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Airways Communication Service

By EDWARD B. CRAFT
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THE present development of air transport is bringing out its need for adequate communication in much the same manner as the earlier development of railway operations disclosed for that industry the necessity of special communication services if speed and density of traffic were to be attained with safety. The electric telegraph by a most fortunate coincidence was available just at the time the railways required it; and as the demand for speed became pressing the telephone was perfected. By another fortunate coincidence, radio appears to be available just at the time it is needed for communication with aircraft in flight. During the war, both in this country and abroad, radio equipment of relatively crude design was installed in aircraft and proved of great utility. Since the war, radio telegraphy for aircraft has been further developed by the naval and military services, but radio telephony has received less attention, probably because of the inherent difficulties and lack of a pressing demand.

When surprises due to bad weather can be eliminated, the safety of air transport should compare favorably with that of other forms of transportation. By means of a suitable communication system weather reports from observers located along and near an airway can be collected; and it should be possible, therefore, to reduce materially the weather hazard of air transport.

A full-scale meteorological experiment of this nature is now being conducted in California by the Weather Bureau with the cooperation of the Guggenheim Fund for the Promotion of Aeronautics and of the Pacific Telephone and Telegraph Company. Meteorologists at the Oakland and Los Angeles airports receive several times a day, by long-distance telephone, weather data from about forty observers at a large number of selected points in the state. After an exchange of these collected data, the meteorologists forecast flying-weather for aviators starting out over the air-

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Our flying laboratory ready to take off: A. R. Brooks is in his place as pilot and Mr. Craft is ready to talk when the plane gains altitude

way between the two airports. On the basis of these forecasts, it is hoped that the pilots may be able to avoid bad weather by choosing an alternative route or by selecting the terminal field where weather conditions are more propitious. The experiment will be carried on for a full year and so cover the complete cycle of the seasons. On the basis of the demonstrated value of this service to the users of the airway, the matter of its continuance or possible extension to other airways can then be decided by the Weather Bureau.

In addition to the problem of collecting weather data, there is the closely related matter of distributing local weather reports and forecasts between airports. This is "point-to-point service." It may be accomplished by a special radio-telegraph network, by commercial telegraph or by long-distance telephone, and over private or leased wires either by telephone or by telegraph. Local conditions, volume of traffic and economic considerations, in general, determine which of these types of service should be provided.

Besides its use for weather messages, point-to-point communication between landing fields along an airway is desirable for following the progress of an airplane with its passengers and cargo. Such a dispatching service is somewhat analogous to that of a railway and is a necessity if scheduled connections with trains and other aircraft are to be met. Point-to-point communication facilities are also required for the general administrative business of the airway and of the air transport companies.

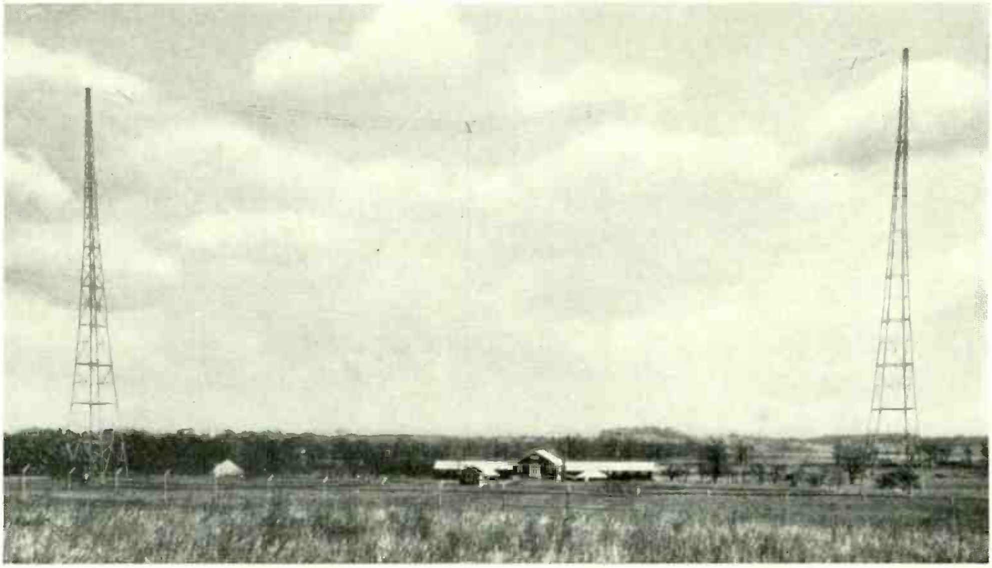
On some airways communication between terminal landing fields or airports is now handled by radio telegraph and on others by long-distance telephone. Neither system is ideal for the purpose. An ideal system which is instantaneous and reliable, repeats messages at all airports, is free from interference, takes up no radio channels, and furnishes a permanent record of all messages at all airports, is the telephone-typewriter service. This makes possible the instantaneous transmission of communications between distant offices and simultaneously provides each office and any desired intermediate stations with typewritten copies. This service has been used for a good many years by the principal press associations and is now being extended rapidly to serve the needs of our larger business organizations.

To utilize the telephone-typewriter system along an airway requires only the installation of keyboard transmitting apparatus and tape printing apparatus at terminal fields and their interconnection by a private or leased wire circuit. Then anyone familiar with a typewriter may type a message which will appear on the tape fed automatically from the apparatus at every other connected point. The message is automatically and permanently recorded under the control of the sending station. Constant attendance or listening-in is, therefore, not required; and operators at the various receiving points are thus free to attend to telephone calls from intermediate fields, to operate radio beacons and lights, and to carry on whatever duties are assigned to them.

Telephone-typewriter service has been initiated by the Department of Commerce at Hadley Field, at Cleveland, at Chicago and at San Francisco, where in each place the local radio stations, weather bureau offices and the airport offices are all interconnected. It is planned, at a later date, to equip experimentally some airway with complete telephone-typewriter service between airports.

When an aviator leaves an airport he should be given information of the weather along the route ahead of him and a forecast of the nature of probable changes during the time of his flight. If general weather conditions are settled, or if his flight is a short one, a forecast is entirely adequate. However, for long flights and at times of uncertain and threatening weather, it is important that the pilot

Mr. Craft inspects the radio transmitter and receiver



Building and antenna system of the experimental station at Whippany, where one end of the plane-and-ground channel is located

be continuously advised by radio of the weather conditions he may encounter during his flight. In particular, storm warnings and reports of the visibility and landing conditions at the airport where he expects to land should be sent him. Weather and landing advice can be broadcast from each airport along the airway. Provision of radio transmitters at airports and receiving sets in the planes will make possible a simple one-way system of communication and permit any number of planes in the air to be advised without confusion.

The perfection of facilities for communicating weather and landing information to planes in flight, which will enable them to operate with safety under relatively unfavorable meteorological conditions, will greatly stimulate the demand for improved aids to navigation. It seems to be established that under conditions of poor visibility, when landmarks are totally obscured and beacon lights are useless, flying requires some form of radio goniometry if the pilot is to find his way through.

A number of systems have been proposed for this purpose; evolution of the system which is most satisfactory will be a matter of time and will require close cooperation on the part of all factors in the industry.

Bell Telephone Laboratories, at its radio station at Whippany, New Jersey, has erected an experimental two-way radio-telephone system and radio beacon. In connection with this apparatus it utilizes a Fairchild Cabin Monoplane with Pratt and Whitney "Wasp" engine. The plane has been carefully bonded and shielded and is equipped with radio field-measuring apparatus of the Laboratories' design. With this plane exact measurements can be made at various altitudes under different weather conditions of the efficiency of radio transmission from the Whippany transmitter. In addition the plane carries radio transmitting and receiving sets of experimental design. It is, in fact, a flying radio laboratory in which the engineers may experiment under actual flying conditions.

A radio-telephone system with a sufficiently powerful transmitter and sufficiently sensitive receiver to give reliable communication for 100 miles will give fair communication for perhaps 200 miles, and its carrier wave will interfere with reception for a much greater distance. To avoid interference due to the beating of carrier frequencies, airports within a few hundred miles of one another may be assigned to different frequency channels, but serious difficulty is at once apparent from a map of the National Airways. Within 800 miles of Chicago, for example, there are over fifty terminal fields or airports. It would seem obviously impractical to assign the available telephone channels of which the international agreement allows six, to cover the eastern and central United States without serious interference. By restricting power as much as possible and by other means yet to be devised, it may be found possible to assign the same wave length to airports relatively nearer together. For the distribution of weather information only, however, the airways may well find insufficient the frequencies in the exclusive band, 315-350 kilocycles.

On certain main routes, air transport companies will eventually require two-way telephone despatching systems of their own to control plane movements. These systems will consist of radio stations situated at the various airports along the route and interconnected by suitable wire lines. The frequency channels required for such services cannot be found in the 315-350 kilocycles band which, as just indicated, is apparently inadequate for the public services of weather broadcasting from airports. Further channels in the short-wave region appear to be necessary.

In the short wave region Bell Telephone Laboratories have initiated an additional development project. In cooperation with the Boeing Air Transport Company, the Laboratories have undertaken to survey the Chicago-San Francisco Airway and to develop a system of two-way telephony between planes in flight and terminal landing fields on this route. The Boeing Company planes and landing fields will be equipped with experimental radio apparatus and a cooperative experiment will be conducted during the winter of 1928-29. From this work it is hoped to determine for an air transport company the requirements for a two-way radio telephone service. The investigation will furnish the basis for offering such facilities to other air transport operators.

In all these present and future problems, it is the policy of the American Telephone and Telegraph Company and the Bell System to assist by developing ways and means for making available to commercial aviation the best possible communication service.

The Nobel Laureates

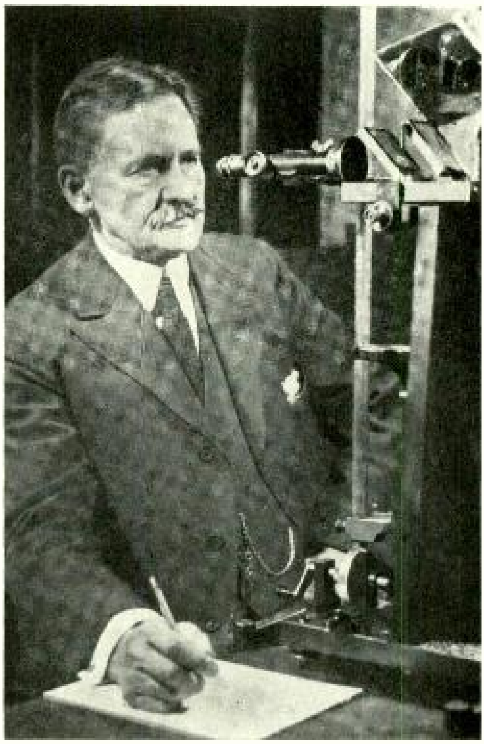
By KARL K. DARROW
Research Department

RENOWN in art is still so controversial, opinions about art are influenced so much by feelings and emotions of deep and unknown source, that hardly ever is a prize awarded in painting, music or belles-lettres without exciting violent dissent. Usually the next day after the name of the "best novel of 1927," the "gold medal of the Salon" or the "grand prix de l'Académie" is publicly announced, there is an outburst of unflattering remarks about the committee which made the choice. All of the old contentions about the nature and purposes of art flare up; the modernists jeer at the upholders of the classics, and the conservatives retort with ridicule; those who think that art exists for its own sake go to one side, and those who think that it should teach a lesson take the other; and the conflict often ends in passionate appeals to the "verdict of posterity," as though men could not pass just judgments on their own contemporaries.

