August, 1933

The Commercial Radio Magazine

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Production and Utilization of Micro-Rays

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More Volney Mathison Fiction

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Radio Range Beacon Identification

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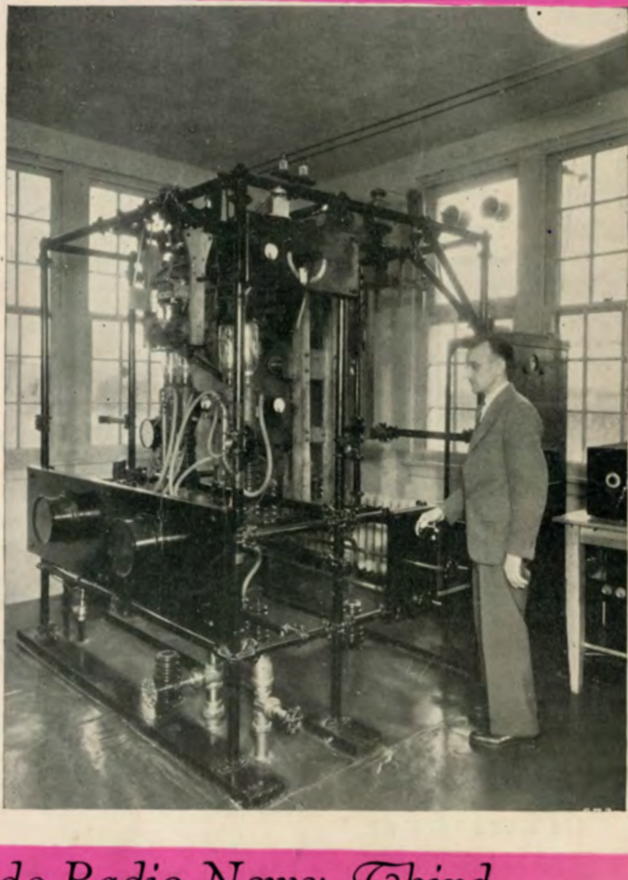
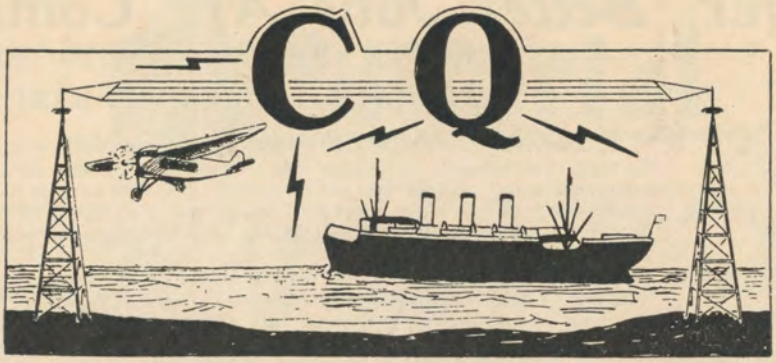
Design of Filters



World-Wide Radio News; Third Report of Liaison Committee on Aeronautic Radio Research



THE COMMERCIAL RADIO MAGAZINE

The ONLY Magazine in America Devoted Entirely to the Commercial Radio Man.

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JAMES J. DELANEY, Editor   L. D. McGEADY, Bus. Mgr.

VOL. II   **AUGUST, 1933**   **NO. 12**

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Editorial

W2XV RECOMMENDED SILENCED

An unusual case is presented in the Federal Radio Commission hearing on renewal license application of Station W2XV, in the name of The Radio Engineering Laboratories, Inc., Long Island City, N. Y.

The case came up for hearing, and Mr. C. Buteman appeared for the Radio Engineering people to ask for another and later hearing, as Mr. Srebroff, President of the firm was to address that day a meeting of the police heads of municipalities in the State of New Jersey. It does not take much visualizing these days to understand that Mr. Srebroff believed he would lose an opportunity to sell some of his merchandise if he were not present in New Jersey, while the hearing for removal of his permit was elsewhere.

However, if we were to judge from the report, it would seem that the hearing was to consider other things than the way in which the license of Station W2XV was handled. Station W2XV it will be understood is an experimental license using 65 and 34 meters.

Witnesses for the Commission were present who claimed that merchandise of Radio Engineering Laboratories in the form of radio transmitting equipment had been found in raids on land hide-away wireless stations, as well as rum runners, and contact boats. The inference of course is that the applicant must have sold this apparatus, but it is also true that the firm has jobbers all over the country.

The examiner recommended that the license be not granted. Without taking issue on the wet or dry side of the case, it is rather hard for us to see the connection in this case, and in our humble opinion, should the Federal Radio Commission act on the recommendation without a new hearing, it would seem that Congress in passing the Federal Radio Act went further in its licensing the Commission to act in its place and stead than it originally intended.

SHIP AND AVIATION MAIL SUBSIDY INVESTIGATED

Three months, one of which has already been used up, is the time given to a Senate investigating committee to look into air mail and ocean mail subsidy contracts granted by the Hoover administration.

The Committee is headed by Senator Black, of Alabama. Charges have been flying fierce and thick on this subsidy matter. Among these charges is that of lobby in behalf of subsidy legislation, use of the money to pay loans, disinclination to reduce operating expenses with the free flow of govermental money, and even the direct accusation of suspicion of fraud.

Without a doubt ocean shipping has been hard pressed. It is safe to say that in this day of reconstruction there is plenty of room for reconstruction there. As to how much government money is to be used, no one has a better right to investigate than the Senatorial Committee which will have a great influence on either cancellation or continuation of these. Certainly among the radio fraternity, this Committee will see no splurge of spending in the payment of salaries of ship radio operators. Salaries of the operating staffs on the boats themselves have surely been slashed in accordance with the times, so much in fact, as to make it appear that it has already gone too far.

In the flying field a rather different picture is presented. With the consolidations, re-organizations, etc., that are going on Uncle Sam is certainly entitled to look well where his air mail subsidy money is going. Let him try to find any salary spending on the part of the firms to the underling. From our contacts with the men working in this field, he will not find it going to the radio operator. Very likely he will not find it going to the general working staff. If he can and does find the money going to the officials, directly, or indirectly, it is well time that a committee be appointed to portion these contracts out parcel at a time, or at least to recommend to the Senate itself that it be portioned out parcel at a time to such deserving outfits as are entitled to it. This will at least encourage such firms as are on the "up and up," and certainly properly discourage such others are not.

YOUR OPERATING LICENSE

The Radio Commission has shown a real spirit of assistance in many cases of renewal There is absolutely no reason for a commercial ticket to expire.

As has been pointed out in previous issues, the new rules state that a renewal may be had if application is made in time by merely filing an affidavit along with the expiring ticket. It is unfortunate to hear of cases where men have been lax in this, waiting until after expiration date. The ruling is that the application must be made at the expiration date, or before that date, **NOT** after. If you wait that long you will have to be re-examined, and may lose your ticket entirely on the examination.

To show how far the Commission is willing to go on this, it was recently decided that an operator now blind, could be examined at his own home. This is an exceptional case, but it shows that if you have a special case, you will find the Commission both sympathetic and receptive. Just because you may not be using the ticket now, does not say that you will never need it. So keep it active by keeping it up to date.

PRODUCTION AND UTILIZATION OF MICRO-RAYS*

By A. G. CLAVIER
Les Laboratoires, Le Materiel Telephonique

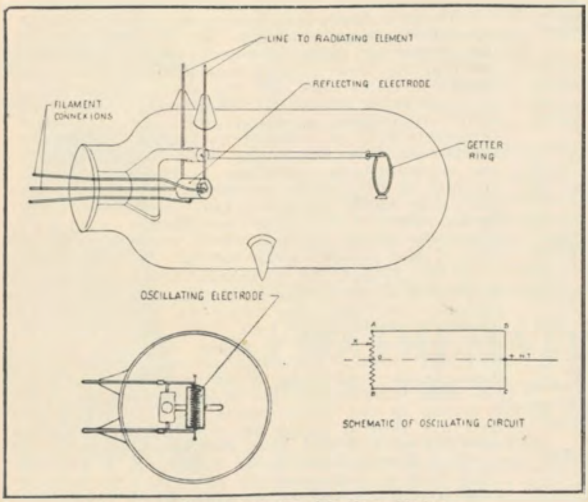

Fig. 1—Micro-Ray Oscillating Tube

The reader will recollect the statements which appeared both in the daily and technical press after the successful demonstration between Dover and Calais on March 31st, 1931, of the duplex telephone link operating on a wavelength of the order of 18cm. The success of this demonstration made engineers engaged in the communication art realize what part these very short waves might play eventually in the general system of communication.

An order has since been received for a permanent link operating between the aerodromes of Lympne and St. Inglevert across the Straits of Dover. This will be the first commercial application of the system.

A description of this link will be published in the near future in Electrical Communication, but it was felt that a paper dealing with the methods used to produce oscillations of a wavelength shorter than 20 cm. would be of immediate interest. These waves have come to be generally known under the name of "micro-rays" and we will use this term throughout this text.

*Reproduced from and by courtesy of Electrical Communication (July, 1933).

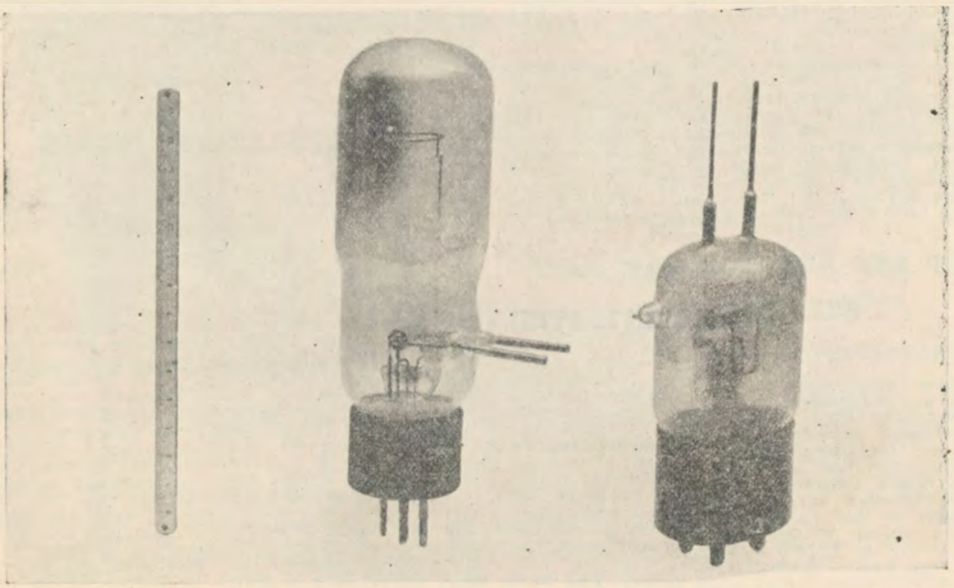

Fig. 2—Micro-Ray Tubes (the scale is in centimetres)

The main property which distinguishes these waves from the longer ones comes from the fact that use may be made of phenomena which are more commonly considered as optical, such as reflection, refraction and diffraction.

There is of course no sharp upper limit to the wavelength of micro-rays; we have mentioned 20 cm simply because for longer waves the dimensions of reflectors become so large as to be impracticable or too expensive. In fact, even for the very short wavelengths which we are considering, the dimensions of the electrooptical systems which can be used remain much smaller in respect of the wavelength than they would be in the light spectrum. It is, on the other hand, very easy to obtain polarised sources in the shape of half-wave antennae. Indeed it may be said that the technician finds himself in this field half-way between optics and radio-electricity.

1. Description of the Tube Structure

The tube used is made of three electrodes having a cylindrical symmetry. The filament is the axis of the structure and is made of pure tungsten. A helicoidal electrode is centered on the filament and is made of some 20 turns of tungsten wire. It is called the "oscillating electrode" for reasons which will be explained later. The external electrode is a molybdenum cylinder and will be referred to as the "reflecting electrode."

The two extremities of the oscillating electrode are connected to a transmission line which leads to some sort of radiating element. The simplest case is when the transmission line is of the parallel conductor type and the radiating element constituted by a small length of wire placed at right angles to the transmission line.

When this system is correctly adjusted there is a current maximum in the radiating element.

This element remains small as compared with the wavelength and functions as a theoretical "doublet." That is to say the amplitude of the high frequency current is substantially the same in all points of this doublet at any particular time.

Experiments show that when the transmission line remains short the radiation of the doublet is predominant and all other radiation effects in the system may be considered as secondary.

A positive voltage E_o of about 250 volts is applied to the oscillating electrode by means of a connection which is placed perpendicularly to the doublet at its middle point. The reflecting electrode is polarized by means of a battery E_r negative with respect to the filament battery which is an ordinary 6 volts A battery.

A schematic of the tube structure is shown in Figure 1 and a photographic view in Figure 2. Figure 3 shows the apparatus which has been used to study the properties of the tube and its doublet. The presence of oscillations is proved by a wave-meter which has a very sharply tuned circuit. A description of this wave-meter will be found in the February 1932 number of L'Onde Electrique.*

2. Production of Oscillations

The oscillations are always produced in the part of the static characteristic curves of the tube corresponding to the voltage saturation of the filament by the D.C. voltage of the oscillating electrode.

The electrons are attracted by the positively polarised oscillating electrode. A certain number fall directly on this electrode. Others travel through the meshes of the oscillating electrode and fall into the space between the oscillating electrode and the reflecting electrode These electrons are submitted to a retarding field, lose their speed and finally turn back to the oscillating electrode. On their way back, some fall again on the wire of the oscillating electrode, while others reach the filament region and are not distinguishable from other electrons which leave the filament for the first time.

Neglecting all initial velocity effects and space charge effects we will now show that when a high frequency voltage appears along the oscillating electrode the total number of electrons which fall at any point either directly or after being reflected will not always be the same and that at any point of the oscillating electrode there will consequently be a leakage current made up of an average D.C. value and a high frequency component which will not be in phase with the original high frequency voltage along the oscillating electrode. It is this dephased leakage current which makes it possible to sustain the ultra-short wave oscillations within the tube.

3. Case of Plane Electrodes

Let us first consider the simpler case when the cathode and reflecting electrode have the shape of parallel planes. The oscillating electrode is made of wire in a plane parallel to the other electrodes. Let us call r_a the thickness of the cathode, r_o the distance from the radius to the oscillating electrode, and r any radius between r_a and r_o. Although r_a plays no part in the plane

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*R. H. Darbord, "Reflecteurs et Lignes de Transmission pour Ondes Ultra-Courtes."

