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A Physical Background for Permalloy

By L. W. McKEEHAN

IN the natural course of things invention depends upon and follows advances in pure science. The clearer the dependence and the quicker the succession the better for both inventor and scientist. But besides these orderly advances in technique which depend upon applying what is already known, there is now and then an invention of another kind which is "supernatural" on the basis of what at the time of the invention is supposed to be the nature of things. The scientist then finds himself in an embarrassing position. Either he or his predecessors must have made some mistake in painting that picture of nature which investigators and philosophers are always touching up and extending to render it a better likeness. Old paint must forthwith be scraped off and new paint put on in quite a different way.

One of these supernatural inventions was made in these Laboratories some time before the writer of this note joined the staff (in 1921), and he was asked as his first job to try his hand at the necessary repairs to the picture of ferromagnetism then on view. There was no possible place in that picture for a new magnetic material—namely, permalloy invented by G. W. Elmen. In the best book on ferromagnetism which has ever been written, Ewing himself—the author—had concluded from his own studies and those of others that no material with higher magnetic permeability than the best iron would ever be found; and this statement had stood as a "Law of Nature" for more than thirty years.

This law had now, at last, been broken; and since in the case of infraction of natural law it is not the criminal but the law which must be reformed, the problem was so to revise the broken statute as to make permalloy—an iron-nickel alloy with a permeability enormously greater than iron—a law-abiding member of the community of magnetic materials. To a devotee of research for its own sake—a very rare bird indeed—what had to be done would doubtless have seemed secondary and inferior, since it was not true pioneering but only the sort of exploration which joins up the outposts of knowledge with its

main body. To the one who got the job, however, the puzzle proved sufficiently fascinating, and after a good many false starts the way through was found to have been in plain sight for many years.

This path had not been followed by earlier explorers into ferromagnetic behavior, perhaps, because better marked roads lay invitingly before them. In the new alloy the crystals were in no way peculiar, as our X-ray analysis soon showed. Nothing but a uniform solid solution of iron and nickel has ever been detected in magnetically satisfactory permalloy. Sensitiveness to strain was then seized upon as the most promising clue to the mystery of permalloy, and a great deal of study was devoted to magnetic measurements of elastically deformed specimens. Without describing these experiments, their outcome, our present "explanation" of permalloy, can be stated briefly; and the statement begins, as it should, by saying something about better-known materials.

Magnetization of iron, nickel or cobalt must be accompanied by changes in inter-atomic forces. The proof of this is a minute change in overall dimensions amounting at the most to only a few parts in 100,000; and for this reason of little significance to most students of ferromagnetism, although these changes in dimensions, collectively given the rather prickly name of "magnetostriction," have been studied spasmodically for about eighty years. It occurred to the writer that if these changes in inter-atomic forces take place suddenly, like changes in atomic structure so far observed, and if the consecutive changes occur at widely different points in the metal, energy ought to be wasted in heating the metal just as if it were being pounded by a multitude of tiny hammers. It was an easy step to identify this wasted energy with magnetic hysteresis losses.

Now magnetic hysteresis losses are abnormally low in permalloy and—most suggestive of all—when its components, iron and nickel, are separately magnetized their changes in dimensions (their magnetostrictions) are opposite, iron extending and nickel contracting along the magnetic axis. This has made it reasonably obvious that somewhere in the range of iron-nickel alloys magnetostriction must pass through zero. Just at what composition the change of sign should take place was not so obvious; but some time after the invention of permalloy had been made, and while its application to submarine telegraph cables was well under way, two Japanese experimenters reported that the critical composition lay just in the region where the magnetic behavior of permalloy had here been found to be most strikingly abnormal.

A review of all this evidence suggested, to one who had had no early training in ferromagnetism to fetter his imagination, that the reason why permalloy was so much more easily magnetized than any other material was because in it iron and nickel atoms could conspire in little groups to make their magnetic changes together rather than separately, and so, by not forcing sudden changes in the positions of atoms beyond the group concerned, to avoid the shocks and energy losses to which either iron or nickel alone is subject under the same conditions. The disappearance of "gross" magnetostriction, that is, the disappearance of changes in shape or size of the specimen as a whole,

was to be taken as a sign that in permalloy of that particular composition the conspiracy had involved practically every atom in the piece. A notable success in the necessary measurements of magnetostriction was achieved by P. P. Cioffi, who reached a new limit of accuracy under experimental conditions at least as technically difficult as any previously encountered by students of this subject.

A theory of ferromagnetism based on these views, that is, on what has been called "atomic magnetostriction," and supported by these measurements, allows us now to sketch in, roughly at least, a background against which permalloy appears entirly "natural." In this it is also increasingly easy to find places for other attractive alloys which would have been equally out of drawing in the original picture of ferromagnetism.

The JOHN SCOTT MEDAL
HAS BEEN AWARDED TO
GUSTAF WALDEMAR ELMEN

for his invention of permalloy, a nickel-iron alloy of remarkable magnetic properties. This metal finds use in transformer cores, in certain telephone receivers, and most strikingly in the loading of submarine telegraph cables for high-speed transmission.

The Medal and its accompanying premium were founded in 1816 by John Scott, of Edinburgh. It is awarded from time to time by the Board of City Trusts of Philadelphia. Time and place of the presentation to Mr. Elmen have yet to be determined.

Recipients of the John Scott Medal have been inventors of outstanding achievement, among them William G. Houskeeper of our Laboratories.

Dispatching Trains by Telephone

By J. C. FIELD

IN many a railroad station the song of the cricket and the gentle sighing of the big round stove alone break the silence between trains. Gone is the cheery clatter of a shelf-full of telegraph instruments: a telephone is called into action by the familiar tinkle of a bell. For railroad communications are being handled more and more by the spoken word rather than by the chatter of a key.

To keep traffic flowing without delay or accident, every train movement must be directed from a central point. There sits the chessmaster of railroading, the dispatcher; he must win every move, for a failure may mean destruction or death. His chessboard—the division—may be three hundred miles long, for a single-track road; where traffic is heavy, twenty miles of line may be all he can handle. Along the line and at its terminals are way-stations, signal towers, and offices to which orders are transmitted and from whose reports the dispatcher learns for every train its make-up and crew, and its arrival and departure from each station.

Between the dispatcher and outlying points, the telegraph offered the first practical system of communication; and from 1851, when the Erie began its use, telegraphy and railroading grew up together. Although 1879 saw the Boston, Revere Beach and Lynn Railroad using the telephone, it was not taken up by the larger roads for nearly thirty years. This was due in part to conservatism but more to the lack of suitable methods of calling the outlying stations.

In our Laboratories in 1907 work was begun on the application of telephony to the specific needs of train dispatching. Because nearly all messages concern the dispatcher, the communication system or train wire is in effect a heavily loaded party-line from his office to all the outlying points. Particular attention was therefore directed to the search for some method of signalling which should be selective rather than code-ringing. This involved the development of apparatus to be installed at each station which should function for certain combinations of electrical impulses and not for others. Among the specified operating conditions were that lines might be as long as 300 miles: and that signalling should not in any way interfere with telephone transmission. As to number of stations and length of line each installation was different from every other. To serve under such conditions the selective mechanism had to operate with very little energy and yet reliably.

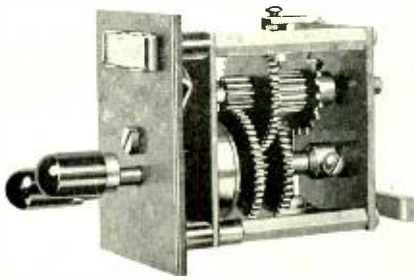
A device then and still used on telegraph lines, the Gill selector, was modified and adapted for that purpose. It was soon replaced by the Western Electric 50-A selector,* a ro-

**It is usually the case in developments of our Laboratories, this selector embodies ideas of many engineers, among whom were E. B. Craft, A. F. Dixon, G. Brown, R. N. Hill, G. A. Anderegg, J. A. Wotton and J. C. Field.*

tary switch arranged to close a local bell-circuit only when one particular number of impulses had been transmitted. At the dispatcher's desk was a bank of rotary keys—one for each station. Each key was arranged to send out through a common relay a different number of direct-current impulses. This system functioned satisfactorily and between 1910 and 1916 several thousand selectors with associated equipment were installed. It had, however, certain disadvantages —among them the need of an individually proportioned resistance at each station.

In 1915 the Laboratories began the development of a new system which Western Electric placed on the market the following year.* This selector was known as the Number 60. It is still the standard device on all railroads in the United States; and it is in satisfactory service in nearly every country throughout the world.

Its selection of stations depends not on the total number of impulses, but on the number in each of three impulse trains. The operating magnet, similar in structure to a polarized ringer, advances a ratchet-wheel one step for each current impulse which must be alternately positive and negative. Mounted on the ratchet-wheel shaft is a second wheel with a number of holes into which pins may be inserted. If one of these pins is engaged by an arm during the pause between impulse-trains, the wheel will be held in position, otherwise a spring will swing the wheel back to its starting point. If the first train should contain eight impulses, all wheels carrying a pin in the eight hole will be held, and the others will drop back. If the second train is of five impulses, only one wheel will be found to have advanced so as to be held by the second pin, which is in the thirteenth hole. When a



A signalling key: turning the handle winds up a spring which drives the contact wheel

Among the contributors to this development and design were Messrs. E. B. Craft, J. C. Field, J. B. Harlow and L. E. Coon.

The 60-A selector: as the armature vibrates, it advances the wheel from which stop-pins are seen projecting downward

third train follows with enough impulses to bring the total to seventeen, it will advance this wheel far enough to close certain contacts and ring the local signal-bell. Two seconds later, a single impulse releases the holding arm and the selector returns to its normal position.

All the combinations have the same total number of impulses. In the case illustrated there are available seventy-eight different combinations of three numbers whose total is seventeen. This number of individual codes is sufficient for one system or dispatcher's division. In a few cases, such as that of the Erie Railroad's terminal network near New York, it is desirable to have a different code for every station, regardless of the circuit to which it is connected, so that the selectors will function correctly if, in emergency, one circuit is connected or "patched" to another. A total of twenty-seven impulses are then used, divided into three trains, and 253 different combinations are available.

In addition to ringing each station individually, as just described, the 60-A selector is arranged to call all stations by sending seventeen impulses in a single train. If seventeen impulses are sent in a single train, each selector will close its bell circuit and all stations will be called. For the transmission of Standard Time signals, twenty-two consecutive impulses put all wheels in such a position that for each impulse sent over a master clock they repeatedly open and close their contacts and so cause a bell at each station to tap once. The 60-B selector is so arranged that when a particular selector is called, any one of four bells may be rung, as, for instance, in a nearby freight station, ticket office or employee's residence.

In the dispatcher's signalling equipment, turning a key causes a common relay to send out alternately positive and negative impulses. On account of the low frequency at which the impulses are applied to the line, and because of a filter which rounds off the waves, signalling creates no disturbances objectionable to listeners on the line. This allows the dispatcher to call additional stations while he is talking—a great convenience when every second counts. The selectors can be operated through repeating coils, making possible also efficient through circuits for simplex telegraphy or phantom telephony.