In the sciences, however, it is generally by much more nearly unanimous consent that eminence is conceded or withheld. It seldom happens that a man is ranked as very great by one large body of his colleagues, as insignificant or stupid by another; and appeals to the verdict of posterity are relatively rare. Is this because the purpose of a science is more definite than the purpose of an art, leaving less room for difference of standards? or because no one cares enough about a science to render an opinion on such a subject or to criticize one already rendered, except the few who are really qualified? or because the commissions and the committees which choose the laureates in science are wiser or more conscientious than those which venture to judge artists? The first two of these, I should say, are certainly contributory causes. It would be a delicate matter to try to prove the third; and yet if one gives any weight to it at all, he must admit that the commission which allots the Nobel Prizes in physics is of a singular discretion; for its awards are greeted as rule with a chorus of applause. Indeed it often seems that the bestowal of the prize has ratified a judgment which was universal though tacit, waiting only for some public sign to give it recognition. This is exemplified by the prizes which have fallen to America; for, among all the living physicists of the United States, the three who have to their credit the most famous of American achievements in physics are certainly those three, who have been crowned by the Swedish Academy of Sciences fulfilling Nobel's will.

Michelson, Millikan and Compton—three names which span the interval from one epoch of physical science to another, though happily the bearers of all three are still among us! Michelson, who carried the undulatory conception of light to its utmost limits, and experimented more delicately and more precisely on and with light than any man before him, is an outstanding figure of the *ancien régime* of physics—that period which is fondly remembered as the "classical age," and now seems so remote, even though fewer than thirty years have passed since the beginning of the transition into the new age, even though the old physics is the foundation of the new. Millikan promoted the transition by measuring with unexampled precision the atom of electricity and that other mysterious atom the "quantum of action," which though itself entirely intangible is probably in the last analysis responsible for the subdivision of matter and electricity and light—perhaps of time and space as well, who knows?—into atoms. Compton with his demonstration of corpuscles of light stands forth altogether as a figure of the new era.

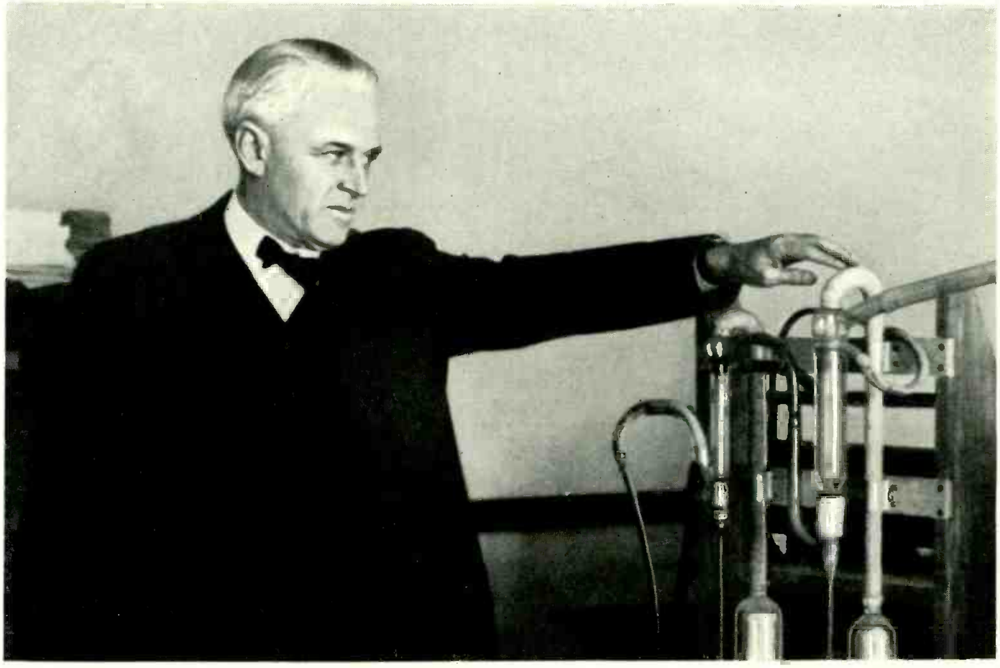
To appreciate the work of Michelson in its true setting, one must think himself back as best he can into the classical age—into that time when the Newtonian mechanics, the electromagnetic theory, the wave-conception of light were each in its own field triumphant and had no rivals and seemed adequate in every way—when people quoted with approval that famous dictum that the future of physics lies in the sixth decimal place, meaning that nothing remained to be done except to make better instruments, and with them better measurements, than any which had yet been made. In this field Michelson was paramount. It is now exactly fifty years since he made his debut by a measurement of the velocity of light, which in two years he supplanted by one much better than any which had gone before. Two years later, he made one better yet; and forty-six years after his first publication he returned to his earliest problem, and is re-measuring—for of these experiments one may still speak in the present tense—this all-important constant with such resources of *matériel*, cooperation and experience as were



Albert A. Michelson

never before united, having already attained a degree of accuracy far higher than any previous, with a higher one yet in prospect. Tenacity of purpose could not be carried further; and this is not the only instance of the sort in Michelson's career. In 1890 in the *Philosophical Magazine* he described an interference method capable of measuring "the apparent size of minute telescopic objects, such as planetoids, satellites, and possibly star disks," and of this last-mentioned aspect of the problem, then as now insoluble with any feasible telescope, he wrote: "The possibility of gaining some positive knowledge of the real size of those distant luminaries would more than repay the time, care and patience which it would be necessary to bestow on such a work." Thirty years went past, during which apparently no one else possessed the requisite "time, care, and patience,"—or was it possibly the requisite adroitness which was wanting? and in 1920 Michelson himself made upon Betelgeuse the first measurement in all history of the size of a star. By the test of the saying that *success is a dream of youth realized in mature age,* no man was ever more successful.

Yet notable as are these, it is still another experiment which is the chief basis of Michelson's fame—the renowned experiment, on the negative result of which the theory of relativity is founded. If light is a wave-motion in a medium through which the earth is gliding without displacing or disturbing it, then various experiments can be conceived which should disclose the speed of the earth through this "aether." Various such experiments had in fact been conceived and performed, but there was always some loophole of escape from the conclusion to which all tended—the conclusion, that is to say, that if there is such a medium the earth is permanently at rest in it. Michelson, however, performed, but there was always result of which there was no possibility of escape, shor of making some such strange assumption as that every object moving through the aether shrinks by virtue of its motion, or else remodelling the current notions of time and space. Like most of his



Robert A. Millikan

researches, it involved the interference of light, and required so excellent a technique that in spite of its crucial importance, no one but his collaborators attempted to reproduce it for thirty years. Everything turned on whether or not a pattern of light and dark stripes, the interference-pattern of a pair of beams of light which had traversed different paths through the "aether" if such there were, moved sidewise by a fraction of the width of a single stripe when the entire massive apparatus was revolved through ninety degrees as it floated on a pond of mercury. Not even so feeble an effect as this was seen; and so it happened that one of the outstanding figures of the classic physics unexpectedly became one of the founders of the new.

Millikan's most famous work is another which cannot be appreciated duly, except against the background of its time. Not so very long ago, the obscurest passage to be found in almost any textbook on electricity was the definition of electricity itself. In France there was a joke about a man who had understood everything in Maxwell's classic treatise except the notion of electric charge. There used to be a story of a teacher who asked one of his pupils "What is electricity?" The pupil replied "I am sorry . . . I knew yesterday, but I have forgotten." The teacher turned to the class and said "What a pity! here is the only man in the world who ever knew what electricity is, and he has forgotten!"

Well! nowadays these stories seem to have lost their point; for nearly all of us conceive an electric charge as a cloud of tiny particles, roaming around in space or organizing themselves into systems which are atoms. A philosopher perhaps might say that after all we do not understand an unseen thing the better, when we visualize it as a multitude of particles rather than as a fluid or as an algebraic symbol on a sheet of paper. Still it cannot be gainsaid that the picture helps us enormously in dealing with conduction of electricity and thermionics and photoelectrics, to name only a few of many fields. Now it was Millikan's measurement of the electron-charge e which more than any other one thing established this conception.

One must not underrate this contribution by thinking of it as nothing but a measurement. Measurements as such are certainly not to be disparaged, indeed it is said that nothing which has not been measured is a fit subject for physical inquiry; but this was something more. We say that Millikan "measured the constant e," as if everyone had known beforehand that there was a constant e lying waiting to be measured. That however, in spite of many anticipations and much excellent prior work, was not yet made quite certain. It was the celebrated "oil-drop experiment" which settled that there *is* an electron — that is to say, that any charge of electricity, whatever the body which carries it and however it was gathered upon that body, consists of some integer number of identical and fundamental units.

Droplets of oil or of some other liquid were endowed with charge by many different methods, and the charge on each was ascertained by measuring the rate at which it was drawn upwards through air by an electric field, against the downward drag of gravity upon the liquid mass. Sometimes Millikan would watch a single droplet incessantly for hours, during which at frequent intervals it gained or lost electric charge of either sign, by capturing ions from the air or by irradiation; after every such event he would observe its rate of rise, and every time the charge turned out to be some integer multiple of the fundamental quantity. So much could be proved, without know-

Arthur H. Compton

ing the mass of the drop; but this had to be known, that the charge might be measured in the stricter sense of the word — evaluated, that is to say, in the standard electrical units. The drops could not be weighed; their weights must be computed from the rates at which they fell through air under the pull of gravity alone, and the formula for computation involves the value of the viscosity of air. Often as experiments had been performed to measure this, the values in the literature were not sufficiently concordant; and beside his major series of experiments, Millikan directed another sequence in which the viscosity of air was redetermined by every method known. Moreover, if a droplet is extremely small, its law of fall through air is not the same as that of the larger drops—it slips, so to speak, between the molecules of the gas. Having established the constancy of *e*, Millikan inverted his procedure, and taking *e* for granted he used it to investigate the variations of the law of fall. These I cite to show what unforeseeable by-products a great research may have. Millikan's subsequent work is too extensive by far to be related here, except for the mere mention that for the quantum of action *h* he later performed the same service as formerly for the electron-charge — measuring it, and by his measurements authenticating it as a constant of nature; for prior to his work it was by no means certain that such a thing existed. Discontinuity was now established in two fields where thirty years earlier it had scarcely been suspected. And this brings us to the work of Arthur Compton.

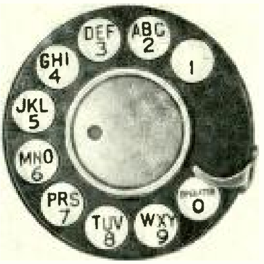
Compton discovered one outstanding way, in which a beam of light acts candidly and undeniably as though it were a stream of corpuscles. His great experiment was in principle extremely simple. A beam of light of very high frequency, that is to say a beam of X-rays, is projected into a substance containing many nearly free electrons—carbon or lithium for instance, since in the atoms of these elements the electrons are but loosely bound. These then are flung about in all directions, as though the beam of light were a hail of massive particles, knocking out of their way whatever small loose objects they may strike. Now if these particles of light were bits of ordinary matter, they would be slowed down by any such collision; for a moving body of unchangeable mass cannot give motion and therefore energy to an obstacle which it strikes, except by sacrificing some of its own speed. Light, however, moves with unchangeable speed, and therefore its particles when they give motion to electrons must sacrifice some of their mass. Now it is known, from other phenomena earlier discovered in which light acts as a stream of corpuscles, that the mass of one of these is proportional to its frequency, and reciprocally. Therefore the corpuscles of light which have rebounded from impacts with electrons must be of lower frequency than those which were projected into the "scattering" substance; in the technical language, the "scattered" X-rays are "shifted" downwards in frequency. The exact amount of this shift is definitely fixed by the mass which we are required to assign to the corpuscles of light. Compton established the downward shift, and measured its value, and calculated the value demanded for it by the mass of the corpuscles of light, and found that these agreed. In this way he added a new member, perhaps of all the most immediately striking, to the ensemble of phenomena which are explained by supposing that light consists of corpuscles instead of waves.

