BELL LABORATORIES RECORD

TELEPHONE ORDER TURRET
H. M. Hagland

TONE ALTERNATOR
C. W. Van Duyne

TEST PLOTS FOR TELEPHONE POLES
G. Q. Lumsden

SEPTEMBER 1932 VOL. 11 NO. 1

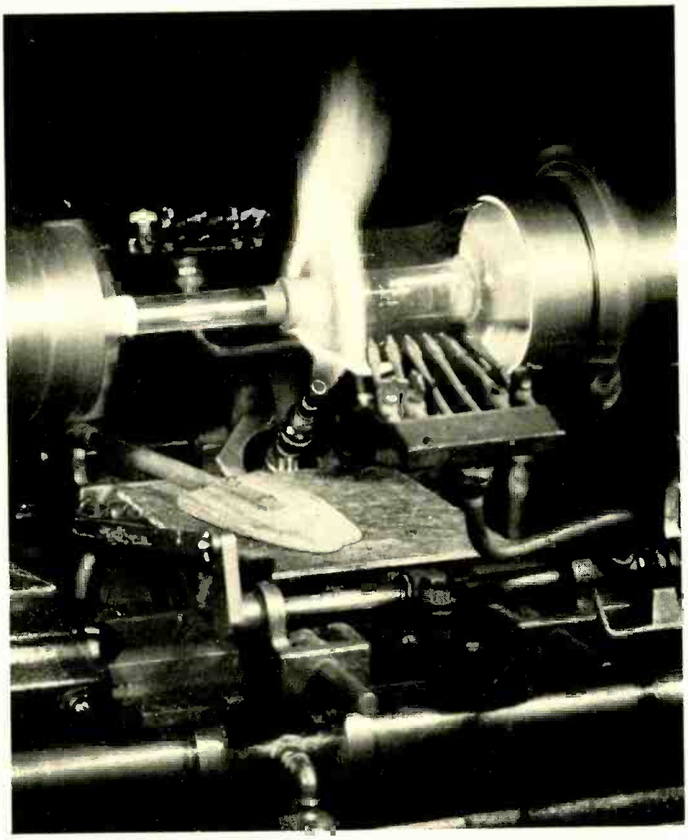
August 1933

Bell Laboratories Record

Bell Telephone Laboratories, Incorporated
463 West Street, New York, N. Y.

In this Issue

BELL LABORATORIES RECORD



VOLUME ELEVEN—NUMBER ONE

for

SEPTEMBER

1932

Order Turret No. 3

By H. M. HAGLAND
Equipment Development

THE tendency of the public to rely more and more on the telephone to purchase their everyday commodities, to shop at large department stores, and to send telegrams is being encouraged by the development of telephone equipment particularly suited for this purpose. This equipment must provide for dispatching the exceedingly numerous calls of large mercantile establishments with the utmost speed and convenience. This class of service is usually rendered by a central bureau separate from the P.B.X. that serves the various extensions in the establishment. The equipment required is known as an order turret, and it provides for completing incoming calls to a group of attendants who take the orders or give the necessary information.

One form of order turret, suitable for medium amounts of traffic, has already been described in the Record*. To provide facilities on a still greater scale, the No. 3 Order Turret has recently been developed, and an installation in the offices of the Western Union Telegraph Company in New York City is shown in the accompanying photographs. This new order turret has a capacity of 120 trunks and 110 attendants in one unit, and among other features provides for distributing calls automatically, so as to divide the load evenly as they come in, for assigning the calls serially to the attendants, and for giving information to the supervisory staff as to the general relationship between the number of incoming calls and available attendants, so that the force

*Record, *March*, 1929, *p*. 270.

of attendants may be increased or decreased as required.

The order turret equipment at each attendant's position consists of a small box with three or four keys, and two indicator lamps, and external jacks for the attendant's headset. At positions equipped with outgoing trunks to a dial central-office, a dial is also provided. The other facilities at the attendant's position will depend on the type of establishment in which the turret is installed. In this particular installation a conveyer is built into the low partition separating the rows of facing desks, which carries the telegrams to the dispatching room. Other types of establishments would have other desk arrangements, but for all the operating procedure is the same. In the photographs shown, where the work is mostly receiving telegrams, typewriters are provided at each position so that the attendant may type the messages as she receives them over her headset.

The work that the attendant has to do in handling calls has been reduced to a minimum. When a call comes in to a position one of the indicator lamps lights, and just before the call is connected, the attendant receives a double buzz in her receiver to notify her that a call is about to be connected. Without any effort on her part the call then comes in over her headset, and she takes the order or types the message as she receives it. When through with the call she dismisses the trunk by operating one of the keys in the box. When she is ready for another call, she restores this key which prepares her circuit for receiving another call. Should a call come in to her position for information or service other than she usually renders, she may transfer it to the regular P.B.X. board of the establishment by operation of one of the other keys. The second lamp at each position lights only when there are unanswered calls and all attendants are busy. The third key is employed for flashing the central-office operator if this should be necessary.

Relay and miscellaneous equipment required for the operation of the No. 3 Order Turret is shown in Figure 1, and its functions are indicated by the block schematic of Figure 2. The major operating elements are: an incoming circuit for each trunk, from one to three selectors for each trunk depending on the number of attendants, an allotter circuit, a selector control circuit, a start circuit, and a maximum of twenty sequence-storing circuits. Each incoming call is assigned to a sequence storing circuit by the allotter circuit, and if all positions

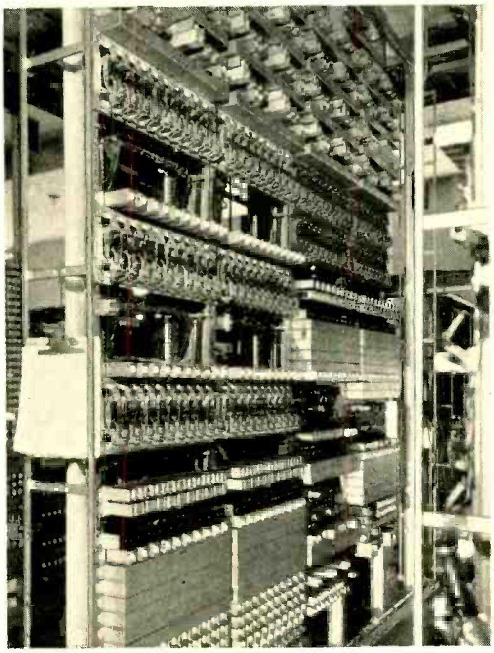


Fig. 1—Relay and miscellaneous equipment for the No. 3 Order Turret is mounted on standard relay-racks and located where convenient on the premises

are not busy the start circuit causes the call to be passed immediately on to a selector, which connects it to an idle position. Should all positions be busy the storing circuit will hold all calls received until a position becomes idle, and then pass them on in the order received.

In this particular installation the attendants are divided into three groups, each group being connected to one of the selectors of each trunk. The selector control circuit operates the selectors in order, assigning calls to the three groups of attendants in turn except when all positions of one group happen to be busy.

