Bell Laboratories Record

Volume Five — October, 1927 — Number Two

Hearing Aids and Deafness

By HARVEY FLETCHER
Research Department

THOSE of us who are associated with the telephone business are frequently asked questions regarding the value of hearing aids, sometimes miscalled "deaf sets." There is a natural feeling that telephone people should know something about hearing aids because they are essentially miniature telephone systems.

This feeling is strengthened by the knowledge that our Laboratories, as part of the research work which it carries on for the American Telephone and Telegraph Company, studies every phase of hearing, that it investigates such matters as articulation, the relative importance of vowels and consonants in speech interpretation, the influence of loudness, and the characteristics of the ear as an organ of hearing.

These studies are finding numerous applications in the design of telephone apparatus and have also made possible the development by Bell Telephone Laboratories of certain hearing aids. These developments are made available to the public through manufacture by the Western Electric Company under the name "Audiphone," and are distributed by the Graybar Electric Company. When selected with respect to the individual's impairment of hearing and needs these aids give valuable assistance.

Loss of hearing is not a simple matter, not even one that varies in quantity only, but an extremely varying phenomenon that takes many forms. It is comparatively easy to make a hearing aid that is merely a sound amplifier, which to many might seem sufficient, but to make one that will aid the greatest number of deafened people to understand the largest percentage of spoken words requires a knowledge that can be obtained only from extensive studies of hearing and can be applied successfully only by those widely experienced in the art of electrical communication.

There is a level of loudness above which sounds begin to affect the sense not of hearing but of touch, causing a sensation of tickling in the ears which very soon becomes painful. This represents the upper limit of hearing and is called the "threshold of sensation" since feeling then begins. It is useless to amplify sounds above this point, for were this done the sounds would produce pain and not hearing. At the other extreme

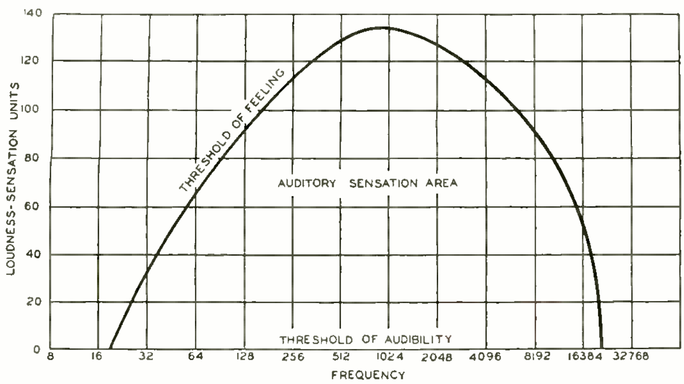


Figure 1—The two thresholds of a normal ear

there is a level of minimum loudness, referred to as the "threshold of audibility." Below this level sounds are not sensed at all. All speech must fall between these two limits.

Loudness is conveniently measured in "sensation units" and from the threshold of audibility for normal ears to that of sensation is a range of about 110 sensation units.

The situation is complicated by the fact that this range of audibility is not the same for all pitches. It is less for sounds both very low and very high in vibration frequency. If the threshold of audibility is plotted as a horizontal line with increasing frequencies marked along to the right, the threshold of feeling would be plotted as shown in Figure 1 which gives the average values for normal ears. The entire auditory sensation area which this line encloses normally covers a frequency range from about twenty to twenty thousand cycles per second, corresponding to a range from about three and one half octaves below to something more than six octaves above the note of "middle C." It rises to a peak of nearly 140 sensation units in the neighborhood of a thousand cycles, that is for a sound about two octaves above middle C.

Deafness in any form cuts down this area but it may do so in a large number of ways. The threshold of feeling is about the same for all people whether deaf or not. The effect of deafness is to raise or modify in some manner the threshold of audibility. That base line may be bodily raised so that the area maintains its same general shape but with higher values; or it may be both raised and bent so that the maximum value is moved toward the lower or

The 6332-A Audiphone as demonstrated by B. A. Clarke. A two-stage amplifier with batteries occupies the box in the foreground the higher end of the frequency range.

Sounds of speech as they are normally pronounced differ in loudness. That of "aw" is the loudest of them all, and the sound of "th," as in "thin," is one of the weakest. In general, vowels are loud and consonants are weak; and the difference between them may be as much as thirty sensation units. The auditory area must, therefore, be at least thirty sensation units wide if all vowels and consonants are to fall within it. When it is narrower than this, no hearing aid can be of much assistance as the auditory area could not then include all spoken sounds. If the weak consonant sounds are amplified so that they fall within it, the louder vowel sounds would at the same time be raised above the threshold of feeling and become unendurable, while if the vowels were kept satisfactorily low the consonants would be inaudible. An improperly designed hearing aid might actually raise the vowel sounds more than the consonants, which would have the effect of aggravating this situation.

Due to the fact that partial loss of hearing means a modification of the auditory area in a different manner for each individual, it might seem that a perfect set would be one designed especially for each case. Practically, however, this would make the sets so expensive that they would be beyond the reach of most of those who need them. Fortunately such an extreme is not essential for with sufficient knowledge of the circuits that are used so generally in telephone work, one can make a standard set approaching the desired perfection.

Noise, however, is a factor which forcibly enters any hearing problem. Obviously amplifying speech sounds amplifies noises also. Improper design might even cause a set to amplify slight noises more than ordinary sounds and thus to be inexcusably noisy. Noise also limits the range of a hearing aid. The greater the distance between a speaker and the hearing aid of a listener the greater will be the effective amount of noise which the set will pick up and so the poorer will be the result. A considerable experience leads to the conclusion that no set should be expected to operate very satisfactorily when the speaker is more than ten feet away. To compare hearing aids on the basis primarily of the distance at which they will function, as has sometimes been done, amounts to rating them only on a basis of amplification which is only one of several factors that affects their usefulness.

The 6034-A Audiphone requires no vacuum tubes. In the case are the transmitter and batteries

If a person of defective hearing is to select intelligently a set which will be best suited to him, he must have some simple method of comparison. There are so many types on the market that a selection without some definite criterion is generally a matter of very considerable difficulty.

Realizing this, our engineers

adapted methods for articulation testing and devised a method of comparison for all types of hearing aids. This was presented before the annual meeting of the American Federation of Leagues for the Hard of Hearing at their annual convention during the last week in June and was enthusiastically received.

Most of the large cities of the country have societies for the hard of hearing. At their various headquarters they ordinarily keep sample sets of the many types of hearing aids. Their members may then try the different ones in an effort to find something suitable. The selection is left to the user's judgment with no very good criterion to guide his decision. In the proposed method, however, his judgment is eliminated. Tests are made which indicate accurately the ability of the hearing aid to assist in the interpretation of speech. Also tests can be made which will indicate whether or not any type of hearing aid will be of real service.

In brief the test consists in determining the percentage of vowel and consonant sounds which may be interpreted correctly. Simple words, carefully chosen for the purpose, are pronounced very slowly, either with the hearing aid or directly with the ear. Such words as bat, bait, bet, bit, and bite are used which differ only in their vowel sound, or such as die, fie, guy, incorporating changes in their consonants. A list of one hundred suitable words has been made up composed of fifty monosyllables which differ only in their vowel sounds, and fifty differing only in their principal consonants.

VOWEL LIST

bat	bait	bet	beat	bit
bite	but	bought	boat	book
boot	bout	bat	bait	bet
beat	bit	bite	but	bought
boat	book	boot	bout	back
bake	back	beak	bit	bite
buck	balk	boat	book	boot
bout	back	bake	beck	beak
bit	bike	buck	balk	boat
book	boot	bout	bake	bike

CONSONANT LIST

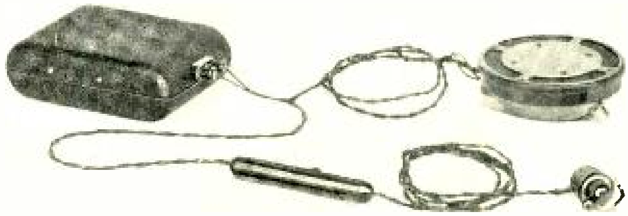
by	which	die	fie	guy
high	wick	lie	my	nigh
wing	pie	wry	sigh	shy
thy	thigh	tie	vie	why
wiz	by	which	die	fie
wig	high	wick	will	whim
win	wing	pie	wry	sigh
shy	thy	thigh	tie	vie
why	wiz	whiff	whip	sigh
wish	with	thigh	wit	vie

List of words used in testing the relative efficiency of hearing aids

This list is shown in the illustration. As only twelve vowel and twenty-one consonant sounds are used it is evident that there would have to be many repetitions of the same sound. The recommended procedure is to write each of the hundred words on a separate card. These may then be shuffled before each test so that the order in which they are given will be different each time, thereby eliminating any possibility of memory effecting the result. The words should be pronounced in a natural voice and at a fixed distance, preferably about three feet, from the hearing aid. Effort should be made to keep the speech volume constant. The rate of pronouncing them should be determined by the time required to write one word before the next one is pronounced.

A round total of fifty words each for the vowel and consonant lists was chosen so that the percentage heard correctly could readily be computed. In determining the vowel percentage only the vowel part of the word is considered. If 'bat' were pronounced and 'pat' recorded it would be rated correct since the vowel was correct. Similarly when considering consonants only the consonant part of the word is used for rating. Were "hay" recorded where "high" had been pronounced it would be marked correct as the significant consonant is the letter 'h.'

A merit figure, expressing for any individual the value to him of any particular hearing aid, is obtained by multiplying the percentage of vowel sounds he hears correctly by the percentage of correct consonant sounds and again by the percentage of correct consonant sounds. If 94% of the vowels had been right and



The 6033-B Audiophone is similar to the 6034-A, but the transmitter is hung on the coat-lapel and batteries are carried in the pocket

72% of the consonants the combined grade would be 49%. (.94 × .72 × .72 = .49). Consonants contribute more to intelligibility than do vowels which makes it necessary to give them more weight in the final rating. Much experimenting has been done to determine just how much more important the consonants are. The expression finally derived for the ratio is somewhat complicated, but is very closely approximated by using their percentage twice in the total product as was done above.

In the final selection of the hearing aid, two considerations must enter: first the ability of the set to aid in the interpretation of speech, and second its convenience as determined by such matters as its size, weight and ease of maintenance. Although the proposed method will give a definite measure of the first, the second can be judged only by the person who is actually using the set.

Church of the Sorbonne, University of Paris; one of the oldest of the University buildings

The Polarity of Learning

By J. S. HARTNETT
General Service Manager

IN the lounge of an Atlantic liner, a San Franciscan meets a man from Montreal. The camaraderie of shipboard leads to the finding that both have friends in Texas—the same friends. According to those who would classify our platitudes, here is merely another occasion for the repetition of that banal remark, "What a small place the world is, after all."