The method of dispatching explains why all the calling is "one-way." The dispatcher is required to be "on the line" continuously. A way station operator merely cuts his transmitter into circuit and says "ZB Tower" to be instantly answered by "Dispatcher." The report is then given by the operator, and repeated by the dispatcher as he notes it on his train sheet.

Regular trains run according to standing orders embodied in a schedule; when any change has to be made, or when an "extra" is to be run, a train order is issued. The dispatcher, as he gives the order over the telephone to the operator at the distant station, writes the order in a log book and at the same time the way-station operator writes it on duplicate forms for handing to the conductor and the engine-man. As a check, the operator reads the order back to the dispatcher, who underlines each word in his log book to indicate he has received the order back as originally given. All important words and numbers are both pronounced and spelled. This procedure is effective: so far as is

A typical dispatcher's desk equipped for telephone operation. To the left is a loud speaking receiver; in front of the dispatcher is the bank of rotary keys

known there has never been an accident due to the operators or trainmen failing to receive a train order correctly over the phone. Vivid reasons for the triumph of the telephone over the telegraph are stated by C. H. Gaunt, Superintendent of Telegraphs of the Santa Fe System, who wrote in the *Santa Fe Employees' Magazine* for October, 1909:

"To the dispatcher time is the one thing that must receive the greatest

consideration. It may be assumed that a man can utter words with a speed equal to the operation of his mind. But the train dispatcher, in using the telegraph, has always been obliged to transmit his words at a speed but one-tenth his capacity to express himself, and also to receive a reply at the same rate. It means that the dispatcher has been permitted to multiply the time within which he may form his plans of train operation fully three times. This, of itself, further means that his mental calculations are vastly improved in accuracy and general value. There is the certainty that more movements will be better planned and executed, and that the art of direction of operation of trains will be greatly advanced and the work more safely rendered."

High commendation, this; when one remembers that it appears in 1909, just two years after the Laboratories began development work, it is easy to see why the telephone has so quickly forged ahead. A report to the 1926 convention of the American Railway Association states that the Class 1 railroads last year handled a total of 132,850 miles of line by telephone as against 121,521 miles by telegraph. In view of the fact that both first cost and maintenance are higher for the telephone, this is a truly remarkable showing. In fact, the only lines still using the telegraph for dispatching are branches and a few other lines where traffic is so light that the extra cost of the telephone system is not justified. Summarizing the advantages of telephony, the report says in part:

"Less physical and mental strain are borne in the operation of the telephone, and men who have become incapacitated as telegraph operators continue to function satisfactorily as telephone handlers.

"In the event of emergencies in train operation the train conductor or engine-man, using a way station or portable telephone, can give first hand information to the dispatcher or superintendent more intelligently, with less excitement and in less time than with the telegraph. There is more of a personal feeling and better *esprit de corps* developed between the dispatchers, the different operators and the train crews than is possible with the telegraph, with obvious results."

As so often happens in our Laboratories, this particular development has been applied also to a number of other uses. The selector has been used in ship-to-shore radio telephony; to call way stations along a power-line carrier-telephone system; to signal any or all or groups of New York City police stations by radio impulses; and to control the switches of distant power stations. It stands ready to assist in any sort of remote-control problem, and so plays its part in the drama of electrical communication.

When The Radio Squeals

By E. G. FRACKER

"EVERYTHING is used but the squeal" was once the boast of the pork-packer. Another sort of squeal of which there is an all-too-liberal supply, well assorted as to pitch, timbre and loudness, exasperates many a radio listener. His memory turns to times, not far distant, when the only squeal was that very useful one which helped him tune in a station. That is now denied him—either by the circuits of his own set, or by his unwillingness to inflict it on his radio neighbors' ears. But others there are aplenty—from interfering broadcasters, from nearby radiating receivers, and at times even from his own receiver itself. How to get rid of them is a problem of rising importance as the congestion of transmitters and receivers continues to grow.

A wide variety of disturbing sounds, characterized by notes of any pitch, is dubbed "squeal" in radio slang. To communication engineers the "singing" amplifier is all too familiar, while the "howling telephone," long known in the art, finds practical use as a tone-generator.

Broadly, feeding back of energy from output to input of any amplifying device tends to set up a steady vibrating state. A telephone transmitter, receiver, and associated network form such a device; when receiver and transmitter are coupled by a sufficiently short air-path, howling can take place.

In general, the conditions for no howling are met by having the losses in the feed-back path greater than the gain in the amplifier. Losses are increased by reducing series capacities and by weakening the magnetic coupling in the direct path; and by providing low-resistance shunt paths. The gain being a fixed quantity for any amplifier, the losses have a minimum value above which singing will not take place. Near this value, a ringing sound, like the fading tone of a bell, will follow the louder notes. Distortion will also result, since frequencies near the "singing-frequency" will be unduly amplified. The safest procedure, therefore, is to minimize feed-back in every way.

In the audio-frequency amplifier of a radio receiver, stray fields of transformers or retardation coils may provide electro-magnetic coupling which will induce voltages in phase with the input voltages. Singing from this cause may be prevented by using closed-core coils arranged so that the coupling between them is reduced to a minimum and by adding magnetic shielding where the amplification is high. Electrostatic coupling can be reduced by arranging the apparatus so that there will be but little capacity between parts connected in the input and output circuits and by keeping the grid and plate leads as short as possible. Transformers should be connected in the circuit exactly as directed by the manufacturer. In some cases it is also necessary to ground the

transformer cores. In amplifiers designed for high amplification, it is often necessary to enclose one or more stages in a complete metal shield.

Resistances, where drop-of-potential is used for grid or plate voltages for more than one stage, should be shunted by a large-capacity by-pass condenser, as also should be batteries used for supplying grid or plate potential for more than one stage. The shunting capacities should be so connected that a low-impedence path to ground is provided at the low-potential end of each grid- and plate-circuit.

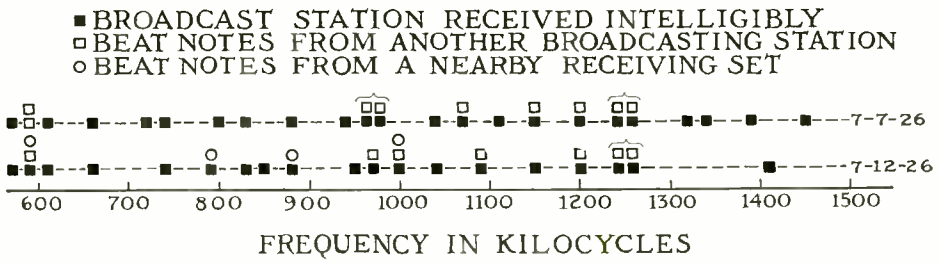
Singing from acoustic feed-back occurs in some cases when the loud speaker sets up a mechanical vibration of the tube elements, generally starting with a detector tube and causing a periodic variation of its plate current which, amplified, is reproduced in the loud-speaker. This cycle is repeated until a continuous howl is produced which is resonant to the mechanical period of vibration of the tube elements. Such singing may be eliminated by placing the loud-speaker at a distance from the set; where horn-type loud-speakers are used, by pointing the horn away from the receiving set. If it is necessary that the loud-speaker be located near the set, the detector tube and sometimes the amplifier tubes should be equipped with vibration-proof sockets.

Several types of squeal originate in the radio- or intermediate-frequency circuits of the receiving sets. They are due to the presence of high-frequency currents in addition to that of the carrier-wave to which the set is tuned. For example, when transmission is being received with about equal intensity from two stations only a few thousand cycles apart in carrier frequency, a note will be heard.

Another common type of squeal, also due to heterodyning, is that produced by nearby oscillating receivers. Among these are regenerative receivers, radio-frequency amplifier circuits which are not arranged to prevent oscillation, and super-heterodyne receivers under some conditions. Receivers of these types, when in oscillation, act as low-power transmitting stations, producing in nearby receivers high-frequency currents which may heterodyne with currents from a transmitting station. In general the closeness of coupling between the antenna and the circuits of a tube which is oscillating governs the extent to which a receiving set offends its neighbors. The tone does not remain constant but changes pitch more than does that due to two broadcasting stations, because their equipment is designed and operated to keep the carrier frequencies as constant as possible. But when the circuits of a receiving set are oscillating, the swaying of the antenna and the movement of the hands about the set, which is generally unshielded, produce changes in circuit constants and hence in oscillating frequency, even though the dials are not moved. Furthermore, the quality of reception cannot be satisfactory when a receiving set is oscillating at a frequency close to that of the station being received, and in the attempt to obtain the greatest volume without destroying intelligibility the set is thrown into and out of oscillation repeatedly. These factors all tend to produce the changing note by which the source of interference may be identified as an oscillating receiver.

Annoyance, sometimes blamed on amateur transmitting sets, may occur

in the form of a long squeal which suddenly breaks into the dots and dashes of the telegraph code. This is caused by continuous-wave telegraph stations. The fundamental carrier frequencies at which these stations transmit are far below those of the broadcasting range, but as considerable power and few precautions



Two groups of squeals: these observations made on two evenings, indicate the prevalence of beat-notes in the metropolitan area

against harmonics are used by some of them, it is possible to receive harmonics of their carrier-frequencies within the broadcasting band, at several points on the dials. Interference from this source is rare, however, and occurs only when the harmonic-frequency is sufficiently close to a broadcasting-frequency to produce beat notes.

It is impossible to eliminate entirely the squeals of external origin which have been described. They may be reduced in volume and some may be stopped by increasing the selectivity of the receiver. However, if the receiver be made too narrowly selective, the complete sidebands transmitted by broadcasting stations will not be received, and distorted reception will be the result.

Additional sources of beat notes exist in a super-heterodyne receiver unless the set is designed to eliminate them. When the oscillation-frequency is midway between the carrier frequencies of two stations, it will heterodyne both carriers down to the same intermediate frequency. If the oscillator frequency is not exactly midway it will therefore send through the intermediate amplifier two currents differing by a few thousand cycles; in the second detector these will heterodyne with each other and a squeal will result. The remedy is to improve the selectivity of the radio-frequency circuits so as to reject one of the original carrier currents.

Transitory beat notes are also occasionally heard from a super-heterodyne receiver when the radio-frequency input and oscillator circuits are tuned to approximately the same frequency as that at which a powerful nearby broadcasting station is transmitting. With this condition, heterodyning occurs directly between the two oscillating currents in the first detector tube and the note is heard due to the leakage of audio-frequency current through the intermediate-frequency amplifier. The remedy is to improve the selectivity of the intermediate-frequency circuits.

Receiving sets having one or more stages of radio-frequency amplification are potential squeal-producers because the circuit in general use, utilizing interstage transformers, makes a potential oscillator of each tube cir-

cuit due to the coupling through the tube capacity, which permits feedback from plate to grid. Oscillation may be prevented by reducing the plate inductance, by introducing resistance into the grid or plate circuits, or by using reversed inductive or capacitative feedback. The last method, employing a neutralizing or balancing condenser, is most commonly used. It is also necessary to arrange the radio-frequency transformers so that no coupling exists between them. Among the methods employed may be mentioned "figure 8" or toroidal coils and the use of shielding. Connections in the tuned circuits and the grid and plate leads should be kept short and well separated from current-carrying parts of the apparatus.

