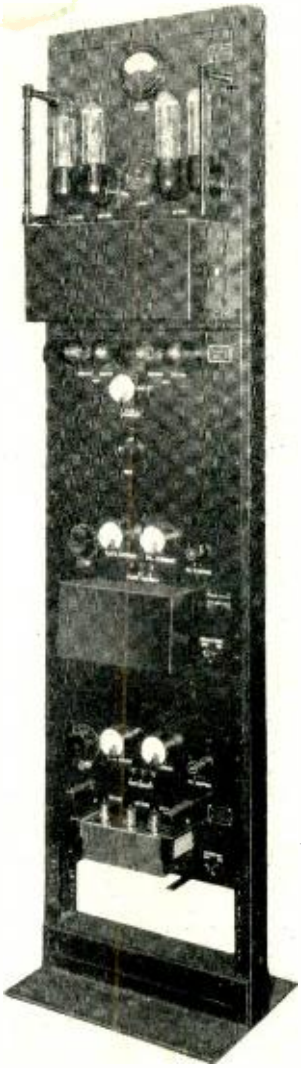
Schematic of 42-A Amplifier

tube, which connects a second milliammeter into the circuit. Two volume controls are provided. The dial in the upper left-hand corner of the panel affords a control of sixty-six TU in steps of three TU each, and a key located beneath the vacuum-tube cover, marked Key 4 on the diagram, can be set to produce an attenuation of fourteen TU.

The 42-A amplifier is a single-stage push-pull power circuit employing 205-D vacuum-tubes. It is operated entirely from an alternating current source and consumes about eighty watts. Four vacuum-tubes are used: two as amplifiers, and two as rectifiers for the plate potential of four hundred volts. The only control provided on this amplifier is a snap switch for connecting the alternating current supply. In starting, this switch is turned to the first position which lights the filaments only. After they have had time to warm up, the switch is advanced to the next position which places the amplifier in operation by applying potential to the plates. This procedure reduces the strain on the vacuum tubes which would occur if the high voltage were applied while the filaments were still cold.

The 41-A unit gives an amplification of one hundred times or forty TU, and the 42-A of eighteen times or twenty-five TU additional. The latter has sufficient capacity to serve as the final power amplifier where the location requires only a moderate volume. Where greater volumes are found necessary they may be obtained by using two 42-A units in parallel or by adding the third unit of the series, called the 43-A.

This last unit of the series is also a single stage push-pull power amplifier, but uses 211-E tubes. It also is operated entirely by alternating current and consumes about three hundred watts. Its circuit is similar to the 42-A except that 211-E tubes are used with a plate potential of eight hundred volts. Behind the sheet metal container on the front



41-A, 42-A, and 43-A Amplifiers mounted on a rack

of the panel are the filter condensers connected in the rectifier circuit. They may be examined and repaired by removing the hinged cover.

This unit produces an amplification of six times or fifteen TU, which makes the three units combined yield an amplification of ten thousand times or eighty TU. The 43-A amplifier has sufficient capacity for locations where considerable volume is required. To obtain even greater volumes for distribution through very large theatres two of the 43-A amplifiers may be used in parallel.

In the Vitaphone system the input terminals of the 41-A amplifier are connected to a "fader" which is used to transfer the amplifier system from one reproducer to another at the end of each record. Two projection machines are operated side by side so that while the record used with one is being changed, the other is in use. The output terminals of the last amplifier unit are connected to a receiver control panel which permits a selection of the receiver desired and also permits the volume of each to be adjusted. The complete assembly on the rack as shown makes a convenient and easily operated outfit.

Communication: A Force in Intellectual Evolution

The intellectual evolution of the individual may have come to an end but whether or not this is true, it is certain that the intellectual evolution of groups of individuals is only at the beginning. Progress along this pathway is vitally dependent upon the work of the engineer, for the perfection of all forms of communications and transportation is essential in order that this new superorganism, human society, shall achieve its destiny.

The use of the spoken word to convey ideas distinguishes man from all other created things. It is the function of the engineer to provide for the extension of the spoken word by means of electrical systems, serving to connect the nervous system of each unit of society with all of the others, thus providing an indispensable element in the structure of that inconceivably great and powerful organism which it is believed will be the ultimate outcome of the marvelous evolution society is to undergo.

The ideals of the engineer will not be realized until man has achieved his destiny in that social organism which is foreshadowed "with its million-minded knowledge and power to which no barrier will be insurmountable, no gulf impassable, and no task too great."

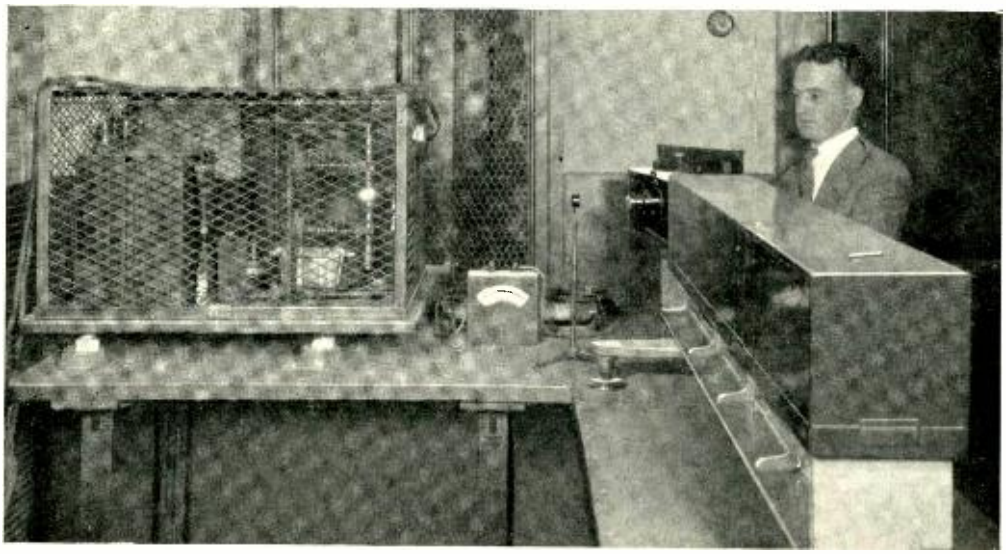
—From an address delivered by Gen. John J. Carty upon receiving the John Fritz Medal.

Spectrographic Analysis

By EARLE E. SCHUMACHER
Research Department

CHEMICAL analyses both qualitative and quantitative are required daily of the Chemical Department of Bell Telephone Laboratories. Standard methods in some cases are slow, difficult, and costly, particularly when applied to the determination of impurities present in small amounts. A shorter method is available, however, as it has been satisfactorily demonstrated in recent years that many of the more difficult analyses can quite easily be made spectrographically. This method is frequently used therefore, and for such work the Laboratories are equipped with a Hilger Quartz Spectrograph, shown in the illustration.

When an electric spark passes between two electrodes the intense heat developed vaporizes and brings to incandescence a small amount of the electrode material. If the electrodes were composed of a single element the radiations would contain only a limited group of wave lengths characteristic of that element. In this respect the spark radiation differs from that of the sun which contains all wave lengths. On this individuality of radiation of each element spectrographic analysis is based.



A. H. Staud in charge of the quartz spectrograph taking a spectrogram. Light from the arc on the left passes through the focussing lens onto the slit through which it passes to be reflected at right angles toward the front end of box. Here is mounted the prism which spreads out the spectrum and reflects it back to the photographic plate projecting above the case at an angle in the rear

Substances to be identified are ionized in the electric spark and their light, after passing through an optical system consisting of lenses and a prism, is finally photographed. In passing through the prism the light waves are bent through angles dependent upon their individual wave lengths and are recorded on a sensitized plate as a series of bright lines. The relative position of each line corresponds to the wave length of the ray producing it and thus each element produces a spectrogram showing a definite and individual set of lines. Distances between spectral lines are measured with a comparator, a precise instrument that enables the position of all the sensitive lines shown in a spectrogram to be compared to those of any known element merely by making the required micrometer settings.

