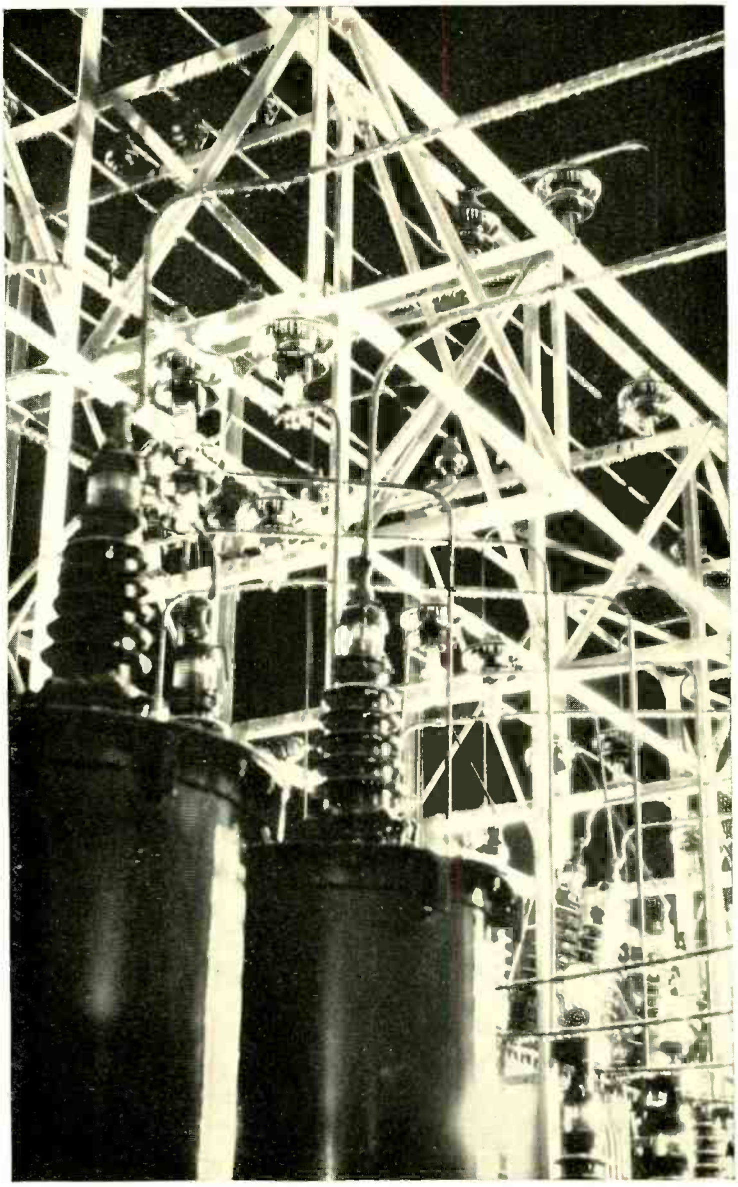
BELL LABORATORIES RECORD



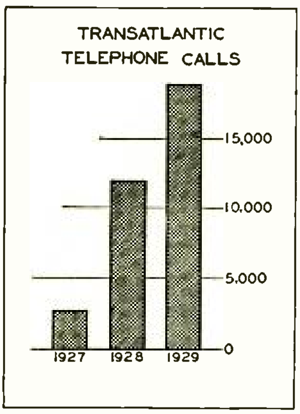
APRIL 1930 — VOL. 8 NO. 8

A Year of Progress in Telephony

In his report to stockholders of the American Telephone & Telegraph Company for the year 1929, President Walter S. Gifford, on behalf of the Directors, said in part:

THE year 1929 has been one of distinct progress throughout the Bell System in the improvement and extent of communication by telephone. About 900,000 telephones — the largest number in any year — were added. Approximately 1,600,000,000 more local telephone calls and 100,000,000 more toll and long-distance calls were handled than in the previous year. At the same time, the quality and speed of service were not only maintained but definitely improved.

To provide for growth and to improve service, $588,000,000 was spent on construction of new telephone plant and $45,000,000 on construction of new manufacturing facilities. These expenditures for additions, betterments and replacements were the largest in any one year and furnish a basis for still further progress. It is expected that the expenditures for construction in 1930 will be over $700,000,000 as compared with the 1929 total of $633,000,000.



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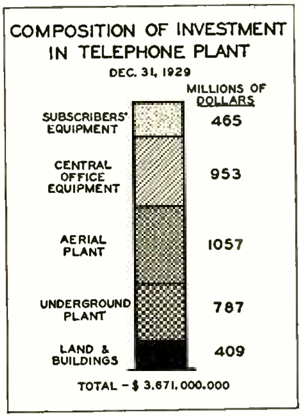
During the year there has been a considerable increase in the size of the group engaged on research and development problems designed to produce new and improved equipment and systems for telephony and telegraphy. At the present time there are in the Department of Development and Research of the American Telephone and Telegraph Company, and in Bell Telephone Laboratories, Incorporated, more than 5,400 scientists, engineers and assistants engaged on this work.

The results of the work of this group during 1929 have emphasized again both the wisdom and the necessity of adequate expenditures for fundamental research and development if our policy of enlarged and improved service at minimum cost to the user is to be maintained.

The fundamental physical conditions which underlie efficient telephone and telegraph operation are such that large expansion either in volume of service given or in range of distance covered cannot be made economically — frequently cannot be made at all — merely by an enlarged use of existing instrumentalities.

For example, the commercial necessity for very long circuits in stormproof cable and the need for a higher of transmission over such circuits, have required an entirely new adaptation of physical principles many of which are themselves new and therefore applicable only in the hands of those who are highly trained. Due



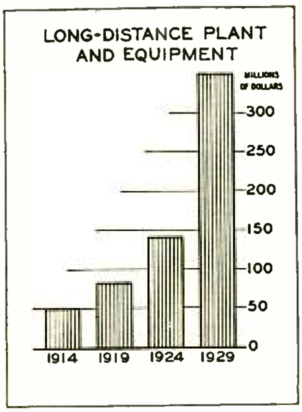
to the fact that the telephone plant is a complex interconnected structure, all parts of which must function harmoniously on every connection if satisfactory results are to be assured, the introduction of new and improved facilities in one part of the plant frequently requires modification of existing plant which would otherwise be satisfactory.

During the past year, in addition to completing a large number of important developments connected with central office and outside plant equipment, noteworthy progress has been made in extending the range, improving the quality of transmission and cheapening the cost of the long-distance plant, particularly that part involved in the longer distances. Initial designs of commercial two-way radio telephone equipment for use in airplane-to-ground and ship-to-shore service were completed and put in production. On the transatlantic telephone cable project the final development work, both on the cable itself and on the very intricate terminal apparatus required, has progressed and is rapidly nearing the point where final manufacturing specifications can be prepared.

Increase of the research and development activities has necessitated an enlargement of our laboratory facilities. New laboratories for work on radio problems and outside plant developments have been established. Land adjacent to the present laboratories in New York has been purchased and a large addition to these laboratories is under way.

* * * *

The gratifying progress in the extent and improvement in telephone communication during the past year was made possible only by the co-operation of hundreds of thousands of men and women in a nation-wide or-



ganization where the work of each is accurately adjusted to the work of all.

Great credit is due to the individuals composing the Bell System, each of whom has contributed his or her part to the smoothly running, effective organization necessary to provide a vital service for the people of this country.

Discontinuities in Magnetization

By RICHARD M. BOZORTH
Research Department

WHILE experimenting with vacuum tube amplifiers in 1919, a German physicist named Barkhausen discovered that under certain conditions a peculiar crackling noise was heard in a telephone receiver connected in the output circuit of the amplifier. The apparatus he was using is indicated by Figure 1. Whenever the magnet was moved in the vicinity of the iron core, the sound was noticeable. After repeated experiments he concluded that changes of magnetization in the iron did not proceed uniformly but in definite small and rapid steps: that a minute portion of the core would suddenly change its magnetization and after a very brief interval another change would occur, and so on. Since that time this discontinuous nature of the change in magnetization has been known as the Barkhausen Effect.

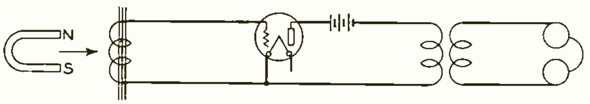


Fig. 1—By use of the simple circuit above, the Barkhausen effect may readily be observed

The approach of the permanent magnet of Figure 1 produces a change of magnetic flux in the soft iron core and as a result an electro-motive force is generated in the surrounding coil of wire. The motion of the permanent magnet is made continuous, without any sudden changes in speed, and if the change of flux were equally regular no sound would be heard in the receiver. Barkhausen's experiment indicated, therefore, that at least part of the flux changed suddenly or discontinuously.

Each atom of the core is considered to be a small magnet. When the core is unmagnetized, the atomic magnets lie at all angles so that their total effect is zero. As a magnetizing force is applied the atoms line themselves up and produce an overall magnetization. There had been two theories previously as to how this was accomplished. The one most commonly held was that the atoms lined up one by one. The change in flux would be discontinuous, therefore, but the discontinuities would be of the magnitude of only a single atom and as there are a hundred-thousand billion billion atoms (10^{23}) in a cubic centimeter, the change of a single atom is far too small a discontinuity to be detected. The other theory was that the atoms comprising a single crystal changed as a unit. This would give a distontinuity large enough to be detected with sufficient amplification.

Barkhausen's experiment, therefore, indicated that the commonly accepted theory of change by single atoms was not wholly correct because some of the change was taking place in much larger units. Whether these larger units were crystals or some

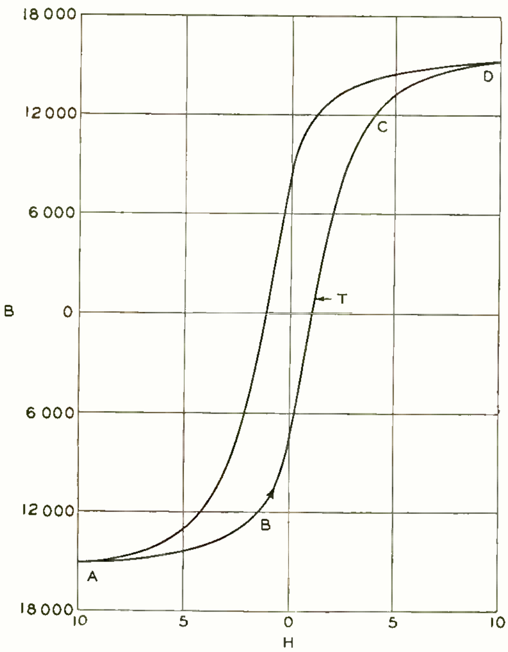


Fig. 2—An ordinary magnetization curve of iron

other undetermined grouping, and how much of the total change was made up of these changes of large units was entirely unknown.

Early experiments gave evidence that the Barkhausen effect was chiefly if not entirely confined to the steep part of the magnetization curve—along the section B to C of Figure 2. This would seem to indicate that ordinarily but single or very small groups of atoms changed at a time, and that only when magnetization is taking pace at a rapid rate do large groups change simultaneously and cause the crackling noise in the receiver.

To answer the questions presented, it was necessary to devise a circuit which would give an indication of the size of the individual changes and also would integrate the individual changes so that the sum of the small Barkhausen reversals could be compared to the total change in magnetization. For the latter purpose an arrangement similar to that shown in Figure 3 was provided.

The essential elements of the experimental equipment are a magnetic core in which the magnetization is changed very slowly from saturation of one polarity to saturation of the other, a coil wound on this core which would have induced in it currents proportional to the sudden changes in magnetization, an amplifier to increase the current flowing in the coil to measurable values, and some form of indicator which would integrate the individual changes over a short period of time. The detector shown is an ammeter which due to its sluggishness integrates the individual impulses over a time long compared to the individual impulses but actually of only a few seconds duration. Other forms of detectors were used at different times depending on the type of measurement being made but a somewhat similar principle is embodied in all of them.

As the circuit was arranged, two secondary coils were used connected in series opposition. This was done partly to neutralize any stray magnetism that might pass through the

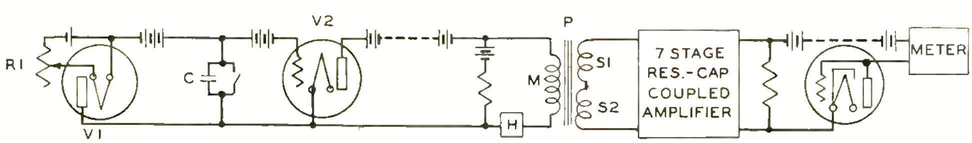


Fig. 3—Measurements of the Barkhausen effect were made by means of the circuit shown in this illustration

shielding but mainly to make the mean voltage applied to the amplifier equal to zero so that the charges on the coupling condensers, produced by many successive impulses in one direction, would not be lost by discharging through the grid leaks. The use of two coils necessitated a rectifier, shown in the detector circuit of Figure 3, so that the impulses from only one coil would be indicated. The change in magnetization caused by the primary winding is made so slow that only very rarely will Barkhausen changes occur at the same time within both coils and thus produce no effect on the meter.

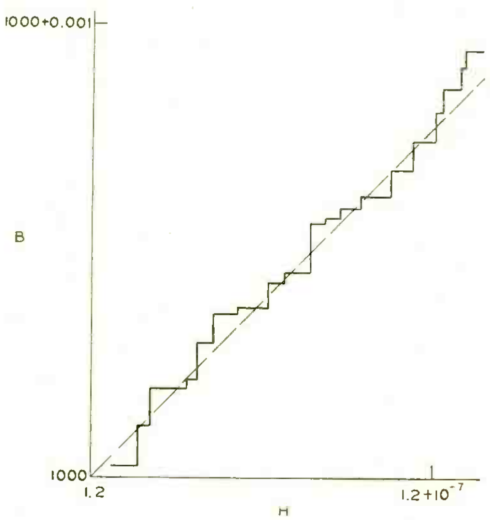


Fig. 4—The above diagram illustrates how the irregular progress of magnetization characteristic of the Barkhausen effect would appear if a small section of the magnetization curve at "T" of Fig. 2 were greatly magnified

This gradual change in magnetization was brought about by charging a condenser C very slowly by the vacuum tube V1. The voltage building up across the condenser slowly changed the input voltage of the tube V2, and caused a corresponding slow increase in the output current, which produced the magnetizing force.

The sensitivity of the detecting circuit employed for measurements on the steep part of the magnetization curve was such that a sudden change of ten billion atoms or less would not cause an appreciable reading. As a result the summations obtained from the experiment include only those changes involving more than ten billion atoms. This set the volume of the smallest detectable change at about the equivalent of a cube a ten-thousandth of a centimeter on a side. The largest changes observed were of the order of 10^{17} atoms, corresponding in volume to a cube of about a hundredth of a centimeter on a side, so that the entire effect recorded by the indicators corresponded to changes in groups of from 10^{10} to 10^{17} atoms.

This would correspond in many cases to actual crystal sizes; but that the correspondence was accidental was shown by using core material composed both of very small crystals, from which changes larger than crystal size were obtained, and of very large crystals where the changes were less than crystal size. Cores containing only one very large crystal, prepared by D. D. Foster, were experimented with and it was found that the changes in them were of the same order of magnitude as for the very small crystals.