Observe, I do not say that he discovered that light consists of corpuscles. For a physicist of the *ancien régime*, there would indeed have been no possible alternative; not however for those whose minds have learned to acquiesce in our strangely inconsistent science of contemporary physics —this science where opposites do not exclude each other, where contradicting statements live amicably side by side, and a dilemma is accepted by grasping both its horns. The undulatory theory of light was not deposed in any domain where it had ever ruled. Interferometers continued to form fringes, and gratings to diffract; and from the spacings of the fringes and the deflections of the diffracted beams, wavelengths continued to be calculated in the same way as they had always been. No one in the optical laboratory or the broadcasting station desisted from speaking of waves; no one ceased to use the wave-theory to determine the resolving-power of a telescope, the arrangement of atoms in crystals by X-ray analysis, or the tuning of a circuit to receive a carrier. Though Michelson on the one hand, Millikan and Compton on the other, appear to stand for opposing tendencies in the development of physics, nothing in Michelson's work is invalidated and nothing is depreciated by the work of his younger colleagues. The province of the wave-theory remains intact, the province of the corpuscular theory is organized beside it. If ever the two are united in some higher synthesis, the wave-picture and the corpuscle-picture will survive as two of its aspects. Meanwhile physicists work onward, hoping that some day the theories will be synthesized, but confident that whether they ever are or not, whatever in either is precious will be faithfully preserved.

Human Errors and the Dial Telephone

By A. O. ADAM
Systems Development Department

DRAWING or making meaningless marks on a memorandum pad is a commonplace diversion while using the telephone, particularly while one is waiting for the person called to answer or to get some information. Spinning the dial, if a dial telephone is being used, is equally instinctive; it is an attractive and apparently harmless occupation for idle fingers. Turning the dial, however, momentarily breaks the circuit and would cause a disconnection had not such a possibility been foreseen by the designers of the system and steps taken to prevent it.



The dial, as it looks to the subscriber

Mounted back of the dial, and controlled by it, are two sets of springs with contacts. One of them, operated at the first movement of the dial away from the normal position, by-passes the transmitter and cuts the receiver out of the circuit; the other, operated during the return of the dial to normal position, opens the line circuit once for each numbered position that the dial moves. The opening of the line is an indication that the conversation has been completed and that the circuits associated with the call can disconnect. Since rotating the dial causes a series of line-opens the result of idly playing with it during a conversation would normally be a disconnection.

The disconnect signal in the manual system is caused by holding down the switchhook which lights a lamp in front of the operator. When the subscriber moves the switchhook up and down rapidly, however, a series of short flashes results which the operator knows is not a signal to disconnect, and she listens in on the line to discover what is wanted. To simulate the manual operator in this respect it is necessary to arrange dial-circuits so that momentary line-opens can be tolerated.

In the panel system* a definite time interval has been introduced through the action of an interrupter which guards against disconnection on short line-opens but yet recognizes long line-opens as a disconnect signal. The time interval is such that a line-open must be in excess of a quarter second

* *This article deals only with the panel system; analogous precautions embodied in the step-by-step system will be described in a future issue of the* RECORD.

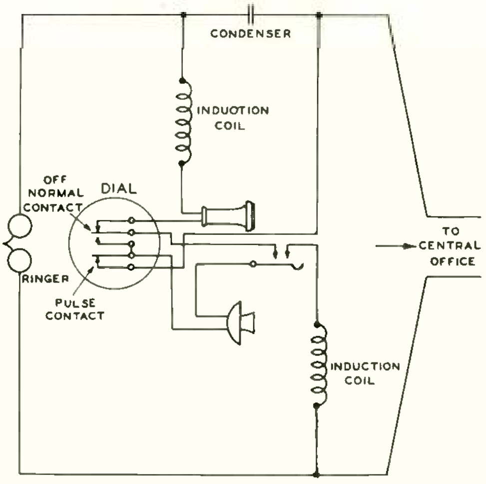
in order to cause disconnection. It would be desirable to permit a longer period, but, due to variations in the apparatus, it is not practicable to do so and at the same time insure that a subscriber will not meet with delay in originating another call.

The time interval introduced does not, of course, prevent all possible disconnects due to short line-opens but reduces the number of them and eliminates particularly those which are most likely to be accidental.

When dialing a number with a repeated final digit such as Chelsea 1000, it is quite possible for the subscriber to become uncertain regarding the number of zeros so that in many cases an extra one is dialed. Here again if it were not for the time-delay feature preventing disconnect, the line-opens caused by dialing an extra digit would result in a disconnect. As it is, however, any final digit may be repeated without causing trouble.

This is only one of the many possible human errors in dialing that have been foreseen and forestalled by building into both panel and step-by-step systems special mechanisms to lighten the subscriber's responsibility. To better understand how this is accomplished in the panel system it will be necessary to take a bird's-eye view of the operation of completing a call.

When a subscriber in a manual office removes the receiver from the switchhook a lamp associated with the line is lighted at the switchboard. The operator answers by plugging a cord into the jack indicated by the lamp and switching the talking key so as to obtain the desired number from the calling subscriber. In the panel system the first operation, similarly, is to find the calling line. This is accomplished by a "line finder" which, associated with a district selector, corresponds to the operator's cord. The district selector in turn connects to a sender, and this entire group of operations is usually completed before the subscriber can lift the receiver to his ear. The sender corresponds to the operator and re-



Wiring diagram for subscriber's set showing how dialing opens the circuit

cords all the information required for completing the call. A relay in the sender circuit is bridged directly across the subscriber's circuit and pulses caused by the opening and closing of the dial contacts are transmitted by this relay to a registering circuit which records each digit dialed.

A subscriber, due to some mishap such as dropping the desk stand immediately after removing the receiver from the switchhook, may flash the receiver hook before dialing the first digit. This causes a momentary opening in the circuit and is equivalent to dialing 1. The digit 1 is now falsely recorded in the sender circuit so that a wrong number would result. The subscriber probably does not realize what has occurred and continues dialing. The sender circuit, however, has been arranged to cancel this first false pulse. This is made possible by designing the sender registering circuit so that if a 1 is dialed as the first digit of an office code the following digit instead will be recognized as the first.

Instead of recording all the dial pulses caused by the second operation of the dial, the first pulse is cancelled and the remaining pulses are added to the 1 which is already recorded. Thus if a 1 were dialed followed by a 5, only four of the five pulses from the dial would be used, and these added to the 1 already recorded would result in a correct registration of 5. This makes it possible for the subscriber to obtain the correct number even though a false pulse has been sent prior to dialing the first digit of the office code. It eliminates, however, the possibility of having an office with 1 as the first digit.

Another error likely to occur during dialing is caused by confusing the letter O with the number 0. The ten positions of the dial are numbered consecutively from one to nought and eight of them, two to nine inclusive, have each three letters in addition, Q and Z alone being omitted. In large areas each subscriber's number requires seven or eight dialing operations, three to locate the central office for which the letters are used, and the remaining four or five to locate the subscriber within that office. If a call were to be made to an office such as Monument which contains an O in the first three letters the subscriber might easily dial the number nought in place of the letter O. The correct office code would be the equivalent of dialing 666, each operation of the dial making six successive breaks in the circuit, but if the number 0 were dialed in place of the letter O the resultant office code would be 606, so that the second dialing operation would make ten breaks in the circuit.

Although the subscriber alone is responsible for this, it is advisable to make such an error harmless. The difficulty has been overcome by designing the sender circuit to recognize the letter O—six breaks—or the number 0—ten breaks—when dialed as part of the office code, as being identical. This makes it possible for the subscriber calling a person in the Monument office to dial 600, 606, 660, or 666 as the office code and still be directed to the proper office. This same immunity can not be given when the number 0 is dialed in error for the first letter, as the number zero is reserved to call the operator; the subscriber's service is safeguarded, however, by the operator being brought in on the connection.

The foregoing gives some idea of the various small details that must be considered in attempting to render better telephone service. The effort has been made not only to develop a system that will work satisfactorily if it is handled correctly but one in which no likely mistake in the use of the dial can cause inconvenience to the subscriber.

The foregoing gives only a few of the human errors possible in dialing and explains how they are rendered harmless in the panel system. Similar methods are used in the step-by-step system to accomplish the same purpose. The effort has been made not only to develop a system that will work satisfactorily if it is handled correctly but one in which no likely mistake in the use of the dial can inconvenience the subscriber.

Speech Interpretation in Auditoriums

By E. C. WENTE
Research Department

THAT different auditoriums of approximately the same size vary greatly in their acoustic properties is apparent even to the casual observer. In some halls it is difficult to follow a speaker who might be heard easily in a room with better acoustics. An auditorium which is acoustically bad for speaking purposes usually has one or the other of two defects; either the speaker's voice is too faint at remote points, or, on account of excessive reflections from the walls, the spoken syllables do not reach the ears of the listener as articulate sounds but as a chaos of tones, from which he can extract the meaning only by a tiring effort.

In the open air, words reach the listener directly from the speaker; in a closed room, however, they are reinforced by reflection from the enclosing walls. This gives rise to the phenomenon that in a room a spoken syllable is heard for some time after it is uttered, and the greater the reflecting power of its walls, the longer is this time of reverberation. If the room has hard walls the loudness of one syllable at some distance from the speaker may still be great enough to interfere with the interpretation of the succeeding syllable. There are thus two extreme conditions: if the walls are highly absorbing, the loudness of the speech at remote parts of the room may be insufficient; if the walls are hard, the loudness will be almost the same at all parts of the room but the excessive reverberation will make it difficult to distinguish the individual syllables of the speech. Obviously in the design of an auditorium these two extreme conditions must be avoided.

The late Professor Sabine of Harvard conducted a series of noteworthy experiments in which he set up as a measure of the acoustics of an auditorium the time required for the average sound-energy density to fall to one millionth of (60 TU below) its initial value. This time is technically designated as the reverberation time. Sabine found that for a given size of room it has an optimum value. Most of his data, however, refers to sounds of a frequency of 512 cycles, which lies near the middle of the musical scale. The absorption of sound by materials, however, varies greatly with frequency. Hence even rooms having the optimum reverberation time at 512 cycles may yet vary widely in their acoustic characteristics. Sabine recognized this fact, but it was not sufficiently stressed, especially with reference to the interpretation of speech.

Speech sounds may be regarded as composites of pure tones of different frequencies and intensities. The distribution of energy among the component tones of representative English speech sounds throughout the frequency range from fifty to five thousand cycles per second has been determined by Crandall and MacKenzie.* Their results are shown in Figure 1. Curve A gives the relative amount of energy in speech corresponding to the frequency shown as abscissa. In the region around two hundred cycles there is approximately forty times as much energy as around fifteen hundred cycles. Curve B gives the energies plotted in a little different way. Here the ordinate gives the fractional part of the energy that lies below the corresponding frequency

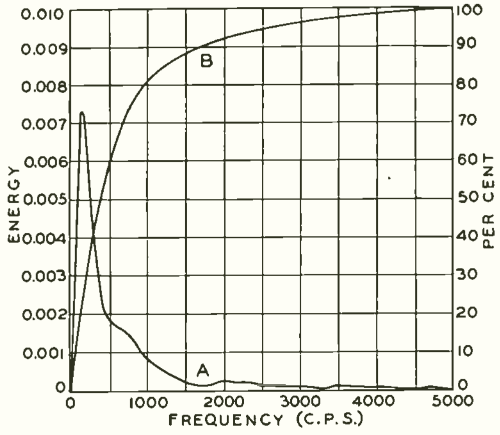


Fig. 1 — Energy distribution in speech. A, Relative energy at each frequency. B, Per cent of energy below given frequency

plotted as abscissa. This curve shows that sixty per cent of the energy in speech lies below five hundred and thirty-five per cent below two hundred cycles.

In view of the preceding data it might seem that the low frequency components in speech are relatively important. However, it has been shown that, although the components in speech lying below five hundred cycles are of value in preserving the naturalness of a speaker's voice, they contribute relatively little to the interpretation of speech sounds. The curve shown in Figure 2 is from a paper by Fletcher.* This curve gives the percentage of syllables found in the English language which are correctly understood when all the energy below the frequency given as abscissa is suppressed by the transmitting system. For example, if all the energy below five hundred cycles is suppressed, the articulation is still within two percent of the maximum, although sixty percent of the energy in speech lies below this value. This fact points to the importance of considering the absorption characteristics of materials that are used in rooms for damping purposes.