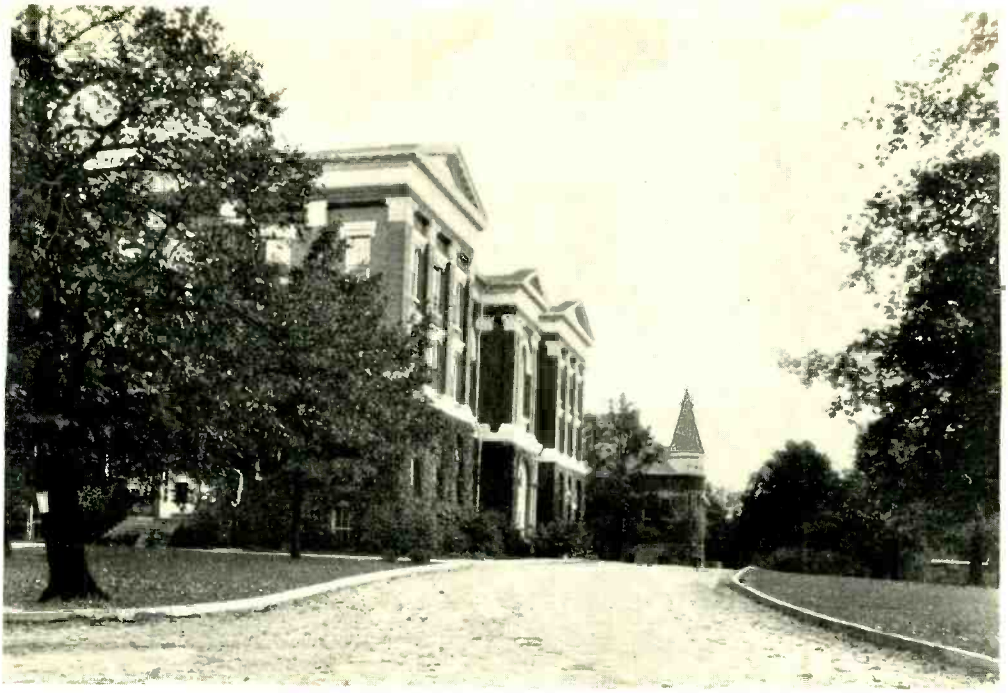
But a trite expression may clothe a glamourous thought. Relatively, the world is a small place. Recast this little scene; make its setting any one of our laboratories or any corridor of our building, and its time any day. Across our stage the Briton from South Africa walks regularly with the Dakotan, and the Carolinian rubs shoulders with the Dane. Their training in science, arts and law having brought these men together, we may in phrasing not entirely fanciful entitle our scene as I have entitled this article. For we are strikingly an organization drawn from world-wide places of learning and engaged reversely in pursuits which are eventually a reaching-out to the ends of the earth, making it aurally ever smaller, oblivious to distance. And thus in a sense even to effects of the planets—does not New York this morning give ear to London's voice of this afternoon?

The personnel records of our organization outline well this tale of men and places. Reduced to a card form for each member of our staff and filed tightly in a cabinet drawer, they have all the dull aspect of their kind. None the less, they give imagination wing. Taking from these cards the colleges and universities from which our personnel is derived, we have indirectly the chapter-headings for a Baedeker or the sub-titles for a travelogue—and history galore.

Seeing America first, there are represented more than one hundred and fifty institutions of higher learning. Think of the name of almost any one of our States and then of any several others, either at random or in all of their possible alliterative cadence, and you will find in our ranks graduates from one or more colleges within the borders of each. "Believe it or not," a cartoonist says and then proceeds to add place or date to his pictures of striking facts. Appending my statements with similar data, incredulity becomes much less the alternative. The evidence is at our elbows in person.

'Way down East, for instance, in Maine are Bowdoin, Bates, Colby and the State University. In terms of a graduate respectively from each*, we have E. S. Pennell, L. B. Hilton, W. L. Dodge and S. H. Willard. Of these institutions the earliest in inception is Bowdoin. Deferred by the failure of John Hancock as Governor

* *Graduates mentioned are either the earliest or the most recent to become members of the technical staff of the Laboratories.*



Administration Building, University of Kentucky

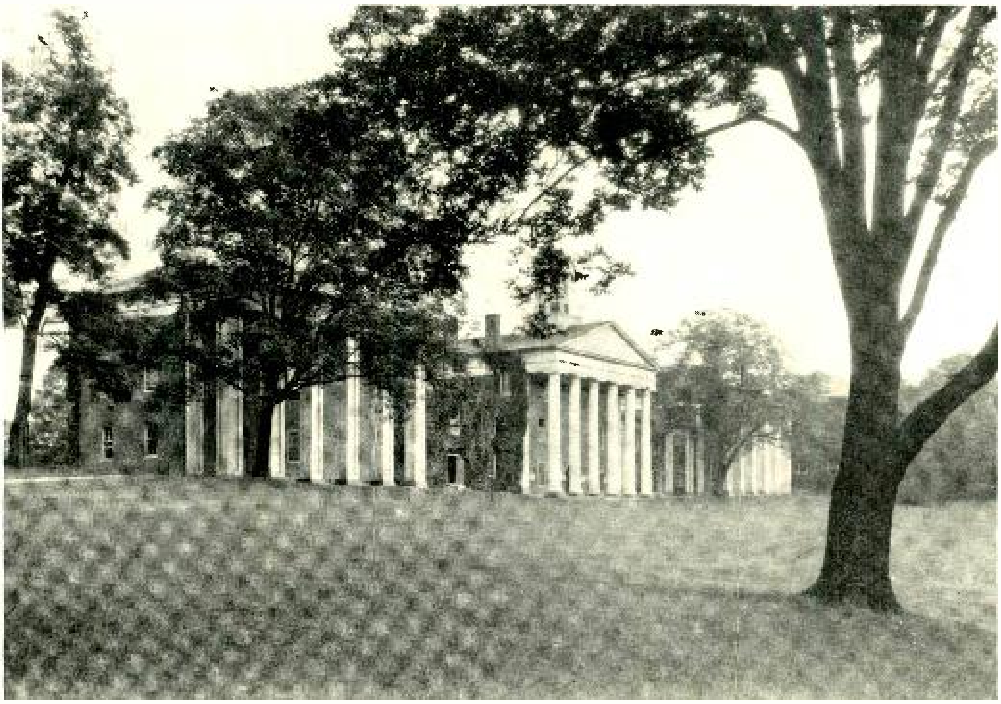
of Massachusetts, of which commonwealth Maine was then a district, to put his name to the covering act, its charter was eventually granted in 1794 and the college named for James Bowdoin, a former governor. Thirty years later it graduated Franklin Pierce, fourteenth President of the United States. In the following year, 1825, Hawthorne and Longfellow emerged from its doors, and in '77 the Peary who was to reach the Pole.

From across the continent, the University of California has representatives in M. B. Kerr and W. B. Warren. Thence also come W. B. Snow and B. R. Cole, graduates of the institution which Leland Stanford, capitalist, governor and senator, caused to be reared in the Santa Clara Valley in memory of his son. Stanford the elder dreamed magnificently. Today the university which he founded has enrollment of more than four thousand students and de Ballore, laureate of the Institut de France, gives it special mention in the Index Generalis as offering scientific training of the highest type. Occidental College, set down in the purlieus of Los Angeles, gives us R. G. Watling; the California Institute of Technology, A. R. Kemp; and Pomona, P. W. Stroud.

Ohio, Oklahoma, Oregon – to consider again widely separated states. Twelve institutions, within the first of these states alone, have graduated various members of our staff. From the University of Oklahoma, under patronage younger in statehood, are E. B. Ferrell and J. R. Reeves, now assigned to our radio stations on the Jersey coast. Oregon's University has alumni in F. E. Haworth and C. O. Wells, both of our Research Department. Mid-century, at Tualatin Plains in this same state, Pacific University was founded, as were so many others, under clerical auspices; H. G. Romig, Inspection Engineering, is of its class of '21. And from the college in western Portland to which Simeon Reed and his wife, Massachusetts pioneers of 1854, left their name and fortune, we have R. M. Bozorth, Research also.

So on to increasing numbers and to references even epic goes the story of our personnel and the American sources of its training. In the very listing of the latter ring the echoes of the nation's history from its nascency. Institutions that bear names self-explaining: George Washington, Washington and Jefferson, Washington and Lee, Harvard, Yale, Cornell, John Marshall, Princeton, Gettysburg, Lafayette; those that are known for their technological standing: Massachusetts Institute, Chicago, Johns Hopkins, Stevens; founded by various sects: Notre Dame, Brigham Young, Trinity; the universities of our various states; and marking our modern cities: Pittsburg, Cincinnati, New York—all of these and others are represented. An anthology could be written but my space is in pages. There are yet other countries.

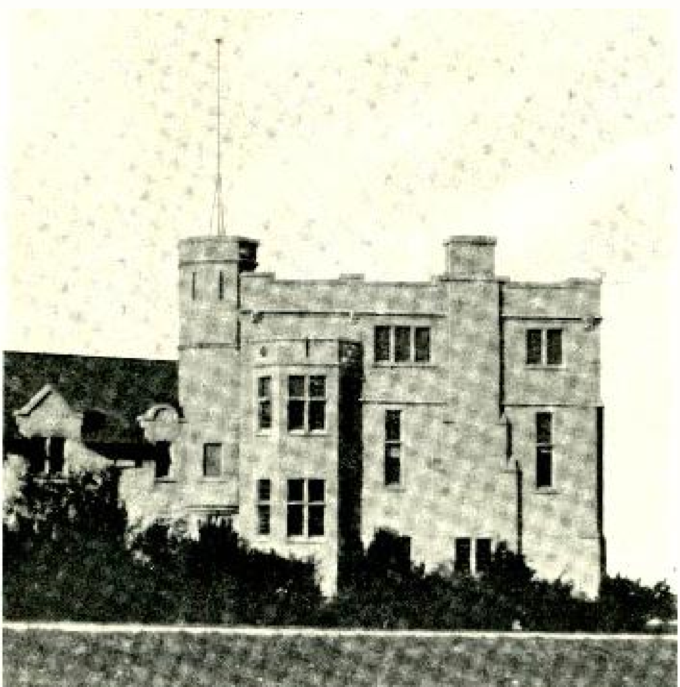
Northward, in the City of Saskatoon on the great plains of Canada, is the University of Saskatchewan. New, in a newly developing country, it began in 1907 to raise its buildings of native stone. Oxford stretched hands across the sea and granted it affiliation. To the opening of its hall of chemistry in 1924 came Baly of Liverpool and Irvine of St. Andrew's to present a discussion of the former's work in photosynthesis. Heri-



Washington and Lee University

tage it has; what may not vision do? On the staff of our Chemical Laboratory is E. J. Murphy, Saskatchewan '18.

Graduates of other and older Canadian learning are with us: from Toronto, J. L. Hogg; from McGill in Montreal, T. P. Neville. Across in New Brunswick, Mount Allison University, founded in 1862 at Sackville near Chignecto Bay, brings M. H. Lindsay; New Brunswick itself, J. O. McNally. From Acadia University, at Wolfville in Evangeline's country, Nova Scotia contributes.