The experiments indicated also that practically the entire change in magnetization over the steep part of the curve is accounted for by these sudden reversals of magnetism in groups ranging from 10^{10} to 10^{17} atoms with an average of about 10^{15}. The average size varied somewhat for differ-

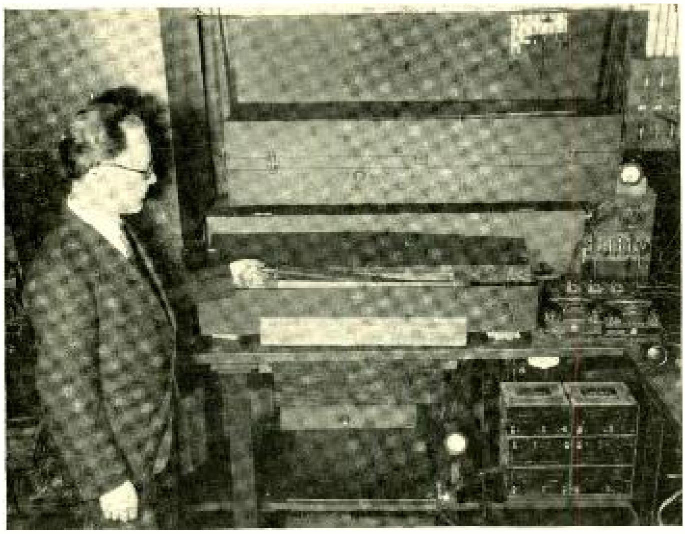


Fig. 5—J. F. Dillinger with the experimental apparatus used for measuring the Barkhausen effect

ent materials but the range was small.

Another set of experiments determined that Barkhausen changes are found over the entire magnetization curve. That previous to these experiments they had been observed only on the steeper portions was probably due to insufficient amplification. The average sizes of the Barkhausen changes, however, are smaller at the ends of the hysteresis loop (magnetizing force of ten gauss for iron). Here their average is about 10^{11} atoms as compared to an average of 10^{15} on the steeper parts; and the changes may be only partial and not complete reversals of the magnetism of the atoms within the group. Although it was formerly thought that the magnetization changed along a smooth curve as shown in Figure 2, except for some small discontinuities along the steep part of the curve, it is now known that the change is discontinuous over the entire range. A small section of the curve of Figure 2 at T has been magnified a million fold and given as Figure 4 to show more nearly the manner in which magnetization changes.

As a result of these experiments, therefore, the theory of magnetization must be modified. Instead of accounting for a steady change in magnetic state, proceeding atom by atom, the theory must be based on changes of very large groups of atoms occurring simultaneously. For different kinds of magnetic material the sizes of these groups are not radically different but they do vary in size at different points on the magnetization curve. At saturation on either end of the curves the groups are smaller but they increase in size with decreasing magnetization. A maximum is reached near the steepest part of the curve where the total magnetization is about zero.

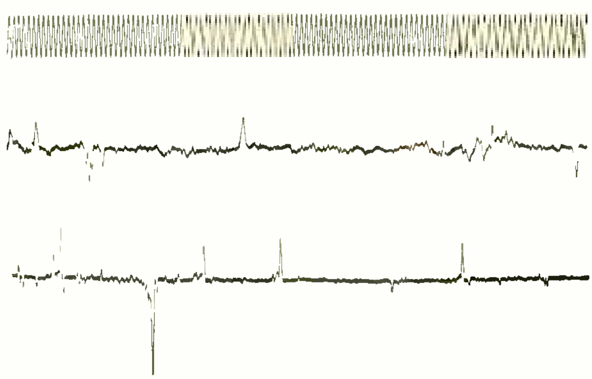


Fig. 6—Oscillograph of amplified Barkhausen effects with 1,000-cycle timing wave for comparison

Recording the Sound Picture

By T. E. SHEA
Special Products Development

NOTHING less than amazement can follow a first survey of sound-picture recording systems and practice. Attending performances of sound-pictures prepares us inadequately for the magnitude of addition and extent of change which sound has introduced in motion-picture procedure. What appears in mechanical effect to be a simple audible supplement to cinematography, requires not only much new apparatus but new talent and technical training, new care and habits: the complete transmutation of a large industry.

Thus the several buildings, themselves largely transformed, which shelter the stages are electrically connected with an entirely new building containing the sound-recording and auxiliary equipment. These buildings are staffed by new technicians: transmission engineers, articulate actors, musicians. Of the complex system, acoustical, electrical, mechanical and chemical, thus housed and animated, almost the entirety is novel to the motion-picture field. Such of it as is not (the cameras and stages, for example) is greatly modified.

To simplify a survey of it, the system can be split into its component similar "channels." Each channel, the equipment associated with one sound-scene stage, is independent of its fellows in machinery and procedure, except for such circuits as permit interchanging apparatus.

The stage itself is the first, and the only acoustic, element in the channel. To fill this new important function, the old stage had to be recast to satisfy acoustic as well as visual needs. But beyond this, the acoustic problems of sound-scene stage design are for many reasons far more exacting even than those of theater stages, in which sounds are directly projected from actors to audience.

Obviously the stage problems are at least doubled by the fact that two stages, the recording and the reproducing, take additive part in the sound picture between the original playing and the final hearing: the total permissible divergence from naturalness must be divided between them. Inability to see the whole of the original sound-scene stage in the final picture makes it impossible for the audience to accomplish the unconscious psychological adjustments which assist it in the legitimate theater. The microphone lacks the binaural property of the ear which helps us to distinguish the directions of sounds. Further, sound-picture stages are used more daringly than theater stages to display scenes whose actual construction differs greatly from the visual and acoustic illusions they are intended to create. Finally the intensity level used in reproduction is so much higher than the level of the stage-sounds recorded that undesired noises originally near the threshold of audibility may be disconcertingly audible when reproduced.

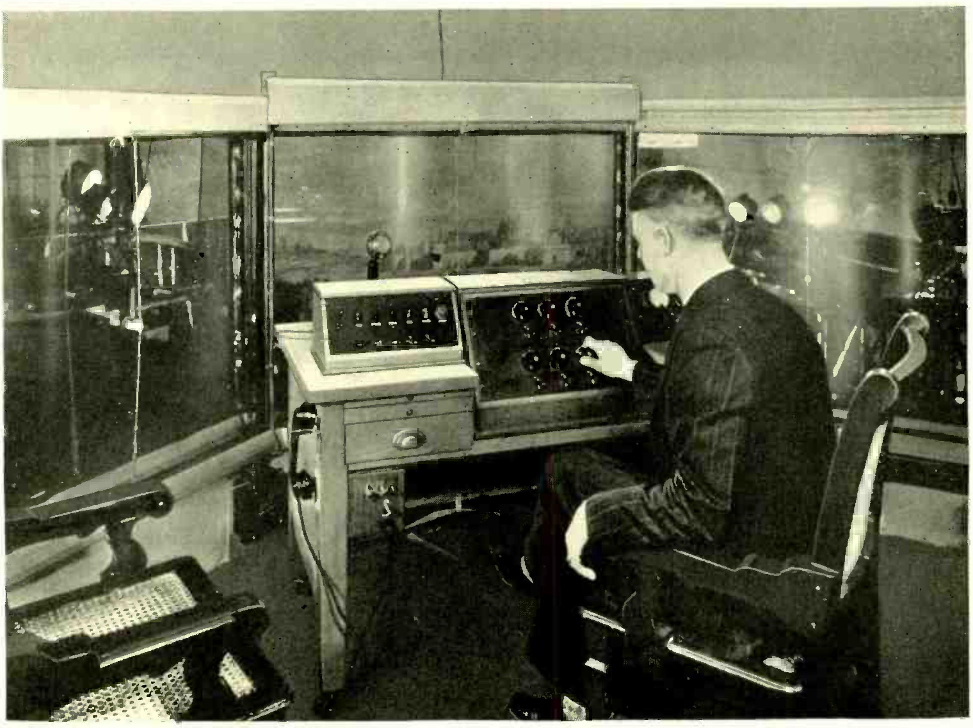


Fig. 2—On the "mixer" table in the monitor room overlooking the stage are faders (center) for the several microphones, an overall volume indicator and volume control (right) and a communicating system (left) of lights and telephones

Hence the motion-picture architects construct the sound-stages to exclude outside noises by multiple walls with intervening air spaces, and usually to reduce reverberation of inside noises by coverings of sound-absorbing materials on walls and ceiling. To counteract special and varying acoustic features introduced by scenic "sets," the monitor, who is responsible for the sound effects, places further reverberation damping in the form of portable sound-absorbing "flats." So far as possible the sets themselves make use of carefully selected sound materials, occasionally of multiple walls, and are seldom in completely enclosing form. In general the monitor seeks acoustic conditions intermediate between the objectionably "live" and the objectionably "dead," but the extent to which he finds damping desirable depends upon the sound and scene to be recorded.

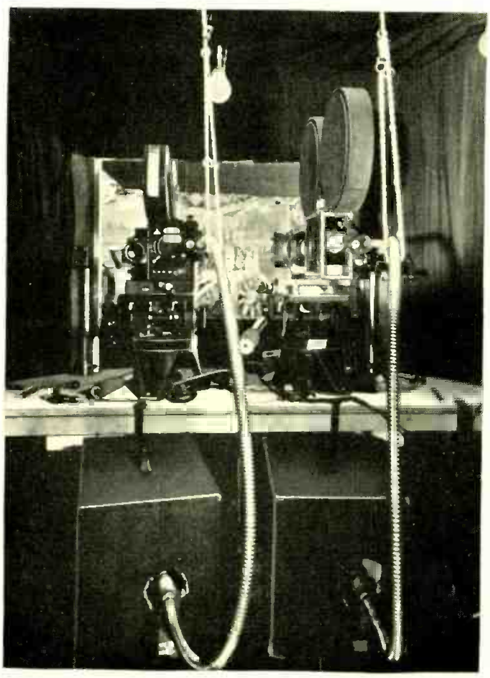


Fig. 3—Development of silent cameras is in progress to remove the necessity of placing the cameras in these sound-proof booths, and thus to regain the camera freedom of the silent pictures

Playing in the past only to spectators—the cameras—actors on the new stage play also to auditors—the microphones (Figure 1). These sound-sensitive instruments are usually suspended, with their associated amplifiers,* from the ends of long movable booms, and are electrically connected by flexible cables with a microphone junction box in the stage wall. Carefully, and often with difficulty, the monitor locates them about the stage in such positions that they will satisfactorily pick up the desired sounds. The construction of the set, correlation with the viewpoint of the camera as eyes and ears are correlated, and personal elements introduced by the actors, conspire to complicate this location.

In the monitor room (Figure 2) above and behind the cameras, sound-insulated from the stage and constructed to simulate theater acoustics, sits the monitor, observing the action through a bay window and listening to the sounds presented him by the monitor horn. It is from this position that he performs and directs all the activities, before and during recording, for which he is responsible. For the preparatory arrangement of microphones and damping "flats," he gives orders to stage-hands through a loud speaker on the stage. On his monitor table, to which the microphone circuits are independently led, attenuators permit him to "fade" the microphone currents individually and collectively, and thus entrust him control over the balance, quality and volume of the sounds transmitted to the recorders. To ensure that the sound

* Bell Laboratories Record, *June*, 1928, *page* 329.

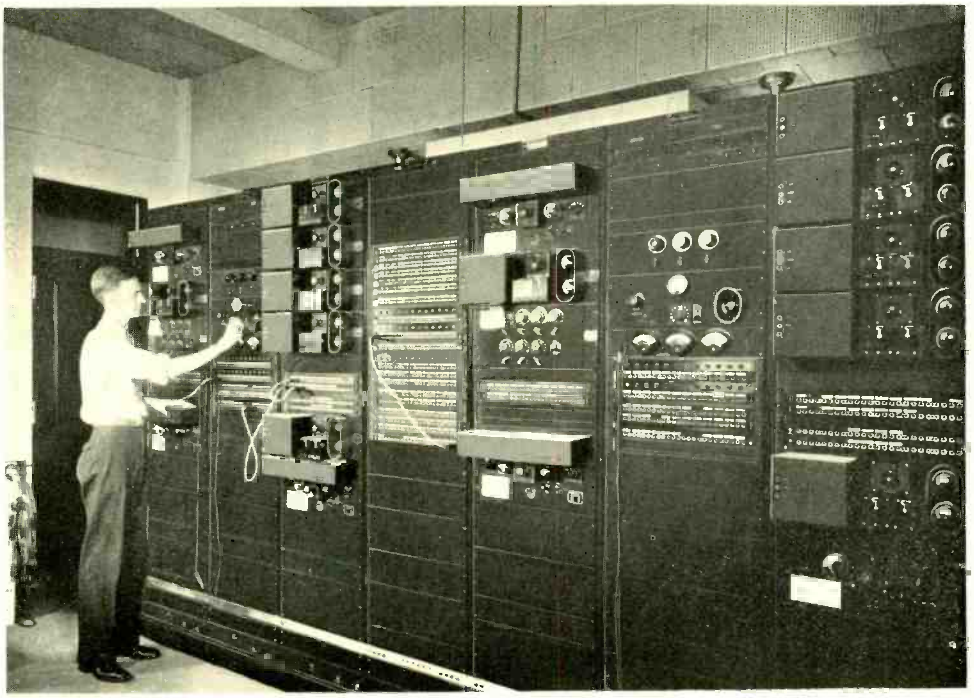


Fig. 4—In the United Artists' installation, amplifiers (of three bays for each channel) are mounted in pairs, with the members of each pair separated by a patching bay

volume is always within the distortionless range of the recording system, a volume-indicator appears at the table. Master controls give him supervision over voice and lamp systems for communicating between various locations in the channel.

During recording, the mechanics of play must be acoustically as well as visually suppressed. Absolute silence is required of directors and stagehands; they even wear shoes whose soles are covered with rubber sponge. The noise of cameras and motors is excluded by enclosing them in soundproof booths, fronted with clear glass windows and mounted on rollers for mobility (Figure 3). Camera booths are constructed for one and for two cameras, of which in the latter case one is used with a telescopic lens for close-ups. Several booths may be used with each scene, to provide the film-cutter with a choice of viewpoints from which the pictures are all synchronized with the same sounds.

Amplified in the monitor room, the sound currents are trunked for further amplification and final recording to the recording building, which is separated from the stages because of fire hazard. Following a channel amplifier, four bridging amplifiers, leading from a bridging bus, divide the channel and feed their outputs to the recording machines (Figure 4). A fifth amplifier, leading from the bus and feeding the monitor man's horn, affords him "direct monitoring"—an accurate index of balance, volume, and quality, especially valuable in predetermining acoustic conditions during rehearsal.

The sounds now pass to the recording room of the channel, in which attendants have charge of two disc and two film recorders driven by synchronized motors in step with the cameras on the stage. When film is to bear the sound record ultimately released, he operates both film recorders simultaneously, for insurance against costly

Fig. 5—Testing equipment is used each morning for transmission measurements on each channel

failure of one. A wax recorder is also operated, to provide a record for immediate playback. By a variable attenuator adjoining each machine he adjusts the volume of sound to its proper level before recording begins.

In the wax recorder,* the sound currents actuate a sharp stylus of sapphire or ruby, shaped to ensure a clean cut, which records the sound as lateral variations from a smooth spiral groove in a polished disc of metallic soap. In the film recorder,** the currents operate a "light-valve," shining on sensitized film and recording the sound as a photographic track of varying darkness. After recording, directors and actors can immediately judge the dramatic effect of the record, without waiting for processed films or discs, by using a play-back reproducer on the wax. This instrument differs but little from reproducers used with hard finished records in theaters, chiefly in the care with which it is designed to minimize damage to the soft wax.