Under normal conditions the load on such a bureau varies considerably during the day, and in the interest of efficiency and economy it is desirable at all times to have as many attendants at positions as is necessary to handle the calls, but no more. To assist the supervisory force in determining when attendants should be added or when some may be relieved, a group of supervisory lamps is provided. There is a lamp associated with each incoming trunk, with each storing circuit, and with each attendant's telephone circuit. The attendant's lamp is lighted whenever its associated position is available for receiving calls. The caps of these lamps are green, and the number lighted indicates the number of idle attendants. One trunk lamp, with a white cap, lights whenever a call is received, and a storing circuit lamp, with a red cap, lights whenever a call is connected to a storing circuit. Both of these lamps are extinguished as soon as the call is connected to a position. When all attendants are busy, the number of calls waiting will be indi-

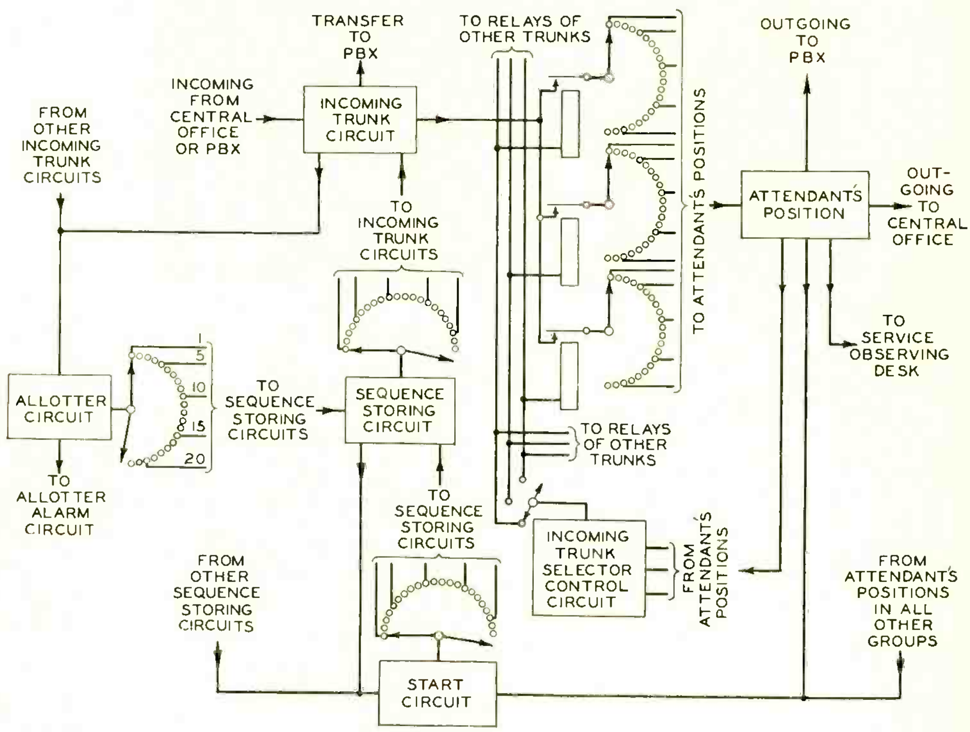


Fig. 2—Major functional elements of the No. 3 Order Turret and their interrelations

cated by lighted trunk and storing-circuit lamps. A supervisor, therefore, by watching the supervisory lamps for a short time can readily determine whether the number of attendants is properly proportioned to the number of calls coming in.

As already mentioned, the key boxes at the attendants' positions may be equipped with either three or four keys. The fourth key, where employed, is used for making outside calls. In the Western Union installation some of the positions, like those shown at the head of this article, are employed only for receiving calls and have boxes with only three keys. Other positions, like those shown in Figure 3, are equipped for both receiving and delivering messages and have boxes with four keys. Only these latter positions are equipped with dials.

The development of the No. 3 Order Turret makes available for large establishments a highly efficient and effective system for taking orders by telephone. Very little space is required by the telephone equipment itself at the attendant's position, and so the customer is free to provide those facilities for the attendant that will allow her to perform her duties most effectively.

Fig. 3—From a position equipped with four keys outside calls may be made. This enables the attendants at these positions to deliver messages as well as to receive them

A Tone Alternator

By C. W. VAN DUYNE
Equipment Development

TONES of various sorts have been used for nearly a third of a century in the Bell System for passing certain types of information over the telephone. Some of their uses have already been described in the RECORD.* That most commonly heard by the subscriber is the audible-ringing signal, which indicates that the bell of the called subscriber is being rung. With the rapidly increasing use of the dial system tones have been more widely used. The dial tone—indicating that the subscriber may begin to dial—is familiar to any user of the dial system, and many other tones are used for passing signals to the operating staff. All of the tones used may be divided into three fundamental groups: high tone, of about 480 interruptions per second; low tone, of about 160 interruptions; and the audible ringing tone. The low tone is further divided into sub-groups by interrupting it 60 or 120 times a minute.

Until recently these tones were obtained by interrupting the central-office battery current at the required frequency by commutators mounted on a shaft extension of the ringing machine. Such a set of commutators is shown in Figure 1. A continuous and a segmented ring are used for both high and low tones, while audible

*RECORD, *April*, 1931, *p.* 385.

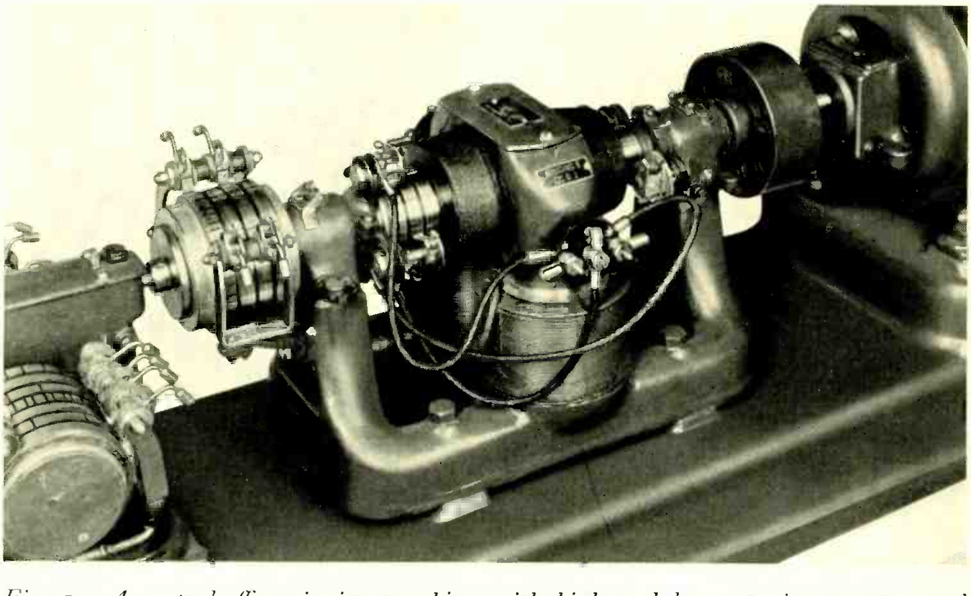


Fig. 1—*A central-office ringing machine with high and low tone interrupters and audible ringing commutators* ringing is taken from a two segment commutator at the collector ring end of the ringing machine. This method was satisfactory as long as the current to be interrupted was not too great. In heavily loaded offices, however, the tones would steadily deteriorate, both in volume and quality, because of burning of the interrupter segments. To keep the tones satisfactory it was necessary to polish the surface of the interrupters at frequent intervals. To produce tones which would always have the same quality, and to eliminate this expense of cleaning as well, a tone alternator has recently been designed.

Essentially it consists of three alternating current generators built into a single machine that may be mounted on the bearing housing of the ringing machine, thus allowing it to replace commutators in existing offices. The alternator is of the inductor type, and has a common field winding connected to the central office battery, and a set of "pick-up" windings for each of the three tone channels. Three rotors are provided mounted side by side on a common shaft. The arrangement of field, pick-up windings, and rotor may be seen in Figure 2.

The rotor for the high-tone channel, in the middle, has 25 teeth equally spaced around the periphery, which at 1200 rpm—the synchronous speed of the motor—gives 500 cycles per second in the pick-up winding. The rotor for the low-tone channel has teeth spaced to give a frequency of 660 cycles, but there are six evenly distributed blank spaces, which "rough up" the tone to give a modulated frequency of 120 cycles. What one hears, therefore, is a low frequency fundamental with a higher frequency superimposed. The rotor for the audible-ringing channel is constructed on similar principles, with teeth spaced

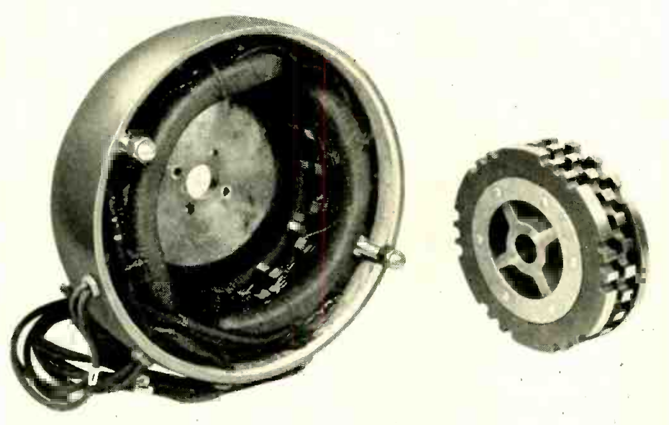


Fig. 2—Rotor and stator of new tone alternator

to give a frequency of 420 cycles but with two blank areas which give a modulation at 40 cycles per second. The pick-up windings are all designed to give the voltage and power outputs required for their several services but are alike for all machines.