Qu'Appelle Hall, University of Saskatchewan, Saskatoon, Canada

Non-stop to France, to a university probably the oldest in the world: that of Paris. Vaguely set in the twelfth century, the date of its actual beginning remains unknown. A revival of interest in learning had come with the Crusades. The schools of the great cathedral towns were replacing the monasteries as seats of culture. Paris had recognizably, as we say today, the advantage of central location. The fame of Abelard, its great scholar, had gone afar. Thus tendencies converged towards an event and the year 1200 records the first chartering of the Paris University by royal grant of Philippe-Auguste. Relatively soon, questions of jurisdiction came up for hearing. A student foray, so ageless is instinct, had resulted in harm to the keeper of an inn. Lectures were suspended for two years. Then by papal bull of Gregory IX were established the controlling rights of the masters, some of which are even today in practice. Centuries later, the storm of the French Revolution checked the university's growth until on France and its institutions Napoleon laid reorganizing hand. Old though it is, the university is yet new enough to include in its curricula courses in radio-activity, aviation and optics. L. A. LeBaut of our Physical Laboratory comes from it.

In our Patent Department, A. J.

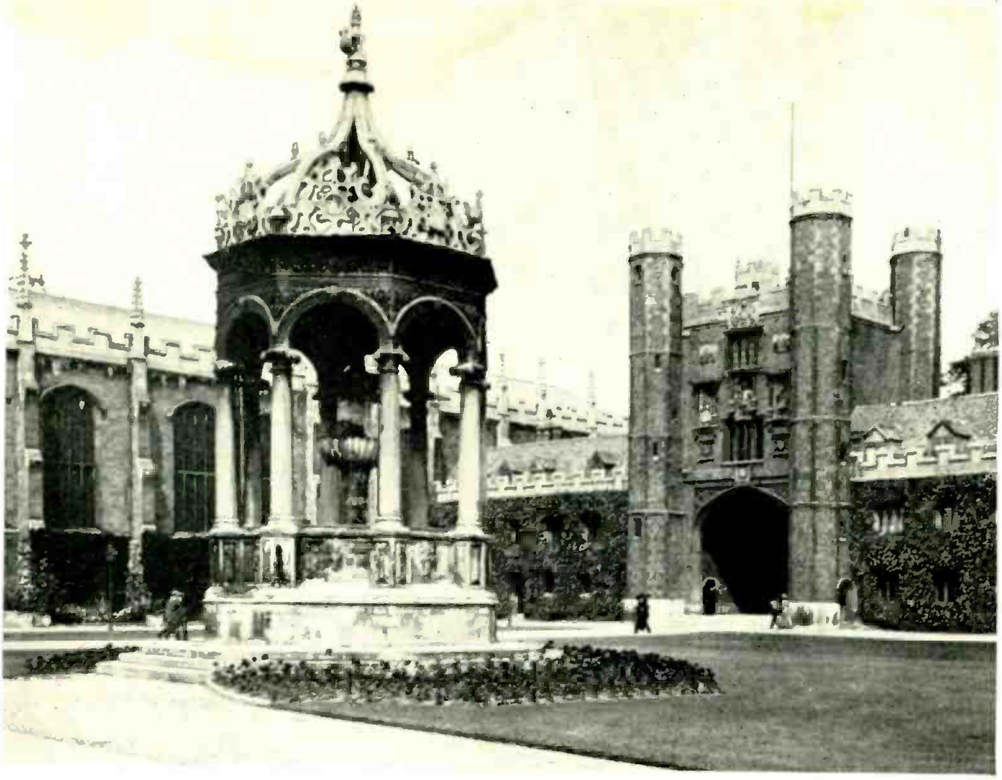
Michel comes from another French university: Nancy, in the town of that name on the Meurthe. To Stanislas Leszczynski, dethroned as King of Poland in 1735 and appeased with the Duchies of Lorraine and Bar, the university owes much of its development and the town its beauty. The former dates its inception but four centuries after Paris. Its faculties had at first covered only theology and the arts. In 1582 law was added and later, letters and science. From Charles the Bold to von Hindenburg, wars of attrition have swept around Nancy. Yet in 1926 its university was providing tuition to more than two thousand students.

Of like early origin is the present-day University of Grenoble. Grenoble lies to the southeast of France, in a center noted for its development in hydro-electric engineering. Scenically its site is superb: to the north are the mountains of the Grande Chartreuse and within sight to the east, the Maritime Alps; through it runs the Isere. Significant of Grenoble's history, a series of fortresses rise high above the town. Strange admixture of his time, warrior and scholar, Francis I gave it impetus as a place of learning. A member of our Systems Development Department, R. A. Leconte, holds the university's degree of E.E.

Elsewhere, too, in these earlier centuries, learning was beginning to stir. Continental upheavals were felt in England, despite the protecting seas. As in France, the mid-Crusades saw the first lighting of the torch. Before the flare was dimmed, Oxford and Cambridge had birth.

It was the nineteenth century, however, that marked the spread of the university college through the British Isles. Industrial development to the north, bringing population in its wake, made Oxford and Cambridge remote. So arose, under the sagacious if staid Victoria, the Universities of Liverpool, Manchester, Durham. At Newcastle-upon-Tyne, Armstrong College, a constituent of Durham, typifies this expansion. Brought into being in 1871 through the efforts of the North of England Institute of Mining and Mechanical Engineers, its first quarters were an upper floor in the Coal

Students' Hostel, University of the Witwatersrand, Johannesburg, South Africa



Trinity Court and Gate, Cambridge University, Cambridge, England

Trade offices. In buildings covering city squares, widely technical training is now afforded. Its president is Grey of Fallodon. Armstrong graduated F. C. Willis, Apparatus Development; Manchester, the Wilsons, W. and R. H. At Oxford R. V. L. Hartley was a Rhodes Scholar coming from the University of Utah; L. E. Krohn, Research also, is from the University of London. From the National University of Ireland, constituted of Dublin College and Queen's at Cork and Galway, we have J. G. McIvor, Systems Development.

Across the North Sea to Delft in the Netherlands, around the Skagerrak and Kattegat to Copenhagen on the island of Zeeland, to Lund and Boras in Sweden, to Christiania nowadays Oslo—the technical institutes of all of these places are represented in our present personnel, although the beginnings of the institutions themselves are in instances dim in saga. So down the face of Europe to the ancient port of Genoa, claimant of Columbus—from a college of its university comes F. A. Bonomi, Manual Switching.

Thence to Asia Minor, the country east of the Aegean. In the military organization of the East Roman Empire, Anatolia was the name given to one of the three themes or provinces of Phrygia. Times much later, it signified a division of the Empire of the Turks. The currents of history back-wash strangely. Under a Massachusetts charter, the American Board of Foreign Missions established in 1886 at Marsovan, Turkey, an institution to provide in that land advancement in learning—in name Anatolia College. The college followed naturally its American prototypes, drawing its faculty in part from Princeton, Williams, Iowa and Middlebury. Even this college is represented among us: by G. H. Paelian. An area turbulent for centuries, Anatolia is not yet quiet. With the World War came the closing of the college. It remains closed. The Turkish Republic is very young.

South Africa, to most of us, seems as far off as Cathay. About its university colleges we may not even have wondered. Yet there are among others those of Cape Town, Rhodes, Stellenbosch and the Witwatersrand. Outgrowth of the Kimberly Technical Institute and the South African School of Mines, the University of the Witwatersrand is located in Johannesburg, on a ridge a mile above the sea. Previously under Boer rule, Johannesburg was the center of the Uitlander agitation which marked the turn of the century and ended in the Transvaal War and occupation by the colonizing British. Thus does learning always expand with empire and the finding of rich fields of ore. It is a long route from the Transvaal to a building beside the Hudson. But we have on our chemical staff W. E. Campbell, Witwatersrand '23.

In one of the more brilliant passages of his classic treatise on the "Idea of a University," John Henry Newman inserts the terse conclusion: "It is a place to which a thousand schools make contribution." I borrow the sentence to describe our Laboratories.

A Compact Direct-Current Amplifier

By H. C. CURL
Apparatus Development Department

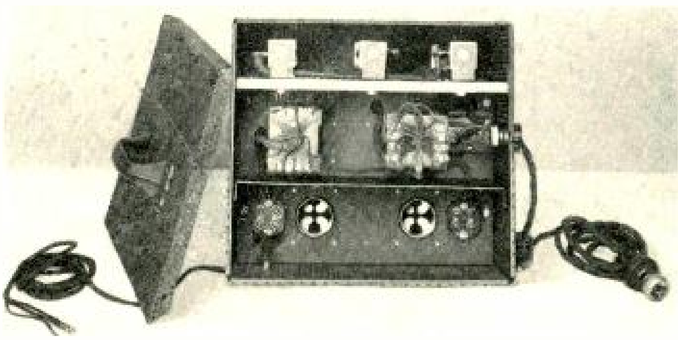
FOR some time there has been available to radio users an amplifier—the 6025-B—designed to form the last stage of a radio receiving system and to draw its power from a source of sixty-cycle alternating current. Only direct current is available in many parts of metropolitan areas, particularly in hotels and large apartment houses. Following the favorable reception given by the public to the 6025-B amplifier, the Laboratories took up the development of an amplifier of similar operating characteristics which should draw its power from a 115-volt direct-current circuit. The result is the 6031-A amplifier, now made by the Western Electric Company and sold by Graybar Electric Company.

Direct-current power supply simplified the design of this amplifier by removing the need for rectification, but at the same time it introduced a difficulty since it prevented the possibility of stepping up the available line voltage. It thereby restricted plate potential, and made it necessary for adequate power output to use a tube of low internal impedance. For that characteristic the 104-D tube was chosen; two of these tubes are used, connected in a push-pull circuit.

Current for the filaments, which are in series, is drawn from the direct-current line, being held to the proper value by series resistances. This current is one ampere, and represents power consumption of 115 watts. Since most of this power is dissipated in the resistances, they are of heat-resisting construction and are mounted on a panel of heat-insulating material. The box containing the apparatus is of perforated metal to provide ventilation and so to aid in keeping the temperature at a safe value.

The 6031-A amplifier is enclosed in a perforated steel box and is provided with cords for connection to the radio receiver and to the electric-lighting circuit

It will be noted from the circuit diagram that two of the series resistances R1 and R2 are connected at the positive side of the vacuum-tube filaments, and the other resistance R3 at the negative side. The drop in voltage in this resistance provides a negative grid potential of about fifteen volts for one tube and twenty volts for the other. There is a like difference between the plate potentials of the

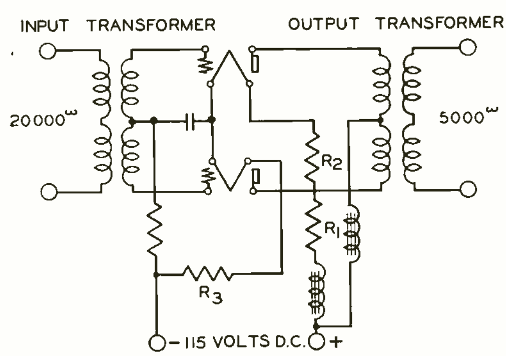


The amplifier as here shown (without tubes) is coded as the 31-A Amplifier

tubes, due to the voltage drop in the filament of the second tube. These unequal voltages on the grids and on the plates of the two push-pull tubes introduce an unbalance in the operating characteristics which could be avoided at the expense of some additional apparatus. For the 104-D vacuum tube, the value of grid voltage to give maximum power output is not so critical as it would be for a tube having a higher amplification factor, and the additional expense is not justified.

