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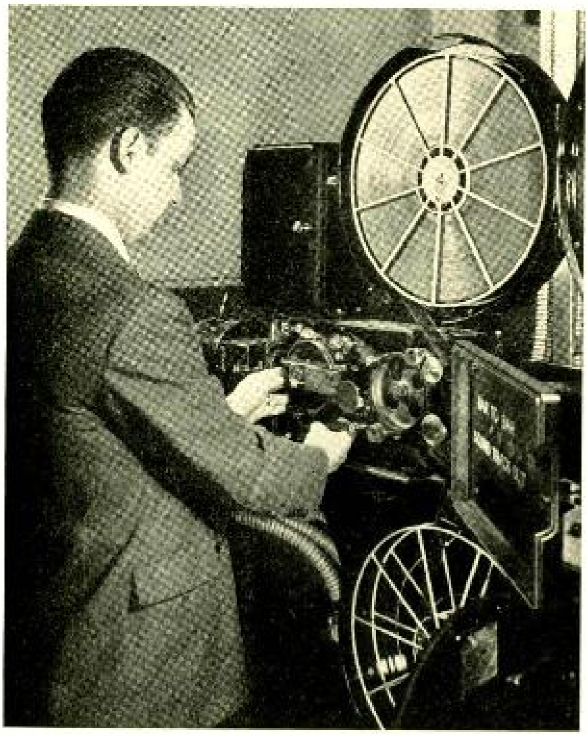
Machine for testing the strength of wet paper, described on page 309



Film Scanner for Testing Television Transmission

By W. A. KNOOP
Television Research Department

JUST as program broadcasting requires extensive networks of cable circuits to connect studios and radio transmitters, so television broadcasting will need similar cable connections for its most effective growth. To a limited extent the Bell System has already supplied such facilities* on an experimental basis. The development and testing of these facilities is complicated both by the very wide band of frequencies that must be transmitted and by the varied requirements for television transmission. In some respects these are much more severe than those placed on multi-channel telephone circuits, even when the total band width is the same. A circuit entirely satisfactory for high-quality telephone transmission might not be satisfactory for television transmission because the response of the eye is not at all like that of the ear to certain types of distortion. The most satisfactory way to test television circuits, therefore, is to transmit television signals over them, and to judge the results visually.

In making such tests it is desirable to transmit the same scene or series of scenes over the cable again and again. For this reason a motion-picture film is the best source of the transmitted material. With this method the picture frames on the films are scanned successively by some form of television scanner, and the resulting television signals, suitably amplified, are transmitted over the circuit. Each frame is scanned in a series of lines one above another, and thus there is a vertical as well as a horizontal component of the scanning. In using film, it seemed desirable to let the motion of the film provide the vertical component, and thus to simplify the scanning equipment. Since the ordinary motion-picture projector moves the film intermittently, a suitable transmitter for these tests was developed by modifying a Western Electric film recorder to secure steady motion of the film and the other features that were required.

*Record, *Feb.*, 1938, *p.* 188; *June*, 1939, *p.* 312; *Oct.*, 1939, *p.* 34.

The complete machine is shown in Figure 1. At the extreme left is the scanning equipment, and the rectangular case next to the right carries the projection lamp. Light from this lamp passes through a lens in one side of the case and then through an opening in the film case adjacent to it, where it is refracted by a right-angle prism to pass through the film and into the scanning equipment.

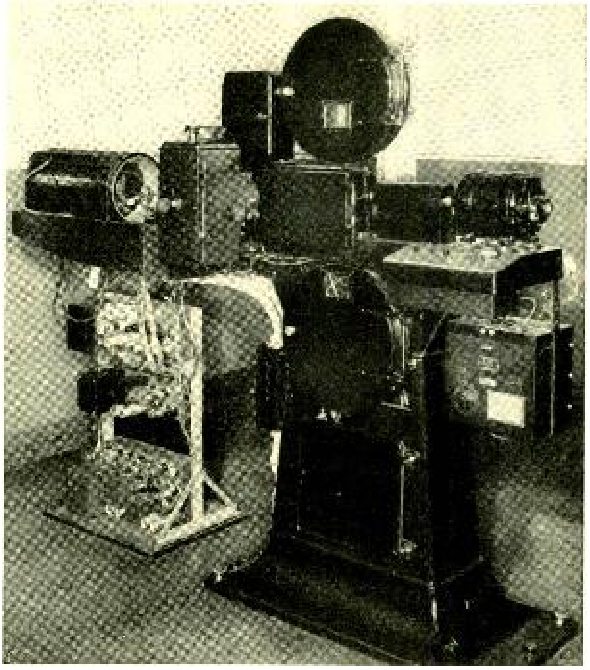


Fig. 1—The film-scanning machine

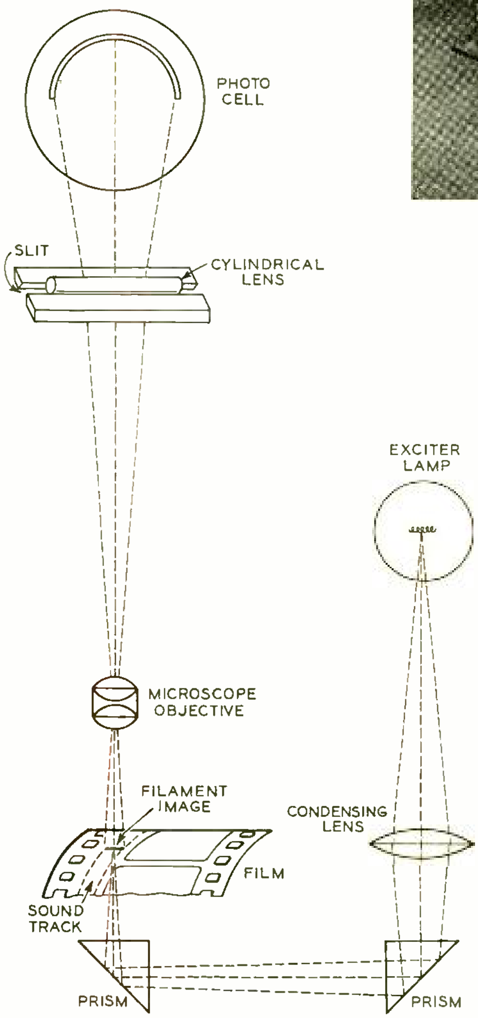


Fig. 2—Path of light for sound scanning

Just above the left end of the film cabinet is the equipment for sound pick-up. It includes a photo-electric cell, lenses, and certain miscellaneous equipment. The film supply reel is at the upper center, and the film take-up reel is below it and just beneath the film compartment. At the right is the motor that drives the film. The lamp housing is mounted on a hinged bracket, and may be swung out to give access to the film cabinet.

A close-up of the apparatus with the various doors open is shown in Figure 3. The film passes down from the film magazine, over the top of a film sprocket that pulls the film from the magazine, thence around the main sprocket at the left, back against the bottom of the first sprocket, and down to the take-up reel. The rectangular prism is within the main sprocket at the left center, whence the light passes through the film and is formed into an image of the film on the cathode of the dissector tube which is used for scanning. The sound gate is at the top of the main sprocket, whence the light passes through the sound track on the film, through an optical system, and to the photo-electric cell in the cabinet above. Light for the sound pick-up comes from a rear compartment of the photo-electric cell cabinet, down through a prism, and thence horizontally through the semi-circular bridge just above the main sprocket and then through another prism up through the film. The path of this light is shown in Figure 2.

The rim of the main sprocket overhangs its shaft to provide space for the prism and to enable light to be transmitted through the film for television scanning. To meet this latter requirement, the rim is a lattice, with its outer edge supported by crossbars spaced so as to fall between the frames on the film. Light for the sound pick-up does not pass through the rim of the sprocket, and thus there is no interruption of the sound beam.

An ordinary motion-picture film is projected at the rate of twenty-four frames per second, while present television standards call for the equivalent of thirty frames per second. Moreover the picture is scanned in 441 lines interlaced. This means that each frame is scanned twice, each scanning passing over alternate lines; on the first scanning the odd-numbered lines will be covered, and on the second, the even-numbered lines. Since the film is moving steadily, this inter-