Both the low-tone and audible-ringing channels are given a combination of low frequency fundamental with a higher frequency superimposed, because the low frequencies alone are not satisfactorily transmitted by the associated repeating coils, and do not resemble as well the tones obtained from the existing commutators as do the roughened tones. The tones from the new alternator thus resemble those from the present interrupters in their clean condition, and have the great advantage of always remaining the same. One of the new alternators mounted on a ringing machine is

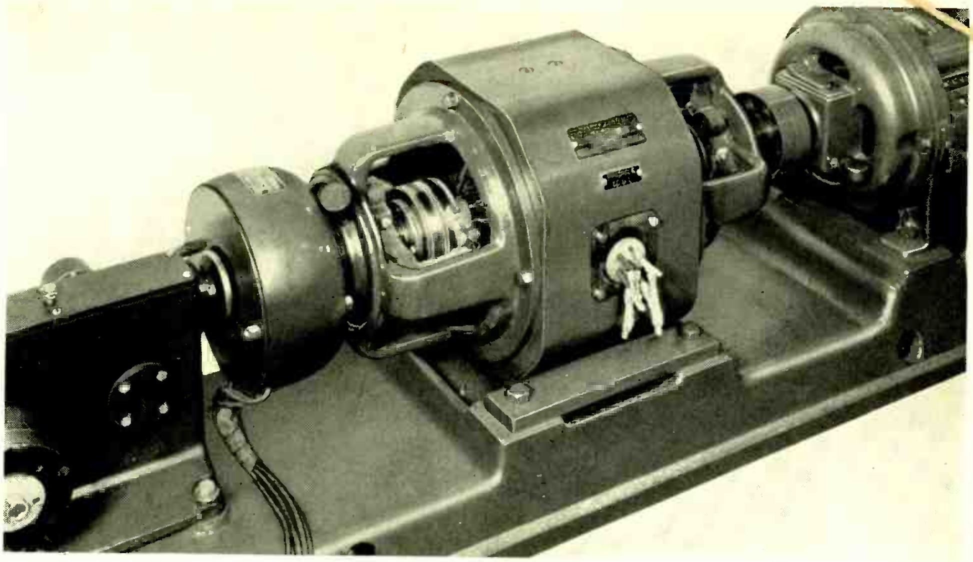


Fig. 3—A modern ringing machine with the tone alternator fastened to its bearing housing

shown in Figure 3. At the right is the driving motor, then the ringing machine, and to its bearing housing is bolted the tone alternator. To the left of the tone alternator, and driven through the same shaft, are the low frequency interrupters that interrupt the low tone to form the sub-group of tones already mentioned.

At the present time one tone alternator and a set of repeating coils are used to furnish tones for one nominal 10,000-line manual unit, or a combined 10,000-line manual and toll unit. One alternator and set of repeating coils will also supply tones for three 10,000-line dial offices or for a combined three-unit dial and toll office.

Proving Grounds for Telephone Poles

By GEORGE Q. LUMSDEN
Outside Plant Development

IN the early days of telephony, poles were cut from trees that were naturally durable and resistant to the attacks of wood-destroying fungi and insects. Poles of cedar, chestnut, cypress, Douglas fir, juniper and redwood, were set in line without preservative treatment, and many of them have made excellent life records.

With the turn of the century the art of wood preservation moved forward rapidly under the spur of commercial enterprise and economic necessity, and through the use of preservatives less durable species of timber became available for pole-line construction. As far as mechanical properties were concerned, woods like southern pine had always been considered suitable, but their lack of resistance to attack by fungi rendered them unfit for use as poles. With the development of creosoting processes suitable to southern pine, this species in particular has become an important factor in pole production. Concurrent with this development, preservative treatment has also been applied to the butts of cedar and chestnut poles to extend their naturally long lives.

In all cases, of course, the effect of any treatment on the life of the pole should be determined as accurately as possible. With this end in view, parts of regular pole lines have been designated from time to time as test sections so that the behavior of poles in service could be observed periodically. In recent years, in order to eliminate many variables that are ordinarily

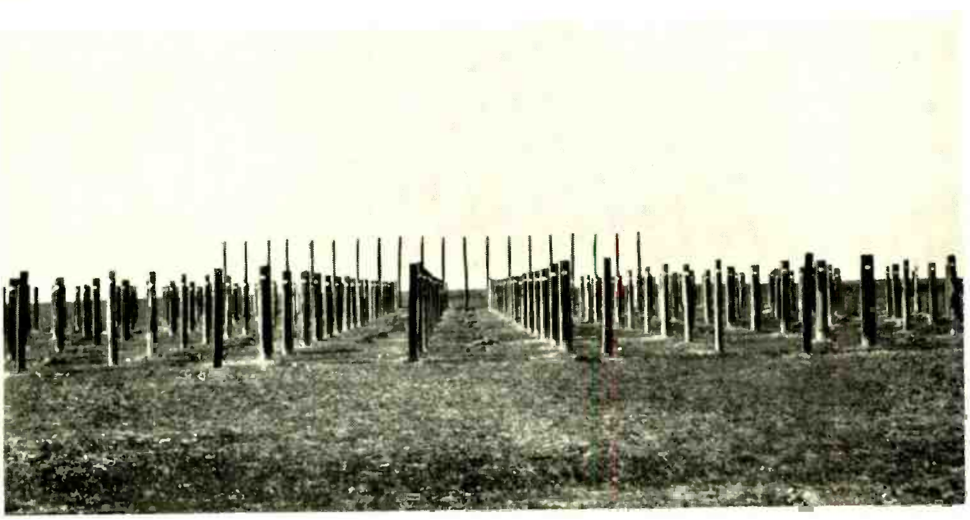


Fig. 1—One of the plots in which treated poles are given exposure tests is at Limon, Colorado

Fig. 2—Poles for use in testing are sawed into eight-foot lengths before they are treated

encountered in experimental sections of pole-lines, and to facilitate intensive study, approximately 1000 specimen posts of pole diameter have been installed in test plots.

These test plots are located at three widely separated points: Gulfport, Mississippi; Limon, Colorado; and Chester, New Jersey. In each case the environmental conditions are representative of the general area in which the plot is located.

The work at Gulfport was started in 1925. The plot is located a few feet above sea level within seven miles of the Gulf of Mexico and immediately

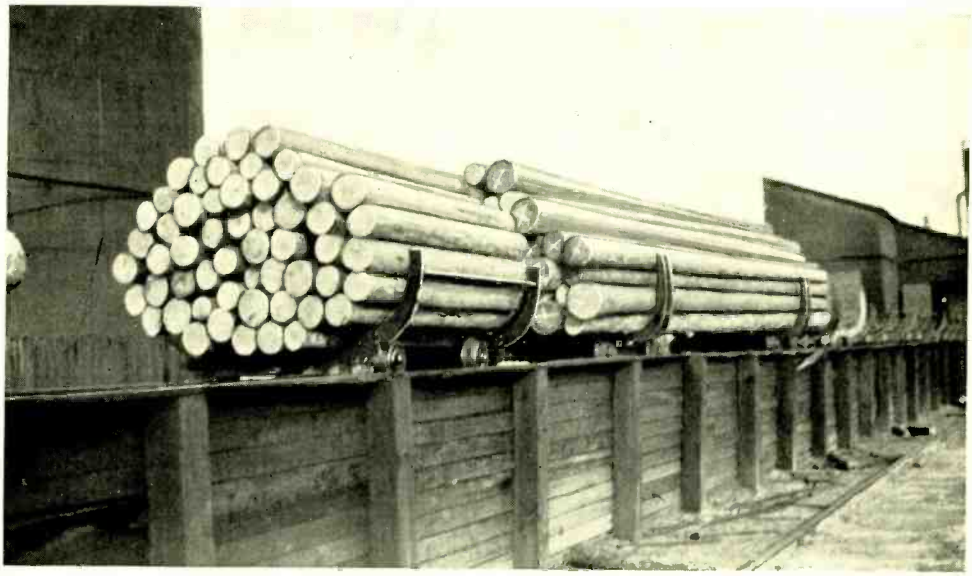


Fig. 3—The test specimens are placed on trams and rolled into the treating cylinder

Fig. 4—These treated specimens are ready to be set in the ground for test at the Gulfport plot

adjacent to a typical southern bayou. The soil is a fine sandy loam overlying a fine sandy clay. The rainfall approximates sixty inches a year, the humidity is high, and the growing season is about nine months long. Termites, or "white ants" as they are commonly called, are abundant. Experience has proved that these conditions, taken all together, are very favorable to decay and insect attack, and all the experiments carried out at this plot are therefore regarded as accelerated tests.