The driving system for camera and recorder motors secures synchronism and constancy of speed in all, by electrically interlocking all motors through a single distributor and driving this distributor by a motor whose speed is kept constant by an electrical governor.* The interlock effects an exactly equal number of rotations for all motors, permitting a "start" point to be marked on sound and scene records while they are still stationary so that they can be set in step when ultimately reproduced.

Thus the sound-scene recording system comprises a rather large number of pieces of apparatus, decentralized and interconnected, which are served by attendants with diverse duties. Because of this extent, and the fact that failure during recording is seriously expensive, suitable routine must protect the functioning of the system and coordinate the activities of the personnel. In these general respects the sound-picture system is like a telephone system, and telephone experience has helped greatly to provide the testing and coordinating procedures, just as it has more familiarly helped to devise the apparatus itself. Maintenance routines similar to those of

*Bell Laboratories Record, *November*, 1928, *page* 85, *and July*, 1929, *page* 445.

**Bell Laboratories Record, *November*, 1928, *page* 95.

*Bell Laboratories Record, *November*, 1928, *page* 101.

large telephone repeater stations furnish primary protection. A test man, in a laboratory equipped with suitable measuring apparatus, anticipates potential trouble by testing each channel daily before it is put in use (Figure 5).

Analogous to the monitoring of long distance lines and transoceanic links is the monitoring of sound-scene systems. To secure overall supervision of the performance of the system, the monitor supplants "direct" by "indirect" monitoring when recording is in progress. By this substitution he retains all the control that direct monitoring gave him, and gains insurance against overloading the light valves in the film recorders. Monitoring indirectly, he has a continuous presentation of the sounds as they are being delivered to the film, and immediate warning of breakdown anywhere in the direct path of sound.

Roughly like the signal-lamp system of central office supervision is that which directs sound-picture recording routines. Its use is only a part, however, of many operations preliminary to recording, operations necessarily more numerous and exacting than for silent films. Actors rehearse to such proficiency that silent direction is satisfactory. The monitor meanwhile fixes the locations of the microphones, and at a final rehearsal verifies his judgment by indirect monitoring, using the entire recording system except the films and discs themselves. When these recording media have been inserted in the machines, the monitor signals the recording room to "interlock." By master controls, the recorder attendant locks the motors by closing one phase of their three-phase power supply, places start marks on discs and films, and signals that all is ready. On signal from the monitor, the recording man closes the polyphase and direct-current supplies, and, when his meter shows that motors are up to speed, lights red bull's eye signals at all stations to start the action and indicate that recording is in progress.

A remarkable feature of the extent of the system is the number of mutations (Figure 6) through which the embodiment of the sounds passes, to emerge at length with extraordinary fidelity. Thus, in the film system, sound imparts mechanical motion to the diaphragm of a condenser transmitter which translates the motion into a minute electric current. After amplification the current modulates a light, to which film is exposed. The resultant latent image is developed chemically and permitted to modulate a light to produce a positive print.

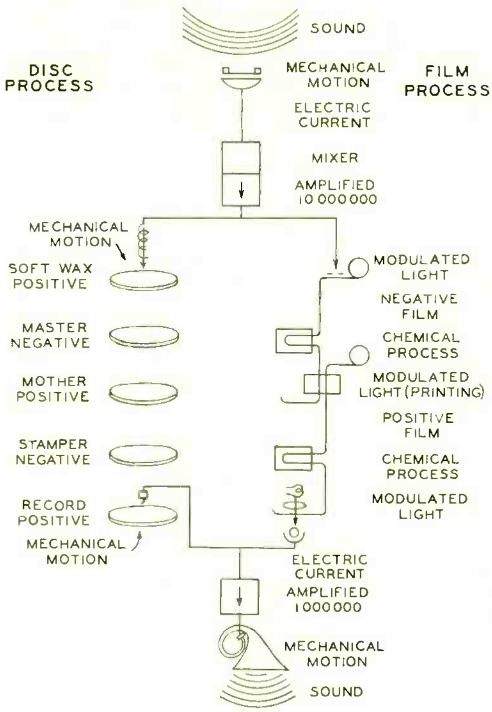
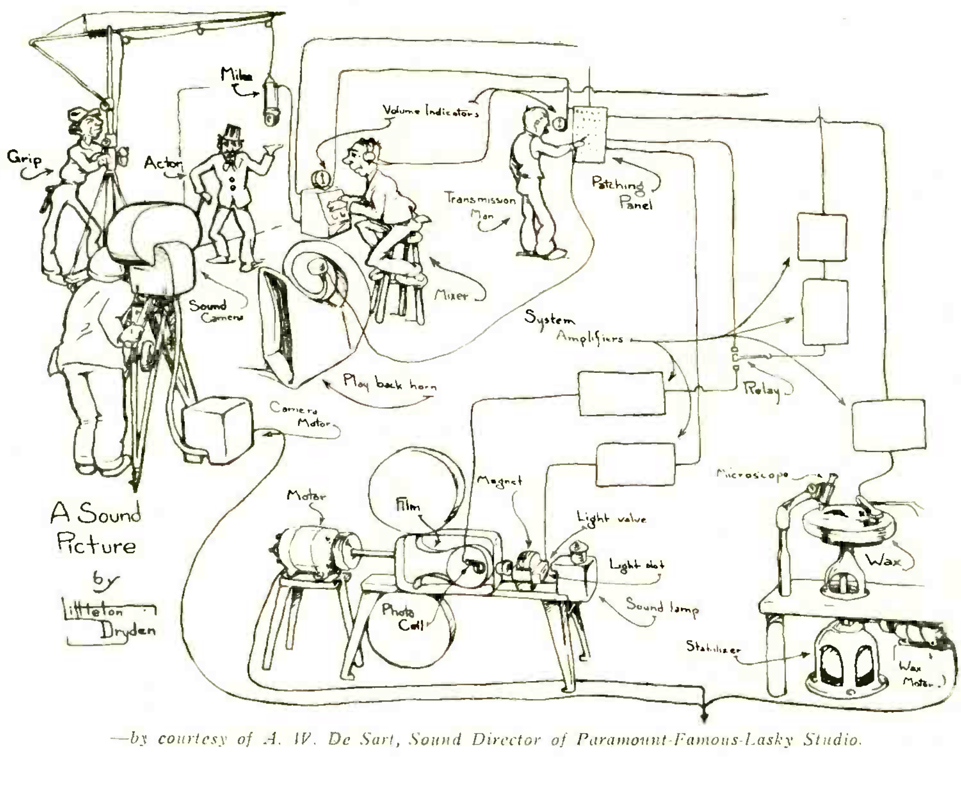


Fig. 6—Transmutations of sound from recording stage to reproducing stage

The developed positive modulates a light in the projector, which controls a minute electric current through a photoelectric cell. After amplification the current imparts mechanical motion to a loud-speaker diaphragm, which sets the air into a vibration closely approximating the original sound. A similar series of transformations takes place in the disc system.

Only great care in design and vigilance in operation could ensure such a satisfactory result. To the end that care in design may progressively supplement skill in operation, Bell Laboratories will continue the development of both recording and reproducing systems in its new Sound Picture Laboratory.

A more technical presentation of this subject was given by K. F. Morgan of Electrical Research Products Incorporated and the present writer in the Journal of the A.I.E.E. for October, 1929. *The technique here described is that of the average studio; in this rapidly changing art practices vary between studios and from day to day.*



—by courtesy of A. W. De Sart, Sound Director of Paramount-Famous-Lasky Studio.

Sound-Picture Slang

Enviably detached, movie men called their western pictures "horse opera." With gentlemanly ideals always uppermost, they dubbed the actor seeking undue prominence a "lens-louse."

And now about the sound-picture also, there gathers the special language of the adept for his trade and the devotee for his art. The sound expert, when he travels in highbrow circles, styles himself an "acoustician". On the set, however, he is known, without loss of self-respect, by somewhat less complimentary terms. The sound-picture fraternity have developed a special vocabulary, brief as a ballet-skirt and no less expressive, for the complex ideas of their technique. Here are a few phrases, culled from various sources.

Apple—amplifier tube

Blimp—sound-proof hood over camera. Also known as *bungalow* and *baby booth.*

Cans—headset sometimes used by the mixer operator

Dubbing—re-recording of sound by electrical methods

Freek—frequency (of alternation)

Flats—surfaces for construction of sets

Gobo—light shield to protect camera lens

Hards—arc lights for illuminating sets

Inkies—incandescent lamps

In Sink—in synchronism

Mike—the Great Joss of the talkies—otherwise, the microphone

Pan Stock—panchromatic film

Pec—photoelectric cell

Props—stage properties and the men who handle them

Rushes—prints of the previous day's shooting, processed in a hurry for review. Also called *dailies*

Soup—film developing solution

Stew—undesired sounds

String—light valve ribbon

When something often done before must be done again right away, a wealthy noun and a gutty verb supplant the lengthy latinisms of leisure. Thus, at the shout "Lock 'em up!" camera men are consigned to their sound-proof booths. Orders for the steps in synchronizing cameras and recorders are: "Interlock" or "sink 'em". In a moment the word comes back "Sunk!" Final pleas to the actors for "quiet"—then "Turn 'em over". The return "Red light" means that cameras and recorders are up to speed. Action begins, to end with the director's shout "cut" at the close of the scene.

A New Electrolysis Switch

By J. D. TEBO
Telephone Apparatus Development

LEAD sheaths of underground cables are subject to electrolytic corrosion chiefly where direct currents—straying for the most part from the rails of electric railways—leave them and enter the ground. Where the paths followed by the stray currents are consistently in the same general direction, corrosion can usually be prevented by connecting the cable sheath—at places where current would tend to leave the sheath for the earth path—to points of lower potential on the return system.

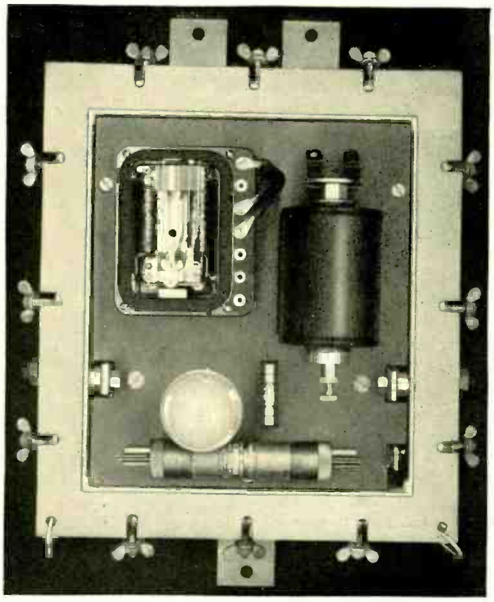


Fig. 1—In this view of the electrolysis switch both the outer metal cases and the glass cases for the polarized relay have been removed

The routes and direction of the stray currents, however, may be varied by shifting loads on the power distribution system, or by the starting up or shutting down of sub-stations. Frequently these variations cause portions of the underground cables to become intermittently positive and negative with respect to nearby portions of the negative return circuit of the power system. Under these conditions a drainage wire connecting the cable sheath to a return conductor of the power system would sometimes take current from the sheath and at other times deliver it to the sheath. Although the former action is beneficial, and necessary for the protection of the sheath, the latter is highly objectionable, since the current so delivered will of necessity leave the sheath at some other point.

For this reason it is desirable, where current reversals are experienced, to have a drainage device that will furnish a low resistance path to current leaving the sheath and a high resistance path to current seeking to flow to it. Such a device is the KS-6254 electrolysis switch recently developed jointly by the Laboratories and the Development and Research Department of the American Telephone and Telegraph Company. With the increase in automatic substations and in electrification of railway systems, as well as with the expansion of the cable plant, there is a growing demand for this type for protective apparatus.

The new electrolysis switch consists essentially of a voltage-sensitive polarized relay, a high current contactor, a ballast lamp, and one or two fuses, all mounted together in a galvanized steel box about 14 inches wide, 16 inches long, and 7½ inches deep. Figure 1 shows the general appearance with cover removed. The operation of the switch can easily be understood by reference to the sketch of Figure 2. When the cable sheath is positive with respect to the negative return, current will flow through the solenoid contactor winding, ballast lamp, both windings of the polarized relay, and through the fuse to the negative return.

When the current reaches the required value, the polarized relay operates, closing the contact "A" which shunts the ballast lamp and the high resistance winding of the relay. The current now flows through the solenoid coil, the relay contact, the low resistance winding, and the fuses. If the current increases to a value sufficient to operate the solenoid contactor, a third path of very low resistance is formed, including nothing but the contacts and winding of the solenoid, and a fuse. If the potential of the cable above the negative return should decrease, the sequence described above takes place in the reverse order.

Under the influence of reverse voltages, the cable sheath becomes negative with respect to the negative return and the relay, being polarized, tends to operate in the opposite direction so that the contact is held open. If the potential of the negative return increases, the ballast lamp will limit the flow of current to the sheath because of the rise in resistance as the filament becomes heated. Under these conditions the current is never sufficient to operate the solenoid contactor.

The sensitivity of the electrolysis switch is affected by the kind of ballast lamp used. Each switch is equipped with a label which gives the operating voltage, maximum reverse

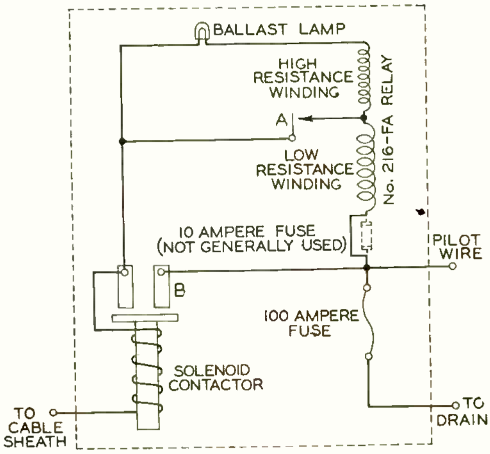


Fig. 2—Three parallel paths of different resistance are clearly indicated in this circuit diagram of the electrolysis switch

voltage permissible, and sizes of ballast lamps for the several cases. To determine the size of ballast lamp required, it is necessary to make a survey of voltage variations between the cable sheath and negative return. Where such surveys show that the maximum reverse potentials are of the order of twenty volts or less, a plug type fuse may be used in the ballast lamp socket, since the operating winding of the relay is self-protecting at these low voltages, and the sensitivity of the switch is somewhat increased with the lamp omitted.

The voltage sensitive relay is a modified telegraph relay of the 216 type, and is equipped with two windings on a permalloy core, and special contacts. The operating or high resistance winding consists of a large number of turns of small wire, and the holding or low resistance winding of a small number of turns of large wire. Permalloy is used in the magnetic circuit, in place of the magnetic iron used in other relays of this type, to reduce the effect of residual magnetism which might cause the relay to remain operated on zero voltage after it had been subjected to sudden surges of current.

Considerable trouble has been experienced heretofore with the relay contacts of electrolysis switches, due to the frequent arcing and welding which takes place under quick reversals of potential. The relay used with the new electrolysis switch, has silver-impregnated carbon and platinum-iridium contacts which have proved very satisfactory in field trials.

Due to the rapid reversals of current which sometimes take place over the drainage connection between cable sheath and negative return, the solenoid contactor has been especially designed to release quickly when the current through the winding falls to zero. In addition there is little or no bouncing of the disc against the brushes when the contactor operates, and thus sparking is reduced to a minimum.