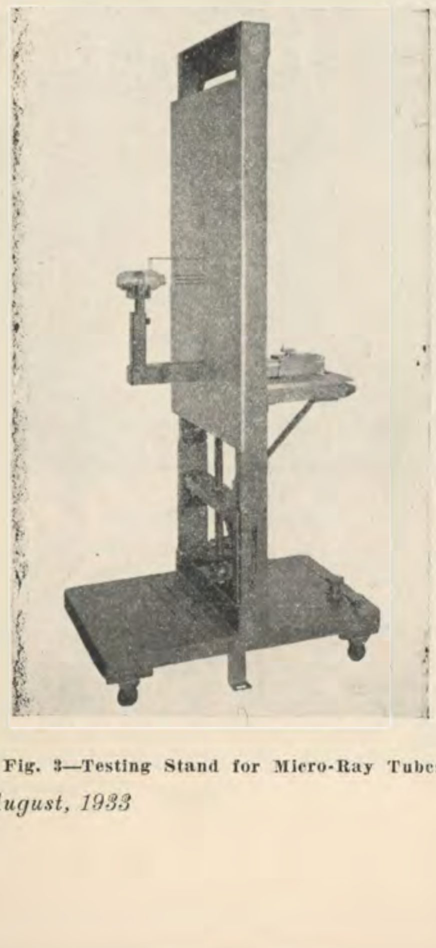


Fig. 3—Testing Stand for Micro-Ray Tubes

DO YOU REMEMBER WHEN-...

The Author: **VOLNEY G. MATHISON**

Had the Jinx of the Bobolink?

"Q-S-T-! Q-S-T-! To all ships and stations! The largest landslide that has taken place since the opening of the Panama Canal occurred at two o'clock yesterday morning, when the side of Culebra Cut caved in for a distance of one and one-half miles, filling the Canal completely with debris. The slide is attributed to earth eruptions in the canal bottom, which have been unprecedented. All available dredges, scoops, and sand suckers have been dispatched to the scene, but the time that will be required to clear the cut is impossible to foresee. All vessels en route to the Canal should immediately radio their home offices for instructions to refuel and take sufficient supplies at Cristobol or Balboa to enable them to proceed to destinations via Cape Horn.

"J. N. BELLOC,
"Military Governor, Canal Zone."

"He sits down in my chair and sticks on my phones."

I believe that every sea-going brasspounder in the world either copied directly or had relayed to him this mysterious forged radiogram, which was sent out from somewhere along the west coast of Central America on the morning of July 16, 1923.

Every operator, taking the signature of NBA, affixed to this broadcast, at its face value, delivered the message to his captain, and then made haste to relay it. For days thereafter there was confusion and uncertainty in many steamship offices, and pandemonium on the air. A thousand freighters, tankers, and passenger liners bound for transit through Uncle Sam's big ditch jammed the ether with radiograms to agents and home offices requesting orders; a dozen ships hove to in midocean to await their answers; several turned back; others changed their courses for the Straits of Magellan, and one of these last eventually met destruction upon the rocks, in essaying that wintry blizzard-swept passage.

At length, definite word followed that the radiogram was a forgery, a malicious joke, and there was peace again, albeit an angry, revenge-thirsting peace that would hang the faker. Then fancy the stir when it was later broadcasted far and wide that the perpetrator of the ill-conceived jest had been apprehended in the person of one Samuel Jones.

Some sort of an investigation followed; but since the subsequent fate of Samuel Jones seems to be unknown to the general public, I feel that justice requires the setting forth of some of the ins and outs of this amazing matter. And now let me surrender the helm to Samuel Jones himself—and you'll find he's not the densest and dumbest.

"When the Steel Bobolink backs slowly out of her berth at Pier 37 I stands over my suitcase an' sea-gab an' mops my face with relief.

"Thank crimminy, I'm off to sea again!" I mutters to the rainbow-tinted amplifier tubes of my private three-steps, as I proceed to tack up my license in the corner alongside the lightning-switch. "May a half-million-volt high tension line drop on me if I ever monkey with a shore job again!"

"Whassamatter with shore jobs?" inquires Ziegfield Stubbs, third assistant engineer of the Bobolink, who has come up topside to trim the big red-throated ventilators abaft the radio shack.

I replies, briefly, "Tried installin' a gang of wimmen brasspounders for a bughouse steamship company down in New Orleans—got five hundred dollars on my accident insurance policy and three months in th' hospital out of it. Wimmen an' me don't mix, an' that's why I'm back on a good iron deck. This Pacific-Atlantic run is goin' to be just my speed—sunshine an' blue sea, th' propellor's thump, an' no skirt inside of five-hundred miles. Great stuff!"

Ziegfield Stubbs looks at me quizzical like, an' scratches his head.

"You'll get sunshine, all right," he replies. "You'll git sunshine that'll burn th' paint off'n your sparky coop an' melt th' bak'rylite in your lead-in gadgets; but you ain't gettin' no rest, nor five hundred miles from th' longstockin's. This ship is jinxed, an' squattin' right up there on th' bridge, 'longside th' chart-house, is th' joner."

Alarmed like, I follows Ziegfield's stumpy finger, an' see sittin' up on the bridge a two-hundred-pound female, strong-shouldered as a battle-ship an' with a hard-square-jawed map like a block of cement.

"By th' holy red whiskers of Trotzky!" I groans, dismayed. "What's that old battle-axe doin' on this freight carrier?"

"Cap'n's wife, of course," replies Ziegfield. "She's king round here, too."

"Well, she ain't goin' t' sit on top of me!" I announces, hard-boiled like. "If she starts any czar stuff around my shack, she'll find out a bullshevik is a tomato-picker alongside of me—

Just as I am deliverin' this declaration, a young kid, about eighteen, with a wide, stupid, empty face an' a burntout cigarette-butt hangin' on his lip, his clothes torn an' dirty, climbs up onto the topside, jostles past me roughly, an' walks right into my wireless shack. Here he sits down in my chair, sticks on my phones, switches in the audions of my private amplifier, an' begins jerkin' the tunin' controls around, careless like.

"This is a crummy rig—I got one home worth a dozen of it," announces the kid, with a sneer, as he hoists his oil-smeared shoes onto my typewriter an' proceeds to turn up my vacuum-tubes until they are blazin' like a bunch of mazda lamps.

"Hey, you gally rat," I yells, enraged, dashin' in through the door after him, "you git th' h—l out'a here!"

"I won't!" snarls the kid, glarin' at me, vicious-like. "I can come in here any time I want to;. I'm Captain Pirky's son." About one-tenth of a second later I have got a couple of fast-movin' fists an' a hard-shod hoof into action, and Sir Pirky scoops up a shovelful of the cinders out on the boat-deck with a well-skinned ear.

"Baww!" he blubbers, his wide, sloppy face wrinklin' up like a struck mainsail. "I'm gonna tell my maw!"

"My gorry, Sparky, you hit that ole woman's boy! You got yoreself in a mess, now, certain!" exclaims Ziegfield Stubbs, with a scared look. "That boy is a spoiled egg, he's signed on here ordinary seaman, but he ain't done a tap of work sence he come on th' ship. They got him eatin' in th' saloon with us off'cers an' sleepin' in th' owner's suite—look; he's up on th' bridge now telling th' ole hag what you done t' him. Goodnight, I'm gittin' down from here!"—an' with this Ziegfield vanishes.

Glancin' through a port-hole toward the bridge, I sees the Amazon of the Bobolink talkin' to her old man, a finger of one knotty-fisted mitt pointin' aft at my hangout an' her jaw workin' like a pair of plate-shears in a shipyard.

Directly Captain Pirky, a spineless-lookin' old weasel with mouse ears an' a weak curved-in nose, comes hustlin' down the boat-deck, while th' empress of the Bobolink stands up on th' after side of the bridge, watching him.

"Mr. Jones, what have you done to my boy, Elmer?" he demands, all steamed up like.

"I threw him out't here!" I replies, belligerent-like. "If he comes in again, I'll do worse!"

"You'll do no such thing!" exclaims old Pirky, wobblin' his narrow bean around, angrily. "Elmer is privileged to go into any part of this ship he wants to—

"No, I'll be hung if he is!" I barks. "When th' crew can hang around in th' radio shack an' fool with my gear, I'll take my license an' wipe my autostrap with it. With this I turns my back an' puts on my phones.

Old Pirky hesitates kind of uncertain-like, then returns up on the bridge, where he wobbles his head some more, like he was tellin' his boss how he's bawled me out proper an' set me in the corner.

"I s'pose ya see what kind of a joner we got on this ship, now, I reckon," Ziegfield hollers into my ear above the heavy roar of the main reduction-gears, when a little after eight bells I climb down fifty feet of iron ladders to visit him at his post alongside the turbine-head. "I gotta hunch somepin's gonna happen 'fore we git back t' Bal'more—a woman's a joner on a freight ship, an' th' only worst one's a pricher—s'pecially a nigger."

Gettin' in on the air, half-an-hour later, I runs across a big bunch of file press on the way over the navy arc circuit from San Francisco to Manilla. The first item I copies is dated from Cristobal, and reads:

"A small slide occurred in the Panama Canal at four this morning, when thirty-thousand cubic yards of earth fell from the upper south face of Culebra Cut. Dredgers are clearing the debris, and there has been no delay to ship transits—"

About this time, I hear a heavy, solid tread out on deck; then the door of my shack opens an' in marches the empress of the Bobolink.

"Mr. Jones, tune in a radio concert!" she commands, in a tone like a Chink mandarin's wife givin' an order to a pig-tailed coolie. "I wish to hear some music."

My first thought is to rise up an' do battle right there—then I gets a idea.

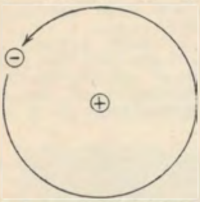
"Sure thing, ever so pleased," I says, chilly polite. I gets up to plug in the loud-speaker with which the ship is fitted out; whereupon

(Continued on Page 28)

WHAT IS ELECTRICITY?

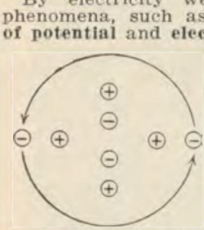
By STEPHEN KOVACS

A well known authority states: "It seems that the electron is nothing but electricity." Further in his text he reiterates: "The electron (negative) is the smallest possible quantity of negative electricity." In the same text the electron is referred to as the negative, and the proton as the positive electron. As we shall see, all atoms are made up of positive and negative electrons in different numbers and arrangements, therefore it would be quite consistent with the above quotations, in answer to the title, to point at any object stating: "This is electricity." However, since this answer would hardly suffice, we shall attempt to draw our own conclusion thru logical discussion rather than scientific treatise.



The HYDROGEN atom (atomic number 1)

By electricity we understand all electrical phenomena, such as **electric current, difference of potential** and **electro-motive force** (E. M. F.), therefore if we can answer what these phenomena are, we have the answer to the question "What is Electricity?" To do this we must first dwell into the construction of the atom as it is accepted today.



The HELIUM atom (atomic number 2)

The atoms are made up of negative and positive electrons. (We shall refer to the positive electrons as protons and the negative as electrons.) Different atoms contain different numbers of electrons and protons in various arrangements. In its neutral state the atom contains exactly as many electrons as protons. The hydrogen atom is the simplest of construction; it contains but one proton and one electron, the electron revolving around the proton at high velocity. The diagram illustrates the hydrogen atom (atomic number 1), the helium atom (atomic number 2) and the lithium atom (atomic number 3). It is evident from the diagram that the protons and some of the electrons form the nucleus of the atom. Since here as in all other instances in Nature, likes repell, the nuclear electrons are so arranged that the repulsion between protons is overcome by them and thus form a closely knit nucleus. It must be understood that the nuclear electrons and protons are not necessarily in the same plane as might be misconstrued from the illustration. It is also evident from the illustration the atom's atomic number is dependent on its orbital electrons; the hydrogen having one orbital electron, is the first in order of atomic weight; the helium has two orbital electrons and its atomic number is two, while the lithium has the atomic number three, having three orbital electrons. The orbital electrons do not necessarily move in the same orbit, nor are their orbits in the same plane.

In studying the hydrogen atom, we can readily see that if the electron revolves around the proton, the centrifugal force has a tendency to throw the electron away from the proton, therefore there must be an attraction between the proton and the electron which keeps the electron in its orbit against the centrifugal force. It is then established that there is an attraction between the proton and the electron; then if, by some means, we remove the electron from its proton the proton will exert an attraction on all electrons until it has attracted an electron into an orbit around itself. If an electron is dispelled from a number of atoms in a substance the positive protons in it will predominate and then the substance is said to be positively charged, and there will be a **potential difference** between this positively charged substance and any other substance containing their full quota of electrons or an excess of electrons, and an attraction will then exist. This attraction or tension is called the **electric** (static) **field** between the two points of potential difference. The electrons that were removed from a substance will be forced onto some other substance and this substance will then have an excess of electrons, therefore the negative will predominate. It is then said to be negatively charged.

We have then seen that there is no electrical quality manifest in the substance until a deficiency or excess of electrons is established in the substance which causes a tension due to the **difference of potential.**

The force which can maintain a difference of potential between two points, even though a more or less free path is available for the electrons to travel between them, is called the **Electro-motive Force.** The two best known sources of E. M. F. are the dynamo and the battery. The dynamo causes an electron flow through its armature by cutting the magnetic flux between its field poles. It seems that some of the electrons' own magnetic fields conflicts with the magnetic flux passing across the conductor and this causes the electrons to move

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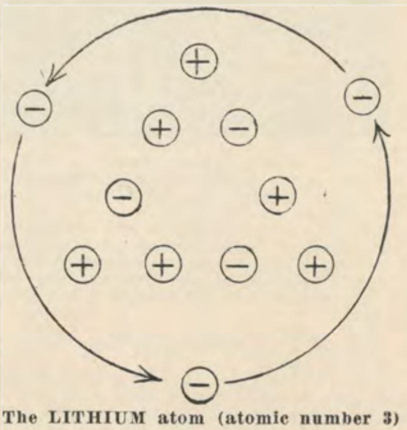

The LITHIUM atom (atomic number 3)

SIMPLIFICATION OF RADIO RANGE BEACON POSITION AND QUADRANT IDENTIFICATION

Should a pilot flying blind on the radio ranges become uncertain as to which of the four courses he is on or, if he is off course, which of the four quadrants he is in, he may have to resort to one of a number of rather involved procedures of flying in order to orient himself. Several of these procedures are described in an article, Flying the Radio Ranges, published in the September 15, 1932, issue of the Air Commerce Bulletin.

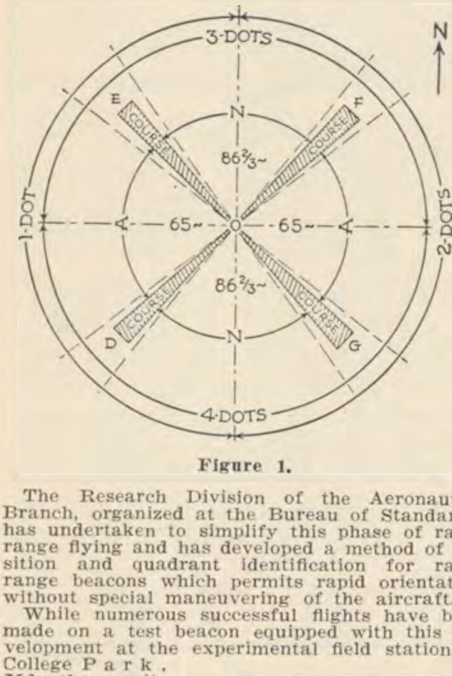

Figure 1.