The plot at Limon, shown in Figure 1, was established in 1929. It is located ninety miles southeast of Denver in typical western plains country. The altitude at the plot is slightly over a mile, in marked contrast to the low elevation at Gulfport. The rainfall averages only fourteen inches a year and the humidity is correspondingly low. The soil is typical upland adobe, like that used in the making of prairie huts in the West. The growing season lasts approximately five months. Decay is less rapid here than at Gulfport.

The Chester plot was established in 1930 on the site of the Field Laboratory of the Outside Plant Development Department, thirteen miles west of Morristown. The elevation of this plot is approximately 860 feet above sea level. The annual rainfall is forty inches and the average humidity is about midway between that prevailing at the other two plots. The soil is a light-brown gritty loam overlying a yellow clay subsoil. The growing season is approximately five and a half months in duration. Taking into account the various factors affecting decay, this plot is considered generally representative of conditions in the northeastern portion of the United States, and the rate of decay is assumed to be somewhere between the accelerated rate at Gulfport and the slower rate at Limon.

With certain exceptions that are described in a later article, the test specimens installed in the plots are

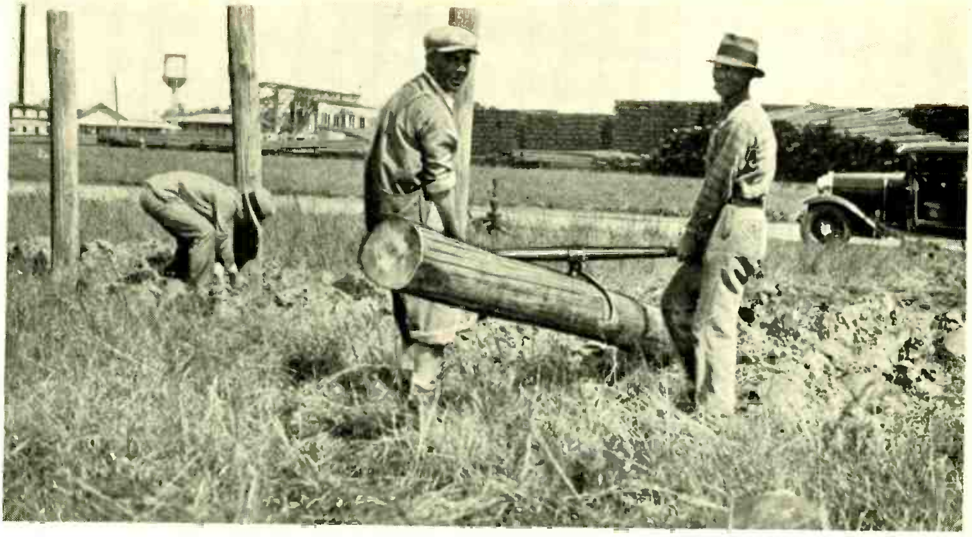


Fig. 5—For examination the specimens are removed from the ground from time to time

eight-foot sections cut from pole-size timber. The reasons for the use of these short sections are threefold. The most critical section of a pole, in relation to decay and insect attack, is normally adjacent to the ground line. The shorter lengths are much easier to handle whenever, in the course of inspection, the sections must be removed from the ground for sampling purposes. Another important advantage in favor of the short section lies in the fact that several specimens may be cut from the same pole for use in comparative tests where elimination of gross variables in the timber itself is desirable.

Each set of creosoted test specimens is prepared and tested in accordance with a uniform routine. Poles that conform to the specification requirements are selected from the supplier's untreated stock, the knots are trimmed close, and any small pieces of bark that may have been left on the surface are shaved off. The poles are then sawed into eight-foot lengths as shown in Figure 2, and the pole number, the section number and the producer's identification mark are stamped by marking hammers on each piece. Sections to be used for the determination of moisture content are obtained at the time of sawing. Data relating to the physical and structural characteristics of the wood are recorded.

The test sections are then placed on trams (Figure 3), rolled into the treating cylinder, and impregnated with creosote. Detailed records are made of the entire treating process. After they are taken out of the cylinder the test sections are sampled to see how much oil had been driven into the wood and how deeply the oil had penetrated. The sampling is done with an increment borer—a tool that removes a small core of wood from the surface to the center of the section. In addition, the general appearance of each treated specimen is carefully observed, and any checking and splitting of the wood that may have occurred during treatment is noted.

The sections are allotted to the

three test plots in accordance with a prearranged plan so that each plot receives one eight-foot specimen from each pole. As a rule the sections are set to a depth of two feet in the ground. A group of specimens for installation in the Gulfport plot is shown in Figure 4.

Fig. 7—This section of a decayed test specimen shows the matted structure of a fungus growing within the wood

Similar procedures are followed in preparing specimens for testing other preservatives than creosote, with such modifications as are required by the preservative or method under test.

The test specimens are examined periodically, generally once a year. Upon each inspection, the exterior of each specimen is again the subject of detailed observation. Then the soil is removed from around the posts, or the posts are withdrawn from the holes (Figure 5), and an examination is made (Figure 6) to determine whether any wood-destroying fungi or insects are present. If, for example, infection had been observed on a previous inspection, the progress of the causal organism through the wood is noted. The condition of the interior of the post is determined by the study of core samples taken with the increment borer; and core samples are also used periodically to find out how much preservative is left in the specimens. From the latter tests data are obtained for calculating the rate of loss of the preservative.

Fig. 6—In this test specimen a rot pocket has formed below the ground line

Figure 7 shows a typical section of a decayed specimen shipped to New York for study in the laboratory. In cases of question as to whether or not the specimens are infected with wood-destroying organisms, the wood is subjected to microscopic examination. Where possible, the organism causing infection is isolated and identified with the help of agar cultures. The chemical nature of the preservative, and its toxicity, are determined by the Chemical Laboratories. When the laboratory work is completed, the data are coördinated and consolidated with the field notes on individual cards similar to those used by physicians for their case records.

The test plots are veritable proving grounds. The Gulfport experiments have already been under way long enough to demonstrate their practical value in connection with the selection of suitable material and economical methods for prolonging the life of the poles that support the lines of the Bell System. Non-permanent preservatives and those with inadequate preservative qualities are effectively eliminated without costly practical tests in the telephone plant.

Communication at the Olympiad

THOSE RESPONSIBLE *for the communication features of the ancient Olympic Games when Greece was at the height of her glory had only one language to worry about. But a working knowledge of four was essential to some of those who performed a similar function at Los Angeles, where this year's Olympic Games (the Tenth Olympiad) opened on July* 30 *and continued until August* 14. *At the center of a special system installed for the great international athletic festival, a switchboard was "manned" by operators who spoke English, Spanish, French and German fluently. Connecting more than* 270 *telephones and supplementing a sport-controlling network of six teletypewriters, the switchboard was in service twenty-four hours of the day. Communication was provided over more than two miles of underground and aerial cables, containing hundreds of miles of wire. To handle the especially difficult problem of calls for information about the games, these were segregated from the rest of the incoming traffic, and transferred to a special board of the turret type, attended by twelve operators each supplied with written answers, arranged alphabetically, to every likely question.*

A Splash-Proof Dial for the Navy

By J. ABBOTT, JR.
Telephone Apparatus Development

THE airplane carriers "Lexington" and "Saratoga" of the U. S. Navy have complete dial telephone systems which were engineered by these Laboratories*. While the ships' communicating systems are in general similar to comparable installations ashore, the service conditions which they encounter are more severe; and for this reason some modification of standard apparatus was required. The calling dials furnished the Navy for these ships offer an example of such modification.