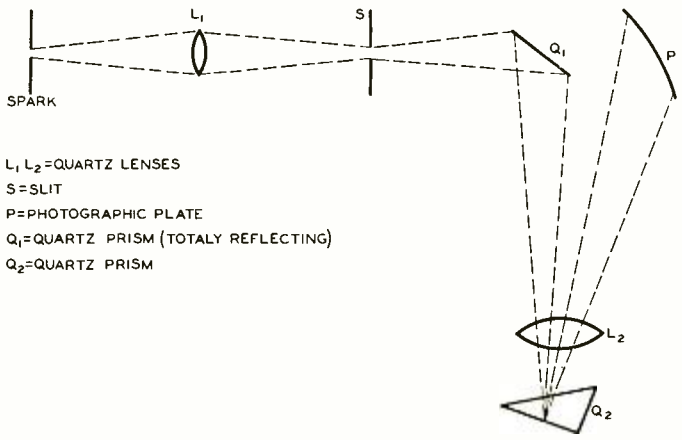


Fig. 1—Diagram of the Hilger Quartz Spectrograph

Since the most sensitive spectral lines for the majority of the elements are located in the ultra violet region the optical system is made of quartz which is transparent to these radiations, instead of glass which is opaque to them. The electrodes are generally made of the sample to be analyzed; but when a case arises where this is not possible, graphite electrodes impregnated with the unknown material are used.

If the presence or absence of any element in a test sample is to be determined, spectrograms of the sample and of the element sought are photographed side by side. After the plate has been developed the results are obvious. If the spectral lines of the known element continue through the spectrogram of the sample, the presence of that element is established.

An accompanying illustration shows the application of this scheme to an unknown alloy which was thought to be composed of copper and gold. The spectra of copper, gold, and the unknown were taken in juxtaposition with the spectrum of the unknown placed between the other two. It can be readily seen that the lines of the copper and gold spectra also appear in the spectrum of the unknown which proves conclusively the presence of these two elements.

Among the practical qualitative applications of spectrographic analysis is the identification of the elements in a material when only a small amount is available. All large concerns are continually receiving small samples of materials bearing queer names such as dreamium, dubium, or miraculum. These materials are supposed to have certain remarkable properties upon which the inventor has high hopes of capitalizing. With-

Fig. 2—Spectrogram of copper (at top), gold (at bottom), and an unknown alloy of copper and gold between them

out undue exertion or expense a spectrogram will usually tell quickly if the material is something new or simply an old model newly labelled.

Another application is the identification of the elements in a valuable specimen without destroying it. The specimen itself is used as an electrode and the momentary spark necessary to make the spectrogram does not vaporize an appreciable part. Where alloys of different composition but similar appearance are handled in the same stockroom the supplies occasionally become mixed. Spectrographic analysis is particularly applicable in such a situation as it offers a rapid and simple method of identification.

Quantitative analysis is also possible to a certain extent with the spectrograph because up to a given percentage, different for each element, the intensities of the characteristic lines of an element are proportional to the relative amount of it in the substances. If one element occurs in another as a slight impurity only, none but the most sensitive characteristic lines of the impurity will appear in the spectrum. As the amount of the impurity increases new and less sensitive lines appear and the old lines become more intense until the whole spectrum is visible. Generally impurities ranging from .003% to 1.0% of the whole can be determined quantitatively by this method. The procedure is to photograph the unknown on the same plate with a graded series of knowns. With a microphotometer to measure the relative brightness of the lines, the unknown can be easily placed.

Figure 3 shows the spectra of a graded series of lead-tin alloys containing from 0.0 to 1.97% antimony. As the antimony content increases the antimony lines are seen to become more intense. With a microphotometer, any unknown quantity of antimony in lead varying from 0.0 to 1.97% can be readily determined by comparing the spectrogram of the unknown with those of the graded series.

Spectrographic analysis is extraordinarily sensitive; authorities state that quantities as small as one three-

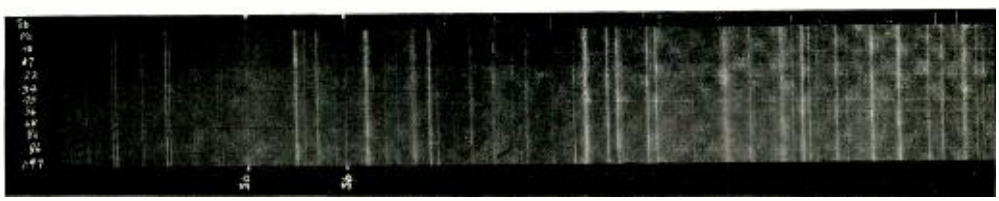


Fig. 3—Spectrogram of a graded series of lead-antimony alloys containing increasing amounts of antimony (given in percent at the left). The spectra of antimony and lead were taken as references. The two most sensitive antimony lines are marked

millionth of a milligram of sodium, one one-hundred-thousandth of a milligram of lithium, or six one-hundred-thousandths of a milligram of strontium or calcium can be easily detected. Practical quantitative applications of the spectrograph include the determinations of small quantities of almost all the elements. It is an interesting fact that the spectrographic method becomes more precise as the proportion of test element decreases, while the wet analytical method becomes less precise.

The Laboratories Take to the Air

WITH the delivery of an airplane and the addition of a pilot, to its staff, the Laboratories have taken two definite steps in the recently-announced program of radio development for aviation. The plane is a cabin monoplane built by the Fairchild Airplane Manufacturing Corporation; the pilot is A. R. Brooks, formerly a captain in the Air Service.

Taking form in a broad study of radio transmission between ground and planes, the field investigation will first concern itself with the effectiveness of various types of antennas, and with the effect on transmission of the plane's height above ground. In this work, the Laboratories' experimental station at Whippany, New Jersey, will be used for transmission. Development in the laboratory is already well advanced on the necessary transmitting and receiving apparatus and tests in the air will shortly begin. The experimental work will be carried on by the radio development group, under the leadership of E. L. Nelson.

A. R. Brooks, pilot of the Laboratories' plane

Since aids to navigation are an outstanding need of commercial aviation, one of the problems to receive early attention will be the development of a system by which the pilot can determine his bearing from various points on the ground. Means for the transmission of weather bulletins and other information to planes will also be developed.

The plane is one designed to accomodate five persons. The seats for passengers have been omitted, and in this space will be installed receiving apparatus and a field-strength measuring set. The electrical system of the plane will be carefully shielded to avoid interference from the engine's ignition circuits. Lamps and flares

The Fairchild plane to be used by the Laboratories for aerial communication research

have been provided to permit night flying. Initially, the plane will be based at Hadley Field, where hangar and laboratory space has been engaged. This is within a few minutes by air of the laboratory at Whippany.

Captain A. R. Brooks, the first man to be engaged by the Laboratories as an aviator, has had a distinguished career in the United States Army. Graduating from Massachusetts Institute of Technology in 1917, he was about to enter these Laboratories when the World War claimed him. During his service in France, Captain Brooks was officially credited with destruction of six enemy planes. He is the holder of the D.S.C. and of several citations. Since the Armistice he has been identified with military instruction in aeronautics, and with commercial aviation.