The Research Division of the Aeronautics Branch, organized at the Bureau of Standards, has undertaken to simplify this phase of radio range flying and has developed a method of position and quadrant identification for radio range beacons which permits rapid orientation without special maneuvering of the aircraft.

While numerous successful flights have been made on a test beacon equipped with this development at the experimental field station at College Park, Md., the results herein reported are those of a research project as the method has not been subjected to service tests.

The method consists of sending a differently coded signal in each of four different directions as illustrated in Figure 1, which shows the usual four courses radiating from a radio range beacon of either the aural or visual type located at the point O. The A (.—) or 65-cycle zones and the N (—.) or 86 2-3-cycle zones are shown between the courses. For convenience in writing, the A (.—) or 65-cycle zone will be referred to hereafter in the text as either the A zone or the 65-cycle zone while the N (—.) or 86 2-3-cycle zone will be referred to as either the N zone or the 86 2-3-cycle zone.

The course indications received by the pilot on all four courses are the same so long as he remains "on-course." The specific course he is following is ordinarily determined by noting the magnetic compass course and then deviating off the radiobeacon course and checking the off-course indications. When off course, the pilot knows by means of the received signals whether he is in one of the two A or the two N quadrants of the radiobeacon. However, without a special quadrant identification system, he is unable to determine in which of the two A quadrants or which of the two N quadrants he is flying except by the procedure to which reference has already been made.

Directional Dot Transmissions

Utilizing the directional dot transmissions shown in figure 1, where a 1-dot signal is sent west, 2 dots east, 3 dots north, and 4 dots south, any uncertainty as to either course or quadrant is cleared up when these dot signals are heard, which may be once a minute or during each fourth interval when the radio-range identification letter is sent. In the figure, the arrows show the arcs over which the respective dot signals may be heard. The procedure found most desirable in the experimental flights on this new method is to transmit the 1-dot and 2-dot signals successively and repeated twice and then to transmit the 3-dot and 4-dot signals in the same sequence. The pilot may then determine which of the 1-dot and 2-dot signals and which of the 3-dot and 4-dot signals are the louder.

Thus, if a pilot finds himself lost in an A sector and hears the 1-dot signal loud, he is in the sector west of the radio range beacon and not east of it where he would have heard 2 dots loud. Similarly, while flying on a course, if the 1-dot signal is heard but not the 2 dots, then the pilot is either on course D or E. However, when the 3-dot and 4-dot signals are sent, if only the 3-dot signal is heard the pilot is following course E. If the 4-dot signal had been heard and not the 3-dot signal, he would have been on course D.

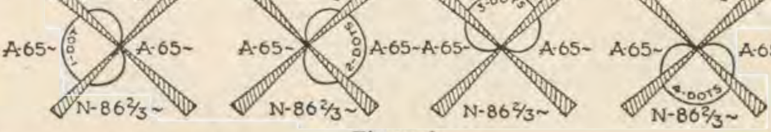

Figure 2.

A further use to which the identification signals may be put is to augment the zero-signal zone, referred to in the aural beacon system as the cone of silence, in giving the pilot information as to whether or not he has passed over the beacon when coming in on a course. Thus, suppose a pilot to be flying in toward the bea-

(Continued on Page 25)

THE DESIGN OF FILTERS FOR CARRIER PROGRAMME CIRCUITS*

By F. RALPH, B.Sc., A.C.G.I., D.I.C.

International Telephone and Telegraph Laboratories, Incorporated

Advantages of Carrier Systems for Programme Transmission

The increasing extent to which telephone administrations are being called upon to provide programme circuits for the inter-connection of broadcasting stations has brought into prominence the problem of obtaining circuits of the required high standard of transmission performance with the minimum outlay on construction work.

The low noise levels obtained on carrier telephone circuits with fairly high carrier frequencies give such circuits an important advantage over voice frequency circuits for high quality transmission. For long distance work the high velocity of propagation on open wire lines at high frequencies, and its uniformity over a wide frequency band give the carrier system a further advantage over voice frequency cable circuits.

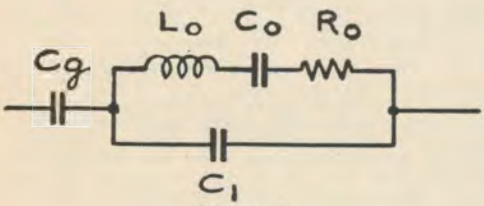

Figure 1

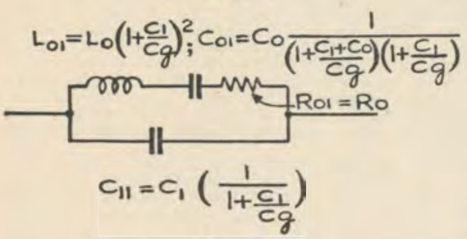

Figure 2

With such a system, also, the desired programme channels may be obtained with minimum reaction upon the existing lines and facilities since, without any modification to the line except possibly additional transpositions, the carrier system may be put into operation without affecting the circuits (d.c. telegraph, physical telephone, phantom, or carrier telephone) already being provided by its pair of wires.

For a programme-transmission carrier system of the above type, the single-sideband and suppressed-carrier method of operation recommends itself on the following grounds:

1. Economy in frequency band width required.
2. Economy in power transmitted to line for a given signal-to-noise ratio at the receiving terminal.

The economy in frequency band width is of considerable importance owing to the large frequency band covered by the programme material and the high attenuation of lines at high frequencies.

The importance of economy in transmitted power lies in the large range of level covered by the matter transmitted and the need for maintaining an adequate signal-to-noise ratio at the lowest transmitting levels.

The Filter Problem in a Single-Sideband Carrier System

Among the problems presented in the production of such a single-sideband system, that of the removal of the unwanted sideband is one of considerable importance. If the carrier freqencies at the transmitting and receiving terminals are not exactly synchronized, even though the difference be, for true single-sideband transmission, negligibly small, incomplete suppression of one sideband will produce undesirable beat effects.

Even if the two carriers are in syntony the phase displacement due to the suppressing filter, at some input frequencies, will cause harmonic distortion, while if the level difference between the two sidebands is less than about 30 decibels, the overall transmission characteristic may exhibit cyclic irregularities at the low frequency end.

To avoid the above effects it is necessary that in the frequency range between the upper and lower sideband frequencies, corresponding to the lowest voice frequency to be transmitted by the system, the attenuation in the sideband suppression networks shall increase by at least 30 decibels. If this lowest frequency is 30 p:s, this increase in attenuation must be effected in 60 cycles, which with a carrier frequency of 40 kC. is only 0.15%.

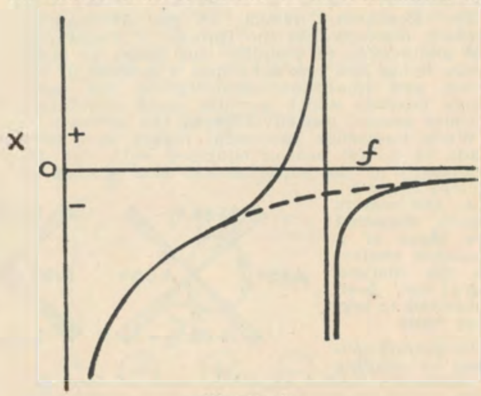

Figure 3

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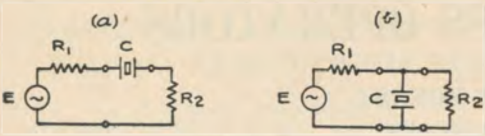


Figure 4

Owing partly to the resistance losses in the coils and partly to the difficulty of obtaining a filter which will combine an extremely sharp cut-off with satisfactory image impedance characteristics, it is not practicable to meet such requirements with a filter consisting of ordinary coils and condensers. Because of the extremely low decrement of the equivalent electrical circuit by means of which it may be represented, the piezo-electric crystal suggests itself as a possible solution.

Since the applications of the piezo-electric effect so far have been limited chiefly to its use for purposes of frequency stabilization, a theoretical investigation was made to determine to what extent existing technique could be directly applied and whether any special aspects of the present problem would necessitate any modification thereof.

It was also necessary to determine the relation between the constants of the crystal and the characteristics of the equivalent electrical circuit by which it may be represented, to ensure that the fullest use was made of the degrees of freedom afforded in the choice of these constants, and to consider the possible reactions of external operating conditions.

The device desired was one which would provide the necessary additional attenuation over the frequency range in which the main filter was rising to the required value.

The results of the theoretical investigation, while stressing the inherent limitations of the quartz crystal for general application as a substitute for ordinary electrical circuit elements, showed that under suitable operating conditions the reqirements of the existing problem could be satisfactorily met.

Equivalent Circuit of Piezo-Electric Crystal

It is well known that if a flat plate of quartz or other piezo-electric material be freely mounted between two conducting plates so as to be subjected to any electrostatic field existing between them, then in so far as its reaction upon any electrical circuit into which it may be connected is concerned, the combination may be regarded as being equivalent to the electrical network shown in Figure 1. In this diagram, L_o, C_o, and R_o are constants depending only on the crystal itself. C_1 is substantially the electrostatic capacity which would exist between the electrodes having regard for the dielectric constant of quartz, if there were no air space between the electrodes and the quartz itself and the crystal were not free to vibrate. C_g is a capacity which takes account of the above air space, becoming infinite when this space is reduced to zero.

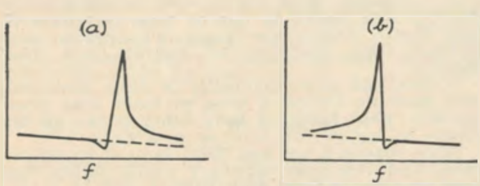


Figure 5

As, in general, the crystal will exhibit more than one resonance when the frequency of the electromotive force applied across the electrodes is varied, the values of L_o, C_o, and R_o will hold only in the frequency range in the neighborhood of a particular resonance. By a suitable choice of the dimensions of the crystal, however, and its direction of cut with reference to the axes of symmetry of quartz, it can be arranged that only one resonance occurs within a wide range of frequency.

The network in Figure 1 may be simplified by omitting the capacity C_g since, provided that the crystal is only lightly damped mechanically so that the reactance of L_o is very large compared with the value of R_o, the values of the remaining quantities may be modified to include its effect. The modified values are shown in Figure 2.

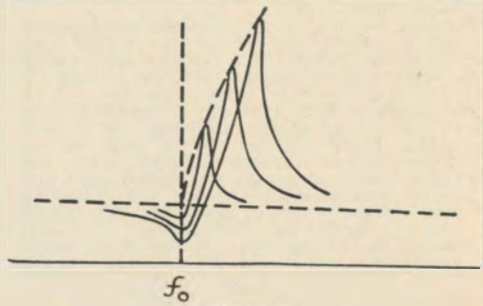


Figure 6

The reactance-frequency characteristic of this network is of the type shown in Figure 3, the resonant frequency f_o and the anti-resonant frequency f_{oo} being given respectively by:

$$f_o = \frac{1}{2\pi \sqrt{L_{o1} \; C_{o1}}}$$

$$ff_{oo} = \frac{1}{2\pi \sqrt{L_{o1} \dfrac{C_{o1} + C_{11}}{C_{o1} + C_{11}}}}$$

Such a network might be made to form a part of any of a number of well-known types of filter section by associating it with ordinary coils and condensers. Owing, however, to the high cost of accurately ground quartz crystals and the large size of crystals required for frequencies less than, say, 50 kC, the cost of such complicated filters would be prohibitive for the present problem.

Attention, therefore, should be given to the possibilities of a single crystal inserted in series or in parallel with pure resistances. The two possible cases are shown in Figures 4a and 4b in which a source of alternating e.m.f. E, of internal resistance R_1, is working into a load R_2.

If α is the reduction, in decibels, of the voltage across R_2 due to the presence of the crystal, then the relations between α and frequency for the two cases are of the general form shown in Figures 5a and 5b, the points of minimum and maximum attenuation corresponding to the frequencies f_o and f_{oo}. The dotted lines indicate the corresponding attenuation obtained by re-

(Continued on Page 24)

Aug 1933

PIONEER WIRELESS OPERATORS

By DR. LEE DE FOREST

As I have already recounted, while these interesting events were transpiring: Wireless to express trains, across the mountains of Colorado, and to the Gambling Boat on Lake Michigan—the plucky gangs of installers and operators down around the Gulf were struggling determinedly, resourcefully against almost overwhelming odds.

Through the stifling heat of that hot summer of 1905 Iradell at Pensacola Navy Yard and Horton in the torrid (then Devil's) Isle of Key West were battling terrific static in a vain effort to effect two-way communication.

The big Key West transmitter which Horton and I had opened of the preceding March was frequently heard by Iradell, at best during those few still hours just at dawn when the relentless heat—lightning static would quiet and before the heat of the rising sun had stirred up its own vicious brand of growlers. But try as he might, juggle his condensers, helix and spark-gap as best he could, Iradell could never get one single dot dash across. There seemed to be a mysterious etheric barrier stretched across the eastern gulf through which the ten K. W. waves of PN. simply could not penetrate.

Horton had been up to Pensacola to find the "nigger." He, quite naturally, looked first at the ground. The station was amid a desolate stretch of sand, dry as Sahara, even after torrential rains. Ten feet down however was salt water a plenty. He corraled all the niggers in the Navy Yard, set them to digging a gigantic pit, whose walls had to be planked as fast as dug, to prevent repeated cave-ins.

He bought up all the sheet copper in Pensacola, soldered it into one sheet fifteen feet square, with wide strips leading up for connection to the transmitter. One afternoon as the diggers and pumpers were leisurly working toward the watery bottom of that pit, Horton's weather eye spied a black cloud rising rapidly out of the Gulf. Instantly he sensed an approaching cloud-burst, which would inevitably have flooded his pit, refilled it with sand so tediously excavated, postponing indefinitely the termination of all his labors. "Get that copper plate into the bottom of that hole, boys, before she breaks—and I'll give every g. d. nigger among you two dollars a piece. Dig like hell!" And did they dig?—More sand flew over that coffer dam in the next ten minutes than those tar-heels had ever shoveled in one day. Just as the first great drops of the onrushing deluge fell the big copper sheet sunk into place under the salt ooze of the pit, and the job was saved. Five minutes later the hole was filled to the brim with rain and in-flowed sand. Luckily for Mac the two ship-rigged masts supporting the double-fan antenna survived the storm. Navy-rigged, they withstood many, equal and worse.

Next schedule hour Horton and Iradell "called" K. W., confidently expecting a prompt O. K. at last. But no; Key West went on calling, calling. The navy ops. had heard nothing; that new ground was not the solution.

Baffled but not discouraged Mac Horton took counsel with the Navy Yard officers. One of these had drilled the well for drinking water, which stood near the wireless station. "How deep did you go down?" asked Horton. "Fifty feet," he replied. "But if I had stopped at forty feet or gone down sixty I would have found only salt water. This white sand here is about forty feet deep, and below that is a stratum of clay and stone some twenty feet in thickness. Below that is an indefinite depth of sand." Whereupon it was determined that the upper or surface stratum of sand and salt water was merely a pie in a saucer resting well insulated upon a layer of high resistance soil.