Since the installations on the "Lexington" and "Saratoga" are full-automatic, each telephone station must be equipped with a dial, and obviously the proper functioning of the dial is an important factor in the operation of the ships' communicating systems. Several telephones are required on deck and in other exposed locations, where they may be used in severe weather. Telephones in such positions are mounted in water-tight boxes (Figure 1) ordinarily kept closed. The cover of the box must be opened to use the telephone, however, and while in use the dial may be exposed to driving rain or spray.

In order to maintain satisfactory dial operation under such conditions, water must be excluded from the interior of the dial. To accomplish this the standard design was modified to make the dial "splash-proof." In this it was desirable from the standpoints of both manufacture and cost to make a minimum number of changes, and obviously necessary to make them so as in no way to interfere with the functioning of the dial. Thus, while a stuffing box on the dial shaft would be effective in excluding water, it would introduce variable friction unfavorable to the maintenance of constant dialing speed. For this reason it was

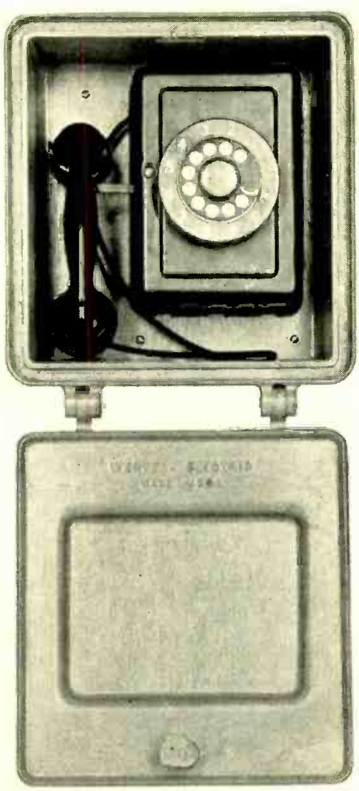


Fig. 1—Outdoor telephones aboard ship are mounted in water-tight boxes

*Record, *June*, 1930, *p.* 458.

necessary to build shields and baffles around the dial to deflect water striking the outside.

A dial adapter (No. 56-A), developed previously for use on coin collectors at public telephones, was found well suited as the base of the splash-proofing construction and the mounting for the number plate. This adapter is a flanged cup-shaped receptacle in which the dial is mounted and bears an annular number plate, mounted on its flange outside the dial finger-wheel. The large figures possible on such a plate are an aid to visibility under poor lighting conditions.

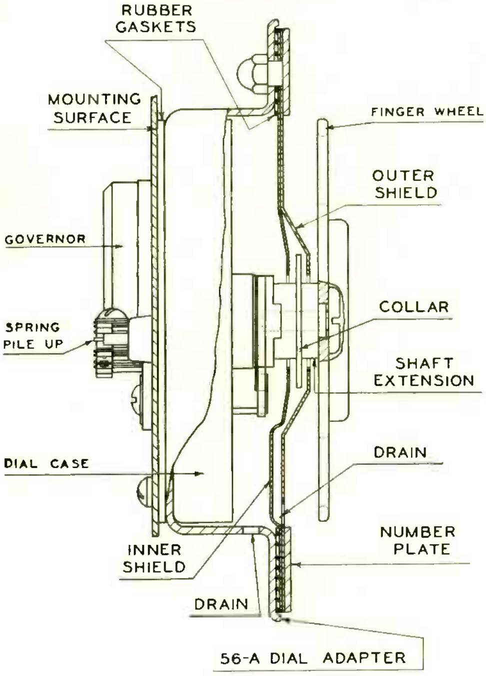


Fig. 2—The extent to which the construction of the standard dial has been modified by the introduction of special parts (larger print) for splash-proofing, is clear in sectional view

The sectional view in Figure 2 shows how the splash-proofing construction is built around the dial. The standard dial, from which the finger wheel, finger stop and number plate have been removed, is placed in the cup of the dial adapter. A rubber gasket and a thin plate, the "inner shield," are then mounted on the flange of the cup. A short "shaft extension" is placed on the dial shaft; the outer shield and number plate are assembled on the flange. A collar machined on the shaft extension is located halfway between the inner and outer shields and overlaps the edges of the hole in each. The dial finger wheel is mounted on the end of the shaft extension, and a special finger stop is fastened to the number plate. So built, the dial may be operated in the usual manner.

In order to prevent water from entering the back of the dial, a rubber gasket is interposed between the dial adapter and the subset on which it is mounted. An unusually heavy finish was applied to many of the ferrous parts of the dial, to provide better protection against corrosion under the severe humidity found at sea.

If water is thrown against this dial, which is always mounted in a vertical plane, most of it will be deflected by the outer shield and will run off across the number plate. Some water may pass through the opening between the hole in the shield and the dial shaft, and this will be deflected by the collar on the shaft and will drain through a radial duct formed in the inner shield and ending in a hole in the outer shield. Finally, a small hole, drilled in the bottom of the adapter cup, permits the drainage of any small amount of water which might possibly enter the interior of the dial. Thus, while the modified dial is not water-tight, the shields make it as nearly splash-proof as practicable, and it has given two years of satisfactory service to the Navy.

Airport Radio Transmitter

By W. M. KNOTT
Radio Development

"AL" WILLIAMS, one of America's leading stunt flyers, had taken off from the Cleveland Airport to thrill the spectators at the National Air Races with aerial acrobatics. As he gained altitude a voice boomed out over a public address system commanding, "Al! Do a barrel roll to the right." Surprising enough was the instant response seen by the crowd as the trim little racer snapped over as though answering the voice directly. Several other maneuvers were completed at the request of the announcer on the ground.

This rather spectacular performance indicated how an airplane pilot can receive information from the ground with Western Electric radio equipment. A 10A Radio Transmitter, connected to a public address system so that those on the field could hear the messages, was used to transmit the radio telephone signals which were received by the pilot with a 9D Radio Receiver. Both transmitter and receiver are recent developments of the Laboratories, and the apparatus used at Cleveland was standard with the exception of the connection of the public address system to the radio circuit.

The 10A Radio Transmitter, shown in the photograph at the head of this article, was designed particularly for use at airports in transmitting information to flyers to regulate their landing and to advise them of weather or field conditions with which they must be acquainted to safeguard and expedite their flight. A frequency of 278 kc has been set aside by the Federal Radio Commission for the use of ground stations in providing this service.

Requirements placed on such an airport transmitter are rather severe. It must have a high degree of reliability since the lives of passengers and pilots may depend upon its performance at a moment's notice, and at the same time it should be extremely simple to operate because personnel untrained in radio operation and maintenance must handle it. It must also be protected against unauthorized adjustment or tampering, since it is frequently installed in places where people other than the operator have access to it. Despite tuning by inexperienced operators and possible changes in antenna position, it must hold accurately to its assigned frequency, and must be capable of delivering adequate power to antennas which are much smaller and less favorably located than those normally used for these frequencies. To secure a maximum operating range without exceeding the antenna power of 15 watts allowed by the Federal Radio Commission, it should be capable of substantially complete modulation.