In Figure 3 is shown the absorption curve for a layer of hair felt such as is frequently used for dead-

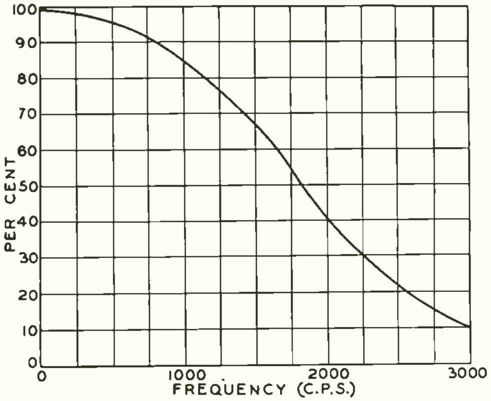


Fig. 2—Syllable articulation when energy below given frequency is suppressed

ening rooms. This material is merely given as an example; most other types of porous materials used for this purpose have very similar absorption characteristics. This material is seen to have large absorp-

* Physical Review, *XIX p.* 221, *March*, 1922.

* Journal of the Franklin Inst., *June*, 1922.

tion in the upper but small absorption in the lower frequency region. The average intensity throughout a room is, to a first approximation, inversely proportional to the absorptivity of all the surfaces. Hence, in a room with a relatively large amount of porous materials, the intensities of the tones of the higher frequencies, which we have seen to be important for articulation, are very greatly reduced in comparison with those of the lower frequencies, which are unimportant for articulation. When, then, enough porous material is introduced to reduce the reverberation of those tones

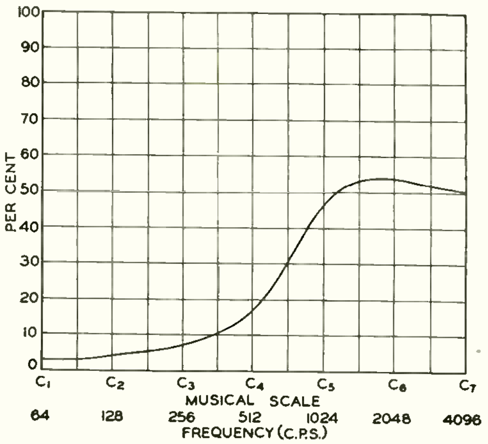


Fig. 3 — *Absorption of hair felt*

in which speech is rich to the point where it is no longer objectionable, the intensities of the important high frequency tones may be below the threshold of audibility at remote parts of the room. At these points it will be difficult to interpret the speaker's words.

Aside from the distracting effect of the reverberation of low frequency tones, their presence in excessive amounts reduces the ability of the auditor to hear those of high frequency. It has for a long time been known qualitatively that the threshold of audibility for a given tone is raised by the presence of another tone, especially if this tone be one of

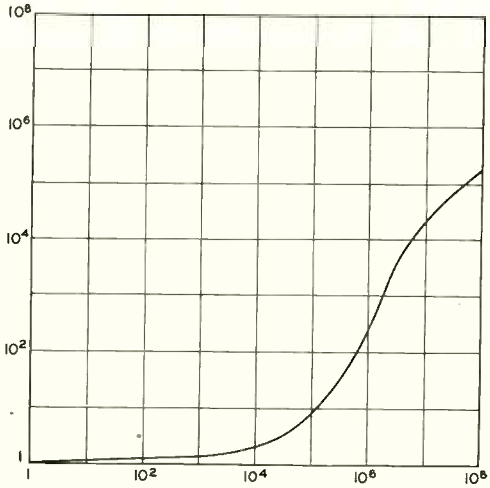


Fig. 4 — *Masking of* 1500-*cycle tone by* 300-*cycle tone*

lower frequency. A quantitative study of this masking of one tone by another has been made by Wegel and Lane,* from whose paper the curve of Figure 4 is taken. An ordinate of this curve gives the relative power of a 1500-cycle tone that is just audible in the presence of a masking tone of three hundred cycles having the power indicated by the abscissa. Unity power for either tone is taken as its power at the threshold of audibility when no other tone is sounded simultaneously. For example, when a tone of three hundred cycles is sounded at an intensity of $10^{6.8}$ times its value at the threshold of audibility, a fifteen hundred cycle tone to be heard must be 10^4 times as intense as when the three hundred cycle tone is absent. These values of intensities for the respective frequencies are quite possible for speech in a room, which has its

* Physical Review, *XXIII, February,* 1924.

acoustic characteristics controlled by the absorption of ordinary porous materials. The phenomenon of masking further emphasizes the importance of keeping down the average intensity

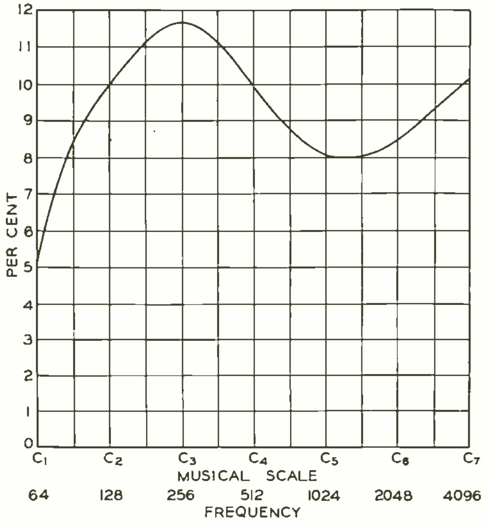


Fig. 5—Sound absorption of wood paneling

of the lower tones, which for articulation are quite unimportant and yet are delivered in large amounts by the speaker.

The conclusions here reached, while resting primarily on indirect data, seem to be borne out by experience. Auditoriums having the most desirable acoustic properties are found to be those which are sufficiently dead but are free from hangings and other porous materials. Many of the best auditoriums have a large amount of wood paneling. Figure 5 gives the absorption curve for such paneling as determined by W. C. Sabine. This is seen to be somewhat selective in favor of the lower frequency tones. For a room that is too reverberant we could thus hardly do better than to increase the absorption by covering certain of the walls by some kind of wooden panels. Unfortunately, as the absorption coefficient for such panels is low, a very large amount of wall space would usually have to be covered in order to bring the reverberation down to a proper value. This the fire laws will not permit in many cases. It thus appears that there is a need for a material which is fire-proof, fits into the decorative scheme of interiors, and has absorption characteristics that are high and selective for low frequency tones. Having available materials of this type in addition to the various porous absorbers now on the market we could place the problem of acoustic treatment of rooms on a better engineering basis.

Critical Relays of the Telephone Systems

By W. KUHN
Systems Development Department

TO INSURE that a telephone call reaches its proper destination, many close races against time must be run and won by the telephone apparatus. To those initiated into the secrets of telephony these races are fully as interesting and fascinating as those being run in the sporting world, for where these latter take into account days, hours, minutes, and possibly seconds, a race in a telephone circuit is only a matter of a few thousandths of a second.

Entrants in the races occurring in telephone circuits are generally relays, which are among the most important elements of the telephone system. The number required for a single call varies from approximately twenty, used to complete a call between manual subscribers, to about three hundred required to complete a connection between subscribers in widely separated areas. All of these relays must be reliable and accurate, particularly those upon whose correct operation the satisfactory progress of the call directly depends.

Fundamentally a relay is an electrically operated switch. It consists of an electromagnet (core and winding), and armature, and contacts. These parts are so arranged that when the core becomes magnetized by an electric current through its windings, the armature is attracted by the core and moves sufficiently to open or close the associated contacts. The speeds at which the armature responds to the make and break of the current through the winding are important. The elapsed time from the instant the current starts to flow through the winding to the moment the contact closes is known as the "operate time," and similarly that from the opening of the winding circuit to the opening of the contact, as the "release time." These are shown graphically in the oscillogram study of a relay operation on Figure 1.

Just as the competitors in a recent

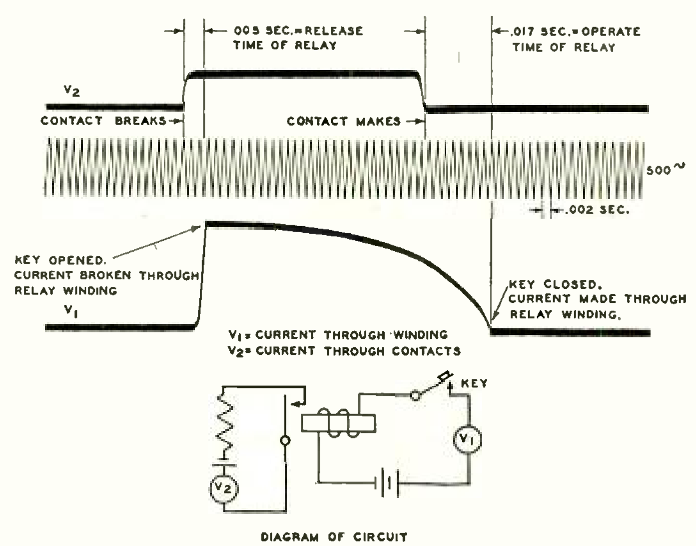


Fig. 1 — Oscillogram showing "operate" and "release" times of a relay in a typical circuit

cross-continental race were required to run under a variety of weather conditions, some of which were adverse, so the apparatus in the telephone system must function properly over a great variation in circuit conditions. A minimum variation in the time characteristic (operate and release times) is desirable, but this is sometimes difficult to obtain on account of circuit variations under which the relays are required to function.

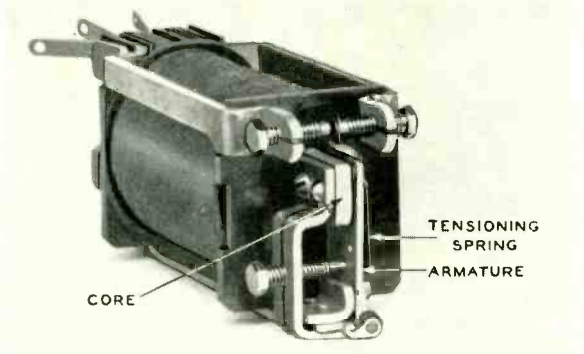


Fig. 2 — An L type relay which finds many uses in telephone circuits where fast "operate" and "release" are required

Many types of relays used in circuits where special speed requirements are to be met, must operate over a wide range of current, and yet release when there is still some current flowing through the winding. These may well be called critical relays. Operating range in many such cases depends upon the distance between central offices or between a subscriber and a central office, which may vary from a few yards to many miles. The current against which the relay is required to release is that flowing through the insulation of the conductors, which is something impaired by damp weather. This small leakage current flowing through the relay causes it to release more slowly.

Another factor which considerably affects the constancy of relay operating-times is variation in central office voltage. In manual central offices this may vary from twenty to twenty-eight volts for rated twenty-four volt circuits or from forty to fifty-six volts for rated forty-eight volt circuits. The corresponding voltage ranges in dial-system circuits are twenty-one to twenty-five, and forty-five to fifty volts, respectively. It is evident that a relay operating over long cable loops on minimum voltage will be slower in operating than one operating on maximum voltage on shorter

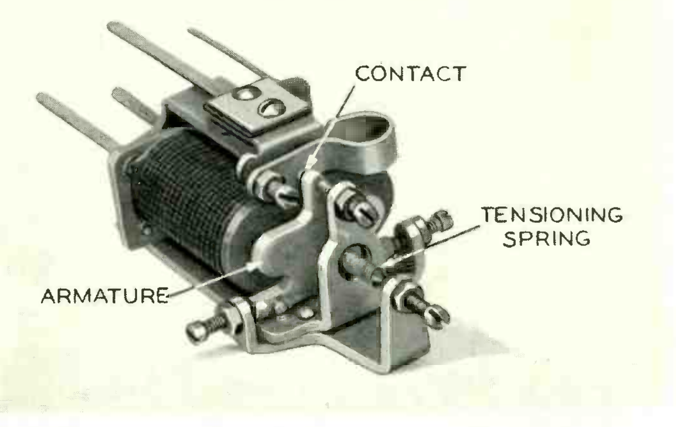


Fig. 3 — Having, like the L type, very fast "operate" and "release" times, the stepping or 207 relay is used for but one purpose in the Bell System

lengths of cable. Similarly, a relay compelled to release against leakage currents will act more slowly on maximum than on minimum voltage.