Whereupon Mac secured some twelve forty foot iron pipes and had these driven, or hosed deep into the ground, arranged in a circle surrounding the house, their tops all bussed together, and tied into the strip lead from the copper plate.

With this combined ground Key West simply must hear Pensacola. But to his dismay, and contrary to all the laws of wireless and geology. K W was yet deaf to PN. Discouraged, baffled, Horton wrote me all the details, and returned to the foul-smelling cistern water of Key West; just in time to escape being quarantined in Pensacola. For, to make matters worse yellowjack broke out early in July, and poor Iradell thereafter was confined to the Navy Yard reservation, denied as yet even the solace of sending official reports, except by Western Union, to his buddy at Key West.

But plenty of other stations were reading him, loud and clear. That was what made the situation all the more puzzling.

Finally it was decided that "the Doc" alone could correctly diagnose the strange ailment at PN. I must leave the blue lake, the humid heat of St. Louis, and get under the stegomyia netting of the yellow-fever quarantine, where one hundred degrees was considered comfortably cool. From my Diary: "Aug. 1905—I have been an inmate of this old Navy Yard now three weeks, through the heat of mid summer, striving to solve the wireless riddle, why Key West can not hear us.

"The desired goal is not yet attained, but much hard work has been done, and so I feel the solution is so much the nearer. I am optimistic, determined. We have at least established good communication with our new station at South West Pass, two hundred miles distant, and begun to handle paid messages to and from." (Note how eager we always were to meet that real test of success—paid messages.)

"Other and new apparatus is daily expected, and upon its arrival I hope to reach Key West quickly. **That failing I have other tricks up my sleeve to try.** ("You can't stop a Yank.")

"One reason I am less impatient at these delays, and less cast down—I really enjoy this kind of free and out-door life.

"I am sleeping in the Navy Wireless Station, all doors and windows open. I am tanned and burned, and not withstanding the terrific heat, the not too sumptuous nor too diversified meals, never felt better in my life. Then too, I am working so entirely at my own work, actually living in it, that I feel content that it is so; and one who has a work to do cannot feel happy unless so living. At least I am freed (let me hope forever) of the drudgery of office work which so fretted during Pres. White's long absence from St. Louis. Neither the company nor I can afford my time and energies in clerk's work.

(Continued next month)

PRODUCTION AND UTILIZATION OF MICRO-RAYS

(Continued from Page 7)

case, it is introduced to maintain the same form as in the cylindrical electrode case. We assume that the oscillating electrode is oscillating. Opposite a certain point X of this electrode the voltage will be:

$$E_o \frac{r - r_a}{r_o - r_a}(1 + m_x \cos \omega t) \quad (1)$$

where m_x is a small quantity equal to the ratio of the assumed amplitude of the high frequency oscillation at point x to the D.C. potential impressed on the oscillating electrode and where

$$\omega = \frac{2\pi}{T} \quad (2)$$

T being the period of oscillation. We assume that the speed of the electrons is considerably smaller than the speed with which the electric field is propagated. From the fundamental equation:

$$m \frac{d^2 r}{d t^2} = \frac{\varepsilon E_o}{r_o - r_a}(1 + m_x \cos \omega t) \quad (3)$$

where m is the mass of the electron and ε its charge, we find by means of two integrations:

$$\frac{2m(r_o - r_a)^2}{\varepsilon E_o} = (t_o - t_a)^2 - \frac{2m_x}{\omega}(t_o - t_a)\sin \omega t_a - \frac{2m_x}{\omega^2}(\cos \omega t_o - \cos \omega t_a) \quad (4)$$

in which t_a is the time when the electron leaves the cathode and t_o the time when it reaches the oscillating electrode. If there were no oscillations, the time of transit to the oscillating electrode would be given by:

$$t_o - t_a = \sqrt{\frac{2\,m}{\varepsilon E_o}}(r_o - r_a) = A \quad (5)$$

As m_x is assumed to be a very small quantity, as it at any rate should be when we consider the initial phenomena, we find an approximate value of the time of transit under dynamic conditions by replacing $t_o - t_a$ by A in equation 4, which finally leads us to

$$t_1 = A\left\{1 + \frac{m_x}{\omega A}\sin \omega t_a - \frac{2m_x}{\omega^2 A^2}\sin\frac{\omega A}{2}\sin \omega\left\{t_a + \frac{A}{2}\right\}\right\} \quad (6)$$

t_1 is the time which electrons leaving the cathode at time t_a take to reach the oscillating electrode under dynamic conditions. Equation 6 shows that it fluctuates around the value A, which is the time of transit for static conditions. In this process, it will be seen that the density of electrons falling on point X will be variable with time according to the change of the time of transit between the cathode and the oscillating electrode.

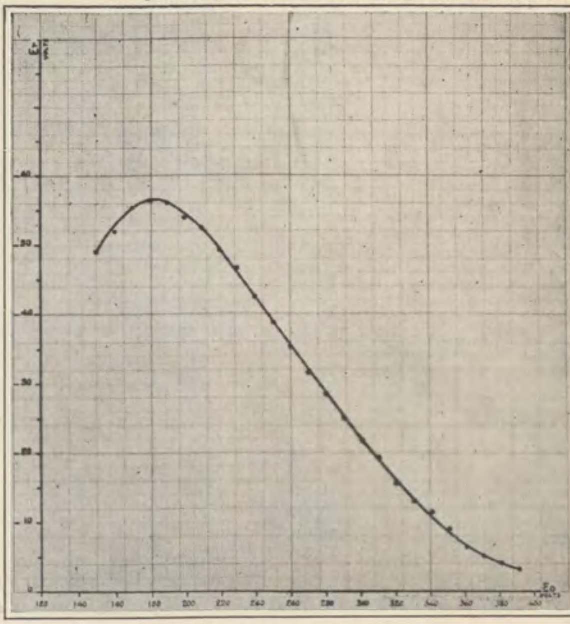


Fig. 4—Constant Frequency Curves

One electron leaving the filament at time t_a will reach the oscillating electrode at time $t_a + t_1$. Another starting at $t_a + \delta t_a$ will reach the oscillating electrode at time $t_a + t_1 + \delta t_a + \delta t_1$. Let the number of electrons sent off in interval δt_a be $\alpha . \delta t_a$. The density of the direct electron current falling on a length dx containing point X will be equal to

$$\frac{\alpha . \delta t_a}{\delta t_a + \delta t_1} = \alpha \frac{1}{1 + \frac{\delta t_1}{\delta t_a}} \quad (7)$$

and the direct electronic current on length dx may finally be written:

$$i_{dx} = \alpha\left\{1 - \left\{1 - \frac{\sin \omega A}{\omega A}\right\} m_x \cos \omega t_a - \frac{2\sin^2\frac{\omega A}{2}}{\omega A} m_x \sin \omega t_a\right\}.dx \quad (8)$$

Therefore, the high frequency component of this current is not in phase with the high frequency voltage at the point of the oscillating electrode under consideration (see equation 1). The phase difference as well as the amplitude of this high frequency component depend on the average time of transit of the electrons, i.e., on the dimensions of the tube and the D.C. voltage applied on the oscillating electrode.

4. Reflected Electron Current to the Oscillating Electrode (Plane Electrodes)

Those electrons which pass thru the meshes of the oscillating electrode, progressively lose their speed and finally come to rest in a region which may be considered as a virtual cathode, situated somewhere between the oscillating electrode and the reflecting electrode, the radius of which will be called r_r. The distance r_x where this virtual cathode will exist is not very different from the radius where the electrons would stop if there were no oscillation.

When the electrons cross the plane of the oscillating electrode their speed has an average value given by

$$\frac{1}{2} m v_o^2 = \varepsilon E_o \qquad (9)$$

Neglecting the effect of any space charge, the field between the oscillating electrode and the reflecting electrode will correspond at any radius r to the equation:

$$E = E_o - (E_o + E_r)\frac{r - r_o}{r_r - r_o} \qquad (10)$$

so that the distance r_x will be given by

$$\frac{1}{2} m v_o^2 = \varepsilon E_o = \varepsilon \frac{E_o + E_r}{r_r - r_o}(r_x - r_o). \qquad (11)$$

We have then for this virtual cathode the same process as we had for the real filament. The time of the transit of electrons between the virtual cathode and the oscillating electrode will fluctuate around a value B which corresponds to static conditions and will give rise to a reflected electron current variable with time, the value of which may be written

$$i_{r_x} = \beta \left\{ 1 - \left\{ 1 - \frac{\sin \omega B}{\omega B} \right\} m_x \cos \omega t_a - \frac{2 m_x \sin \frac{2\omega B}{2}}{\omega B} \sin \omega t_a \right\} dx \qquad (12)$$

where β is a constant characterising the emission of the virtual cathode as α did for the real filament.

The factors α and β give the relative importance of the direct and reflected current in the total electron current falling on point X of the oscillating electrode.

5. Total Electron Current and Negative Leakance Effect

At the point of the oscillating electrode which we have considered there will be a leakage current per length dx equal to the sum of those parts of the direct electron current and reflected

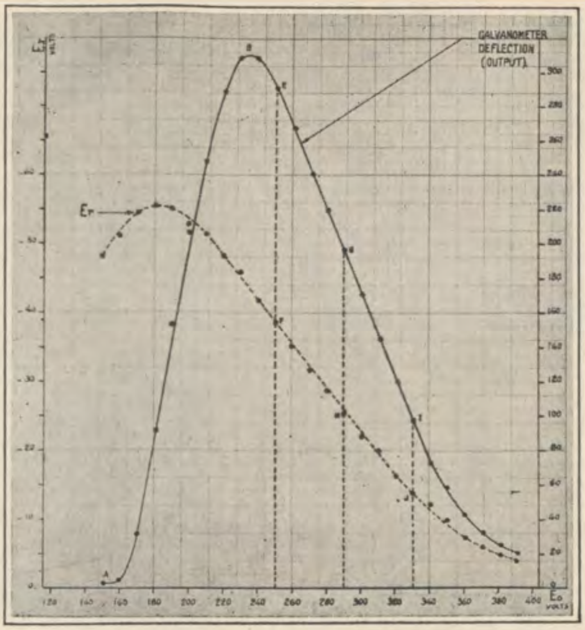


Fig. 5—Variation of Output Along Constant Frequency Curve

electron current that fall on the oscillating electrode. That is to say this current will be

$$i_{dx} + i_{r_x} \qquad (13)$$

As the filament gives its saturation current, the integration of the mean value of the above expression along the oscillating electrode equals the saturation current I_o, i.e.,

$$(\alpha + \beta)\,\Lambda = I_o \qquad (14)$$

where Λ is the length of the oscillating electrode.

The electron current which falls on dx can finally be written

$$i_x = \frac{I_o}{\Lambda} dx - \frac{I_o}{\Lambda} m_x \cos \omega t \left\{ \left\{ 1 - \frac{\sin \omega A}{\omega A} \right\} \frac{\alpha}{\alpha+\beta} + \left\{ 1 - \frac{\sin \omega B}{\omega B} \right\} \frac{\beta}{\alpha+\beta} \right\} dx$$

$$- \frac{I_o}{\Lambda} m_x \sin \omega t \left\{ \frac{2 \sin^2 \frac{\omega A}{2}}{\omega A} \frac{\alpha}{\alpha+\beta} + \frac{2 \sin^2 \frac{\omega B}{2}}{\omega B} \frac{\beta}{\alpha+\beta} \right\} dx \qquad (15)$$

This indicates that at point X of the oscillating electrode there exists a negative leakance per unit length equal to

$$\frac{I_0}{A\,E_0}\left\{\left\{1-\frac{\sin\omega A}{\omega A}\right\}\frac{\alpha}{\alpha+\beta}+\left\{1-\frac{\sin\omega B}{\omega B}\right\}\frac{\beta}{\alpha+\beta}\right\} \qquad (16)$$

This explains the possibility of oscillations being sustained provided the integrated effect of that negative leakance along the oscillating electrode more than compensates for the damping resistance in the oscillating circuit.

6. Case of Cylindrical Electrodes

The analysis of the above process for the plane electrode case suggests a similar explanation for the actual case of cylindrical electrodes.

In the space between the filament and the oscillating electrode the distribution of potential will be

$$E_0\frac{\log\frac{r}{r_a}}{\log\frac{r_0}{r_a}} \qquad (17)$$

and fundamental equation 3 becomes

$$m\frac{d^2r}{dr^2}=\frac{\varepsilon E_0}{r\log\frac{r_0}{r_a}}(1+m_x\cos\omega t) \qquad (18)$$

It is thus seen that the case is rather widely different from the plane electrode case, as the static electric field strength varies considerably between the filament and the oscillating electrode, in fact in the ratio of $\frac{r_0}{r_a}$ which, in the case of the tubes we have mainly experimented on, is equal to 24.

As equation 18 leads to mathematical difficulties, we will simply assume that, as before, the density of electrons per length dx of the oscillating electrode will have a high frequency component giving a leakance g (ωA) without presupposing the sign of this quantity.

In the space between the oscillating electrode and the virtual cathode, the potential is distributed according to equation

$$E_0-E_0\frac{\log\frac{r}{r_0}}{\log\frac{r_x}{r_0}}=E_0\frac{\log\frac{r_x}{r}}{\log\frac{r_x}{r_0}} \qquad (19)$$

and the static field strength varies much less than in the space between the real filament and the oscillating electrode; in fact, for the type of tube we are considering, it varies in the ratio of 7 to 4. We thus approximate the plane electrode case much more closely and can reasonably assume that the fluctuating density of electrons due to the reflected current will lead to a conductance g (ωB), which will be a negative quantity.

We believe that oscillations occur in the system because the total conductance

$$g(\omega A)+g(\omega B) \qquad (20)$$

is negative when the voltages applied to the tube are suitable, and oscillations will be sustained in this case as in the plane electrode case provided the effect of this negative leakance along the length of the oscillating electrode more than compensates for the damping resistance in the oscillatory circuit.

This view is strongly supported by the experimental investigation of the tube properties, to which we will now turn our attention.

7. Constant Frequency Curves

We have found that for a certain external circuit, that is to say for a definite length of the transmission line leading to the doublet, there is one particular frequency for which the tube gives its maximum output. To find this optimum frequency we adjust the wave-meter for different wavelengths in a suitable range and for each wavelength adjust the voltages of the tube for maximum output, checking each time to ascentain that the maximum deflection of the galvanometer is not due to differences in amplitude for different frequencies. It is soon found that a particular setting is much better than any other—it corresponds to the above-mentioned optimum frequency.

For this optimum frequency we now plot what we call the constant frequency curve. This

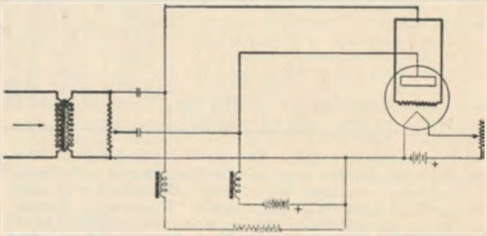


Fig 6—Amplitude Modulation of Micro-Ray Oscillator

curve gives the relation which must exist between the biasing voltage on the reflecting electrode and the voltage on the oscillating electrode to produce the optimum frequency. The usual shape of such a curve is given in Figure 4.

