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JULY-AUGUST 1935

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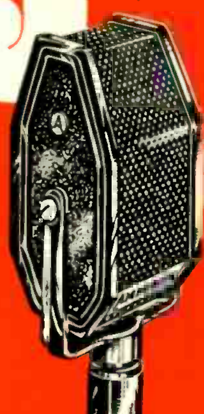

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VOLUME IV NO. 9

IN the following pages your attention is called to the invitation of the Technical Editor to discuss technical subjects in which sufficient interest appears to be present.

Early in the month the so-called Wagner bill was signed by the President. It is rather surprising to find criticism of the bill in certain labor circles, but no more so than to find certain loyal paid up members of labor organizations come to meetings with the usual shout, "We pay our dues and get nothing for them." What both mean is, "We want more!" A perfectly human, if not excusable, trait.

The old expression, "The rich get richer, the poor get — troubles," seems to hold good with the broadcast stations of the country. The big stations get bigger, and the little fellow certainly gets his share of troubles. It is probably for the same reason; the big fellow spends his energy figuring out how to get bigger, and the little fellow spends his trying to bite off more than he can chew.

Your assistance is asked in our personals. No more interesting reading is possible than the little goings on around you. Not only is the man close to these little personals interested, but others as well find them worth while. We will appreciate the favor if you will tell us more of what is going on in your own station as others have been doing so well for you in our pages.

COMMERCIAL RADIO

(FORMERLY "C-Q")

The Only Magazine in America Devoted Entirely to the Commercial Radio Man

Contents for July - August, 1935

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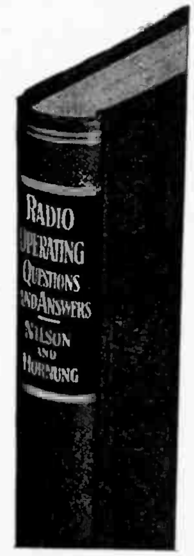

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Police Radio Combating Crime

By MATT SLOAN

THE number of municipalities in the United States using police radio systems is rapidly increasing, and what was first looked upon as just a new branch of radio work is now a matter of serious intent.

Today, there are close to two hundred cities, and almost a dozen states using this type of radio. About fifty have been added in the last year. Due to the speed with which intelligence may be transmitted to all points within the working range, there is nothing to compete with the radio system in police work.

The early systems called for a central transmitting point, generally police headquarters, for the transmitting. More recent developments of the two-way communication is fast gaining popularity, and the police cruising cars are carrying their own means of reporting back to headquarters their positions, and acknowledgements of messages received. This also affords a means of immediately advising headquarters of instructions followed and results obtained.

Transmitters are sometimes remotely located from police headquarters. This is often advisable in the case of ultra short wave transmission, to give a better aerial facility for sending.

It is always possible for cities at present using the medium high frequency police transmitter to install two-way communication by providing ultra high frequency "report back" transmitters in police cars, by providing a suitable headquarters receiver and antenna point.

Cost of Systems

A 50 to 200 watt transmitter with from .5 to 1 KW power output may be purchased and completely installed for less than $5,000 and often will more than pay for itself in economies made possible elsewhere in less than one year. A 500 watt transmitter with approximately 4 KW antenna power completely installed can be had for about $7,500.

Larger equipments of 1,000 watts with 6.5 KW power output may be had completely installed for about $12,800. Of course these are round figures, and in many cases the cost will run a little under or over this figure. It takes into consideration the installation, the complete equipment, antenna and mast, set of tubes for the transmitter, and such other incidentals as may be expected.

There is then the additional cost of the receivers, depending upon the number and type. These will run for car receivers with tubes, and installation, about $125 each. Where installations are made at fixed points, such as precinct houses, or fixed posts where police are stationed at roads leading to or out of the city, the cost of the receivers is about $75 each.

Two-Way Communication

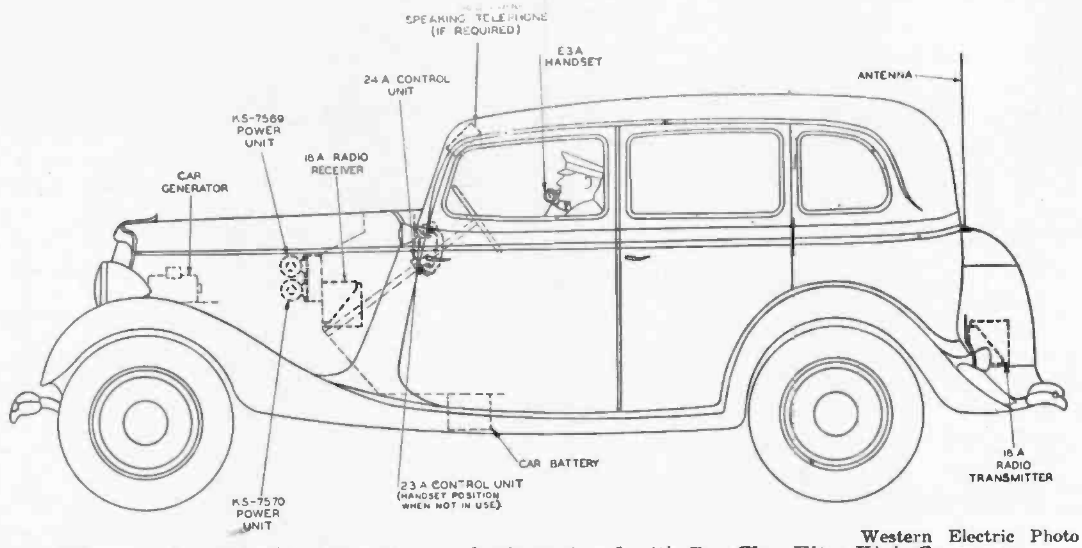
On ultra high frequency for cities where two-way communication is permitted, the cost of the installations will run about $750 per car with transmitter installed. In some cities a large number of cars are equipped with receivers, and a fewer number with two-way communication. This allows immediate contact with all cars, and report back facilities from a selected few.

At headquarters, where two-way communication is used, the cost of receivers will run a little higher than ordinary fixed receivers, as a better type of receiver, and of a more permanent and reliable nature, is used. Also, a suitable location of the antenna which must be high is a matter that may lend additional cost to this item bringing it in most cases to about $350 for a first class installation.

Where line amplifiers are required for remote control as have been adopted in many points where police headquarters do not afford the best location for transmitters, an additional cost factor enters into the picture to the sum of about $250 additional cost.

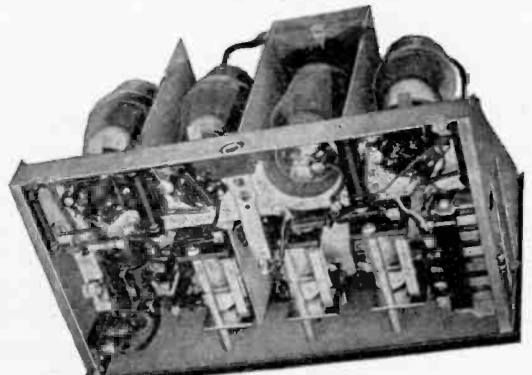
Two-Way Is More Costly

The ultra high frequency two-way



Western Electric Photo

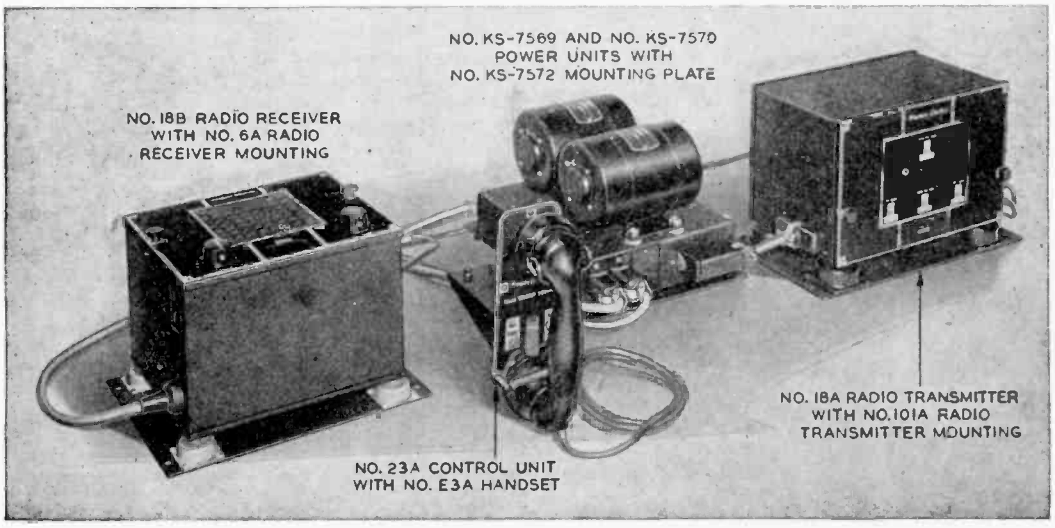
Schematic drawing of a police car completely equipped with Two-Way Ultra-High Frequency Radio Telephone Equipment



Western Electric Photo

Correct design and rugged construction enable the transmitter to withstand all the shocks and jars of constant mobile use communication while affording the better means and more satisfactory in many cases, increases the cost. The results more than warrant the additional cost of such installations.

In two-way communication it is sometimes possible to use the car battery charger with the standard generator supplied with the car. However, it is considered better practice to replace this charger, never intended for such heavy duty, with a more suitable type of charger. The special charging generators installed in cars cost about $50 additional completely installed.



Layout of complete equipment for two-way communication as installed in a police car Western Electric Photo

License Required

The usual formality preceding any installation is to first submit plans and outlines of the radio equipment to the Federal Communications Commission and receive a "license to construct" before any actual installation work is attempted. This point is entirely covered in a printed pamphlet which may be had from the Superintendent of Documents, Government Printing Office, Washington, D. C. at a cost of 30 cents.

When construction permit has been issued, it is entirely satisfactory to go ahead with installation work, as it is sanctioned by the Federal Communications Commission. When construction has been completed along the lines given in the original plans submitted to the Commission an operating license will readily be granted.

Those actually engaged in operating the transmitter itself must of course have a commercial radio operating license. No one else is at any time to take charge of the transmitter while it is on the air. Where commercial radio men are not engaged for this work it has been the practice to have certain men trained and licensed for this work.

Frequencies Available

Frequency allotments in the band between 1712 and 2490 kilocycles have been given municipal police. Between 1610 and 1706 kilocycles is reserved for State police work, in the medium high frequency band.

The ultra high frequency channel of between 30,000 and 42,000 kilocycles (10 to 7.14 meters) is considered experimental, but two-way communication has been found best on these bands, and they are the ones being licensed to police departments by the Commission. Two-way communication is in use on the ultra high frequency in many of the larger cities of the country, and is proving very satisfactory. The Boston (General Electric), Newark, N. J. (Western Electric), and the uncompleted Erie, Pa. (Westinghouse), police radio installations are considered models of what may be accomplished as they are the products of three of the largest manufacturers, working with the best available engineering staffs, on two-way ultra high frequency installations.

About two-thirds of the police radio installations of the country today are in the medium high frequency band, and one-third in the ultra high frequency band. The trend is toward the ultra high frequency band.

Power Allotment

In the matter of State Police Transmitters a slightly different problem offers itself than in the case of municipalities. The distance covered does not lend itelf to the ultra high frequency transmission, and it then becomes a problem of power for coverage. Authorizations have been made from 400 watts to 5 KW, but the Commission's attitude is to not allow anything above 5 KW, and to encourage the construction of several transmitters at different points within one state rather than to try to cover the entire territory with one transmitter. With one transmitter the power required may be above the 5 KW limit already set. Ultra high frequency is not adaptable to State Police work.

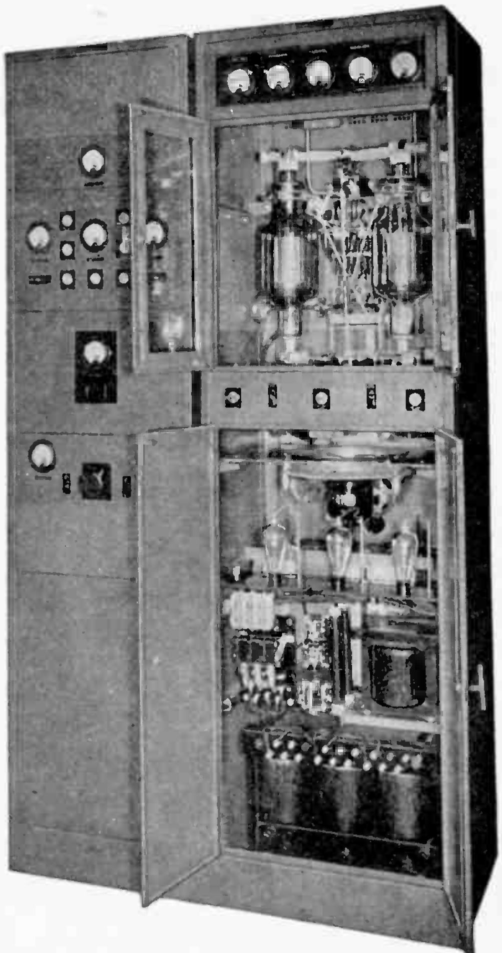
Municipalities offer a much simpler problem in regard to power. On medium high frequency transmitters the antenna power is set by population of area covered, by the Federal Communications Commission, as follows:

100,000 population—50 watts
100,000 to 200,000—100 watts
200,000 to 300,000—150 watts
300,000 to 400,000—200 watts
400,000 to 500,000—250 watts
500,000 to 600,000—300 watts
600,000 to 700,000—400 watts
over 700,000 —500 watts

Where particular problems present themselves, the Commission will study the individual case and make recommendations to the municipality concerned, or allow a larger output than is ordinarily allowed for the size of the city having trouble in transmission.

Ultra high frequency lends itself well to city police work. The range is limited depending on the elevation of the transmitter, and earth curvature. Where the ground is fairly flat it is most satisfactory. Where mountains or hills, or large metal structures such as buildings, etc., are between the receiver and the transmitter it will give "dead spots"

(Continued on Page 23)



Western Electric Photo *View of 500-watt Headquarters Radio Transmitter*

MULTIVIBRATORS

by

BERNARD EPHRAIM, E.E.

An Analysis and Discussion Replete With Practical Notes and Technical Information
IN FOUR PARTS—PART I

IN foreign and domestic engineering journals, there have appeared a number of general discussions treating the theory, design or technique of the multivibrator. To the technician, laboratorian, and practical radio engineer, it is regrettable that most of the featured material has been either intensely objective, highly academic or too technical, or the papers have been cast in foreign languages which necessitates costly translation. In this series of papers these complexities have been largely overcome; and herein will be found the essence of many authoritative papers published in scattered journals throughout the world. In preparing these articles, the technical theme has been interwoven whenever possible, yet at all times it has been the endeavor to keep within the practical aspects of the subject; hence, for the first time, a practical presentation of the theory, design, and technique appears under one general heading.