The particular critical operating and releasing characteristics required depend upon the circuit conditions under which the relay is used. In the sender circuit of panel-type equipment, for example, the "pulse" relay must accurately follow the make and break of the contact of a subscriber's dial. If the operate and release times of the relay are such that it will not faithfully repeat these pulses, the selector which registers them will not have sufficient time to function, and the call will be routed incorrectly. Furthermore, unless the armature of the pulse relay has sufficient spring tension the relay may operate falsely due to the discharges of cable capacity and the condensers in the subscriber's set, or to the cable-inductance. This would result in a false registration of pulses and a wrong number. Although a "stiff" adjustment of this relay prevents false operation, it necessarily limits the length of cable over which the relay will operate. The relay which performs this function must be fast both in operating and releasing. For this purpose an accurately adjustable model is used equipped with a light armature having a low moment of inertia. The "L" type relay shown in Figure 2 meets these requirements, and is used as the pulse relay in all the newer sender circuits. It operates over wide ranges with very little variation in its operate and release times.

Another relay which performs an extremely important function in the sender circuit is the stepping relay. Located in the originating office, it must reproduce the pulsations of current originated by the selectors in the terminating office with sufficient accuracy to insure the operation of fast-operate counting relays. The stepping relay also must have extremely fast operate and release characteristics and since it derives its driving current over trunk loops, is subject to cable discharges similar to those experienced by the pulse relay. To perform its task a very delicate and highly sensitive relay is required. Here the 207 relay shown as Figure 3 is used and serves no other purpose in the telephone plant.

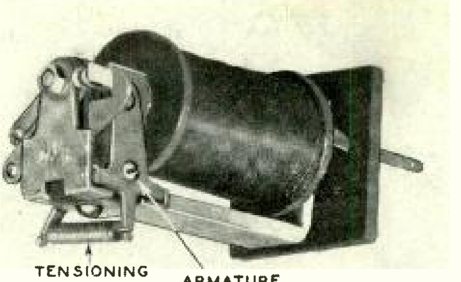


Fig. 4 — The 208 *type or counting relay; one of the high-speed relays of the Bell System*

Counting relays of the sender cirsuit serve as another example of very accurate high-speed relays. These are among the fastest relays in use in the telephone plant. They are required to function from the contact of the stepping relay. The operate time of these relays is of the order of five thousandths of a second and is very constant. This high degree of constancy is possible because the relays operate in a local circuit and are not required to function over such great circuit variations as the pulsing relays. The high speed of these relays can be more readily appreciated by comparing it with that of an automobile going sixty-five miles per hour, which travels only six inches in the operate time of one of them.

The 208 type counting relay is shown in Figure 4. It is equipped with a light armature on a pivot suspension, and operates through a small air gap. The contacts are mounted on comparatively rigid springs which, once adjusted, maintain the adjustment without change for a considerable time.

Other circuit conditions require slow-acting relays which yet must function within the time limits set by the circuit requirements. Slow-acting relays may be slow operating, slow releasing, or both, and are used for various purposes. One of the more important is the "register advance,"

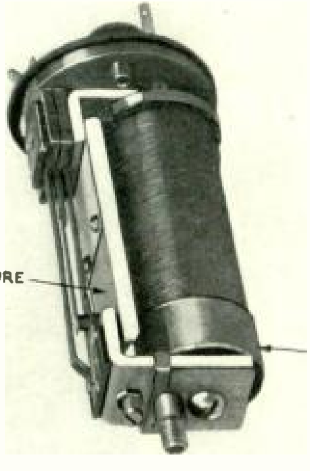


Fig. 5 — Slow-acting relays have heavier armatures and copper heads, as may be seen in this 149-BR relay

or "steering" relays—a relay in the sender circuit closely associated with the registration of the dial pulses. Its function is to insure the registration of the dial pulses of successively dialed digits on the correct registers.

Operated by the first closure of the pulse relay contacts the "steering" relay is designed to remain operated during the individual make-and-break periods of the dial pulses, and to release during the break periods between the dialing of successive digits. If the relay releases either too quickly or too slowly, the dial pulses are registered on the wrong register and an incorrect number results. Because of the narrowness of the time limits which the relay is required to meet, considerable study is required to obtain a relay which will perform satisfactorily. Many sender circuits use for this purpose the round-core slow-releasing 149-BR relay illustrated in Figure 5, This relay, equipped with a heavy armature and a copper head, is typical of the slow action relays used.

Another illustration of the importance of the time element in operation is found in the supervisory relays. These, as well as the pulse relays, must operate over subscribers' and trunk loops which vary from practically zero resistance to the maximum resistance through which the relays will operate, and must release against small leakage currents tending to hold them operated.

Supervisory relays in cord circuits are usually required to flash a lamp or other signaling device. A subscriber in a manual area wishing to recall an operator moves his switchhook up and down, thereby operating and releasing a supervisory relay, and alternately lighting and extinguishing a supervisory lamp in front of the operator. Such relays must respond quickly so that the period between operate and release is greater than the time required to light the lamp filament or to operate the signal. The visible signal received by the operator is therefore dependent on the ability of the supervisory relay to quickly follow the make and break of the subscriber's switchhook.

Some supervisory relays are required to repeat a "reorder signal" of 120 interruptions per minute when relayed from the terminating office through the contacts of one or more other supervisory relays. This flashing signal tells the operator in the originating office to repeat the called number to the operator in the terminating office. Relays required to repeat the flash to these supervisory relays must also function over trunk loops, and on extreme circuit conditions each one distorts the signal by changing the original length of the make and break periods of the reorder pulse. Under these conditions it is difficult to insure that the "A" operator will obtain a visible flashing signal.

Because most supervisory relays are connected in series with the line outside of the repeating coil it is necessary, in order to obtain a low impedance path for voice currents, to use a non-inductive shunt in parallel with the inductive winding of the relay. This tends to give the relay slow operate and release characteristics which are undesirable for flashing. To overcome this undesirable tendency supervisory relays are designed to operate and release at a rate of 180 per minute under testing conditions. The "B" type relay shown in Figure 6 is the type most used for supervisory purposes.

These are but a few of the more prominent examples of the circuit conditions which require critical relays. In many cases where time is not an important factor the current-flow conditions are critical. A relay may be required to differentiate between operate and non-operate current differing in magnitude by only a small amount. In each case relay adjustment plays a vital part in obtaining

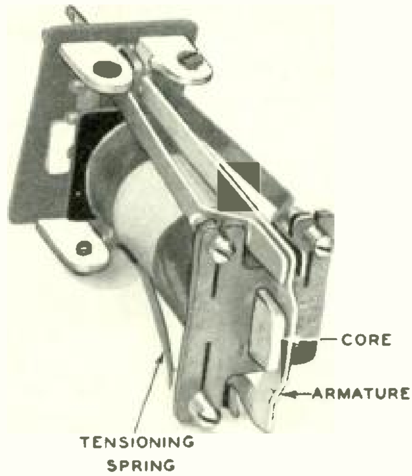


Fig. 6 — A "B" type relay used for supervisory purposes

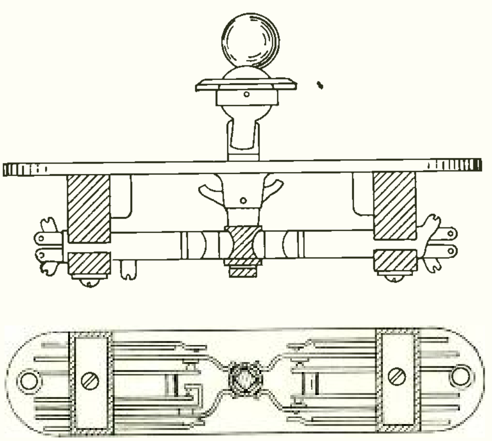
satisfactory operation. The design of the relay structure and particularly of the movable parts has a considerable effect upon its characteristics and its suitability for the circuit condition in question.

To make sure that relays will function properly in service, thorough tests must be made in the laboratory before they are approved. Tests are also continually in progress to increase the operating ranges, and to determine the adjustments for most satisfactory operation.

Lever-Type Keys

By G. A. RITCHIE
Apparatus Development Department

OF THE great variety of keys used in manual telephone switchboards, the lever keys are the most characteristic and probably the most useful. The earliest of these to come into general use in the Bell System was the 52 type, used for ringing and listening, on which application for a patent was filed in 1888. In the key itself two spring combinations, with a swinging cam between them, were mounted in a frame of cast brass which was fastened to the under side of the wooden keyshelf. A lever was mounted directly above, in a separate frame, and

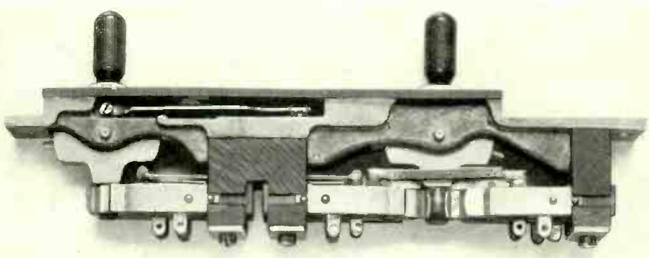


A 51-type key, the first key lever key containing two pileups

engaged a slot in the cam of the key so that movement of the lever was transmitted to the cam. These keys were generally used until, with the inception of two-party selective ringing systems, it became necessary to provide in each cord circuit two spring combinations for ringing in addition to the combination for listening.

To meet the new demand with the addition of another spring combination and another lever the 102-type key was brought out. Opportunty was taken in the new design to facilitate mounting by several important changes in construction. The levers were made integral parts of the key rather than separate assemblies; the key frame was changed in shape and finish to form part of the upper surface of the keyshelf; and mounting lugs were added at the front and back of the frame. At the same time the keyshelf was redesigned with a rectangular opening to hold the customary number of keys. At the front and back of the opening were mounting bars, to which the keys were bolted. The upper surface of the lug was below the surface of the keyshelf, and after installation lugs at front and back were covered with wooden retaining strips parallel with the edge shelf. This construction afforded greater flexibility in mounting, since it eliminated the need for cutting new holes when the key spacing or centering was changed at any installation.

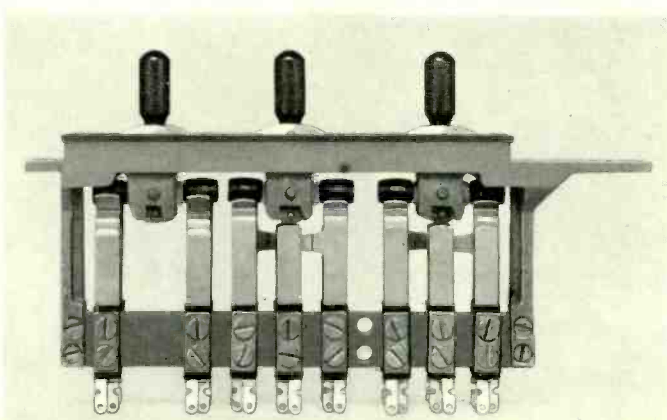
The horizontal arrangement of the springs made them easily accessible for inspection and maintenance, since the edges were exposed when the hinged shelf was raised. This feature, together with the substantial construction, made the 102-type keys so satisfactory that many thousands of them are still in service. However, the side-by-side position of the springs made the minimum width possible for a particular key dependent principally on the number of springs in its largest pileup. Only a moderate width was necessitated by the number of contacts used at the time, but later circuits, requiring a larger number of springs, would have increased the width to such an extent as to cut down the number of cord circuits with which a keyshelf could be equipped to a figure below that for the most efficient handling of calls. Furthermore the introduction of prepayment coin-box service made necessary keys with more spring combinations to provide for collection and return of coins in addition to ringing and listening.