There are now available for members of the Laboratories sets of personal financial records in booklet form. These records supplement the A. T. & T. income and expense record which has been available to members of the organization for some years. They are especially intended for those who do not keep a detailed expense account, but who wish to determine their financial status at intervals. Copies of these records may be obtained by applying to the Employee Service Department, Section 1-H, Extension 435.

Rotary File Type Information Desk

By V. I. CRUSER
Systems Development Department

YOUR chief concern as you hold the receiver to your ear after having asked for "Information" is that you find out what you want to know as quickly as possible. Probably you do not give a thought to the facilities that must be available to enable the operator to give the information with the least possible delay. Until the new Information desk, briefly referred to as the Number 2, had been designed operators at information desks used books much like the larger city directories, which were kept in a book rack upon the desk top, and in which were printed the latest addresses and telephone numbers of the subscribers. Due to the rapid growth of telephone service in recent years, it became necessary in the larger cities to print daily supplements and to reissue the entire book frequently in order to have it up-to-date. Studies indicated that to keep records in rotary type files would overcome a number of the difficulties previously encountered excepting in the very largest cities.

Each section of the No. 2 Desk is arranged for a single operator. The front part of the keyshelf is a narrow writing space; behind this are the trunk keys, depressed in a trough to prevent accidental operation. Each keyshelf is arranged for fifty-two trunks incoming from various central offices through which the inquiring subscribers may be connected to "Information." A signal lamp and a listening key are provided for each trunk by which the operator may know when a call is on the trunk and connect her headset into the circuit. The same set of fifty-two trunks are connected in multiple to several positions; if traffic is heavy as many as eight operators may be required, while late at night or at other times when traffic is light, all but one or two operators for each set of trunks may be excused.

Just in the rear of the keyshelf, within easy reach of the operator, a rotary file is placed on each section. The section was designed for a file approximately thirty inches in diameter and twenty-six inches high. A file of this size has a capacity, somewhat dependent on its make, of approximately 75,000 listings, but in a district of a large city served by a centralized information desk there may be as many

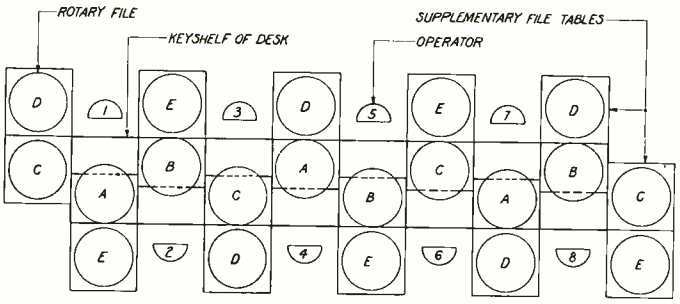
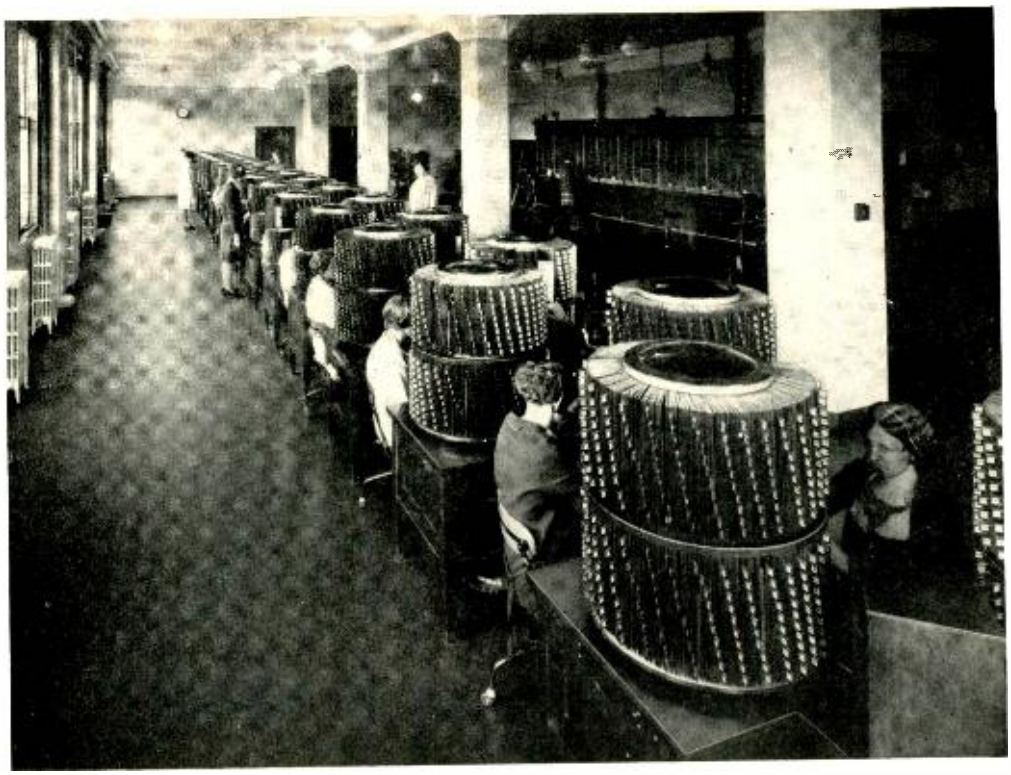


Fig. 1—Floor plan whereby each operator can reach five files

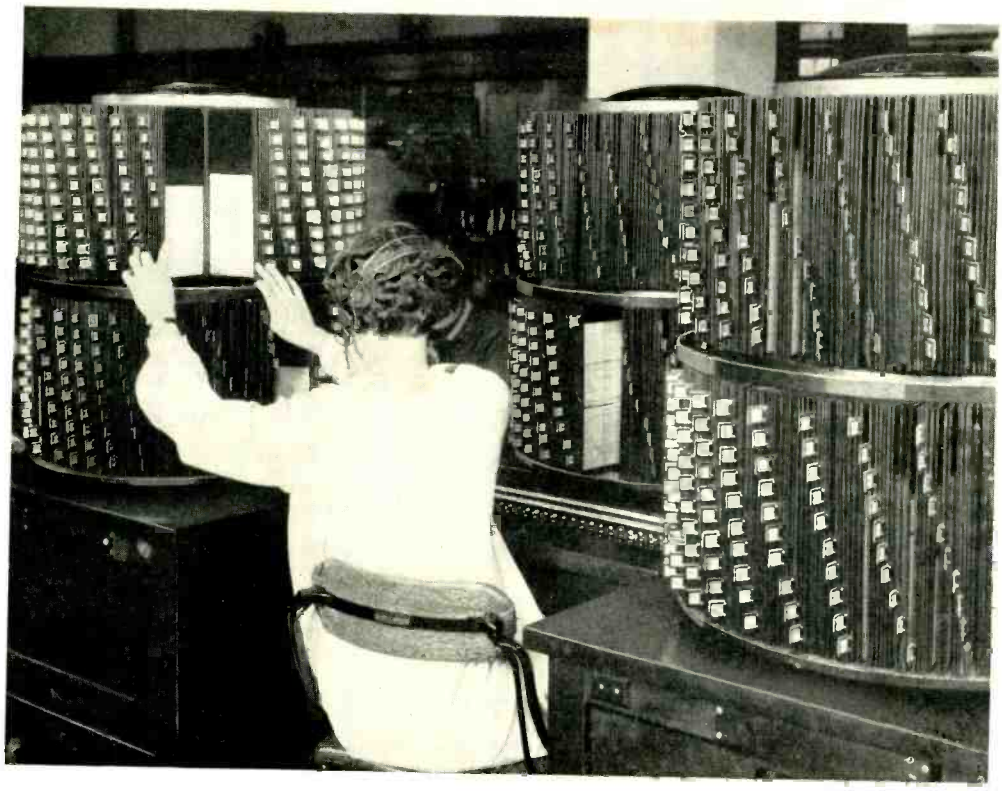


The new information bureau at Cleveland

as 200,000 or even 300,000 subscribers. Since it was considered essential to have all listings before each operator, some way had to be devised to give each operator access to several files. The result was the so called "staggered" line-up. The positions are arranged side by side but alternately facing opposite directions. The key-shelf of each section is indented slightly between the rear of the two adjacent positions. In this way each operator has three files of the rotary type within easy reach: one on her own section in front of her, and one on each side of her on the adjacent sections. A glance at the photograph of Cleveland's new information bureau will help to give a clear picture of the arrangement.