The capacity of the KS-6254 switch, as at present designed, is 100 amperes, and larger sizes have been developed to provide for larger currents. The switches are fused to their rated capacity in order to protect the apparatus from overload. Under certain conditions a 10 ampere fuse, shown in both illustrations, may be used to protect the relay winding should the solenoid contacts fail to operate and short out the relay. A pilot wire lead may be attached as shown on Figure 2 and run to some nearby office to keep a check on the operation of the switch or blowing of the fuse.

Bell System Security Holders

The Bell System is owned by about 700,000 *security holders according to statistics as of December* 31, 1929. *Approximately* 90,000 *Bell System employees are share holders, owning an average of* 9.3 *shares each. These statistics also point out that during the last quarter of* 1929 *the operating expenditures including taxes amounted to* $2,360,000 *per day. The daily outlay for gross construction in this period was* $1,950,000.

Clutches for the Panel System

By P. E. BUCH
Telephone Apparatus Development

In a manual office the lines of all the subscribers terminate in the multiple before each operator. By the use of small jacks closely spaced, ten thousand lines may be mounted within the reach of a single operator who, by reading the designating numbers, may select the jack of the desired line. In dial offices this selection, due largely to mechanical difficulties, cannot be made in one operation. The single act of the operator is divided into several successive selections, each narrowing the field until the final choice is made of a particular line.

For each of these selections, the panel system provides a brush which is carried vertically upward in contact with a row of lugs acting as terminals of the various trunks to other selectors, or—in the case of the final selection—of the lines themselves. The driving power is a motor-driven cork roll. A rack attached to the brush rod is pressed against the motor-driven cork roll at the proper time by an electro-magnetic clutch mechanism. A typical arrangement of rolls, clutches, racks, brushes and of the terminals built into banks is shown in Figure 1. One roll is provided for lowering the brush, one for raising it at high speeds and—for final selectors, full mechanical tandem translators, and cordless "B" links—a third roll to give a low speed upward.

The rack, attached to the lower end of the brush rod, is a flat bronze strip with narrow rectangular slots as shown in the illustration. The distance between slots is the same as that

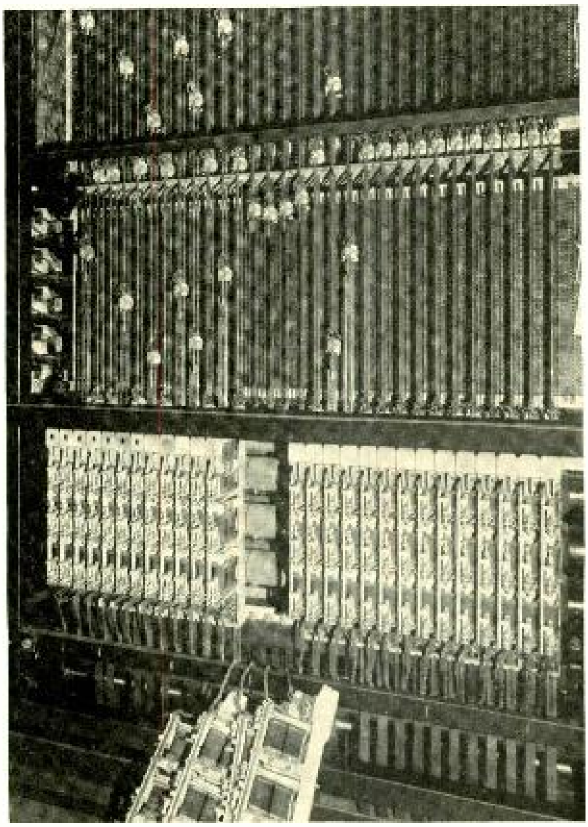


Fig. 1—A selector frame has space for thirty elevator rods on one side. Three of the clutches have been laid back to show the cork rolls

between successive terminals in the bank, except for five slots at the top of the rack used for the tripping function. A pawl mounted on the clutch frame falls into these slots as the rack moves upward so that when the clutch is released the brush will remain at the elevation it has attained. The armature of the down drive clutch is provided with an arm that releases the pawl and allows the rack to move down. In the illustration the down drive clutch is the third from bottom and, as will be noticed, its magnets are smaller than those of the two up drive clutches. Comparatively little pressure is required to drive the rack down because it would fall by gravity when the pawl was lifted if it were not restrained. The down drive roll acts merely to check the speed of the brush rod in returning to normal position.

The banks in front of which the brushes travel are built of alternate layers of sheet metal and insulation. The sheets are punched to form a number of small rectangular lugs, projecting from each long edge, which are the contact terminals along which the brushes pass. As there are usually three conductors composing a circuit, three such metal sheets are used for each trunk or line, and the brushes correspondingly have three contact shoes. The series of terminals along the edge of each sheet form the multiple connections to each trunk and for every set of terminals there is a brush rod with its brushes and clutch.

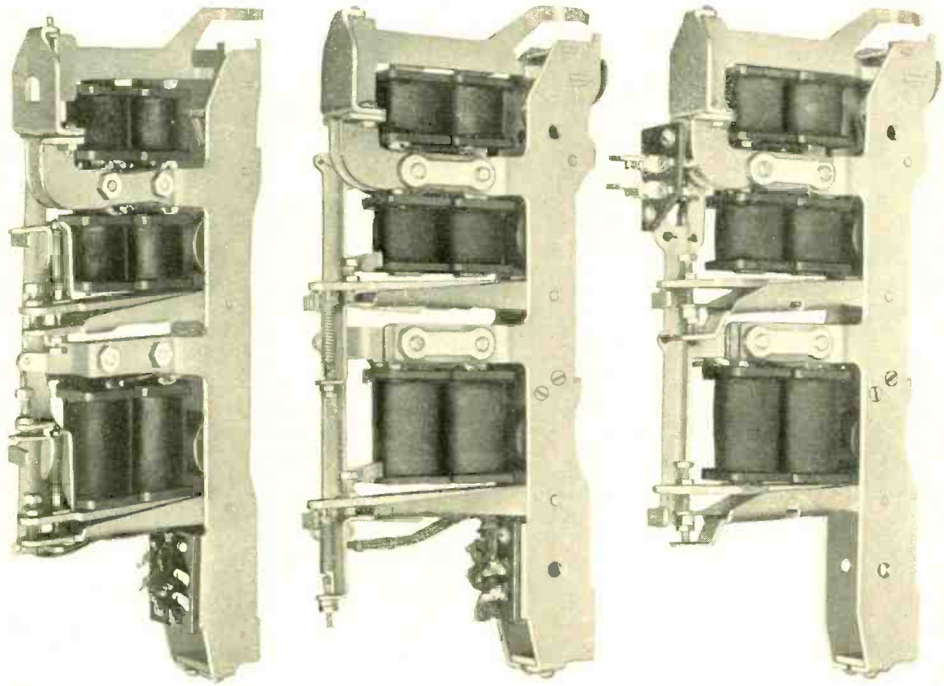


Fig. 2 — The earliest type of clutch, shown at left, resembled those used at the present time except for the spring arrangement. The recently authorized clutch, shown at the right, differs mainly from the clutch in use at present (center) in its spring construction. A reed type spring replaces the helical spring

Banks are built up of a number of such groups of three sheets and contain a maximum of one hundred trunks. Ordinarily from two to ten banks are mounted in a single frame and the brush rods for the frames carry a brush for each bank. The contact shoes of the brushes are normally spread so that they do not touch the bank terminals but they may be "tripped" to a position in which they make contact. In general only one brush on a brush rod is tripped at a time.

A trip rod parallels the brush rod as may be seen in Figure 1. Just below each bank is a finger attached to this rod and if the rod is rotated through a certain small angle one finger will engage the trip lever of the associated brush as the brush rod moves up. The fingers are mounted at different distances beneath their banks so that a momentary operation of the rod will trip only one brush. This is, in the majority of cases, done by the trip magnet mounted at the top of the clutch assembly which rotates the rod at the right moment to trip the desired brush.

The complete clutch assembly includes, therefore, from two to four sets of magnets. The top magnets, except for those few cases where brush tripping is not required or performed in some other way, are the trip magnets. The next lower set is the down drive clutch. The third is the normal or up-drive clutch for high speed, and the bottom, on frames requiring it, is the up-drive clutch for low speed.

The 200,000 odd clutches manufactured yearly by the Western Electric Company are of three forms; single speed clutches with a trip magnet, single speed clutches without a trip magnet, and double speed clutches with a trip magnet. The first form of clutch is used with incoming, district, office, and translator frames; the second with line finder and "B" link frames; and the third form with final and full-mechanical translator frames. During the development of the panel system since 1914 these three forms of clutches have been made in three types. The early type as well as the present type, and one recently authorized, are shown in Figure 2. Although many improvements have been incorporated in these clutches from time to time, the major evident modification is in the spring mechanism used to obtain pressure between the roll and rack.

As the average vertical distance between the corresponding terminals of adjacent trunks is only an eighth of an inch and as the brushes travel at a speed of approximately sixty terminals per second, for the high speed, the clutches must act very rapidly to prevent over travel. Two adjustments are necessary: one to secure the proper pressure against the cork roll and one to allow for a reasonable amount of wear before readjustment is necessary. The clutches today are very similar to those installed in 1914 except for the parts used to secure these adjustments.

The essential elements of one of the present clutches are shown in Figure 3. There is the clutch roller which presses the rack against the cork roll, a roller arm which carries the roller, and an armature pivoted at the same fulcrum as the roller arm. The armature moves the roller arm through a helical spring. The two adjustments already referred to are shown in this illustration. That marked "screw gap" adjustment allows the position of the roller to be adjusted relative to the armature when the clutch magnet is released. The amount the gap is open when the magnet is operated is a measure of the wear possible before readjustment is necessary.

The spring tension adjustment regulates the pressure with which the clutch roller presses against the driving roll. It must not be so great that the armature will fail to operate fully but must be large enough to drive the rack upward without slipping. Unfortunately the two adjustments in the type of clutch shown are not independent of each other. A change in one requires a change in the other.

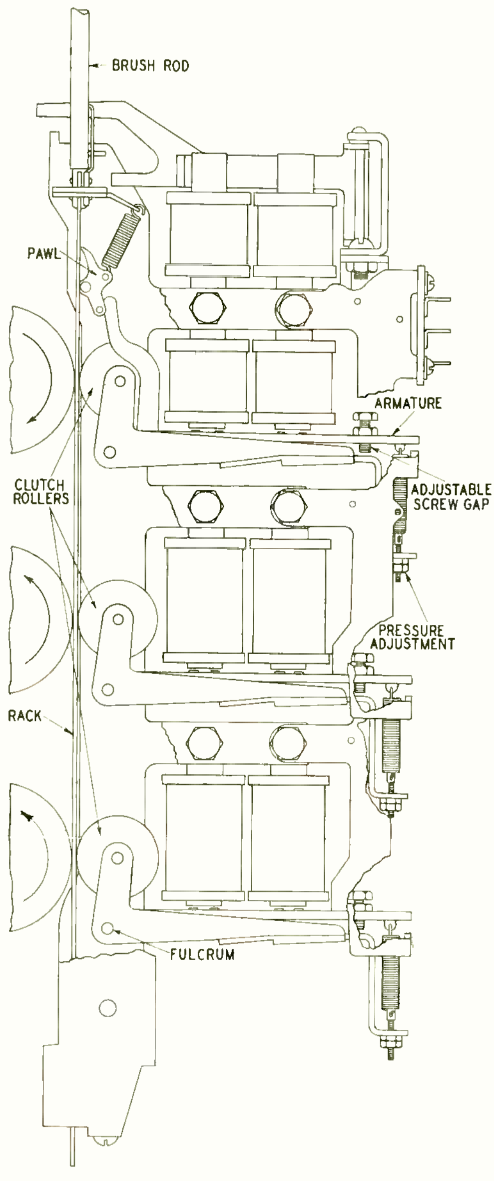


Fig. 3—A diagramatic view of a four magnet clutch assembly shows the essential operating elements

The new clutch which is shown at the right in Figure 2 was designed to eliminate this interdependency of these adjustments. When the two adjustments are independent of each other the spring tension adjustment may be made at the factory where it can be done more effectively and economically, and only the screw gap adjustment need be made when the clutch is mounted on the frame in the field.

In the new clutch the spring, instead of being helical, is of the reed type. A flat spring is fastened to the roller arm and its tension is adjusted by moving the stop nuts up or down on the screw used for the gap adjustment. The armature is threaded and the screw gap adjustment is changed by turning the screw on these threads. The screw passes through a clearance hole in the spring so that the tension adjustment is not changed by modification of the screw gap adjustment. The independence is almost complete.

In addition to this major improvement in the new clutch, several others have been made. Among these might be mentioned a redesigned roller mounting that permits the clutch roller to be properly aligned with the cork driving roll, a one piece stainless steel pawl, and the use of self-aligning non-freezing plates of sufficient area to withstand the continued blows of the armature on the magnet core. This eliminates a separate armature stop lug. Two non-freezing discs were used in the earlier clutches and offered considerably less area than the new plates shown in Figure 2.

With all these changes, which have improved both the operation of the clutch and its maintenance, it is interesting to note that there has resulted at the same time a reduction in cost.

Employees' Stock Plan Extended

Effective as of April 1, 1930, *the "Employees' Stock Plan" of the American Telephone and Telegraph Company dated May* 1, 1921, *has been extended to permit employees who have acquired stock under any of the Employees' Stock Plans to invest the dividends on such stock in the purchase of additional shares at the current subscription price under the Plan, in the ratio of one share of new stock for each four shares thus acquired and which are registered in the name of the employee. All shares registered in the employees' name at the close of business on April* 1, 1930, *and not in excess of the total number theretofore actually acquired under the Employees Stock Plans, shall be considered as having been acquired under said Plans. Additional shares acquired under this Plan or under other stock offers to employees after April* 1, 1930, *will also be available in the same proportion for subscriptions under this Plan. The first quarterly dividend assignable to subscriptions under the extension of the Plan is that to be paid by the American Company on July* 15*th. Applications filed with the General Auditor on and after April* 1*st, but not later than May* 31*st will participate under this extension in the above dividend period. Subsequent applications will be accepted and applied to succeeding quarterly dividends. A copy of the Employees' Stock Plan pamphlet revised to include this and certain other minor changes, together with a letter of explanation, has been furnished to all members of the Laboratories.*

A Thousand-Cycle Frequency Standard

By L. ARMITAGE
Telephone Apparatus Development

SOME standards, such as those of length or mass, may be made of a durable metal and preserved for convenient reference when needed. Frequency standards, however, are different; frequency is the number of recurrences of some event per unit of time, and thus its correct evaluation depends on a counting process and on a time unit. Time, however, is reckoned in terms of the period, or duration between recurrences, of some basic cyclical phenomenon. For a fundamental standard the rotation of the earth is used and the unit of time—the second—is defined as the 1/86,400th part of the average time of the earth's rotation or, as it is commonly called, the mean solar day. The earth's rotation is thus not only the fundamental standard of time but of frequency as well.