Satisfactory reception is impossible when a program is punctuated by squeals. A set which is itself guiltless may be forced into evil ways by bad companions. Little can then be done, except to exercise moral suasion on one's neighbors, and to listen to local high-power stations with adjustments which reduce the interference below the threshold of annoyance. Both transmitting and receiving operators are unable to deal effectively by apparatus and its adjustment with that large class of squeals which arises from the indifference or carelessness of neighbors. Increased consideration for the other fellow is a necessary accompaniment of increased facilities for communication; and, just as improved considerateness has unmistakably been brought about in wire telephony, it may be hoped that further improvement will accompany the expansion of radio broadcasting.

RESEARCH AND THE COMMUNITY

In his Presidential Address to the British Association for the Advancement of Science, H.R.H. the Prince of Wales, said:

"In order that the community may fully realise all that it owes, and all that it might owe, to the advancement of science, the channels of communication between research and the public mind have to be kept clear, maintained, and widened. The non-scientific public is accustomed to view science as it might view a volcano; prepared for the eruption of some new discovery from time to time, but accepting the effects of the eruption without realizing the processes which led up to it during the preceding period of quiescence. The period of preparation by research before science can offer the world some new benefit may be long, but the scientific machine is always running quietly in the laboratory."

A Piano String Model of the Human Ear

By R. L. WEGEL

WITHIN the ear, sounds are differentiated by the fibres of the basilar membrane and are detected by the nerve terminals distributed on it. The fibres, of which there are estimated to be 24,000, compare sufficiently well with the strings of the piano so that a picture, or model, of this portion of the ear may be constructed in terms of the more familiar and larger strings which stretch across the sounding board of a piano.

Imagine a thin piece of paper about five inches wide pasted across the bank of strings of a piano, with the black and white keys of the keyboard painted on it. Using a grand piano the result would be as pictured in Figure 1. These piano strings now correspond, with certain limitations and exceptions, to the fibres of the basilar membrane.

When the piano is played its strings will vibrate and emit sounds of their particular pitches. If another piano in the same room is played, corresponding strings of the first piano will respond. This is because of the property of the sound board of picking up the vibrations from the air and communicating them to the strings. These vibrations will be much smaller in amplitude of motion but similar to those which would be produced if the same piece of music were played on the keyboard of the first piano. In that case the painted keyboard stretched across the strings would indicate, by a blurred appearance due to vibration, the keys which were being depressed by the pianist. The motions would be sufficient so that those of the bass string would be easily visible to the naked eye, although the higher pitched ones would have to be viewed with a micrscope to observe the vibration.

The strings of the piano of Figure 1 correspond more or less in their action to the fibres of the basilar membrane. One difference lies in the fact that the piano contains usually eighty-eight notes with twelve notes to an octave; and in the treble there are three strings to each note, or thirty-six to the octave. In the basilar membrane each octave includes about 3500 fibres and covers a linear distance of about five millimeters. Since in the interval of a half tone there are so many fibres a larger number respond to each note of the musical sound which reaches the ear. The membrane, in fact, responds to tones between those of the strings. On the piano also the highest note is one of a few more than 4000 vibrations per second, but the human ear has fibres responding to vibrations of 16,000 cycles per second.

A piano, therefore, of many more keys and a larger range of pitches would be needed for a more exact mechanical model, and a larger number of strings per octave with finer intervals between the notes of the strings. A very satisfactory picture,

however, of the action of the human ear may be obtained by using the piano model of Figure 1. Suppose that a lightweight photomicrograph about thirty millimeters long were made of the strip of paper pasted on the strings of that piano. Now, imagine that it were possible to paste this photomicrograph on the basilar membrane of the human ear and with a very high-powered microscope to observe the motions of these keys while the possessor of the ear is listening to the playing of a piano. The keyboard on the basilar membrane would then be seen to perform very much like the painted one on the piano strings of Figure 1.

The ear of which the basilar membrane has been altered in this manner would appear like that of Figure 2. For convenience, however, the

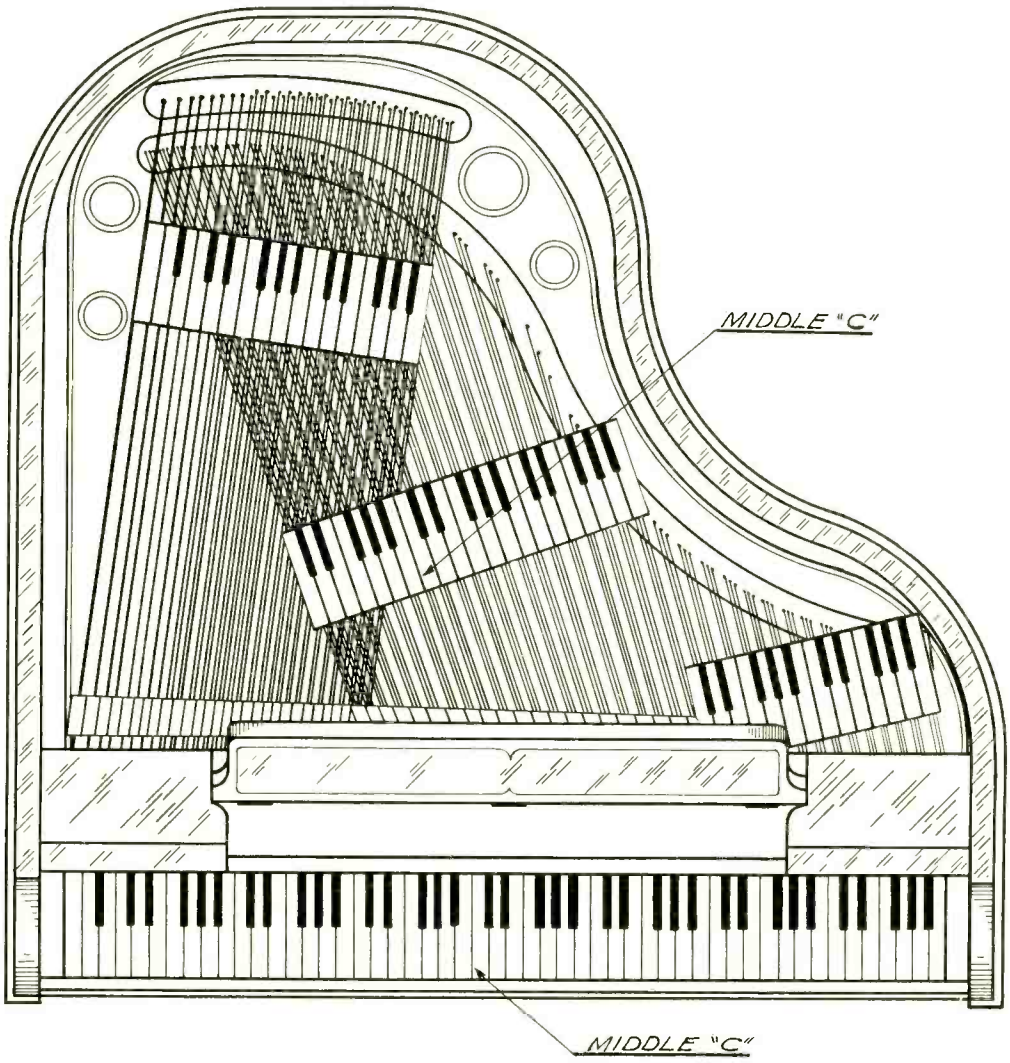


Figure One

membrane in this figure has been straightened out instead of following its usual spiral. The first thing that is noticed about the model thus produced is that the highest note of the piano, corresponding to the key at the right end of the membrane, is five or six millimeters from the end of the membrane. This is in accordance with the fact that the piano keyboard stops at 4000 while the basilar membrane extends to 15,000 or 20,000 cycles per second, thus covering about two octaves more than the piano.

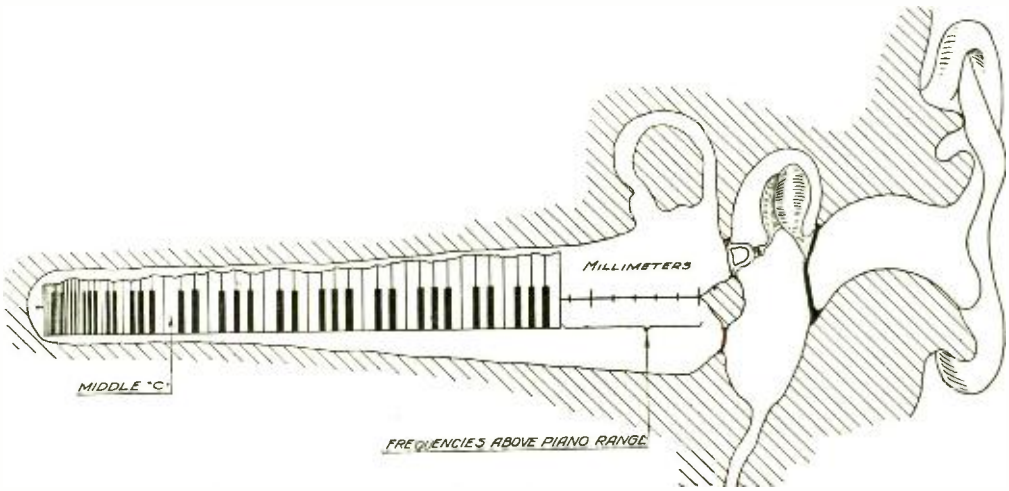


Figure Two

This model also affords further details as to the operation of the ear. If one could observe while the ear is listening to a tone, the pitch of which is continuously varied from about 1600 to 16,000 cycles per second, there would be observed at the start a motion of a very small amplitude but covering a rather wide area near the helicotrema, that is, at the extreme right of Figure 2. As the pitch is continuously increased while its sound intensity is kept constant the area of vibrations would contract somewhat while it moved toward the "round window," that is, to the left of Figure 2. Accompanying this contraction of vibrating area, which in effect means higher selectivity, there is a very considerable increase in the amplitude of the vibrations. The amplitude increases until the pitch is about 1000 cycles per second, at which time the area is very close to the middle of the membrane. The sensitivity, or acuity, of hearing is greatest in the range from 1000 to 5000 cycles, and comparatively much less for higher or lower frequencies; and the model just described conforms to this fact.

As the pitch of the continuously varying note is increased beyond 1000 cycles the vibrating area remains essentially constant until it reaches a point about five or six millimeters from the "round window." This point is about at the end of the piano keyboard which has been imagined to be superimposed upon the basilar membrane. Beyond this point as the pitch continuously increases the vibrating area moves very slowly; its width decreases somewhat and the amplitude of the vibrations decreases very greatly.

After Office Hours

By L. J. BARKER

A Story of Building Service by a Watch Foreman who knows our Laboratories by night as well as by day.