Names, addresses, and telephone numbers of the subscribers are printed on cards which slide in the many radial leaves of the rotary file. A space 1/6″ wide and about 5″ long is provided for each subscriber. It is evident that, since one file is common to three operators, more than one of them may wish to use the same file at a time. In order to reduce the liability of interference double-tier files are used. They are made with two circular frames for the leaves, one above the other, each rotating independently so that one operator may use the upper part while another uses the lower part without interference.

When more than three files are required for the information cards, rotary files on a supplementary table placed at the rear of each desk afford the operator access to two additional files. At Cleveland only the three file arrangement is used but the floor



"Information" getting the information

plan shown as Figure 1 illustrates the five-file arrangement.

Since subscribers' addresses are ever changing, and since the information bureau is the one place which must have the new addresses almost before the telephones have been connected, some rapid means is required to furnish the information in a form for the files. To accomplish this an attachment is supplied for use with an ordinary typewriter which, in place of typing on paper, prepares a stencil of thin sheet aluminum. These stencils, in turn, are used with a simple duplicating machine to produce any desired number of clean-cut prints on file cards. The machines are easily operated and a typist with no special ability can have the new address of a subscriber in all files a few minutes after the information is received.

Each group of eight operators at the Number 2 Information Desk is placed directly under the jurisdiction of a supervisor whose duty it is to see that all requests for information are dispatched efficiently and to answer any calls of a complex nature which would take up too much of an operator's time to complete. Provision is made so that the supervisor may be called, both by a bell and a visible signal, to any of the operators who wish to ask her a question or to have her complete a call personally. The supervisor's circuit is so arranged that after she has picked up a call by plugging into a set of jacks, the operator who originally answered the call is free to handle any other unanswered calls.

ecause of the fact that a great many of the incoming calls are for information other than that which the operators are equipped to give, the supervisor is kept particularly busy. She may be asked whether Mrs. Brown has moved into her new home, or what is the telephone number of the man who lives opposite Mr. Smith? Many queries such as these she may not be able to answer, but in any case she must make sure that the subscriber puts the receiver on the hook without dissatisfaction.

Another feature has been incorporated in this new desk which is of general interest. There are always apt to be moments when calls come into the information desk faster than the operators there can handle them. As each call arrives a signal lamp lights but if several calls have come in while the operators are busy there is no way of distinguishing those that came in first, and should for that reason have attention first.

To avoid this difficulty and to make sure that each call will be given attention in the proper order a flashing circuit has been developed which flashes the signal lamp to show that the call has been waiting. When the call first comes in the signal lamp burns steadily. After a short interval, the duration of which is adjustable, the lamp starts flashing at the rate of sixty flashes per minute.

The next time you ask for "Information, please" try to visualize what is taking place at the information desk. See the operator catch a glimpse of a lighted trunk lamp, see her flip the trunk key so that she may tell you that she is ready to help you; see her twirl one of the files around, pick the particular leaf, spread the leaves at that point, and run her finger up to the name of the particular person whose number you want —all this in a few seconds.

Does Business Want Scholars?

Writing under this title in Harper's Magazine for May, Walter S. Gifford discusses the results of a study of the correlation between scholastic attainments and business success. College records of some 3800 graduates within the Bell System were compared with their subsequent business records and it was found that scholastic success in college showed a marked correlation with later success in the Bell System. For instance, of those in the first tenth as to salary, seventeen per cent came from the highest tenth of their classes, while only four and one-half per cent came from the lowest third. The article has received a number of favorable comments in newspapers.

Life Insurance Protection

By J. F. MORAVEC
Commercial Manager and General Auditor

A RECENT conversation with a member of the Laboratories brought to light this story of one man's experience.

"Less than a year ago I purchased a home in which my equity is rather small. A goodly part of my mortgage is payable over a period of about seven years and this had me considerably worried. Of course, I can meet the obligations as they become due, if I stay on the job; but I worried because, should I die, my wife and the children would be burdened with a debt of large proportions with no means of liquidating it. I had given some thought to additional life insurance, for I carry only a little, but dismissed that idea because of the cost which I felt I couldn't afford.

"With the introduction of the Payroll Deduction Plan for insurance, the salary deduction feature appealed to me and I arranged to see Mr. Bunting about my problem, but with no great hope of finding a solution. Imagine my agreeable surprise, therefore, when I learned through him of a form of policy just suiting my case and costing comparatively little for the protection offered. This is a special 'term policy' for the period of my mortgage which decreases in principal as well as in premiums as I make payments on the mortgage. I have that policy and worry no more. Should I drop off during the next seven years, my family will obtain the free and clear title to our house.

"I am getting on in years and am now trying to do what should have been done earlier, that is, get together some little estate for my family. I feel confident that if the plan for insurance which is offered us today, with the opportunity of free and intelligent discussion of the various forms of protection and with its easy payment features, had been available to me 23 years ago when I first joined the Company, (and that is on the supposition that I would have been foresighted enough to subscribe to it) I would now have sufficient protection for my family at considerably less cost and with very much less worry.

"Another thing, — it is only within the last few years that I have come to fully appreciate the advantages to me of the A. T. & T. Stock Plan. While I have always subscribed for a few shares, I sold them for profit and now have neither profit nor savings to show. I am now subscribing to the limit permitted under the plan and later this year when my present shares are fully paid for, the certificate will go at once to my strong box. At the same time, a new subscription for my limit will be filed. Had I done that from the beginning, I would be 'sitting pretty' now."

These are the views of one of our associates, who after a discussion of several business matters drifted into

a general discussion of the thrift plans made available to us.

It is unnecessary to point out the moral in the foregoing. It is, however, a story worth repeating, for it illustrates the adaptability of life insurance to individual needs.

From numerous comments that have come to me, it would seem that most of us agree that life insurance takes first place in, and is an indispensable part of, our individual thrift programs. If that is true, have we taken steps to make it effective? Have we given thought to and have we selected the kind of insurance that best meets our requirements? Many factors enter into the making of this decision. Such considerations as marital status, age, amount we can spend on premiums, amount of insurance wanted and whether we want insurance for protection or primarily for investment are all important. To help us in these considerations, Mr. Bunting who is an expert in such matters is always available for consultation and advice in selecting the kind of policy which will "fill the bill."

If we are looking primarily for protection, the type of policy best adapted to the needs of most of us is "ordinary life." While "term insurance" is the cheapest protection that can be bought, it should be bought only in unusual cases where for a brief period it is essential to obtain the maximum protection at minimum outlay. Term insurance does not provide permanent protection but automatically expires at the end of a limited period unless converted into some form of permanent insurance. Premium payments on term insurance do not build up a reserve cash value as under permanent policies, and if converted the advantage of original age is lost as the premiums on the permanent insurance will be based on age at the time of conversion.