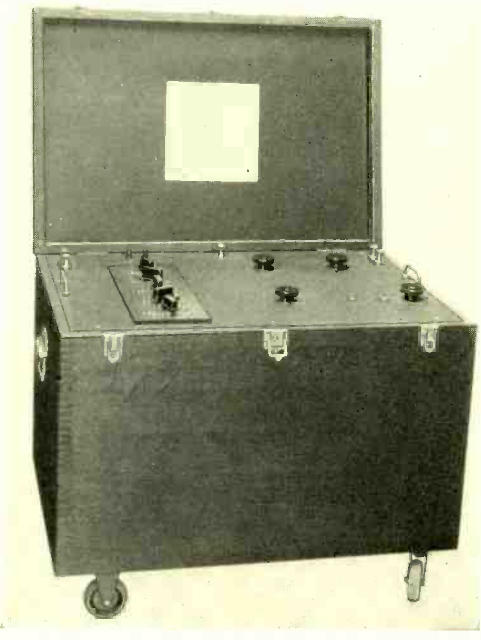


Fig. 1—The resonance-type meter measures frequency in terms of inductances and capacitances

In addition to this fundamental standard it is necessary to have other and more convenient sub-standards of frequency for daily use. Such sub-standards are of three types: primary laboratory standards* which are maintained for occasional reference only, secondary standards serving also for reference use but of greater portability, and working standards. Both of these latter types must be of rugged construction, requiring little maintenance, and of an accuracy depending upon their use. The primary standard may, if necessary, sacrifice ruggedness to some extent to attain high accuracy and reliability, but in secondary and working standards ruggedness and portability assume greater importance.

For a long time ordinary tuning forks were considered satisfactory secondary standards of frequency and were used for adjusting vacuum tube oscillators. The process was simply to strike the fork and then to adjust the frequency of the oscillator until the beat note, produced by the combina-

* BELL LABORATORIES RECORD, *August*, 1928, *page* 385.

tion of the frequencies of the fork and the oscillator, could no longer be detected by the operator. The overall accuracy of this method, limited by the accuracy of the fork and the personal errors of the operator, is about 2.5 cycles in 1,000.

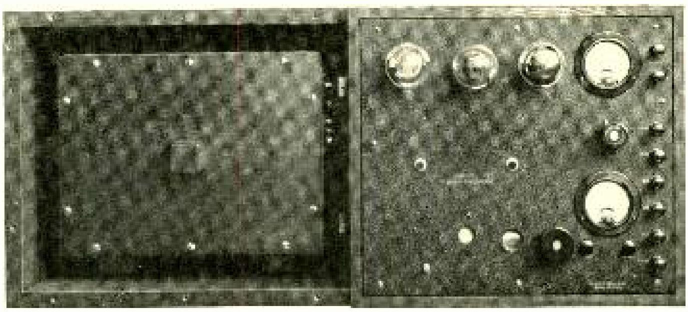


Fig. 3—The frequency control unit for the D-85737 *oscillator is in an insulating box*

Later a resonance type of frequency meter was introduced as a secondary standard. This instrument (Figure 1) measures frequencies in terms of inductances and capacitances. It is limited in accuracy only by the precision with which the values of its circuit constants may be determined. Frequencies from 100 to 50,000 cycles may be measured to 1 part in 1,000 with this type of meter. These meters were calibrated several times each year against the laboratory standard previously mentioned, by means of a cathode ray oscillograph.*

During the past few years the accuracy requirements of secondary standards of frequency have become more rigorous. The higher requirements are due largely to closer limits in the testing specifications on such apparatus as coils and filters, for the

* BELL LABORATORIES RECORD, *April*, 1926, *page* 281.

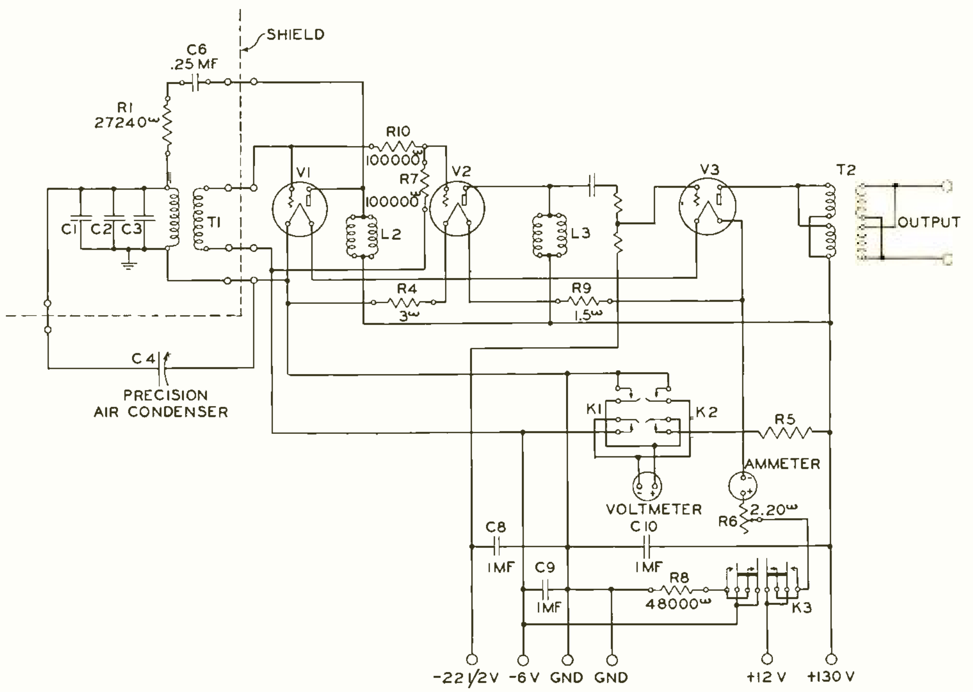


Fig. 2—Diagram of D-85737 vacuum tube oscillator circuit

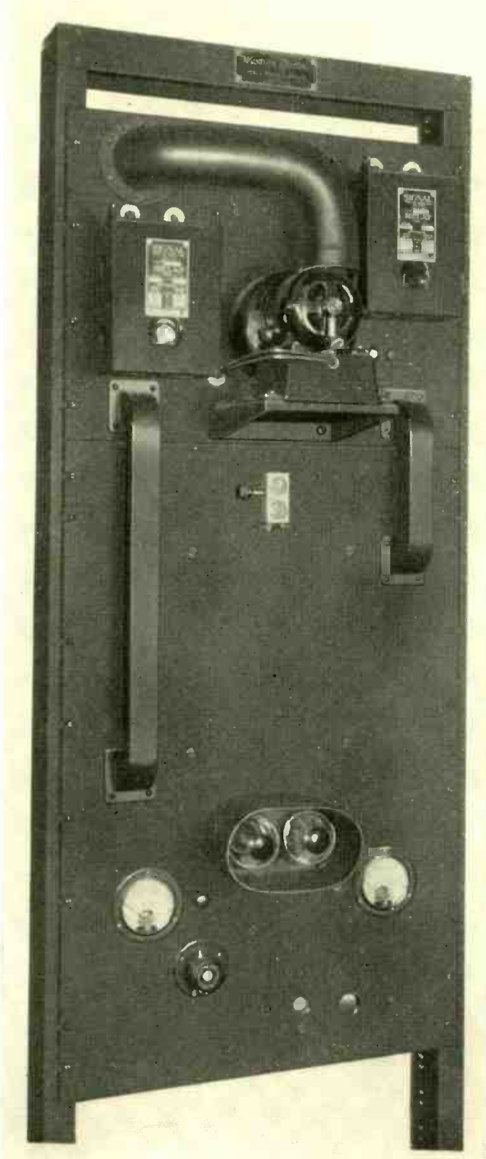


Fig. 4—Electrically heated air is passed into the box containing the oscillator to maintain a constant temperature of about ninety-five degrees Fahrenheit

measurement of whose constants the frequency of the testing current must be known. Accurate knowledge of frequency is also important when measurements are made with the resonance type of bridge.

Recently, therefore, a vacuum-tube oscillator has been developed by the Laboratories for use as a secondary standard of frequency. This standard, known as the D-85737 oscillator, is designed to produce a frequency of high stability. It differs (Figure 2) from the usual reversed feed-back type of oscillator only in the very small frequency variation that occurs with changes in temperature, and in the potentials required of its A and B batteries.

The frequency of the D-85737 oscillator is 1,000 cycles. Its frequency control unit is assembled in a compartment insulated by means of an air chamber so as to be unaffected by rapid changes in room temperatures. The cover was left off in the photograph (Figure 3) to show this construction. The tuned circuit of the oscillator is compensated for temperature changes by the use of two types of condensers having temperature coefficients of opposite signs. For a given temperature change a positive frequency increment due to one type of condenser will be countered by an equal, or nearly equal, negative increment due to the second type of condenser. The resultant frequency change is of the order of only .001% per degree Fahrenheit over a range of 15 degrees.

This oscillator is used as a frequency standard in carrying out tests at the Western Electric factories at Hawthorne, Philadelphia, and Kearny. Its frequency is ordinarily measured and corrected once a week by comparisons made over telephone wires to our Laboratories. For these calibrations the primary frequency standard of the Research Department and the cathode ray oscillograph are used. Since the Western ectric Company introduced this new frequency standard into their plants, their working standards have been calibrated against it rather than against the Laboratories' standard.

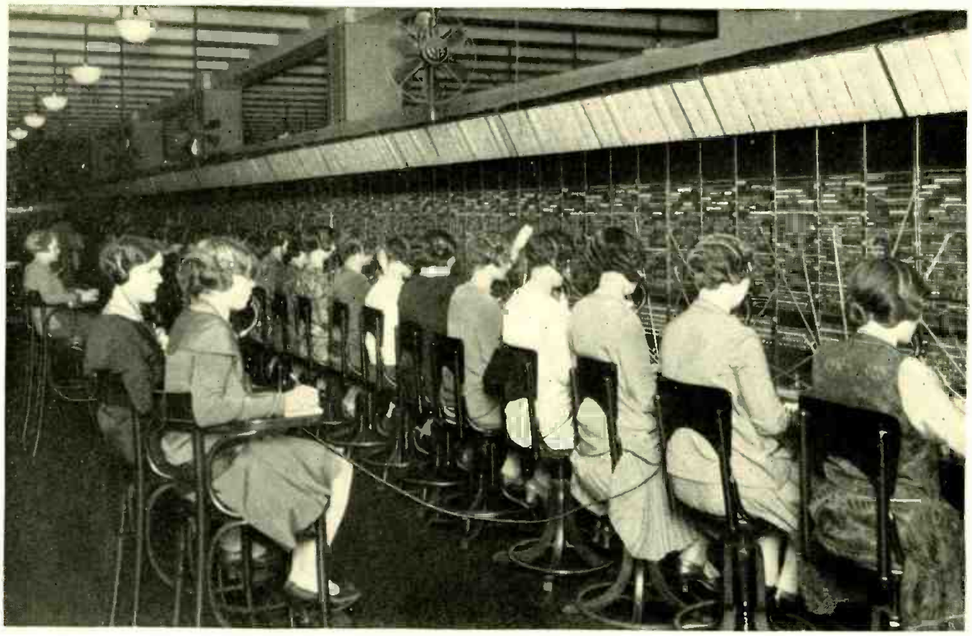
It is common practice to plot the deviations of standards determined by weekly measurements over a year's time. It has been statistically calculated that the inherent accuracy of this frequency standard under ordinary conditions and when corrected once each week is about 2 parts in 10,000. If the setting of the oscillator were fixed throughout the year instead of being corrected each week, the accuracy would be about 3 parts.

The accuracy of the D-85737 oscillator is considerably increased if special precautions are taken to maintain constant temperature and battery conditions. In Figure 4 a modified form is illustrated which has a heating system to maintain the temperature fairly constant by circulating heated air through the compartment containing the tuning unit. The temperature of the air, circulated by a small blower, is controlled by a thermostat. With this heating system and with battery potentials maintained constant, an accuracy of a few parts in a million has been obtained over a period of several days.

Dial and Other Telephones

According to recently released statistics compiled up to December 31, 1929, 4,014,000 *of the* 15,414,000 *telephones owned by the Bell System in the United States, approximately* 26%, *are dial operated. The report also shows the associated companies comprising the Bell System operate a total of* 6,396 *central offices.*

By virtue of the transoceanic radio and other long distance service, Bell System telephones can be connected with 29,500,000 *of the world's* 34,500,000 *telephones. There are* 20,233,000 *telephones in use in the United States, the Bell System owning* 15,414,000.



New Equipment for Central Office Supervision

By L. A. O'BRIEN
Local Systems Development

WITH a view to promoting improved operating service the American Telephone & Telegraph Company has recently recommended a new method of supervision and the Laboratories have developed the necessary equipment which is being introduced into the larger central offices of the Bell System. The method allows the supervisors to render greater assistance and more constant advice to the operators, which, it is expected, will help in maintaining a high grade of service.

The operating room of a central office is usually in charge of a chief operator; in larger offices, one or more assistant chief operators are also employed; supervisors are in direct charge of the operating force. The switchboard is divided into supervisor's divisions, and supervisor's telephone circuits are provided so that the regular operators can refer unusual calls to their supervisors to handle. Each supervisor's telephone circuit is arranged with jacks for receiving the plug of her transmitter-and-receiver set. These jacks are multipled through the division, one set appearing in every second or third position. A typical arrangement of these jacks with respect to the supervisor's divisions is shown in Figure 1.

Until recently, the operating plan provided that the supervisors should patrol their divisions, handling calls which required special attention and watching the work of the regular operators. It was not intended that they should "listen in" on the operators although the jacks in each operator's telephone circuit permitted this on occasion. Transmission was appreciably impaired with two headsets plugged into the circuit, but this was of little importance because lasting for such short periods.

The desirability of closer co-operation between supervisors and operators has led to the development of better facilities so that now the supervisor can monitor the telephone circuits of her operators, one at a time, and obtain first-hand information regarding the words heard and said by the operator. Each supervisor is provided with a new type of transmitter-and-receiver set which can be plugged in multiple with that of an operator without serious transmission losses. The new set uses the No. 525 high-impedance receiver, instead of the No. 528 receiver formerly used, which has relatively low impedance. A switch is provided in the cord so that the supervisor can open her transmitter circuit while monitoring. With this set, the transmission losses in the operator's telephone circuit caused by the supervisor's monitoring, is only one-half db receiving, and no loss transmitting. This condition is considered quite satisfactory.

The supervisor may now listen in continuously on the telephone set of an operator and thus become familiar with the work of each operator. If difficulties arise while the supervisor is listening, she can give immediate assistance and instruction to the operator. This method has been found effective in improving the operator's efficiency and in giving the supervisors a better knowledge of the difficulties constantly confronting the operators.