A key of the 102-*type. Although the design has since been changed in almost all respects, this type marks a major step toward the keys of today*

Two new types of keys, similar in design, were thereupon developed, the 462 and 463. The 463 type key was equipped with three levers, while in the 462 the rear lever was replaced by two push buttons for collection and return of coins, or by a single push button for operation of a message register. The springs were mounted vertically, and as a result six groups of springs were provided in keys the same length as those of the 102 type, where there had been room for only three. The pileups still extended sidewise, however, so that increase in the number of springs meant greater width, but some additional spring capacity was obtained when needed by providing an auxiliary set of springs between the two main spring combinations of each lever, operated by extensions protruding from the springs of the main pile-ups.

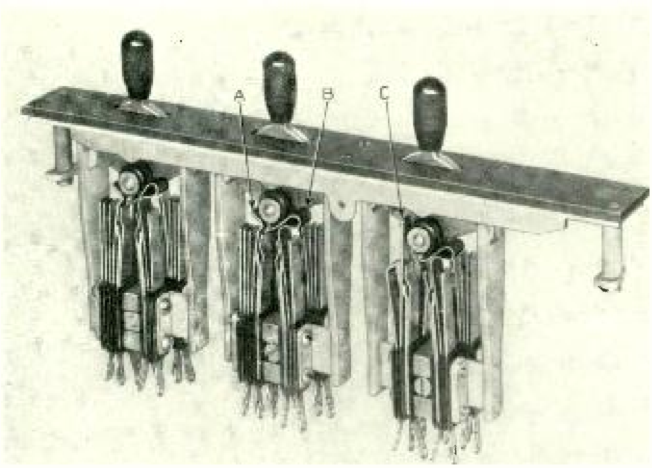
To meet the demand for larger spring combinations brought by the standardization of improved operating practices the present standard



A 463-*type key, with auxiliary springs beneath two of the levers* keys of the A1 and A2 types were developed. A radical change in construction brought advance from the standpoints of manufacture, installation and maintenance, as well as in the number of contact springs that could be accommodated. The heavy frame of cast brass formerly used was replaced by a channel pressed from light sheet steel, to which are bolted subordinate frames for holding the spring pileups and the levers or plungers. Thus unit construction was introduced. Whenever a new key was wanted its production involved the comparatively simple process of combining standard units, rather than the previous course of designing and manufacturing an entirely new entity.

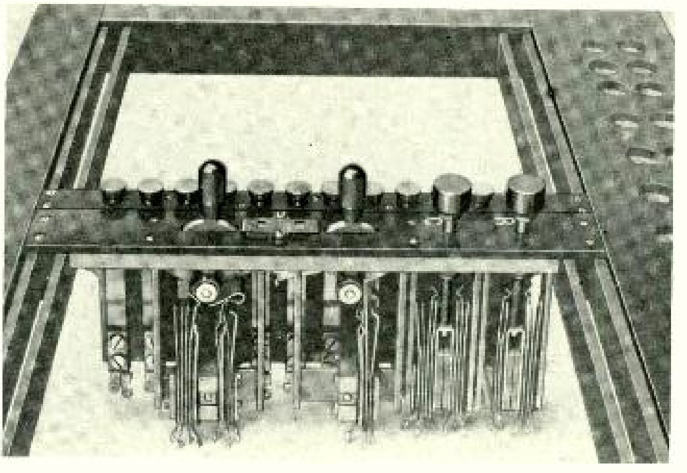
The springs are vertical as before, but they have been turned through 90 degrees so that their surfaces are parallel to the edge of the keyshelf. With the springs extending from front to back rather than from side to side, width is independent of the number of contacts in a pileup. At each corner of the sub-frame associated with a lever is a pileup in which there may be a maximum of seven contact springs. When the lever is moved in either direction two rollers supported by pins on opposite sides of the cam operate a pair of the pileups, and thereby as many as fourteen contact springs, a number sufficient for all standard circuit conditions encountered at the present time.

In one pileup of each pair there is a spring, longer than the others, which transmits the motion of the roller on the lever cam to the other springs. This plunger spring may be straight, to restore the lever to normal as soon as it is released, or made with a V-shaped crimp for holding the lever operated until restored manually. In the other pileup of the pair motion of the cam roller is taken by a long curved spring, commonly called a crook spring from its fancied resemblance to a shepherd's crook. The reason for its peculiar shape is its main function, that of preventing even momentary false operation of any of the contacts. After release of a lever from either operated position one of the rollers, passing the neutral position, strikes the crook spring at the opposite side; flexing of the spring absorbs the energy of lever and cam before the rollers have gone far enough to operate any of the contacts.



A-1 type key, showing the mounting posts and the auxiliary frame supporting each lever unit. A, plunger spring with crimp; B, crook spring; C, straight plunger spring

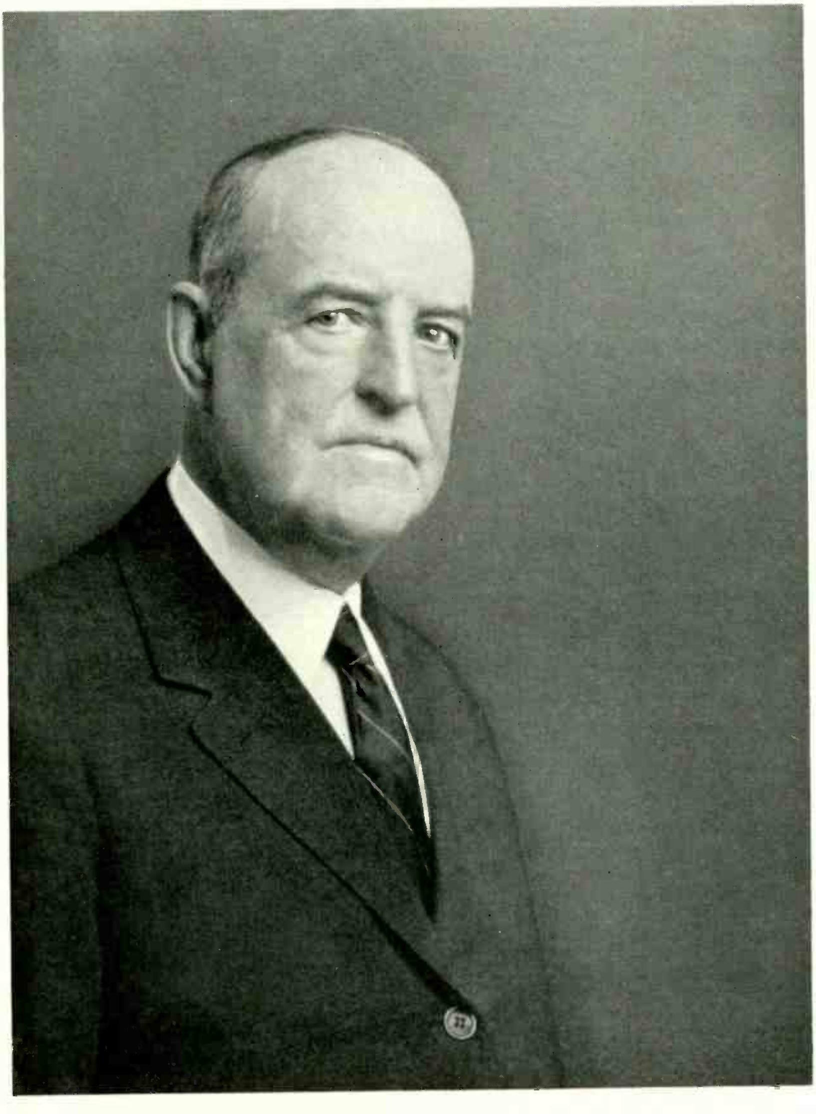
The method of mounting in the keyshelves has also been simplified. A small post is provided at each end of the key base, with a threaded hole at the end, into which is inserted a screw bearing a narrow, flat-sided washer. These posts pass through a space between pairs of parallel mounting bars at the front and rear of the opening in the keyshelf, and are held in place when the washers are turned through 90 degrees and the screws tightened. The redesign of key frame and shelf has made it possible to keep the top surfaces of the keys level from end to end. The wooden retaining strips which ran across the front and back of the key-shelves, covering the lower ends and the mounting screws of previous keys, have therefore been omitted.



An A-2 type key mounted in a keyshelf, with the posts between the mounting strips at front and back of the shelf

By these changes in construction, the work of mounting keys has been greatly facilitated. It is no longer necessary to drill and tap the mounting bars of the keyshelves, but merely to place a key in position, give the clamping washer at each end a quarter turn and tighten the screw. Removal of a key to give access to the springs has likewise been simplified of course; loosening the two screws and turning the clamping washers takes the place of removing two retaining strips and a number of screws, formerly necessary to get a key out.

Construction of the pileups has made possible a wide variety of spring combinations from a small range of individual parts. That this feature is of major importance is shown by the facts that more than 500 types of spring combinations are now in use, and that this number is being steadily increased to meet the needs of new circuit developments. When plunger-type units are mounted on any of the keys, for coin-box or message-register operation, each is assembled on a frame punched from sheet steel, just as the lever units are; two such plunger units take up about the same space as a single lever unit. Practically all lever-type keys of recent design are of three standard lengths, accommodating respectively one, two and three lever units; in the last of these two plunger units may be substituted for the rear lever unit. Call circuit keys and mechanically locking keys are made with a similar type of unit construction, and use the channel frames of standard lengths.



Wilton L. Richards

Fifty Years of Bell System Service

ON September first, 1878, a telephone career began which has proved one of the longest in the telephone industry. Wilton L. Richards, entering that day the shop of Charles Williams in Boston, has seen telephony unfold from a scientific marvel into a close-knit system spanning continents and oceans. At first as the assistant of Francis Blake in installing his transmitters, and of Emil Berliner in his researches, Mr. Richards began a fruitful career in telephone transmission. Every operator, listening unconscious of the receiver which sits lightly on her head, is equally unconscious that Mr. Richards developed the first practical head-receiver. The bipolar receiver, which hangs from every desk-stand, traces its ancestry through Mr. Richards' development of the "long distance" instrument of 1890. Today's broadcasting was presaged by his work on transmitters to pick up theatre programs.

Telephone lines, too, came under Mr. Richards' attention; he was associated with G. A. Campbell in the early transmission measurements of circuits and their equipment which led up to the use of loading by the Bell System. In the first days of the vacuum tube, Mr. Richards made numerous tests of their application to our needs. His interest in repeaters led to the conception and an original development of the balanced-circuit method by which a two-way channel is split into two one-way channels; this operation is performed in every 22-type repeater and every linkage of wire circuits to radio for two-way communication. A number of other patents also stand to his credit which include protective devices, loading-coil arrangements, telephone receivers and transmitters.

Mr. Richards had much to do with the Bell System exhibit at the Chicago Worlds Fair in 1893, and in 1915, he was in charge of the transmission features of the exhibit at the Panama-Pacific Exhibition at San Francisco. At about this time he was placed in charge of the Historical Museum at West Street. It is to his historical knowledge, painstaking care, and enthusiasm that the Museum in its present form is largely due.

The beginning of his fifty-first year finds Mr. Richards as Consulting Historian of the Laboratories an active member of the Bell System which he has served so long, proud of the wonderful growth and communication accomplishments of the System and happy in the affection of his many friends.