Thus, where permanent protection at the lowest premium rate is wanted, the ordinary life policy seems best. This is often referred to as "whole life" or "straight life" insurance because it provides for payment of the full face amount upon the death of the insured in exchange for uniform premiums throughout life. It also combines a considerable amount of saving, since after the first year the policy has a cash value, increasing from year to year, which the insurance company will lend to the insured at interest or pay to him if the policy is cancelled. If one wishes to avoid payment of premiums throughout life, dividends may be allowed to accumulate with the insurance company, thus producing a fully paid up policy in about twenty-one years. Of course, payment of face amount is still deferred until death; but premium payments are no longer made and yearly dividends continue to accrue and may be withdrawn in cash.

Of numerous special features which have been added to life insurance policies in recent years, none, perhaps, is more deserving of mention than the provision of disability benefits. For a small additional charge, the insurance company, in case of disability before age 60, will pay disability benefits at the rate of ten dollars a month for each one thousand dollars of insurance and will waive all premium payments during such disability. Payments for disability leave unimpaired the death claims of the policy plus any accumulated and unpaid dividends. Many persons become disabled for a considerable period pre-

ceding death. So far as the family budget is concerned, a protracted illness resulting in death is more serious than the sudden demise of the breadwinner. In many instances lingering disease renders the insured incapable of earning anything for many months, sometimes for several years. During this time heavy expenses are often incurred for professional services, and in other ways. We are quite apt to think that no such catastrophe will overcome us. But should we take the chance? The disability clause added to an ordinary life policy may prove to be of inestimable value.

Ordinary life contracts are also written, upon payment of a small additional charge, to provide death benefits of double the face amount of the policy in case death results from bodily injury. This is a desirable feature at small cost, particularly in cases where no accident insurance is carried.

For those of us who wish to be relieved of premium payments after attaining a certain age, probably the limited payment type of policy will have a greater appeal. This type of policy is identical with the ordinary life policy except that instead of paying premiums for life, one pays them for a limited period of 10, 15, 20, 25 or 30 years. At the end of the specified period, the policy becomes paid up for its full face value and continues to share in dividend distribution. For the longer periods, the limited payment policy is not much more expensive than the straight life and is well worth considering for those who can afford to pay a little more per year. Without sacrificing protection during one's productive years, it affords one means of accumulating an income-producing investment for the later years of life.

In all the foregoing, I have only scratched the surface of a subject which deserves the careful consideration and study of everyone. There are many points which I have not covered at all, and many which I have barely mentioned. However, we have with us Mr. Lloyd H. Bunting who is eminently fitted to assist us in working out our insurance problems. Mr. Bunting is the authorized agent of the Equitable in charge of this insurance plan and I recommend him to you as the proper one to whom you should go for advice on insurance and to make your purchases under this plan. He is located in Room 144, Extension 264.

It is with regret that we record the death of a friend and a valued member of our Technical Staff:

Harry Raymond Kuettles

radio engineer

December 6, 1896—April 12, 1928

Associate of the American Institute of Electrical Engineers and of the Institute of Radio Engineers; for several years identified with the creation of the New York-London radio telephone circuit

News Notes

THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY has purchased the entire block front on Church Street, between Walker and Lispenard Streets, adjoining their present Walker-Lispenard building.

INCLUDED in the program of the Student Branch Convention of the New York Section of the A. I. E. E. was a trip through the Laboratories on the morning of April 19. The visitors included students from Columbia University, Newark College of Engineering, Cooper Union, College of the City of New York, Rutgers University, Stevens Institute of Technology, New York University, Brooklyn Polytechnic Institute.

THORPE HISCOCK, Communications Officer of the Boeing Air Transport Company, which operates between New York and Los Angeles, visited Whippany and the Laboratories on April 3.

AT THE COLLOQUIUM meeting on April 16 W. S. Gorton was elected President for the 1928-29 season, O. E. Buckley, Vice-President, and J. C. Steinberg, Secretary. M. J. Kelly spoke at the meeting on "Oxide Coated Filaments," and P. S. Olmstead, on April 2, spoke on "Adsorption of Gases by Carbon."

* * *

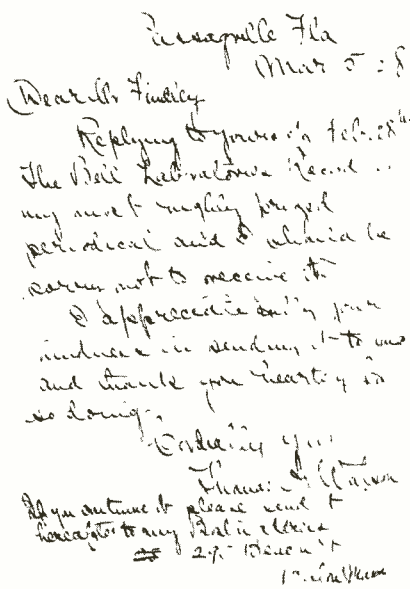
APPARATUS DEVELOPMENT

J. T. ACKER, H. A. ANDERSON, R. M. BURNS, C. H. GREENALL AND J. R. TOWNSEND attended the meeting of the A. S. T. M. Committee on Non-Ferrous Metals and Alloys, held in New York on March 21, 1928.

W. J. SHACKELTON was present at the meeting of the A. S. T. M. Committee on Magnetic Materials held March 22 in Washington.

W. J. LEVERIDGE visited the Victor plant at Camden, New Jersey, in connection with a new type nineteen-foot horn for music reproduction.

H. L. WALTER visited Philadelphia to assist in the production of reproducer outfits to be used in small theatres for non-synchronous music reproduction.



Reproduced above is the reply of Thomas A. Watson to a letter sent as well to many of those on the mailing list of BELL LABORATORIES RECORD, *enquiring as to their continued interest in the magazine*

R. V. TERRY visited Rochester to confer with the Bausch and Lomb Company, the Eastman Kodak Company and others on matters relating to equipment necessary for talking motion pictures.

W. V. WOLFE made an extensive trip which included visits to installations of carrier current telephone apparatus for the Northern States Power Company at Wissota and Eau Claire, Minnesota; the Portland Power Company at Portland and Salem, Oregon; and the Pacific Gas and Electric Company at Claremont, Vaca-Dixon and Pitt River, California.

H. PFANNENSTIEHL assisted at New Haven in installing and testing a new type universal projector base which has been developed for theatre use in connection with the reproduction of talking motion pictures.

G .W. FOLKNER AND A. C. GARRECHT visited the Nebraska Exchange in Philadelphia to study lubrication problems.

G. W. FOLKNER AND C. C. BARBER were in Hawthorne during the week of March 26 to confer on multiple brushes and sequence switches.

D. H. GLEASON AND D. W. MATHISON visited the Evergreen Exchange in Philadelphia to observe contact resistance studies on 200 type selectors.

D. T. MAY AND I. E. COLE attended a meeting of the Joint Sub-Committee on Development and Research of the National Electric Light Association and the Bell System held in New York on April 5.

H. O. SIEGMUND served recently on the Committee on Elections of the A. I. E. E.

H. A. ANDERSON visited the W. H. Buckingham Company at Binghamton, New York, on April 11 to discuss the manufacture of linemen's climbers.

At the Stockholm, Sweden, long distance board, a copy of the New York telephone directory lies within easy reach of the operator

H. M. STOLLER visited the Fort Wayne works of the General Electric Company during the first week in April to test a new type of direct current motor to be used for talking motion pictures. He was also in Philadelphia, testing and inspecting other new equipment for theatre installations.

E. C. MANDERFELD visited Philadelphia to test new control boxes for use with the motor equipment of talking motion picture apparatus.

AT PHILADELPHIA A. F. PRICE discussed the design and manufacture of apparatus required for talking motion pictures.