Since the new method of management assumes that the supervisor will monitor each of her operators for an appreciable length of time, it becomes

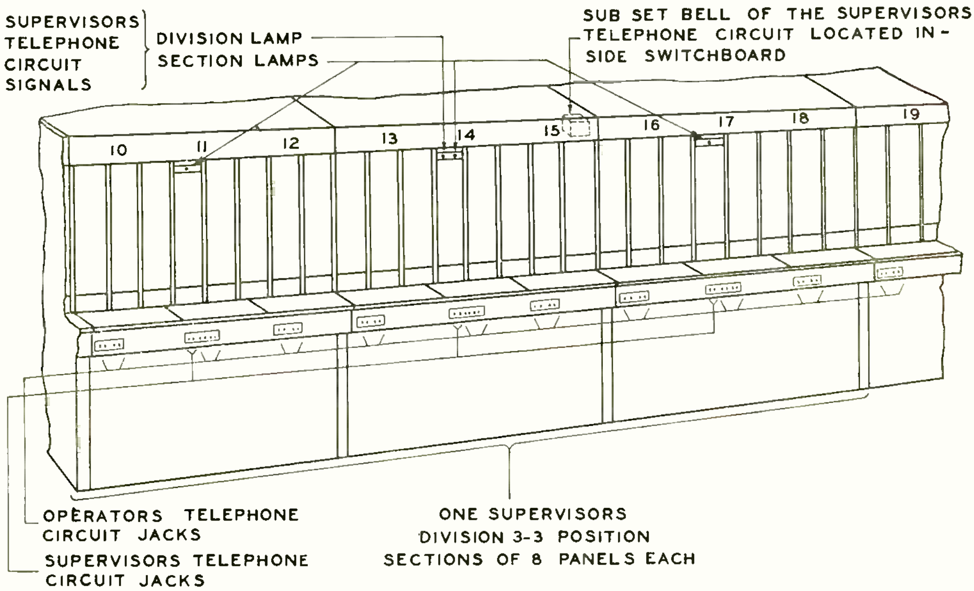


Fig. 1—Nine operator's positions form a supervisor's division and jacks are provided so that the supervisor can listen in on any operator or answer calls on her own division circuit

practical to allow her to sit down for a large part of her time on duty. Suitable chairs have, therefore, been developed for the supervisors to use and are now being supplied. It is

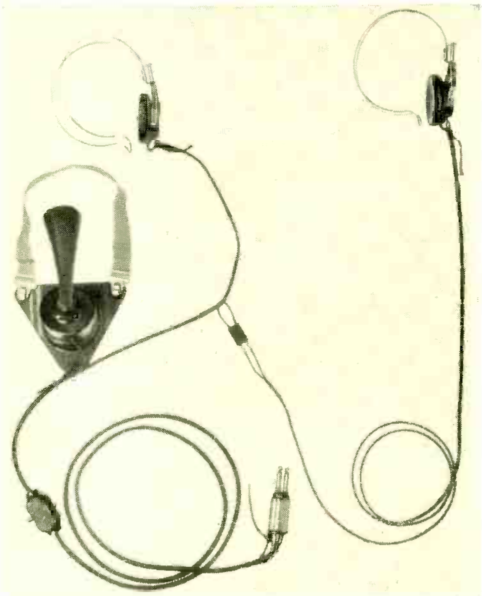


Fig. 2—A supervisor's cord showing connecting block from chief operator's headset

planned that the supervisor will sit from six to eight feet behind the particular operator she is monitoring, and the new transmitter-and-receiver set has been provided with a cord ten feet long to make this possible. While monitoring from this advantageous position, the supervisor can watch the entire portion of the switchboard included in her division.

The new chairs, among other features, differ from regular operator's chairs in not being of the swivel type. They are of comfortable shape, with arm and foot rests, and are furnished in two heights, so that they may be used in rooms with or without switchboard platforms. The arm rests are wide enough to serve as writing space to allow the supervisor to take notes while monitoring.

Arrangements have also been made for the chief operator or her assistant to monitor with a supervisor. An additional chair is provided so that the chief operator, equipped with a high impedance receiver, can sit beside the supervisor. A connecting block has been added to the supervisor's cord, which makes it possible for the chief operator or her assistant to connect her receiver set in multiple with that of the supervisor. This method of operating is shown in the photograph at the head of this article.

To match the impedance of the No. 525 high-impedance receiver to the supervisor's division telephone circuit, a No. 110-A repeating coil has been added in the circuit between the jack and the induction coil. This repeating coil was designed especially for the purpose and makes it practicable for the supervisor to use the same transmitter-and-receiver set for handling special calls on her division telephone circuit.

Although the changes in facilities necessary for the new method of central office supervision were comparatively simple, a high value is placed on the improvements expected in operating. Several thousand supervisors will be supplied with the new chairs and the improved transmitter-and receiver sets within the next year according to present plans, and the improved supervisory method should do much toward maintaining the high grade of service rendered by the Bell System.

Synthetic Photography

By W. L. HEARD
Equipment Development

IN response to the varied demands made upon them, the Systems drafting group produces many unusual types of drawings and reproductions, some of which have already been described in the RECORD.* A type of work of rather unusual character is the production of photographs synthetically. By an apparent annihilation of time, photographs are made of apparatus not yet built.

From a set of ordinary mechanical drawings, one can visualize to some extent what the completed apparatus will be like, but the visualization requires time and usually it is not perfect. Perspective sketches show much better how the final product will appear but even they lack a very desirable quality of reality. Nothing less than an actual photograph is entirely satisfactory for displaying, instantly and clearly, exactly how new and as yet unbuilt apparatus will look. Many uses for such photographs exist.

* BELL LABORATORIES RECORD, *September*, 1927, *page* 22.

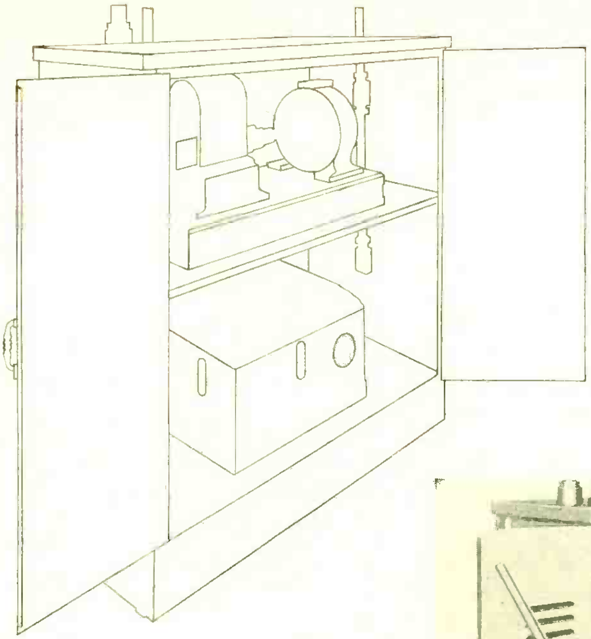


Fig. 1—A perspective drawing is the first step in the construction of a synthetic photograph

Whenever a non-technical group requires education in the appearance or operation of new apparatus, photographs are almost indispensable. If the apparatus is not yet built a synthetic photograph must be prepared.

With the complete drawings available to him, the draftsman who is to prepare one of these synthetic photographs first makes a true perspective drawing of the apparatus as shown in Figure 1. On this is filled in all the necessary detail. Then with an air brush, color is applied to bring out the lights and shades, and to give the drawing a further appearance of three dimensional reality. The colors used are only some of the shades of grey ranging from white to complete black. A photograph itself is nothing but a perspective scene livened by the various combinations, blendings, and shadings of black and white so that the drawing as finally colored by the draftsman has all the elements of a true photograph. As a final step this colored drawing is photographed and the result is the finished product shown in Figure 2.

The air brush is a mechanical contrivance by which a color solution is blown through a small nozzle upon the drawing. Masks are used when needed to confine the coloring to the desired sections. The operator has complete control of the density of coloring; anything from a hair line to a wide soft shadow can be made by properly handling the brush. A motor driven air compressor, supplying air at a constant but adjustable pressure from 40 to 100 lbs., completes the equipment.

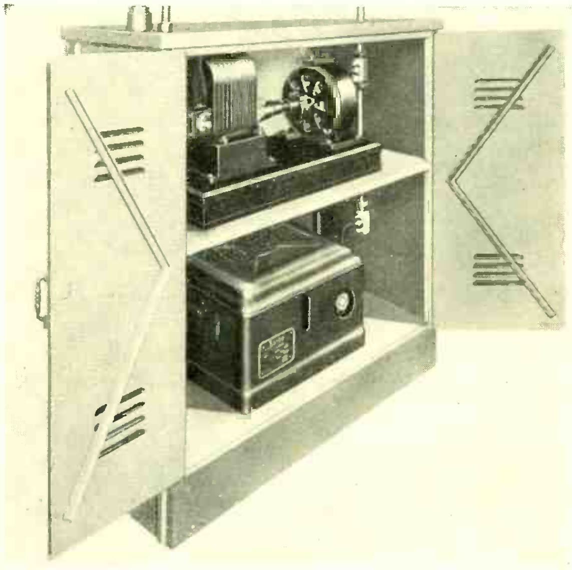


Fig. 2—After the drawing has been colored it is photographed to produce the final result

If blueprints are required, a special

dye that will not injure the texture of tracing cloth is substituted for the ordinary color solutions, and tracings, bringing the objects into relief, may be made as shown in Figure 3.

In building up the completed drawing, it is possible at times to cut certain parts from photographs and paste them on the drawing. On the illustration shown as Figure 4, for example, the fuses on the panel about half way up the frame were cut from a photograph of other apparatus.

The method is not extremely difficult to use and the complete apparatus, shown in the illustration at the head of this article, is neither expensive nor particularly cumbersome. The making of a moderately simple perspective drawing, followed by a skillful but not difficult coloring process is sufficient to yield photographs of apparatus not yet built, which will depict to anyone the appearance of new equipment well in advance of completion.

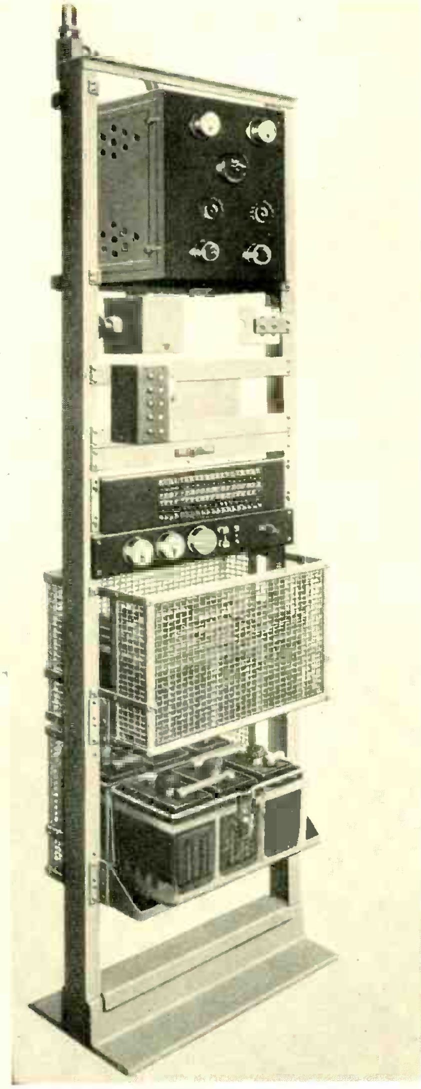


Fig. 4—Some of the synthetic photographs contain parts cut from photographs of already completed apparatus

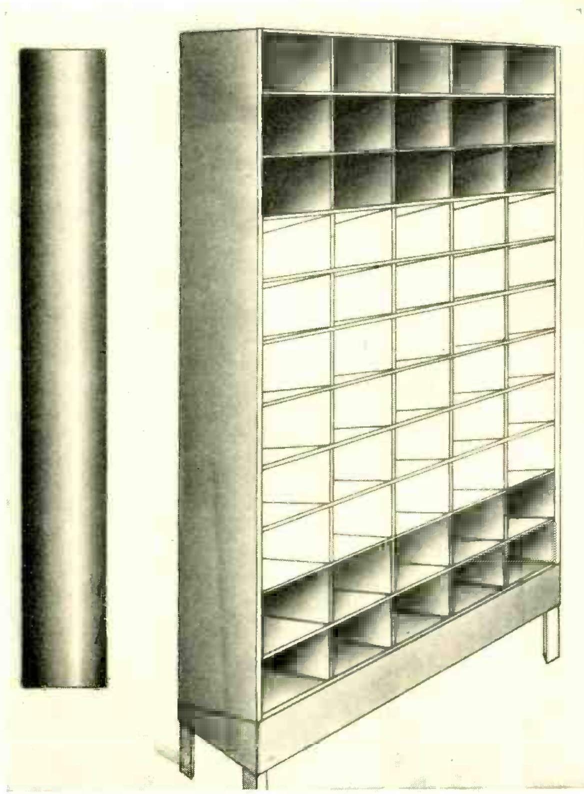


Fig. 3—A similar process done on tracing cloth makes remarkably satisfactory blueprints

Employees' Benefit Committee Makes Report

A TOTAL of $155,748 was expended for all purposes under the Employees' Benefit Plan in 1929; fourteen retired members of the Laboratories received pensions; there were no fatalities due to industrial accidents. These are some of the high spots in the report of the Employees' Benefit Committee for last year.

Two notable modifications were effected in the Plan during 1929 and were described in detail in earlier issues of the Record. Breaks in Bell System service are to be bridged when any member of the Laboratories has completed ten years of continuous service before the age of sixty-five. Under certain conditions other breaks may be bridged at the discretion of the Committee. The other modification extended the Sickness Death Benefits payable to a wife or other qualified dependents, to be four months' salary for employees of two years' service, and up to a maximum of a year's salary after ten years' service; the former limit of $2,000 was removed. Payments may also be made on the death of pensioned employees, up to the amount which could have been paid had death occurred on the last day of service.

Members of the Employees' Benefit Committee are H. D. Arnold, Chairman; A. F. Dixon, J. W. Farrell, R. L. Jones, J. E. Moravec, J. G. Roberts, and G. B. Thomas. A. F. Weber is Secretary, and C. Drake is Assistant Secretary.

A report of payments made under the Plan, during 1929, as prescribed in paragraph 30 of Section 8 of the Plan for Employees' Pensions, Disability Benefits and Death Benefits follows:

Pensions	$6,821
Accident disability and death payments	17,627
Sickness disability payments	112,240
Sickness death payments	19,060
	$155,748

A. F. WEBER, Secretary
Employees' Benefit Committee.

The above statement of payments audited and found correct.
E. J. SANTRY, General Auditor.