OF the many who serve, work and achieve in our Laboratories, least is known of the men who labor while you sleep, for they have not had the opportunity of personal contact. Their work is taken for granted and you are apt to forget that it is an essential factor in your life, in your work, in your physical health and your mental attitude.

Just about the time you are getting ready to go home, and, (if you are wise enough) are locking up your desk, a night supervisor is busy planning the night's task of scouring and cleaning our little city, which comprises an area of floor space equal to ten city blocks. He would probably much rather clean ten city blocks, for there would be fewer obstructions. In our building we have seven hundred enclosed offices. The desks, file cabinets, chairs, waste baskets, safes, and even the pair of rubbers left under the clothes locker are an annoyance and a handicap to the cleaner. Not only must our little city be cleaned, it must have the attention of many skilled craftsmen during your absence.

As you leave the building you pass the door watchmen, our traffic cops. They are trained to handle crowds and they prevent stampeding in the catholic desire for trains, home and recreation. The last stragglers leave, and the doors are secured and locked. Even the window guards on the first floor must be padlocked each night. A gang of men are busy closing windows which you have left open. They are glad to render you this service, but you could cooperate on a rainy night or when the clouds are heavy, for it takes nine men an hour to shut three thousand windows, and rain can do a lot of damage in an hour.

And now we must post the men of our fire and police department, called "watchmen" on the payroll. Each is thoroughly trained in fire-fighting—an oil fire requires very different handling from a cotton-fire or a paper fire. They know all the hose and sprinkler connections. Three blasts of the whistle—our fire-signal—find them alert and ready. They have never been found wanting in an emergency; it is even more to their credit that they discover hazards before fires occur. Soldering-irons, hot-plates, annealing ovens left connected; gas-burners left lighted—these are some of the hazards which they correct. Their log-sheets note as well burnt-out lamps, loose floor-boards, leaking pipes and faucets, broken plaster, door-checks out of order. In making current repairs our Building Shop is guided largely by these log sheets, and the Building Engineers frequently get timely warning of conditions requiring their attention.

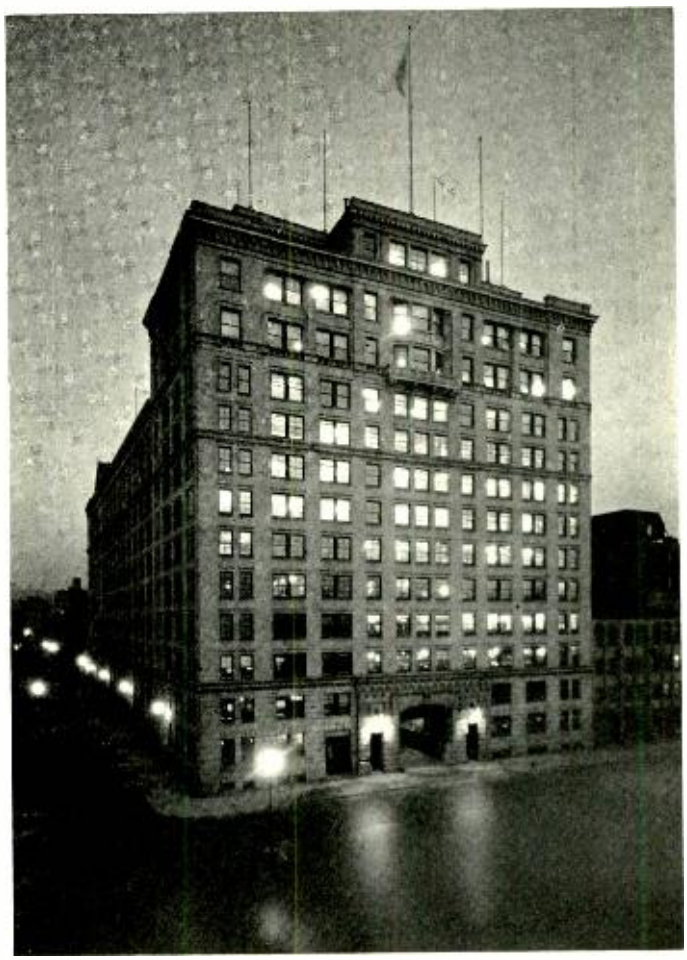
Our power plant operates twenty-four hours every day. For while you sleep our building must have light,

heat and ventilation; pumps must supply the house-water tanks; the sprinkler tanks must be kept full, and refrigerating machines must run. An alert watch-engineer is watching his boilers, the automatic fire and sprinkler alarms, or the recording instruments which tell of light being consumed. We find the engineer an interesting fellow. He can tell us that in the past twenty-four hours we used 8000 kilowatt-hours of direct current, 2000 kilowatt-hours of alternating current and 10,000 cubic feet of water. A peep into the boiler room and we see the usual picture of physical endurance—a fireman scantily dressed, grimy and sweaty but cheerful.

Leaving the power plant we must walk upstairs, for elevators are inspected and overhauled at frequent intervals and this cannot be done during the office hours of a busy day. We may meet carpenters, millwrights, electricians, plumbers, pipefitters, skilled craftsmen intent on saving you annoyance by doing their task after you have gone home. Perhaps we have to duck under the painter's scaffold for in the winter months a night force of painters are employed redecorating those localities that would become chaotic if we should attempt to paint them during the day.

At seven-thirty the night cleaner is ready for work. It takes a force of fifty-two trained men to clean this little city. "I didn't know it needed a trained man to do cleaning," you will say; "anybody can do that." I'll grant that you are right in that assertion but you have to train a man to make him like to do cleaning.

C. T. Boyles, general foreman of building service, takes personal charge



Belted by light at its base, starred by lighted windows, our building looms massive against the city's glow

of this work. When a new man is hired for the monotonous task of night cleaning, Mr. Boyles spends a good deal of time with him. The

Protectors of the night: J. F. Sullivan and a West Street policeman

problem is to make a man look at the drudgery of cleaning from the point of view of Service. The cleaner must feel that his work is necessary and useful, that he has a standing in our community and in our country, for often he is a newly arrived immigrant. His period of probation being over, he is handed to one of the supervisors —J. M. Reilly, P. J. Monahan or L. J. Barker.

With this spirit the cleaners go to work. There is much competition among them to be allotted a definite part of the building to keep clean; and they show a great deal of pride in the appearance of their sections. The "free-lance" cleaners are allotted other tasks—of mopping, waxing and polishing floors, sweeping and mopping service stairways, cleaning and scouring toilets. The care of thousands of electric lights and fixtures is in itself a gigantic task.

The routine of systematic cleaning is interesting. Floor space is first cleared of obstructions. The contents of thousands of waste-paper baskets are emptied into box trucks which have been previously and conveniently placed on each floor. These trucks are taken by elevators to the boiler room and emptied for burning.

Now all the floors are swept—the rugs with portable vacuum cleaners, and other floors with push-brushes.

Watch Engineer T. G. Bulman reads his meters

In addition, certain sections are selected for mopping, on a schedule which covers the entire building every two weeks. A group of cleaners specializes in mopping; with practice they can cover a lot of ground and do a thorough job, too. Waxing and pol-

ishing linoleum is another specialists' task. Liquid wax is mopped on, and polished by a machine with two motor-driven, revolving brushes.

We may pause a moment in the inspection of our night cleaners to talk with H. Jones, who is responsible for the continuous operation of experimental circuits, on which the engineers have found it necessary to leave apparatus in operation overnight. Jones makes an hourly tour of the laboratories, where his attention has been requested. In addition, he is responsible for the power rooms, storage batteries on charge, and the general electrical maintenance of the plant during night hours.

You are surprised to find the telephone exchange deserted. But when the last operator went home at seven o'clock she did not leave us without service. She plugged in a series of night trunk-lines through our switchboard to the Chelsea Exchange. Thus we are in telephone communication with the outside world until another operator arrives at seven in the morning. Intercommunicating service is given by connecting one or more telephones on each floor to a special circuit which ends in the booth in the Court. At the beginning of each watchman's round—and in case of any emergency—he reports over one of these telephones to the booth. A whistle signal calls all watchmen to report by telephone. This is how an alarm would be spread to our firefighters. At midnight there is a pause, while everybody seeks refreshments in the dinner-bucket or at one of the nearby restaurants. Now comes a change of supervisors. In their eight hours' tour of duty they have laid out the night's work; those who relieve them must learn what has been planned and then see that the work proceeds.

By three-thirty the sweeping and removal of heavy rubbish is complete, and the box trucks containing rubbish are back in the boiler room. The cleaner then turns his attention to dusting his sections. He must find time also to wash, oil, and polish one or two desks in each of his two sec-

C. T. Boyles
General Foreman of Building Service

tions. He has been warned while dusting your desk to put every article just where he found it. Sometimes he may misplace a few papers but you can depend on it they are on your desk. Occasionally a waste basket or a cuspidor has disappeared; these little things do happen occasionally. When you realize the hundreds of desks he has dusted and the many waste baskets he has emptied, you must admit that he has done a wonderful job.

In the night some human derelict

P. J. Monahan

J. M. Reilly

L. J. Barker

One of these Watch Foremen is always on duty

from the water-front may seek admission to our building. Sullivan, our night gate-watchman is confronted with some uncomfortable situations. He is a courteous fellow, but he can be very persuasive when occasion demands. He is in touch at all times with the Police officer who patrols West Street, and quickly calls him when need arises.

As the sun comes up we hoist the Bell System House flag, emblematic of telephone service. On national holidays the House Flag is replaced by the flag of our country. If occasion will permit, a supervisor may perform this duty himself, for what could be more soul stirring than the hoisting of our flag of freedom at the break of day!

With the sunshine comes Louis Fuhrmann—better known as "Louis the Baker." After the breakfast cereal is on the fire, Louis and his helper start the day's supply of pastry. About seven-thirty arrive the kitchen- and counter-forces. Under the direction of A. Scaglione, our chef, and John Bachor, his assistant, the preparation of breakfast goes on, while work is begun on vegetables, meats and soups for lunch. Milk and ice are early arrivals also, and an elevator must be ready to take them upstairs.