D. H. NEWMAN made a preliminary survey for the installation of a one-kilowatt broadcasting equipment for the Durham Life Insurance Company of Raleigh, North Carolina.

H. S. PRICE supervised the installation of a five-kilowatt broadcasting equipment for the Churchill Evangelistic Association of Buffalo, N. Y. He also inspected the one-kilowatt station of the Edison Electric Illuminating Company, Boston.

W. L. TIERNEY visited the Pacific Coast to make a survey for a five-kilowatt installation for the Los Angeles Express and to supervise the installation of a one-kilowatt broadcasting equipment for Don Lee, Incorporated, Los Angeles. While there he inspected the one-kilowatt stations of Hale Brothers and Don Lee, Incorporated, at San Francisco.

GENERAL STAFF

S. P. GRACE spoke on inverted speech and other recent developments of the Laboratories before the Kansas Independent Telephone Association at Topeka on April 4, the Ohio Independent Telephone Association at Columbus on April 12, and the Iowa Independent Telephone Association at Des Moines on April 18. On the following day, Mr. Grace addressed the Rotary Club and the Chamber of Commerce at Des Moines on the same topic.

P. B. FINDLEY gave a lecture "Through Electrical Eyes" before the Hazelton, Pennsylvania, section of the A. I. E. E. on April 20.

R. W. KING gave several lectures on television in Montreal, addressing the Canadian Railroad Club on April 10, the Electrical Club of Montreal on April 11, the Engineering Institute of Canada on April 12, and the employees of the Bell Telephone Company of Canada and the Northern Electric Company. On April 13 he spoke on the same subject before the Physics Society of McGill University at Toronto, and on April 23 he again lectured on television before the New Brunswick, New Jersey, Scientific Society at Rutgers University.

L. S. O'ROARK spoke on "Electrical Transmission of Personality" before the Lynn, Massachusetts, Section of the A. I. E. E. on April 25, and before the New England Chapter of the Telephone Pioneers on April 26.

RESEARCH

C. A. KOTTERMAN was in Washington, D. C., March 15 to 19, to supervise the installation of an automatic moving picture projector showing an exhibition picture "On Telephony." This apparatus is part of the permanent exhibit of the Bell System at the National Academy of Sciences.

H. H. LOWRY, J. M. FINCH AND H. N. VAN DEUSEN visited the research department of the Bakelite Corporation in Bloomfield, New Jersey on April 4.

A. R. KEMP AND W. S. BISHOP visited the E. I. Du Pont de Nemours Company at Wilmington on April 5, to discuss vulcanization accelerators and antioxidants for rubber.

H. E. IVES lectured on the transmission of pictures before a meeting of the Illuminating Engineers' Society held in the A. T. & T. Auditorium at 195 Broadway on April 12.

COOPERATING with the New York League for the Hard-of-Hearing, Harvey Fletcher and J. B. Kelly arranged for a showing of certain motion pictures illustrating the use of audiometers at the Parents Exposition, held at Grand Central Palace, which began April twenty-first. Mr. Kelly also gave a demonstration of

the 4-A Audiometer in connection with the portion of the program allotted to the New York League for the Hard-of-Hearing. The League's booth at the exposition displayed a placard that was made up by John G. Marinac, a member of the Bureau of Publication.

J. B. KELLY spoke on Recent Researches in Audition before the Ohio Academy of Sciences at Cincinnati.

SYSTEMS DEVELOPMENT

R. C. DAVIS AND C. H. ACHENBACH spent the week of March 5 at Hawthorne discussing the introduction of the new cordless "B" switchboard for panel dial systems, arranged for distributing calls between the operators.

F. A. KORN visited Columbus to confer with engineers of the Ohio Bell Telephone Company on new dial equipment.

F. A. COX investigated requirements for panel dial equipment in Philadelphia.

J. L. DOW visited Pittsburgh March 27 and 28 to discuss panel equipment with engineers of the Bell Telephone Company.

E. W. HANCOCK inspected the new No. 701 P. B. X. in the Western Electric Distributing House at Chicago.

C. W. GREEN spent several days at the Universities of Wisconsin and of Illinois interviewing students in regard to employment.

F. H. CHASE AND R. E. CRANE spent several weeks at Hawthorne observing performance tests on type "C" and type "D" carrier systems.

G. W. AMES visited Denver to test filter equipment for carrier systems.

A. C. DICKIESON studied field conditions on the type "D" carrier system at Atlanta, Macon and Canton.

W. J. BOHRMAN attended the cutover of a new satellite dial system exchange at Whitesboro, New York.

C. H. BIDWELL attended field trials of a new method of producing tones at Springfield, Massachusetts, and Hartford, Connecticut.

M. A. FROBERG tested commercial generator equipment at Indianapolis.

E. H. SMITH discussed step-by-step problems with engineers of the Automatic Electric Company at Chicago.

INSPECTION ENGINEERING

W. A. BOYD AND O. S. MARKUSON attended regular Survey Conferences at Hawthorne during the latter part of March. R. M. Moody and H. C. Cunningham attended a similar conference at Kearny.

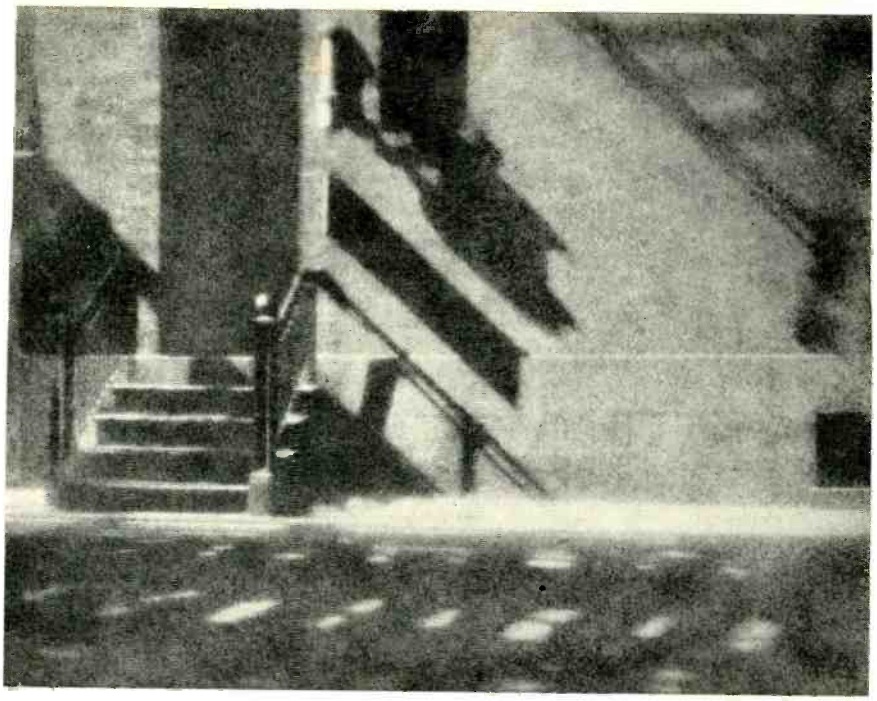
W. C. MILLER AND R. V. TERRY visited the Bausch and Lomb Optical Company in Rochester on March 25 and 26 to discuss the manufacture of a lens system to be used for sound reproduction with motion pictures.

E. F. HELBING was in Schenectady on April 11 and in Utica on April 12 to observe the operation of Foos Type T Emergency gas engines.