Definition

The multivibrator, an invention of H. Abraham and E. Bloch[1] (France), is a type of harmonic oscillator consisting of a two-stage capacity-resistance coupled amplifier in which the output is connected back to the input in order to produce a distorted wave-form containing a powerful high-harmonic output.

The basic principle underlying the action in a multivibrator is dependent upon the phenomenon known as a "relaxation oscillation." A complete survey of the electrical phenomena leading up to a relaxation oscillation[2] is so vast and the ramifications are so far reaching, that it would be practically impossible to be content with the briefness of the subsequent exposition. However, for those who desire greater detail than that which is encompassed herein, reference should be made to the footnotes and to the appended bibliography.

Relaxation Oscillations

Any type of oscillatory phenomena that wholly or partially comes to rest, or is appreciably retarded during any part of its harmonic motion is called a *relaxation-oscillation* This specie of oscillation can be electrically produced by automatically allowing a condenser to be quickly charged at regular intervals, then allowed to gradually discharge over a high resistance; or by permitting the condenser to slowly charge, then rapidly discharge over a comparatively low resistance.

Relaxation oscillations produced by the slow-charge fast-discharge method are commonly generated by oscillators employing neon[3] or grid-glow (thyratron type) tubes. The shape of the voltage wave-form produced by the gas tube relaxation oscillator during condenser charge and discharge cycles is shown in Figure 1. By closely examining the curve, it will be seen that the condenser charging voltage rises slowly and linearly to some fixed and finite amplitude. The linearity of the charging time is due to the charging epoch occurring over a limiting device, such as a pure resistor or saturated pentode-type vacuum tube. The finite amplitude attained by the accelerating voltage is governed by the ignition level of the gas in the tube. When the critical ignition point is reached, the gas in the tube ionizes which provides a low resistance path over which the condenser quickly discharges. The curve shows this speedy discharge by almost dropping vertically from the critical ignition level down to where the voltage across the tube can no longer maintain ionization. As soon as this extinguishing point has been reached, the charge again begins to build up as shown by the rising characterictic in the second part of the curve. It should be observed that the relaxation period in the oscillator occurs to suddenly relieve the charge on the condenser; this is depicted in the Figure by the abrupt drops in the saw-shaped sinusoid. This same period also occurs in certain types of multivibrators, although the rapidity of relaxation is often lengthened into a more gradual discharge.

Relaxation Characteristics in the Multivibrator

In the multivibrator the principle relaxation-oscillations are produced by utilizing two separate condenser charge and discharge paths. Here, the condensers are alternately allowed to either charge or discharge slowly or rapidly in their respective circuits, while the reversals or periods of each alternation are being governed by the values given to the resistance in the various circuit branches. A simple circuit by which it is possible to trace the aforementioned electrical paths is shown in Figure 2.

A typical relaxation-oscillation curve, produced in the grid circuit of any one of the vacuum tubes referred to in the above diagram, is shown in Figure 3. An inspection of the curve will show how the relaxation characteristic is developed. Note that the curve "jumps" from point "a" to "b". Next the curve slowly decreases from "b" to "c" whence then it suddenly drops thru zero axis to point "d." Here the curve gradually increases to "e," then suddenly jumps to "f" or "a" as above, thus starting another relaxation-oscillation.

By closely examining the wave-form, it will be seen that each relaxation-oscillation has a form that reaches a finite amplitude after one relaxatory period. (In any other oscillator, save the relaxation type, the wave-form is built up slowly and exponentially from a zero state to a finite stationary amplitude after a series of sinusoidal oscillations.) The finite amplitude attained during any one period of relaxation is governed by the amount of negative resistance in the circuit and upon the characteristic curvature of the tubes' operating resistance. The stability of amplitude (meaning the condition necessary for maintenance of a steady state of oscillation for an uncontrolled multivibrator) is maintained, claims B. van der Pol[4] (Holland), by the inherent residual inductance in the grid circuit leads, there being no 'lumped' inductance in the circuit. On the other hand, K. Heegner[5] (Germany), states that the steady state is maintained by the "falling characteristic" of the system (a property inherent in any regenerative amplifier. Of late, Y. Watannabe[6] (Japan), building upon Heegner's theory, claims that the steady state can be maintained by both falling and non-falling characteristics. Whether the theories of these able investigators can be melded into a single generalization is without the scope of

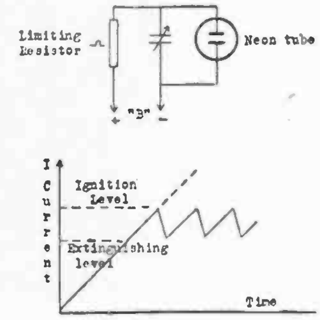


Figure 1

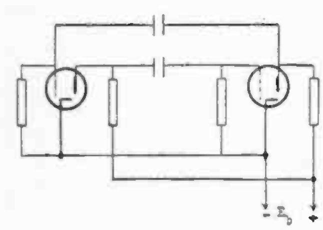


Figure 2

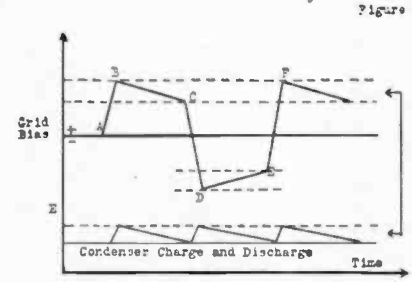


Figure 3

1 Abraham and Bloch, "Mesure en valeur absolue des periodes des oscillations electriques haute frequence," Ann. der Phys., Vol. 12, pp. 237, 1919.

2 B. Van der Pol, "Relaxation oscillations;" Phil. Mag. pp. 978-92, Nov. 1926; also Zeits. f. Hochfr. Vol. 29; pp. 14, 1927.

3 D. Pollack, "Neon tube oscillators," Radio News, Two Parts, Dec. 1932, and Jan. 1933; with seven references.

4 B. van der Pol, Loc. cit. No. 2.

5 K. Heegner, Zeits. f Phys., Vol. 42; pp. 773, 1927, also Jahr. der Draht Tel und Tel., Vol. 29, pp. 151, 1927.

6 Y. Watannabe, "Some remarks on the [illegible] Proc. IRE Vol. 18, No. 2 pp. 327, 1929.

this discussion. However, a study exploring the salient details of the above authors' published works would, no doubt, be an interesting investigation.

Unfortunately no discussion can be given in these articles investigating or analyzing the harmonic content of the multivibrator by the use of the Fourier Series. The reason for excluding this formal topic is because the multivibrator system cannot be exactly analyzed or investigated by the Fourier method. The wave patterns may, never-the-less, be qualitatively studied through the medium of the cathode-ray or string oscillograph device.

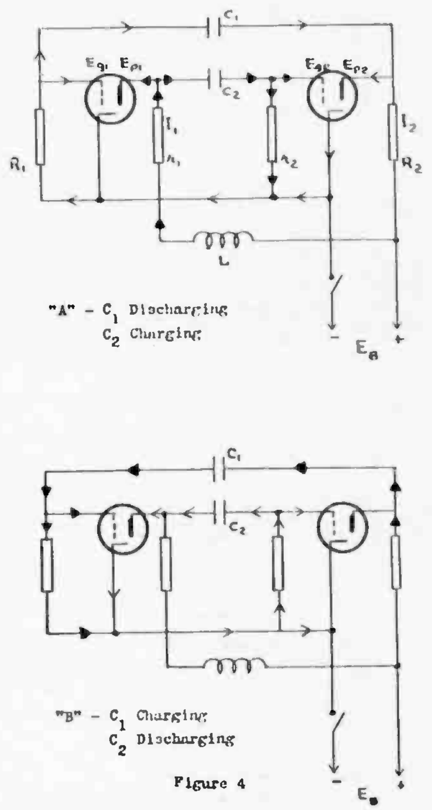


Figure 4

Since the control function in most all types of vacuum tubes depends upon the grid bias, it is obvious that if this bias were of a simulated alternating voltage, and each alternation had sufficient amplitude, the tube could be swept over its entire characteristic. Through such control, and by proper selection of the circuit constants, the condensers in the multivibrator can be made to quickly charge and slowly discharge or vice versa in practically any sequence with respect to time. Thus, a wave-shape of the familiar saw-tooth configuration can be developed in the system. This waveform is similar to that produced by a neon-tube oscillator with the exception that the progression of the wave development is reversed in the multivibrator. For comparison, see Figures 1 and 3.

The general outline of the wave-form depends upon the time periods allowed to the alternate condenser charge and discharge transitions. If these periods be equal, that is, if the charging times be of one value and the discharge times another, the contour of the voltage curves described by the alternate condenser charge and discharges will have practically the same shape. When such a symmetry exists, the multivibrator has SYMMETRICAL CHARACTERISTICS. On the other hand, if the charging and discharging alternations have different time periods, such as charging times unequal, the shape of the wave-forms in one circuit will be somewhat modified from that of the other, the degree of dissimilarity depending upon the difference existing between the two circuits; hence, if the multivibrator develops dissimilar wave shapes in each circuit, the system has UNSYMMETRICAL CHARACTERISTICS. Any multivibrator circuit can be instantly classified by simple inspection of the values of the grid and plate resistors in the two circuits forming the oscillatory system. In addition, in a symmetrical system each time the grid changes potential, the change is greater than the straight line part of the tube characteristic. In an unsymmetrical system one of the tubes usually operates as a straight amplifier, while the other functions over the complete tube characteristic from saturation to cut-off.

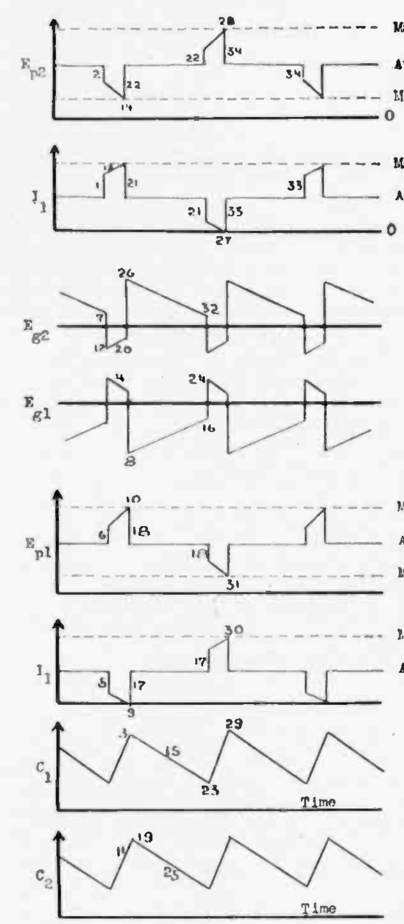
Function of a Symmetrical Multivibrator

In Figure 4 are two simplified wiring diagrams which, with the subsequent explanation, illustrate the electrical action in the multivibrator. In the Figure, open and closed arrows indicate the direction in which the current flows during alternate condenser charge and discharge periods. Plus and minus signs show the grid voltage biases on the respective tubes during inter-circuit reversals.

GENERAL EXPLANATION: Refer to either drawing "a" or "b" in Figure 4, then assume that the plate supply voltage has suddenly been applied to the plate circuits. Now, from a brief examination of either diagram, it would seem that if resistors r_1 and r_2 were of an equal value, an equal charge would be placed upon condensers C_1 and C_2 thereby stabilizing the system. But, in a symmetrical or unsymmetrical combination, experiment and theory prove that an unbalanced condition exists in the intra-circuit of some one tube causing an unsymmetrical current equilibrium to be established between one tube and the other. This instability causes the circuits to feed back upon each other producing self-excited oscillations.

CIRCUIT ACTION: To properly depict the circuit action together with the building up of the relaxation characteristic, reference will be made to the diagrams in Figure 4 together with the graphical representations shown in Figure 5. As regards the graphs, these describe excursions of the plate voltage E_{p1}, E_{p2}; plate currents I_1, I_2; grid voltages E_{g1}, E_{g2}; and condenser voltages C_1, C_2.

In drawing "a" suppose that the potential applied to plates E_{p1}, E_{p2} and to condensers C_1, C_2 were of one value. (This is strictly a supposition as such conditions do not exist for even the duration of a moment. In experiments it has been repeatedly demonstrated that in order for self excited oscillations to be produced it is a necessary condition that there be no point of equilibrium with respect to the direct current.) Now, if the plate current i_2 flowing through r_2 should slightly increase (1) (these numbers refer to portions of the curves shown in Figure 5) a small voltage drop (2) would occur at E_{p2} due to the IR drop in r_2. The reduction of voltage at E_{p2} permits condenser C_1 to slightly discharge (3) through the elements of tube number 2, thence through resistor R_1 back to the negative side of C_1. During this slight discharge, the voltage across R_1 increases the negative bias E_{g1} (4) which decreases the plate current I_1 (5) more times (amount governed by the mu of the tube) than the initial current change through r_2. The decreasing plate current at I_1 increases the voltage at E_{p1} (6) which starts to increase the charge on C_2. The charge acting through C_2 decreases the negative bias E_{g2} (7) which, when multiplied by the mu of the tube, is great enough when carried back to E_{g1} to drive the grid so negative (8) that the plate current I_1 (9) is suddenly cut off. This, of course, increases the voltage at E_{p1} (10) which charges condenser C_2 (11). The charge acting through the condenser drives grid E_{g2} positive (12), which increases the plate current I_2 (13) and decreases the voltage at E_{p2} (14) causing condenser C_1



Curves E_{g2}, and C_2 are similar to those produced by oscillographic devices. The remaining curves are only relative.

Figure 5

to discharge (15). The condenser will continue to discharge until the grid voltage on E_{g1} has reached such a value (16) that the plate current begins to flow (17). At this instant, refer now to diagram "b", the voltage E_{p1} across r_1 begins to drop (18) causing condenser C_2 to slightly discharge (19) across R_2 which, due to the IR drop therein, causes E_{g2} to be driven slightly negative (20). This change decreases I_2 (21) and increases E_{p2} (22) more than the initial change across r_1 due to the mu of the tube. The increasing voltage at E_{p2} starts to charge condenser C_1 (23). The charge acting through the condenser drives E_{g1} positive (24). This causes C_2 to suddenly discharge (25) across R_2, which due to the IR drop therein, drives E_{g2} negative (26). This cuts off the plate current (27) at I_2, raises the voltage at E_{p2} (28) and so charges condenser C_1 (29). While E_{g1} is positive, the plate current I_1 is at maximum (30) and the plate voltage E_{p1} is at minimum (31). When the bias E_{g2} reaches a low value (32) the plate current I_2 (33) begins to flow and the plate voltage E_{p2} (34) begins to drop, which brings this explanation back to the conditions first assumed in (1) and (2).