George Carr, the clock man, inspects every clock before eight-thirty;

John Murray

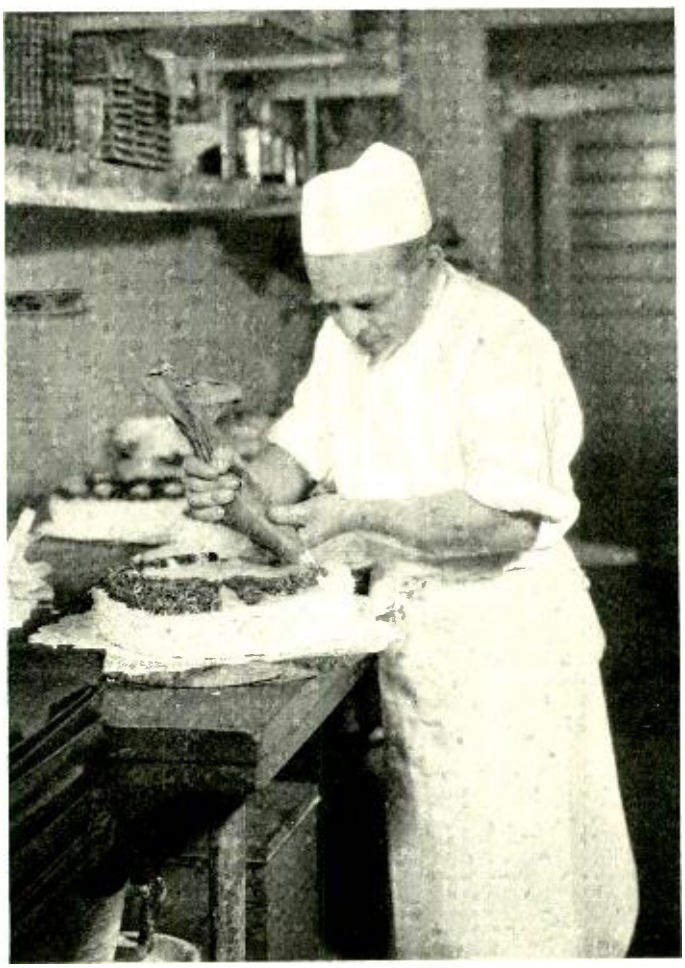
Walter C. Connick

Patrick J. Doorly

sets and winds them, and sees that the time clocks have fresh sheets on their drums, ready to record the day's comings and goings.

W. A. Moore, our specialist on radiators and heating, will inspect your section for temperature between six and half-past seven and regulate the heating. He is guided by the weather forecast and by an hourly record of outside temperature.

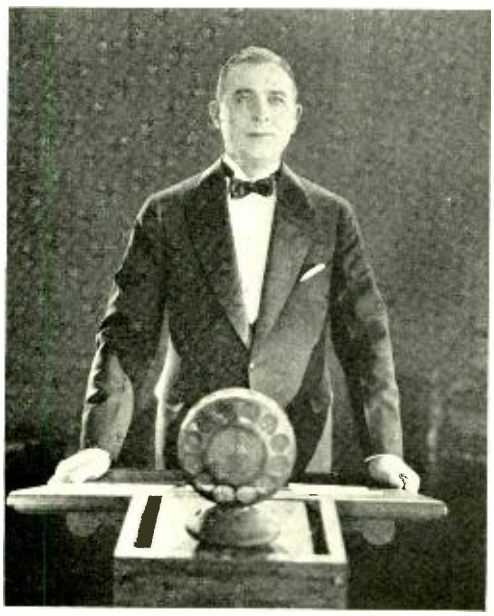
The night cleaners go home and a force of window cleaners, members of the day gang, take their place. There are three thousand three hundred windows to be kept clean in our little city—many of them high up in the building. Although the cleaners are amply protected with safety belts, the job is not one to be envied, especially in windy weather. Doors and windows and even your office, if you have requested it, are unlocked at seven A. M. Door watchmen and elevator operators take their posts ready to greet you with a cheery "Good Morning." And so your day begins —its comfort and security dependent in no small degree on those whose night's work has just ended.



Louis Fuhrmann puts the final decorations on one of his cakes

The Vitaphone Tells Tales of Itself

HOW the Vitaphone works was told by Vitaphone itself on the occasion of an address by Edward B. Craft to the New York Electrical Society on October twenty-seventh. This film in which Mr. Craft himself plays the role of expositor, was later shown to four large audiences of Bell Laboratories people in their own Auditorium. It marks the entry of the Vitaphone into the educational field, where many interesting futher possibilities await.



Mr. Craft addresses his Vitaphone audience

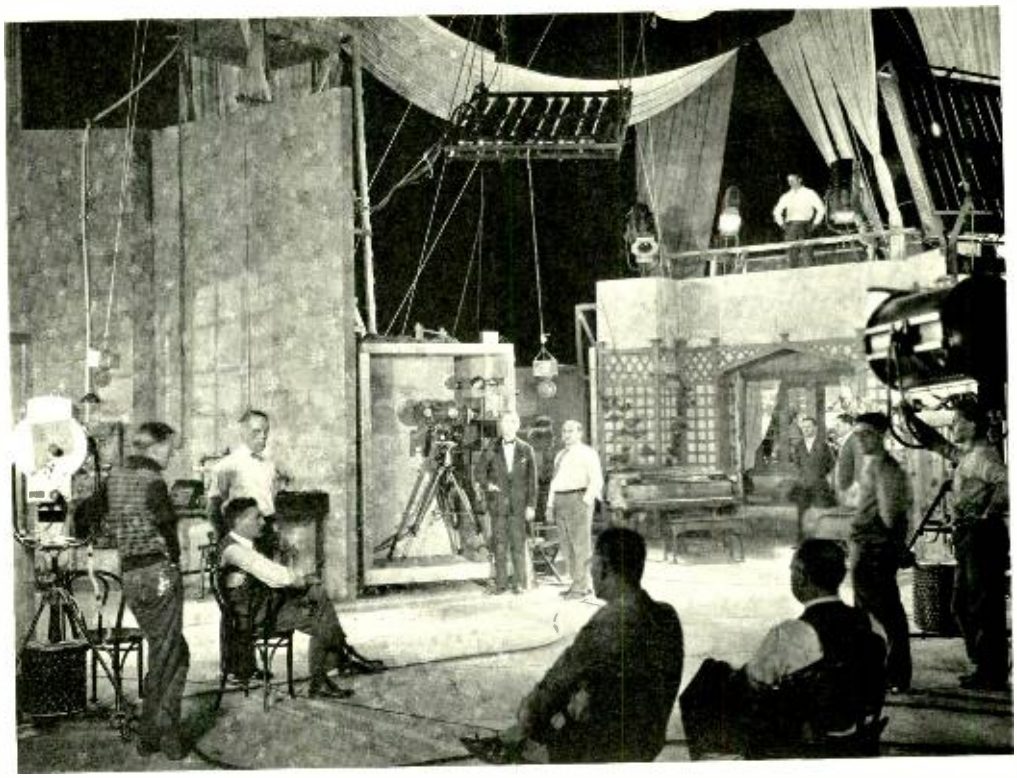
Mr. Craft was introduced to the Electrical Society by S. P. Grace, its President. After a few remarks, in which he expressed appreciation of the interest and cooperation of the Vitaphone staff, Mr. Craft retired in favor of his pictured presence on the screen. Standing at a speaker's desk, his screen image then sketched briefly the underlying scientific discoveries:

". . . The simple coordination of sound with moving pictures is not a new accomplishment but it was not until some recent and fundamental advances in the art of telephony had been perfected that we had available the elements necessary to accomplish sound reproduction which could really be termed 'a perfect illusion.'

"From the beginning of the attempts to accomplish what the Vitaphone now does with such precision, the problem was not so much that of synchronization of sound and picture as it was the recording and reproduction of the sound portion of the combination in such volume and with such clarity as to make it appear that one was listening to the sound at its original source.

"The first big step in this direction was the perfecting in Bell Laboratories of the so-called Public Address System by means of which the volume of sound from the telephone could be amplified to such an extent that the voice of the speaker could be heard simultaneously by many thousands of listeners.

". . . The next was the perfecting of means for electrically recording at a distance sounds, such as speech and music, in such a way that permanent and reproducible records could be made.



The Vitaphone studio, arranged to demonstrate its operation. Center: Mr. Craft and the studio director

". . . The last step had to do with perfecting the means of reproducing the sound in such volume and with such faithfulness that it would appear as a perfect reproduction of the original sound regardless of the size of the auditorium used or of the number of listeners."

A short description followed of the process of making and reproducing Vitaphone records; inspection of that process began with the dissolving of Mr. Craft as lecturer into a "long-shot" of the Vitaphone studio. Standing in mid-scene Mr. Craft named the various elements: the "set" of scenery with two performers ready to be filmed; elaborately sound-proofed camera booth, with one side removed to show its interior; the amplifier and sound recorder. Describing the camera, he explained that it was driven by a special motor in exact synchronism with the recorder. The camera's eye then followed him to the recording room, where he named the apparatus in sequence from microphone to wax, and described the phonograph recorder in detail. Mr. Heller, the Vitaphone director, then took charge of the studio and the camera recorded the actual operations in it while an instrumental number was being produced.

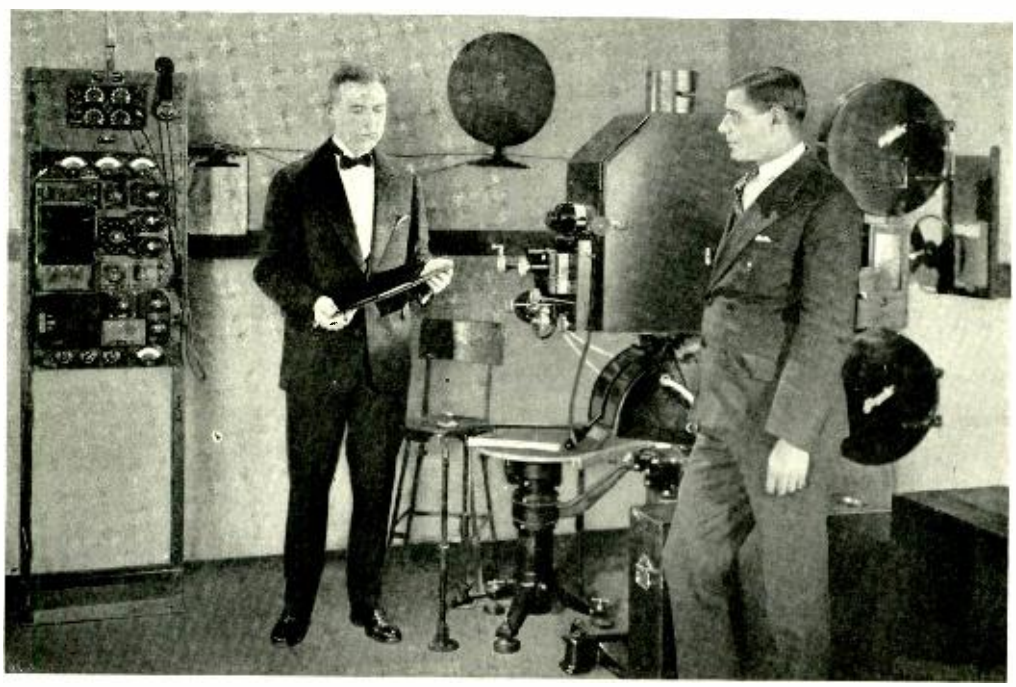
By one of those lightning jumps, so easy in movie technique, the scene changed to the projection booth of a theatre, where Mr. Craft described the sound-reproducing system. An operator appeared and started the apparatus as though to show a picture. The audience then saw—and heard—

the musical number whose studio production had been watched a few minutes before. As a finale, Mr. Craft reappeared on the rostrum from which he had first spoken. Summing up, he pointed out in these words the significance of the entertainment:

". . . Events, complete in actions and in sounds, can now be reproduced by these methods regardless of time or place. We of the immediate present and the generations to come will be the gainers by this possibility. The Faraday of the future, the Pasteur and the Galileo, may by this method make available to students in any place or at any subsequent time a demonstration of their scientific researches and synchronize therewith their own comments, discussions and even their personalities. The communication and demonstration of scientific material will be facilitated and our entire educational process may undergo changes beyond the reach of our present imaginations.