The explanation we have given for the existence of a high frequency component in the leakage current along the oscillating electrode readily gives an explanation for the constant frequency curves. For any given value of the voltage on the oscillating electrode, A will have a fixed value and the energy which will be available in the system for sustaining the oscillations will depend on B. The best condition will correspond to the maximum negative value of

$$g(\omega A)+g(\omega B) \qquad (21)$$

and, as the first part is fixed, to the maximum negative value of

$$g(\omega B),$$

i.e., from equation 16 (in the case of plane electrodes) $\omega B=\frac{3\pi}{2}$ approximately. (22)

This means that for each particular adjustment the biasing voltage on the reflecting electrode will have to be adjusted so as to give a particular constant value to the average time of transit of electrons between the virtual cathode and the oscillating electrode. This average time of transit can be easily calculated by equaling the kinetic eneergy of the electron to the product of the charge and the potential drop. It is thus found that

$$B = \frac{1}{\sqrt{\frac{2 \varepsilon E_o}{m}}} \int_{r_o}^{r_x} \frac{dr}{\sqrt{1 - \frac{\log \frac{r}{r_o}}{\log \frac{r_x}{r_o}}}} \qquad (23)$$

It depends on both E_a and E_r which determines r_x and this gives the equation of the constant frequency curve, Fig. 6, as B should remain constant along the curve.

The extent to which such a conclusion is backed by experiment will be found in the following table:

EXPERIMENTAL QUANTITIES:		COMPUTED QUANTITIES:	
E_o volts	$-E_r$ volts	A(10^{-9}Sec)	B(10^{-9}Sec)
150	—57.0	0.30	0.37
200	—52.0	0.26	0.365
220	—45.0	0.25	0.37
250	—34.5	0.23	0.375
300	—19.5	0.21	0.38
350	— 9.0	0.20	0.375
400	— 1.5	0.18	0.38

Observations: $\lambda = 18.4$ cm. $T = .61$ (10^{-9} Sec). Max. output shown above.

This table gives the corresponding values of E_o and E_r for one of the numerous constant frequency curves we have plotted for tubes of widely differing structures. The value found for B from formula 23 is not very different from the value which would be obtained by identifying the present case with the case of the plane electrodes.

If for every value of A we adjust the bias of the reflecting electrode so as to reproduce the optimum frequency of the tube, it is found that the output given by the tube varies and goes through a maximum, as shown in Figure 5. This maximum corresponds to the value of A which gives to g (ωA) the optimum value, corresponding to the maximum negative value of g (ωA) + g (ωB).

In all the experiments considered above, the filament current is kept at a constant value.

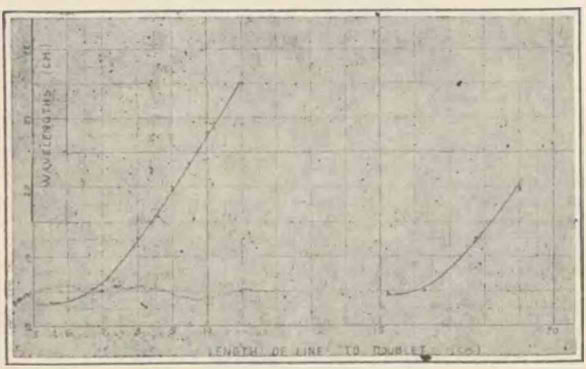


Fig. 7—Experimental Variation of Wavelength With External Circuit

This is so chosen that the dissipation on the oscillating electrode never exceeds a reasonable value.

8. Application of Constant Frequency Curves to Amplitude Modulation

The constant frequency curves are very important for the correct utilization of the microray tube. For instance, they give the possibility of obtaining amplitude modulation. In Figure 5, the right-hand side of the curve shows that the output there varies almost linearly in a certain region provided the relation between E_a and E_r follows the law indicated by Figure 4. Now this law gives also a linear relation between the two voltages. It is thus possible to apply the modulation voltage on both electrodes in such a way as to keep the correct relation between the voltages applied on the tube, and consequently the same frequency. It will thus be generally possible to obtain at least a 40% amplitude modulation (Figure 6).

9. Influence of External Circuit

The power which the electronic process inside the tube makes available is dissipated in the external circuit comprising, as already explained, a short transmission line leading to a radiating doublet.

Oscillations are sustained provided the apparent resistance as viewed from the tube does not exceed the negative resistance produced by the difference of phase between the leakage current and the high frequency voltage along the oscillating electrode.

Supposing this condition to be fulfilled, the optimum frequency will be obtained when the oscillatory circuit is resonant on that frequency for which the electronic phenomena inside the tubes are adjusted.

In order to express this last condition, we may consider that the tube is equivalent to a source of energy the internal reactance of which would be equal to the reactance of a short-circuited line having a wire length equal to the length of the wire of the oscillating electrode. The characteristic impedance of that line is not easy to determine, but we may assume for the sake of simplicity that it is not far different from the characteristic impedance of the transmission line which leads to the doublet. If this be the case, the condition for adjustment of the external circuit would simply be written:

$$\frac{A}{\lambda_1} + \frac{2\,l}{\lambda_2} = M \qquad (24)$$

In equation 24 M is equal to any integer. Assuming again that the wavelength along the transmission line is not very different from the wavelength along the wire of the oscillating electrode, we finally get:

$$\lambda = \frac{A + 2\,l}{M} \qquad (25)$$

This should be considered as an approximation and gives a linear relation between the wavelength and the length of the transmission line. Figure 7 shows some of the results given by experiment.

It is to be expected that variation of the length of wire in the oscillating electrode will bring about a change of the range of wavelengths produced by the tube. The following table gives a certain number of experimental results obtained on tubes, for which the length of wire of the oscillating

(Continued on Page 20)

THIRD REPORT OF LIAISON COMMITTEE ON AERONAUTIC RADIO RESEARCH

I. INTRODUCTION

This committee has functioned steadily in accordance with its announced purpose since its organization at the end of 1929 by the Aeronautics Branch of the Department of Commerce. That purpose is to assist in focusing the aeronautic radio research work of governmental and industrial organization on the early solution of the most pressing problems with a minimum of duplication of effort. The committee has to do primarily with aeronautic radio research and concerns itself with air navigational aids other than radio only to the extent necessary to coordinate research and development in aeronautic radio with progress in other fields.

Following is a list of the members of the committee and the organizations by which they were designated.

Harry H. Blee, director of aeronautic development, Department of Commerce, chairman.

Dr. J. H. Dellinger, Research Division, Aeronautics Branch, Department of Commerce, secretary (H. Diamond, alternate).

Capt. A. F. Hegenberger, Air Corps, War Department (Lieut. Walter B. Hough, alternate).

F. C. Hingsburg, Airways Division, Aeronautics Branch, Department of Commerce (H. J. Walls, alternate).

Thorp Hiscock, Aeronautical Chamber of Commerce of America (H. G. Leuteritz, alternate).

Herbert Hoover, Jr., American Engineering Council (Paul Goldsborough, alternate).

Dr. Lewis M. Hull, Radio Manufacturers Association.

George W. Lewis, National Advisory Committee for Aeronautics.

Lieut. Commander A. I. Price, Bureau of Aeronautics, Navy Department (Lieut. G. H. DeBaun, alternate).

F. M. Ryan, Institute of Radio Engineers (C. C. Shangraw, alternate).

Ray Stearns, National Electrical Manufacturers Association (D. G. Little, alternate).

The first report of the committee, issued June 1, 1930, included a statement of governmental and other requirements affecting this field of research, a survey of research in progress on aeronautic radio problems, and preliminary conclusions and recommendations as to the direction of such research in the future.

The committee's second report issued October 15, 1931, reported the progress of aeronautic radio research since the publication of the first report. The present report similarly summarizes the trend of development in this field since the date of the second report. Much specific information on many of the items reported herein is given in the publications listed in the Appendix.

II. COMMUNICATION IN AERONAUTICS

A. MEDIUM FREQUENCIES (100 TO 1,500 KILOCYCLES)

Extensive experience has been accumulated in the use of these frequencies in airplane operation, largely in air transport work with the Department of Commerce system of radio aids to air navigation. In this system ground transmitting stations give information by radio telephony and also radio range-beacon signals to airplanes in flight, on frequencies between 200 and 365 kilocycles. Certain frequencies up to 550 kilocycles are used in two-way aircraft communication, particularly in over-water service.

An improved 2-kilowatt telephone and telegraph transmitter was designed and a number of these units were supplied to the Department of Commerce. This design provides the most modern performance features, such as 100 percent telephone modulation from a high-efficiency class B modulator which gives a total of less than 6 percent audio harmonic distortion. Radio-frequency harmonics are minimized by a special design of harmonic filter and the arrangement also makes possible continuous variation of output coupling while power is on the transmitter. Plate and bias power supplies are obtained from mercury-vapor rectifiers which are included in the transmitter unit. No rotating equipment is necessary.

There was progress in the development of the combined radio-telephone and range-beacon transmitter, and one of these units was installed at Elizabeth, N. J. The Aeronautics Branch experimented on the use of this system with the T-L antenna described in section IIIB. The new antenna was found to be advantageous, simplifying adjustments of the transmitter and improving the reliability of both the telephony and the beacon signals. Improvements were made in the operation of the transmitter through the development of an oscillographic method to secure optimum adjustment of the component units. Flight tests were made which demonstrated the improved performance.

There were a number of advances in the development of airplane radio receiving apparatus. Automatic volume control was applied to commercial receiving sets used for the range beacons. Improvements were made in the design of the pointer type of visual course indicator, reducing weight and size and rendering it more free from the effects of vibration and external interference. Improvements were made in methods and equipment for calibrating visual indicators of the reed type. A study of such indicators showed that they retain their calibration with satisfactory constancy. Specifications were prepared by the Aeronautics Branch, for use by radio manufacturers and air transport operators, on airplane radio receiving equipment for the visual radio range-beacon system, the combined phone and beacon system, and the radio system of blind landing aids.

A beginning was made in the manufacture of receiving sets for the combined phone and beacon system. These receiving sets have an output of 500 milliwatts with less than 10 percent total harmonic distortion, a value higher than common with the previous airplane receiving sets. This output allows a number of headphones or reed indicators to be operated on the output of the receiving set at the same time without overloading. The receiving set was designed to keep cross modulation and harmonic distortion to a minmum. It has an automatic volume control which allows the input voltage to vary from 15 to 450,000 microvolts without the output changing more than 50 percent. The automatic volume control does not interfere with voice reception.

One manufacturer began the development of a superheterodyne type of radio receiver to cover these frequencies with push button or dial selection of stations. Fixed tuning is provided for a single frequency, enabling the operator to switch instantaneously to a frequency suitable for landing aids. All frequencies covered by a chain are available by selection. Conversion of the present beacon receivers presents some mechanical difficulties. The first step is to provide quick shift to 278 kilocycles for airport use. With the increase in number of stations, improved selectivity is mandatory. Greater selectivity practically demands locked tuning.

B. MEDIUM-HIGH FREQUENCIES (1,500 TO 6,000 KILOCYCLES)

In the period since the second report of the committee, there has been greatly increased use of the frequencies between 2,800 and 6,000 kilocycles for two-way plane-to-ground radio telephony on the scheduled air transport lines of the United States.

Considerable quantitative data, of a more or less routine nature, have been collected on wave propagation in this frequency range. While such data lead directly to conclusions on the characteristics of the radio medium between aircraft, and ground, and between aircraft, no conclusions have been reached which modify to any significant extent the previous conceptions generally held by those active in this field. The natural effect of the work has been to divert apparatus development mainly in the direction of electrical and structural refinement in existing equipment, rather than toward basic or fundamental changes.

The designs of aircraft radio receivers have been modified and improved to yield (a) less weight and space, together with greater ease of operation for a given electrical performance; (b) increased frequency coverage, with improved sensitivity in all bands; (c) improved selectivity characteristics; and (d) improved automatic volume control. Broadly speaking, no fundamentally new requirements have been found by the operating agencies of a nature calculated to demand wide departures from existing practice either in frequency or in other primary apparatus characteristics. The requirements originating with the users of radio equipment have been confined to such items as (a) longer life; (b) physical simplification, conducive to lowered maintenance costs; (c) simplified operation.

There has also been a large increase in the amount of night flying and the practice of using two frequencies, one for day operation and one for night, has become general. Frequencies between 4,900 and 5,700 kilocycles are now ordinarily used in the daytime, and frequencies from 2,900 to 3,500 kilocycles are usually employed for night communication. The changing from day to night frequency or vice versa simultaneously in all planes over an extensive airway has become a serious operating problem. This problem has been solved by the development of new airplanes transmitting and receiving equipment capable of rapid adjustment to either day or night frequency while the airplane is in flight.

The receiving set of this new equipment is of the superheterodyne type and of very great selectivity. This makes possible the simultaneous use of nearby frequency channels for aviation telephony, thus facilitating the handling of the increased traffic. The new equipment is so designed that its operation and maintenance is much simplified over that heretofore available. For example, the radio receiver circuits are pretuned to two operating frequencies and the beating oscillator held constant at the correct frequency by means of quartz crystal control. The radio receiver is also provided with wide-range automatic volume control, thereby practically eliminating the need of manual volume adjustment. Transmitter adjustments are greatly simplified by the use of screen grid tube, avoiding the necessity of neutralization and the employment of interstage coupling units having bandpass characteristics.

(Continued next month)

PRODUCTION AND UTILIZATION OF MICRO-RAYS

(Continued from Page 18)

electrode was decreased, but the diameter kept constant. As shown in the table, the need to adjust the average time of transit of electrons between the filament and the oscillating electrode leads to an increase of D.C. voltage applied on the oscillating electrode and consequently to a bigger dissipation. A better alternative to get shorter wavelength is to reduce the diameter of the oscillating electrode as much as possible.

Tube No.	No of Turns of Oscillating Electrode	Λ	Optimum Experimental Wavelength	Tube Adjustments		
				E_o	I_o	$-E_r$
1054	20		19.32	250	60	32
1055	20	23.1	19.90	220	60	29
1059	20		19.10	230	60	28
1072	18		18.00	270	60	49
1076	18	20	18.04	280	60	47
1084	16		16.82	310	70	39
1085	16	18.5	17.22	280	60	23
1086	16		16.90	300	60	35
1089	14		14.72	390	40	36
1092	14	15.4	14.72	380	50	29

10. Use of a Transmission Line Between Tube Circuit and Radiating System

The system considered above was used for the experiments between Dover and Calais on March 31, 1931. The doublet was placed at the focus of a paraboloidal reflector; it has been found in certain cases that it would be more convenient to locate the transmitting or receiving tube behind this reflector in order to control or change the tubes more easily. This can be done by means of a transmission line which connects the oscillating circuit to the radiating system, which can take the shape of a half wave-length antenna.