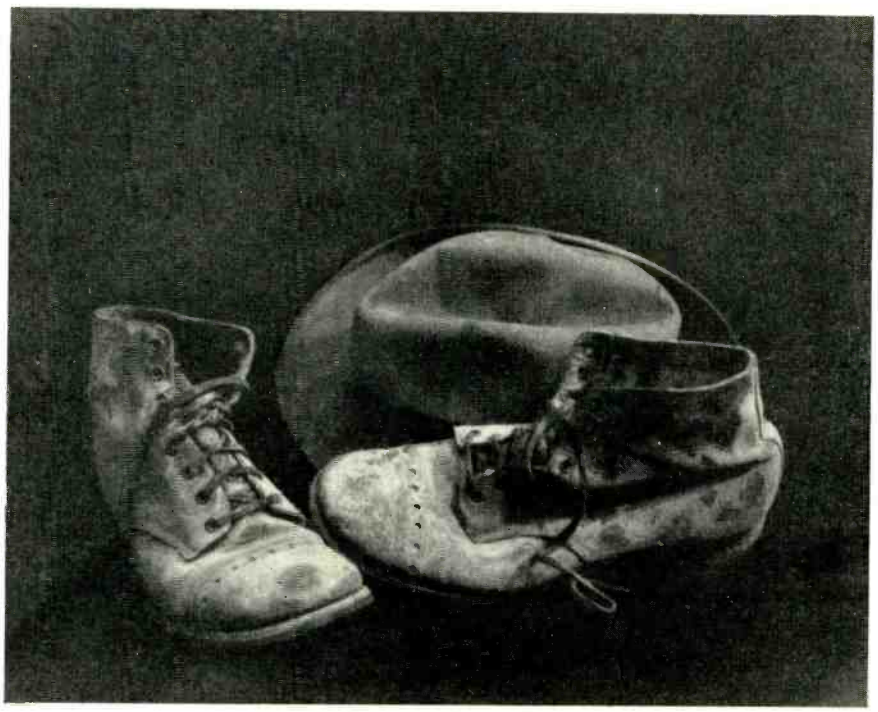
OUTSIDE PLANT DEVELOPMENT

C. D. HOCKER was in St. Louis and Chicago during April studying leather tanning and the manufacture of leather products.

J. A. CARR visited Wakefield, Rhode Island on April 3 for studies in regard to placing of cable rings.



"Shadows," by E. Alenius; first prize, Landscape Class



"Shoes," by E. Alenius; first prize, Still Life Class

Club Notes

The second annual photograph contest included pictures from Finland, Italy, England and Bermuda, but a scene from our own Greenwich Avenue took first prize in the Landscape Class. This was "Shadows" by E. Alenius. M. K. Kruger's "Brook" took second place, and "Birch Tree" by A. C. Chaiclin was awarded third place in this class.

The first prize for portraits went to P. Husta for his picture "The Baby," while C. G. Schofield's "The Slave Girl" took second place, and J. Popino's "Theresa," third. Other portraits received favorable comment.

The first and second places in the Still Life Class were taken by E. Alenius' "Shoes" and "The Jewel Case." C. G. Schofield won third prize with "Table Top." A. O. Casey received Honorable Mention.

A. C. Chaiclin was awarded Honorable Mention for his group of pictures.

Representatives of seven departments competed for the Department prizes. The awards were given to A. O. Casey, Apparatus Development; J. E. Clark, Research; E. Alenius, Systems Development; D. D. Haggerty, Personnel; J. Popino, Commercial; J. A. St. Clair, Inspection Engineering, and D. E. Hartshorn, Patent Department.

The exhibition was judged by Dr. W. H. Zerbe, who is connected with the staff of the New York Herald-Tribune and with the Brooklyn Institute of Arts and Sciences.

There is a possibility that the Club may arrange some interesting talks on photography, if there are enough members interested. For further information, call K. B. Lambert on 1366, or Margaret Horne on 786.

Handball

The second annual handball tournament of the Club was held on Tuesday and Thursday evening during March at Labor Temple, with twenty-four men taking part in the elimination matches. T. J. O'Neil, repeating his victory of last year by defeating A. E. Hague in the final match, received a wrist-watch as first prize. A. E. Hague won the second prize of a five-dollar order, and A. L. Dresch was awarded a two-and-one-half dollar order. A Club team was selected to play in a Bell System Handball Tournament which started Tuesday evening, April 3, in the gymnasium in the Hudson Street building of Western Electric.

Track and Field

On Saturday afternoon, June 16, the Bell System Athletic League will hold the first intercompany track and field meet at Erasmus Hall High School Field. The program will include thirteen events which are listed as follows: For men—100 yd. dash, 220 yd. dash, 440 yd. dash, 880 yd. run, shot put, high jump, broad jump, mile relay, novelty race and tug of war. For women—60 yd. dash, quarter-mile relay, and basketball throw.

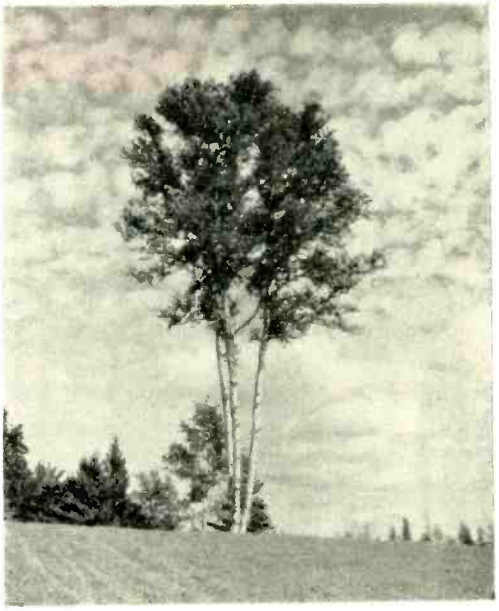
Fourteen branches of the Bell System in the metropolitan district will

"The Baby," by P. Husta; first prize, Portraits

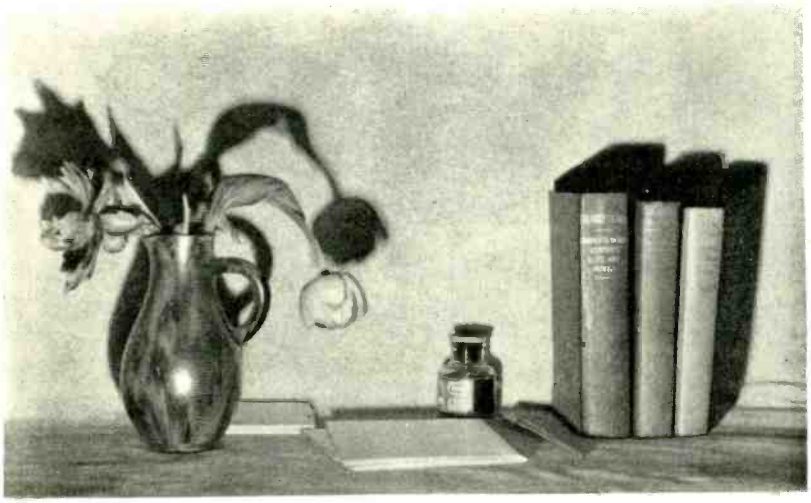
"Theresa," by J. Popino; third prize, Portraits