It has been pointed out that one of the limits of the output power obtainable from this amplifier is set by the plate potential available. This potential is not the full voltage of the power line, but is less than that value by the fall-of-potential across the resistance R3. Were negative bias on the grids to be secured from a "C" battery, the drop in R3 might have been added to the plate potential with an appreciable gain in the load-carrying capacity of the amplifier. A battery, however, in such an amplifier was objectionable from the standpoint of space and design requirements; a more serious objection was the inappropriateness of using a battery in a piece of apparatus intended to end maintenance and replacement cares.

Available power sources yield currents which although fairly smooth are not entirely free from voltage variations due to commutator ripple and to various other causes. As far as the plate circuit is concerned, these fluctuations are unimportant; acting in opposite directions through the primary winding of the output coil, they do not affect the secondary winding. A small amount of filtering is required for the filament and grid circuits; it



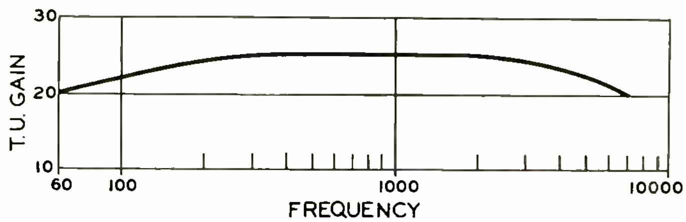
Circuit of the 6031-A amplifier

is provided by the retardation coil in the filament circuit and the resistance-and-condenser combination in the grid circuit.

The load-carrying capacity of the 6031-A amplifier is approximately thirteen transmission units above zero level.* While this is about seven transmission units less than the load-carrying capacity of the 6025-B amplifier, it furnishes sufficient volume without appreciable distortion for the average living room when used in connection with a 540-AW loudspeaker. The amplification of the 6031-A amplifier is about twenty-five transmission units under usual operating conditions. This is about five transmission units less than the amplification of the 6025-B amplifier. Considering, however, the difference in output capacity, it will be seen that at full load each amplifier requires about the same input level. The 6031-A amplifier, like the 6025-B, is designed to be operated from a radio receiver having one stage of audio-frequency amplification after the detector. No volume-control is provided, as this adjustment can readily be made in the radio-receiver circuit.

One point which might be forgotten when using this amplifier is that the attachment plug must be connected to the house lighting circuit with the proper polarity. If the negative side of the house lighting circuit is connected to the positive power terminal of the amplifier, the tubes will light but nothing will be heard in the output of the amplifier, since the plates will be negative to the filament.

* *Zero level has been assumed as .006 watt.*



Characteristic performance-curve of the 6031-A amplifier

A Practical Short-Wave Oscillator

By C. R. ENGLUND
Research Department

SHORT waves, by which is meant waves under one hundred meters and corresponding to frequencies of over three million cycles per second, have been attracting more and more interest and attention during recent years. The time seemed opportune, therefore, for an investigation of the short-wave-length limit of vacuum-tube oscillators, the only known generators of continuous trains of such waves. As considerable work had already been done by others the purpose here was to pick up and carry on the threads of past researches with the hope of more definitely settling the question. During the past year, therefore, work has been carried on which has not only attained its objectives by determining the limitations of vacuum-tube oscillators, but has actually demonstrated the sending and receiving of waves of three and one-half to four meters over distances of one mile.

In the production of very high frequency oscillations two distinct difficulties arise. These may perhaps be better appreciated by a consideration of a mechanical analogy. Picture for example a short section of a roller coaster such as is shown in Figure 1.

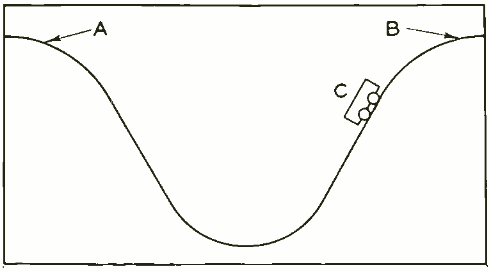
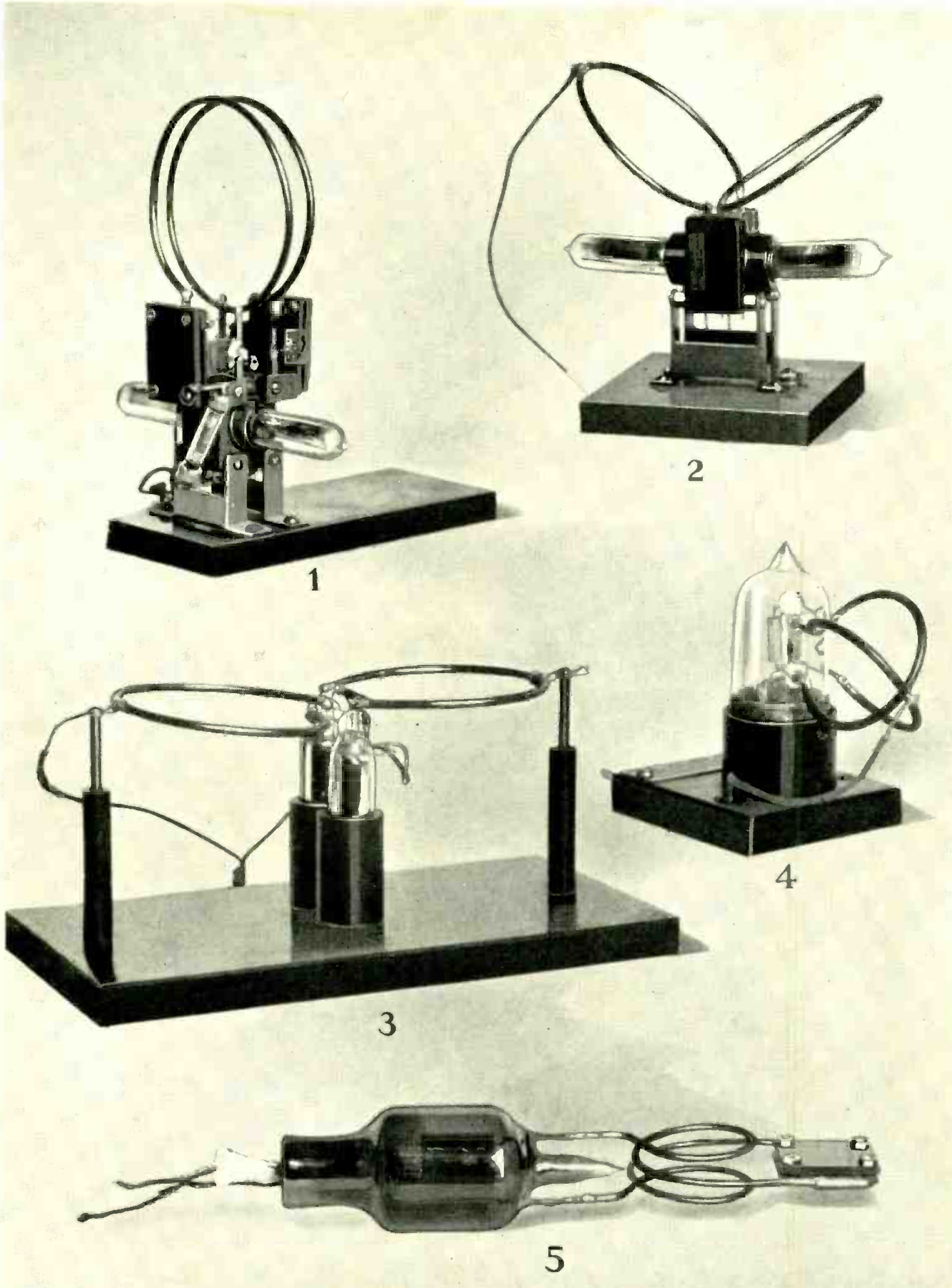


Figure 1

The car C starting from the point A would roll down the slope pulled by gravity and then due to momentum it had acquired would rise up the opposite slope toward B. Because of the frictional losses of the car, however, it would not quite reach B. But let us assume that some means has been found to give it the push needed to bring the car up to the level from which it started. With only this slight periodical addition of energy the car will now oscillate back and forth indefinitely. This push applied at the proper time corresponds to the action of the vacuum tube oscillator in an electrical circuit.

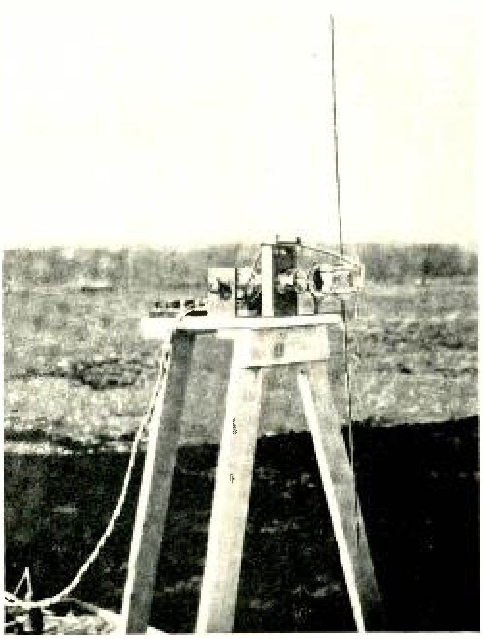
The time for one complete oscillation of the ordinary roller coaster would be relatively long. To shorten it the track would have to be made steeper and shorter. In doing this, however, the point is soon reached when it becomes impossible to make the track shorter and have room for any sort of car. In other words, there is a certain, but more or less indefinite, limit below which the time of oscillation can not be shortened. The limitation in this case is due to the fixed value of the gravitational constant "g" which directly determines the acceleration of the car



The metamorphosis of the short-wave oscillator. Figures show its development from a two-tube push-pull outfit to a single tube with two sets of electrodes down the slope, and to the size restrictions, structural features if you will, of materials and tools.

Turning back now to the radio waves, similar factors also limit the rapidity of oscillations. These are the size of the equipment used to obtain the oscillations—in particular the magnitude of the inductance and capacity. For as the car of the roller coaster coasts down one side of the slope and up the other, so the energy of the electric current oscillates back and forth from inductance to capacity in its resonant circuit. The smaller the inductance and capacity, the more rapid will be the oscillations. Here lies the difficulty, however, for capacities and inductances can not be reduced indefinitely. Just a straight piece of wire has an inductance—small but of appreciable amount, and between the tube electrodes there also exists a capacitance. Thus in the effort to get oscillations of greater and greater frequency the point is reached when the capacitance and inductance are reduced to merely that between the tube electrodes and in the necessary connecting leads.