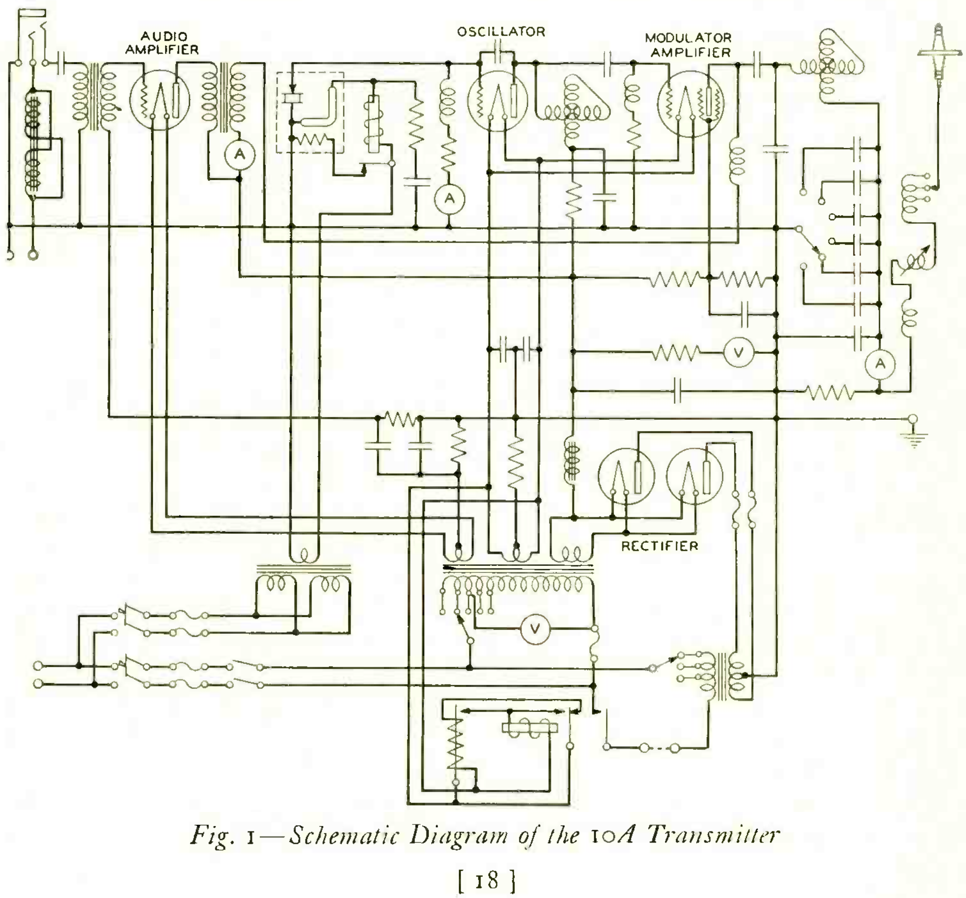


Fig. 1—Schematic Diagram of the 10A Transmitter

All these requirements have been met in the design of the 10A Transmitter, the schematic diagram of which is shown in Figure 1. It will be noted from this circuit that in addition to two rectifier tubes, used to convert the ordinarily available 110 volt alternating current supply to direct current of various potentials, only three vacuum tubes are employed. The frequency is maintained constant by a crystal controlled oscillator to within .025% under all conditions of use. A thermostatically controlled heater unit, obtaining power from a small transformer, holds the crystal at a constant temperature. A second transformer supplies low voltage for all the filaments including those of the rectifiers, and a third transformer furnishes high voltage for the rectifiers which are of the hot-cathode mercury-vapor type.

At the top of Figure 1 on the left is the audio amplifier, a 252A Vacuum Tube capable of supplying sufficient power for substantially complete modulation of the carrier wave. An input transformer couples the microphone to the grid of this tube. Next to the right is the crystal oscillator with its temperature control, and to the right of this, the oscillator tube with a tuned plate circuit. The modulating amplifier, next to the right, is a four-element 254A Tube. The plate circuit of this tube has two branches: one containing a condenser, and the other a variometer and adjustable condenser in series. Across the latter is shunted the antenna circuit. The antenna tuning coil, on the extreme right, has sufficient range to resonate antennas of a great variety of sizes.

Unless the transmitting frequency or the antenna is changed, tuning is required only at intervals of several months. To prevent the adjustments

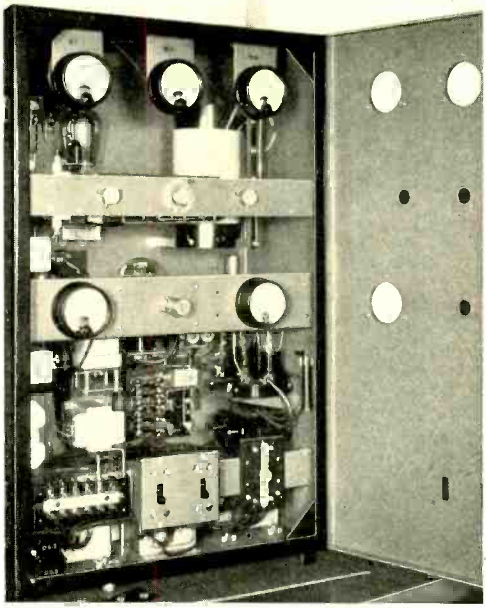


Fig. 2—The 10A Transmitter is compactly arranged and when the front cover is locked shut only two control switches project

from being changed except by authorized persons, the tuning elements are arranged for control only by a special tool that is normally locked inside the case. Meters are furnished to indicate the correct tuning positions.

For normal operation only two controls are required and these project through the lower part of the front of the case. One is the heater switch, which places the set in readiness for operation. Operation of this switch connects power to the crystal temperature control unit which maintains the crystal at the proper temperature. The other is the transmitter switch, operation of which connects power to the tube filaments and to the heater of a time-delay switch which, after an interval of about twenty seconds, connects the high voltage to the plates and grids. All the power transformers are wound for a primary voltage of from 100 to

120 volts so that an ordinary lighting circuit may be used. Only 225 watts are required in all.

The transmitter is usually left on the air during an entire conversation although provision is made for the addition of an external plate control switch which can be used to disconnect the plate supply without the operation of the transmitter switch, which would also interrupt the filament supply. This switch may be used to stop the carrier output during periods of reception, if necessary to avoid interference with the receiver.

Although the transmitter is operated on 278 kc when employed for ordinary airport purposes, it can be operated on any frequency from 230 to 500 kc. It will deliver ten watts of power to antennas of the type with which it will ordinarily be used. A range of from 40 to 50 miles can be relied upon under average conditions.

NEWS NOTES *for September, ordinarily found on a tinted paper insert at the center of the Record, will be deferred from this issue. They will appear in combination with similar notes of later date in the October issue.*

A Radio Transmitter for the Itinerant Flyer

By J. B. BISHOP
Radio Development

WITH the rapid growth of the aviation industry in the last few years a need arose for a light weight radio transmitter to enable airplanes to communicate with their ground stations by telephone. The need was most urgent for the large transport planes carrying passengers over established routes, and as a result the No. 8 type radio transmitter was developed as already described in the RECORD.* It has proven highly satisfactory for the service for which it was designed but it is not particularly suitable for the lighter types of aircraft, such as are commonly used by the itinerant flyer. For these ships with their already limited load-carrying capacity, reduction in size and weight is even more important than for the larger ships, although the range of the transmitter need not be so great. To meet this need, the Laboratories have developed the 11A Radio Transmitter which weighs scarcely eighteen pounds, occupies little more than

*RECORD, *October*, 1930, *p.* 65.

three-quarters of a cubic foot of space, and may be expected to furnish ample signal strength to a radio receiver located within a radius of 30 to 40 miles.