The above cyclic relaxation-oscillation continues: the period or frequency of each oscillation depends EXACTLY upon the "initial time of condenser charge" PLUS "the initial time of condenser discharge" or approximately upon the capacity-resistance product (CR) of the grid oscillatory circuits. A more thorough discussion regarding the frequency of the system will be taken up later on.

Voltage and Current Changes

The variations in current and voltage occurring during any relaxation-oscillation may be determined by inserting a simple vacuum-tube voltmeter in any of the branch circuits shown in Figure 6. When using the meter, it is essential that its damping constant be higher than the CR period of the multivibrator, in seconds. This limitation means that only quantitative readings can be obtained at only very low relaxation frequencies. With the meter it is possible to determine six voltage and six current variations during each oscillation, a list of these appears below.

(1) Two changes in grid voltage — E_{g1}, E_{g2}

(2) Two changes in Plate voltage — E_{p1}, E_{p2}

(3) Two changes in condenser charges — E_{q1}, E_{q2}

(4) Two changes in grid current — I_{g1}, I_{g2}

(5) Two changes in plate current — I_{p1}, I_{p2}

(6) Two changes in condenser charge and discharge currents — I_{q1}, I_{q2}

Equations by which any of the above variations may be determined are:

GRID VOLTAGES:

$$E_{g1} = I_{g1}R_1 = R_1(I_{g1} + I_{q1})$$

$$E_{g2} = I_{g2}R_2 = R_2(I_{g2} + I_{q2})$$

PLATE VOLTAGES:

$$E_{p1} = r_1(I_{p1} - I_{q2})$$

$$E_{p2} = r_2(I_{p2} - I_{q1})$$

CONDENSER CHARGES

$$E_{q1} = C(E_{p2} - E_{g1})$$

$$E_{q2} = C(E_{p1} - E_{g2})$$

GRID CURRENTS:

$$I_{g1} = \varphi(E_{g1}, E_{p1})$$

$$I_{g2} = \varphi(E_{g2}, E_{p2})$$

PLATE CURRENTS

$$I_{p1} = \phi(E_{g1}, E_{p1})$$

$$I_{p2} = \phi(E_{g2}, E_{p2})$$

CONDENSER CHARGE AND DISCHARGE CURRENTS:

$$I_{q1} = C\frac{dE_{g1}}{dt} - \frac{dE_{p2}}{dt} \text{ Condenser charging}$$

$$= -\frac{dE_{g1}}{dt} \text{ Condenser discharging}$$

$$I_{q2} = C\frac{dE_{g2}}{dt} - \frac{dE_{p1}}{dt} \text{ Condenser charging}$$

$$= -\frac{dE_{q2}}{dt} \text{ Condenser discharging}$$

The condenser charge and discharge currents must be determined by differentiating over the charge and discharge times. In practice, it is seldom necessary to determine these values

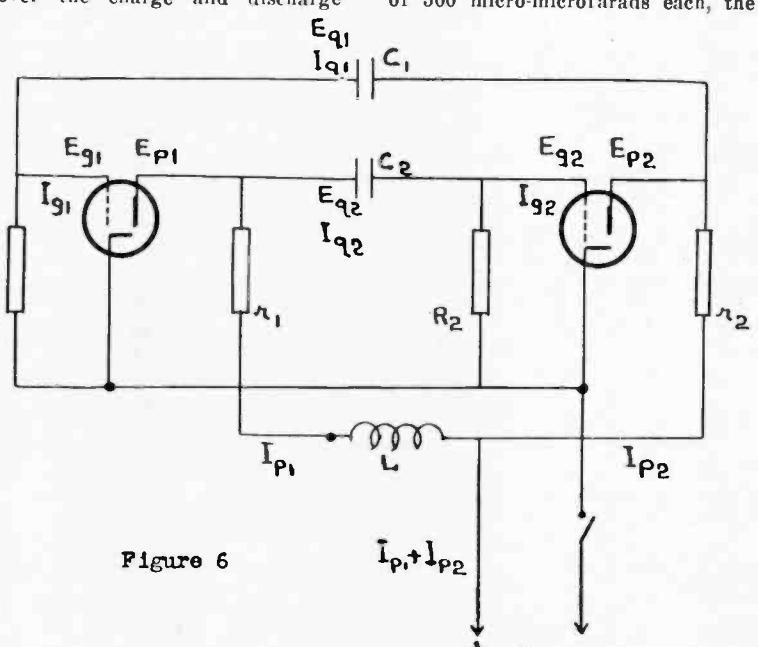


Figure 6

Frequency Determination

The fundamental frequency of the multivibrator cannot be determined from formula employed in determining frequency in other types of oscillatory systems. This is because the sustained oscillations produced in the multivibrator are arc oscillations of the second type. In this category even the abridged Thomson formula is valueless because the circuits comprising each shunt branch have no effective inductance during the times when the current remains substantially at one value over a certain part of each relaxation-oscillation. However, the fundamental frequency may be closely approximated by computing the relaxation-oscillation time constant of the system. This constant may be determined from the following expression

$$T = \overline{RC} \log \frac{V_1}{V_2}$$

where C is the total capacity in the circuit, R the total effective resistance in series with the capacity, and V_1 and V_2 the initial and final voltages, respectively, across the condenser.

Another method for calculating the frequency of the system, while not as accurate as the above, consists of simply taking the CR product of the grid circuits. Expressions for calculating frequency by this method are

$$f = \frac{1}{C_1 + C_2\ (R)}$$

$$f = \frac{1}{R_1 + R_2\ (C)}$$

where f is the frequency in cycles; C, the capacity in microfarads; and R, the ohmage of one of the grid leak resistors.

Applying one of the above equations, take the following example:

If a multivibrator had grid leak resistors of 20,000 ohms each, condensers of 500 micro-microfarads each, the frequency could be determined by the following solution:

SOLUTION:

$$f = \frac{1}{C_1 + C_2\ (R)}$$

$$= \frac{1}{500 + 500\ (20{,}000)}$$

$$= \frac{1}{(10^{-9})\ (2 \times 10^{4})} = \frac{1}{2 \times 10^{-5}}$$

$$= \frac{1}{.00002} = 50{,}000 \text{ or } 50 \text{ KC/sec.}$$

NOTE ON TECHNIQUE:

To find the value of the grid leaks for some specific frequency when the value of the condensers are known, use the following method.

(1) Take the frequency in cycles and

(Continued on Page 21)

Automatic Receiver For Distress Signals

By O. BRACKE and P. GIROUD

Introduction

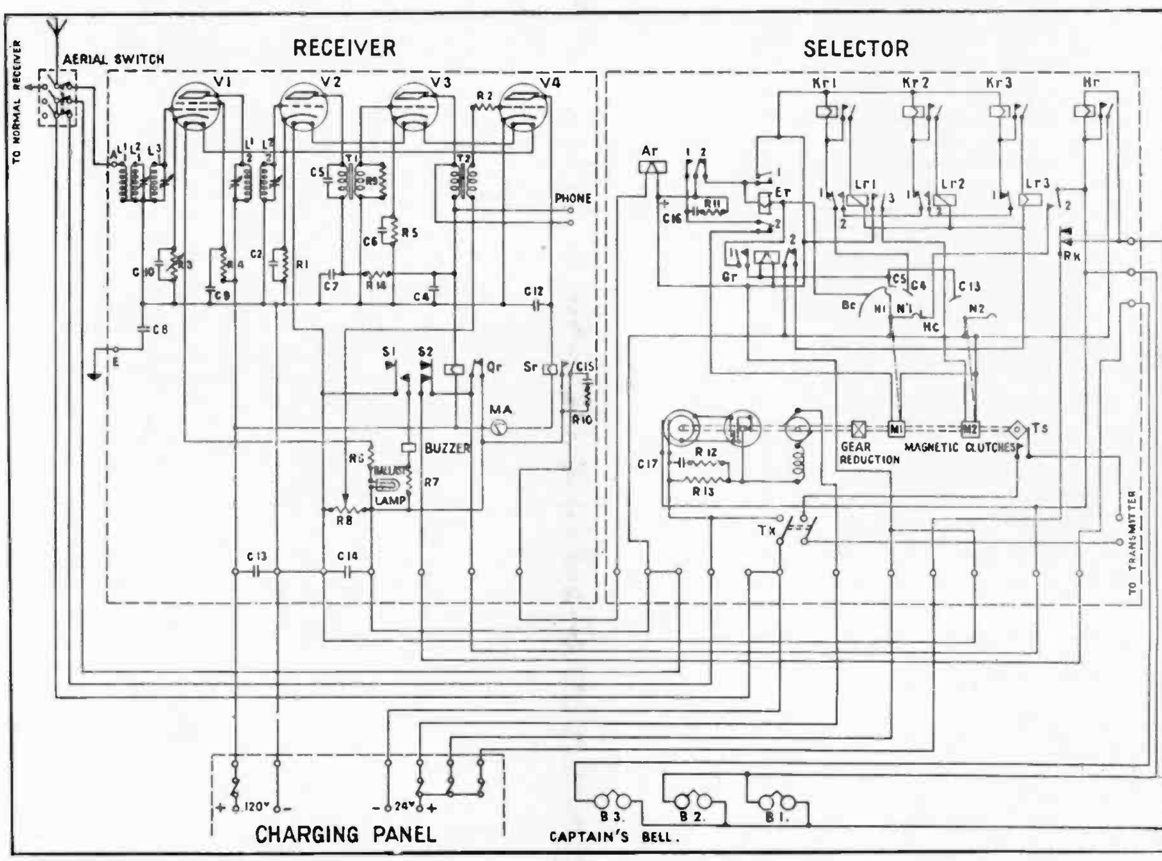
According to their classification and importance, all sea-going ships are compelled to have one, two or three wireless operators on board, who, under the Merchant Shipping Act of 1927, are to keep a wireless watch during certain hours imposed by the rules laid down in the Act.

Outside these watch-keeping periods, the ships have been unable to receive distress signals. To obviate this inconvenience and in order to reduce the number of required wireless operators, the Washington International Wireless Telegraphy convention of 1927, instituted the required that the auto-alarm equipment shall be capable of receiving signals within certain limits. The duration of each dash may vary between 3.5 and 4.5 seconds, and the duration of the intervals between 0.2 and 1.2 seconds.

The automatic instruments used for receiving the alarm signals must satisfy the following conditions:

(1) They must respond to the alarm signal after three consecutive dashes, even when numerous transmitting stations are working and when there is atmospheric interference;

(2) They must not be started by atmospheric or by powerful signals other than the alarm signal;



Circuit schematic of A.A.2.B. type auto-alarm

(3) They must possess a sensitivity equal to that of a crystal detector receiver connected with the same antenna;

(4) They must give warning when their operation ceases to be normal.

To comply with the aforesaid regulations, the laboratories have recently developed an automatic receiver for distress signals of a new type. This equipment has been approved by the General Post Office of Great Britain for installation on board of compulsorily fitted ships and it has been standardised by the International Marine Radio Company, Ltd.

This article describes the equipment known as the A.A.2.B. Auto-Alarm.

Signal Time Checking

Numerous types of automatic receivers have been developed by different firms, the signal time checking being done by tuned relays, pendulum clock systems, or clutch or motor driven switches. All of them are based on the principle of the direct measurement of the duration of each individual dash and interval.

The duration of the dashes is a relatively stable element; atmospheric interference or powerful signals other than alarm signals can only add to their duration without changing their characteristics. The intervals which, according to the regulations, may be as short as 0.2 second are, on the contrary, liable to be upset to a greater extent by the "automatic distress signal" which precedes the ordinary distress signals.

The "automatic distress signal" is transmitted on a wavelength of 600 meters. It consists of a series of twelve dashes sent out in one minute. The duration of each dash is four seconds, with a one second interval between dashes.

The only purpose of this special signal is to set in operation the automatic receiving apparatus which gives warning of the receipt of a distress call when watch is not being kept by an operator. It is used solely to announce that the distress call or message is about to follow.

The automatic distress signal may be sent out either automatically or manually. For the latter case, it is generally interferences. Consequently, under normal service conditions, two consecutive dashes are not separated by an interval of the correct duration but by an interval containing a number of extraneous short signals.

By eliminating the measurement of the interval separating two consecutive dashes and substituting a check of the total time from the end of a first dash to the end of the following second consecutive dash, the new auto-alarm developed by the Laboratories completely solves the problem. The principal cause of failure of the other types of automatic distress signal receivers is suppressed.

Description

The equipment consists of:

(1) A watertight box containing the

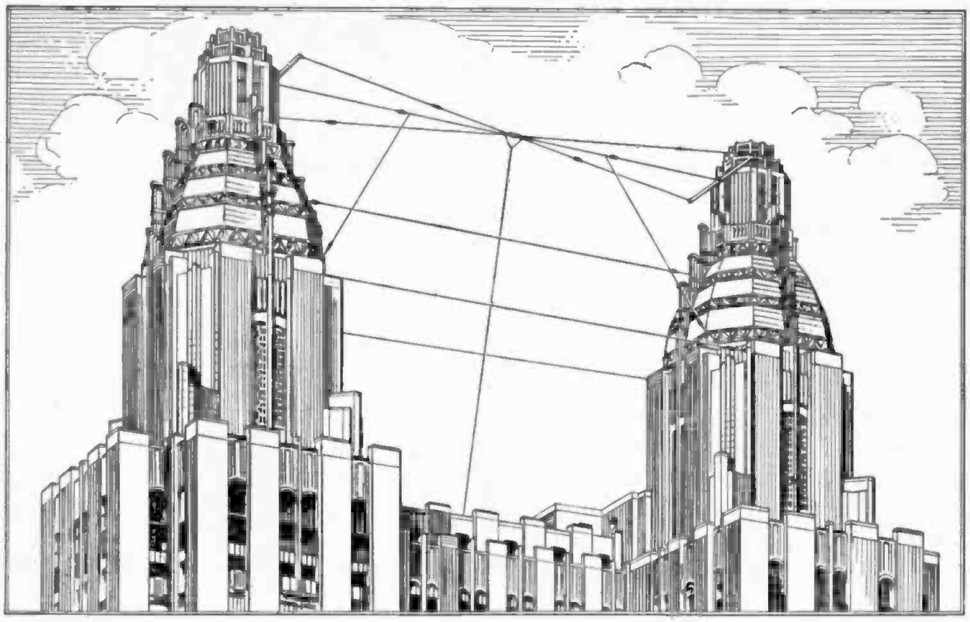
(Continued on Page 15)

Reproduced by courtesy "Electrical Communication," April, 1935.

Short Wave Programs for Waldorf Guests

By H. T. BUDENBOM

Member of Technical Staff, Bell Telephone Labs.