Above, left, Henry Olsen; right, Otto Muller; center, Mary Lindner; below, left, Frank Meehan; right, John Lawless

Recent Retirements from Active Service

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

SINCE August of last year the Laboratories has lost the services of five of its members through their retirement under the provisions of the Plan for Employees Pensions, Disability Benefits and Death Benefits. Leaving us as they do after years of service, they should carry with them the pleasurable knowledge that their individual efforts have contributed to the development of the Laboratories today, and that their friends, whom they leave behind to continue its work, wish them many years of health and happiness.

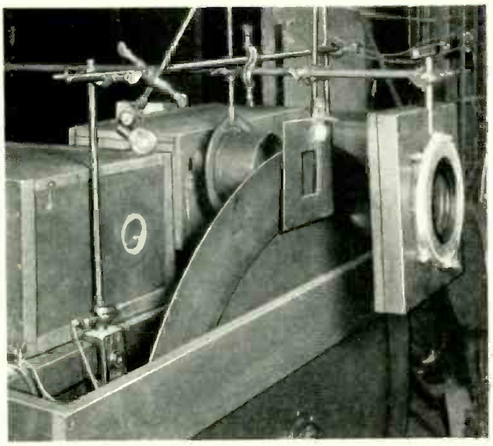
Miss Mary Lindner, who has most recently been a technical assistant in the lamp and battery group of the Apparatus Development Department, since the granting of her application for retirement last November has been living with her sister and niece in Bayonne, New Jersey.

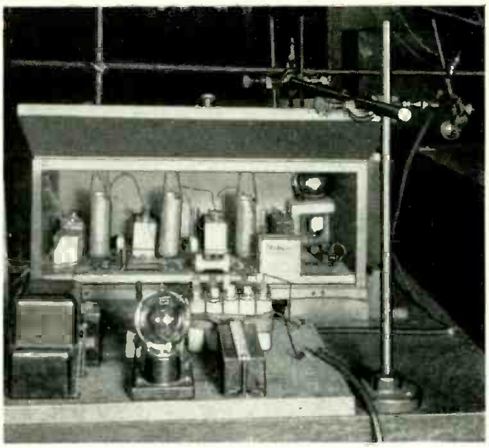
Frank Meehan, whose genial face has been missed for some time from the 1-C entrance on Bethune Street, was also retired at his own request after twenty-three years of service with the Western Electric Company and Bell Telephone Laboratories as a porter and watchman.

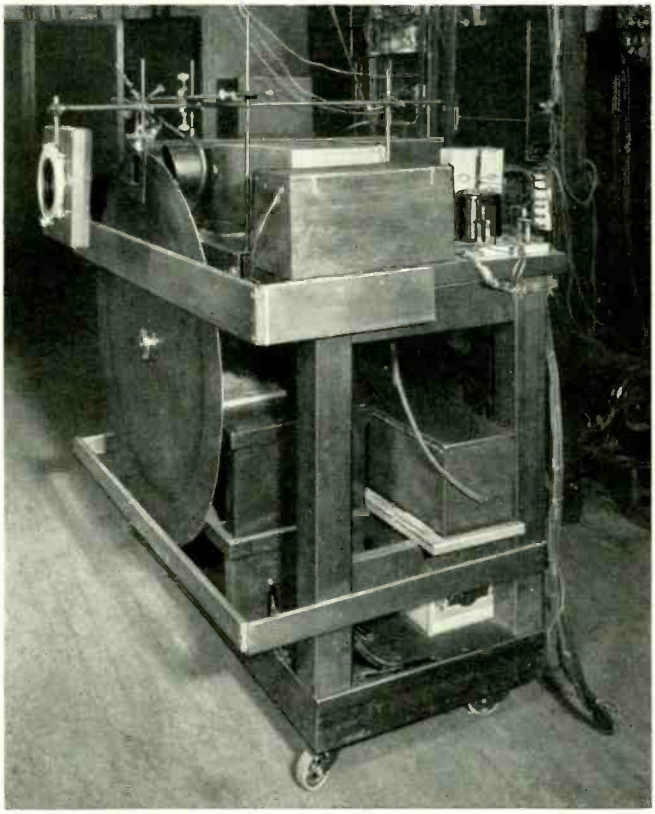
Henry Olsen, who was at the time of his retirement a supervising draftsman in the Systems Development Department, is now living on his farm near Saratoga Springs, New York.

John Lawless, who has been continuously employed in the Plant Department of the 463 West Street building since joining the Western Electric Company in 1901, requested his retirement because of failing health but continues his residence in Greenwich Village where he has been living for the past seventeen years.

Otto Muller, the "grand old man" of the Engineering Shop, shortly after celebrating his eightieth birthday, requested retirement so he might enjoy his leisure while still in good health. Mr. Muller has not been absent for sickness or other reasons for almost five years. Entering the Western Electric Company in 1892 as a skilled mechanic in its Manufacturing Department, he has been continuously employed on the more difficult and accurate work such as that requiring diamond cutting-tools. His ability especially fitted him to be retained in our Engineering Shop when manufacturing work was transferred to Hawthorne in 1913.







Television by Direct Scanning

Set up outdoors last July, the transmitter (center) viewed a scene illuminated only by daylight. Brought by the large lens to a focus, the image was scanned by holes in the rotating disc. In the box (upper right) appear the cell and the first three amplifier tubes in their lead jackets. Black-and-white segments on the back of the disc, illuminated by the lamp (upper left), are viewed by a second cell to furnish alternating current for synchronizing

News Notes

A VISITOR to the Laboratories on September 6 was Professor Jonathan Zenneck of Munich, upon whom the Institute of Radio Engineers recently conferred the Medal of Honor. Dr. Zenneck, escorted by W. Wilson, inspected the laboratories for radio research and for electronic physics. Accompanied by R. A. Heising and F. M. Ryan he then visited the radio laboratory at Whippany.

SEVERAL LABORATORIES ENGINEERS were present at the fall meeting of the Society of Motion Picture Engineers, held at Lake Placid, New York, during the week commencing September 24. Several papers on sound recording were read, including "The Quality of Speech and Music" by J. C. Steinberg, "Sound Reproduction in Theatres" by E. O. Scriven of the Laboratories and H. B. Santee, of Electrical Research Products, Inc., "Recent Advances in Wax Recording" by H. A. Frederick, "Light Valve Recording" by Donald MacKenzie, "General Principles in Sound Recording" by E. C. Wente, and "Methods of Synchronizing" by H. M. Stoller.

Patent

C. A. CONRAD, H. A. FLAMMER AND T. P. NEVILLE visited Washington in connection with the prosecution of applications for patent. J. A. Hall visited Rochester and I. MacDonald visited Philadelphia for the same purpose.

General Staff

S. P. GRACE addressed the Convention of the New Hampshire Telephone Association at Laconia, New Hampshire, on September 13. He also spoke at the Convention of the Maine Telephone Association at Portland, his subject being, on both occasions, recent work and developments in the Laboratories.

Inspection Engineering

R. M. MOODY visited Hawthorne during the week of August 6 and O. S. Markuson visited Kearny during the week of August 13 for the regular Survey Conferences.

DURING THE WEEK of September 10, S. H. Anderson visited the Fort Wayne Plant of the General Electric Company to study the manufacture of regulated electric motors.

Outside Plant Development

C. H. KLEIN visited the plant of the Bethlehem Steel Company at Lebanon, Pennsylvania, during August to make studies on the development of pole-line hardware.

L. M. LINDENMUTH was in Norfolk, Virginia, on August 6 and 7 for the purpose of selecting samples for pole preservation studies.

Research

D. G. BLATTNER visited the Victor Talking Machine Company at Camden in connection with tests on the Orthophonic Victrola.

C. H. G. GRAY returned on August 20 from London and Paris. While in the latter city, he supervised the installation of the European master telephone transmission reference system, a replica of the American system adopted as an international standard last year.

C. J. Davisson sailed on August 25 to attend a meeting of the British Association for Advancement of Science at Glasgow, Scotland.

C. W. Borgmann and E. G. Mayer attended a meeting of the American Chemical Society at Swampscott, Massachusetts.

H. H. Lowry and W. B. Warren investigated grinding machinery at the Dorr Laboratories at Westport, Connecticut.

D. J. Salley visited New Brunswick, New Jersey, to observe a case of local action in the Philadelphia-New York cable.

A. C. Walker and E. J. Ernst investigated a humidity recorder for use in cable storage ovens at Kearny.

A. G. Jensen left on August 28 for New Southgate, England, to resume his work on transatlantic radio telephony.

Apparatus Development

W. L. Tierney completed a survey for a 106-A (one kilowatt) equipment installation to be made for Taft and Wasmer, Inc., at Seattle.

R. E. Malles visited Syracuse to inspect an installation of talking movies at Loew's Theatre.

R. E. Kuebler, G. C. Porter and R. M. Pease were in Albany from August 13 to 23 to install a Public-Address System for Governor Smith's notification ceremonies.

H. M. Stoller visited Hawthorne in connection with control equipment for talking motion pictures.

J. R. Townsend visited Hawthorne in connection with specifications for hardness limits of brass, nickel silver and phosphor bronze. He also visited the American Brass Company at Waterbury, Connecticut, to discuss Rockwell hardness-test blocks to be used in the preparation of these specifications.

H. C. Curl spent six weeks on the Pacific coast, where he tested and adjusted the general announcing systems of the U. S. S. "Lexington" and U. S. S. "Saratoga."

A. R. Saunders made tests on contact resistances of 200-type selectors at exchanges in Albany, Schenectady and Syracuse.

Systems Development

H. S. Black attended the Pacific Coast Convention of the A. I. E. E. at Spokane, Washington, where he delivered a paper on "Carrier-Telephone Systems for Short Toll Circuits" of which he is joint author with M. L. Almquist and L. M. Ilgenfritz of A. T. & T.

J. P. Kinzer visited the repeater stations at Harrisburg, Reading and Allentown, Pennsylvania.

J. R. Stone visited the Fort Wayne factory of General Electric to witness tests on a new rating for commercial-type charging sets.

W. O. Fullerton discussed the new 506-A private branch exchange with Stromberg-Carlson engineers at Rochester, New York.

C. E. Hokanson spent several days at Hawthorne arranging for the initial installation of a new information desk at Cathedral central office, New York City.

R. P. Jutson made tests on improved equipment for plate battery supply at Bluefield, West Virginia and Columbus, Ohio.

L. D. Fry and E. J. Kane visited the new step-by-step central office at Atlantic City.

A Sensible Viewpoint on Insurance

Reprinted by permission from an article by Wallace Ames in Popular Science Monthly

"I'M GLAD I've got a good job," thought Warren Cady, as he stayed overtime at the office the afternoon of pay-day to go over his bills and draw checks to cover them.

Let's look over Warren's shoulder and see what his monthly crop of bills is. Here is the itemized list of the checks he drew:

Monthly mortgage and interest payment	$83.33
Gas, electricity, milk, etc.	21.32
Mrs. Cady's monthly allowance	100.00
Mr. Cady's personal miscellaneous	50.00
Installment on automobile	41.20
Installment on radio	8.00
Installment on set of books	3.50
Installment on electric refrigerator	12.50
Total disbursements	$319.85

As Warren had deposited in the bank a salary check of $416.66 he had increased his bank balance $96.81 after paying the month's bills and drawing out the usual amount used by his wife and himself for current expenses. With a feeling of relief that an annoying job was attended to he pulled the day's sheet off his calendar pad as the last act before closing down his desk and starting for home.

Glancing at the notes on the calendar for the next day, Warren was reminded that his semi-annual premium payment on life insurance amounting to $60.00 was due. "Something is always taking the joy out of life," he burst out. "Just when I was enjoying the satisfaction of increasing my bank balance with a hundred dollars this insurance premium has to come due and eat up over half of it." After drawing another check Warren caught the 6:19 for home.

At the dinner table there was talk about their good friend and neighbor, Bill Kane, who had recently passed away, and speculation on what the future might hold for Mary and little Bill.