As previous experiments have shown that replacing the doublet, which is of low resistance, by a half-wave antenna in the experimental system shown above in Figure 2 did not give quite as good results, it has been found necessary to step down the resistance offered by the half-wave antenna, and this may be done with a quarter wavelength transmission line, the characteristic impedance of which is properly chosen. It is also essential to avoid all undue losses, especially radiation losses in the tube oscillating circuit.

Though secondary factors are certainly involved in the behaviour of the micro-ray tube on which we have experimented, the assumptions considered above give at least an explanation of the main experimental results and lead to a correct dimensioning of tube elements and circuits.

American Radio Telegraphists Association News

All communications for The American Radio Telegraphists Association should be addressed to Hoyt S. Haddock, President of the Association, 20 Irving Place, New York City.

AUTHORIZED DELEGATES

Boston, Massachusetts.
Richard J. Golden, Box 1426
Charles W. Marsh, 28 Westland Ave.
Beaumont, Texas.
Clyde B. Trevey, Box 798.
Miami, Florida.
D. L. Scanlon, 1575 Drexel Ave.
D. W. Scott, 1637 W. 55th Street.
Kake, Alaska.
Rollie B Weiss, Alaska Pacific Salmon Corp.
Seattle, Washington
W. C. Connell, Harbor Radio KPE, Pier 1.
Chicago, Ill.
Sumner S. Loomis, 1126 Ainslee St.
Tampa, Florida.
J. A. Campbell, 100 Magnolia Ave.
Buffalo, N. Y.
Harold Smith, 223 Erie Street
Los Angeles, Calif.
M. L. Schaefer, 514 West 55th St.
Philadelphia, Penn.
Charles W. Thumm, 2825 Chalmers Ave.

Radio Operators On Industrial Recovery

I

INTRODUCTION

1. In a spirit of appreciation, approval, and of fullest cooperation, in answer to the challenge to labor to accept the new charter of rights, and in accordance with the suggestions of President Roosevelt and the policies of the National Industrial Recovery Act to encourage national industrial recovery, to foster fair competition, to provide for the construction of certain useful public works and for other purposes as agreed to in conferences, we herewith submit for approval a code of fair competition and working conditions for the Commercial Radio Operating Profession.

2. We, the American Radio Telegraphists Association, Inc., which is an association of, for, and by the American Commercial Radio Operator, wish to file the following information relating to the activities of this Association in order that we may be entitled to receive the benefits of the provisions of the National Industrial Recovery Act.

3. This Association was incorporated under the laws of the state of New York on the 16th day of September, 1931, to raise and maintain the social, technical, and economic status of the American Commercial Radio Operating Profession, to protect the interests of American Licensed Commercial Radio Operators, and to perform any service which may assist in raising the standards of commercial Radio Work or in securing improved conditions.

4. Any person holding a valid Commercial Radio License of any class issued by the Federal Radio Commission is eligible to active membership in this Association. Any person interested in Commercial Radio is eligible to Associate membership in this Association. Any person, so elected by the membership of this Association, is eligible to Honorary membership in this Association.

5. Members of this Association have made application for membership of their own volition, and at no time has coercion or discrimination been used in gaining members for this Association. This Association is in no way whatsoever connected with, or influenced by any employers or their agents.

6. We have voluntarily chosen as our representatives for collective bargaining:
(1) Hoyt S. Haddock
(2) Edward A. Vosseler

II

DEFINITIONS

1. The term "Radio Operator" as used herein means any person who holds a valid Commercial Radio Operator's License of any class as issued by the Federal Radio Commission.

2. The term "fixed station" as used herein means any radio-transmitting apparatus used at a particular location for any class of service and operated under a single instrument of authorization, this location being permanently located on land, other than an ammteur station.

3. The term "mobile station" as used herein means any station that is capable of being moved and ordinarily does move.

4. The term "employer" as used herein means any individual, company, trust, corporation, or government, or their agent who in anyway whatsoever obtains the service or services of any Radio Operator.

5. The term "franking privileges" as used herein means the practice of allowing any person to file for transmission by any radio service anything at a rate which is below the standard rate agreed upon or set by the government.

6. The term "press service" as used herein means that news transmitted for reception by any station.

7. The term "aircraft station" is any mobile station on board an aircraft.

8. The term "class A vessel" is used herein

to mean any seagoing vessel required by law to carry radio.

9. The term "class B vessel" is used herein to mean any seagoing vessel of 5000 or over gross tonnage that is not required by law to carry radio.

10. The term "class C vessel" is used herein to mean any seagoing vessel of 1,600 to 5,000 gross tonnage that is not required by law to carry radio.

11. The term "Chief Radio Operator" is used herein to mean the operator in charge of any station.

12. The term "2nd Radio Operator" is used herein to mean the Radio Operator who is second in charge at any station.

13. The term "3rd Radio Operator" is used here in to mean the Radio Operator who is third in charge at any station.

14. The term "subsequent Radio Operator" is used herein to mean any Radio Operator other than the Chief, 2nd, or 3rd Radio Operator at any station.

15. The term "quarters" is used herein to mean any lodgings afforded any Radio Operator in connection with his duty.

16. The term "subsistence" is used herein to mean any compensation whatsoever made to any Radio Operator in connection with quarters or food or both.

III
MAXIMUM HOURS OF LABOR

1. The maximum number of hours of service of any Radio Operator engaged or employed at any mobile station shall be eight in each calendar day. No Radio Operator engaged or employed at a mobile station shall be required to work more than 8 hours in any period of twenty-four hours, excepting only in case of dire necessity, in which event any Radio Operator may be required to perform services of a period in excess of the maximum number of hours of service, as defined in this section, the Radio Operator shall receive from the employer compensation at a rate which shall be double the rate herein prescribed for service.

2. The maximum number of hours of service of a Radio Operator engaged or employed at a fixed station shall be thirty-six hours in each calendar week, which hours of service shall be so arranged that no Radio Operator will be required to perform more than eight hours service in any period of twenty-four hours. For all services rendered in excess of the maximum number of hours of service, as defined in this section, the Radio Operator shall receive from the employer compensation at a rate which shall be double the rate herein prescribed for service.

IV
MINIMUM RATES OF PAY

1. The minimum compensation which shall be paid by any employer to any Radio Operator engaged or employed at a mobile station shall be at the following rates, together with quarters and substinence as herein prescribed:

(1) The Chief Radio Operator employed at a mobile station of a class A vessel shall receive a minimum wage of $200.00 per month.
(2) The Chief Radio Operator employed at a mobile station of a class B vessel shall receive a minimum wage of $175.00 per month.
(3) The Chief Radio Operator employed at a mobile station of a class C vessel shall receive a minimum wage of $165.00 per month.
(4) The 2nd Radio Operator employed at a mobile station of a class A vessel shall receive a minimum wage of $190.00 per month.
(5) The 2nd Radio Operator employed at a mobile station of a class B vessel shall receive a minimum wage of $125.00 per month.
(6) The 3rd Radio Operator employed at a mobile station of a class A vessel shall receive a minimum wage of $165.00 per month.
(7) Any subsequent Radio Operator employed at a mobile station of any class vessel shall receive a minimum wage of $125.00 per month.

2. The minimum compensation which shall be paid by any employer to any Radio Operator engaged or employed at a fixed station shall be at the following rates:

(1) Chief Radio Operator $250.00 per month.
(2) Second Radio Operator $235.00 per month.
(3) Third Radio Operator $225.00 per month.
(4) Subsequent Radio Operators $200.00 per month.

3. No employer shall supply or contract to supply any Radio Operator for any wage which
4. A Radio Operator employed on a vessel the
is below the prescribed minimum wage.
cargo of which renders the vessel particularly susceptible to fatal accidents or the cargo of which is of such a nature that employment upon such a vessel is detrimental to health i.e., vessels carrying cargoes of oil, ores, sulphur, creosote, molasses, copra, etc., shall receive in addition to his salary a compensation equal to ten percent of the minimum salary.

5. A Radio Operator engaged or employed on any aircraft shall receive in addition to his regular salary a subsistence and quarters allowance which shall be equivalent to fifty percent of his base salary, if such quarters and food are not supplied aboard such an aircraft, and the minimum compensation which shall be paid by any employer to any Radio Operator engaged or employed at any mobile station aboard any aircraft shall be $165.00 per month.

6. At any time a Radio Operator is requested or required to report at any office in connection with his duties he is to receive compensation equivalent to the transportation fares for the trip to and from the office.

V
GENERAL

1. The Radio Operator aboard a seagoing vessel shall receive the same respect, consideration, and/or privileges as other senior officers, vacation privileges included. This section shall not be interpreted as conferring upon the Radio Operator any executive authority other than in the Radio Department.

2. The Radio Department aboard seagoing vessels shall be a separate department, and the personnel of the Radio Department shall rank with the senior deck and engineer officers and the Chief Radio Operator shall be the head of the Radio Department.

3. In the future employers shall be required to consult with and negotiate with a representative chosen by the American Radio Telegraphists Association, Inc., on any and all matters that may affect the Commercial Radio Operator's working conditions in any way.

4. All franking privileges shall be abolished.

5. No Radio Operator shall pursue or be required to pursue any duty or duties whatsoever at any mobile station at any time other than radio operating and specifically the Radio Operator shall not be engaged or employed as a departmental operator such as mate-operator, purser-operator, clerk-operator, captain-operator, seaman-operator, etc.

6. Quarters supplied Radio Operators on seagoing vessels shall be free of all radio apparatus, machinery, or equipment. Such quarters shall be well ventilated, well lighted, contain accomodations for the proper storage of the Radio Operator's clothing and other personal effects, and not more than one Radio Operator shall occupy one room.

7. No Radio Operator shall be required to

(Continued on Page 32)

Veteran Wireless Operators Association News

(Note: All communications to the V. W. O. A. should be addressed to WILLIAM J. McGONIGLE, Office of the Secretary, 112 Willoughby Ave., Brooklyn, N. Y.

Ye Secretary has just returned from a six weeks' cruise down Chile way to find that the weather up here (NY) seems determined to shame the heat of the tropics. At the present writing the thermometer should be on the way off-scale. It must be at least 120 degrees in the shade—and no shade. Oh! what wouldn't we give for a return to that nice spicy fall weather we encountered in Santiago, Chile. And by the way—who do you suppose we met down there? None other than OLE' UDA B. ROSS, formerly Radio Editor of the Evening Telegram before it merged with the World. He is Manager of the Western Electric Company for both Peru and Chile having complete supervision of all talkie movies installed by that company in those countries. He wishes to be remembered to his innumerable friends in the radio fraternity here in the states. Mail addressed to him c/o Western Electric Company of Chile, Santiago, Chile, will be most welcome.

Our good member E. J. Stenman is still confined to the Marine Hospital in San Francisco. We urge fellow operators, whether known to him or not, to drop up and cheer him with the news of the workaday world. He will sure be glad to see you.

A cheery letter from George Clark, who is handling the RCA display, in addition to representing the VWOA, at the Century of Progress Exposition in Chicago. He says there have been many, many VETERAN operators in to see him since the opening of the exposition. We hope to get out to see George before the Exposition closes shop.

Karl Daarslag has been, for the past few months attached to the Yacht Chalena which, judging from the cards received must be making a Scandinavian cruise. The last one we received was postmarked HELL. We look forward to greeting Karl on his return from a truly amazing expedition. We are of the belief that he had no idea that he would ever go there and return to give us advance notice.

Scott G. Hopkins now operates the radio aboard the SS R. G. Stewart of the Standard Shipping Company running to South American ports... Ted Hauber, our Memorial Committee chairman, is connected with the R. K. Carter Company with headquarters in New York City ... Peter Podell has moved to 2819 Morris Avenue, NYC... In a recent letter W. G. Richards, Publicity Manager of the Marconi International Marine Communication Company Ltd., of London, England, expresses his interest in our Association and willingness to co-operate in the furtherance of our ideals. For which we sincerely thank him... A long and interesting letter from Don Harris, operator aboard the SS Grays Harbor which plys between Seattle and the Orient, in which he commends the work of the Japanese operator aboard the SS Oregon Maru in the rescue of the survivors of the SS Nevada. Our Association awarded a Testimonial Scroll to Moichiro Hida, the operator in question, at our last Annual Dinner... We are ever anxious to obtain reports on the work performed by radio operators in safeguarding life at sea. Complete details should be included for our files. Address all communications to the secretary at the above address.

Ye Secretary accompanied by our Treasurer, V. H. C. Eberlin, 2nd, had the pleasure of showing the sights of the GREATER CITY to Mr. Hida on his recent first visit to the metropolis. He seemed perfectly satisfied to view the Empire State Tower from atop a Fifth Avenue bus and despite our repeated urging we failed to inveigle him into making the trip to the tower. He demonstrated the true Oriental thoughtfulness by presenting Fred Muller, our president, with a Japanese "WATERGIRL" statue. The Secretary and Treasurer were the recipients each of a pure silk handkerchief. Mr. Hida commended American operators for their excellent radio operating. He wishes it to be known that he considers it a real pleasure to work American radio stations. He brought with him a message of felicitation from the officers of the Japanese Radio Operators Association.

Oscar Oehmen, radio operator aboard the Mail Boat the President, joins as a VETERAN member. Mr. Shannon, also on the staff of the President, did some excellent communications work in handling messages, to and from the Secretary, via amateur radio during the South American cruise. And as a result our interest in amateur radio has been reborn. Before many moons you may look for W2ASN-W2AEK back on the air from the office of the secretary. Should you hear us—tell us the truth about our sigs... Harry H. Olmstead writes from Texarkana (that's the place that enroaches on three state boundary lines—isn't it?) regretting that he was unable to be with us at the smoker. He expects to get to the Century of Progress. Good luck HHO... After a long silence we were pleased to again receive word from Alonzo S. Carroll, life member and a former director. He is now stationed on the Coast Guard Destroyer Herndon out of Boston... A. Caminetsky who sees to it that real TALK emanates from the talkies presented at the Tivoli Theatre in Brooklyn reports that his address has changed. He continues to reside in Brooklyn, however... Athan Cosmas, who has been running around the world for some few years now, hopes that he will be in port at the time of one of our future affairs. Unfortunately he missed the smoker as well as all of our previous functions ... Clinton F. Gluck, ENTERTAINER PAR EXCELLENCE, member of the operating staff at WJZ at Bound Brook, N. J., reports having enjoyed the STAG immensely. We sure enjoyed his efforts... H. R. Wright now "man's" the key on the SS Helen which runs from Baltimore south... Director Emery H. I. Lee, formerly acting Supervisor of Radio in New York, later transferred to the Detroit Supervisor's office is now located in Washington, D. C. We wish him luck in his new assignment . . . Benjamin G Tempest, who lives at the Lynmore while in New York, joins as a VETERAN member... Hoyt S. Haddock, President of the American Radio Telegraphists Association, recently joined as an Associate member . . . V. H. C. Eberlin, 2nd, our treasurer performed an excellent job of secretarying during our absence. Now it's time for him to take a vacation. Just at the time when we're ready for another one, too. We hope to get a group of the local mem-

DESIGN OF FILTERS FOR CARRIER PROGRAMME CIRCUITS

(Continued from Page 13)

placing the crystal by a capacity equal to C_{11} in Figure 2.