". . . We may well stop to realize that each achievement like that of the present has been accomplished through the painstaking labors of many scientific workers over long periods. These men have grasped nature's secrets and their researches now permit us to make nature obedient to our will in the wonderful ways of the present day.

"Let us therefore consider this demonstration as a tribute to the many workers, some of whose names you will never even hear, the many workers in the various fields of science and engineering, who, through their enthusiastic labors, have made possible such results."



This special "set" was used by Mr. Craft to demonstrate the operation of a Vitaphone projection booth

In the Month's News

AT A RECENT MEETING of the New York Section of the American Institute of Electrical Engineers the following papers were presented by members of the Laboratories:

"Frequency Measurements with the Cathode Ray Oscillograph," by F. J. Rasmussen.

"A Shielded Bridge for Inductive-Impedance Measurements," by W. J. Shackelton.

EIGHTEEN ABSTRACTS of publications by members of the Laboratories appeared in foreign technical journals, mainly during September and October. Among the subjects treated were magnetostriction, radio field strength measurements, loading, sound recording and reproducing, and photoelectric cells.

L. J. SIVIAN of the Laboratories and H. S. Osborne of the A. T. & T. Company sailed on November 13th as delegates of the Bell System to a conference of the International Consulting Committee on Long Distance Telephony which was held in Paris on November 29th.

EXTENSIVE TESTS on switches in the new step-by-step office at Toledo are being made by W. Bennett.

THE BELL SYSTEM is among the largest users of dry cells; the opinion of our engineers is carefully considered by manufacturers. E. B. Wheeler of our General Developopment Laboratory has been designated to represent the Laboratories on a sub-committee of the American Engineering Standards Committee which will prepare specifications for the manufacture and testing of dry-cells. Mr. Wheeler attended a meeting of the Committee at the Bureau of Standards, Washington, on October 25.

F. F. LUCAS has been awarded the medal of the Royal Photographic Society for his exhibit of high power photomicrographs of metallurgical specimens.

F. S. BERNHARD has just returned from a nine months' trip to Chile, during which he collected data for the design of a radio telephone communication system for the Chile Exploration Company. His experience was enlivened by several earthquakes in Chile and a hurricane on the return trip.

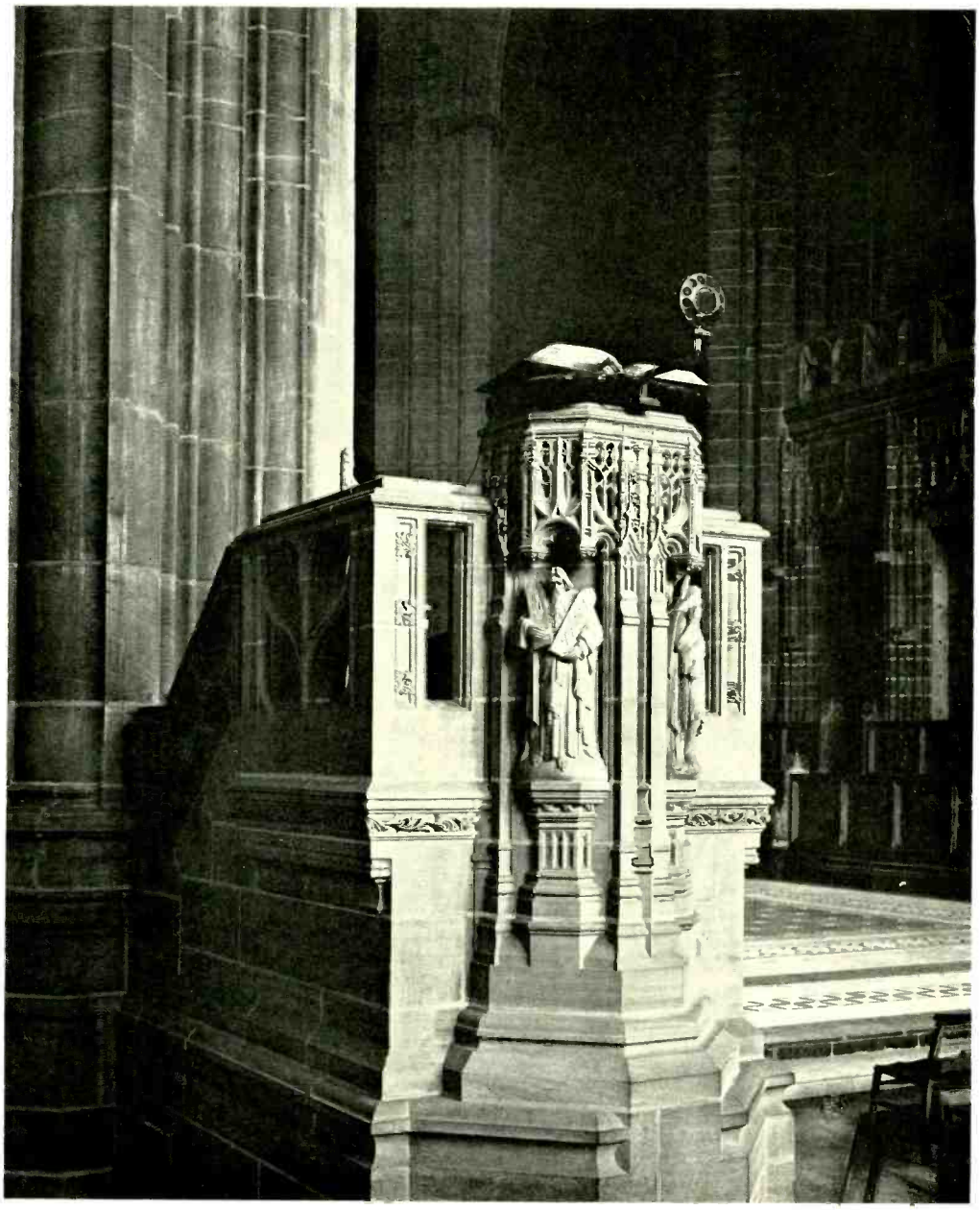
D. H. NEWMAN has gone to Montevideo to supervise the installation of a one-kilowatt broadcasting station for the Republic of Uruguay.

IN NOVEMBER, H. S. Price completed the supervision of a five-kilowatt broadcasting installation for A. H. Grebe and Company at Richmond Hill.

COMMANDER R. E. BYRD, who was in charge of the "Josephine Ford" on its flight over the North Pole, recently wrote to M. J. Kelly:

"I wish to take this means of expressing to you our appreciation of your work in furnishing us with a transmitting tube to be used in our crystal control airplane radio transmitter.

"This tube, in a 211-D casing, bearing the serial number 471713, was carried over the Pole on May



The Microphone in England's Newest Cathedral

So well did the Public Address System serve a vast audience at the dedication of Liverpool Cathedral that ecclesiastical authorities requested Standard Telephones and Cables, Ltd., to make a permanent installation. Microphones are placed on the Lectern (as illustrated) and at the Bishop's Throne or the High Altar as desired. Eight projectors serve various parts of the Cathedral

9th, and has been returned to you. I trust this is a suitable memento of our successful flight."

The tube, designed and made in the Laboratories, is now on exhibit in the Historical Museum.

THE ASTRONOMICAL JOURNAL of September 4th in its discussion of the observations on the moon at the time of the solar eclipse of January, 1925, records the assistance of the telephone system and Bell Telephone Laboratories, and also the individual readings at the time of contact made at the Yale Observatory by H. Clyde Snook and recorded by special wire service at the Laboratories.

DURING OCTOBER, H. C. Eddy, W. C. Miller and C. J. Hendrickson were in Hawthorne in connection with Survey Conference work.

J. A. ST. CLAIR, Local Engineer at Atlanta, and J. K. Erwin, of the New York Field Activities Division, recently visited Memphis and Nashville in connection with field work in the Atlanta District.

A CONFERENCE on the general situation with respect to Engineering Complaints and Questions from the Chicago District was held in Chicago on October 11th and 12th. In addition to Illinois Bell Telephone Company engineers and Western Electric Distributing House people, R. L. Jones, G. D. Edwards, S. C. Miller, W. J. Ripkey and A. I. Rivenes were present from the Laboratories.

Following the conference at Chicago, G. D. Edwards and J. M. Schaefer proceeded to Omaha and Denver to complete studies looking to the establishment of a District Headquarters at Omaha. A favorable decision was reached and J. M. Schaefer was appointed Local Engineer there. The new district embraces the territories of the Northwestern Bell Telephone Company and the Mountain States Telephone and Telegraph Company.

A. I. RIVENES has been appointed Local Engineer for the Chicago District, succeeding W. J. Ripkey, who is taking charge of apparatus and equipment investigations at Hawthorne for the Inspection Department.

F. A. W. HALE, who was in charge of apparatus and equipment investigations at Hawthorne, has been transferred to the Apparatus Inspection Division at West Street.

C. H. AMADON recently visited Portage Lake, Maine, in connection with engineering studies of the poles which are being supplied from that locality.

DURING OCTOBER twenty-five patents were issued to the following present or former members of the Laboratories:

H. B. Brown	M. B. Kerr
W. W. Carpenter	John Mills
A. A. Clokey (3)	H. W. O'Neill (3)
H. A. Frederick	J. C. Schelleng
E. S. Gibson	W. J. Shackelton
F. Gray	J. B. Speed
R. V. L. Hartley	C. L. Weis
R. A. Heising (2)	S. B. Williams
F. A. Hubbard	R. C. Winckel
J. B. Johnson	W. V. Wolfe

G. M. LATHROP and L. D. Plotner visited Sinking Springs, Pennsylvania, and observed a trial of an unattended tributary office which is to be placed in service there.

SEVERAL COMPANIES were recently visited by J. M. Finch, A. C. Walker, and G. T. Kohman of the Research Department, and E. T. Hoch of the Apparatus Development Department. The companies visited were C. H. Dexter and Sons at Windsor

Locks, the Smith Paper Company at Lee, and the Pittsfield Laboratories of the General Electric Company.

L. W. McKeehan recently attended in Washington, D. C., the 944th meeting of the Philosophical Society of Washington, and a meeting of the Magnetic Analysis Committee of the American Society for Testing Materials in Bridgeport, Connecticut.

W. A. Marrison has returned from Ingleside, West Virginia, where he was supervising the installation of a maximum-voltage indicator.

H. E. Ives attended the annual meeting of the Optical Society of America at Philadelphia, and the celebration of the fiftieth anniversary of the founding of Johns Hopkins University in Baltimore.

D. C. Meyer and C. Borgmann visited during October the new No. 11 central office and No. 3 toll installation at Pottsville and the new central office at Reading.