"That reminds me," said Warren to his wife, "I just paid our monthly bills today, and here is your check. What do you suppose you would do if I didn't come home once a month with a handful of shekels?"

Then, without waiting for the answer, for there was really no good answer to Warren's last question, he began to do a little figuring. He computed that there were seven more payments on the car, amounting to $288.40; four radio payments of $32; five book payments, $17.50 and six remaining refrigerator payments totalling $75.

Everything that the Cadys were buying "on time" was a sensible, worthwhile thing, from which they derived a lot of deserved satisfaction and pleasure. Nevertheless it worried Warren when he figured up a total of $412.90 that had to be paid before the auto, refrigerator, radio and books were really theirs.

But those items were only a drop in the bucket. There were the mortgages on the house. While it was a good investment, something like $5,000 was still to be paid over a period of the next seven or eight years.

And then there was little Warren, Jr., their two-year-old son. They had spent many an hour talking and dreaming over his future. Of course they were planning to send him to college. And his daddy had visions of Junior making the football team.

"Yes," said Warren, at the close of the evening, "I'm glad I've got a good job—and my health."

"I saw Mary today," remarked Mrs. Cady, when she met her husband the next evening at the train. "She is a courageous soul and is bearing up better than I expected she would.

"While I was there the insurance man called. His visit was just like the silver lining, if there could be such a thing to the cloud that hangs over her just now. He was there to settle up three insurance policies and I was so pleased to learn how well fixed financially Mary is. Last night you remarked how good Bill had always been to Mary. I thought of what you said when the insurance representative was there.

"One policy for $2,000 was arranged to help put little Bill through college. That is still a long way ahead. That money invested will probably be more than enough. It will buy his clothes and take care of a lot of things while he is growing up.

"Another policy will pay Mary $5,000 right away. It will take care of her extra expenses at this time and pay off the mortgage on their home. So she hasn't got that to worry about. "From the third policy Mary will be paid $125 income every month. She is a good manager and can get along very comfortably on that amount. Bill sure was good to Mary."

"That was certainly far-sighted of Bill to carry all that insurance," said Warren, "But he must have had an awful time keeping up his premium payments. I find it a painful struggle keeping our $5,000 policy in force. Wonder how much he was paying out for insurance?"

"We manage to pay over $40 every month on our automobile," suggested Mrs. Cady.

"That's a thought," replied her husband. "Do you know, I never had the gumption to think of it that way. We readily pay for the car and the radio and the refrigerator because we are using them all the time, getting our pleasure out of them as we go along, and the necessary monthly payments seem even easier than the semi-annual insurance payments. My point of view has just been wrong.

"I think I will see my insurance agent tomorrow and work out a new program. Then I can quit worrying over what would happen to you if I should unexpectedly join Bill. We can extract enough money from our bank account to pay the initial premium. Before the next one comes due we will be through paying for the car and we can thereafter use that money to carry enough insurance to protect you against any financial hardships."

Warren Cady kept his good resolution. The next day he and his insurance agent* worked out a sound, practical program along these lines:

I. Warren Cady's present policy

**A similar service is available to all members of the Laboratories on application to Mr. L. H. Bunting, a specialist in life insurance. Mr. Bunting is to be found in Room 114 and is to be reached on Extension 264.*

was on the 20-payment life plan taken out 9 years before—when he was twenty-six years old. After deducting dividends, premiums on this policy were about $115.00 a year. When he reached age 46, he would cease paying premiums on this policy.

In the new program Warren's 20-payment life policy was left untouched to provide Mrs. Cady with $5,000 in cash to take care of current expenses, mortgages, etc. In insurance parlance this is referred to as a clean-up fund.

II. A $2,000 20-year endowment policy was arranged with his son as beneficiary.

It was planned to allow dividends to accumulate on this policy so that it would actually pay over $2,000 seventeen years hence. Thus in case Mr. Cady should survive the seventeen years, the insurance would provide cash for educational expenses. Provision was made whereby in the event of Mr. Cady's death before the endowment policy matured, the insurance company would hold the principal and pay interest to Mrs. Cady as guardian until the son was eighteen years old and then pay the principal to him in eight semi-annual installments. Thus, before and after entering college, funds would be provided for the boy's expenses.

III. Additional ordinary life policies aggregating $18,400 were taken out. These policies provided Mrs. Cady with a guaranteed income of $100 a month for twenty years after Mr. Cady's death. Together with the average excess interest paid the average total monthly income payments would be approximately $113.50. They also contained a clause whereby if Mrs. Cady should live more than twenty years after Mr. Cady's death, she would receive an income of $100 a month after the twentieth year.

IV. On all the insurance, except the $2,000 endowment, it was planned to use dividends to help pay premiums. These dividends would commence the second year of the new policies. Whereas the first year total premium payments would be $786, beginning the second year they would amount to only $654.

By taking out a number of small policies rather than one large one, Mr. Cady's insurance representative arranged it so that premium payments would come due monthly rather than in a large sum once or twice a year.* The average monthly premium payment beginning the second year was only about $55, in return for which Mrs. Cady was assured of $5,000 cash, plus $100 monthly income and Warren, Jr., was assured of $2,000 at age eighteen, plus income on that sum in the interval, subsequent to Mr. Cady's death.

When Mr. Cady reached age forty-six, he would cease paying premiums on his $5,000 20-payment life policy. Thereafter his monthly premiums would be reduced to an average of $40.

One of the most interesting things about Warren Cady's new insurance program was his point of view towards payments. Once he got the right idea he found that it was just as easy to pay $55 a month in insurance premiums as to pay a similar amount in installments on mortgages or merchandise.

**Members of the Laboratories may accomplish the same end even more conveniently by authorizing deductions from pay, the funds to be turned over directly to the insurance company. See* BELL LABORATORIES RECORD *for April,* 1928, *page* 246.

Club Notes

THE Nomination Committee of the Bell Laboratories Club will meet on Wednesday, October 24, to nominate candidates for the Club elections to be held on Monday, December 17. The offices to be filled for 1929 are as follows: President, First Vice-President, Second Vice-President, Departmental Representatives, two year term—Commercial Telephone Systems, Research, and Tube Shop. At least two but not more than three candidates are to be nominated for each office.

The Nominating Committee consists of the following members: D. A. Quarles, President; D. D. Haggerty, Secretary-Treasurer; Departmental Representatives: S. L. Stranahan, Apparatus Development; G. Rupp, Plant; P. J. Higgins, Tube Shop; T. C. Rice, Patent-Inspection Department; T. J. O'Neill, Systems Development; and J. C. Kennelty, Commercial.

Club members desiring to submit candidates' names to Departmental Representatives should do so before the meeting.

Basketball

The Bell Laboratories Club Interdepartmental League will start on Tuesday evening, October 30, at Labor Temple, Fourteenth Street and Second Avenue. Two games will be played every Tuesday evening with the first game starting promptly at 5:30 P.M. Eight teams representing the various major departments will take part in 1928-29 tournament. The departments represented are Plant, Research, Equipment, Drafting, Systems Engineering, Apparatus Development, Junior Assistants, Tube Shop, and Commercial.

Again this year the Club will enter a team in the Bell System Basketball League, the activities of which will start on Monday evening, November 12. Games will be played on Monday and Friday evenings in Stuyvesant High School and Wednesday evenings in Erasmus Hall High School, Brooklyn, during November, December and January. The team in the Bell System League will be managed by J. A. Waldron and the activities of the Interdepartmental League will be directed by C. F. Gittenberger. C. Maurer will referee the Interdepartmental games. These men can furnish further information regarding the tryouts for the league team and the practice preliminary to the Interdepartmental games which will be held on Tuesday and Thursday evenings during October with the exception of October 30.

Men's Bridge

The men's bridge club will begin its season on Monday, October 8, meeting in Rooms 275 and 277 at 6:00 P.M. After the brief preliminaries of organizing, with G. T. Lewis as director, the players will hold their first contest and will continue at the same place on Monday evenings until the middle of December. There will be two tournaments lasting ten weeks each, of which the second will start in January, and in addition a match with players from 195 Broadway and a series of mixed games with players of the women's bridge club, to be scheduled definitely later. In all there will be about twenty-four meetings. Membership in the bridge group does not involve any pledge of attendance, but to be eligible for prizes in either tournament players must take part in at least eight of the ten meetings. Last year there were fifty-five names on the roster, with an average of nine tables at the weekly meetings. With a successful season as a background, more participants may be expected this year.

Dance

Arrangements for our first autumn dance have now been completed with the engagement of Hood's Orchestra. This group, general favorites among the Club members, have provided the music at many of our previous dances and entertainments.

Tickets are now available at the Club office and through departmental representatives. Only five hundred have been printed, since the attendance is limited to that figure by the hotel management. At our previous dances held at the McAlpin all tickets have usually been sold a week in advance, so that it is advisable to buy them early; in any case none will be on sale at the door. The tickets are $1.00 each, and the date is Friday, November 2. Dancing will commence at nine, and continue until two.

Club Orchestra

The symphony orchestra will hold its first rehearsal on Thursday evening, October 4. Plans are under way for engaging the services of a professional director. The orchestra is particularly in need of more string instruments and will be glad to welcome new candidates. The rehearsals will be held every Thursday evening at 6:00 P.M. in the Women's Rest Room on the 11th floor. For further information regarding these rehearsals, call D. D. Miller.

Hiking

For those who love the woods and mountains in their brilliant autumn colors, an attractive program of hikes has been prepared by A. Grendon and Phyllis Barton. Four expeditions have already returned to their base, reporting the strange manners and customs of the natives and the hardships met and overcome in such far-away places as Bear Mountain and Kensico Quarry. Carrying their rations, two groups of intrepid explorers crossed the Hudson at Dyckman Street, and dispelling the darkness with camp-fires, held counsel as to an advance on Englewood or a retreat to the safety of Manhattan. A little-known section of Westchester County near Grassy Sprain Reservoir will be charted and photographed on Saturday, October 6, under the leadership of Miss Barton. On Sunday, October 21, the invaders will descend upon the country east of Boonton. After casting their ballots on Election Day, the hikers will meet at Dyckman Street Ferry and proceed to follow the shore to Alpine, where marshmallows and popcorn await.

Printed programs may be secured from Mr. Grendon or Miss Barton, who should be advised of your intention to accompany the expeditions.

Women's Basketball

Basketball starts Monday, October 15, and will continue on each Monday, from 5:30 to 7:30. St.

Luke's Court, conveniently located on Greenwich Street, just below Christopher Street, has been engaged for the home court of the team. During October, November and December, the sessions will be devoted to well-planned practices, tactics and rules of the game under the coaching of Charles F. Gittenberger, manager of men's basketball, with a view toward forming a well organized team to represent the Club in outside games during January, February and March. This activity is open to all women of the Laboratories regardless of experience, since plans have been arranged to take care of beginners as well as regular players. Marie Boman will manage women's basketball this year and it is requested that those interested enter their names with her.

Swimming

The fall swimming classes are now meeting regularly at the Carroll Club, Madison Avenue and 30th Street, on Monday nights from 7:00 to 7:30, and Wednesday nights from 5:30 to 6:00. Each class will cover a ten week period ending early in December, and will be held under the expert tutelage of Miss K. Spranger.

Women's Bridge

The Women's Bridge Club, meeting regularly on Tuesday nights, will hold its first meeting October 2, at 5:15 in the Rest Room on the eleventh floor. The Club will conduct another tournament for which prizes will be awarded. Katherine Munn is arranging for the meetings of the Club and would like to know in advance the names of those planning to attend.

Dancing

Another Dancing Class will be formed under the direction of Mr. Vecchio at the Vecchio Studio, 1160 Broadway. This course covers exercises for limbering and stretching, group and individual dancing and musical comedy steps. The class will be held on Friday evenings starting October 19 from 5:30 to 7:00, to continue for ten lessons, at a cost of five dollars. The class is limited to twenty-five members. Further particulars may be obtained from Harriet Newman, Extension 673.