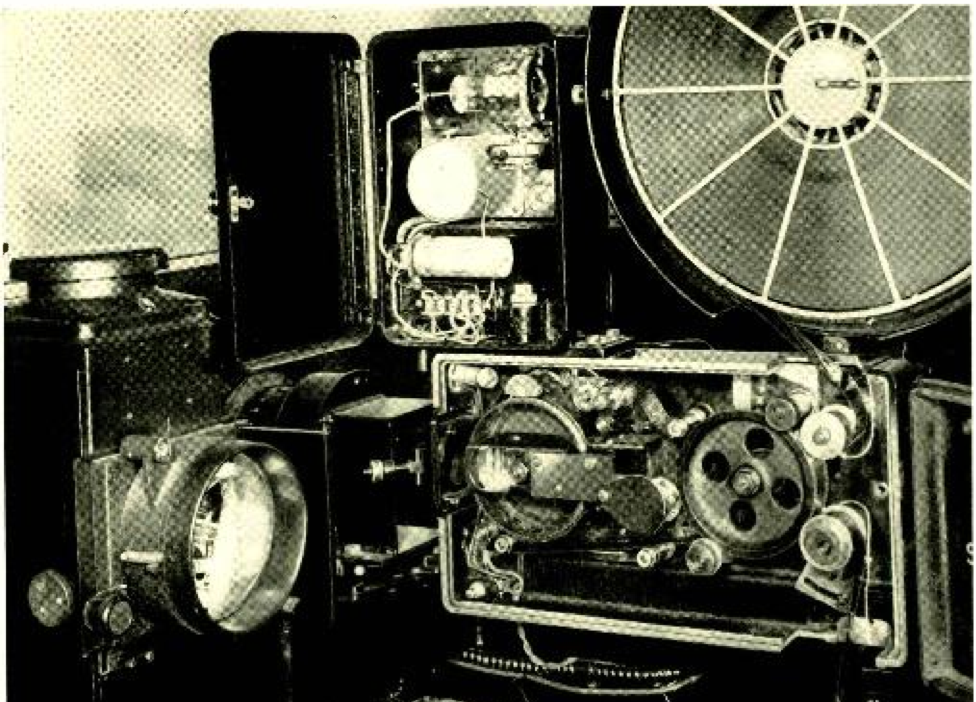


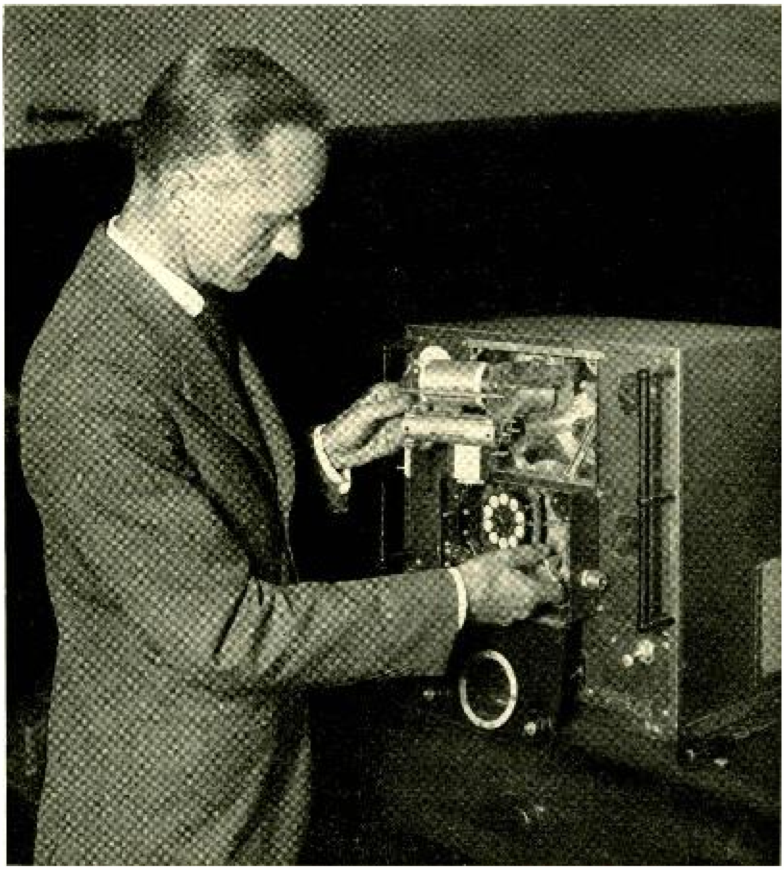
Fig. 3—Close-up of film chamber with sound pick-up cabinet above

laced scanning could readily be accomplished by printing each frame twice. On the first of each pair of frames, the odd-numbered lines would be scanned, and on the second frame, the even-numbered lines. Under these conditions, if the film were moved at the rate of forty-eight frames per second, the picture would be at the rate of twenty-four frames per second. By printing every other frame three times instead of twice, and running the film at the rate of sixty frames per second, the desired thirty-per-second frame speed is secured. A specially printed film is thus required for the scanner, but since only a small number of representative subjects is required, the additional cost of the film is more than offset by the resulting simplicity of the apparatus and the ease of maintenance.

Although the continuous motion of the film avoids the necessity of vertical scanning so far as the picture itself is concerned, a small amount of vertical scanning is used because the distance between frames on a motion-picture film is greater than the equivalent "blanking" time between television images. The difference is about seven per cent of the frame time or about thirty lines of the picture. To avoid this loss, about eight per cent of vertical scanning is supplied. The scanning thus follows the image as the film moves down so that the image is scanned about eight per cent longer than it otherwise would be.

The complete film transmitter consists of a number of bays of equipment, including a monitoring bay, as well as the film-scanning machine itself. It is installed in the Graybar-Varick Laboratories, and has proved very useful in studies made of the three-megacycle television channel between New York and Philadelphia.

THE JOHN PRICE WETHERELL MEDAL *of The Franklin Institute of Philadelphia has been awarded to Harold S. Black for his technical contribution to the modern efficiency of long-distance telephony, particularly his development of the negative-feedback amplifier. The award was made on May* 21 *at the Medal Day exercises of the Institute*



Ten-Frequency Airplane Radio Equipment

WITH the steady growth in the size of commercial airplanes and in the length and number of non-stop flights, there has been a corresponding development in the radio facilities carried aboard. The radio transmitters and receivers used for communication with ground stations are now required to meet a much wider field of use. With the extended flying radius planes span more airline divisions, and since each division has its own day and night frequencies, the sets must accommodate a wider range and greater number of frequencies and be able to shift from one frequency to another with a minimum of delay. Ten or a dozen years ago, single-frequency equipment* was adequate. Within a few years, however, the growing air transport industry required three-frequency equipment.† To meet still more expanded needs, the Western Electric Company has now made available ten-frequency equipment developed by the Laboratories. The major features of the new ten-frequency transmitter and receiver are described in the following articles.

*Record, *Oct.*, 1930, *pp.* 59-76.

†Record, *May*, 1933, *pp.* 262-278.

Ten-Frequency Transmitter

By J. G. NORDAHL
Radio Development Department

THE 27A radio transmitter provides ten preselected frequencies in the ranges from 300 to 500 kilocycles and from 2 to 15 megacycles. Its rated carrier output is 125 watts, but at the very high and very low sections of the frequency range the output is somewhat less. One of the most interesting features of this transmitter, and one that to a large extent determined its physical design, is the means provided for quickly shifting the carrier frequency. A Western Electric 5-type quartz plate, which serves to control the carrier frequency, and the various radio-frequency tuning coils in the transmitter, are mounted in a lightweight unit. Ten of these units, one for each preselected frequency, are plugged into position in an aluminum turret that may be rotated to bring the unit for the desired frequency into contact with the terminals of the transmitter.

This system has several advantages. First, unlike some compromise methods, the arrangement provides for tuning the circuits to maximum efficiency at each frequency; and second, the leads between the vacuum tubes and the tuning elements are short and fixed in length, making it possible to tune for any of the ten selected frequencies with equal efficiency and with freedom from spurious oscillations. The turret and tuning units were borrowed bodily from a transmitter originally developed by the Laboratories in 1936 and 1937 for the Douglas DC4 planes then building. That transmitter is believed to have been the first for commercial airplanes that used the turret principle of frequency shifting. Since the turret is the central and largest part of the equipment, it more or less determines the overall dimensions. The other apparatus is placed behind, below or around it in the most suitable locations. The assembly is made compact so as to occupy as little space in the plane as possible, but at the same time it has been possible to provide ready accessibility to all parts. This is brought out in the accompanying photographs.

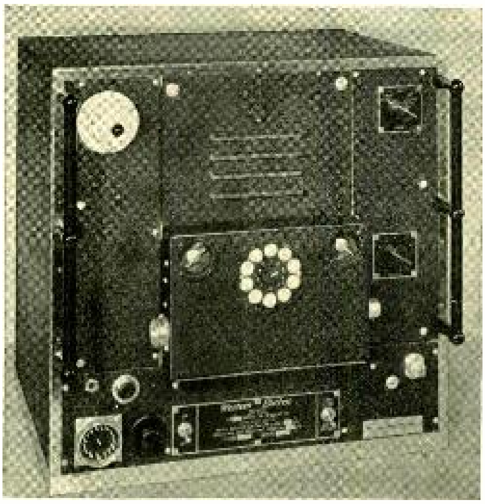


Fig. 1—Front view of the 27A radio transmitter for transport service

A front view of the transmitter is shown in Figure 1. The indicator, which resembles a telephone dial, shows which of the tuning units is in the transmitting position. These units may be inserted or withdrawn by removing the rectangular front plate above the indicator. If the unit to be replaced is not in the proper position at the moment, the cover over the indicator is dropped back on its hinge

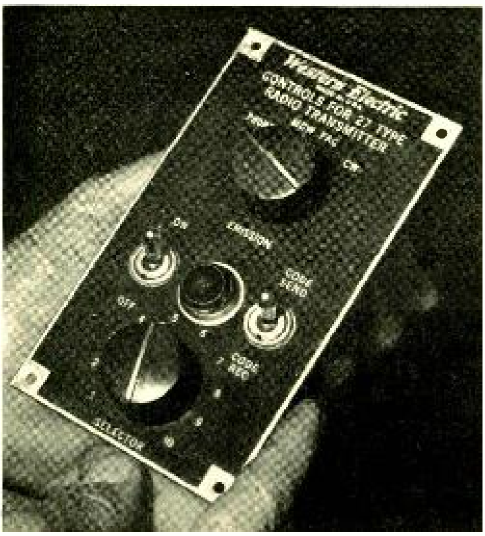


Fig. 2—Remote control unit for the 27-type radio transmitter

and the turret is rotated by turning a stout steel key as shown in the photograph on page 302. Under ordinary operating conditions, the turret is turned electrically by operating a ten-position switch either at the right center of the transmitter or at the control unit, Figure 2, which will be located conveniently to the pilot. A small dynamotor for supplying intermediate voltage is incorporated in the transmitter, and mechanical power for turning the turret is obtained from it through an electromagnetic clutch controlled by these switches. Provision is made for extending a flexible shaft from the drive unit of the transmitter to the receiver, so that when the units are operated in conjunction, both the transmitter and receiver will be turned together.

When access to the transmitter is needed for maintenance purposes, practically the entire casing of the transmitter can be removed. The back cover is removed by one turn of each of the four corner screws, and when this is off, the top and two sides, which are in one piece, slip off without the necessity of removing any other screws or fastenings. After the two side pieces on the front panel have been removed, the turret and the reënforced front of the cabinet, which carries the front bearing of the turret, may be pulled out. At this stage, the transmitter appears as in Figure 3, where some of the tuning units have also been removed from the turret to show their construction and "plug-in" arrangements. On the wedge-shaped plate at the rear center of the transmitter may be seen the wire clips by which connection is made between a tuning unit and the circuit of the transmitter.