Proposed methods of toll operation recently took C. White to Boston and Providence.

J. H. Bell was recently in Canada in connection with the carrier telegraph system which is to be used by the Canadian National Railways.

An installation of a step-by-step system at Springfield, Massachusetts, was visited recently by a number of engineers, among whom were J. L. Dow, R. E. Noble, C. Borgmann and S. F. Butler.

The Bell System Technical Journal for October contained several papers by our engineers:

"Radio Signalling System for the New York Police Department," by S. E. Anderson.

"Electrode Effects in the Measurement of Power Factor and Dielectric Constant of Sheet Insulating Materials," by E. T. Hoch.

"Quality Control Charts," by W. A. Shewhart.

"Load Carrying Capacity of Amplifiers," by F. C. Willis and L. E. Melhuish.

A conference on the college man in business held under the auspices of the Graduate Placement Bureau of Yale University was addressed by John Mills on "The Necessity of a Better Mutual Understanding" between business as to its requirements in men of various personalities, interests and training, and the colleges as to their aims and methods.

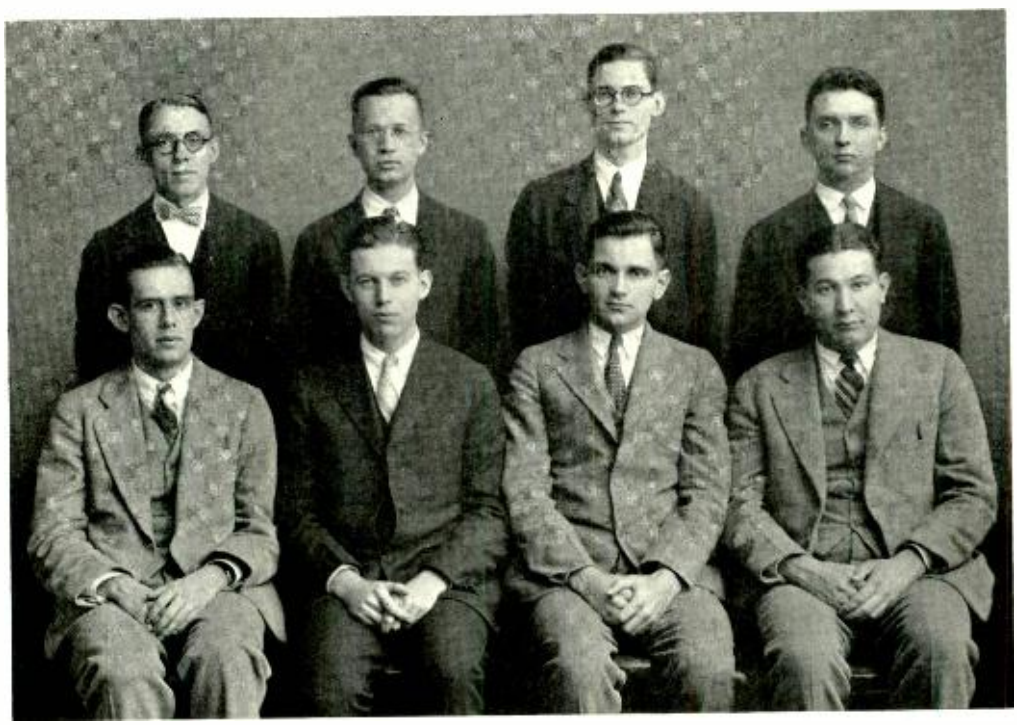
D & R News Notes

Contributed through H. S. SHEPPARD, *Executive Assistant*

IN England are L. Espenschied, A. B. Clark, R. Bown, Austin Bailey and H. C. Silent in connection with transatlantic radio-telephone tests. Mr. Espenschied, who sailed on November 6th, and Mr. Clark and Dr. Bown, who sailed on October 9th, will be away until the middle of December. Dr. Bailey sailed on August 20th and is expected back after the first of the year. Mr. Silent, who has been in England since late in March, is expected back some time after the first of the year.

J. T. O'Leary, H. R. Nein, M. L. Almquist and R. H. Lindsay are at present testing the trial installation of the short-haul (type D) carrier telephone systems recently installed between Watertown and Syracuse, New York.

In this year of the 50th Anniversary of the telephone, demonstrations of talking moving pictures have been



Recent graduates who have completed their introductory training in the Department of Development and Research. Standing: L. R. Montfort, U. of Virginia; W. H. Wise, California Inst. of Tech.; J. T. Dixon, M. I. T.; M. R. Purvis, Johns Hopkins; seated: W. T. Rea, Princeton; A. M. Hughes, Harvard; C. W. Halligan, Bucknell; A. Herckmans, Columbia

given throughout the country. W. W. Sturdy of the Department of Development and Research has been in charge of a number of these demonstrations. One of the demonstrations was given at the Yama Farms Conference of the Associated Companies' Presidents.

J. M. Fell and T. A. McCann have been in Washington and Atlanta in connection with the trial installation of new differential-duplex telegraph repeaters for composited open-wire lines.

F. W. Reynolds and A. Weaver spent several days recently in Boston and Cleveland with the new telephotograph apparatus just installed for the first telephotograph service to those cities.

A. E. Hunt made a brief trip to Washington to study the operation of one of our new types of telegraph systems specially designed for printer service.

T. C. Henneberger and P. G. Edwards have just returned from an extended trip in connection with the New York-Chicago cable, during which they studied fundamental methods of fault locating on toll cables.

D. C. Smith spent three weeks in the field inspecting experimental poles in the Buffalo-Warren Line.

F. D. Powers is now in Texas and Mr. A. P. Jahn is in Indiana in connection with the application of an experimental treatment to poles.

R. W. Morris, R. S. Bailey and L. L. Eagon made a brief visit to Boston and Providence and arranged for a trial installation of a new tandem toll line switching system. Mr. Eagon also made a brief visit to Cincinnati to assist the engineers there on the preparation of a program for converting their offices to straightforward trunking.

B. C. Bellows attended a recent conference of toll traffic supervisors at Chicago.

J. Davidson attended the cut-over of a No. 3 toll board at Reading, Pa.

Eight recent graduates have just completed the training course whereby they were introduced to their work in the Department of Development and Research.

Club Notes

IN September, 1925, we held our first golf tournament at the Salisbury Country Club, and it was so successful that two were held during the 1926 season. The popularity of golf has grown to such an extent that, in addition to the Club tournament, department teams have been organized and both inter-departmental and inter-company matches played.

In the August RECORD we published the account of the first inter-company match, between the Contract Sales Department of the Western Electric Company at 195 Broadway and the Commercial Relations Department of the Laboratories.

On Saturday, September 25, a match was held at the Salisbury Country Club between teams representing the Equipment Branch of the Telephone Systems Department and the Commercial Relations Department. The Equipment team won.

The match between the Kearney Equipment and Bell Laboratories Equipment organizations at the Spring Brook Country Club, Morristown, on Saturday, October 23, was won by the Laboratories team by 9 to 6.

WOMEN'S ACTIVITIES

For the past three months certain activities have played a very definite part in the everyday plans of our members. From all indications, they will continue to do so.

SWIMMING is one of these. The women now appreciate what they accomplished in last season's classes. They have advanced to the point where they can swim the length of the pool, and have acquired some diving form. Miss Steel has been teaching the crawl, sidestroke and backstroke; and some of the swimmers have mastered the swan and jack-knife dives. The last class for this group will meet December 8th, but a new course will start early in February, 1927.

* * * *

We have other forms of exercise

	Kearny Eqpt.	*Score*	*Team Points*	*Bell Lab. Eqpt.*	*Score*	*Team Points*
1—	1. W. M. Hart.....	95	3	W. L. Kidde.....	92	..
	2. C. A. Walls....	86	..	G. T. Lewis.....	101	..
2—	3. S. E. Klunder...	116	1	N. H. Thorne....	104	2
	4. F. B. Longfellow.	97	..	E. J. Johnson....	97	..
3—	5. L. E. Reynolds...	116	1½	E. H. Smith.....	106	1½
	6. W. H. Lang.....	117	..	E. J. Kane.....	136	..
4—	7. J. H. Scull.....	147	..	C. D. Dusheck....	150	3
	8. L. E. Bayment...	145	..	H. H. Lowry.....	121	..
5—	9. M. Loop.....	137	½	C. D. Walker....	120	2½
	10. J. S. Rooker.....	139		I. W. Brown.....	145	..

Score of golf match between Kearny Equipment and Bell Laboratories Equipment

to consider in our New Year's program, and since the Gymnastic and Eurhythmic Dancing Class is taking its place in our history along with swimming, we want to plan for it. Mrs. Watkins has been inspiring the members of her class to work while they play and play while they work when it means exercise. It is interesting to follow through a group of exercises, to find first that you have many muscles which have not been in use and then to find those same mus-

May E. Murtagh, in charge of card parties

cles become flexible, until finally you dance with perfect ease. Ask any member of the class if she is enjoying it. Then plan to be among those present when the next class meets in February. This year we have been having a large number in attendance each evening at the Manhattan Trade School Gym and we find that the evening usually provides an hour of fun.

* * * *

BASKETBALL has not had quite as early a start as have the other activities, but it is none the less popular. Thirty-seven signed up for Monday evenings, and many of these have appeared for the practice games. The present plan is to play as a whole group each week until January; then teams will be formed with strength as evenly divided as possible. Later in the season a team made up of the members who have shown their ability to play well and have been faithful in coming out to the practice games will be chosen to represent the Club in outside competition.

* * * *

Did you hear about the special instruction that the women's bridge club has been having? Each night for four weeks they have been learning the important things that a good bridge player should know. Bridge has been one of the sports that neither winter nor holidays could stop. Men, look to your laurels this year when the tournament is played.

Eleanor D. Bolan, in charge of swimming classes

It is interesting to find that the Riders are still enjoying the outdoors. Even though there have been no regular riding classes the tickets for the Unity Academy have been in steady demand.

Chess

The chess season opened on Saturday, November 13, with a match between the Brooklyn Edison Company and the Bell Laboratories Club. This year the chess players have a rather stiff program. In addition to the inter-departmental tournament, nine matches will be played in the Commercial Chess League of New York and five matches in the Bell System Chess League.

Martha Briegs, in charge of gymnastic and dancing classes

The schedule of games is as follows:

Commercial Chess League of New York

Nov. 13—Brooklyn Edison Co.
Nov. 27—Chase National Bank
Dec. 11—Henry L. Doherty Co.
Jan. 8—Guaranty Trust Co.
Jan. 22—McGraw-Hill Co.
Feb. 5—New York Edison Co.
Feb. 19—Tide Water Oil Co.
March 5—Western Electric Co.
March 19—Western Union Tel.

Ellen Kerney, in charge of basketball

Nov. 19—W. E., Hudson St.
Dec. 3—W. E., 36th St.
Dec. 17—American Tel. & Tel.
Jan. 7—W. E., Kearny.
Jan. 21—W. E., 195 Broadway.

In the Club Tournament, playing for three prizes, will be approximately forty men, grouped into three classes. Each man will play ten matches.