SINCE its opening some four years ago, the new Waldorf-Astoria Hotel has provided radio broadcast programs for its guests in over two thousand rooms. A horizontal antenna, suspended between towers forty-seven stories above the street, is connected to high-quality Western Electric receivers on the sixth floor, from which point the programs are distributed over a building-wide network developed by the Laboratories. Since the Waldorf enjoys an international reputation, and attracts many foreign guests, the management felt it would be desirable to make available to them radio programs broadcast on short waves from their own countries, in addition to our local broadcasts. Moreover, the increasing general interest in short-wave reception would make the availability of short-wave programs an attractive feature for American patrons. To receive such programs the Waldorf has now installed a Western Electric short-wave receiver which can be connected to any of the circuits of the present distributing system.

Most of the short-wave programs are broadcast at frequencies from 6 to 25 megacycles, corresponding to wave lengths from fifty down to twelve meters, and it was decided that the Western Electric 13A Radio Receiver would provide the best quality of signal and most general satisfaction over this range. This receiver was designed for various applications in the short-wave field, including aviation, point-to-point, and ship-to-shore. It was first applied to the Caribbean radio telephone project, as already described in our September, 1933 issue, but has since been widely used both at home and abroad. As shown in Figure 1, all the apparatus is housed in a seven-foot cabinet about twenty inches wide. The cabinet itself forms the back, sides, and top for a number of units, each of which has its own function and carries its own front panel. The scope of the receiver may be broadened, after purchase, by the addition of other units as desired.

Units available are three radio-frequency amplifiers, each with a different frequency range, an intermediate frequency amplifier, and an audio-frequency amplifier and power supply unit, as well as antenna tuning units, a patching panel, and an oscillator panel, which allows the set to be used for receiving telegraph signals. There is also available a panel, used chiefly for point-to-point communication, which may be employed to disable the receiver either when no carrier is being received or when the transmitter associated with the receiver is on the air. Of these various panels available, the installation at the Waldorf includes only the audio and intermediate-frequency amplifiers and the three radio-frequency amplifiers, which are sufficient for broadcast reception over the frequency range from 2.2 to 25 megacycles. Such an arrangement will permit them to receive not only all the short-wave broadcasts, but many police, aviation, and amateur radio-telephone channels as well.

The use of three separate radio-frequency amplifiers makes it much easier to tune in on a given station promptly. Depending on the time of day, a broadcast station may employ any of several frequencies. If it were desired to get a station which used either 6, 9, or 15 megacycles, for example, one amplifier could be tuned to 6 megacycles, one to 9,

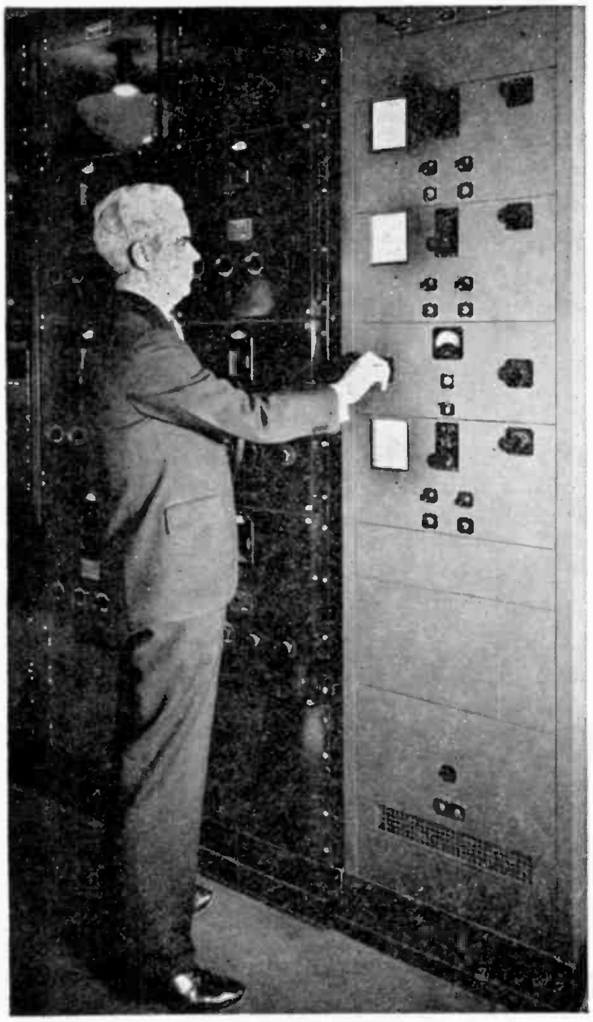


Fig. 1—H. R. Martin, Superintendent of Communication at the Waldorf, tunes the short-wave receiving unit

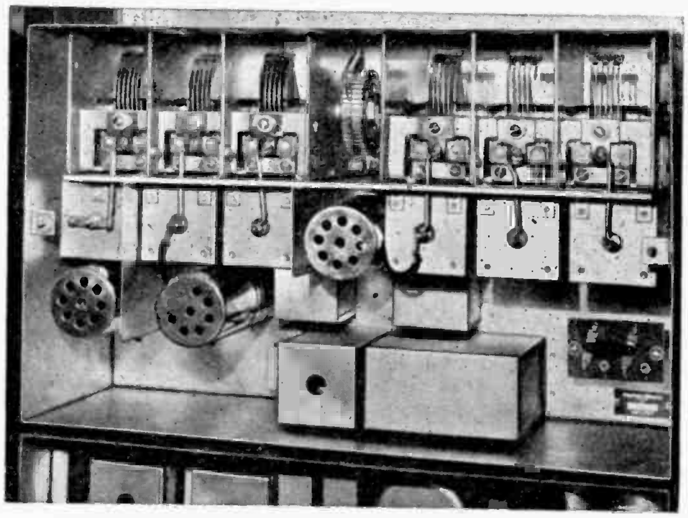


Fig. 2—The radio-frequency amplifiers incorporate accurate gang tuning through a worm drive with a double scale dial

and one to 15, and all three would be connected to the intermediate-frequency amplifier. If the station were on the air it would be immediately heard, and the two unnecessary amplifiers turned off. If it had not yet come on the air the operator would hear it the moment it did and would not lose the station announcement by having to tune successively to several frequencies.

The 13A Receiver is completely a-c. operated: the necessary transformers, rectifiers, and filters being incorporated in the voice-frequency amplifier unit. The signal gathered by the antenna first enters one of the radio-frequency amplifiers where it is amplified, passed through a series of selective circuits, and is then beat down to a frequency of 385 kc.—the frequency of the intermediate amplifier.* Here undesired frequencies are filtered out by sharply tuned circuits, further amplification is obtained, and the signal is detected. The resulting audio-frequency signal, which covers the band from 40 to 5000 cycles, is then further amplified in a suitable audio amplifier before distribution over the Waldorf system.

Outstanding features of this receiver are the high degree of selectivity, an electrical and mechanical design that insures dependable operation as well as high quality reception, and a sensitivity that permits good reception on signals as low as one microvolt. In the radio-frequency amplifiers there are five tuned circuits ahead of the modulator. These, together with the beating oscillator, are tuned by a six-gang condenser operated through a carefully constructed worm drive, shown in Figure 2, which gives very accurate selection. Frequencies separated less than one-tenth of one per cent may be readily tuned in. In the intermediate-frequency amplifier, Figure 5, there are eight additional tuned circuits. In this amplifier there is also a band-changing switch which, in the event of bad noise conditions, can be used to decrease the width of the audible frequency band and thus reduce the interference. Automatic gain control is provided, which is particularly important for short-wave reception, where the variation in signal strength with time may be considerable.

No matter how efficient a radio receiver may be, it must depend on the antenna to extract the maximum amount of energy from the arriving signal with the least amount of noise. Considerable attention was therefore given to the design of an antenna that would best secure these results, and at the same time would not mar the appearance of the building with tall ungainly structures. The multiple-doublet arrangement provided serves admirably to receive signals over a wide range of frequency and direction of arrival with a maximum of noise elimination.

When a horizontal wire is exposed to a high-frequency electro-magnetic field, it acts somewhat as a tuned circuit, and a current-measuring device placed at the mid-point would show maximum current when the length of the wire was approximately half the length of the radio wave. Such a wire differs in action from a tuned circuit, however, in responding not only to the fundamental frequency but to all odd multiples of this frequency. Thus a wire equal in extent to a half wave-length of a 3000 kilocycle signal, or 50 meters, would respond to frequencies of 3,000, 9,000, 15,000, and 21,000 kilocycles, and so on. If such a wire is broken at its mid-point and a tuned circuit or a transmission line leading to a tuned circuit is inserted, the resulting arrangement is known as a doublet. After the introduction of this associated circuit the tuning of the wire is only moderately sharp, and as a result it responds fairly well over a frequency range extending perhaps 20 per cent above and below the various frequencies corresponding to the length of the wire. By using several of these doublets, therefore, it is possible to secure good reception over a wide range of frequencies.

In the Waldorf installation, three such doublets are employed, having ap-

(Continued on Page 19)

Fig. 4—A great-circle chart of the world centered at New York. The paths of radio waves coming to New York are straight lines on this chart.

*Suppressor grid modulation is employed.

"In Baltimore"

By WM. D. KELLY

In Baltimore, vacations are the order of the day.

At WFBR:

Control Man Ruckert and Announcer Hickman have just returned from a trip to Bermuda. Neither will admit having felt the least bit seasick.

Stewart Kennard, that demon of Menos, has journeyed to Ocean City, Md. We all expect to hear some fine fish stories when Stewart gets home.

Eddie Stover has a nice mountain tour mapped out for his vacation.

Bill Kelly will journey down Norfolk and Virginia Beach way.

The Chief—Wm. Ranft—has just returned from his vacation down on the Maryland Eastern Shore and Ocean City, Md.

Carlton Nopper will celebrate his first year of married bliss down at Atlantic City.

The studios and transmitter shack of WFBR have been all fixed up with air conditioning equipment to keep the boys cooled off.

Clem Holloway promises himself a trip back home for his vacation. Norman O'Hearn is the Relief Engineer at WFBR again this year.

At WBAL:

W. J. Kelly spent his vacation down at Ocean City, Md.

Edward W. Shristhlif used his vacation days for a honeymoon. Good luck, fellow, and may the Sea of Matrimony be as smooth as those local pgms of WBAL.

Wm. C. Barham spent his vacation down on the Chesapeake Bay.

John Mutch says he expects to spend his vacation at Ocean City, Md., also.

Stafford Carson is a new man at WBAL, coming there in February.

Andrew Massy is the relief man on the WBAL staff.

At WCAO:

Martin Jones is going down Virginia way in his new Ford.

The Chief—James Schultz—whether to start work on his ham station or take a trip to New York City is the question.

Lynch has left WCAO and has gone down South to take a job with EAT.

Charlie Seibold made a trip to N. Y. C. to see the big time radio.

Sydney Basford is planning a very quiet vacation at home.

At WDBM:

Sammy Houston was married recently and used his vacation for a belated honeymoon trip to Norfolk and Virginia Beach. Happy landings, fellow, and may your new job run very much more smoothly than that Ford you used to drive.

August Eckles is planning a trip to the Middle West.

Frank Snyder, they say, is getting fat—maybe he'll spend his vacation reducing.

Ed Laker—a sound man—will journey out to Akron, Ohio.

George Porter Houston—the Chief—says that he expects to go to Ocean City, Md., for his time off.

WITH THE TECHNICAL EDITOR

Contributions to these columns are invited from readers. They should be concise and may deal with technical articles published in previous issues, or other subjects of some general interest and professional importance.

Statements made by writers do not necessarily carry the endorsement of this publication. Address all communications to the Technical Editor.

England's First Television Station

LONDON, England: The first television station in England, under the new British Broadcasting Corporation's high-definition system, is to be built immediately. The transmitter will be located in the Alexander Palace; this building is in the London sector.

Bids for transmitters have been tendered to the Baird Television Company (240 line type) and to the Marconi EMI Television Company (405 line type).

The British are now on the double to "beat" U. S. broadcasters to this television thing.

* * *

AT&T Television 12 Month (?) Away

By using a co-axial cable, see Electrical Engineering, October, 1934, the AT&T Company plan elaborate tests with the new cable which is capable of transmitting (according to the cable diameter) a frequency of 4000 kilocycles. The cable is useful for interlinking transmitters for chain visual broadcasts. At present, plans are being drawn and monies appropriated for constructing a line between New York City and Philadelphia. According to New York research experts, it is rumored that the project will cost over a half-million dollars.

In this country the ultimate destination of television will greatly depend upon the co-ordinated experiments of both the AT&T and RCA companies.

(Note: An article treating the more practical phases of transmission over coaxial cables will be published in this paper, if sufficient requests are received.) Tech. Ed.

* * *

Frequency Modulation

Major E. H. Armstrong, famous for regeneration, the superheterodyne, and super-regeneration, now startles the professional world with his latest development—"frequency modulation."

Briefly, the invention essentially consists of displacing the station frequency a certain number of cycles each side of the carrier. During frequency transitions the power output remains constant. (Compare this with amplitude modulation and note the differences required to obtain output.)

The practical utility of the Armstrong invention will be principally on the short waves, 10 meters and below. This is because the system requires a wide channel for normal operation. A total band-width of 200 kilocycles being required for 10 kilocycle high-fidelity frequency modulation.

One of the salient features of the development, which is contradictory to all accepted theory, is that the wider the band the better will be the signal to noise ratio. Usually receivers are made highly selective so as to admit only the desired signal, here is a system where just the opposite is true!

Conventional receivers cannot receive the frequency modulated signals, hence, an auxiliary device must be used to convert the received signal into an amplitude-modulated signal before demodulation is possible Push-pull radio frequency input stages operating each side of resonance are required for receiving the signal. The stages selectively amplify frequencies above and below the carrier; these are then combined in a circuit having linear frequency response, the output being demodulated in the conventional manner.

Further details on the Armstrong invention will appear in this journal as soon as released by the IRE. Until such time, the reader is referred to U. S. Pat. No. 1,941,069 and to "A Treatise on Frequency Modulation" published in the June issue of Communication and Broadcast Engineering.

* * *

Wanted: A Silent Tuning Aid

At present there is a trend toward incorporating auxiliary beat-frequency oscillators in broadcast receivers to obtain an audible beat-note signal for indicating and bringing to resonance strong or weak signals. While this method of tuning materially aids in resonating the receiver to the signal frequency, it has a number of disadvantages; some of these are enumerated below:

(1) Close manual adjustment and tedious concentration are required by the user who is generally unskilled in the manipulation of such devices.

(2) The beat-note whistle, which is a varying high-to-low pitched tone, is not only irksome but is also disagreeable to the ear.

(3) Exact or near-resonance tuning is largely accidental; the users of broadcast receivers are not as accurate in their tuning as many engineers would believe them to be. Witness, for example, that receivers equipped with tuning meters usually are tuned 200 to 500 cycles off resonance.