By a suitable choice of R_1 and R_2 the small dip in attenuation at the minimum value may be made negligible. The rapid rise between f_o and f_{oo} is then of the type required by the present problem, provided the reduction in attenuation outside this range is not too rapid to permit the main filter to attain the required value before the crystal attenuation becomes negligible. The series arrangement is suitable for the case in which the lower sideband is to be transmitted and the shunt condition for the upper sideband case.

If the attenuation due to the crystal in Figure 5 is expressed in terms of (f_{oo}—f_o) it is found that the difference between the attenuation at f_{oo} and that at frequencies well remote from f_{oo} is greatest when (f_{oo} — f_o is greatest while this quantity cannot possibly exceed a certain maximum value determined by the piezo-electric properties of quartz. Thus a family of curves for Figure 4a in which f_{oo} — f_o is decreased by adding capacity in parallel with the crystal would be as shown in Figure 6.

As the effect of a capacity in series with the crystal, such as that due to an air gap, may be shown to be equally adverse, it is evident that considerable precautions are necessary if the optimum results are to be obtained.

Operating Circuit

The crystal may be included between suitable resistance between the stages of a 2 valve resistance-coupled amplifier as shown in Figure 7. The resistances R_1, R_2, and R_3, together with the internal impedance of valve V_1, are chosen to give a circuit of suitable impedance.

The value of R_3 must be kept small compared with that of the grid-filament impedance, in order to ensure that the effective series reactance of the combination is very low compared with that of C_1 for the crystal, since otherwise the

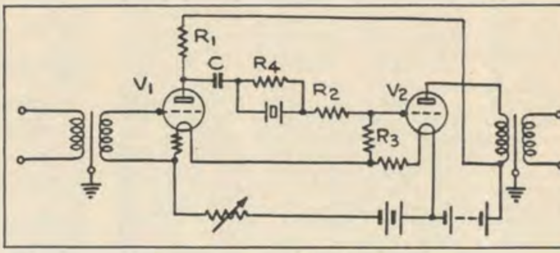


Figure 7

effective resonant frequency f_o will be increased.

The resistance R_4 serves to relieve the crystal of electrostatic stress due to the plate battery voltage, and the condenser C is merely a blocking condenser.

Results

Figure 8 shows three curves, obtained in the manner described, with the crystal in series with a total resistance of 200,000 ohms.

Curve (1) was taken with the crystal alone, i.e., as shown in Figure 7.

Curve (2) shows the effect of adding in parallel with the crystal a capacity having the value $\frac{1}{2}C_1$, the anti-resonant frequency being reduced but the resonant frequency remaining unchanged.

Curve (3) was taken with a small capacity in series with the crystal. It is seen that in this case it is the resonant frequency which is modified, the anti-resonant frequency being substantially unchanged. The importance of avoiding these capacities is thus experimentally verified.

With such a combination at each terminal of the carrier system working in conjunction with main filters in which a steep cut-off is obtained but undesirable reflection effects are minimized by means of suitable impedance correction, adequate discrimination against the unwanted sideband, even when allowance is made for the effect of temperature variation, can be obtained for input voice frequencies as low as 30 p:s.

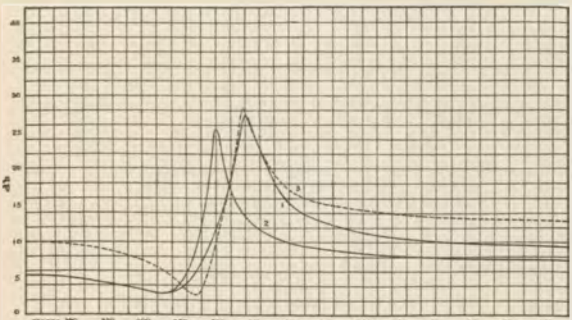


Figure 8

bers together before the summer is out for a trip SOMEWHERE. Further details will be included in the next issue of our Bulletin which will be out shortly

PLEASE NOTE CHANGE OF SECRETARY'S ADDRESS!!! ALL COMMUNICATIONS FOR THE ASSOCIATION SHOULD BE MAILED TO THE ABOVE ADDRESS. WHILE MAIL SENT TO OUR FORMER ADDRESS WILL BE FORWARDED, IT WILL EXPEDITE MATTERS IF THE ABOVE ADDRESS IS USED FOR ALL COMMUNICATIONS.

JUST BETWEEN OURSELVES

It is not easy to resist the pressure that is brought to bear for this or that cause. Boiling it all down, it is unfortunate that many interests become too closely involved in their own affairs to see the good the other fellow is doing.

"Live and let live," or again "A house set against itself cannot stand," should suffice as a worthy reminder that we do not intend to become embroiled, when a common purpose is claimed by those concerned. We hope the same attitude is adopted by every interest aiming in an honst way to better the affairs of "sparks."

SIMPILFICATION OF RADIO RANGE BEACON POSITION AND QUADRANT IDENTIFICATION

(Continued from Page 11)

con located at O, figure 1, on course OF. As long as he remains northeast of the beacon, he hears the 2 dots and the 3 dots loud. Upon passing over the beacon on to course OD southwest of the beacon, the 1 dot and the 4 dots become loud. Thus the beacon location may be found with an accuracy depending upon the frequency of transmission of the identification signals.

Figure 2 shows the four signals as sent in the four different directions, each with a directive characteristic of a cardioid. This directional characteristic is obtained by proper phasing of the currents in two opposite antennas of the T-L antenna system as now being installed at a number of radio range beacon stations. This phasing takes place within the beacon house, no changes to the antenna or transmission lines being necessary.

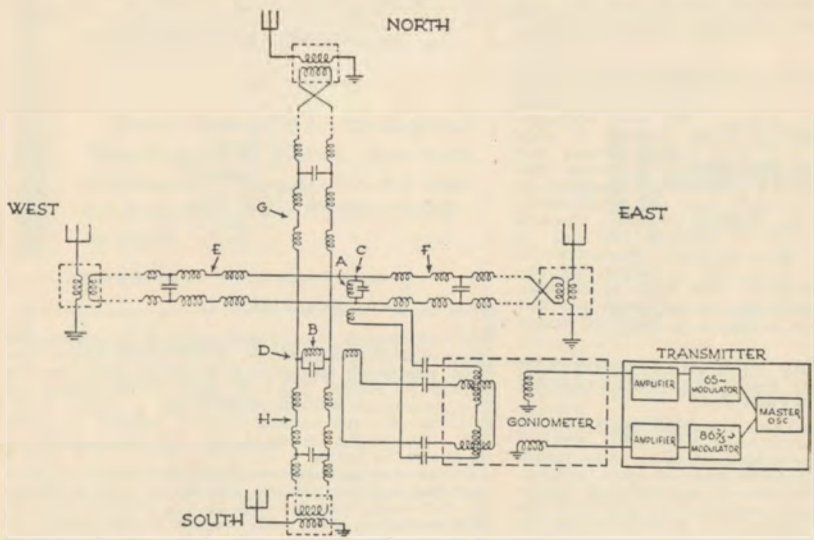


Figure 3.

1. APPLICATION TO THE VISUAL, AURAL, AND COMBINED VISUAL AND AURAL RADIO RANGE

The results thus far obtained indicate that this method of course and quadrant identification is applicable to either the aural, visual, or combined aural and visual radio range beacon system.

Aural System

In the case of the aural system, the set of cardioid directional identification signals is sent when the A and N course signals are interrupted for the transmission of the beacon station identification letter. The dot and 2-dot signals may be sent during one interruption and the 3-dot and 4-dot signals sent during the next interruption. About 2 seconds are required for the transmission of the dot and 2 dots and 3 seconds for the 3 and 4 dots. Each set should be repeated once requiring a total of 10 seconds every 2 or 3 minutes, as desired. The repetition is advisable especially in time of bad static. If resired, the four signals may be sent consecutively, but a time interval between the first two and the second two signals gives the pilot more time to interpret them. An advantage of sending the signals consecutively is that it doubles the frequency of their occurrence.

Visual System

In the case of the visual radio range beacon system, the double modulation 65-cycle and 86 2-3-cycle course signals are interrupted only for the time interval of each dot of the series of identification signals. During the spaces between the dots, the course signal is on again. The identification dot signals are purposely made of very short duration so that the course signals are interrupted for such a short interval of time that the reeds in the visual course indicator do not have time to drop except about one third their amplitude. As the reeds are equally damped, the relative amplitude of the two reeds does not change during this drop, so that the course indications of the reed indicator are not appreciably affected by the identification dot signals.

The effect of the identification signals is even less noticeable on the pointer type of course indication, as the high damping on the microammeter used as the course indicator, will not allow the needle to move appreciably during the very short interruption of the beacon course signals. Furthermore, when flying on course, as is usually the case, the needle is at its null position to which it normally returns when the course signal is not present, which is the case at the instant of sending the dots of the cardioid signal.

Combined Aural and Visual System

The application to this system is a combination of the application to the aural and visual systems. The aural course signals are interrupted for the space of time (10 seconds) required to send two sets of identification signals, while visual course signals are interrupted only for the period of each dot.

2. CIRCUIT ARRANGEMENT FOR SENDING THE CARDIOID DOT SIGNALS

One of the circuit arrangements used in applying this method of course and quadrant identification is shown in figure 3. The T-L type of beacon transmitting antenna system, described in the July 15, 1932, issue of Air Commerce Bulletin, is employed. The transmitter used in the tests was of the visual beacon type. The power from the transmitting set is coupled into the transmission lines through the coupling coils

A and B. With the coils A and B at the points C and D, respectively, the figure-of-eight course signals are sent. By moving coil A to point E and short-circuiting the north-south transmission lines, the phase relation of the currents in the east and west antennas is such that a cardioid directional signal is sent in a westerly direction. By moving coil A to point F, the phase relations are such that the cardioid signal is sent in an easterly direction. During these cardioid transmissions voltage of 1,000-cycle frequency is supplied to the modulator circuits of the transmitter instead of the usual 65-cycle and 86 2-3-cycle voltages. In a similar fashion, if coil B is moved to point G and the east and west transmission lines short-circuited, a cardioid signal is sent north, while when coil B is moved to point H, the cardioid signal is sent south.

In order to make the quick changes from the figure-of-eight transmission used for the beacon course signals to the cardioid dot signals and from the 65-cycle and 86 2-3-cycle modulation to 1,000-cycle modulation, a system of relays is used to throw the coupling coil A from point C to E or F and coupling coil B from point D to G or H, and also to throw 1,000-cycle modulation on the two modulators in the transmitter.

An improved circuit arrangement for accomplishing the directional transmissions has more recently been developed, but is not described here because of limited space. The new arrangement reduces considerably the amount of added equipment required and also provides for increased stability of the cardioid patterns. The arrangement employs a 3-winding transformer for feeding power to each pair of transmission lines, whereby the two vertical elements of each T-L antenna are made to radiate 180° out of phase to produce a figure-of-eight characteristic and simultaneously to radiate in phase for obtaining circular radiation. The ratio of circular to figure-of-eight radiation is adjusted so that the sum of the two produces a cardioid space pattern.

3. APPLICATION OF THE IDENTIFICATION SIGNALS TO THE ESTABLISHED AIRWAY RADIO RANGE SYSTEM.

The results of the experimental work on this system indicate that it may be readily applied to existing beacon stations of either the visual or aural types using the T-L antenna system. It requires no alterations to the antenna structure but merely adds relays and phasing sections in the transmission line circuits inside the beacon station house. A motor-driven code wheel is also required in the case of the visual beacon and a code wheel geared to the motor operating the interlocking A-N switch in the case of the aural beacon.

There are three methods of applying the cardioid transmissions to fit in with the established airways:

1. The simple cases where the T-L antennas are laid out along the four cardinal points of the compass, as shown in figures 1 and 2, in which case the 1 dot is always sent west, 2 dots east, 3 dots north, and 4 dots south.

2. Cases where the T-L antennas are laid out without any relation to the four cardinal points of the compass. There are two alternative methods under this heading:

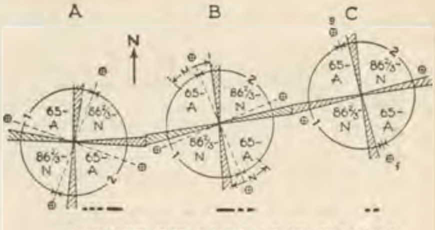
a. Either to transmit a cardioid signal from both T-L antenna systems simultaneously such that the resultant cardioid will be in a direction corresponding to a cardinal point of the compass, this being done for each of the four cardinal points of the compass resulting in cardioid signals as in case 1, or

b. To transmit the cardioid signal in the direction of the T-L antennas and provide the pilot with a set of rules and a map showing the direction of transmission of the cardioid signals for each beacon.

Of the two cases, a and b, the latter seems preferrable as the simultaneous transmission of two cardioids required in case a complicates the radio-transmitting equipment somewhat.

Information for Pilot's Chart

Considering case b therefore, where the cardioid signals are sent in four different directions not coinciding with the four cardinal points of



a-CHART FOR 1 DOT 2 DOT SIGNALS

b-CHART FOR 3 DOT 4 DOT SIGNALS

Figure 4.

the compass, it is only necessary to illustrate the direction of transmission of the coded identification signal on the pilot's chart of each beacon which he should have at hand to give him all the necessary information. Such a chart illustrating the application of this method to three beacons, designated as A, B, and C, respectively, is shown in figure 4. Here the Nos. 1, 2, 3, and 4 indicate the sectors where the dot signal of that number may be heard. The small circled crosses represent the lay-out of the four antennas, differently located with respect to the points of the compass in each case. Now, assume a pilot to be lost. From the beacon identification letter which, let us say is (D) — . ., he finds he is receiving the "B" radio range beacon. He also finds from his beacon course signal that he is in an A or 65-cycle quadrant. When the 1-dot and 2-dot quadrant and course cardioid identification are heard, see figure 4, at a, assume that the 1-dot and 2-dot signals are somewhere near equal in intensity; the pilot is either in the region M northwest of the beacon or in the region N southeast of the beacon. When the 3-dot and 4-dot signals are heard, figure 4 at b, the 3 dots are inaudible while the 4 dots are very loud. This immediately places the pilot definitely somewhere southeast of the "B" beacon, in the region N.

Even though the beacon may have bent courses as shown, the identification method holds good since a different combination of strong and weak signals will always be received on each different course and quadrant.

In a few special cases where the four courses are alined approximately along the lines of di-

(Continued on Page 32)

International Brotherhcod of Electrical Workers, Radio Division, Items:

Address all communications for International Brotherhood of Electrical Workers, Radio Division, to: Mr. Thomas R. McLean, Special Representative, International Brotherhood of Electrical Workers, 1200 Fifteenth St., N. W., Washington, D. C.

Mr. Frank E. Grade having resigned as paid New York Representative of radio operators, Mr. Lou Jurgensen has been appointed in his stead. Good luck Lou, we know you will work hard for us.

Agreements between our organization and broadcast station owners are rapidly being presented in order to speed up the functioning of NIRA. Shorter hours and a decent wage with better working conditions are being demanded.

International Special Radio Representative McLean, arrived in New York by plane from the West in order to adjust matters with officials of Columbia System who it is claimed are objecting to organization by their men.