Receiver



Transmitter

It was found that the shortest wave lengths could be obtained by using two tubes with a push-pull type of circuit. The progress of the search for shorter and shorter waves is well indicated by the accompanying illustrations. Blazed on the one hand by simplification of the circuit and on the other by shortening of the connections, the trail led past the use of unbased tubes to the placing of two tube elements in one bulb. This arrangement finally obtained a wave of 1.05 meters but the price was the loss of adjustment. Without this, practical reception would be difficult, and to regain adjustability it was necessary to return to two meters.

When an effort at heterodyne reception on this wave length was made, however, another serious difficulty developed. Two meters correspond to a frequency of 150,000,000 cycles. To get a one thousand cycle beat for heterodyne reception, a heterodyning wave differing from this by only a thousand cycles is required. This means that the frequency of oscillation must be held to one part in 150,000, a degree of stability impossible to secure with the relatively simple circuits used. As the heterodyne frequency passed through the audible beat range only a hiss was heard. To be able to heterodyne the received wave satisfactorily without adding expensive circuit complications, it was necessary to go above three meters which was stepping back into the region where a single tube was feasible.

It was found possible to obtain a normal power output, with frequency control and without departing greatly from standard vacuum tube construction, at 3.7 meters. This was a single-tube oscillator and was used, as the illustrations show, for radio transmission over short distances. With a double-tube connection and an improved design of tubes there is no doubt that this can be carried to three meters. This wave length corresponds to a frequency one hundred times greater than the normal radio broadcast band and may be taken as the present practical limit.

The System's Newest Associated Company

The New Jersey Bell Telephone Company, which begins its career October first, has been formed by combining the New Jersey properties of the New York Telephone Company and the Delaware and Atlantic Telegraph and Telephone Company. It serves approximately 572,000 *telephones. Chester I. Barnard is President with G. W. McRae, Vice-President and General Manager; Frankland Briggs, Vice-President and General Counsel; C. F. Brisbin, Vice-President in charge of Public Relations and Personnel; S. C. Ormsbee, Secretary and Treasurer and H. A. Trax, General Auditor.*

Headquarters of the new organization are at 1060 *Broad Street, Newark, while a new twenty-story building to house the Company's administrative offices is under construction.*

Sheet Insulating Materials

By J. M. WILSON

TO terminate ten thousand telephone lines within convenient reach of an operator has taxed the ingenuity of the designers of telephone apparatus. In the multiple of a "B" switchboard—a space five feet wide and two and a half feet high—are thirty-one thousand contacts, each insulated from the others. This achievement is possible only by the most judicious use of the space available; it has been accomplished by making the jacks as compact as is commercially possible. In the development of this and other apparatus a careful study has been made of the sheet material which insulates the current-carrying parts.

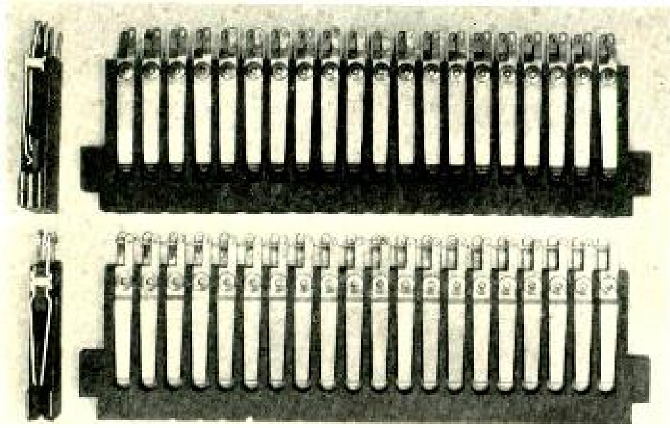
Of the properties of insulators, the most important in telephone work is electrical leakage across and through the material. This is in contrast to the requirements in power work, where dielectric strength is generally the determining factor and where the material must not sustain an arc should flash-over occur. The reason for this contrast is that telephone apparatus is operated at low voltages, and by relatively feeble currents whose loss through leakage must be reduced as far as possible.

Broadly, an insulating material is one which does not conduct electric current. This, of course, is true only in the case of an ideal insulator. For telephone engineering, it is more accurate to consider an insulator as being a very inefficient conductor but a conductor nevertheless. It follows that if we inquire as to the resistance of an insulating material, we are doing nothing more than determining whether or not the resistance is sufficiently high to prevent current leakage of an objectionable amount. Further, we will find that this resistance is decidedly variable, depending largely on the atmospheric conditions to which the material has been exposed, not only at the time of the test but also during some hours preceding the test.

The insulation resistance of all materials drops rapidly during humid weather, in most cases to a small fraction of its original value when dry. Because of this only those materials which are least affected by humidity can be considered for application in telephone apparatus, where there are in every circuit a great number of parallel leakage paths.

The three insulating materials most widely used in sheet form for the construction of telephone apparatus are hard rubber, phenol fibre, and vulcanized fibre. Other materials such as mica, micanite and varnished fabric are used to some extent.

Hard rubber, as everyone knows, is an excellent insulator. It can be made in various grades. Of these some are suitable for difficult machining operations such as in the strip mountings for jacks and lamp sockets; others are suitable for spring assembles, graphically known as "pileups." Hard rubber is, however, not without some objectionable qualities. Spring assemblies using insulators of hard rubber are difficult to keep tight, and repeated tightening of the mounting screws avails but temporarily. Unless the clamping areas are relatively large,



Hard Rubber Mounting Strips for Jacks and Lamp Sockets

so that the unit pressure on the insulators is low, the hard rubber gradually flows from under the clamping surfaces, resulting in loosening of the assembly. This yielding is commonly called "cold flow"; and as the term implies, the hard rubber behaves not unlike an extremely viscous liquid. Cold flow takes place at ordinary temperatures, but becomes very noticeable above one hundred degrees Fahrenheit—a temperature which may be encountered in telephone service.

Another very noticeable limitation to the use of hard rubber is its marked deterioration when exposed to light. This deterioration progresses at a rate depending upon the nature and the strength of the light, and therefore strong sunlight is particularly harmful. The effect is studied in the laboratory by exposing the specimens to direct sunlight; the result, however, can be very closely duplicated by exposing the samples to ultra-violet rays. This deterioration appears to be mostly on the surface but it results in a decided lowering of resistance when the rubber is subsequently subjected to the higher humidities. It is accompanied by discoloration, in which the exposed surface turns greenish-yellow.

These two objections to the use of hard rubber, particularly its tendency to cold flow, led many years ago to an extensive search for better materials. Of those studied, phenol fibre proved to be the most satisfactory substitute, and its use has increased since it was first employed in telephone apparatus about thirteen years ago.

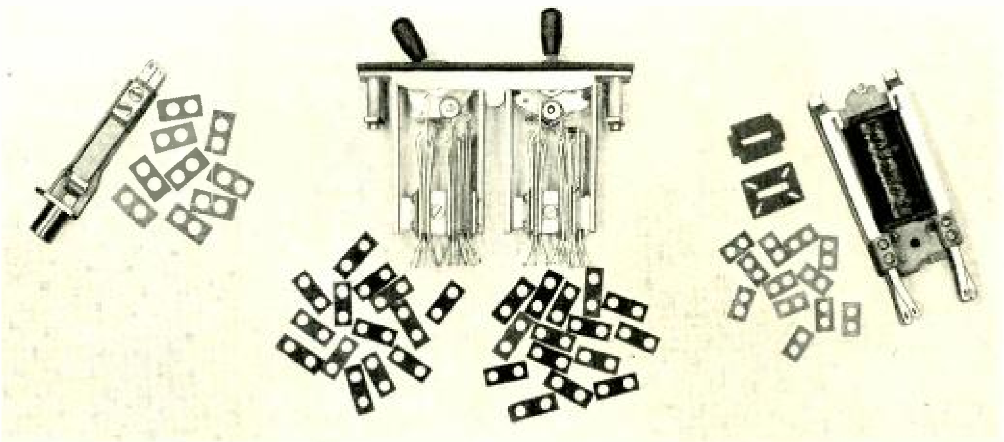
Phenol fibre is a laminated product made in convenient thicknesses from sheets of paper treated with a varnish made from phenol and formaldehyde. The treated sheets are stacked to the desired thicknesses and cured into a solid mass by heat and pressure. A number of phenol fibres are marketed under trade names, such as Bakelite-Dilecto, Formica, Micarta, Condensite Celoron, Bakelite-Duresto and Phenolite. The varnish used in the manufacture of all these products is obtained from the Bakelite Corporation of America. Many of the commercial products of this type have been investigated in the laboratory and a number have been approved for use in telephone apparatus.

Two kinds of phenol fibre are used by the Manufacturing Department of the Western Electric Company. Grade 1, generally used for spring assemblies, has the greater varnish content. This results in a more costly material than Grade 2, but one of somewhat better electrical properties. However, it is slightly more brittle and does not withstand most machining operations as well. The higher varnish content of Grade 1 is due largely to the use of cotton-fibre paper which is more absorbant than the wood-pulp paper used in Grade 2. It is very difficult for the unaided eye to distinguish material of one grade from the other. This was a source of confusion in the stock-room until the scheme was adopted of making up all Grade 2 material with a brown body and black surface, and making all Grade 1 material of solid color throughout, either brown or black.

The insulation resistance of Grade 1 phenol fibre is not as high as that of hard rubber when both are new. Due to deterioration, however, hard rubber soon loses this advantage; while the phenol fibre stands up so well that after a short time its insulation resistance is generally the higher.

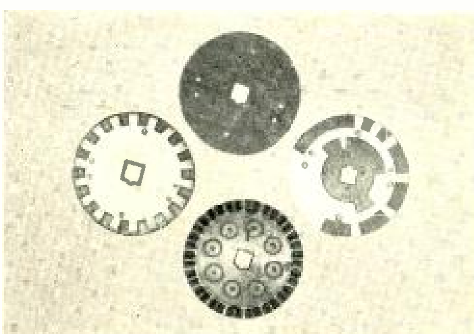
Cold flow is practically absent in phenol fibre; it is this fact which has had most to do with its wide application as a substitute for hard rubber. The very slight change in dimensions which does occur is essentially a shrinkage due to the drying out of the material and the loss of gaseous products. For all but the most exacting uses this shrinkage can be considered negligible with Grade 1 material. In Grade 2, shrinkage is more pronounced and for that reason this material cannot be depended upon to maintain delicate adjustments.

Neither grade of phenol fibre is as readily machined as is hard rubber. Before punch operations it is generally necessary to heat phenol fibre to reduce objectionable brittleness. Drilling and milling operations can be carried out with little difficulty, if they are done in a direction perpendicular to the laminations, otherwise there is a marked tendency for the



Phenol Fibre Punchings for Spring Assemblies and Spool Heads material to split. Considerable gain in strength and toughness can be obtained by using phenol fabric, a more expensive material with a base of cloth instead of paper. As would be expected it withstands punching better than phenol fibre.