(4) At present beat-oscillators are provided with a cut-out switch to enable the user to silence the beat-note tone. This switch becomes a nuisance in tuning distant stations.

(5) It is practically impossible to leave the beat oscillator permanently connected in the circuit due to variations in the oscillator frequency caused by temperature, humidity, and supply voltage fluctuations.

To eliminate the disadvantages enumerated above involves the design of a circuit in which the beat-oscillator remains operative only until the resonance curve of the receiver is aligned or nearly aligned with the signal frequency. When this point is reached, the oscillator must automatically stop oscillating, and at the same time the amplifier channel in the receiver must be unblocked.

In designing the circuit, provision must be made for the operator to control the beat-frequency "band width" so that the receiver may be adjusted to tune; that is, to trigger the amplifier within 0 to 200 cycles off resonance. In this manner the receiver may be adjusted at one's discretion to respond to either narrow or broad resonance peaks. In addition to this refinement, the user should be able to switch "in" or "out" the BF oscillator at will.

It is requested that some of our inventive readers will offer suggestions toward the solution of this problem. Hints: See references in "Funkt. Monatsh (1934) No. 7, pp 259-63" and "Electronics, Feb. 1933, p-40."

* * *

"Mail Order" Education

Here is an excerpt from a letter that tells a complete story—the writer wishes to remain anonymous:

"Has it ever occurred to you by what means the purveyors of mind-training systems, no matter how superficial and metricious, achieve such a measure of success? It is simply owing to the fact that a man, when he has put down a substantial sum, is possessed by subconscious determination to avoid at all cost the humiliation of feeling that he has been such a nincompoop as to have thrown all that money down the drain. Accordingly, he applies himself for the first time in his life, and with grim determination, to the reform of his own mind. Under such circumstances, the pursuit of any system whatever is bound to meet with a certain measure of success."

* * *

Notes on Fixed Attenuation Networks

Since attenuation networks are composed of resistances, it is important that each resistive element employed in the various circuit branches be of certain design; that is, if stability and permanence of calibration are desired. The major factors dealing with the design of the resistive elements are:

(1) Each resistive winding must have a low temperature co-efficient over ambient room temperatures. This means that the resistance of each winding must not change appreciable over ordinary room heats.

(2) Each winding must be free of reactance effects and have a low or zero phase angle. In other words, the windings must be non-inductively wound.

(3) The resistance of each winding must be free from frequency variations between wide limits throughout the entire audio-frequency spectrum. If the elements have poor frequency characteristics, certain frequencies will be attenuated more than others. This effect is especially noticeable in the zones of the upper register.

(4) The impedance of the circuit elements must not vary with frequency else there will be an over-emphasis or loss of certain audio components during random levels of attenuation.

The above requirements have been principally given to show that a great deal of care must be taken in designing or selecting resistors for use in looser or impedance-matching networks. It is well to bear in mind, that it is almost impossible to satisfactorily pattern a fixed network with just "ordinary" or "cheap" resistors of inferior design.

A 13.5 to 550 Meter Receiver

THE R.M.10 Radio Receiver is a nine valve superheterodyne general purpose receiver designed for telegraphy and telephony. The range of 13.5 to 550 metres is covered by five sets of plug-in coils. The high frequency coils for each band are ganged on a single triangular unit and changed simultaneously. The large drum dial is calibrated directly in kilocycles for each of the five wave ranges.

The appropriate calibration track is automatically illuminated by insertion of a coil unit.

Rapid adjustment of tuning is done by turning the knurled rim of the drum dial, and fine adjustment by means of an anti-back lash worm drive. The reduction of the worm drive is sufficient to make band spread coils unnecessary.

A local beat-oscillator is provided for reception of C.W. telegraphy and a control for adjusting the pitch of the received note is also provided.

For conditions of extreme selectivity, an audio frequency filter panel passing a band of 900 to 1,100 p:s is available. To match the receiver to all types of antenna systems, an antenna impedance matching panel is provided. This supplementary panel adds an extra balanced tuned circuit which improves second channel selectivity and assists in duplex operation in addition to providing the correct matching impedance for all types of antennae. This device also considerably attenuates noise pick-up on the transmission line from a doublet antenna.

Further refinements are provided in a time lag control for the automatic voltage control permitting the choice of a long time lag in low speed telegraphy, or a short time lag in telephony or high speed telegraphy. The resonance meter is provided with a switch and multiplier to check high tension voltages. A crash limiting circuit is provided for headphone or loudspeaker operation.

The receiver can be supplied either with four sets of coils to cover 13.5—200 metres or with five sets to cover 13.5—550 metres.

The receiver illustrated, the first model of which was manufactured by Kolster-Brandes, Limited, Sidcup, covers the wave range of 13.5—200 metres. The units from top to bottom are:

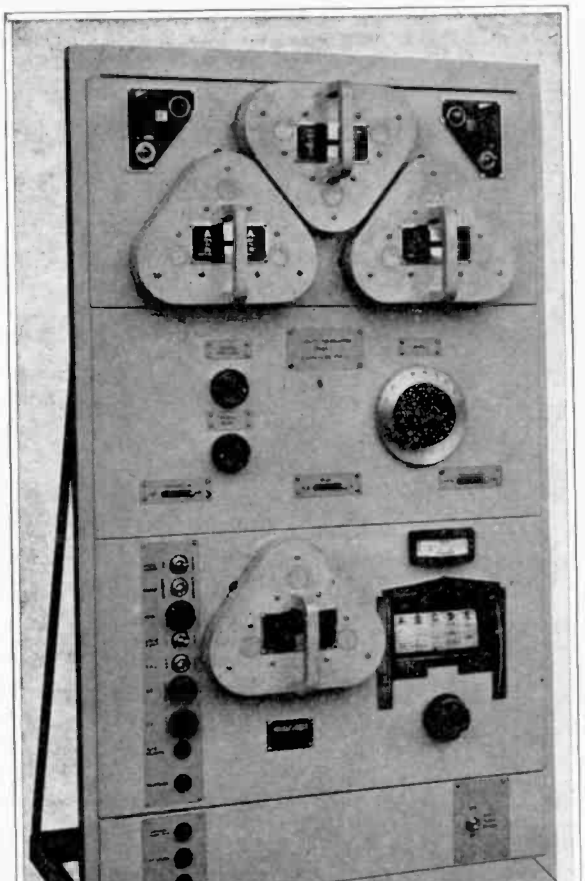
(1) Combined spare coil rack and power supply unit.

(2) Antenna matching panel.

(3) Receiver unit.

(4) 1,000 p:s note filter.

PX or position reporting kept the Pope Field, Fort Bragg, N. C., commerce station pretty busy recently during the seventh annual All American Air Races at Miami. PX traffic was January 9, 117; January 10, 177; January 11, 296; January 12, 135; January 13, 175; January 14, 202. Pretty heavy traffic we think.



Automatic Receiver for Distress Signals

(Continued from Page 10)

wireless receiver

(2) A similar box containing the signal selector device;

(3) Three alarm bells;

(4) An antenna change-over switch;

(5) Two individual power supply batteries and charging panel.

Wireless Receiver

The wireless receiver responds without readjustment to signals on wavelengths between 585 and 615 meters.

The circuit consists of a stage of high frequency amplification, a detector stage, a stage of low frequency amplification, and a low frequency detector.

The valves are of the indirectly heated type, the heater current being regulated by a ballast lamp which compensates a variation of battery between 22 and 26 volts, the normal voltage being 24 volts.

A relay connected in the plate circuit of the low frequency detector valve operates the selector device, whenever a radio signal of required frequency is received.

A safety relay is connected in the plate circuit of the second and third valves and operates the alarm bell circuit whenever the receiver ceases to work, either by reason of failure of a valve, or because of failure of the batteries. This relay otherwise has no direct action on the operation of the auto-alarm device.

A testing buzzer controlled by a push button key located in front of the receiver case is provided to test the working of the complete installation by local excitation.

A special non-locking key is also provided so that, when desired, the bridge alarm bell can be prevented from ringing when the alarm is being tested by local excitation. Release of this key automatically reestablishes the circuit of the bridge alarm bell.

The complete unit is enclosed in a watertight box which is so arranged as to be bulkhead or table mounted. The front of the box is hinged at the bottom. When it is open, the whole unit is readily accessible.

Signal Selector

The signal selector registers the genuine distress signals and rejects all other signals produced by transmitting stations or atmospheric interferences. It chiefly consists of:

(1) A bank of relays;

(2) A constant speed motor and reduction gear;

(3) A time measuring device.

The selector also contains a signal transmission device.

Relay Bank

The relay bank, composed of a mounting plate with an assembly of ten relays, is elastically mounted by means of rubber pads on another plate which in turn is hinged to a small support fastened to the rear part of the containing box. By swinging the hinged plate, easy access is obtained to the soldering lugs of the relays and to the cable form.

The ten relays are in three groups. The first is a group of counting relays which register three consecutive dashes of the distress signal. The second group of relays controls the resetting at zero position of the first time-measuring switch when signals other than distress signals are received. The third and last group of relays controls and blocks the alarm bell circuit after a correct distress signal has been registered. The alarm bell circuit can only be released by a non-locking push button key provided for this purpose on the front of the selector box.

Driving Motor

The driving motor is of the series wound type and is permanently rotating when the equipment is in operation. It is provided with a governor keeping the speed constant at 1,617 R.P.M. ± 2% and a reduction gear device which reduces the speed to 10.1 R.P.M. To give a signal when the motor speed falls below a given value, a special contact incorporated in the automatic governor controls an alarm-bell circuit.

Time Measuring Mechanism

The time measuring mechanism is composed of a small frame on which two special timing switches are mounted. In line with the timing switches and on the same frame, the signal transmission commutator is assembled. The two timing switches and the signal transmission commutator are driven by means of gears fixed on a driving shaft mounted on the frame by two self-aligning bearings. The whole unit is mounted in the selector box and coupled to the motor shaft by means of the reduction gear.

The first switch discriminates among the correct and incorrect received signal dashes and controls, by means of its different contacts, either the counting relays or the releasing and resetting relays.

The second switch verifies the maximum duration admissible for the correct consecutive signal dashes and intervals to be recorded.

For the transmission of alarm-signals, the permanently connected transmission commutator takes the place of the transmitting key and operates in conjunction with the ship's transmitting equipment. Alarm signals are automatically transmitted by the simple process of depressing a key mounted in front of the selector box. This operation can be executed whether the equipment is in the operating position or at rest. The simplicity of starting the alarm transmission is such that the ship is not entirely dependent on its operator in time of distress. It provides means for an abandoned ship to continue to send out the distress alarm signal, thereby increasing the chances of other ships locating her and the lifeboats by means of their direction finders.

Timing Switch

The timing switch consists of a small frame to which the following parts are assembled:

(a) A spindle on which are mounted a magnetic clutch with its driven gear, the contact brushes, the friction spring, and the main spiral resetting spring.

The driven gear attached to the clutch magnet is permanently in gear with the driving gear on the main shaft and consequently keeps the clutch magnet in continuous rotation.

The clutch armature is freely mounted on the spindle and rotates when attracted by the magnet. It drives, under the pressure of the friction spring, a plate to which the contact brush assembly is rivetted.

The pressure of the friction spring is adjusted by means of a nut which in turn is securely locked in position on the armature by means of three set screws. The main spiral resetting spring is located in a small housing hooked to the armature by means of a bayonet joint. One end of the spring is fastened to the spring housing and the other end to a hub fixed at the end of the spindle. When the clutch armature is attracted and rotates it carries the contact brush assembly with it and winds up the resetting spring.

(b) An insulated arc on which are assembled the metallic sectors upon which the contact brushes driven by the magnetic clutch make contact.

(c) A contact spring used as a feeder brush for the magnetic clutch.

The operation of the timing switches is as follows:

When the clutch magnet is energised by the relay controlled by the low frequency detector of the receiver, the clutch armature is attracted and starts rotating instantaneously with the constantly rotating magnet. The armature drives the contact brush assembly under the pressure of the friction spring and rotates it 90° or 185°, depending on whether the first or the second switch is involved. At the end of the movement, a special lug on the brush member butts against a stop provided on the frame and stops the rotation of the brush member. The contact brush assembly now slips, although the armature still rotates as long as the magnet is energised. When the clutch magnet is deenergised, it releases the armatures and brush member. These return to their initial position under the action of the resetting spring which has been wound up by the forward rotation of the brush member. The resetting movement of the armature and brush member is stopped when the lug on the brush member reaches the home position back-stop on the frame. There is no rebound as the brush member is kept against the back-stop by the inertia of the armature which, sliding on the brush member, continues to rotate for a short period. Due to this principle adopted in the design of the switch, the latter has the great advantage of starting rotation instantaneously when the magnet is energised and of returning to its correct home position without rebounding. The last point is particularly important since it is absolutely essential that, if the switch has to start almost instantaneously after having come back to its home position, it should really start from its home position and not from any other position of rebound, as in this case a wrong signal might be registered or a correct one rejected.

Alarm Bells

Three alarm bells are required by the statutory rules of the Merchant Shipping Act: One of these alarm bells is provided in the wireless telegraph room, one in the wireless operator's cabin, and one in the captain's quarters on the bridge. The latter can be prevented from ringing when the complete outfit is being tested by depressing the special key provided for this purpose on the receiver.

Antenna Change-Over Switch

A three-pole change-over switch is provided for changing over from normal reception to auto-alarm reception.

This switch is so connected that one pole transfers the ship's antenna from the normal receiver to the auto-alarm receiver. The two other poles control, respectively, the power supply for the receiver and relay circuit and the power supply for the motor.

Power Supply and Charging Panel

The power supply consists of a low tension battery of 24 volts, the current drain for the receiver and selector being approximately 2.5 amperes, and a high tension battery of 120 volts, the current drain for the receiver being approximately 0.025 ampere.

A spare low and high tension battery is furnished as a standby.

The charging panel is for operation from the ship's mains and includes all the necessary fuses, switches, and meters.

Operation

Before explaining in detail the operation, it is necessary to consider the various possibilities which may arise while the equipment is in service and ready to receive the distress signal.

The possibilities are as follows:

(1) First dash of correct duration;
(2) Second dash of correct duration;
(3) Third dash of correct duration;
(4) Dash of too short a duration;
(5) Dash of too long a duration;
(6) Spurious dashes of correct duration;
(7) Distress signals superimposed on other signals.

Possibilities (1), (2), and (3) correspond to the case of reception of a correct distress alarm signal not marred by any interference.

Possibilities (4), (5), and (6) correspond to the case of reception of a spurious signal mixed with interferences or atmospherics.

Possibility (7) corresponds to the case of reception of a correct distress alarm signal on which are superimposed other signals or atmospherics.