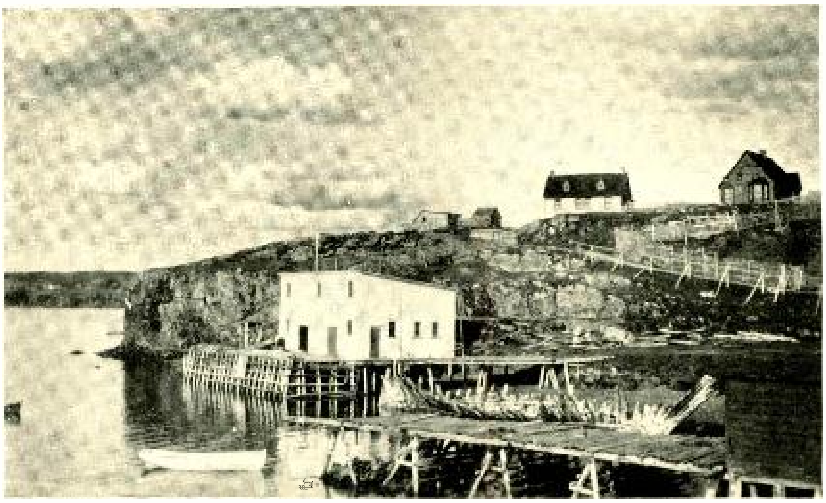
NEWS AND PICTURES

of the

MONTH

including

Biographical Notes



Our Northernmost Outpost

In this white building at Trinity, Newfoundland, E. T. Burton and A. B. Newell made studies of submarine cable interference in connection with the transatlantic telephone cable project

News of the Month

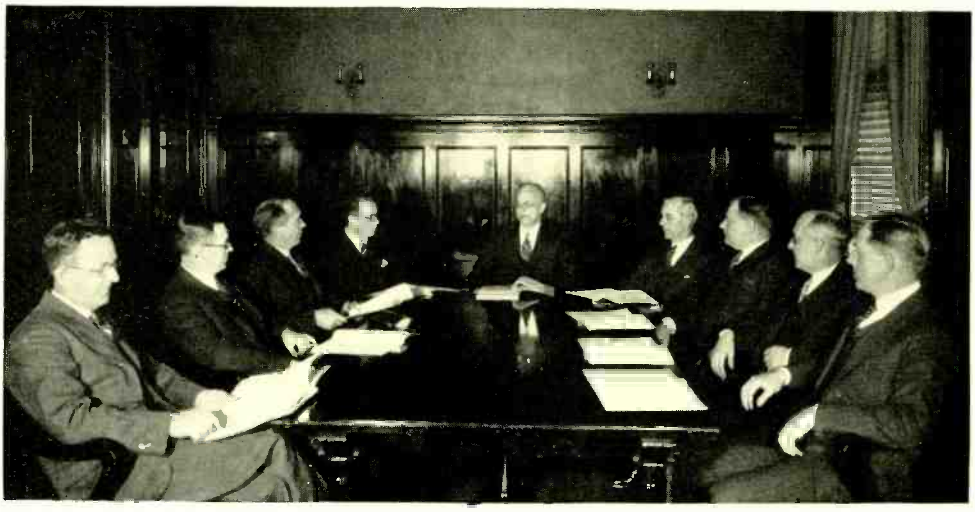
THE Western Air Express has purchased from the Western Electric Company seventeen radio-telephone transmitters of Bell Laboratories design for use at their ground stations and twenty-nine for installation in planes operating on their routes between Los Angeles, Salt Lake City, Oakland, and Kansas City.

The ground transmitters are 400-watt crystal-controlled units operating on a frequency band of 1,500 to 6,000 kc and are used for intercommunication between the ground stations and planes. The plane transmitters are 50-watt units operating in this same frequency band. Two receivers are used in each plane and at the ground stations. One covers the 1,500 to 6,000 kc band and the other tunes between 250 and 500 kc on which the government stations broadcast weather reports and beacon signals.

Communciation between the planes and ground stations enables them to report their position, weather conditions at various points, and exact location and condition in case of forced landings. The ground stations can direct and control the operation of the planes in much the same manner as trains are dispatched and controlled.

JOHN MCCORMACK, world-famous Irish tenor, was a visitor to the Laboratories on February 24. Accompanied by J. J. Lyng, vice-president of Electrical Research Products, Mr. McCormack was taken through the sound picture and acoustical laboratories and shown some of the research and development work being carried on in these departments.

Mr. McCormack displayed much



The Employees' Benefit Committee meets. Left to right: C. Drake, A. F. Dixon, G. B. Thomas, A. F. Weber, H. D. Arnold, J. G. Roberts, J. E. Moravec, J. W. Farrell, and R. L. Jones interest in the design and structure of the artificial larynx and the manner in which it performed the work of the vocal cords. It was his first opportunity to examine the device and he showed much amusement at the ingenuity of its operation. He also expressed himself very much interested in photomicrographical work carried on in F. F. Lucas' laboratory. He was received by R. L. Jones and escorted through the Laboratories by Vice-President Charlesworth, Mr. Jones and other members of the technical staff.

Enticing Electrons from Metals was discussed by Dr. J. A. Becker before the Colloquium. Dr. Becker gave particular attention to thin films, or composite surfaces containing a monatomic layer of adsorbed thorium, caesium, etc., in discussing the nature of forces that tend to prevent an electron from escaping from a metallic surface and methods whereby these forces can be decreased. A number of unexplained facts coming to light in work in these Laboratories and elsewhere was accounted for in a theory developed by Dr. Becker.

A. R. Kemp addressed the Colloquium on paragutta, a new insulating material for submarine cable developed in the Laboratories. He outlined the history of submarine cabling and the characteristics of the various insulating materials used. He then described Para-Gutta, a rubber-balata compound, and pointed out its advantages over the present insulating materials for under-sea cables.

Administration

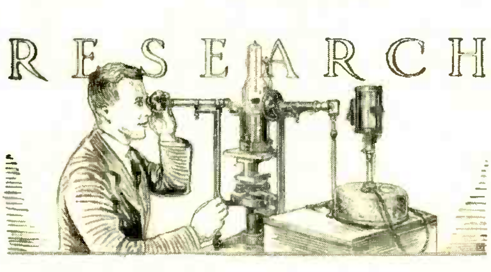
President Jewett on March 1 addressed the Post Graduate School at Annapolis on *Present and Prospective Trends in the Development of Electrical Communication.* While at Annapolis he and Mrs. Jewett were house guests of Rear-Admiral Samuel S. Robison, superintendent of the Naval Academy.

During the latter part of February he spoke before the evening session of the National Educational Association Conference on *Modern Business Looks at Secondary Education.*

On March 4 Messrs. Charlesworth, Arnold, Dixon, Jones and Grace visited the Point Breeze works of the Western Electric Company at Baltimore.

Two large audiences at Cleveland listened to S. P. Grace deliver an address and demonstration of recent telephonic developments. Twelve hundred persons attended a meeting jointly arranged by the Ohio Bell Telephone Company and the Cleveland Engineering Society on February 18. At a noon meeting at the Chamber of Commerce on the same day an audience of about one thousand listened to Mr. Grace's talk.

On February 25, he spoke at Akron under the auspices of the local section of the A. I. E. E. The officers in charge of the meeting reported that thirty-five hundred tickets of admission were requested, but owing to the size of the hall it was necessary to limit the audience to eighteen hundred. Mr. Grace was assisted by R. M. Pease at all the meetings.



T. C. Fry has been named by President E. R. Hedrick of the American Mathematical Society chairman of a committee appointed to investigate the possibilities for a new journal of applied mathematics.

During the past few weeks Mr. Fry has given several talks on mathematical subjects at colleges. At Princeton he gave a short course in *Differential Equations of Applied Mathematics* and also spoke at the University of Wisconsin on *Modern Uses of Probability* and *Science and the Man of Affairs.* He has been recently notified of his nomination to the Visiting Board of Brown University.

H. B. Ely was in Boston to witness a demonstration of a loud speaking device.

H. A. Larlee and H. C. Pauly were in Washington in connection with work on fire control telephone equipment for the Navy Department.

R. M. Burns, H. E. Haring and K. G. Compton were at Philadelphia on an inspection tour of the Electric Storage Battery Company.

C. L. Hippensteel and C. W. Borgmann visited the New Jersey Zinc Company at Palmerton, Pennsylvania, to discuss corrosion. Mr. Hippensteel also visited Allentown in company with J. M. Hardesty and F. F. Farnsworth of the Outside Plant Development department, to discuss the corrosion of lead in concrete.

P. Lasselle and C. L. Erickson visited Hawthorne in connection with investigations pertaining to enamel wire.

M. H. Quell visited the Leeds and Northrup Company at Philadelphia to inspect the humidity recorder now under construction for the cable ovens at Hawthorne and Point Breeze.

Numerous Members of the Research Department attended the meeting of the American Physical Society, held at Columbia University February 21-22. Herbert E. Ives presented a paper *Thin Films of Alkali Metals,* prepared by himself and H. B. Briggs. A. R. Olpin presented two papers, one on the *Validity of Einstein's Photoelectric Equation for Light Sensitive Sodium Compounds,* the other on *Selective Maxima in the Spectral Response Curves of Light Sensitive Compounds as a Function of Valence.*

H. Kahl was in Philadelphia recently taking noise measurements in connection with the development of a new line-noise meter.

R. O. Wise and W. R. Dravneek were at Whippany to make modulation tests in connection with new long-wave radio projects.

R. R. Riesz visited Wilkes-Barre on work in the behalf of the Graybar Company.

A. B. Newell has sailed on the *S. S. Cedric* for Ireland, where he will supervise the construction of a laboratory for experimental work on the transatlantic telephone cable.

R. H. Wilson and C. A. Kotterman were in Boston, where they visited the General Radio Company's laboratory, the new chemical laboratory at Harvard University, the Massachusetts Institute of Technology laboratory, and the research laboratory of the General Electric Company at Lynn. With C. W. Borgmann they attended the exhibit of scientific instruments and laboratory apparatus held in connection with the winter meeting of the National Educational Association at Atlantic City. Messrs. Wilson, Kotterman, and Dr. J. A. Becker visited the General Electric research laboratory at Schenectady to seek information on laboratory design, layout and construction.

G. K. Smith and A. S. King were at Utica where they made investigations of local and switchboard cabling in the step-by-step central office.

C. H. Achenbach went to Hawthorne to discuss general questions in connection with proposed changes in equipment designs for panel systems.

S. F. Butler and H. E. Marting visited Philadelphia to make an inspection preliminary to the introduction of the flat type clip to replace the wire type cable clip.

A. D. Knowlton went to Milwaukee, Cincinnati, Washington and Chicago, where the recently developed automatic display call indicator equipment is now being installed.

E. J. Johnson made a trip to Lexington, Louisville and Knoxville on college recruiting work.

J. T. Motter was at Harrisburg supervising the trial installation of precious metal contact banks.

W. H. Bendernagel visited repeater stations between New York and Pittsburgh in connection with a trial installation of improved program transmission equipment.

F. F. Siebert and F. T. Forster visited the Electric Storage Battery Company's factory at Philadelphia to observe the manufacture of batteries.

J. R. Stone spent several days at Memphis where an improved silencer for the centrifugal exhauster used with the toll pneumatic ticket distributing system is being installed.

J. M. Duguid went to Lewistown, Pennsylvania, in connection with the operation of ringing machines. He also made tests on the trial of tone alternators at Syracuse, New York.

J. H. Sole visited the General Electric Company's factory at Fort Wayne to discuss the transformers for toll signal lamps and automatic voltage regulators.

M. A. Froberg was at Philadelphia and Hartford in connection with power plant noise studies.

J. L. Larew spent several days in Detroit making tests on the a-c supply system for the busy lamps in the new toll office.

F. F. Siebert and V. T. Callahan made a trip to the Buffalo Gasolene Motor Company's factory at Buffalo to inspect a radiator cooling unit.

R. C. Paine was at Philadelphia to investigate protection networks for sender sequence switches.

A. F. Burns made a trip to Syracuse in connection with the trial of inductor alternators.

R. C. Davis visited Detroit to make a general investigation of circuit conditions of the new No. 3 toll key pulsing sender test.

G. V. King spent several days at Cleveland investigating the new No. 701 PBX system.

W. J. Lacerte visited Syracuse in connection with the preselector trial, and Olean to inspect the trial of a new signaling system for rural lines. He was also at Hartford testing methods to avoid double plunging of line switches.

W. L. Filer was in Arkansas, Texas and Oklahoma and E. D. Bryant at Syracuse in connection with college recruiting work.

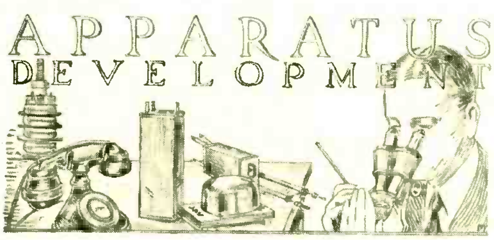
W. H. Matthies, W. L. Filer and S. F. Butler visited the Hawthorne plant and associated companies' engineering offices at Chicago, Cleveland and Pittsburgh.

R. S. Wilbur went to Jackson and Kalamazoo for the cutover of the toll line dialing between these points. He visited Detroit to inspect the installation of the new No. 3 toll board in that city.

C. W. Green spent a week at Ithaca on college recruiting work at Cornell.

J. H. Bell lectured Chicago, Urbana, Madison, and Milwaukee, before the local branches of the A. I. E. E. and universities on the subject of *Telegraphy*.

Messrs. C. R. Meissner, J. O. Smethurst and E. M. Squire arranged for the installation of supervisory and testing apparatus at Netcong for the short-wave radio telephone channels to Europe and South America.



E. Montchyk was in Newark and Trenton in making studies of the common-metal contacts on step-by-step apparatus.

C. E. Nelson has been in Harrisburg, Pennsylvania, and Charlotte, North Carolina, on investigations of noise conditions.

D. W. Mathison has been engaged in contact studies on the official PBX in the Bronx-Westchester headquarters of the New York Telephone Company.

H. N. Van Deusen and J. R. Townsend led a colloquium held under the auspices of the Electrical Engineering department of Massachusetts Institute of Technology on the subject of *The Engineering of Materials*.

During February the annual conventions of the American Society for Steel Treating and the Institute of Metals were held in the Engineering Societies Building and sessions of interest to the Materials group were attended by J. R. Townsend, C. H. Marshall, G. R. Gohn, I. V. Williams and R. L. Geruso. J. R. Townsend and C. H. Greenall also attended a meeting of the A. S. T. M. die-casting committee.

C. H. Greenall and W. J. Farmer visited the Western Electric Company's Brooklyn repair shop on matters concerned with die-castings.

A. H. Falk attended a meeting of the Franklin Institute in Philadelphia on the subject *Metal Spraying Methods and Apparatus for Decoration and Corrosion Protection*.

W. A. Evans visited Hawthorne in connection with hard rubber problems of No. 49 jacks. Accompanied by W. W. Werring and by T. J. Crowe of the Plant Engineering Department Mr. Evans also made a visit to the Bakelite Corporation's plant at Bloomfield, New Jersey, in connection with molding problems.

I. L. Hopkins visited the Western Electric Company's Communipaw Avenue plant in Jersey City to discuss hard rubber problems.

H. G. Arlt examined, at the Western Electric Company's Queensboro plant, the finishes on telephone booths. He visited the U. S. Bronze Powder Company's plant at Closter, New Jersey, also in connection with problems of finish.

J. J. Martin visited the Celluloid Corporation at Newark, to study the molding of cellulose materials.

F. F. LUCAS spoke before the Engineers' Club, New York City, on the subject of *Advance in Metallurgical and Biological Microscopy*.

J. M. WILSON spent the week of March 3 at Hawthorne discussing materials problems with engineers on development work there.

MESSRS. T. E. Shea, W. Herriott, N. R. Stryker and I. H. Parsons attended the meetings of the Rochester section of the Optical Society of America during the latter part of February. A paper on sound pictures was presented by Mr. Shea. While in Rochester they visited the laboratories of the Eastman Kodak and Bausch & Lomb companies.

J. R. IRWIN visited the Trinity exchange in Philadelphia to study results of a trial installation of contact protection on sequence switches.

A. F. PRICE and H. C. CURL visited the *U. S. S. Pensacola* at the Brooklyn Navy Yard to inspect the recently installed announcing system. The *Pensacola* is one of the new 10,000 ton scout cruisers equipped at the Brooklyn Navy Yard. The announcing system transmits information from central points to all parts of the ship.

C. F. BOECK was at Boston to discuss plans for a proposed power line carrier system.

R. A. MILLER visited the Paramount Studios at Astoria, Long Island, in connection with the latest developments of re-recording.

H. M. STOLLER was in Chicago to discuss with the Holtzer Cabot Company the requirements for a noiseless camera motor.

W. FONDILLER was at Hawthorne in connection with relay development work. He also made an inspection trip to the Bureau of Standards.

MESSRS. H. H. Glenn and H. H. Staebner and G. H. Downes of the A. T. & T. Company went to Hawthorne to discuss enameled wire. They also visited Michigan City and Detroit to look over installations of special cable.