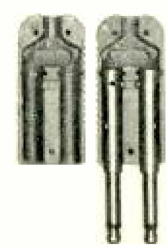
Vulcanized fibre — also known as "ordinary" fibre, "horn" fibre, and "hard" fibre—is used in large quantities. The term "vulcanized" is a misnomer, since heat and sulphur are not used in its manufacture as in the preparation of hard rubber, nor is it cured by heat and pressure as is phenol fibre. Instead, it is made from a rag-stock paper which has been treated with zinc chloride to soften the cellulose fibres. This facilitates the matting of the fibres when the treated paper is wound on a drum. After a sufficient amount has been rolled up to give the desired thickness the wrapping is cut from the drum and flattened into a sheet. When the chemical action has been carried to the desired extent the sheet undergoes a series of washings in water to remove as much of the zinc chloride as possible. After being thoroughly air-dried the sheet is rolled and pressed. This operation toughens the fibre and improves its surface. Vulcanized fibre is generally produced in one of three colors, natural (gray), red or black. The latter colors are obtained by the addition of dyes to the zinc-chloride solution.



Sequence Switch Cam Assemblies Using Phenol Fibre Insulators

The outstanding characteristics of vulcanized fibre which have resulted in its wide use are toughness, adaptability to machine processes, and low cost. Its strength and toughness make it the most desirable insulating material for conditions of severe wear and mechanical abuse.

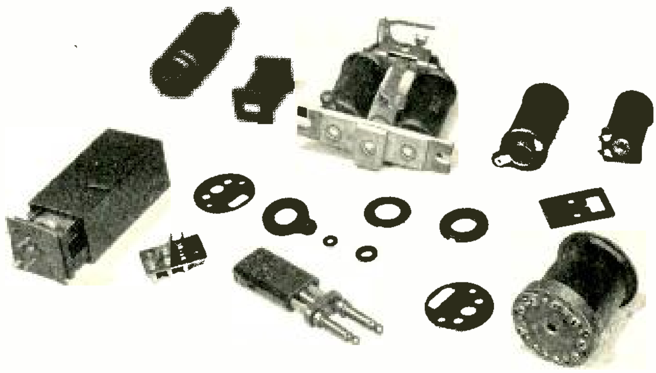
Unfortunately, there are many places where vulcanized fibre cannot be used owing to its tendency to cause corrosion of current-carrying parts. This is the result of electrolytic action involving the traces* of zinc chloride which remain in the fibre. In the past we have investigated a number of so-called non-corrosive vulcanized fibres. Although great care had been used to reduce the residue of zinc chloride to a minimum it appears to be commercially impossible to eliminate the last trace, and only a trace is necessary to restrict greatly the use of this material. Suffice it to say, that we are still looking for a vulcanized fibre which will be truly non-corrosive.



Plug Shell Machined from Sheet Phenol Fibre

** By specification the chlorine content is limited to a maximum of one-tenth of one per cent.*

Another serious objection to the use of vulcanized fibre is that, under high humidity, considerable swelling and warping occur. Impregnation and surface finishes help, but generally their protection is limited to those apparatus parts where ample allowance for dimensional changes may be made. As would be expected with a material having so marked an affinity for moisture, its insulation is so low under adverse weather conditions, that it is generally considered unsatisfactory for insulating terminals in talking circuits.



Sheet Vulcanized Fibre Parts, All Punchings Except the Plug Shell

Each year a large number of new insulating materials are investigated in our General Development Laboratory. Some are brought to our attention by inventors, others by promoters and of a few we first learn in the technical magazines. In spite of the most glowing promises by their backers such materials rarely prove satisfactory for use in telephone apparatus. Frequently the original samples look interesting; when we call for further samples, we sometimes find that the favorable showing in the early tests was pure "beginner's luck." Being made under uncontrolled conditions—in a boarding-house kitchen, for example, or in a hall bedroom—the first sample of the material cannot be duplicated.

No matter what its source, every proposed material is carefully considered since it may prove suitable for some special purpose, if not for widest application. In the investigation of these materials, as many short-cuts are taken as possible. Experience for example has shown that most new materials fail to meet our exacting requirements for insulation resistance; consequently the work is greatly shortened by determining first the insulation resistance of a new material under adverse atmospheric conditions. If these preliminary tests show promise the investigation is then broadened to include other properties, both electrical and mechanical. Due consideration is also given to the material's suitability to established methods of manufacture, to its cost, and to the reliability of its sources of supply. It would be difficult if not impossible to assign to all these properties numerical values which must be attained by a new material before it could be rated as suitable. As an alternative, our practice is to determine how each new material compares with the existing material for which it is a proposed substitute. In this comparison particular attention is paid to properties in which improvement is desirable, so that the changes recommended will be in the direction of better materials for the plant of the Bell System.

News of the Month

Among recent accessions to the Historical Museum are two samples of telephone cable made before the present paper-insulated lead-covered cable was introduced. One sample is a cable of cotton-insulated wires, rosin-oil filled, with a tinfoil cover and wrapped on the outside with jute. This cable was installed in Chestnut Street, Philadelphia, in 1886. The other sample is a cable with cotton-insulated wires, rosin-oil filled, and lead covered; it includes the first splice made in a lead-covered cable in the city of Philadelphia, 1889. These samples were presented to the Historical Museum by James Cunningham of the Bell Telephone Company of Pennsylvania.

* * *

S. P. Grace addressed the fifth annual convention of the Telephone Association of New Hampshire at Laconia, New Hampshire, on September 8. He told of the work of the Laboratories, and accompanied his address with a demonstration of an audiometer and with records of speech and music, natural, inverted and filtered. On September 13 he spoke again on the Laboratories and its work, to the Maine State Telephone Association at Portland, Maine, and gave the demonstration also. At both meetings Mr. Grace showed the film, "The Magic of Communication."

On August 22 Mr. Grace addressed the Business Men's Association at Jamestown, New York, on telephone and other recent developments of the Laboratories. The manufacturers present, many of whom have laboratories in their own establishments, showed the keenest interest in our work.

Research

E. E. Schumacher recently spent a few days at Hawthorne in connection with the development of cable sheathing.

F. G. Brickwedde, in charge of low temperature work at the Bureau of Standards, visited the Laboratories on August twenty-third.

H. H. Lowry, E. E. Schumacher, A. C. Walker, J. A. Lee and A. N. Gray attended a meeting of the American Chemical Society held at Detroit from September 6th to 9th.

R. E. Waterman and C. O. Wells of the Research Department and C. H. Amadon and L. V. Lodge of the Outside Plant Development Department recently returned from a month's stay at Brookline, Mass., where they were interested in wood preservation experiments.

F. F. Farnsworth, E. E. Schumacher and J. H. White attended the Convention of the American Society for Steel Treating held at Detroit in September.

During the week of September twelfth several groups from the Chemical Laboratories were at Hawthorne in connection with different phases of their work. R. R. Williams, A. R. Kemp, J. A. Lee, and A. N. Gray were interested in submarine cable and rubber covered wire, F. F. Farnsworth and J. T. Acker in aluminum diaphragms, and Messrs. Williams and Farnsworth in enameled wire.

A. A. CLOKEY returned to the Laboratories on September first from a three months' trip abroad. His work on the New York-Azores-Emden cable took him to Emden, Berlin and Horta. He also visited London and Penzance in connection with proposed apparatus for the New York-Bay Roberts-Penzance cable.

INSPECTION

DURING OCTOBER H. G. Eddy, W. C. Miller, R. M. Moody and P. S. Olmstead were in attendance at Inspection Survey Conferences held at Hawthorne.

W. A. SHEWHART attended the Colloquium Lectures of the American Mathematical Society and the joint meetings of the American Mathematical Society and the American Mathematical Association, which were held at Madison, Wisconsin, during the week of September 5. On September 7, he delivered an illustrated lecture on "Some Modern Developments in the Method of Analyzing Scientific and Engineering Data." Mr. Shewhart visited at the University of Illinois, conferring with various people who were interested in the theory of sampling. While there, he gave a paper before the Mathematics and Physics Colloquium upon the subject he discussed at Madison.

D. A. QUARLES and H. F. DODGE were in attendance at a Conference on Quality Rating of Manufactured Product held at Hawthorne during the week of August 22.

DURING the week of September 5, J. A. St. Clair, Local Field Engineer for the Inspection Department at Atlanta, was in Gulfport, Mississippi, and New Orleans, Louisiana, on complaint investigation work in his territory.

E. F. HELBING was at the factory of the Buffalo Gasoline Motor Company at Buffalo in connection with the new type "R" gasoline engine.

P. B. ALMQUIST, Local Field Engineer at San Francisco, was in Portland, Seattle, and Spokane recently in connection with regular field work in his territory.

E. G. D. PATERSON visited the factory of the Corning Glass Company at Corning, New York, to investigate manufacturing processes on glass insulators.

OUTSIDE PLANT DEVELOPMENT

E. M. HONAN was in New Haven with engineers of the American Telephone and Telegraph Company and of the Southern New England Telephone Company, making experimental installations of attachments for drop wire.

C. D. HOCKER and W. A. HYDE visited Schenectady and Pittsburgh to study metal corrosion and glass insulator problems. Mr. Hyde was also in Muncie, Indiana, during August in connection with glass insulator development work.

L. V. LODGE was in Brookline, Massachusetts, conducting timber preservation experiments.

S. C. MILLER visited Madison and Minneapolis in connection with timber development studies.

C. S. GORDON and B. A. MERRICK were in Roslyn, Long Island, making tests of devices for splicing cable under tension. Mr. Gordon was in Philadelphia later, conducting field experiments with drop wire attachments.

Systems Development

W. L. Dodge spent several days at Boston on an investigation of sender operation in panel dial offices.

P. T. Slattery visited Scranton, in connection with the installation of repeater equipment.

R. H. Kreider spent a week at Hawthorne making arrangements for the manufacture of equipment intended for use in field trials of new developments in step-by-step P. B. X. design.

Various angles relating to the substitution of ebony-asbestos compound for slate in power boards were discussed with the General Electric Company's engineers by R. L. Lunsford and F. T. Forster during a recent visit to Schenectady. At the same time the new Schenectady step-by-step dial equipment was inspected in connection with a study of the application of the new aluminum finishes to power-room equipment.

The 551-A and 551-B P.B.X. equipments have replaced the 550-C equipments and V. I. Cruser is visiting Hawthorne to assist in connection with the new manufacturing program now under way.

W. F. Malone visited Pittsburgh, Ligonier, Bedford and Harrisburg, Pennsylvania, to inspect special equipment being installed for use in studies of broadcasting over cable pairs between New York and Pittsburgh. F. S. Entz, A. E. Bachelet and R. A. Leconte have also spent several days at the Philadelphia Instrument Shop and at Pittsburgh and other Pennsylvania points making tests on this equipment.

E. P. Bancroft and C. E. White spent several weeks in San Francisco and Chicago, respectively, testing experimental installations of constant-frequency current-supply sets which are being tried out with picture-transmission systems as a replacing medium for the synchronizing channels now in use.

R. B. Steele has recently been conducting tests at El Paso, Texas, on a trial installation of static interference suppressor equipment on carrier-telegraph lines between Denver and El Paso.

Apparatus Development

L. B. Cooke is at Minneapolis, Minn., modifying the power line carrier telephone system of the Northern States Power Company.