The general schematic of the A.A.2. auto-alarm is shown in circuit schematic. It is assumed that the receiver and selector mechanism have been switched on by throwing the antenna changeover switch to the operating position. The equipment is ready for operation after the short time necessary for the indirectly heated valves to be warmed up.

(1) *First Dash of Correct Duration.* When the first dash of a distress signal is received, the rectified current corresponding to this first dash energises relay Sr which pulls up and operates in turn the input relay Ar of the selector. The electromagnet of the first timing switch M1 is energised and the contact brushes N1 and N'1 start rotating. Contact brush N1 connects negative potential to the contact segment BC maintaining the contact on same during the time of rotation of arm N1 either way. The other brush N'1 leaves the home contact segment HC. After 3.5 seconds it reaches segment C4 and energises relay Kr1 which operates and through its front contact is placed in series with the winding of relay Lr1 which is short-circuited and therefore does not operate.

As it is assumed that the received dash is of the correct length, it will cease while the brush N'1 is still on segment C4 and before it reaches segment C5.

Segment C5 is located on the arc in such a position that the time brush reaches this contact after 4.5 seconds.

Relay Sr will release at the end of the dash, as will also relay Ar. The magnetic clutch M1 being deenergised, the brushes N1 and N'1 will return to their home position under the influence of the resetting spring.

As soon as the brush N'1 leaves the segment C4, relay Lr1 is no longer short-circuited. It becomes energised and causes the following operations,

(a) By means of its contact 2, it transfers segment C4 to the second group of counting relays Kr2 and Lr2 in order to allow the recording of the second dash, provided this dash be of correct duration.

(b) Through its contact 3, it energises the magnetic clutch M2 and the timing brush N2 starts rotating.

(2) *Second Dash of Correct Duration.* When a second dash of correct duration, succeeding a first correct signal, is received, the cycle of operations described above will again take place, but instead of energising relay Kr1, the brush N'1 now energises relay Kr2.

When the second signal ceases, the time-arm N'1 leaves the segment C4, and relay Kr2 locks up in series with the winding of Lr2 which operates.

By means of the front contact of relay Lr2, segment C4 is now connected to the third group of counting relays Kr3 and Lr3 and the circuit is ready for the recording of a third dash of correct duration.

(3) *Third Dash of Correct Duration.* When a third dash of correct duration is received, the same sequence of operations will be repeated as previously described for the first and second dashes but now the brush N'1 will energise, through segment C4, relay Kr3 which locks up in series with the winding of relay Lr3 as soon as the signal has ceased, that is to say, when brush arm N'1 leaves segment C4. Relay Lr3 then operates, closing its front contact 2.

When the brush arm N'1 has returned to its home position, the alarm bell circuit is established. At the same time relay Hr operates and locks up over its own contact, maintaining the alarm-bells operated.

It should be noticed that 12.4 seconds after the recording of the first dash of correct duration, the brush arm N2 makes contact with segment C13, thus energising relay Gr which operates. The back contact 2 of relay Gr breaks. This opens the feeding circuit of counting relays Lr1 to Lr3 and Kr1 to Kr3 and all these relays come to rest. The magnetic clutch M2 is no longer energised and the brush arm N2 returns to its home position by means of the resetting spring. The selector is now ready to record other alarm signals.

Should still another correct distress signal be received, the circuit operates as before, but the alarm bell circuit itself remains independently closed. To stop the alarm bells from ringing it is necessary to depress key RK which opens the alarm bell circuit and the locking circuit of Hr.

(4) *Dash of Too Short a Duration.* Any signal having a wavelength between 585 and 615 metres will energise relays Sr and Ar and consequently the magnetic clutch M1.

As the duration of the signal is below 3.5 seconds, the brush-arm N'1 cannot reach segment C4 before the termination of the signal. When the signal ceases, the brush arm N'1 returns to its home position.

As soon as the signal has ceased, relay Ar is deenergised and closes its back contact 2, causing relay Er to energise and lock up through its front contact 1. At the same time, the back contact 2 of relay Er breaks and opens the feeding circuit of magnetic clutch M1.

(5) *Dash of Too Long a Duration.* The rectified current generated by the incoming signal having energised relays Sr and Ar and the electromagnet M1, the time brushes N1 and N'1 start rotating as if a correct signal had been received.

After 3.5 seconds, contact arm N'1 reaches segment C4 and energises relay Kr (1, 2 or 3) which operates and thru its front contact is placed in series with the winding of its associated relay Lr (1, 2 or 3). Relay Lr does not operate as its winding is short-circuited. As we assume the dash to be of a too long duration, the brush N'1 will continue to rotate, and will pass on to segment C5, causing relay Gr to be energised and the following operation takes place:

(a) The opening of the back contact 2 of relay Gr causes the feeding circuit of the counting relays to be broken, and so annuls the signals which may already be recorded. Relay Lr1 is deenergised and its contact 3 opens, thus deenergising the magnet-clutch M2. The timing brush N2 stops rotating and returns to its home position.

(b) By the closing of the front contact 1 of relay Gr the latter locks itself.

When the signal ceases, the magnet clutch M1 is deenergised and the brushes N1 and N'1 return to their home position. As long as brush N1 is in contact with segment BC, the relay Er remains locked and prevents the recording of the signal during the passage of brush N'1 over segment C4.

Relay Er will release and bring back the magnetic clutch circuit to normal only when brush arm N1 has left segment BC and has returned to its home position. In this way, if another signal is received during the return to its home position of timing switch M1, this signal will be without effect.

(6) *Spurious Dashes of Correct Duration.* Due to the superimposing of several radio signals and also due to atmospheric interference, it may happen that relay Sr in the receiver remains energised during a duration of time corresponding exactly to the duration of a dash originated by a distress signal.

In this case, the selector will operate in a similar way as when a firsh dash of correct duration is received. Counting relays Kr1 and Lr1 will lock up and the time brush N2 will start rotatng.

If the signals following are of too short a duration, the operation of the selector will be the same as in the case of a received signal of too short a duration.

Here again it should be noted that 12.4 seconds after the recording of the correct signal, the time brush N2 will come

Total Operating Revenues of Different Radio-Telegraph Concerns

Year, 1935	Jan.	Feb.	Mar.	Apr.
Central Radio Telegraph Co.			$43.11	$260.48
Globe Wireless, Ltd.	$25,296.49	$26,437.86	30,252.41	28,519.72
Mackay Radio & Tel. (Cal.)	79.026.08	74,982.47	83,119.94	87,174.86
Mackay Radio & Tel. (Del.)	65.006.73	59,227.59	65,862.15	66,857.78
Magnolia Radio Corp.	209.10	251.30	212.40	191.68
Mutual Tel. Co. (Wireless)	4,235.25	3,902.61	4,073.11	4,207.09
Olympic Radio Co.		174.57	174.96	175.93
Pere Marquett Radio Corp.	788.48	734.52	677.94	1,145.94
RCA Communications, Inc.	353,398.11	310,271.41	345,986.89	333,603.09
Radiomarine Corp. of Amer.	71,069.38	70,947.00	75,984.34	76,065.88
Tidewater Wireless Tel. Co.	367.55	380.10	501.27	322.36
Tropical Radio Telegraph Co.	71,776.53	45,717.31	58,048.63	57,433.14
U. S.-Liberia Radio Corp.	4,925.94	5,762.33	5,406.50	5,006.11
Wabash Radio Corp.	957.37	995.08	1,264.70	1,030.68

into contact with segment C13, annulling the previous recording. If the signals following are of too long a duration, the selector will operate as in the case of a received signal of too long a duration and the selector will be brought back to its normal position.

If a second dash of correct duration takes place during the time interval of 12.4 seconds following a first correct dash, it will be recorded as a second dash of correct duration.

In order that the selector may operate the alarm bells, it is necessary that a third spurious dash of correct duration be produced before the brush arm N2 reaches segment C13. The probability of such a happening is very remote indeed.

(7) *Distress Signals Superimposed on Other Signals.* Simultaneously with the distress signal, other signals may be received with the following result:

(1) The duration of the dashes may be lengthened in a proportion rather difficult to determine exactly. Practice has shown, however, that this lengthening in most cases is of the order of 0.5 second maximum.

(2) The intervals between consecutive dashes may be filled by spurious signals of short duration, even to the point of completely disappearing, thus preventing any accurate determination of the duration of intervals between the dashes.

Under these conditions, the received signal corresponds to:

(a) Three dashes having a duration not exceeding 4.5 seconds each. In this case, the selector will work as explained above for a correct sequence of signal dashes. If a signal due to interference is received during the interval of time separating two consecutive dashes, the selector will function as for a dash of too short a duration.

(b) Normal dashes mixed with dashes of too long a duration. In this case, the normal dashes are recorded. Too long a dash succeeding one or two correct dashes will annul the previous recording and the selector will start again to record new signals.

As has been previously stated, the "automatic distress signal" consists of twelve dashes sent out in one minute and, provided that the receiver can detect out of the twelve, three consecutive dashes of correct duration, the selector will record them and cause the alarm device to operate.

Results of Practical Tests

The type A.A.2.B. equipment as described above was submitted for approval to the General Post Office of Great Britain, which carried out the following trial tests:

(a) The complete outfit was installed in a small building along one of the quais at Ramsgate, situated at the northern entrance of the Dover Straits. At this particular spot, the interference from numerous ships and coastal transmitting stations is exceedingly heavy.

(b) The receiver was locally excited by an oscillator operating on a wavelength between 585 and 615 metres, and "distress signals" were keyed by a Weston transmitter. Eleven different combinations of signals, taking into consideration the different tolerances on the duration of the dashes and the intervals, were sent out. Each combination was repeated ten consecutive times. Under these conditions, there were no failures in the operation of the auto-alarm.

(c) According to the Board of Trade's Statutory Rules and Orders, 1932, No. 897, the equipment when installed in an area of intense interference for a continuous period of six weeks, must not give more than two false calls in any week, while on the other hand, it must respond to 90 per cent. of test calls.

For these tests, the receiver was connected to an antenna and the "distress signal" received consisted of twelve dashes of 4 seconds separated by intervals of one second, the transmission of the signals being made at random intervals.

During these tests, lasting for two months, there were only eight failures to respond to the test calls out of a total of 700, although the test condition allowed 70 such failures.

Although the "distress signal" was transmitted only during certain periods, the equipment was permanently in service and was subjected to the action of atmospherics and signals other than alarm signals. Not more than the prescribed two false calls in any one week were recorded during the testing period.

(d) During the test, the equipment was placed in an oven as required by the Board of Trade Rules, and raised to a temperature of 113° F. for two hours on every third day for four weeks. The efficiency of the equipment was maintained during the operation of this test.

In addition to the foregoing, the equipment was also subjected to another severe test, which may be called the "bumping test." The apparatus was mounted on a platform which was capable of being rocked about, and of being dropped vertically through a distance of three inches every seven seconds. This rough treatment, continued for one hour a day for four weeks, did not affect the efficiency of the apparatus, or its ability to function satisfactorily during the actual periods of "bumping."

As a result of the above mentioned trial tests, the equipment was approved by the General Post Office of Great Britain for installation on board of all compulsorily fitted ships.

AIRWAY NEWS

RUMOR has it that Tom Wollon is looking for another place to live.—The operator in charge at Nashville Airway Radio and Range Station has been holding his ear to the ground and it is believed that he is expecting to be ordered to Sky Harbor.—This will mean selling or renting his home and moving his family (wife and two pretty girls). —The present indications are that the Donelson station will be remotely controlled from Sky Harbor and that some of the present personnel will be released to other stations.—Sky Harbor is 25 miles from Nashville but is extremely inconvenient to operate the Department of Commerce Weather Bureau at Sky Harbor and have the radio personnel all located some eighteen miles away at Donelson.—The Bureau has started several times to build better radio facilities at Sky Harbor but Nashville's latest action and sentiment in regard to building herself an airport that was closer in is probably the cause of the Air Commerce Bureau holding back with its Combined Range and Broadcast Station for Sky Harbor.

* * *

Charley Goldtrap, America Air Lines acting Flight Superintendent, is a firm believer in radio facilities and he knows how to use them, too.—He is blind landing and beam flying instructor for transport pilots and can land and take off with a covered cockpit.—Charley has one of the finest note books giving comprehensive sketches of each airport and the radio facilities available there that your correspondent has ever seen compiled.

* * *

The Second Air Navigation Division District Headquarters, Atlanta, Ga., has had a new assistant manager appointed to take the place of Mr. VanderWater, now in the First District. The new assistant for Mr. Irl H. Polk is Mr. R. C. Copeland, and he is said to be a nephew of Senator Copeland.

Only two other stations in the entire country use the same letters of the alphabet as does KROW of Oakland and San Francisco. They are WORK at York, Penna., and WROK at Rockford, Ill.

RADIO OPERATORS WIN A RISE IN PAY

Arbitrator Sets Up a Scale Based on $155 a Month for Chiefs of Class A Ships

UNION IS RECOGNIZED

Working Day Is Reduced to 8 Hours—Attitude of Both Sides Is Praised

A NEW wage schedule providing $155 a month for the chief operator on Class A ships, an increase of $45 over previous rates, and the reduction of working hours from 12 to 8 a day are included in the findings of Ben Golden, associate director for the Regional Labor Board, who was recently named arbitrator in the controversy between the International Mercantile Marine Company and the American Radio Telegraphists Association, Inc. In a decision handed down yesterday afternoon Mr. Golden further ordered the steamship company to recognize the union.

The appointment of Mr. Golden as arbitrator followed the unexpected strike of three radio operators which held the Manhattan at her pier for five and a half hours after her sailing time on June 19. At the end of that strike P. A. S. Franklin, president of the I. M. M., made a tentative agreement on wages and hours pending a final decision by Mr. Golden, who was selected by both sides as arbitrator.

The $155-per-month salary for chief operators ordered by Mr. Golden is $30 below the maximum wage schedule of $185 agreed to by Mr. Franklin in his negotiation with the strikers on the pier of the Manhattan. Likewise, Mr. Golden's order for a $140 monthly pay for the first assistant is $45 above the previous schedule but is $35 below the $175-a-month agreement which the strikers were able to extract from Mr. Franklin.

In a statement accompanying his decision, the arbitrator praised the cooperation shown him both by the radio operators and the steamship company.

"Your cooperator has found that the company has recognized the spirit of the times and is willing to grant the men their rights of bargaining collectively through an agency of their own choosing," the statement read. "The policy laid down by the United States Government, as evidenced by the Wagner Labor Disputes Bill, has been strictly followed by the company.

"Your arbitrator further feels that the association of radio operators has shown itself to be genuinely interested in bettering the laboring conditions of its members, and that it has shown an understanding and appreciation of the problems of the steamship company. The association has secured for its members both a substantial increase in wages and a reduction in working hours.

"The intelligent cooperation on both sides will go far to avert unnecessary industrial strife."