The vacuum tubes and the intermediate-voltage dynamotor are accessible from the rear as shown in Figure 4. A small fan operates from the dynamotor to draw air through a spun-glass filter and exhaust it through louvres at the front and back near the higher-powered vacuum tubes. A high-voltage dynamotor is also employed. This is mounted separately, frequently under the pilot's seat, and is started and stopped electrically from the control unit of the transmitter. Either a 12-volt or 24-volt power supply may be used. A multi-contact plug and jack used for connecting to the dynamotor in the transmitter is wired to connect the filaments and relays in series or parallel depending on whether the primary battery supply is at 24 or 12 volts. Every part of the transmitter has been carefully designed and chosen to insure the lowest weight consistent with reliability of performance. Both transmitter and power unit have successfully passed all of the very stringent Civil Aeronautics Authority tests and bear approved-type certificates. These tests not only include the usual electrical tests for radio equipment, but require satisfactory operation when the equipment is subjected to an extremely wide range of temperatures, reduced air pressures corresponding to high altitudes, a long period of high humidity, large amplitudes of vibration over a wide range of frequencies, and a series of drop or shock tests.

Many airlines operating in foreign countries and domestic private flyers who wish to communicate with ships at sea or to fly to foreign countries, require transmission in the low-frequency range of 300 to 500 kc. For these frequencies a tuning unit has been developed which mounts on the transmitter turret in the same manner as those for the higher frequencies. A long trailing-wire antenna is usually employed for low-frequency operation since it is much more efficient than the fixed antenna normal for the high frequencies. Accordingly, provision has been made for installing an additional antenna terminal at the rear of the transmitter for connection to a trailing-wire antenna. To facilitate changing from a high to a low frequency, the low-frequency tuning unit is fitted with an extra contact pin which connects it to the rear antenna terminal when the tuning unit is rotated into operating position. With this arrangement the low-frequency tuning unit may be used in any turret position, and no switching operation on the part of the pilot is required for any high or low frequency other than the movement of the channel selector switch to the desired position as noted above. The tuning units are usually adjusted at the time of installation for operation at one frequency into a fixed length of antenna. A thermocouple in the transmitter, however, provides for remote indication of the antenna current so that, if desired, the length of the trailing-wire antenna may be adjusted from the pilot's position in the plane for maximum antenna current.

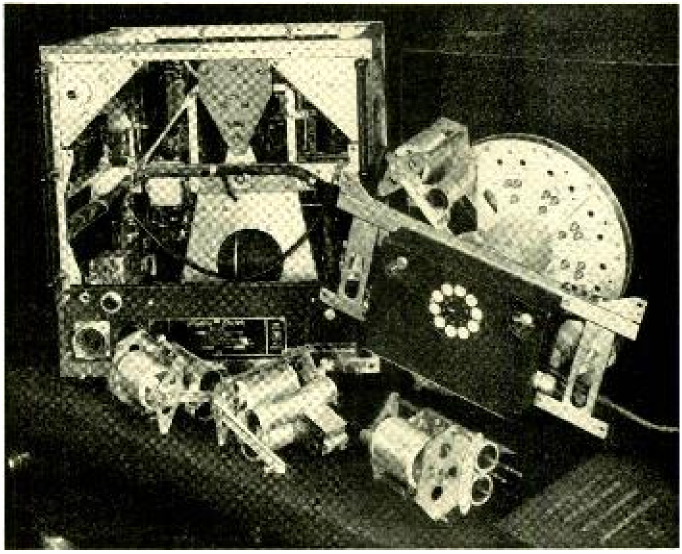


Fig. 3—The complete turret may be readily removed from the transmitter to give access to the apparatus beneath it

Voice ("PHONE") transmission is

Fig. 4—A. K. Bohren inserts a tube in the new ten-frequency transmitter during an inspection of one of the early samples at the Laboratories

used almost exclusively for domestic flying in the United States, but many airplanes operating overseas use continuous wave ("CW") or modulated continuous wave ("MCW") telegraph transmission. These types of emission have been provided, and sidetone is delivered to the pilot's headphones when operating on all of these emissions. Facilities have also been provided in the equipment for "facsimile" emission for high-speed keyed transmission, such as would be needed for transmission of weather maps and news. Any one of these types of emission may be selected by an emission selector switch on the transmitter panel—at the upper right in Figure 1—which is duplicated at the remote control unit. Another switch, the "CODE SEND-RECEIVE" switch, also duplicated at the remote control unit, is used only during telegraph transmission to operate the antenna transfer relay and place the circuits in readiness for operation of the telegraph key or facsimile apparatus. The "CODE SEND-RECEIVE" switch and the master "ON-OFF" switch on the remote control unit afford control of the transmitting equipment when the frequency and emission selector switches on the transmitter are placed in the "REMOTE" position. When a new frequency is being selected, a light on the control unit is energized until the turret arrives at the desired position, at which time the lamp goes out, indicating that the circuits are ready for operation. An indicating light for this purpose is not provided at the transmitter because the turret position is indicated by the dial.

Ten-Frequency Receiver

By HOWARD MORRISON
Radio Development Department

THE receiver for the ten-frequency airplane equipment covers the range from 2 to 15 megacycles. It is of the super-heterodyne type, and employs quartz crystals for control of the oscillator circuit. Ten quartz plates and ten sets of tuned circuits are thus required when the receiver is fully equipped. While the transmitter uses a turret which is rotated to a different position for each one of the ten frequencies which it houses, the receiver has fixed crystals and tuning circuits, which are selected electrically by a ten-point switch. The size and appearance of the receiver is indicated in Figure 1. It is mounted like the drawer of a filing cabinet in the radio rack of the airplane.

Besides selecting the quartz plate, the frequency switch also connects appropriate tuning inductances into each of three circuits. These inductances are small coils, and thirteen of them are required to cover the range from 2 to 15 megacycles. There are three tuned circuits in the radio-frequency stages of the receiver; and thus thirty coils are required to obtain the full complement of ten frequencies. They are mounted in three separate compartments in front of the quartz plates as shown in Figure 2. The switch is operated either from the control unit, shown in Figure 3, or indirectly from the transmitter control unit. When the frequency of the transmitter and receiver are to be changed together, a flexible shaft connects the transmitter drive to the receiver switch; but when the receiver is to be controlled independently, a motor drive is operated from the control unit over an 11-conductor cable. Relays are included in the receiver to permit it to be operated in conjunction with the transmitter from the push-button on the microphone. When the transmitter is switched on, the receiver is disabled and side-tone is connected to the telephone.

The receiver includes an antenna tuning circuit followed by a radio-frequency amplifier working into a first detector through a band-pass filter. The antenna circuit and filter

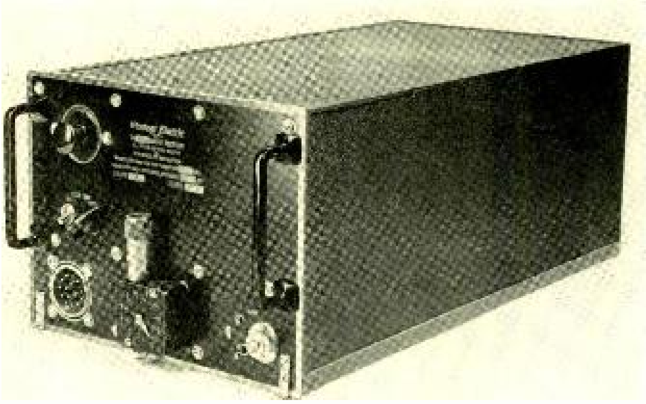


Fig. 1—The 29A radio receiver is shaped like the drawer of a filing cabinet to fit the radio rack of the airplane

provide adequate selectivity to reduce image frequencies to negligible values. Two vacuum tubes are included in the 385-kc intermediate frequency amplifier, and all intermediate-frequency transformers are doubly tuned, making each serve as one section of a band-pass filter. The detection function is separated from the automatic volume control function by the use of

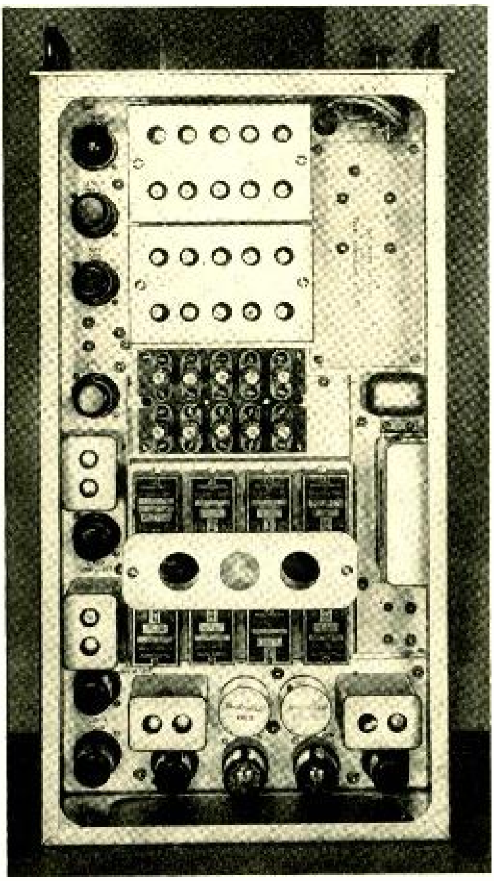


Fig. 2—When the receiver is removed from its casing, all the major pieces of apparatus are readily accessible

two tubes, thus improving both functions. Two audio-output channels, each fed from a separate final amplifier tube, are provided. Each of the two pilots can connect his headset to any of the receivers, and the provision of double output circuits enables one pilot to listen to the beacon or marker signals as well as to the speech channel without affecting the

Fig. 3—Remote control unit for the 29A ten-frequency receiver

reception of the other pilot who may be listening to speech alone.

A separate oscillator operating at 386 kc is provided for continuous-wave telegraph reception. This oscillator beats with the 385-kc intermediate frequency to give a 1000-cycle telegraph signal. An on-off switch and a frequency control are provided for this service on the front of the receiver just above the power receptacle at the left.