E. Montchyk and J. T. Butterfield were in Boston early in August to investigate field tests of 1-A bearings.

H. S. Smith was at Hawthorne the middle of August and early in September in connection with the development of a special tinsel cord for step-by-step switches.

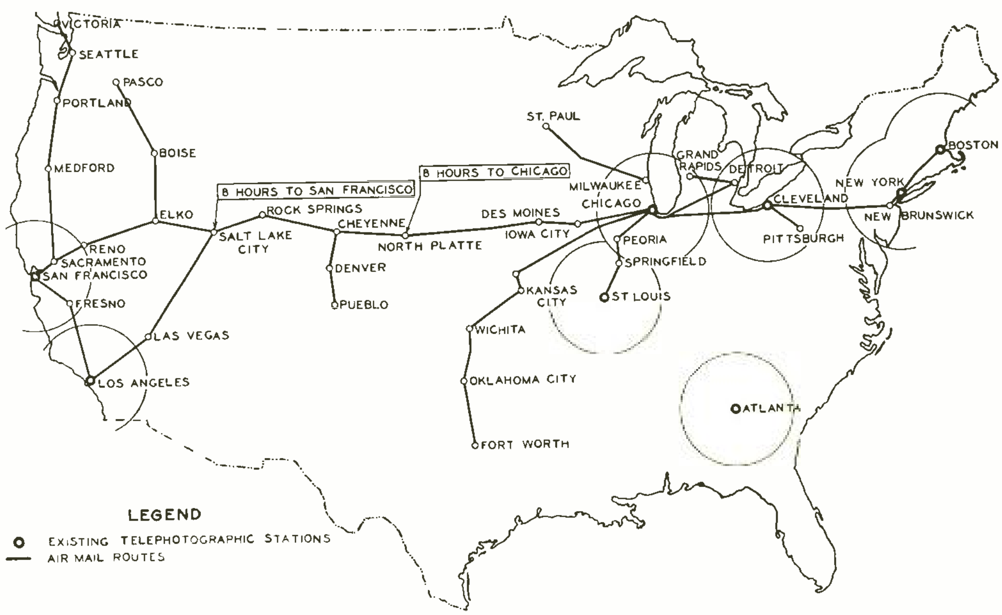
H. R. Kimball spent some time at Hawthorne installing and testing a test set for measuring the reflection coefficient on single channel carrier systems.

R. S. Bair, J. W. Grieg, R. E. Poole and H. S. Price have been directing various stages of the preparation of Station WOR, which is to be key station of the Columbia Broadcasting System. A five kilowatt transmitter has been installed near Kearney, and the studios in New York are being provided with equipment developed in the Laboratories for speech input control.

W. L. Tierney went recently to Shenandoah, Iowa, and H. S. Price to St. Louis and to Fort Worth, Texas, for consultation with broadcasters. Control exercised by the Federal Radio Commission has brought many requests for assistance of the field engineers in instructing staffs and suggesting improvements in equipment and operation procedure.

W. V. Wolfe went to Barberton, Ohio, early in September to inspect the new condensers to be used on the power line carrier telephone installation for the Pacific Gas and Electric Company.

James A. Wotton, for many years a member of the Apparatus Development Department, died on August twenty-second after a short illness. Since his graduation in 1884 from the University of Georgia, Mr. Wotton had spent practically all of his active career in the telephone industry, to which he made important contributions. For some years he was Chief Electrician of the Southern Bell Telephone and Telegraph Company.

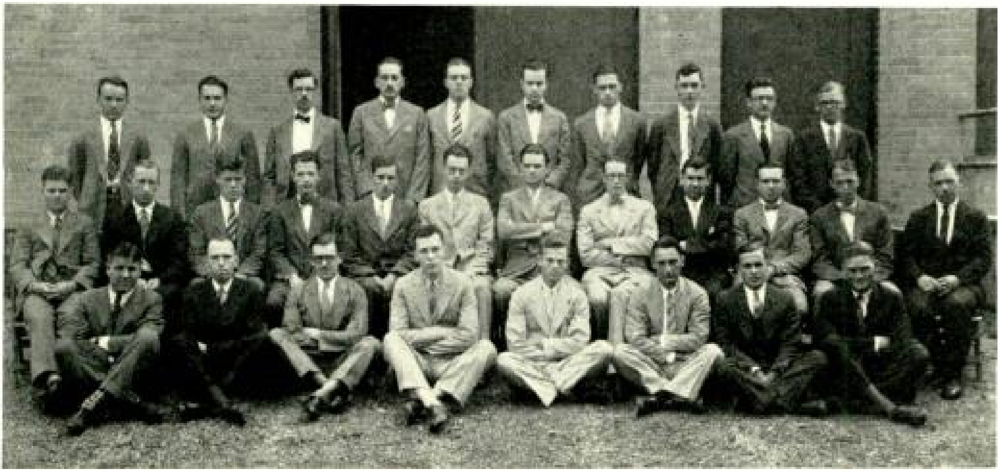


How the telephotograph system has drawn this country together is visualized by this map. The larger circles represent roughly eight hours by train from the nearest telephotographic station. A picture originating in any of these areas can within a few hours be in the hands of newspapers in eight cities. Air mail still further increases the areas served by the telephotographic system

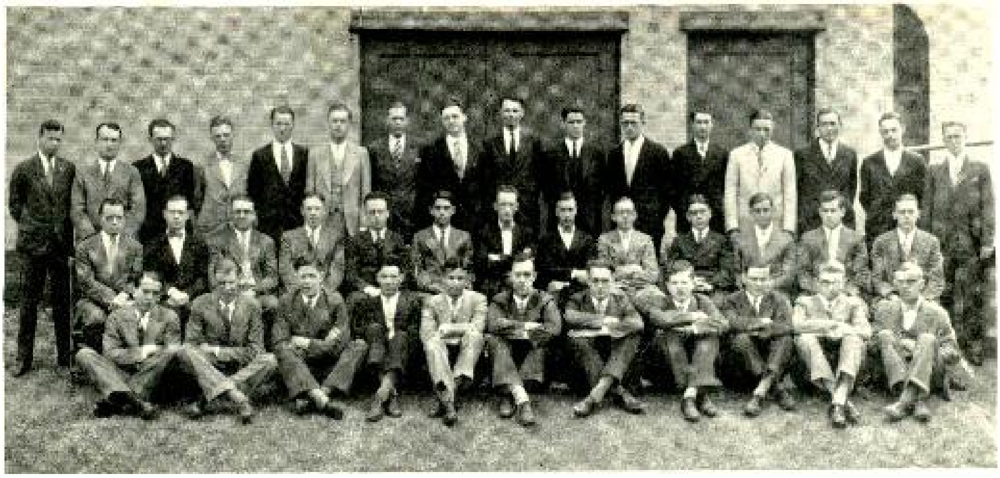
Introducing the New College Men

TODAY the Bell System stands in the front rank of American industrial organizations. The criteria of size—stockholders, capital, personnel — accord it preeminence. Its bigness together with its geographical extent have caused the responsibilities for carrying it on to be divided not only among many departments but among many distinct companies. These considerations together with the unusually technical art upon which it is founded make it often seem to new members that the business they have entered is extremely complex. As a matter of fact the reverse is actually the case.

To help over any initial difficulties for those coming from the colleges and elsewhere, and affiliating themselves with the Laboratories, it is customary for our Educational Department to offer a brief but intensive introductory course. During this instruction, the newcomers have explained to them the organization of



Top Row: S. T. Meyers, Stevens Institute; E. R. LeRoy, M. I. T.; P. C. Jones, M. I. T.; J. W. Obreiter, Brooklyn Poly.; E. J. Thielen, U. of Cincinnati; F. D. Kurie, McGill U., Montreal; F. J. Grignon, Cornell; W. F. Schoening, Washington U.; W. C. Parnell, Queens U., Kingston, Canada; G. C. Engel, Stevens Inst. Middle Row: C. G. Scofield, McGill U.; H. J. Scott, U. of Wash.; T. G. Fischer, Johns Hopkins; H. P. Smith, U. of Kansas; E. L. Alford, U. of Mo.; E. S. Willis, U. of Mo.; H. N. Walker, Brooklyn Poly.; R. C. Shaw, U. of Mich.; W. C. Slauson, Hamilton College; C. E. Fay, Washington U.; P. W. Wadsworth, Ohio Northern; A. L. Bonner, U. of Minn. Bottom Row: H. G. Lindner, U. of Wis.; W. S. Bishop, M. I. T.; A. L. Stillwell, U. of Cambridge, England; G. J. Harms, U. of Kansas; F. A. Minks, Miss. A. & M.; E. F. Brooke, Ohio State U.; W. C. Ellis, Rensselaer Poly.; O. L. Walter, Oregon State College



Top Row: R. V. Mills, Johns Hopkins; A. C. Findlay, U. of Chicago; R. L. Tambling, U. of Illinois; P. V. Koos, U. of Wis.; F. W. Boesche, Cornell; O. J. Murphy, U. of Texas; P. W. Swenson, Worcester Poly.; M. Brotherton, U. of London; S. D. White, Rutgers; M. E. Maloney, Cornell; H. W. Garbe, Kansas State; G. E. Long, Jr., U. of Iowa; C. W. Borgmann, U. of Colo.; W. H. Cortelyou, Rutgers; L. E. Brown, U. of Texas; C. E. Schissler, Johns Hopkins. Middle Row: W. G. Gustafson, Union College; J. R. Power, Carnegie Tech.; J. O. Johnson, Kansas State; J. F. Lee, Fordham; J. F. McEneany, Catholic U.; F. X. Obold, Catholic U.; R. M. James, Occidental; W. F. Jurgens, B. P. I.; L. R. Lowry, U. of Wash.; I. L. Hopkins, M. I. T.; H. G. Och, N. Y. U.; W. E. Gilson, Haverford College; L. N. St. James, Cornell. Bottom Row: H. A. Blake, Cornell; S. R. Durand, U. of Wis.; R. D. Smith, Drake; J. Donelson, Jr., Vanderbilt; W. T. Jervey, Tulane; W. A. MacMaster, Union College; A. P. Steensen, M. I. T.; P. H. Taylor, Stevens; W. F. Simpson, Carnegie Tech.; I. H. Gerks, U. of Wis.; E. J. Fogarty, Yale

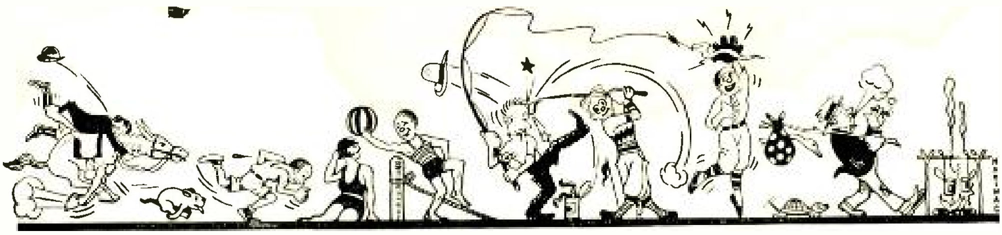
our Laboratories, its purpose and its place in the Bell System, and they are also given a picture of the interrelationships of the twenty-five odd companies that compose the Bell System. Members of the technical staff describe the work of their particular departments, the problems encountered and the opportunities offered for development. Visits to various laboratories and to telephone exchanges supplement the lectures and give the newcomers a fairly broad view of the functions of the Laboratories and its contribution to electrical communication. At the conclusion of the introductory course, each new member is assigned to a type of work consistent with his training and propensities.