The decision also calls for a continuous vacation of three weeks with pay for each radio officer for each three-year period. In the past, radio operators received no vacations.

Roy A. Pyle, vice president of the American Radio Telegraphists Association, called the decision "fair and satisfactory." While the decision of the arbitrator does not establish working conditions as good as those now existing on the Pacific coast, it does mark a "no-

(Continued on Page 21)

Experimental Visual Broadcast Stations in the United States

Call Letters	Power (watts)	Company	Location
		2000-2100 kilocycles	
W2XDR	500	Radio Pictures, Inc.	Long Island City, N. Y.
W8XAN	100	Sparks-Withington Co.	Jackson, Mich.
W9XK	50	University of Iowa	Iowa City, Ia.
W9XAK	125	Kansas State College of Agriculture and Applied Science	Manhattan, Kan.
W6XAH	1000	Pioneer Mercantile Company	Bakersfield, Calif.
		2750-2850 kilocycles	
W3XAK	5000	National Broadcasting Co.	Portable
W9XAP	2500	National Broadcasting Co.	Chicago, Ill.
W2XBS	5000	National Broadcasting Co.	Bellmore, N. Y.
W9XAL	500	First National Television Corp.	Kansas City, Mo.
W9XG	1500	Purdue University	West Lafayette, Ind.
W2XAB	500	Atlantic Broadcasting Corp.	New York, N. Y.
		42000-56000, 60000-86000 kilocycles	
W2XAX	50	Atlantic Broadcasting Corp.	New York, N. Y.
W6XAO	150	Don Lee Broadcasting System	Los Angeles, Calif.
W9XAL	150	First National Television Corp.	Kansas City, Mo.
W1XG	500	General Television Corp.	Boston, Mass.
W9XD	500	The Journal Company	Milwaukee, Wis.
W2XBT	750	National Broadcasting Co.	Portable
W2XF	5000	National Broadcasting Co.	New York, N. Y.
W3XE	1500	Philadelphia Storage Battery Co.	Philadelphia, Penna.
W3XAD	2000 & 30000	RCA Manufacturing Co., Inc.	Camden, N. J.
W1OXX	50	RCA Manufacturing Co., Inc.	Portable-mobile (vicinity of Camden)
W2XDR	1000	Radio Pictures	Long Island City, N. Y.
W8XAN	100	Sparks-Withington Company	Jackson, Mich.
W9XK	100	University of Iowa	Iowa City, Ia.
W9XAT	500	Dr. George W. Young	Portable

Relay Broadcast Stations in the United States

Frequency kc	Power kw	Call Letters	Company	Location
6040	5	W1XAL	World Wide Broadcasting Corp.	Boston, Mass.
6040	2.5	W4XB	Isle of Dreams Broadcasting Corp.	Miami Beach, Fla.
6060	1	W3XAU	WCAU Broadcasting Co.	Newtown Square, Penna.
6060	10	W8XAL	The Crosley Radio Corp.	Mason, Ohio.
6080	.5	W9XAA	Chicago Federation of Labor	Chicago, Ill.
6100	35	W3XAL	National Broadcasting Co. Inc.	Bound Brook, N. J.
6100	10	W9XF	National Broadcasting Co. Inc.	Downer's Grove, Ill.
6120	5	W2XE	Atlantic Broadcasting Corp.	Wayne, N. J.
6140	40	W8XK	Westinghouse Elec. & Mfg. Co.	Nr. Saxonburg, Penna.
9530	40	W2XAF	General Electric Company	So. Schenectady, N. Y.
9570	40	W8XK	Westinghouse Elec. & Mfg. Co.	Nr. Saxonburg, Penna.
9570	10	W1XK	Westinghouse Elec. & Mfg. Co.	Millis, Mass.
9590	1	W3XAU	WCAU Broadcasting Co.	Newtown Square, Penna.
11790	5	W1XAL	World Wide Broadcasting Corp.	Boston, Mass.
11830	5	W2XE	Atlantic Broadcasting Corp.	Wayne, N. J.
11830	.5	W9XAA	Chicago Federation of Labor	Chicago, Ill.
11870	40	W8XK	Westinghouse Elec. & Mfg. Co.	Nr. Saxonburg, Penna.
15210	40	W8XK	Westinghouse Elec. & Mfg. Co.	Nr. Saxonburg, Penna.
15250	5	W1XAL	World Wide Broadcasting Corp.	Boston, Mass.
15270	5	W2XE	Atlantic Broadcasting Corp.	Wayne, N. J.
15330	25	W2XAD	General Electric Co.	So. Schenectady, N. Y.
17780	40	W8XK	Westinghouse Elec. & Mfg. Co.	Nr. Saxonburg, Penna.
17780	35	W3XAL	National Broadcasting Co. Inc.	Bound Brook, N. J.
17780	.5	W9XAA	Chicago Federation of Labor	Chicago, Ill.
17780	10	W9XF	National Broadcasting Co. Inc.	Downer's Grove, Ill.
21460	5	W1XAL	World Wide Broadcasting Corp.	Boston, Mass.
21540	40	W8XK	Westinghouse Elec. & Mfg. Co.	Nr. Saxonburg, Penna.

ASSIGNMENTS

Radio officers assigned Mackay Radio, New York:

Yorba Linda—T. J. Burns
Shawnee—P. B. Kimball (Jr.)
San Jacinto—E. H. Cole (Chief)
Black Osprey—R. C Horscroft
Manhattan—F. W. Kent (4th)
Manhattan—W. E. Smith (5th)
Thos. P. Beal—J. J. Bamberg
Sage Brush—A. Adamson
Cherokee—T. J Cain (Jr.)
W. R Keever—C. R. Hamilton
Scanpenn—H. Weinstein (Chief)
Edouard Jeramec—H. McGoldrick (Ch.)
Edouard Jeramec—M. Gardiner (2nd)
Edouard Jeramec—R. C. Williams (3rd)
City of Fairbury—W. R. Weber
Shawnee—A. Sopko (Jr.)

Short Wave Programs for Waldorf Guests

(Continued from Page 12)

proximate lengths of 12.5, 25, and 50 meters, arranged as shown in the illustration at the head of this article. This arrangement permits reception of all frequencies from 2200 to 25,000 kilocycles except for a slightly lower response over the narrow range 3600 to 4800 kilocycles. This low frequency range is extended and re-enforced, however, by using the vertical lead-in wire from the horizontal doublets as a vertical antenna. Such an arrangement, with the lower end of the vertical antenna connected to ground through the coupling transformer, acts as a vertical doublet with its lower half buried in the ground, and responds to odd multiples of wave-lengths of four times its length. By suitable "loading" the effective length of this vertical section may be considerably modified and, as arranged at the Waldorf, the vertical section of about 100 feet which is "loaded" by the doublets responds to frequencies of 800, 2400, 4000, 5600 kilocycles, etc. By design, however, the response of this vertical section to frequencies above 6000 kilocycles is progressively nullified in the special coupling transformer to the radio-receiver transmission line.

The manner of covering the wide frequency range by these horizontal doublets and the vertical half doublet is indicated in Figure 3. Here the odd-multiple response frequencies of the various antennas are indicated by the vertical lines, while the horizontal lines indicate the frequency range brought in, allowing a 20 per cent spread on each side of the multiple frequencies. The vertical lead-in consists of two wires twisted together —one wire being connected to each half of the horizontal doublets. The current from the horizontal antennas comes down one of these wires and up the other, thus traversing the vertical section in both directions. The current induced in the vertical section, however, travels in the same direction in both conductors. The special transformer at the foot of the vertical lead allows both of these currents to be fed to the radio apparatus, but shuts off the higher frequencies from the vertical part of the antenna.

Most transmitting antennas are effectively vertical rods, and the waves they emit are vertically polarized—providing the greatest effects on vertical receiving antennas. In traveling great distances, however, these waves undergo a series of reflections between the earth and the ionized regions of the upper atmosphere. By this multiple reflection their vertical polarization is changed to an elliptical polarization, with the result that they may produce even greater effects on a horizontal antenna than on a vertical one. For this reason the horizontal structure used at the Waldorf is very sensitive to waves coming from remote points, where because of the great distances involved the greatest sensitivity in reception is required. This form of antenna will also minimize interference by nearby stations, the waves of which are vertically polarized. It happens, moreover, that the waves from most man-made sources of interference affect a horizontal doublet much less than a vertical antenna. Most of this form of interference is at the higher frequencies and thus does not prove objectionable over the range from 2000 to 6000 kilocycles where the vertical section of the antenna becomes effective. Stations operating at these lower frequencies are for the most part local, representing mainly police, aviation, and amateur radio telephone channels. These waves retain sufficient of the vertically polarized component to be readily picked up by the vertical antenna.

Fig. 5—In the intermediate-frequency amplifier, shown undergoing inspection by F. Stevens, Radio Technician of the Waldorf, the power of the signal is increased a hundred thousand million fold

This multiple antenna system is thus highly suited to picking up high-frequency signals coming from great distances and lower frequency signals from near-by stations, both with a large signal-to-noise ratio compared to vertical receiving antennas. The effectiveness of the antenna is further enhanced, however, by taking advantage of the directional characteristics of a horizontal doublet. Greatest sensitivity is obtained for waves arriving in a direction at right angles to the doublet. In Figure 4 is a map of the world in gnomonic projection centered at New York. The distinguishing feature of such a scheme of projection is that a line joining New York and any part of the world lies in the true direction over which radio waves would travel. The horizontal antenna system of the Waldorf—considerably enlarged in scale—is superimposed on this map at New York, and it is at once evident that waves from most of the international broadcast stations would reach the antenna from a favorable direction. The end-on directions of the antenna are toward the South Atlantic and North Pacific oceans where there are practically no stations, but even end-on, the antennas have some response because the short-wave signals arrive at a slight angle above the horizontal.

With these facilities the Waldorf is now in a position to offer its patrons short wave radio broadcast programs of a high order of merit. Short-wave stations in London and Daventry, England, in Paris, France, in Madrid, Spain, in Koenigswusterhausen, Berlin, Germany, at Rome and in the Vatican, can be as readily heard as local broadcast stations under favorable conditions. Even the short-wave stations in remote locations such as Moscow, Tokyo, Rabat in Morocco, Melbourne in Australia, and the various South American stations will at times be available for instruction and amusement.

An Efficient Marine Transmitter

THE International Marine Radio Company's type M. 100.D. radio transmitter provides facilities for C.W. and I.C.W. telegraphy on the medium and short wave ship-to-shore bands.

The installation possesses several features which have not hitherto been incorporated in a ship's radio equipment. The short wave transmitter, for example, has been specially designed to meet the high standard of frequency stability now called for by the Regulations of the International Radio Telegraph Convention. In addition to its wide range it is notable for two special features, viz., master oscillator control over the whole wave band and crystal control on any two selected spot waves. These features not only ensure that its operation meets international requirements but also that communication is maintained at maximum efficiency on the medium wave band.

Particular attention has been given to the requirements of safety to life at sea, an automatic sending key being supplied with the equipment which, in the event of distress, enables the operator to send out the alarm signal without hand manipulation, thereby leaving him free to attend to other important matters at such a critical moment. At the same time the mechanical accuracy of this transmission ensures the reception of the alarm signal by the auto alarm apparatus installed on other ships in the vicinity.

The wavelength range and power consumption of this equipment are:

Wavelength Range: 22.4-24.4 and 33.7-36.6 metres, 550 to 850 metres.

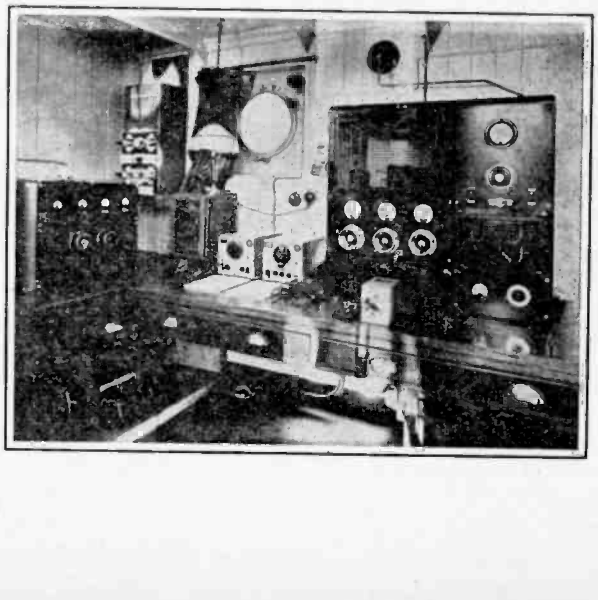
Power consumption from Mains: 1.9 kw.

Power Consumption from Batteries (Emergency): 300 watts.

The equipment has been approved by the British Board of Trade and the British Post Office as meeting all the requirements of the Safety of Life at Sea and International Radio-telegraph Regulations.

The following is an extract from the *Nautical Magazine*, describing the excellent results obtained by the Anglo-Saxon Petroleum Company with this type of equipment, which has been installed as part of the radio equipment on their most recently commissioned tankers.

"The four 12,000 ton tankers built in Great Britain for the Anglo-Saxon Petroleum Co., have all passed into commission after very successful trials. All these vessels had a speed of 13 knots in loaded trim. They are fitted with all the latest appliances including the new short and medium wave wireless equipment supplied by the International Marine Radio Co. of London. The first ship *Ancylus* while on trials off the Tyne called up an American station which reported the reception was excellent. The second vessel *Acavus*, while on trials in Belfast Lough, called up and spoke to her sister ship the *Ancylus* which was then over 3,000 miles away and nearing the West Indies. Again the sending and reception from both ships were excellent. *Acavus* communicated with the short wave station at Portishead every other day during her voyage to Curacao and was then ordered through the Panama Canal to San Pedro. It then became a real test, for while in the Pacific and right up to the day before arrival at San Pedro, she was in direct communication with Portishead, a distance of 5,400 miles. The direct line to ship's position was across the Atlantic and right across the United States. The last two ships, *Anadara* and *Amastra*, while on trials at the entrance to the Firth of Clyde, were both in communication with the *Ancylus* which was then 2,000 miles out in her voyage to the West Indies. These results will astonish the average shipowner and seafaring man because we have imagined up to the present that the range of an ordinary wireless as fitted in our ships was 500 to 700 miles at the utmost. But what has been a dream has now come true, and this new direct service with Portishead as the receiving station for Great Britain is in full operation. What has been the privilege of the big liners up to the present is now open to the Mercantile Marine as a whole. This new development has only been made possible by the introduction by the International Marine Radio Co. of their new crystal control short wave. It was introduced for the first time on a cargo boat or tanker on the *Ancylus*, this crystal control having hitherto been exclusively confined to large passenger vessels. Instead of waiting days for a reply to a message sent, while it was being relayed by other vessels, the direct communication now offered enables a reply to be received the same night of the next day. Then again these ships are acting as wireless transmitting stations sending messages from other vessels which have only medium wave equipment. This is indeed a great stride ahead and shipowners will be quick to see its advantages."