This new receiver is designed to operate on any power supply now used in airplanes or likely to be adopted in the near future. Most planes are now equipped with 12-volt storage batteries, with a few using

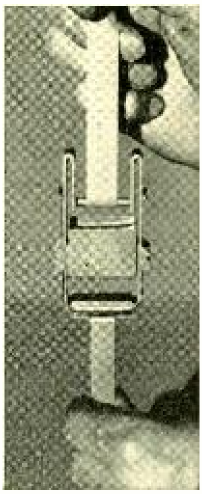
24 volts. A dynamotor mounted in the receiver is available for either of these voltages, and the filaments and control circuits are connected in either a series or a parallel arrangement to conform with the supply voltage. The dynamotor is connected to the receiver through a multi-conductor plug and jack; and the plug attached to the dynamotor for each voltage is so strapped as to give the correct arrangement of the filament and control circuits for the voltage applied. The receiver is also arranged to accommodate a tapped transformer when the power supply is either 400 or 800 cycles at 110 volts.

An exceptionally good automatic volume control has been provided. It operates over a range from one microvolt to two volts, aided over the upper part of the range by a volume limiter consisting of a biased rectifier tube connected across the grid-to-cathode circuit of the first amplifier.

Every effort has been expended to make the receiver as reliable a unit as possible. Flameproof wire of exceptional resistance to humidity has been employed throughout, and all components were chosen with care and subjected to rigid tests in the assembled receiver. In addition, the receiver has been subjected to the acceptance tests of the Civil Aeronautics Administration which include operation for a long period at high temperatures and humidity, tests at low temperatures, and vibration and shock tests. Equipped for ten frequencies and with the electrical drives, it weighs only a little over twenty-seven pounds; and this light weight, combined with its accessibility for maintenance, makes it well suited to the transport field.

Wet Strength Tester for Paper

A method for the reliable determination of the tensile strength of paper when wet has been developed in the Laboratories under the direction of J. M. Finch. Such tests are important, for example, in the case of paper used for making phenol fibre. To avoid tearing, the paper should have the greatest possible wet strength consistent with high absorbency for the water solution or suspension of synthetic resins. In early tests water was applied by a pipette, or brush, to the paper while on the testing machine. This method of application was unsatisfactory because successive specimens were not uniform and sometimes were damaged.



In the new method a strip of paper is looped under a horizontal rod in an assembly which is held by the lower jaws of a paper-testing machine. The two ends of the loop are clamped in the upper jaws. Below the rod is a container filled with water which can be raised so as to immerse the paper.

The apparatus gives reliable results in wet strength tests on weak specimens such as absorbent paper, and also on very thin paper like that of condenser tissue which is only 0.0003 inch thick.

Dielectric Strength Tests on Aerial Cable

By W. W. STURDY
Protection Development

FOR many years the Western Electric Company has tested the dielectric strength of new cables before shipment. Their strength has been found somewhat less after several years in service and the Laboratories has recently carried out field studies to determine the factors responsible for this change; also the voltage required to produce permanent insulation failure. Tests were made on 19-, 22- and 24-gauge exchange cables which had been in service for periods ranging from six to thirty years. The results showed that the average dielectric strength of such cables is about seventy-five per cent of that of new ones. This loss is due to partial destruction of insulation from overvoltages or mechanical causes, rather than to age-deterioration of the paper insulation.

The cables tested had all been supplanted and were to be dismantled. Each section was terminated at one end in standard cable terminals mounted on a pole in the normal fashion and the other end was insulated and capped. Before testing, the sections were carefully inspected to see that all drop wires had been disconnected. Plant forces in the area were advised of the tests and the cable sheath was always maintained at ground potential as an additional safety measure.

Increasing voltage was applied to cable pairs until momentary insulation failure occurred and in another test 2400 volts r.m.s. was applied repeatedly until permanent failure resulted. That was the minimum voltage which would definitely cause temporary failure on every application. The damage to the insulation varied at random from a burn the size of a pin head to complete destruction for an inch along the wire.

Of the fifteen cable sections tested, several were located in outlying areas at Greenfield, Massachusetts, and mobile testing equipment was used. The apparatus was carried in three units: a three-and-one-half-ton truck which housed the power equipment, a one-and-one-half-ton truck for the control equipment, and a station wagon which pulled a trailer in which were an oscillograph and a dark room for processing the film. The normal output of the power-supply unit was

9 kva single- or three-phase, but several times this amount could be drawn for short intervals. Two phases of the three-phase generator were used to provide auxiliary power for the lights, motors and vacuum-tube filaments and the other to supply the main testing power. Both main and auxiliary power were at 240 volts and 60 cycles.

To ensure the safety of the testing group—an engineer, a record-keeper and an oscillographer—testing voltage could be applied to the cable only by push-button switches. Operation of these switches was the duty exclusively of the engineer, who alone made the necessary connections to the cable terminal.

In the control truck were a timer for determining the duration of the testing voltage, a 25-kva step-up transformer, and the necessary control and safety equipment. The timer consisted of a condenser-resistance circuit and two mercury-vapor tubes large enough to pass the test current during the timed interval. A string oscillograph with three elements was used. Its operation was synchronized with the test voltage by a sequence switch whose cams controlled the starting of the oscillograph, application of the test voltage, photographing the identifying clock, and resetting for the next test. The film speed was approximately one foot per second and each test covered about one foot of film.

The two conductors of the pair under test were strapped at the terminal and all the other pairs were bunched, connected to the sheath and grounded. Test voltage was applied, in series with a current limiting resistance, between the test pair and all the others (see Figure 3). Duration of the voltage and series resistance could be varied, but were maintained constant for any one pair. Since application of 2400 volts generally involved destruction of insulation on pairs other than the test pair, it was necessary to make the increasing-voltage test on all pairs in the cable before starting the other types of test.

Fig. 1—Mobile equipment for insulation tests on aerial cable

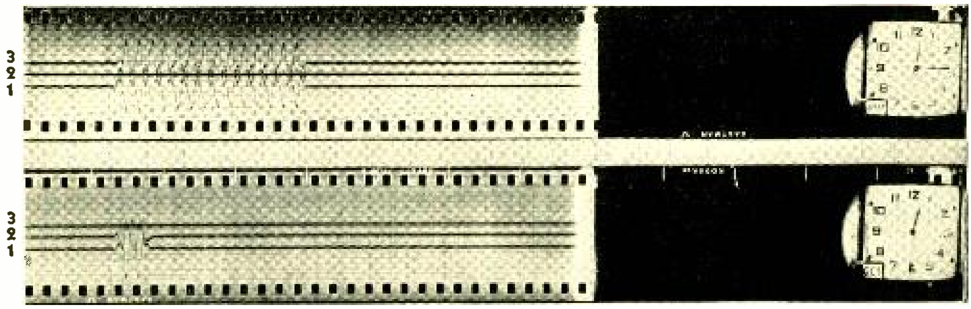


Fig. 2—Top, breakdown current (3) on application of 2400 volts as recorded at (1); bottom, breakdown voltage (2) with 2520 volts applied as shown at (1)

After the insulation on all pairs in the cable had been destroyed, a check was made to determine which pairs were crossed. The number of conductors involved in each failure was generally two, but in some cases there were as many as fourteen. A list of crosses for each cable was turned over to the Associated Company concerned and the crosses were located by their regular cable splicers with cable test sets. Each cross was repaired and short pieces of the damaged wire involved, including the destroyed insulation, were filed in appropriately labeled envelopes. After a cable section had been repaired, both types of test were repeated to investigate the effect of the insulation destruction and repair on the dielectric strength of the cable.

These studies provided a large amount of data in the form of oscillograms. They showed that the insulation strength of cable pairs in service is somewhat less than that of new ones but that the decrease is not sufficient to affect the usefulness of the older types of cable under normal operating conditions.

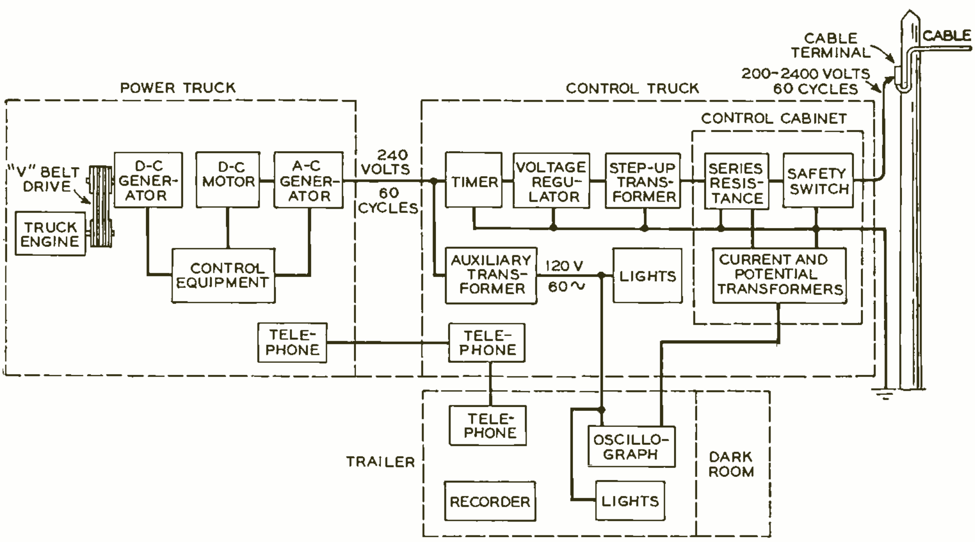
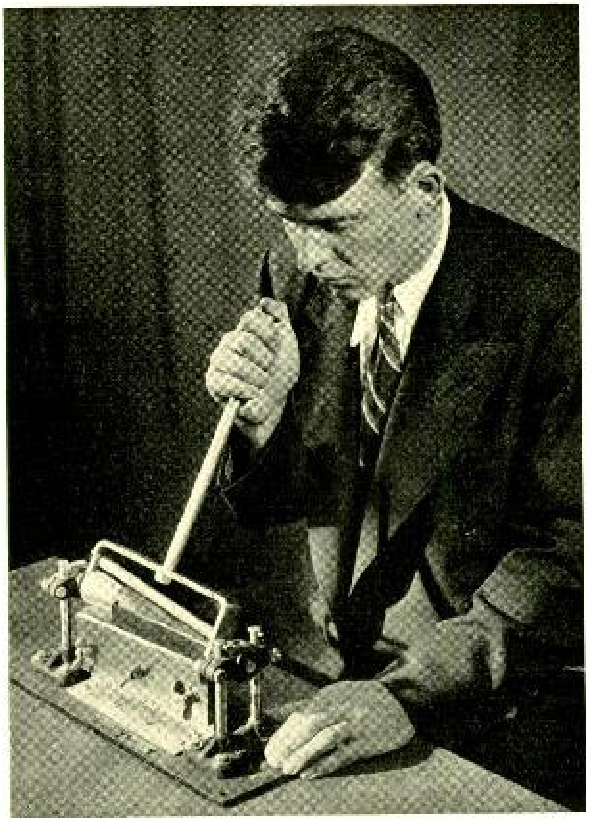