If you are a player and are not taking part in the activities of the chess club, you are cordially invited to attend the next meeting. Arrangements may be made by calling D. D. Haggerty.

One of the oldest and most popular sports is handball; and now the Club has added it to the list of the

many activities which it is sponsoring.

For the present, available facilities do not permit of an inter-departmental tournament but a team has been organized to represent the Club in the Bell System Handball League which opened its season on Thursday evening, November 11.

Tryouts for this team were held on Monday, November 8, and ten men were picked.

The schedule of games is as follows:

Nov. 11—W.E., 36th St.
Nov. 23—W. E., 195 Broadway.
Dec. 7—American Tel. & Tel.
Dec. 14—W. E., Hudson St.

All games will be played in the gymnasium at Hudson Street and will start at 5:30 P. M. Five games will be played in each match, three singles and two doubles.

ENSURING HEALTH

Health, and efficiency in athletics are inseparable. To make certain of the former the college football team regularly undergoes physical examinations. Health, and periodic examinations, are just as important in the world of business. These facts are well brought out by H. T. Marshall of the Dartmouth football team:

"Daily examination of the men was one of the functions of the trainer which was important. Many concerns make a practice of examining their employees periodically and the benefits are apparent. It is unreasonable to expect a man to give his best to anything if he is not absolutely well. Few persons are conscious of ill health, yet there are many not in perfect health who are unaware that they are not wholly fit. They are not efficient in their work; they are nervous and irritable. They seem to be getting nowhere yet seldom do they trace these results to ill health."

Election of Club Officers for 1927

Early this month an election will be held, to choose the president, vice-presidents and four departmental representatives for the coming year

At a meeting held on October 25, as provided by the constitution, the Nominating Committee, W. Wilson, D. D. Haggerty, K. B. Doherty, L. B. Eames, J. G. Motley, J. V. Moran, G. Heydt and J. J. Fennelly, *selected the following candidates:*

For President

Albert F. Gilson

Edward J. Johnson

For First Vice-President

John A. Waldron

John V. Moran

For Second Vice-President

Helen Cruger

Vivian Kilpatrick

Departmental Representatives—Two Year Term

Commercial

Arthur Reading

George J. Fallon

Research

Arthur L. Johnsrud

John C. Steinberg

Tube Shop

Edmund F. O'Connell

Paul J. Higgins

Telephone Systems

Thomas Ingram

Thomas J. O'Neil

Ballots will be mailed to all Club members on Saturday, December 4, 1926, and must be placed in Ballot Boxes between the hours of 8.30 A. M. and 6 P. M., on Monday, December 13, 1926. No employee who is not a member of the Club will receive a ballot. Membership application forms may be had from departmental representatives or by calling at Room 164.

Applications for membership received after December 8 will not entitle new members to vote in the current election. Non-members should file applications at once to insure themselves the right to cast a vote for their candidates.

For President—Edward J. Johnson

For Vice-President—John V. Moran

We have a candidate in the person of E. J. Johnson who is well qualified for the office of President of the Bell Laboratories Club on account of his ability and personality. He has been a member of the Engineering Department for fifteen years and has a wide personal acquaintance throughout the Laboratories' organization. In the

Edward J. Johnson

many activities sponsored by the Club, he has always taken a direct personal interest. He has been a representative by appointment to the Board of Advisors of the Club for the past year to take care of the golf interests. The enthusiasm of the participants and success of the last two golf tournaments are directly the result of his efforts.

The bowling records will show that he has been up with the leaders since the bowling league was organized. Those who have attended the Club dances will recall his smiling countenance and humor on these occasions. If you have been his partner in the bridge tournaments held under the Club's direction, you will vouch for the fact that he plays the right card at the right time. His support has been demonstrated at our baseball and basketball games as a rooter par excellence. With such a record, he cannot fail to lead our Club successfully.

In soliciting your support for "E. J.," we are asking your support of a candidate who is an active participant in the social and athletic affairs of the Club, and who therefore would bring to this position direct experience and a sympathetic understanding of the problems of the Club.

* * * *

J. V. Moran has been the department representative from the Telephone Systems Department for the past three years. In fulfilling the duties of this office, he has become familiar with the details of the various activities of the Club. In these activities he has participated directly and indirectly in making them a success. From his experience in the affairs of the Club, he realizes that besides the present activities sponsored by the Club there are others, which should be promoted for the interest and enjoyment of many more of the Club's members. He will endeavor to determine these facts and strive to obtain success in new work in this direction. If "Pat" is elected to the office of Vice-President, he will fulfill the obligations of this office in a satisfactory manner.

John V. Moran

VOLUME Plenty

The Gilson Herald

NUMBER A1

Devoted to the interests of the Club with Gilson as President

Gilson Comes out for Progressive Platform

Big Year Ahead in all Club Activities

BELL LABORATORIES, Dec. 1.—Many factors account for the wide approval which is being accorded Al Gilson's candidacy. He has earned an enviable reputation not only in his own organization but in others generally for his ability as an organizer, respected leader, and energetic executive. Al Gilson is personally well fitted for the Club presidency. In addition to his well known abilities, he possesses an engaging personality which would admirably grace the functions of the presidency in the coming year.

Al Gilson stands on the following platform:

More popular method of nominating candidates.

An equitable distribution of the Club's financial support.

Resumption of free monthly basket-ball games and dances.

Encouragement of Departmental dances and social affairs.

Promotion by the Club of educational features, such as lectures and demonstrations.

John A. Waldron

If what Al Gilson has accomplished generally in fostering a spirit of cooperation, zeal and good feeling in his and his associates' daily contacts, counts for anything, then those who vote for Al Gilson can look forward to the biggest and best year of the Club with him at the helm.

Albert F. Gilson

Waldron for V.-P.

You name the sport and we will tell you what part our candidate has played to insure its being a success.

Few candidates for office can produce a record of achievements such as that acquired by Johnny Waldron, as he is known to all followers of sport throughout the Laboratories. No job is too large and none too small for Johnny. That "no trouble to help you" spirit of cooperation is always at your service.

What he has accomplished is history, and based on past performances the future of sports with Johnny as Vice-President has a glorious outlook.

Needless to say, Johnny heartily endorses the platform of his running mate, Al Gilson.

For Second Vice-President

HELEN CRUGER

One of the leading spirits in the Bell Laboratories Club, since its beginning, has been Helen Cruger. She was one of the organizers of the very successful Women's Basketball League. This year, as a member of the Board of Advisors, she has helped make several of the Club activities—among them swimming, sewing, and bridge—more popular than ever before in the history of the Club.

Helen Cruger

Miss Cruger has been one of the present Second Vice-Presidents' chief assistants. Under her leadership continuation of the present as well as the initiation of a number of new activities will be assured.

GUESS WHO!

Wanted: Ambitious, wide-awake young woman for 2nd Vice President of the Bell Laboratories Club. One with executive ability, capable of socially organizing new group activities for women. One who has had actual experience in club work, is a good mixer and an all around athlete. Pep and personality essential. Only one with unusual ability need apply.

HERE SHE IS !

Vivian Kilpatrick

DOES SHE GET THE JOB?

Departmental Representatives

Among the articles of the constitution provided by the Fathers of the Bell Laboratories Club, is one to the effect that each major department of the Laboratories shall have a representative upon the Club's Board of Advisors. The function of these dignitaries is to sit in at meetings of the Board and see that the athletic and other interests of their various constituencies are not slighted.

A. A. Reading

G. J. Fallon

Departmental representatives are elected for terms of two years. Last year, Lester B. Eames was chosen by the Apparatus Development Department; James G. Motley, by Plant and Shops; and

E. F. O'Connell

George H. Heydt, by Patent and Inspection. This year, representatives will be selected by Commercial, Tube Shop, Research, and Telephone Systems Development. Since the election of a departmental representative is a purely local affair where everyone, presumably, knows all about everybody else, no formal campaign statements have been issued by the candidates. For general information, therefore, it devolves upon the RECORD to name and identify, with its customary perfect impartiality, the various and sundry nominees.

A. L. Johnsrud

The RECORD takes great pleasure in presenting the following:

For the Commercial Department, Arthur A. Reading and George J. Fallon. Mr. Reading, who entered the Laboratories in 1922, is a member of the Estimating group of the Commercial Relations Department. Mr. Fallon is a member of the Payroll Department; his service dates from 1923.

T. Ingram

The Tube Shop's nominees are Edmund F. O'Connell and Paul J. Higgins. Mr. O'Connell's service started in 1922; Mr. Higgins entered the Company in 1919.

P. J. Higgins

In the Research Department, John C. Steinberg is engaged in transmission work, and Arthur L. Johnsrud in special research. The former entered the Laboratories in 1922, the latter in 1917.

J. C. Steinberg

Telephone Systems' nominees are Thomas Ingram and Thomas J. O'Niel. Mr. Ingram, whose work is in the testing laboratory, joined the company in 1919. Mr. O'Niel has been a member of the organization since 1918. He is engaged in estimating work on machine-switching systems.

As soon as the election is over, the seven elected members of the Board will appoint four additional members. One of them will be a woman, to have general charge of women's Club interests.

T. J. O'Neil

News Notes

DIRECTORS OF RESEARCH in fifteen industrial corporations were the guests of Mr. Craft and the Laboratories on Tuesday, November 16th. The companies represented were: American Telephone and Telegraph, Westinghouse, Union Carbide and Carbon, Aluminum Company of America, Goodrich Rubber, Standard Oil, National Lead, International Nickel, Remanol, Research Service, National Canners Association, New Jersey Zinc, Corning Glass Works, E. I. duPont de Nemours, and the Dorr Company. After luncheon, the guests proceeded to the Auditorium where they were told some details of our work and witnessed a Vitaphone demonstration. Then the guests divided into groups and were shown several phases of our work.

GERMAN TELEPHONE OFFICIALS and engineers were a recent group of visitors to the Laboratories. They were C. A. Kruckow and Dr. Ferdinand Stegmann, Ministerial Counsellors of the Reichpost; Dr. Georg Grabe, Director, and Dr. Hermann von Siemens, Engineer of Chemical Research, of Siemens & Halske; Ernst Jungheim, Georg Fruebing, Otto Weeber and G. Storch of the engineering staff of Siemens & Halske. Several matters concerning telephone systems were discussed with engineers of our Systems Development Department.

SIR RICHARD THRELFALL, K.B.E., F.R.S., F.C.S., distinguished English physicist and chemist, was a recent visitor to the Laboratories. Sir Richard, an Honorary Fellow of Caius College, Cambridge, and formerly Professor of Physics at the University of Sydney, contributed to scientific progress by numerous papers on physical and chemical subjects, and through various committees on coordination of research of which he is now chairman.

AN APPROACH to modern thought and its basis in fact is "The New Universe" by Baker Brownell. Among those to whom acknowledgement is made for criticism of the manuscript is John Mills. Intended as a guide for thought rather than as a source of information, the book makes clear that to each of the three fields of *matter, human relationships,* and *spiritual values* there is a different approach in thought.