NIKOLA TESLA NOW 79

On July 10, 1935, Nikola Tesla, well known member of the scientific world celebrated his seventy-ninth birthday. Tesla, as is usual on his birthday celebrations called attention to several of his "pet" developments. Listing them himself, he believed would come to be his greatest development, the one by which mechanical energy can be transmitted to any part of the terrestrial globe. Those who have followed Tesla's thoughts for many years will be familiar with the many plans he has worked on for this.

Second, he placed a new method and apparatus for producing direct current without a commutator. He said he has found a solution to this problem, but details were not made public.

New Orleans Airway Radio Station on Ancient Graveyard

During the last two months the FERA and Tulane University have been undertaking excavations in the marsh land along the banks of Lake Pontchartrain and have discovered some extremely interesting material in the old shell banks near Hayne Blvd. and the road from Shushan Airport along the lake front.

Several skeletons were removed from the shell right under the loops of the New Orleans Radio Range Station and Indian pottery, beads, arrowheads, and other relics and remains are constantly being unearthed. The skeletons are believed to be those of Indians and while the Smithsonian and Tulane experts have not made a complete study as yet, it is thought that the graves are very old, probably pre-Columbian.

At the present time many of the bones and skulls are lying on the ground as they were first uncovered preparatory to being photographed and it is a rather gruesome and ghostly sight to see these old boys grinning at one with their empty eye sockets staring so intently. These skulls show wonderful teeth almost without exception.

Gov't Price for Communication

On June 27, 1935, the Federal Communication Commission, in Order No. 15, sheet 13,518, issued a lengthy order covering "Rates of Pay for Government Communication by Telegraph." Those interested may secure copies by writing the Secretary of the Commission.

MULTIVIBRATORS

(Continued from Page 9)

divide into 1; this gives the *time constant* in seconds.

(2) Divide the *time constant* by the SUM of the condensers in micro-farads; the result gives the value of each grid leak resistor in ohms.

ILLUSTRATION: Given a frequency of 50 KC/sec. and two 500 uufd. condensers. Find the value of the grid leak resistors to obtain the given frequency.

SOLUTION:

$$(1)\ \frac{1}{50{,}000} = .00002 \text{ or } 2 \times 10^{-5} \text{ seconds}$$

$$(2)\ \frac{2 \times 10^{-5}}{(5 \times 10^{-10}) + (5 \times 10^{-10})} = \frac{2 \times 10^{-5}}{10^{-9}}$$

= 20,000 ohms per grid leak resistor

Producing Sinusoidal Oscillations in a Symmetrical Circuit

In an engineering paper by Y. Watannabe[7] (Japan), it was shown that sinusoidal oscillations could be produced in a symmetrical multivibrator if capacities Cx and Cy were shunted across the plate resistors in the respective circuits. Mr. Watannabe says, "If the shunted capacities Cx and Cy has some given value, sinusoidal oscillations could be produced under the following conditions:

$$G_m = \frac{1}{R_p} + \frac{1}{R_1} + \frac{1}{R_2}\left(1 + \frac{Cx}{Cy}\right)$$

Where G_m and R_p are respectively the mutual conductance and the plate resistance. The angular velocity of the vector representing the sinusoidal oscillation is

$$w^2 = \frac{1}{R_1C_2} \cdot \frac{1}{Cx}\left(\frac{1}{R_p} + \frac{1}{r_1}\right)$$

When the system is arranged to function as a producer of sinusoidal oscillations, the operating condition of each tube must be adjusted to give the maximum value of mutual conductance; that is, the point of equilibrium with respect to the direct current must be nearly in the middle of the characteristic curve. It is an interesting fact that one can produce either sinusoidal or relaxation oscillations by means of a two-tube symmetrical multivibrator by simply varying one of the anode capacities over a certain setting."

(To be continued)

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7 See loc. cit. No. 6.

RADIO OPERATORS WIN A RISE IN PAY

(Continued from Page 18)

table" advance over the "abominable" situation preceding the strike, he said.

The detailed monthly pay schedule follows:

Class A Ships

Chief Radio Operator	$155
First Assistant	140
Second Assistant	125
Third Assistant	120

Class B Ships

Chief Radio Operator	$155
First Assistant	130
Second Assistant	120

Class C Ships

Chief Radio Operator	$120
First Assistant	110
Second Assistant	100

Class D Ships

Operator	$110

(*N. Y. Times*, July 6, 1935)

CAN SERVE ONLY ONE

Ten prominent officials of communications companies who sought permission of the Federal Communications Commission to serve as officers or directors of more than one carrier subject to the Communications Act, were denied that right, on June 10th, by the Federal Communications Commission.

The petitioners were: Sosthenes Behn, Newcomb Carlton, Edwin F. Carter, Edwin F. Chinlund, E. Y. Gallaher, Frank L. Polk, Walter S. Gifford, John J. Halpin, David Sarnoff, and Lewis MacConnach.

Commissioners Walker, Payne, Case, Sykes and Prall voted in the negative, Commissioners Stewart and Brown voted in favor of granting said petitions.

The order was made effective August 9, 1935.

Federal Communications Commission Memorandum

The Commission on July 2, 1935, directed that the present Rule 258 be renumbered as Rule 258(a). In addition, the Commission adopted Rule 258(b) as follows:

258(b) Airport marker beacon transmitting equipment will not be separately licensed, but shall be described in the application for construction permit and license for the airport station with which it is associated. When such an application is approved the marker beacon transmitting equipment will be considered as an integral part of the airport station and its authority for operation will be included in the instrument of authorization for the airport station. Airport marker beacons may be operated during periods when no interference will be caused to airport radiotelephone communication. The frequency to be used by marker beacons shall be 1000 cycles plus or minus the frequency assigned the airport station, and the transmitting equipment shall be installed so that the direction of radiation will be substantially vertical.

HERBERT L. PETTEY, *Sec.*

NEW APPARATUS

ONE radio development of the year is the announcement of P. R. Mallory & Co., Inc., that the well-known line of Mallory Replacement Vibrators is now complete—and completely competitive. At the moment more than 50 per cent of the two million vibrator units now in use on all makes of automobile radio receivers are Mallory Vibrators. In the future this will be greatly increased. In the past the service man was limited by reason of limitations of the line. His practice, based on performance, was to replace with a genuine Mallory Vibrator wherever he could. Now new types and new low prices enable him to meet vibrator replacement requirements with Mallory Replacement-Vibrators.

In 1934 Mallory Replacement Vibrators were available for the following sets: Admiral, Airline, Arcadia, Audiola, Belmont, Blackhawk, Bosch, Cadillac, Captain, Colonial, Commander, Console, G-E, Governor, Gulbransen, Lafayette, Lt. Governor, Majestic, Motorola, Pilot, President, R. C. A.-Victor, Recorder, Solar, Star, Stromberg-Carlson, Tropic-Aire, Truestone, Truevalue, Wells-Gardner.

Additional auto radio sets for which

Mallory Replacement Vibrators are now available include Buick-Olds-Pontiac 980383, 980393, 980455, 980459; Buick Pontiac 544245, 544246; Chevrolet 364-441, 600153, 600566, 600249, 600565, 601-038, 601176, 601177; Clarion 100, TC50; Consolidated 51; Crosley 98, 99, 102, 103, 119, 5 A2, Detrola 60, 1100, 1100A; Dewald 52, 61, 640; Electric Auto-Lite 062, 062A; Emerson 965-667, 5A, 678-1, 678-2; Erla Sentinel 5500, 602, 603; Fada 101, 102, 104B; Fairbanks-Morse 346, 347; Ford (Majestic) 40, 18805; Ford (Philco) all; Ford (Lincoln) all; Federated Purchaser 92, 92A, 94A, 460; Freed A9; General Motors (Canada) 135; Graybar 15 (Chassis); Grebe 61-R; Harley-Davidson, all; Hudson Terraplane (Majestic Head); International K-60; Larkin Company 91; Mission Bell 10A, 11, 12, 14, and 25A; Montgomery Ward 87, 62, 118; Auto Radio 5Y chassis; Oldsmobile 393885, 393884; Philco (all); Rebler 27 (Scotty) -35; Sears Roebuck 7188, 7117, 1859A; Simplex T; Sparton 33, 33A, 333; Stewart Radio 60; Stewart Warner 1171, R1112, 1121, 11-22; United Motors Service 2035, 4036, 40-37, 4038; Utah (B Eliminator Non-Syn chronous); Westinghouse WR25, WR26; Wilcox Gay 4B6; Zenith 7, 460, 462, 650 HD, 651 HE, 660 TD, 661 TE; Wurlitzer 460, A60.

Mallory's announcement of a Replacement Vibrator line is an important announcement—and the news of new low prices, standard distribution and dealer discounts is good news. Another bit of information equally interesting concerns the preparation of the new Mallory Auto Radio Service and Replacement Manual. This new manual, to contain accurate schematic charts of more than 200 popular automobile radio receivers, will be one of the finest works of its kind ever published. It will be available, without charge, to all authorized service men.

"The House that Radio Built" is the title of a 36 page issued by the National Broadcasting Co., R. C. A. Building, New York City. It is a story of the experience and research which went into the building and equipping of the NBC studios in New York, and was prepared by Mr. O. B. Hanson, Chief Engineer. Well worth the time of any broadcast station engineer taken in the time of reading and many ideas may come from your interest.

"The Educational Program" by Merrill Denison is the title of a 20-page booklet published and distributed by the Radio Institute of the Audible Arts, 80 Broadway, New York City. Mr. Denison offers many suggestions along the lines that should be understood by the party giving an educational talk before the microphone. Other booklets also available from the same organization are entitled, "The Use of Radio in Leisure Time", "Music as Presented by the Radio", "Radio Music for Boys and Girls", "Women and Radio Music," and written in general character may be had for the writing.

"Western Electric Radio Transmitter No. 14A" is the title of a 12 page booklet issued by the Western Electric Company, 195 Broadway, New York City, describing their transmitter of that designation for CW, ICW, or Telephone work, with Frequency Range Preadjustment to any 10 frequencies in range of 2 to 18.1 megacycles, with carrier power output of 400 watts at the lower frequencies, and 300 watts at the higher.

Lear Developments, Inc., 125 West 17th st., New York City, have issued a beautiful booklet with the title "Aircraft Radio," covering their products of receivers, transmitters, and direction finders for aircraft. For free copy address Mr. Johnson, business manager.

WHERE YOU WILL FIND IT

In an article under the title of "Noise and Its Measurement," by A. J. Muchow, in the G. E. Review, the author says the following measurements were made using sound level meters made up of Microphone, Amplifier, and output meter.

(Painful Sound: Threshold of Feeling	120 db)
Noise in Subway Car	90 db
Noise in Railroad Car	80 db
Noise in Automobile going 40 mph.	70 db
Quiet Street	50 db
Average New York office	40 db
Country Residence	30 db
Noise in Room specially constructed for sound measurements	10-20 db
(Minimum of Audible Sound: Threshold of Audibility)	

The author makes reference to an article in the January Electrical Engineering, by R. G. McCurdy, under the title of "Standardization of Noise Meters," as a good basis for manufacturers to follow.

2,000,000th PATENT ISSUED

Joseph Ledwinka, Chief Engineer of the Edward G. Budd Mfg. Co., of Philadelphia, recently had the honor of receiving U. S. Govt. Patent No. 2,000,000. The first million patents were issued between the years 1790 to 1911, and the second million since that time.

The first patent was issued with the signatures of President George Washington, Secretary of State Thomas Jefferson, and Attorney General Edmund Randolph in 1790.

Police Radio Combatting Crime

(Continued from Page 6)

due to the actions of the shorter wave following the straight line radiation principle of light, and metal absorption quality.

The other factor that must be considered here is that in two-way communication from patrol cars on ultra high frequency the headquarters receiving antenna must be well elevated to receive as the patrol car cannot have a high transmitting antenna.

Distance Covered

Where the suburban points to be reached are of great distance ultra high frequency becomes a matter of height for the transmitting antenna, as the distance is largely a matter of antenna height. If the surrounding territory is fairly flat and a suitably high transmitting antenna point can be established by either the flag pole of a large building, or a very high transmitting antenna tower the ultra high frequency transmission will reach a large area. Other than these conditions medium high frequency affords the better system.

Electrical and other disturbances must be considered in business and industrial localities when considering the range of transmitters. Where a signal strength of 1.0 millivolt is considered necessary in the receiving antenna in business sections, a .2 millivolt antenna signal will often serve in residential territory, and a .05 millivolt antenna signal will serve very well in rural territory. The reason for this is that the antenna at former locations is bound to pick up some slight impulse as signal and when amplified in the receiver the unwanted signal will be proportionately amplified with the desired one, and it has been found that at least 1.0 millivolt signal is necessary to prevent this condition in business territory.

Generally speaking a good table to follow on this matter of transmission is afforded by the following prepared by one large manufacturer as average; Medium High Frequency:

Power Output	State Police 1658 to 1706 kc.	Municipal Police 1712 to 2490 kc.
50 watts	8 to 12 mi.	2 to 4 mi.
100 watts	12 to 18 mi.	3 to 6 mi.
500 watts	25 to 40 mi.	6 to 12 mi.
1000 watts	35 to 60 mi.	
2000 watts	45 to 80 mi.	
5000 watts	60 to 120 mi.	

On Ultra High Frequency, Municipal Police only:

Power Output	Distance
15 watts	3 to 5 mi.
100 watts	5 to 10 mi.
500 to 1500	10 to 15 mi.

The above distances of course being in any direction in a straight line from the transmitter antenna.

Allowing for night time approximately 200% greater range, and 40% larger range during winter.

The cruising car transmitters of 5 watts have proved very satisfactory in operation, having crystal control these are able to maintain frequency within .025 per cent. Most up to date cruising car radio receivers are of the super heterodyne type using 7 tubes, locked to receiving channel, and mounted either on dash or on top of rear partition behind driver in a coupe.

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	Radio Amateur Call Book	4 00
	Radio Music Merchant	2.00
	Radio & Electric Sales	1.00
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	Radio Retailing	2.00

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$1.35	Popular Science	1.50
2.50	Review of Reviews	3.00
2.25	Red Book	2.50
3.75	Scribners	4.00
2.25	Science & Mechanics	2.50
3.75	Scientific American	4.00
	Saturday Evening Post	2.00
	Cosmopolitan	2.50

Club Price		Regular
	American Magazine	$2.50
	American Boy	1.00
	Aero Digest	3.00
	Adventure	3.00
$3.75	Atlantic Monthly	4.00
	Boys' Life	1.00
1.75	Colliers Weekly	2.00
2.75	Current History	3.00
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	Esquire	5.00
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