The pilot whose radio equipment includes this transmitter as well as a weather and beacon receiver, such as the Western Electric 9D Radio Receiver, has many advantages over the pilot flying with the receiver only. He may ask for and receive special information pertinent to his flight at any time without waiting for a scheduled broadcast of general weather information. As weather conditions change rapidly and vary greatly from place to place, the exact knowledge of the progress of a storm is extremely important to the pilot and will often enable him to proceed with assurance and safety around the storm area. In case of fog there is frequently sufficient "ceiling" for a safe landing at the port of destination or a nearby emergency field while the surrounding country is completely "closed in." With these conditions accurately known, the pilot may safely fly above the clouds to his destination and land without delay or danger. On arrival at a strange airport, the itinerant flyer, before landing, may wish to know the condition of the field, the direction and velocity of the wind and what obstructions, if any, are liable to interfere with his landing. Equipped with the radio telephone, he merely calls the operator of the airport station for this information. By no means the least important safety feature of the radio telephone is realized in the

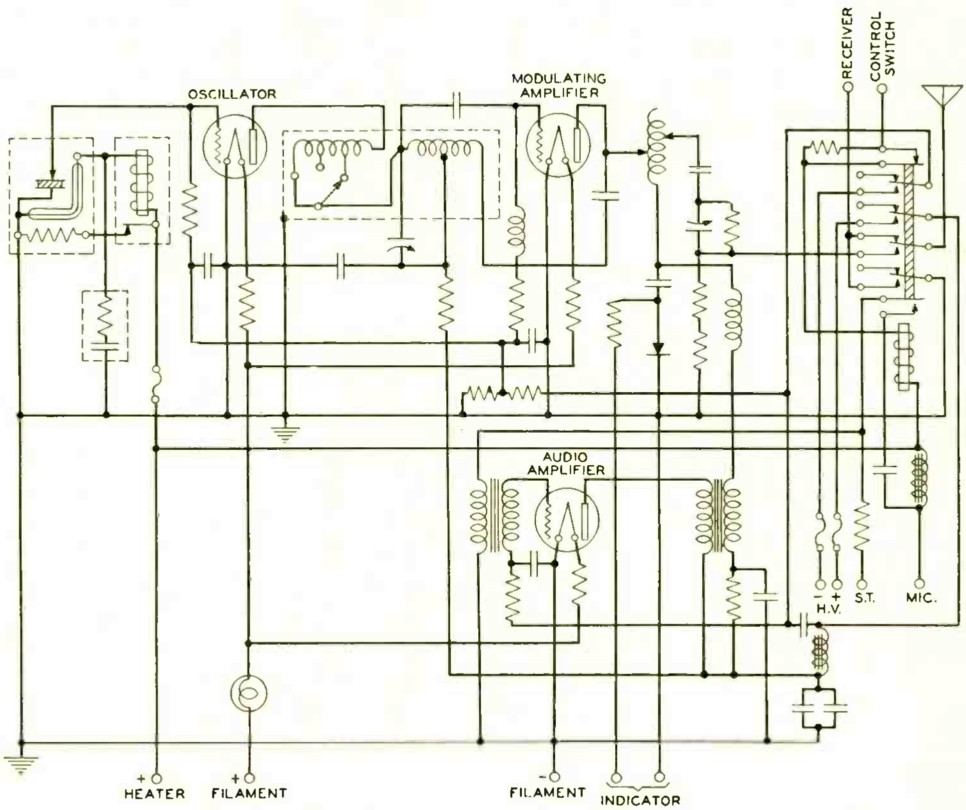


Fig. 1—*Schematic diagram of the* 11*A Transmitter* ability of the pilot to secure immediate assistance from a nearby airport should he be forced down at some point other than his destination.

The Federal Radio Commission has provided for this radio telephone service to itinerant aircraft by assigning the frequency of 3105 kc for transmission from plane to ground and the frequency of 278 kc for transmission from ground to plane. This assignment for ground to plane transmission permits the use of the weather and beacon receiver in the plane for reception from a suitable airport radio transmitter, such as the 10A described in an accompanying article. The higher frequency of 3105 kc is more satisfactory for plane to ground transmission as it allows the use of a fixed type of antenna on the plane with satisfactory transmission for day and night operation. Although operated at this frequency for the itinerant flyer service, the new airplane radio transmitter may be used for other services on any frequency from 3000 to 6500 kc. When operating on 3105 kc a flyer will be heard not only by the airport stations in the vicinity but also by aeronautical ground stations operated by the Department of Commerce whose attendants are instructed to stand watch on this frequency for emergency communications.

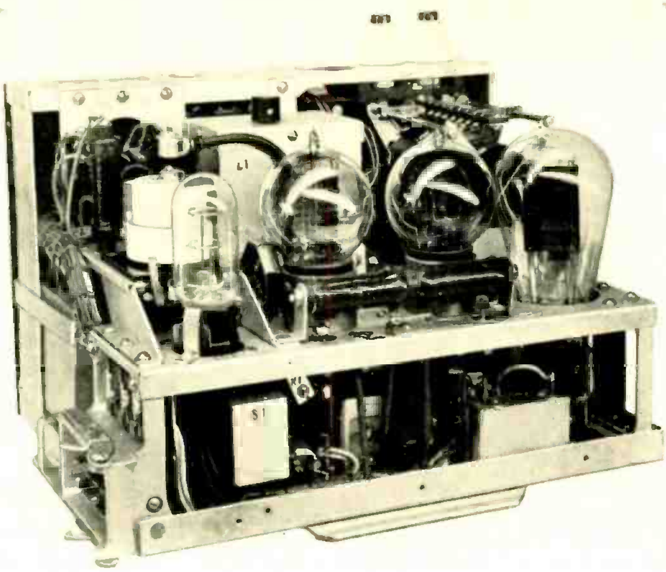


Fig. 2—The extremely compact arrangement of the transmitter is evident when the sides and top are removed. The bulb at the left is the ballast lamp used to control current to the filaments

Although the new transmitter has been reduced to diminutive proportions, no features important to the service it has to render have been omitted. The carrier frequency is determined by a temperature controlled quartz crystal and the set may be quickly adjusted to transmit on any frequency within its range of 3000 to 6500 kc by inserting the proper crystal and making a few simple adjustments. Substantially complete modulation is obtained during loud passages of speech and the response characteristic is practically flat from 300 to 6000 cycles. The output circuit is arranged to work into almost any airplane antenna that would be practicable to erect. One of the outstanding features of the design, and one which has done much to make possible the reduction in size and the simplicity of the new transmitter, is that it employs only three vacuum tubes.

The schematic diagram of the transmitter is shown in Figure 1, and the arrangement and compactness of the set may be seen in the photograph of Figure 2. One vacuum tube, a 205D, serves as a combined oscillation generator and frequency doubler by selecting the second harmonic of the oscillator frequency with a tuned circuit for input to the second tube. The second 205D Tube, operating as a power modulating amplifier, is neutralized by the Rice method with a fixed condenser and supplies modulated power to the antenna through a series tuned circuit consisting of a tapped coil and a variable condenser. A stopping condenser and static leak resistors protect the antenna from plate supply voltage and static charges. A copper-oxide-disc rectifier located in the output circuit is connected to an external DC meter which indicates the amount of antenna current as well as the degree of modulation present at any instant. The third tube, a 252A, is used as a speech amplifier with transformer coupling from the microphone circuit and to the modulating amplifier plate circuit.

The control circuits for the itinerant flyer's radio telephone are so arranged that both outgoing signals from the transmitter and incoming signals to the receiver employ the same antenna. This is accomplished by the aid of an antenna relay located in the transmitter and shown diagrammatically in Figure 1. A small control unit in the cockpit at the flyer's side contains an antenna current indicator and two small switches, the only controls needed during flight. One switch lights the tube filaments in the transmitter, thus making the set ready to transmit, and the other is a two-position switch marked "receive" on one side and "transmit" on the other. With the first switch in either position and the second switch in the "receive" position, the antenna is connected through the antenna relay to the receiver and the pilot may receive only. When the control switch is thrown to the "transmit" position, the pilot may talk to the ground station, since this switch operates the antenna relay which connects the antenna to the transmitter, puts the plate and grid voltages on the vacuum tubes, completes the speech input circuit, and grounds the antenna lead to the receiver.

Power for the transmitter is obtained from the ship's twelve-volt storage battery; from 18 to 20 amperes is the normal load while operating. Approximately five amperes of this current is used to heat the vacuum tube filaments and the crystal control unit, while the remainder is employed to operate a specially designed light weight dynamotor that delivers 520 volts for the vacuum tube plate and grid supply.

The transmitter may be located in any convenient section of the fuselage of an airplane as it is small in size, and need not, of course, be within sight of the operator since only the initial adjustments, which may be made on the ground, require access to the unit.

Biographies

H. M. Hagland entered the employ of the Western Electric Company in the old Clinton Street, Chicago, factory and worked for a year on the inspection of subscribers' sets. He then went with the Chicago Telephone Company where he obtained a wide experience in telephone work. Until coming with the Western Electric engineering department in 1919 he worked on telephone installing, central office maintenance, local test work and switchboard repair. As a member of the Equipment Development group of the Western Electric Company and Laboratories he has been engaged on the engineering of toll equipment, local operating desks, local test desks and general standard practices. He has been doing equipment engineering of P.B.X.'s since 1928.