The group just issuing from the introductory course, like its predecessors, represents educational institutions in every section of the United States and in some foreign countries as well as various other departments of the Bell System. Wide representation is distinctly advantageous in that it brings together men with common interests but with varied backgrounds of experience. The operating companies by keeping in close contact with the engineering colleges and describing our work to qualified students have greatly assisted our Per-

Top Row: G. Brekke, Stevens; Burton R. Cole, Stanford U.; W. W. Mutch, Wis.; C. A. Kotterman, Yale; R. C. Dehmel, U. of Cal.; C. F. Wiebusch, Texas; John R. Fincher, Cornell; John R. Flegal, Penn State; Benjamin Slade, Harvard; J. M. Hardesty, Illinois; J. H. King, Stevens; C. H. Young, Mich. Middle Row: G. F. Kern, Syracuse; W. S. Hunt, V. P. I.; E. M. Tolman, Bowdoin; L. E. Vandevere, Miss. A. & M.; J. E. Lambly, Cornell; M. A. Logan, Cal. Tech.; Frank R. Dickinson, Union; Olney B. Cook, Columbia; F. L. Morgan, Rensselaer; H. H. Staebner, M. I. T.; P. Komroff, Yale; C. L. Erickson, Kansas State; Haig P. Iskenderian, Mich.; W. A. Munson, U. of Cal., So. Branch. Bottom Row: O. W. Towner, U. of Kan.; G. R. Woodford, Mich.; M. H. Quell, B. P. I.; G. R. Harris, Carnegie Inst.; Frey Hamburger, Cal. Tech.; Ardis M. Walker, U. of So. Cal.; Thomas Pope, Illinois; H. A. Bredehoft, Kan. State; C. E. Rinehart, Oregon State College; C. H. Bidwell, Cal. Tech.; H. K. Farrar, Cal. Tech.; George Moore, Cal. Tech.; Russel Sherman, Pratt Inst.

sonnel Department in the selection of new employees.

The Laboratories expects these new members to bring with them the habit of study and the susceptibility to instruction which has characterized their previous training and hopes that they will utilize the facilities offered for further study and advancement. They will soon begin to realize—what those of us who are older at the business know so well—that employment marks not the end of one's education but rather its beginning. On its side, the Laboratories will not forget, that although dedicated to the achievement of distinctly practical ends, it must cooperate with the members of its organization in broadening their knowledge of electrical communication. To this end and to supplement the introductory courses, many other courses both in and out-of-hours are offered.



Bell Laboratories Club

THE nominating committee of the Bell Laboratories Club will meet on Wednesday, October 26, to nominate candidates for the Club elections to be held on Monday, December 5. The offices to be filled for 1928 are as follows: President, First Vice-President, Second Vice-President (woman); Departmental Representatives — two year term—for Apparatus Development, Patent-Inspection, and Plant.

In accordance with the Club constitution, the nominating committee consists of the following members: E. J. Johnson, President; D. D. Haggerty, Secretary-Treasurer; Departmental Representatives S. J. Stranahan of Apparatus Development, J. G. Motley of Plant, A. A. Reading of Commercial, P. T. Higgins of Tube Shop, G. H. Heydt of Patent-Inspection, A. L. Johnsrud of Research, and T. J. O'Neil of Systems Development.

Club members having candidates should submit their names to their departmental representatives before the meeting. There shall be nominated at least two but not more than three candidates for each office.

Dance

A few tickets are still available for the Fall Dance to be held on the McAlpin Roof Friday evening, October 7. If you plan to attend this party, the committee suggests that you buy your tickets at once. The management of the Hotel McAlpin has limited the sale of the tickets to five hundred and will not permit the sale of tickets at the door the evening of the dance. Buy now and be one of the lucky five hundred.

Music will be furnished by Deacon Johnson and his colored entertainers, who have furnished music in the past for the Hotel Martinique, the Bellevue-Stratford and the Hotel Astor. Dancing will be from nine until two.

Club Orchestra

The orchestra held its first 1927-28 rehearsal on September 27, with excellent prospects for a successful season. At the close of last season, it was felt that such advancement had been made that the services of a professional director were essential to further progress. During the summer months a great deal of work was done by the officers along this line and a director was secured. Mr. Egon Ebert, who began his season's activities with the Club by conducting the opening rehearsal, was secured through the co-operation of the American Orchestral Society. This organization handles the training of conductors for the New York Philharmonic Orchestra and practically all of the symphony orchestras in America. Mr. Ebert has studied in the conservatories of Krefeld, Germany, and Milan, Italy, and is now connected with the conductors' school of the American Society upon whose recommendation he came to us. Those who attended the opening rehearsal were unanimous in their approval of the excellence of Mr. Ebert's work and in their enjoyment of the evening's activities.

The employment of a professional director for our orchestra can only be justified if it results in bringing together all the musicians in the building who play any orchestral instrument. The degree of ability of the performer does not constitute any obstacle. It is the function of the director to solve that problem.

If you play an orchestral instrument, if you enjoy playing it, if you want to play it better and thereby increase your own enjoyment and add to that of others of like tastes—then the orchestra wants you at the next rehearsal. Auditorium—Tuesday evenings, at six o'clock.

Basketball

On Thursday, August 11, in the office of Mr. Stevens at 195 Broadway, was organized the Bell System Basketball League. The companies represented in the league are as follows:

Western Electric, G. H. Q.
Western Electric, Installation.
Western Electric, Telephone Department, Hudson St.
Bell Telephone Laboratories.
New York Telephone, Northern Manhattan.
New York Telephone, Southern Manhattan.
New York Telephone, Westchester.
New York Telephone, Long Island.

All the games will be played in the gymnasium of the Stuyvesant High School, First Avenue and Fifteenth Street, on Monday and Wednesday evenings; two games on each evening. The first game on Monday nights will start at eight-fifteen, and on all Wednesday evenings the first game will start promptly at seven-thirty. There will be dancing between the halves and after the games until eleven-thirty.

Season tickets which will entitle the holder to be admitted to all fourteen evenings of play will cost one dollar each. Tickets for individual games are twenty-five cents each. The schedule of Club games is as follows:

October 26—Western Electric, Inst.
October 31—New York Tel., S. Man.
November 9—New York Tel., West.
November 14—New York Tel., N. Man.
November 28—New York Tel., L. I.
December 7—Western Electric, G. H. Q.
December 14—Western Electric, Hudson St.

The Bell Laboratories Club Interdepartmental League will start on Tuesday evening, November 1, at Labor Temple, Fourteenth Street and Second Avenue. Two games will be played every Tuesday and Thursday evenings, with the first game starting promptly at five-thirty. Eight teams representing the various major departments of the Laboratories will take part in the 1927-28 tournament: Plant, Research, Equipment Drafting, Systems Engineering, Apparatus Development, Junior Assistants, Tube Shop and Commercial.

All men in the Laboratories are cordially invited to take part in the basketball activities of the Club. If any Club member has not played with the Club team previous to this season, he is invited to call on D. D. Haggerty, Room 164. The Club is especially anxious to hear from men who have had basketball experience, whether it be with local teams or school or college organizations.

Our team in the Bell System League will be managed by J. A. Waldron and the activities of the interdepartmental league will be directed by T. J. O'Neil. Either of these men will be glad to tell you more about the basketball activities and furnish information regarding the nights on which try-outs will be held for the league team and practice for the interdepartmental organizations.

WOMEN'S ACTIVITIES

Basketball. Everyone is anticipating an interesting and exciting season for the Women's Basketball Team. Beginning October tenth we have practice nights the tenth, seventeenth, twenty-fourth, thirty-first; November fourteenth, twenty-first, twenty-eighth; and December fifth and twelfth, with Mr. A. Turner as coach. Along about the middle of this period we expect to separate the group into two teams, one playing Modified Girls' and the other Boys' Rules. With two teams ready to meet anyone we expect to line up games for practically all the Monday nights from January ninth to March twenty-sixth.

If you are acquainted with any

Plant Department team, winners of the Interdepartmental Baseball trophy: Left to right, standing—G. F. Kallensee, 3rd base; A. Hansen, 2nd base; W. Flynn, 1st base; J. Jorgensen, Pitcher; W. Eichinger, Right Field, and J. M. Veseley, Center Field. Left to right, sitting—W. S. Haffner, Left Field; J. H. Westenberger, Pitcher; C. A. Grant, Manager; W. Bodenstedt, Catcher, and C. Schepperle, Short Stop girls' teams, send the manager's name to Marie Boman that she may arrange a game with them. Our team will play Monday evenings at the Manhattan Trade School Gym, Lexington Avenue and Twenty-second Street, from five-thirty to seven-thirty.

Swimming. Swimming Classes are held at the Carroll Club Pool, 120 Madison Avenue, Mondays, seven to seven-thirty and Wednesdays five-thirty to six. The charge is two dollars and fifty cents for eight lessons and the lesson period covers ten weeks. Miss Steil is again in charge and will continue the instruction with those who started last year as well as give instructions to the beginners.

Dancing. The Physi-cultural Dancing Class is ready to start its fall season the middle of this month at Louis Vecchio's new studio, Broadway at Twenty-seventh Street. The new studio is better equipped than the old one and has larger dressing rooms. We hope to continue the fun we all had last year and that many new recruits will join the class. The course of ten lessons costs five dollars.

Bridge. The women plan to play their first game of bridge for the season in the Rest Room, Tuesday, October 4, at five-fifteen. In order to help Miss Murtagh to arrange the prizes, will all those who wish to play be sure to return the game card to her by Monday each week.

Hiking. The hikers seem to be all set for plenty of exercise this year, although with due consideration to those of us who only plan to go out occasionally, they have included several short walks and campfire suppers.

This is the schedule for October. Just let Miss Barton know if you wish to join them at any time, in order that she may provide enough supper.

Saturday, October 1: this will be an eight-mile walk from Summit, New Jersey, through a reservation of Essex County. There will be a campfire supper. Cost, about one dollar and sixty cents. Meet at entrance of the new building at twelve-thirty.

Wednesday, October 12 (Columbus Day): meet at Erie Station, tube waiting room, Jersey City, at nine, to walk from Sterling Forest to Tuxedo. Distance, fifteen miles. Cost, about two dollars and fifty cents, using ten-trip tickets. This is a good walk, combining cross-country trails and dirt roads.

Saturday, October 15: meet at the entrance of the new building at twelve-thirty to walk from Englewood to Alpine. Camp-fire supper at end of the hike. Distance, six miles. Cost, including supper, seventy-five cents.

Sunday, October 30, a pleasant fifteen miles over trails and dirt roads in the country around Croton Lake. We will pass the dam, which is one of the finest pieces of masonry in this part of the country. The trip will cost about two dollars and fifty cents.