"The Slave Girl," by C. G. Schofield; second prize, Portraits

"The Jewel Case," by E. Alenius; second prize, Still Life Class



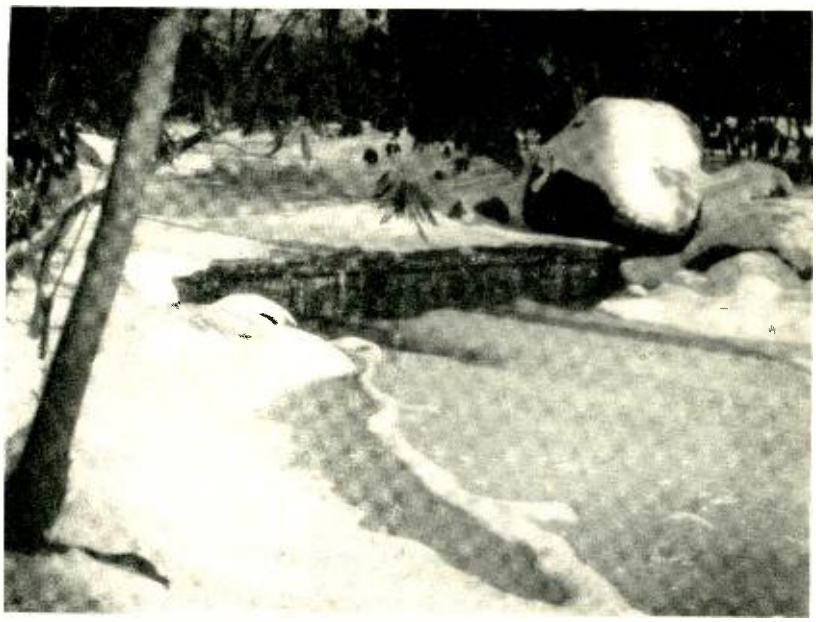
"Birch Tree," by A. C. Chaiclin; third prize, Landscape Class



"Table Top," by C. G. Schofield; third prize, Still Life Class

compete in this meet, and each will be limited to three entries in each event except the tug of war and relay races, in which each organization will enter one team. The athletic committee of the Bell Laboratories Club will hold tryouts for the track team at Erasmus Field on May 19 at 2:00 P. M. Communicate at once with either L. P. Bartheld, extension 749, or D. D. Haggerty, extension 542, if you intend to participate in these tryouts, at which, incidentally, prizes will be awarded. Strong men should call W. C. Calmar, manager of the tug of war team.

The prizes for the meet on June 16 include eight Elgin watches for first places, silver medals for second and bronze medals for third, for many of the events.



"Brook," by M. K. Kruger; second prize, Landscape Class

Golf

The third and last men's indoor golf tournament of the season was held on Tuesday evening, March 27, at the Vander-Built-In Golf Course. In point of numbers this last tournament was the best, eighty-three players who took part bearing witness to the growing interest in golf which is evident among members of the Laboratories.

In the qualifying rounds, consisting of thirty-six holes of medal play, L. G. Hoyt and H. Wood led their respective groups. E. C. Mueller had to down such formidable opponents as J. Dusheck, L. G. Hoyt and R. C. Koernig to win the Group 1, Class A prize, and H. Wood, winner of the Group 2, Class A trophy also had to overcome keen competition. The consistently fine putting of J. G. Roberts gave him a victory over A. A. Reading in Group 1, Class B, and W. C. Burger won from H. L. Dowing in Group 2 of the same class. In the Class C, Group 1 competition O. H. Danielson defeated W. F.

At the Montreal end of the Montreal-New York chess match

Johnson and in Group 2, H. Leicht defeated G. W. Burr. In Class D, Group 1, G. F. Doppel defeated H. W. Dippel, while in Group 2, A. I. Crawford won from P. R. Brousse.

A new feature was introduced in this tournament in the form of two novice prizes for players who, having played in more than one of our tournaments, had never won a prize. N. H. Thorn won one of these, and E. K. Eberhart the other.

The success of the indoor tournaments during the past season has been due in no small measure to the cooperation of Mr. Mothersele, proprietor of the Vander-Bunt-In Golf Course. In each of our tournaments he has voluntarily contributed valuable prizes. His last contribution, consisting of a pair of splendid wooden clubs, was won by H. Wood.

The next tournament will be held outdoors. The qualifying round will be played on the links of the Salisbury Golf Club on Saturday, June 2, and the finals on June 9.

Baseball

The Bell System Baseball League of New York opened the 1928 season on April 30 at 6:00 P. M., at

The Laboratories group that played Montreal

Erasmus Hall Athletic Field and the Laboratories team will play its first league game on Tuesday evening, May 1. The League this year is composed of fourteen teams instead of eight, and has been divided into two groups of seven teams each to provide enough playing days. Complete printed schedules of all league games may be obtained in Room 164. The Laboratories schedule is as follows:

May 1 Western Electric, 195 Broadway.
May 11 Western Electric, Hudson Street.
May 25 New York Telephone, L. I. Plant.
June 6 New York Telephone, L. I. Traffic.
June 19 Western Electric, Installation.
June 29 New York Telephone, Long Island Commercial and Engineering.

The winning team in each group will receive one of the Spalding trophies, and will then be required to play a series of post-season games for the League championship. Fifteen prizes valued at one hundred and fifty dollars will be given to the players on the team winning the series.

The officers of the Bell System League for 1928 are as follows:

President, D. D. Haggerty, Bell Leboratories.
Vice-President, R. S. Kirkwood, N. Y. Tel. Manhattan.
Secretary-Treasurer, E. H. Straus, N. Y. Tel. Long Island.

The Club Interdepartmental League will open the 1928 season on Saturday, May 5, at Erasmus Field and with the exception of May 12 and June 16, games will be played every Saturday through July 28. This season the baseball committee has arranged the schedule so that all games will be completed before August 1 to avoid conflict with the August vacation schedules.

Chess

For the fifth consecutive year the Laboratories team has won the championship in the Commercial Chess League of New York, and in that time has not lost a match. This year ten teams representing commercial houses and banks competed for the league trophy. The final standing in the league is as follows:

	Won	*Lost*	*Drawn*
Bell Telephone Laboratories	8	0	2
Chase National Bank	8	1	0
Western Union Telegraph Co.	6	2	1
Brooklyn Edison Co.	6	3	0
Guaranty Trust Co.	4	3	2
New York Edison Co.	2	5	2
Western Electric Co.	2	5	2
J. C. Penney Co.	1	5	3
McGraw-Hill Co.	1	7	1
H. L. Doherty Co.	0	6	3

Hawthorne defeated West Street by a score of six to four in the annual telegraphic chess match which was played on Saturday, March 31.

The Laboratories team won by 7½ to 4½ the telegraphic chess match played April 14 with the Telephone Chess Club of Montreal, the first such match with Canada to be conducted by means of printing telegraph apparatus. Play started at 2:30 and continued until 11:30 with an hour's intermission for dinner. The referee was Mr. H. Helms, Editor of "The American Chess Bulletin"; Dr. E. A. Robertson, President of the Montreal Chess League and of the Montreal Chess Club, represented our players in Montreal; and Mr. D. G. Grimley, formerly a member of our team, held up the interests of the Canadians here. J. H. Feeny was captain of the Montreal players, and H. D. Cahill our captain. The final standings:

Montreal	*Board*	*New York*
½ G. Gaudet	1	½ F. A. Voos
½ W. H. Rawlings	2	½ R. L. Dempsey
½ W. K. Detlor	3	½ H. W. Bode
½ J. L. Clarke	4	½ H. D. Cahill
0 A. L. Buckland	5	1 D. A. Quarles
0 W. G. Brisbane	6	1 H. T. Reeve
1 W. M. Paterson	7	0 E. G. Andrews
0 R. H. Spriggs	8	1 A. Grendon
0 J. H. Feeny	9	1 G. H. Heydt
½ G. R. McGregor	10	½ T. Slonczewski
½ J. Carleton	11	½ W. Kuhn
½ G. Goumy	12	½ E. Breny
4½		7½