Fig. 3—Schematic of equipment for cable insulation tests

Conical Mandrel for Testing Organic Finishes

By H. G. ARLT
Chemical Laboratories



FOR many years, fingernail or penknife has been used to test the relative toughness, hardness and adherence of organic finishes. It has also been customary to bend coated test-panels to determine the distensibility of the coating. These crude tests offer considerable information to an experienced observer but the results are qualitative, at best, and not sufficiently accurate. An improved technique for evaluating the properties of paint coatings quantitatively and reproducibly has been developed by the Laboratories. In its latest form it involves wrapping the test specimen around a conical mandrel and computing the elongation limit of the finish from the position of cracks. The experience of the operator is of minor importance in the new procedure.

The property of an organic coating which usually shows the effect of age most quickly is its elongation characteristic. A good finish must be distensible enough to withstand the expansion and contraction of the base material caused by changes in temperature and humidity. The coating also has to remain intact even though mechanically deformed in manufacture or service. Many organic finish coatings meet these requirements during their early life but become brittle as they age. The rate of degradation in elongation characteristics is therefore used as a measure of the useful life of these films.

The percentage of elongation at fracture of the coating is measured initially, and periodically after normal or accelerated aging. These values are obtained on uniform coatings of controlled thickness on typical metal surfaces. The testing is carried out at constant temperature and humidity and to insure reproducible values the samples, prior to and during the tests, are equilibrated to a closely controlled atmosphere.

By bending a coated panel over cylindrical mandrels of different radii, the convex side is stretched and the percentage elongation of the film before fracture can be determined quantitatively. The elongation obtained depends on the kind of metal, its thickness, and the radius of the bend. In an early device developed in these Laboratories, the bend was made over six mandrels which ranged in diameter from one-eighth to one inch. This determined limiting values of elongation from 2.8 per cent to thirty-three per cent in six fixed steps.

An improved method, recently developed by the Laboratories, uses a single mandrel, conical in shape and varying in diameter from one-eighth to one and one-half inches. This permits determinations on a single test specimen and gives actual values at fracture instead of limiting values. Since only a single wrapping mechanism is required, the conical-mandrel test equipment is mechanically simpler than that for the multiple cylindrical mandrel and appreciably less expensive. Cost of equipment and simplicity of operation are important because flexibility tests are widely

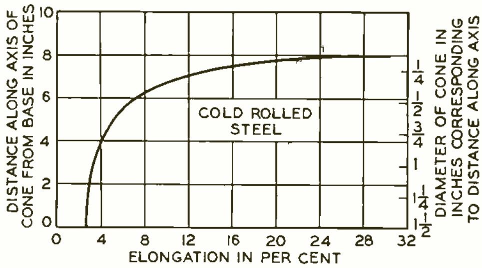


Fig. 2—The elongation limit of a finish can be computed from the diameter of the mandrel where the finish breaks. This limit varies with the backing material

made by both consumers and producers. The conical mandrel for testing finishes is shown in the headpiece.

An investigation of several finishing materials and tests with duplicate panels on both machines showed that the same values are obtained whether the specimen panels are bent over a conical or cylindrical mandrel. To show that no error is introduced by the additional stresses caused by bending over a cone instead of a cylinder, tests were made on finished specimen panels which were scored through to the basis materials at one-inch intervals along the axis of the cone as well as on unscored panels. The experiments indicated that additional stresses caused by the conical mandrel do not affect the tests appreciably. For example, in a rather brittle material with very poor adhesional characteristics, which showed small cracks over a relatively large distance along the mandrel, the character

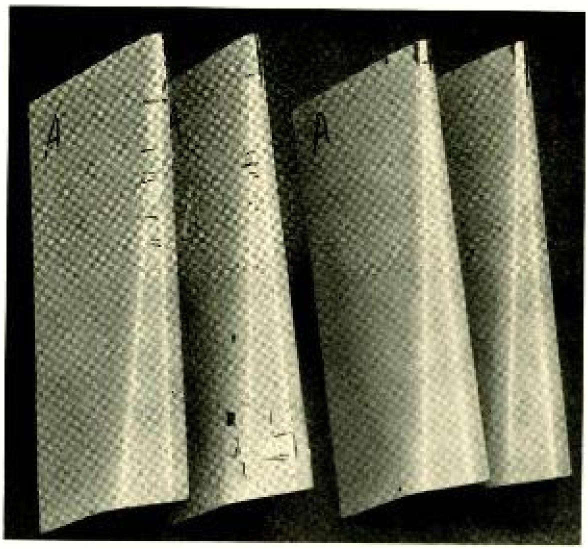


Fig. 1—To prevent the drawbar of the testing machine from injuring the finish, sheets of Kraft paper lubricated with talc are used between the roller and the specimen. The four specimens illustrated were identical but the two shown at the left were tested without the use of slip papers

and extent of the cracks was the same whether the panel was scored or not. This shows that the cross stresses introduced by the cone are low.

The relation between elongation and mandrel diameter is different for various metals and has been separately determined for several of those in common use. Values for one metal are shown in Figure 2. The determination involves measuring accurately the elongation of the outer face of a bent panel. A rough approximation of the elongation can be calculated from the stretch by assuming that the elastic limit of the material has not been exceeded. The error involved by this method ranges from about three-quarters per cent elongation for a mandrel one inch in diameter to about eight per cent for one of 0.15 inch.

When determining the elongation of films more than 0.001 inch in thickness, a correction is usually made for the added thickness of the finish coating. As in any other elongation determination the speed of stretch must be controlled. A bending rate of 180 degrees around the mandrel in fifteen seconds is usually employed.

To prevent the sliding action of the drawbar from marring the finished surface when testing organic films of low adhesion, slip planes are placed between the drawbar and the finished surface of the test specimen. Two loose sheets of Kraft paper lubricated with talc serve this purpose successfully. Coatings tested with and without slip planes are shown in Figure 1.

The conical-mandrel test has proved to be a useful, reliable and economical tool in studies of organic finishing materials; and it will undoubtedly contribute materially to the development of increasingly durable finishes for telephone apparatus.

Television Experiments on Coaxial Cable

Following completion on May 12 of tests preliminary to the multi-channel telephone use of a 200-mile length of coaxial cable between Stevens Point, Wisconsin, and Minneapolis, the Laboratories engineers, by looping back the coaxial conductors, formed an experimental circuit of 800 miles for the transmission of television signals. Scenes televised in the Minneapolis Telephone Building were transmitted over this looped-back circuit and compared with direct transmission when only a few feet of wire connected the camera and the receiving tube. The difference was imperceptible to most observers although the Laboratory engineers could detect impairments somewhat greater than were observable in the earlier test of 190 miles over the New York-Philadelphia coaxial. Transmission was by carrier with an effective band width of 2¾ megacycles. This transmission, over a total length more than four times as long as that previously obtained over the New York-Philadelphia coaxial, marks a further but by no means a final experiment in the development of coaxial-cable systems for television transmission

The 355A Community Dial Office

By J. T. MOTTER
Switching Equipment Department

SOME years after dial equipment had been introduced in the larger centers of population, two arrangements of step-by-step dial equipment were made available to the smaller communities. These small dial offices,* the 350A and the 360A, were designed to operate unattended except for the occasional visit of a maintenance man; all trouble conditions and service calls were referred to a neighboring "operator" office. The 350A, which was the larger of the two, provided practically all the services given by a step-by-step central office, and used similar equipment arrangements. The 360A office provided only a limited number of features, and the equipment arrangement—suited to the requirements of the time—provided more economical service for the majority of offices with less than 800 lines.

At the time these offices were designed, the demand for them was small; equipment for only some 70,000 lines was bought by the entire Bell System prior to 1937. In the past few years, however, the demand has increased enormously—the orders for 1939 alone totaling over 100,000 lines. A contributing factor to this increase is the trend toward the conversion of magneto offices to common-battery operation.

Experience during the past ten years has shown that the majority of offices from 100 to 2,000 lines in size could be better served by equipment that combined the variety of services of the 350A office, and its ability to grow, with the equipment flexibility obtained with universal switch frames, capable of mounting a variety of circuit units, after the manner of the 360A office. The development of such an office was therefore undertaken; and the new office—known as the 355A—has been in production since early in 1939. Besides blending the best features of existing equipment, it has a number of novel features that make it unusually economical, not only in original cost but in the labor of ordering, engineering, and installing. Its flexibility both of circuit features and of equipment arrangements has been amply demonstrated by the ease with which new services have been continually added to care for the widely varying conditions that occur in the field.

These offices are called upon to serve hamlets and towns in all parts of the country, where they must be able to reproduce the types of service existing in each area. In most cases the existing plant, whether farmer-owned 20-party lines or the most modern cable, must be connected with manual and dial offices of whatever variety and vintage. Sometimes the operator offices act as centers of tandem networks to serve a rural area of as much as fifty miles radius, with all toll and manual service for the area concentrated in one building.