C. A. WEBBER was at Baltimore in regard to the splicing of distributing frame wire.

C. R. YOUNG and H. A. ANDERSON visited the General Electric Company at Schenectady to inspect a new type of welding machine.

E. B. PAYNE and C. M. HEBBERT are making modulation measurements on radio equipment at Whippany.

J. G. FERGUSON attended an A. S. T. M. committee meeting on resistance materials held at the Engineering Societies building.

C. W. RAMSDEN went to Philadelphia in connection with transmitters for the Coast Guard.

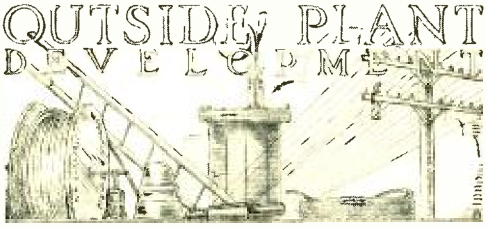
E. L. NELSON and F. M. RYAN presented a joint paper entitled *Provision of Radio Facilities for Aircraft Communication* before the aeronautical meeting of the S. A. E. at St. Louis. This meeting was held concurrently with the Aircraft Exhibition in the Arena where a complete line of Western Electric radio communication equipment for aircraft was shown. Captain A. R. Brooks also attended the meeting.

W. C. TINUS conferred with engineers of the Boeing Aircraft Transport Company in California regarding the installation of Western Electric radio communication equipment in their planes and ground stations.

F. R. MCMURRY has been in Chicago during the past few weeks at the plant of the Teletype Corporation in connection with the manufacture of printing telegraph apparatus.

A. D. Hargan, with H. A. Steiner of the Western Electric Company, visited the Philadelphia Distributing House Shop to discuss repairs on calculagraphs.

R. R. Peterson and C. A. Webber at the Point Breeze plant of the Western Electric Company inspected the tools and methods used in making splices in flame-proof enameled wire for distributing frames.



D. A. Quarles attended the Outside Plant engineering conference held during February at both New York and Cleveland.

L. W. Kelsay made a trip to Hawthorne and to the Reliable Electric Company, Chicago, in connection with the development of cable terminals.

C. S. Gordon and I. C. Shafer, Jr., went to Phoenixville, Pennsylvania, to make tests on emergency cable.

C. R. Moore was in Hawthorne at a conference on arrangements for the manufacture of tools to be used in a field trial of a new type of wire joint recently developed in the Outside Plant Department.

R. G. Watling made a several days' visit to Washington study mechanical testing methods at the Bureau of Standards.

F. F. Farnsworth made a trip to Florida to inspect corrosion tests being carried out at Key West by the American Society for Testing Materials. He later inspected motor vehicle finishing tests being made in the territory of the Southern Bell Telephone Company. With J. M. Hardesty he visited the plant of the Lehigh Portland Cement Company at Allentown.

S. C. Cawthon returned on February 24 after about a month's stay in Oklahoma in connection with development studies on tape-armored cable.

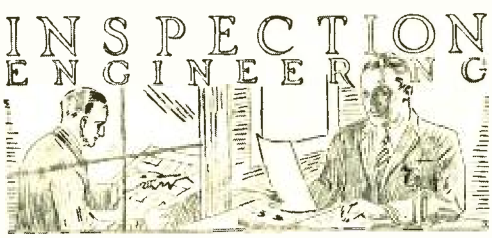
L. H. Campbell was in New Haven to observe motor vehicle painting tests being carried out by the Southern New England Telephone Company.

D. T. Sharpe visited the Plymouth Cordage Company's plant in Massachusetts.

L. S. Ford visited Point Breeze on matters concerned with the cable engineering development problems being handled there.

O. S. Markuson has been transferred from Inspection Engineering where he had been handling problems concerning lead covered cable, to our cable development group at Kearney.

R. J. Nossaman, formerly in charge of the Field Engineering force, has been transferred to the Outside Plant Development department. J. A. St. Clair has been named to supervise the Field Engineering activities, replacing Mr. Nossaman.



D. S. Bender, field engineer in the New York No. 1 territory, visited Bridgeport and Manchester, Connecticut, to inspect installations of PBX power plant equipment. Mr. Bender was also in New Milford and

Stamford, Connecticut, and Lynn, Massachusetts, in connection with engineering complaint investigations.

During February, I. W. Whitefield engineer in the Philadelphia territory, visited Baltimore, Charleston, Richmond, and Washington in connection with routine investigations and field review conferences. Later in the month he spent several days in New York discussing field engineering matters with other members of the department.

R. J. Nossaman and R. C. Koernig visited New Haven to inspect the new step-by-step equipment recently installed there.

G. Garbacz, field engineer in the Cleveland territory, attended field review conferences in Cincinnati and Columbus.

J. F. Chaney attended a quality survey conference on vitreous enameled and spool wound resistances held at Hawthorne.

R. C. Kamphausen, field engineer in the Detroit territory, visited Indianapolis in connection with engineering complaint investigation matters.

H. C. Cunningham visited Kearny to attend a quality survey conference on relays.

C. A. Johnson, field engineer in the Chicago territory, made a trip to Milwaukee and Marinette, Wisconsin, to discuss general inspection and complaint matters.

T. A. Crump is now in Philadelphia assisting I. W. Whiteside, field engineer in that territory.

L. G. Hoyt spent a week at Hawthorne, where he attended a quality survey conference on sound picture apparatus. During part of the week he visited the Electrical Research Products warehouse in Chicago in connection with special studies of data used in determining current quality of product of sound picture apparatus and equipment.

During the early part of February, A. F. Gilson visited the plants of the Standard Underground Cable Company in Perth Amboy, the Safety Cable Company at Baltimore, and the National Electric Products Corporation at Elizabeth to make arrangements for the inauguration of quality surveys on cable and wire. Later in the month, E. G. D. Paterson and W. H. Stracener attended the inaugural survey conferences held at these plants as well as at the Hastings Wire and Cable Company in Hastings, N. Y.

Mr. Gilson was also in Schenectady to discuss engineering complaint matters with the general Electric Company and later made a trip to the Stromberg Carlson Company plant at Rochester in connection with quality surveys on PBX switchboards and equipment.

R. C. Koernig has been appointed field engineer in the Omaha territory succeeding W. E. Whitworth, who has returned to New York for special assignment work.

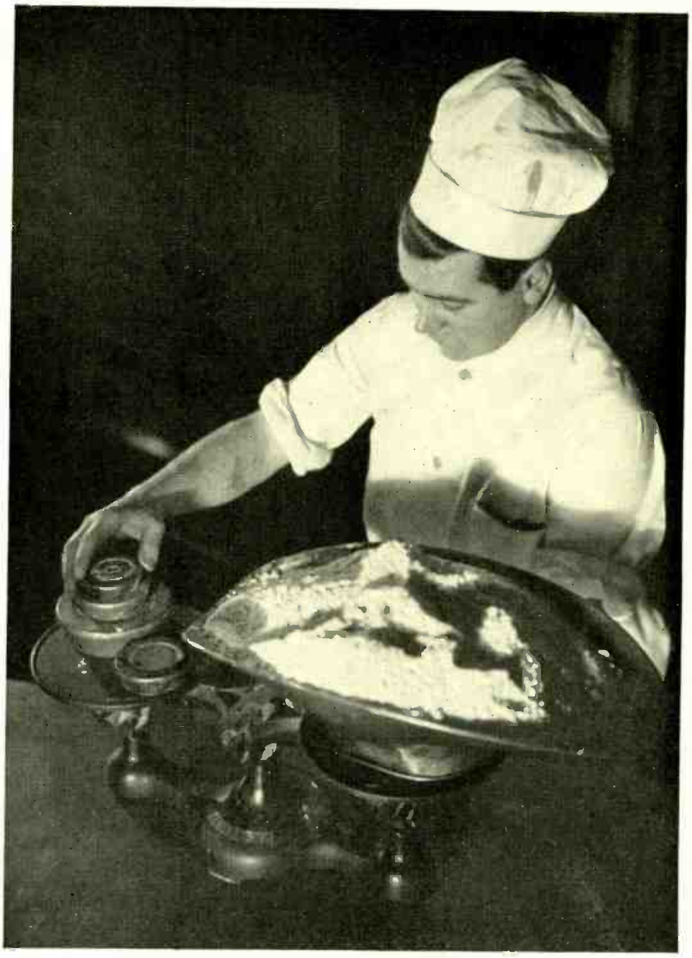
H. W. Nylund has been appointed field engineer in the San Francisco territory, replacing J. A. St. Clair.

G. D. Edwards has returned from a recent trip to the West Coast on which he visited several of the field engineering headquarters of the Inspection Engineering department and principal cities of the various operating areas. Mr. Edwards was accompanied on his trip east by J. A. St. Clair, formerly field engineer in the San Francisco territory, who has returned to New York to take over the duties of field engineering supervisor.

During the period from February 4, to March 4, 1930, members of the Patent Department visited the following cities in connection with the prosecution of patents: Washington, G. M. Campbell, G. F. Heuerman, I. MacDonald; Philadelphia, G. M. Campbell; Princeton, J. W. Schmied.

Publication

John Mills has been on a trip through the southwest where he delivered a series of addresses on *Modern Electrical Methods of Communication.* On March 11 he spoke at the University of Missouri under the aus-



Charles Erb does some delicate weighing, not with the precision of some laboratory measurements to be sure, but with extreme care nevertheless. And the excellence of Baker Erb's cakes bears testimony to the accuracy of his weighing pices of the honorary scientific society, Sigma Xi. On March 13 he spoke before the Oklahoma Utilities Association at Tulsa and on the following day he talked at the Oklahoma A. & M. college at Stillwater. On his return he spoke at Chicago before the Western Society of Engineers.

L. S. O'Roark spoke on industrial benefits of research and the work of the Laboratories at an Executives' Night meeting of the Production Club of the New York and New Jersey Plant Managers Association of the Paint and Varnish Industries.

Bell Laboratories Club

The score of 267 rolled by L. E. Parsons established a new high single game record for the Club's bowling activities. Highest average in Group A was again rolled up by H. C. Dieffenbach. Second place was taken by A. W. Dring. L. W. Drenkard tops the Class B bowlers and W. R. Steeneck is first in Class C followed by N. Scribner. The Executive Committee has announced that a contract for 1930-31 has already been signed for all of Dwyer's Broadway alleys.

One of the most interesting evenings in the chess club activities occurred when Mr. Lajos Steiner of the A. T. & T. Co., was guest of the Club and in a simultaneous exhibition pitted his skill against twenty-seven members of the Club Chess team. Mr. Steiner, who is among the foremost chess players of the country, managed to win all his contests although it was midnight, after five hours of playing that Mr. Cahill the last survivor finally succumbed.

The annual recital and dance which is to the Glee Club what the Mardi Gras is to New Orleans, will be held on May 1 at the Hotel Pennsylvania. There will be singing by the combined club chorus as well as renditions by the men's chorus and women's chorus. Several solo numbers are also on the program. The recital which will begin at 8:30 o'clock will be followed by dancing until 2 o'clock.

A Four-Year Index for the Record

Incident to the binding of Volume 7 of Bell Laboratories Record, *a four-year cumulative index has been prepared for the magazine, from its first issue in September,* 1925, *through August,* 1929. *An innovation is the addition of subject-headings to the index by title. The pamphlet will be useful not only to those who wish to bind their files of the magazine, but also to those who refer to the bound volumes in the Library. Copies may be requested by memorandum addressed to the Bureau of Publication.*

Contributors to this Issue

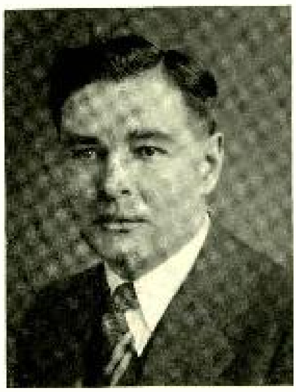
JOINING the Western Electric Company in 1913 as Laboratory Assistant, L. ARMITAGE spent five years in various development undertakings among which was that of iron dust cores. During this period he received the degree of B.S. from Cooper Union. After a year's absence in military service he returned to West Street and spent two years on the mechanical design of carrier equipment. For the next six years he was in business for himself, manufacturing radio sets. He returned to the Laboratories in 1927. Since then he has been employed in the development of impedance bridges and frequency equipment.

IN 1917 R. M. BOZORTH received an A.B. degree from Reed College in Portland, Oregon, and spent the following two years in Army service. Continuing his education, he entered the California Institute of Technology and received a Ph.D. in physical chemistry in 1922. He remained there for another year as a Research Fellow and in 1923 joined the Laboratories where he has been carrying on research work in magnetics.

AFTER obtaining a degree of B.E. from Johns Hopkins in 1924, J. D. TEBO spent a year with the Westinghouse Company on relay design. He then returned to Johns-Hopkins for post graduate work and in 1928 received the degree of Dr. Eng. The summers of these two years he spent with the Laboratories—one season in the Systems Department and one in the Apparatus Development Department. After receiving his doctor's degree he joined the Laboratories' Technical Staff and has been employed on relay design, particularly as applied to the reduction of interference.

L. A. O'BRIEN received the B.S. degree in electrical engineering from Kansas State Agricultural College in 1914, and returned there, to receive the E.E. degree in 1919, after four years with the Equipment Engineer-

J. D. Tebo



L. Armitage

R. M. Bozorth

T. E. Shea

L. A. O'Brien

P. E. Buch

ing Department of the Western Electric Company. After two years as Employment Manager for the Dain Manufacturing Company, and two years as Production Engineer of the National Carbon Company's Jersey City works, he came to the Systems Development Department of these Laboratories. During his first three years here Mr. O'Brien was concerned with toll-equipment development including that of picture transmission. Following this, he spent several years on local-systems development work after which he returned to the toll system group where he is a supervisor of telegraph equipment development.

W. L. Heard

T. E. Shea received the S.M. degree from Massachusetts Institute of Technology in 1919, and instructed there in physics and electrical engineering from 1918 to 1920. After a year with the Manufacturing Department of the Western Electric Company, he joined the Apparatus Development Department of these Laboratories where he engaged in the development and design of electric wave filters and allied apparatus. Since 1928 Mr. Shea has been in charge of certain special products developments, especially in the sound-picture field.

P. E. Buch spent five years at the University of Copenhagen studying mechanical engineering and on leaving there in 1921 came at once to this country. A few months after his arrival he found employment with the installation department of the Western Electric Company and was employed in installing the present Ashland Office. Later in that year he transferred to the engineering department where he was engaged in circuit testing. The following year he transferred to the Apparatus Development Department and since then has worked on the design of dial apparatus.

After obtaining the degree of

B.S.E.E. from Kansas State College in 1911, W. L. HEARD entered the employ of the Automatic Electric Company in Chicago. The next year, however, he became affiliated with Western Electric in Hawthorne and remained with them until 1919 when he was transferred to the Laboratories. Both at Hawthorne and in New York, his work has been equipment engineering, and he is now Equipment Methods Engineer.

A MEAN TRICK

A hundred-and-sixty-pound reading on the Medical Department's scale is no laughing matter for Genevieve Kramer, regardless of how it may appeal to her playmates. If Genevieve could only see Marie Widmaier's foot adding—well, several extra pounds—to her true weight! Perhaps Dorothy Staack laughed out loud, giving away the trick, and restoring her friend's confidence in the scales as a health-indicator