While attending Stevens Institute of Technology during the war period, C. W. Van Duyne was called into service in the U. S. Navy and assigned to active duty at the transatlantic radio station at Sayville, Long Island. Later he was assigned to sea duty in the Overseas Naval Transport Service where he received a commission as an Engineering Officer. After the armistice he joined the Technical Staff of the Laboratories, then the engineering department of the Western Electric Company, where he has since been engaged in the design and development of power equipment.

George Q. Lumsden was graduated from Cornell in 1922 with a B.S. degree. He was appointed an assistant at the University and in 1923 received the degree of Master in Forestry. That year he entered the Inspection Engineering Department of the Laboratories where he was engaged in inspection studies of timber products. Upon its establishment in 1927, he became a member of the Outside Plant Development Department. His work there has been in connection with general development studies of timber products and their preservation, and especially with that phase involving field trials at test plots.

J. Abbott, Jr., was graduated from Stevens Institute of Technology in 1919 with the degree of M.E., and shortly after-

H. M. Hagland

C. W. Van Duyne

G. Q. Lumsden

J. Abbott, Jr.

J. B. Bishop

W. M. Knott

ward entered the Apparatus Development Department of these Laboratories. Since then he has been engaged in testing and development work on both step-by-step and panel dial apparatus and for the past few years has been concerned chiefly with dials and dial testers.

J. B. Bishop received a B.Sc. degree from Acadia University at Wolfville, N. S., in 1921. He then spent two years at Yale as a graduate student in physics, and the following three years at Cornell—both as graduate student and instructor in physics. In 1926 he received his Ph.D. from Cornell, and immediately went with the Westinghouse Lamp Company as Vacuum Tube Development Engineer. In 1928 he joined the Radio Development Department of these Laboratories. Here he initially spent some time in studying the dynamic behavior of radiation cooled vacuum tubes, but for the most part he has worked on the design of radio transmitters for aircraft service.

W. M. Knott graduated from the University of Wisconsin with the degree of B.S. in 1923. He spent four years with the General Electric Company—first with the Radio Test department and later with the Radio Engineering department—and then became associate Radio Engineer in the Aircraft Radio Laboratory of the U. S. Signal Corps. In 1930 he joined the Technical Staff of Bell Telephone Laboratories where he has since been engaged in the design of aeronautical radio transmitters.

Notes on Technical Advances

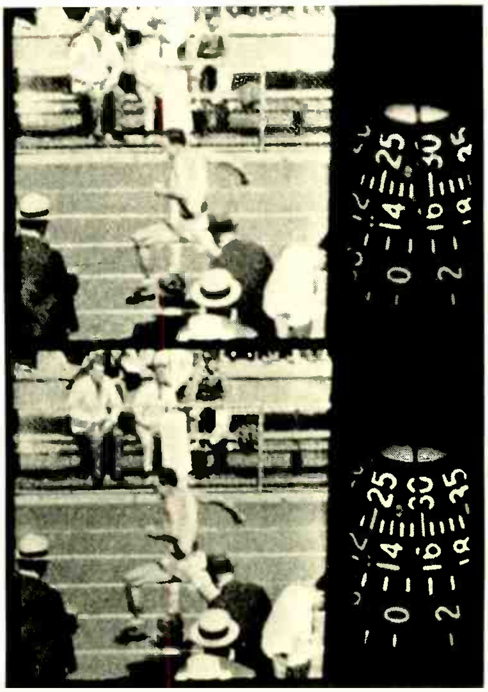
NEW TWO-EYED CAMERA TIMES RACES

At the finish line of the Olympic Games this summer there might have been seen a two-eyed motion-picture camera developed by these Laboratories for E.R.P.I. One of the eyes photographed the runners at the finish of each race, and the other recorded the exact time. The resulting strips of film, produced at the rate of 128 frames per second, show the runners crossing the line, and beside them the time accurate to a hundredth second. If the records of the device compare favorably with the official stop-watch records, it may supplant the present official time-keeping methods. Known as the Kirby Two-Eyed Camera, the device was developed under the sponsorship of Gustavus T. Kirby, member of the Executive Committee of the Olympic Games, and Chairman of the Advisory Committee of the I.C.A.A.A.A.

The need for a more accurate method of timing races was brought home to Mr. Kirby and other I.C.A.A.A.A. officials about five years ago when, looking at a motion picture record of the finish of an intercollegiate race, they realized that second place had been won by a man who had not even been placed by the judges. Kirby worked on the idea for several years and succeeded in producing a timer which utilized a stop watch as the timing element. A similar project was being turned over in the minds of Electrical Research Products officials. Realizing that the facilities for research and development at these Laboratories would hasten the solution of the problem, Kirby turned his project over to E.R.P.I. for completion.

The present precision timer utilizes a standard 16-millimeter, spring-driven slow-motion camera. Two-thirds of each frame registers the runners as they cross the line in slow motion. The remaining third is exposed to the face of an electric clock by means of a system of prisms and lights in the camera.

The equipment weighs about thirty-five pounds. It is elevated at the finish line upon a metal ladder, to prevent one runner from blanking another from the field of the camera. The dials of the clock, one recording minutes, another seconds, and a third hundredths of a second, rotate from the instant the race begins. They are started by an electric impulse received over a pair of wires from a plug which fits into the stock of the starter's pistol. The camera begins to operate only as the



Two successive frames of film taken by the two-eyed camera, to show the passage of time and runner runners approach the finish line. The developed film shows indisputably the order of the finish. To determine the time it is merely necessary to pick out the frame which shows the winner crossing the finish line and read the record of the time from the film.

Many sources of error present in the old system of timing are eliminated by the new device. The time that elapses between the moment the official sees the flash of the gun and the moment he presses the stem of the watch is longer for some timers than for others. There is a variation of from one-tenth to one-fifth of a second among individuals. Even the very finest stop watches also vary. Furthermore if the timer holds the watch so the balance wheel works against gravity, the timing is slower than if it works with gravity.

The electric clock used in the camera timer is a commercial adaptation of the tuning fork clock developed and used by these Laboratories for measuring frequencies. The tuning fork in this clock is driven by a vacuum-tube oscillator at 200 cycles per second, and the power output is amplified to drive a synchronous motor which turns the time registering units through a train of gears.

HELLO, SPANISH MAIN!

TELEPHONE SERVICE to almost all points bordering the historic Spanish Main will be in operation early in the coming year. Radio links between Florida, the Bahamas, the Canal Zone, Honduras, Nicaragua, Costa Rica, and probably Colombia, and Venezuela will connect the American telephone system with the systems of the bordering countries and will bring to 45 the total number of foreign countries within telephone reach of the United States. For much of the equipment necessary for the links to Central America and the Bahamas, these Laboratories have provided designs, and a considerable amount of the apparatus is being built in our shops.

The radio development group in the Apparatus Department is engineering extensive modifications in standard aviation radio transmitters and receivers* to suit them to the particular frequencies on which they are to operate. These vary according to the distance to be traversed; the shortest link is the 200 miles from Miami to Nassau in the Bahamas, and the longest link is the span of more than 1200 miles to Panama City. The modified sets are now being built in our model shop. The toll equipment group of the Systems Department has provided the designs for the line-terminal equipment.

The radio research group has provided designs for directive antennas of the horizontal diamond type†, and for the transmission lines connecting them to the radio units. Of the two transmitters and receivers at Hialeah, near Miami, one of each is capable of communication with five different stations. To this end their frequencies can be rapidly changed from one to another of those assigned to the links they serve, and each can correspondingly be connected to one or another of four directive antennas. The transmitter will be connected through a remotely-controlled motor-driven switch, built in our shops. The receiver will be switched at a patching panel by small flexible coaxial conductors.

In Managua, Nicaragua; Tegucigalpa, Honduras; and Panama City, the stations are owned by the Tropical Radio Telegraph Company, as are the land and buildings at Hialeah which the Long Lines Department will use to house its equipment. The station in San Jose, Costa Rica, is owned by the Compania Radiographica Internacional de Costa Rica; and in Nassau by the Bahaman Government.

---

*RECORD, *October* 1930.

†RECORD, *April* 1932, *p.* 291.