Basic equipment simplicity is secured by using a single size of switch

*Record, *August*, 1931, *p.* 562.

frame. The various apparatus and equipment units are mounted on "shelves," which consist of two angle-iron supports welded together by cross struts. Several types of shelves are provided, and drilled and equipped for certain types of equipment such as line finders, selectors, and connectors as well as such equipment as ringing machines, trunks, and alarms. Those used for step-by-step switches carry the multiple banks, and the jacks into which the switches themselves are inserted. If each shelf were arranged with a conventional local cable for extending the jack terminals and miscellaneous wiring to terminal strips, it would be necessary either to provide many varieties of local cable or to furnish fixed combinations of services, which would do much to destroy the economy and flexibility sought. Instead of using local cable on the 355A shelves, therefore, a small distributing ring has been placed at each switch position on the shelf; and all cabling that is individual to each switch is run by the installer directly to the switch jacks through these rings.

Cable brackets are also provided at the ends of the shelves through which cables and loose wiring may be carried vertically up the frame. Each switch frame has its own section of cable rack along the top, so that when the frames are installed, the rack is all in place and lined up except for the cross-aisle rack. This rack with its associated material for mounting may be ordered, as desired, as an assembly. Only the multiple wiring of the banks, and certain leads required for all shelves, such as the alarm, ringing, and tone or interrupter leads, are carried to terminal strips. Many of these features can be noticed in the illustrations.

The line-finder units, shown in Figure 1, have several novel features. Instead of using a line relay and a cut-off relay for each line, a combined line and cut-off relay is provided. In addition a lock-out relay is available

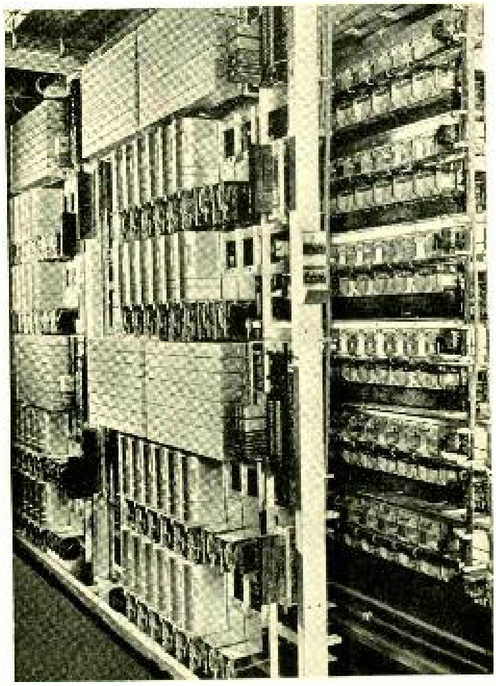


Fig. 1—Line-finder equipment in a 355A office uses a combined line and cut-off relay

that may be used on all lines where faults are likely to occur. Without such a relay, a fault in the line would tie up a line finder and its associated first selector until the fault was cleared. The lock-out relay, however, in conjunction with a timing circuit, releases the line finder and associated selector after a short interval and prevents the line from seizing other line finders until the trouble has been cleared. A distributor type of control, using a 206 type selector, is employed to allot the line finders to the calls as they come in, thus providing simple and economical equipment. Instead of providing separate line-finder units for the various classes of service, such as flat rate, message rate or coin lines, two, three, or four classes may be served by the same group of line finders by assigning the various classes of service to different levels.

Only two types of shelves are provided for all the varieties of selector equipment. One is for local and toll-intermediate selectors, and the other for toll-transmission selectors. About twenty-five types of connectors are provided for the various possible combinations of service, and one type of shelf will mount any of them. Provision is made for practically all types of ringing that are available in the Bell System.

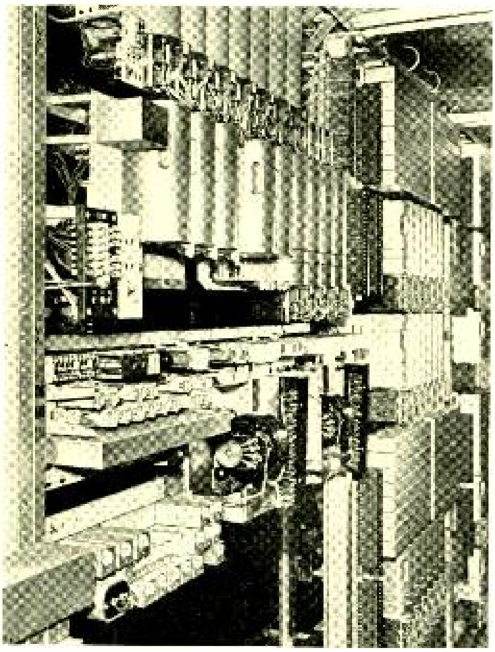


Fig. 2—Miscellaneous equipment mounts on shelves on the same frames as the step-by-step switches

In addition to these shelves for the usual step-by-step switches, two types are available to accommodate any combination of trunks and miscellaneous circuits of different kinds. The trunk equipment may be arranged on horizontal strips for mounting on 23-inch relay racks, or on step-by-step switch plates for mounting on the shelves in the usual manner. To accommodate the former type of trunks on the 355A step-by-step frames, brackets are provided on the shelves so that three groups of 23-inch mounting plates can be mounted across the standard frame, each group comprising ten mounting plates. In some offices relay racks may be employed, and to permit the switch-plate type trunks to be mounted on them, a small shelf of four positions has been provided which mounts directly on the relay rack. The ringing plant consists of one or two rotary

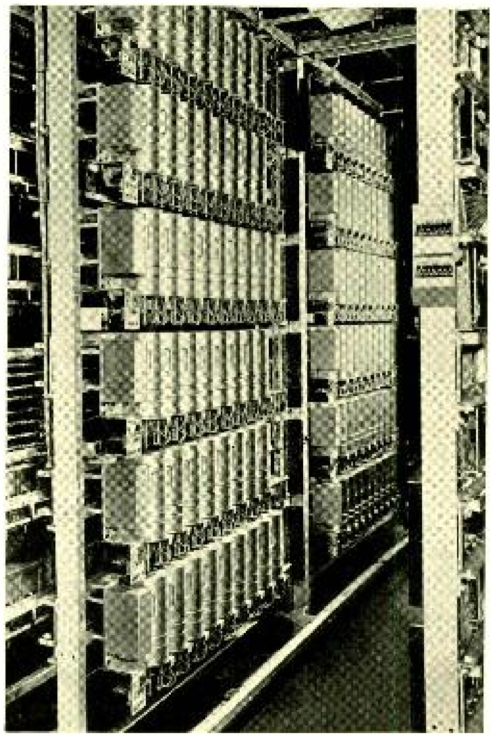


Fig. 3—An installation of selector equipment in a typical 355A office

ringing machines* complete with shaft-driven interrupters for generating all the required tones and codes.

A simple alarm arrangement is used whereby an operator may dial an alarm-checking terminal and tell by presence or absence of one tone or another whether or not trouble exists, and if so, its nature. In addition to the usual alarms, such as individual permanent signals, call blocked, release, fuse and power failure, two new types of alarms are provided which further tend to safeguard service. One is an alarm that operates after a predetermined number of permanent signals have occurred. This might be caused, for example, by branches falling on an open-wire pole line. The other gives an indication of impending cable failure due to moisture, determined by leakage measurements.

The variety of 355A office equipments now available, together with some yet to be added, should care quite economically for the great majority of unattended offices in the Bell System. Low cost of material alone, however, does not insure an economical office. With a choice of so many equipment items, engineering, ordering, and installing costs might well offset low material costs unless special steps were taken to lower them. In developing the 355A office, therefore, definite steps have been taken to minimize effort in engineering, ordering and installing. The framework, frame equipments, floor plans and cabling have been so designed that the majority of offices may follow typical patterns. Such floor-plan patterns have been standardized for typical offices of 400, 800, and 1500 lines; and two forms have been prepared which can readily be filled in to serve as complete specifications. One form serves as an order for the material, and the other as a specification for the installer.

The circuit and equipment design is such that practically all apparatus

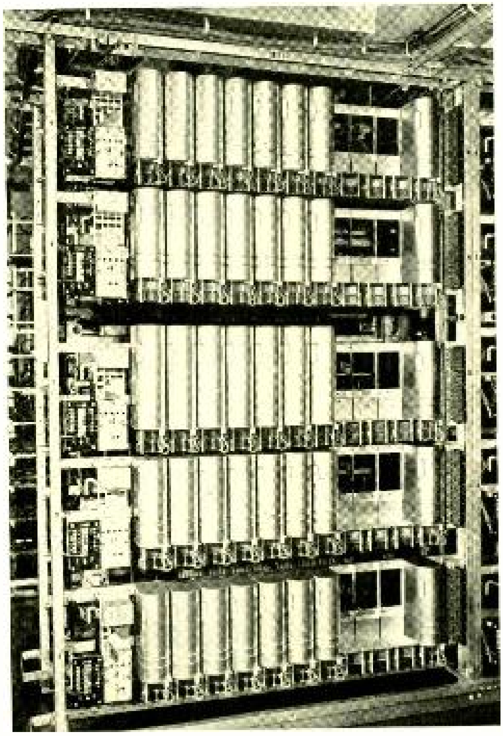


Fig. 4—Connectors in a 355A office

in an office is mounted and wired on switch shelves or units during manufacture. This provides packages of a size and arrangement convenient for ordering and installing without restricting flexibility. The switch frames are all drilled and tapped so that any combination of shelves may be arranged on the fewest frames that will suit the needs of any particular installation. All shelves are arranged with fuse panels, alarm relays and keys, traffic registers, terminal strips, and cable brackets in corresponding positions. In this way, maintenance points will always be found in the same locations regardless of the fea-

*Record, April, 1940, p. 243.

tures and the arrangement of shelves.

Orders are anticipated for 300 or 400 of these offices a year. In view of this demand and the wide variety of options to be exercised, particular attention has been paid to the standardizing of the engineering of individual installations. Most of the jobs are small, averaging perhaps below 300 lines, and the budget for any particular office is necessarily small. On the other hand, considerable detail engineering is required for each office to prepare an order for material, to give the installer the information he needs, and to maintain an adequate plant record. For jobs of this size it is preferable for the Telephone Companies to do their own engineering, and the order forms provided make this a comparatively simple matter.

The installing specification provides blanks that serve as job drawings when filled in as recommended. These forms cover traffic diagram, frame equipment, floor plan and interswitch cross-connections. In addition, complete wiring lists have been provided so that when the circuits applying to a particular job are chosen, the interconnections required between equipment units are easily specified to serve first the installer and later the maintenance forces.

"Science, Philosophy and Religion"

"Karl Darrow, of the Bell Telephone Laboratories, writes one of the most valuable contributions to the volume before us. He describes, accurately and not with the allusiveness which is too often a pretentious avoidance of careful thinking, the various revolutions in the fundamental ideas of physics which have taken place during the last half-century. His paper ends with the blunt inquiry: 'But what has all this to do with the democratic way of life, or with the contrast between democratic and totalitarian systems?' He answers:

> *'So far as the development of physics in particular and science in general is concerned, what it seems to require is a supply of talented people enabled and permitted to go their own ways, so that discovery may occur in whatever logical or capricious or ironical ways may be chosen by destiny. Non-interference is essential. If a government discourages some doctrine of physics because of a fancied clash between it and some political or economic dogma, it is adverse to physics. (Other sciences are more exposed to this danger, but even physics has not been exempt.) If a government impedes the free passage of scientific men or scientific writings to and fro across its frontier, it is adverse to the development of science even within that frontier. If a government denies opportunity to a group which has a great aptitude for science, it is doing harm to science within its own dominion, though some of the harm may be repaired by the benefit to science in other countries from the resulting emigration. If a government extinguishes a class which by breeding and inherited tradition and leisure is devoted to things of the mind, it is doing irrevocable harm to science. Everyone knows that it is mainly in totalitarian states that these things happen.'"*

—From a review in "Nature" for March 29 by Ernest William Barnes, Bishop of Birmingham and a mathematician of distinction.

New Dial-Testing Machine

A. SCHREIBER
Switching Apparatus Development

In life tests on dials, the use they get during their normal life is duplicated in a very short time. To give reliable results the machine which operates them must simulate closely the action of a subscriber or operator. In early testing machines a finger or other device, which revolved at a constant speed, engaged the dial and suddenly accelerated it to the speed of the mechanism. When fully wound, the dial was released and permitted to return to normal under control of its own governor. The sudden acceleration was greatly in excess of that which an operator could produce and resulted in much greater ratchet wear in laboratory tests than was observed in corresponding field tests.

Since many dials are ordinarily tested simultaneously, the speed of the machine had to be adjusted initially to allow sufficient time for the slowest dial on test to return to normal before the cycle was repeated. During the test, failure of one of the dials to return to normal within the allotted time, either because its speed decreased or from sticking, would cause the dial to operate improperly and a considerable number of such operations might occur before the condition was observed.

To correct these shortcomings a pneumatic testing machine has been developed by the Laboratories. It has an air piston which drives a crosshead to which ten individual dials are connected by cords wound around grooved finger wheels. Electrically controlled valves admit air to the piston at the beginning of the wind-up stroke and release it at the end of that stroke; the piston is then returned by retractile springs. Needle valves are provided in the intake and outlet openings to control the speed of the operating and release strokes. The inlet valve of each unit is operated by a series circuit through the off-normal springs of all ten dials under test. If any dial fails to return to normal the inlet valve will not open and the test automatically stops so that every failure of this type is detected. There is no delay between the return of the last dial to normal and the succeeding stroke. This permits increasing substantially the total dial cycles per day.

Starting from rest the crosshead is accelerated to a steady speed and the motion of the dials on the wind-up is adjusted by the needle valve to be almost identically that given by the subscriber or operator. With the inlet needle valve the machine can also be adjusted to the wind-up speed of a subscriber or to the faster action of an experienced operator. The outlet needle valve is always adjusted so that the crosshead returns on release at a speed greater than that of any dial. The wind-up cords are thus slack and permit the dials to return freely under their own governor action.

In the testing machine, there are five individual units, each of which accommodates ten dials. These units are assembled in a cabinet and normally operate independently so that dial failures on one unit will not stop the tests on others, but they can also be interconnected to act together. Phenol-fibre panels hold the dials at the conventional angle. Each unit has separate control switches and is equipped with its own counter. Individual lamps operated by the pulsing contacts of each dial permit observation of the pulsing during the test and there are jacks for taking oscillograms of any dial without removing it.

A portable unit has also been provided to permit making the dial tests in humidity or temperature-controlled rooms. In this case the crosshead is replaced by a series of rotating discs driven from the air piston by gearing. The dials are operated by cords wound around these discs. All the operating features of the larger machine are retained.

This new testing apparatus not only greatly shortens the time required for dial tests but it gives results which are more representative of service conditions than apparatus that had previously been employed.

THE PRIZE PAPER *award of the Basic Science Group of the A.I.E.E. New York section was received by R. I. Wilkinson for his paper "The Theory of Measurement of Linear Quantities by Scales with Fine and Coarse Rulings." Mr. Wilkinson presented the paper, along with other contestants, at a meeting of the Group held in the Engineering Societies building on April* 24

Adjustable Filters for the 2B Pilot Channel

By F. S. FARKAS
Transmission Networks Development

IN THE three-channel carrier systems used for open-wire circuits, a single-frequency test current, commonly called a pilot, is applied continuously to measure the change in line attenuation with temperature and weather conditions, and to set in operation the apparatus that corrects that change. The complete circuit traversed by the test current, together with the regulating apparatus, is called a pilot channel; one is provided for each direction of transmission of a carrier system. For the three types of system, CN, CS, and CU, each of which have different frequency assignments, there are thus six pilot channels, each having its own frequency. Each is located between the carrier frequency and the transmitted sideband of the middle voice channel. They are placed about 50 cycles from the carrier frequency so as not to interfere with the sideband, which begins about 250 cycles from the carrier. In the early carrier systems, the cut-off frequencies of the channel band filters were not precisely located, and it was necessary to adjust the carriers from their nominal frequencies in some cases as much as 350 cycles to enable the sideband to be transmitted efficiently by the particular filters provided for the system. The pilot frequencies were correspondingly adjusted, and thus the narrow band-pass pilot filters had also to be of the adjustable type. An adjustable pilot-channel filter is not required for the latest models of type-C carrier systems, since the channel filters are constructed to such accurate attenuation limits that the carrier frequencies may be fixed, but since the 2B regulator is designed to work with all existing systems, the adjustable feature was retained.

Besides having their pass band adjustable, the pilot-selecting filters must meet a number of other exacting requirements. Since they are bridged across a 600-ohm circuit at the output of the receiving amplifier at each terminal and across the output of amplifiers in each direction at repeater points, they must have high input impedance so as to give low bridging loss at frequencies outside their passed band, and they must have steep attenuation characteristics on each side of their pass band to avoid

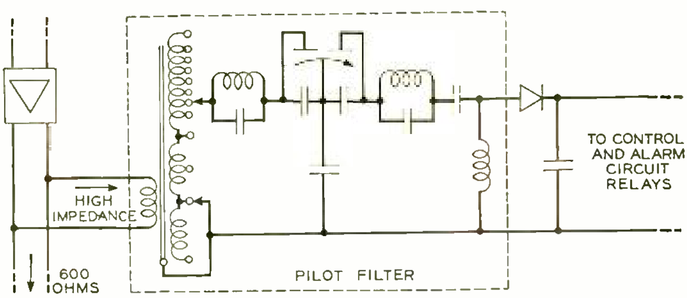


Fig. 1—The pilot filter circuits include an input transformer, filter, and impedance corrector

admitting speech or carrier frequencies to the regulating circuit.

The pilot filter developed to those requirements is shown in schematic form in Figure 1. It is composed of a transformer, a filter section, and an impedance corrector. The transformer, which is located on the input side of the filter, raises the low impedance of the filter section to a high impedance suitable for bridging across a 600-ohm circuit. The low impedance winding of this transformer is provided with taps to permit adjustment of the input power to the amount necessary for the satisfactory operation of the control and alarm circuits of the 2B regulator. The impedance corrector, which resembles a half-section high-pass filter, is located at the output of the band filter. It is represented in the schematic by the dotted series condenser and by the shunt coil, and serves to transform the high impedance of the rectifier circuit to a suitable terminating impedance for the filter. The shunt coil of the impedance corrector also provides a d-c path for the rectified current, which operates the regulating and alarm circuits. The series condenser of the impedance corrector is actually combined with the series condenser of the filter section, and for this reason is shown dotted in the diagram.

The filter section is a simple three-element "T" type of structure consisting of a tuned coil and condenser in the series arms and a condenser in the shunt arm. The series condensers of the filter are each divided into two parts: one a fixed and the other a variable unit. The variable condensers have equal capacitance, and their rotors are connected both electrically and mechanically by a metal shaft. By varying the rotor position of this condenser, equal amounts of capacitance may be added to or subtracted from each of the series arms. This adjustment changes the position of the pass band of the filter. The capacitance values employed in the variable condenser unit are such that the pass band of the filter may be adjusted over a frequency range of at least ±350 cycles for the high-group pilots. These pass-band adjustments are sufficient to cover the variations of the pilot frequencies

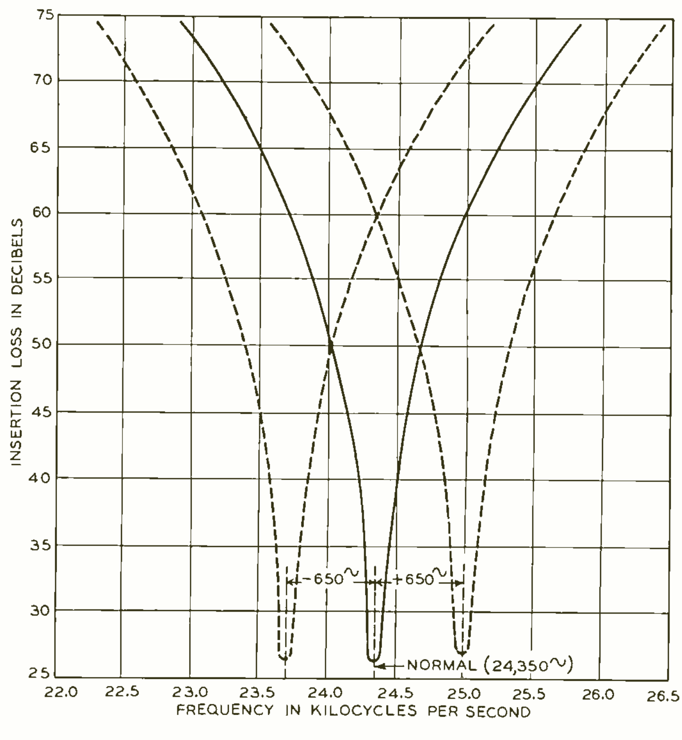


Fig. 2—Typical insertion loss characteristic of pilot filter showing its adjustment range with frequency

found in the telephone plant. In practice, the pilot channel adjustments are made with an ordinary screwdriver. This screwdriver engages in an insulated screw, which is mechanically coupled to the shaft of the condenser.

The elements of each series arm of the filter, excluding the air condenser, consist of the coil, fixed condenser, and a small trimmer condenser in parallel with the coil for initial adjustment purposes. These elements are grouped in a hermetically sealed unit. The connections from these three-element assemblies to the stator of the adjustable condenser are the high potential points of the filter circuit. To provide adequate insulation at these points, the leads are brought out through long hard rubber bushings which offer a very high insulation resistance path to ground. Because of this high insulation, the changes in mid-band loss that occur with variations in humidity are minimized, and there is eliminated the consequent possibility of false line regulation. The six pilot channel filters now available will pass frequencies of 9450, 10,630, 19,750, 21,450, 23,750, and 24,350 cycles with the air condenser adjusted to its mean position.

The insertion loss characteristic of a typical 24,350-cycle pilot filter and the range of adjustment of its band are shown in Figure 2. The dotted loss characteristics which have mid-band frequency positions of 23,700 and 25,000 cycles correspond to maximum and minimum capacitance in the adjustable air condenser. At mid-band there is an insertion loss between the 600-ohm bridged line and rectifier circuit of about 27 db, 18 db of which is reflection at the junction of the transformer and the 600-ohm line and 9-db transmission in the filter itself. The filter loss corresponds to an over-

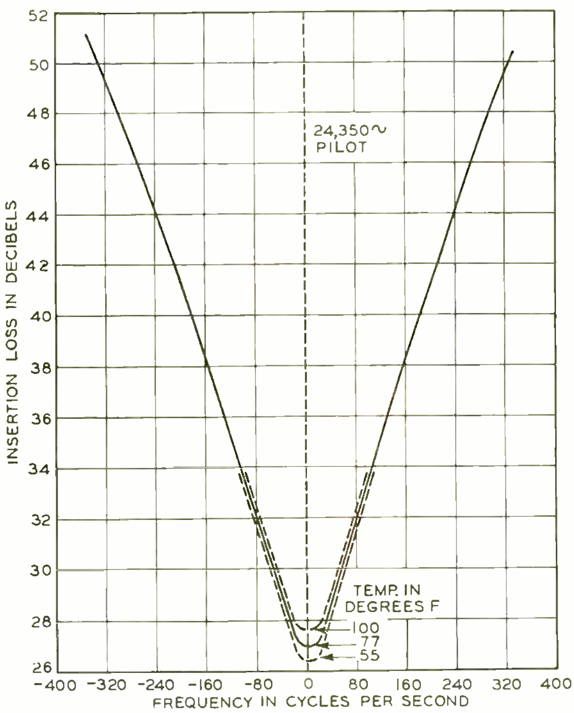


Fig. 3—Stability of band location with temperature of a typical pilot filter

all circuit "Q," or ratio of reactance to resistance, of 260. In this ratio the coils are the controlling factors and any appreciable reduction in filter loss would necessitate the use of very large and costly coils.

The input impedance of this particular pilot filter over its pass-band range is of the order of 300,000 ohms at its bridging terminals. This means a bridging loss of about .01 db when connected across the 600-ohm line. Because of the type of filter section employed, maximum bridging loss occurs in the mid-channel band at those frequencies corresponding to the pass-band range of the pilot filter, and this bridging loss decreases rapidly for frequencies away from the neighborhood of the pilot.

Precautions must be taken to avoid an appreciable change in the attenuation characteristic of the filter due to fluctuations in temperature and humidity encountered in normal service. A small shift in frequency of its attenuation characteristic might translate the pass band sufficiently to result in false line regulation. To secure the needed stability, the inductance of the coils should have a temperature coefficient either equal in magnitude but opposite in sign to that of the condenser, or ideally, they both should have zero temperature coefficients. It has been possible to secure the desired stability by combining mica condensers with coils using core materials having a controlled negative temperature coefficient that offsets the positive coefficient of the condensers.

The general effect of temperature on the attenuation characteristic of a typical filter is shown in Figure 3. For temperatures between 55 and 100 degrees Fahrenheit, the band location remains unchanged due to the high degree of stability of the resonant frequency of the coils and condensers. The 0.6-db change in loss from the normal 77-degree characteristic, as shown by the 55-degree and 100-degree dotted characteristics in Figure 3, is due to the variation in effective resistance of the coils and condensers caused by temperature changes.

The pilot filters employed in the 2B regulator occupy about one-half the space needed for the coupled tuned circuits used in previous regulator equipments. They are more selective in discriminating against frequencies outside their pass ranges, more stable to the temperature and humidity variations encountered and more economical than their predecessors from the plant standpoint of adjustment and maintenance.

The National Prize for Initial Paper *presented in* 1940 *was awarded by the American Institute of Electrical Engineers to V. E. Legg and F. J. Given. The title of the paper was "Compressed Powdered Molybdenum Permalloy for High-Quality Inductance Coils"; it was presented at the* 1940 *winter convention of the Institute held in New York City. Presentation of the awards will be made at the summer convention to be held in Toronto in June*

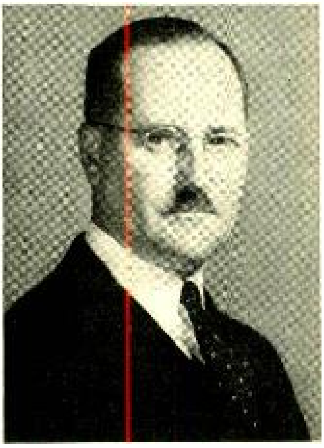
Contributors to this Issue

J. T. Motter joined the Equipment Development Department of the Laboratories in 1929. After a period in the trial installation group, he transferred to switching equipment where he was concerned with the development of step-by-step equipment for central offices and community dial offices until 1932. After installation and maintenance work with The Chesapeake and Potomac Telephone Company in Washington, he returned to the Laboratories in 1936, and has continued his work with step-by-step equipment.

J. T. Motter

W. A. Knoop first joined the Western Electric Company in 1913, when he spent six months assembling train-dispatching selectors. Following this, he spent two years at Pratt Institute, and then joined the Research Laboratories. Here he first worked on the vacuum tubes for the 1915 Arlington-Paris radio demonstration, and then engaged in investigations of vacuum tubes in oscillating circuits and of the noise in vacuum tubes. In 1926 he transferred to the submarine cable telegraph group, and spent some time in the Azores and England installing and testing equipment for the first permalloy-loaded cable. Since 1932 he has been with the television research group where he has been engaged in the design and development of television equipment.

Howard Morrison spent a year and a half testing machine-switching telephone equipment for the Western Electric Company, and then entered Worcester Polytechnic Institute in the fall of 1923. At the end of his junior

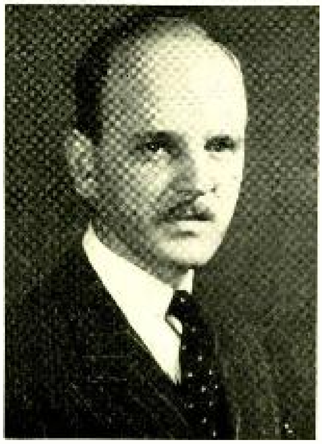


W. A. Knoop

Howard Morrison

W. W. Sturdy

H. G. Arlt



F. S. Farkas

J. G. Nordahl

year, he joined the Systems Development Department of the Laboratories as a co-operative student, and spent fifteen months in the local systems laboratory. After receiving the B.S. degree in 1928, he rejoined the Laboratories, and, with the Special Products Department, engaged in the design of broadcast transmitters. Since 1930 he has been concerned with the design of aircraft radio receivers.

W. W. Sturdy was graduated from M. I. T. in 1924 with the S.B. degree and joined the D & R in July of that year. His work there included transmission testing apparatus and studies of transmission maintenance. Later he was concerned with the design of test apparatus and field tests in connection with the coördination of power lines for railway electrification and telephone lines. Last December he was called for active duty as a Captain of the Signal Corps.

H. G. Arlt joined the Laboratories in 1923 after receiving the degree of M.E. from Stevens Institute of Technology. Following a short period of preparing apparatus specifications, he became engaged in the engineering of finishes and materials in the Physical Laboratory. Mr. Arlt continued in this field in the Materials Department and the Chemical Laboratories. He is now directing the work on finishes and that on the development of the chemical requirements of various organic materials.

F. S. Farkas joined the Engineering Department of the Western Electric in 1920 as a technical assistant, and on completion of the technical assistant's course in 1923, continued evening courses at the Polytechnic Institute of Brooklyn, receiving an E.E. degree in 1929. He was first associated with the drafting, and then with the specifications group of the Apparatus Development Department. In 1926 he transferred to the Network Development Department where he has since engaged in the study and development of transmission networks, such as filters and equalizers for carrier telephone and program systems.

J. G. Nordahl received the B.S. degree in E.E. from the University of Washington in 1925 and immediately joined the technical staff of the Laboratories where he was associated with the development of broadcast and other radio transmitters. Since the latter part of 1928, he has been associated with the development of aircraft and point-to-point radio transmitters.

Albert Schreiber, of the Switching Apparatus Development Department, had for many years been responsible for setting up and maintaining all test equipment and the design of special testing apparatus for the Dial Apparatus Laboratory. Mr. Schreiber's death occurred on November 14 and the December issue of the Record carried his obituary.