Mr. McLean will take the part of broadcast operators, public address men, etc., on presentation of Radio Code. He will be ably supported by the legal minds and economic experts of the American Federation of Labor, who by this time have had considerable experience in the handling of such matters.

As regards representation of broadcast operators, if you have not already registered your name and station with the organization, you are invited to do so at once. It costs nothing but a postage stamp to have yourself represented during the discussion of a code before NIRA.

A definite code for broadcast operators is being prepared and modeled after the conditions existing in union operated stations of St. Louis, but in all probabilities when the time arrives it will narrow down to an agreement between station owners and organization representatives with NIRA as judges and finally an acceptance of the best terms procurable.

Union operators in St. Louis, Chicago, and other already organized points are asked to send in items for publication in our section of CQ each month to keep the boys informed.

In answer to many inquiries this radio division has been in existence for seven years and has had a traveling representative on the road for over three years. It has also had a representative in New York for the past four years.

We hope the sound men's situation in Hollywood will be adjusted soon to the satisfaction of all concerned. Frankly we do not like strikes and have only had two officially sanctioned strikes in seven years. A strike should be a last resort when all other negotiations fail absolutely.

A committee of seven representative members has been appointed in Greater New York to handle members' problems and for the conduct of general business of the local B.C. operator. Please register, whether you need an operator or a job.

Many old friends have called us up recently since we started activities in the New York area. Keep coming—we need each other.

FACED THE JINX OF THE BOBOLINK?

(Continued from Page 9)

the kaiserin' takes possession of my chair an' sits watchin me, hawk-eyed.

Tunin' down on phone waves, I bring in the San Jose Radio Shanty's wash-tub jazz clatter: "Yer gotter see mommer ev'ry night, tiddie de plunk, bananas and asncans—honk, konk, bolegna—

"Eliminate that!" snaps the old battle-axe, glarin at me, murderous-like.

"Excuse me," I murmurs, hastily. "I took it fer a Rigoletti op'ra. With this I proceeds to tune in "The Flies Loss-Ennghelles, Caleeforneea," whereupon from the loud-speaker busts out a roar of: "Desfaceradero de mee casa! Le vee besando-le ah mee moohair! Con coocheellyo le matar-r-r-e-e-e!"

"What do you mean by this, sir!" flares the kaiserin of the Bobolink. "I want you to tune in Kale Brothers, Inc., of San Francisco, where on the pipe-organ tonight Subein Gotchowski is going to play "The Soul Kiss."

"I'm sorry, but the Kale boys ain't broadcastin'," I replies, regretful as the Reichstag explainin' to the Frenchys about the war debt. "They've gone bankrupt buyin' pipes for their organ fast as old kid Gotchowski splits 'em."

With a hostile sniff, the empress of the Bobolink takes her departure. Relieved, I makes up my press news and send copies down to the messrooms.

The next evening I finds the younger Pirky in my shack rootin' into the ship's library, which is kept in a bookcase in the wireless house; and just as I come in I catch him deliberately tearing a page out of a book which is titled "Days and Nights on the Isthmus."

"I'm gettin' a couple of pictures that Zokur II wants to try to copy with one of his cameras," he says, fresh-like, when I call him on it. Zukor was one of the wipers that the kid had taken for a buddy. He had a ole rattle-trap camera machine that he shot moving pictures with

After landin' the kid roughly out on the boat-deck, I step down to the saloon pantry to get a cup of coffee, only to hear the shrill whistle of my motor-generator suddenly start up. Dashin' back up onto the boat-deck, I finds the old kas'erin in my shack again, while her kid Elmer is sittin' in my chair with the phones over his head an' his fingers on the key.

"Wha. th' Hades!" I begins—

"Cease that cursing, sir!" snaps the old battle-axe. "I'm having Elmer call up the station at Los Angeles to find out when Hamburgers Home Friend Furniture Company is going to broadcast the Reverend Sarah Hotstetter's sermon "Woman the Goddess; Man the Beast."

"By th' holy whiskers of Trotzky! You git out'a here, both a' you!" I yells; then grabbin' the mutt Elmer by the scuff of his neck, I slams him with a teeth-jarrin' bump against the opposite bulkhead.

"You wretch!" snarls the old shewolf of the Bobolink. Snatchin' up a heavy insulator, she lands me a crack over my dumbbell obligata that makes me see a shower of shootin' stars, followed by nothin' at all.

* * * * *

Two days out from the Canal, when on Ziegfield Stubbs' morning watch he and I are sittin' under a ventilator alongside the singing turbine havin' a checker battle on a greasy old home-made board which is kept hid behind the feed-pump when not in use.

Ziegfield, glancin' up at the gaugeboard overhead lets out a yell:

"My gor-y, lookit that steam—down twelve pounds!" Fumin' an' sputterin' he dashes out into the fireroom, and I, like a fool goat, follows. Steppin' out of the alleyway between the boilers, we see the fireman has one fire out, probably to change a burner tip, an' is tryin' start it again by squirtin' the hot crude oil from the burner nozzle onto the red glowing fire-brick in the furnace.

"Hi there, ya idjit—shut that off!" yells Ziegfield, furious-like. "Git a torch! Git a torch! Do ya want a blow-back—

At this instant, the furnace full of hot crude oil takes off with a terrific w-h-o-m! that kicks out the doors of the boiler-front an' sends us all skiddin' across the floor-plates in a blindin' swirl of flame an' fire-brick, while from overead comes the roar of a steamline blow-out.

"Goodnight!" howls Ziegfield—a dancin' Tasmanian devil painted with crude oil an' ashes, he grabs his monkey wrench an' vanishes into the smoke, while I spit out a couple chunks of hot brick an' crawl up topside through the steam an' smut.

Arriving on the boat-deck, I observes Adolph Zokur II up on top of a pile of life-rafts forward of my shack excitedly grindin' a picture of the big four-masted ex-German square-rigger Scharmbeck, which is standin' close abeam; and as we lunge and roll broadside to in the heavy sea with our engine stopped, our grimy young Greek cameraman gradually swings his machine around aft, following the big windjammer and at the same time sweeping the decks and topwork of the Bobolink.

Shortly after gettin' into my coop an' rubbin' off some of the oil an' soot plastered all over me, I gets a ring from the bridge to warn any nearby ships that we are lying hove to.

Upon lighting up my tubes, however, I discover a dead stillness on the ether, such as follows an SOS call. I waits a few minutes; then beginnin' to wonder if some ship is in distress, I steps in with a cautious CQ an' asks what all the earthquake is about.

"Where ye been—asleep!" crashes in a high-pitched oil-tank Hertz. "Didn't ya copy that QST a while ago?"

"No, what was it?" I replies.

"Here copy!" comes back the tanker brass-pounder; and he hands me the "largest landslide" that everybody has already heard about.

* * * * *

O'd Pirky turned in a message to New York asking for orders; but since a couple hundred other skippers have done the same thing there is now such a deadlock on the air that it looks like I'll have to wait a week to slip a dash in edgewise. Finally I resolves to come on wide open an' try to bust through to somewhere; but while screwin' up my transmitter to full power I does the hammy trick of gettin' a turn of my phone-cord around a clip on the quenched gap—an' when I shove on the key there is a crash like all of Ziegfield Stubbs' boilers have exploded in my ears, followed by a sensation that I am a' aviator full of bootleg writin' my name in th' sky over New York.

When Ziegfield with a bucket of icewater brings me to some time later lyin' under my desk with my head back of the motor-generator, I finds nothin' remainin' of my phone-cord but a streak of charcoal, while my four vacuum tubes have that glassy six-fifty-gonetohell look that we all know too well.

That settles the communication department of the Bobolink the rest of the way to Panama. Two nights later we creep into the bay at Balboa, expecting to find it choked up with a swelling fleet of delayed ships. We fail to see more than two or three anchor lights, however, and at daybreak we discover the harbor is empty save for a deeploaded Tide-Flat oil-tanker, a dirty Jap tramp with a list, an' a rust-streaked freighter of the Dollar-Squeezer Line. By this time, like old kid Marcellus, I am gettin' a strong hunch that somethin' is rotten in Denmark.

As the sun comes up glowing and hot from beyond the distant Colombian hills, the port doctor and canal pilots come out to us in their speedy white launches.

"How is the slide?" are our first words, as the pilot puts his white ducks over the rail.

"There is no slide!" he replied, wearily, as if his tongue was sore from repeating this thing.

"There is no slide!" echoes old Pirky an' a dozen others, astounded; then everybody turns loose a barrage of black looks in my direction.

"Have some strawberries, Sparks!" sneers old Pirky's kid Elmer, sarcastic-like.

"This is an outrageous sort of joke!" fumes the old she-wolf of the Bobolink, angrily. "Fred, you will remove that man from the radio room and let Elmer do his work the rest of the way to New York."

"How about that broadcast from Balboa?" I demands, cooly.

"It is a forgery," replies the pilot, "Balboa has been shut down five days for the installation of new equipment. That message was sent out from some ship; and eventually it will be known from what ship. The Canal army officials and the naval radio are investigating every vessel passing through the locks—here comes their boat, now."

Glancin' over the rail, I see a fast gray motorboat full of army an' navy gold stripers, and one civilian gink, comin' alongside. Directly they are aboard, a couple of them carrying bundles of charts an' papers. Callin' old Pirky aside, they all go up topside to the chart-room, while I return to my shack with a kind of ominous feelin' that somethin's goin' to happen.

And directly it does. Thirty minutes later I am called up into the chartroom, where I am confronted by five hard faces an' a pair of handcuffs.

"Mr. Jones, you are under arrest," announces the king-pin of the goldstripers, steely-like. "You are charged with originating and broadcasting this false radiogram of the Culebra slide, and with forging the call letters NBA as a signature."

"Say, look here, how do ya git this way?" I demands, backin' off. "Show me how you do your stuff!"

The gold-striper pauses a moment.

"Yes, I'll show you," he snaps. "When you began to transmit that message the naval listeners here on Ancon Hill realized at once that it was forgery and they applied their radio compass to your signals, while by quick action on the wire to Cape Mala we obtained another bearing on you from that station. It fortunately happens that the destroyer Zane and the scout-crusier Omaha, which are lying off the coast of Costa Rica carrying on some static experiments, became suspicious because your signals seemed too strong to be from NBA and also took bearings on you. From Balboa your signals bore 265 degrees true, from Cape Mala 283, from the Zane coming out of the Gulf of Nicoyo 190 plus, and from the Omaha off the Grande del Terraba River 242 plus. These bearings coincide accurately in a point in the Pacific in Latitude 8-31 North and 28-28 West. By reference to the log of the Steel Bobolink and a dead-reckoning calculation, we find this ship precisely in this position at 9:02 A. M., July 16th—the time when the false broadcast was completed."

For a minute, I am too dazed to say a word.

"There's somethin' wrong with those bearin's," I sputters, finally.

"You might claim that if we had only two of

them—but not when you've been caught on four compasses, and the readings agree as these do," snaps the gold-striper, pointing to the chart, where the four lines have been laid down.

"It's phony somewhere," I insists, desperately. "That message never came from this ship."

"That's for you to prove," returns the gold-striper, curtly. "Mr. James, the handcuffs."

The investigators were first going to pull me off the ship; but finding they have to take me to the States for a preliminary hearing before a radio inspector, they decide to keep me aboard the Bobolink with a guard, while a navy gadget is given special detail to pound the brass on the return from Cristobal to New York.

During the eight days of this passage I don't sit around an' bathe the deck carpet with tears, for by this time I have got a couple of ideas. Being allowed visitors, I call in Ziegfield Stubbs and instruct him to fetch me a certain book out of the ship's library.

"Now, Ziegfield," I tells him, when I have looked into the book and found what I wanted, "After supper this evening you swipe th' sugar bowl off the saloon table—the one up at old Pirky's end—

"My gorry, Sparky, I've jist thought of somethin'!" busts out Ziegfield, excited-like. "That German windjammer. Them navy compasses could be afoul of him, because he was close on us that mornin', an' Zokur's movin' pitchers'll prove it.!"

"I ain't forgot that," I replies. "The first chance you get, go back into the crew's quarters an' gather in every foot of Adolph Zokur's picture film you can find, and bring it up here."

The next morning the steward gives the saloon googoo a black eye over the missin' sugar bowl, believin' th' flunky has broke it an' threw it overboard, while Zokur II sets up a terrific howl over his stolen celluloid treasures; but since Ziegfield has passed all these things into my stateroom through a outside porthole, neither my guard nor anybody else dreamed I had them stowed under my bunk.

Upon our arrival in New York, where the front page of the newspapers already have me nine an' nine-tenths of the way into a tiger-striped uniform playin' rock-pile billiards with safe-crackers an' counterfeiters, I am visited by a officious young law-twister lurkin' behind a pair of Harold Lloyd spectacles, who has been sent down by my old friend kid Cunningham. This bird starts in explanin' how he's goinin' to pull off a lot of phony black-is-white stuff to save me from sojourning the rest of my life behind the gray stone walls.

"Say, look here, Bone-Shells," I cuts in on him, short-like. "Here's what you have to do: First, get me a copy of the 1916 edition of Arthur Bollard's book 'Days and Nights on the Isthmus'," then on the morning the big show starts in the radio inspector's office, have up there without fail Ziegfield Stubbs, his oiler, fireman, old Pirky's kid Elmer, the black-gang's Adolph Zokur II, a finger-print expert, a movin' picture machine an' a operator for it, and the log of the Steel Bobolink. Take this strip of negative motion-picture film I got here an' have a positive printed off it; bring it up also. Then we'll see who gets th' strawberries."

Ten o'clock in the morning, two days later, we are all assembled in the radio inspector's hangout down in the Battery customhouse—Elmer Pirky being accompanied, of course, by the kaiserin. In the opening scene of the first act, the army and navy gold-stripers show their charts, compass bearings, and the Steel Bobolink's position.

"This seems pretty conclusive evidence," observes the radio inspector, givin' me the cold eye "What have you to say in your defense, Mr. Jones?"

"Even so. I didn't send out that radiogram," I says cool-like; then I turns to the king-pin of the gold-stripers. "That fake broadcast was sent out at 9:02 A. M., wasn't it?"

"It was," he replies.

"All right I can prove by Ziegfield Stubbs, his oiler, an' his fireman, that from 8:30 to 9:05 I was down in the engine-room—er—helpin' Ziegfield to analyze a test-tube of boiler feed water—

"Huh—yuh can't prove that by me, though!" breaks in Adolph Zokur II, after exchangin' a quick glance with Pirky's kid Elmer. "I was cleanin' oil pans under the turbine, and you were sittin' under the ventilator playin' checkers with the third assistant until the blow-back in the fireroom, which was before nine o'clock. You went up then, and I never saw you after that, an' neither did anybody else in the engine-room!"

There is a tense silence, except for the grittin' of Ziegfield's teeth as he glares bloodthirsty-like at Zokur II.

"All right, we'll drop that a minute," I says, recovering myself; then I turn to the finger-print expert, whom Bone-Shells has brought, according to instructions.

"Will you take prints of both that snipe's thumbs please," I points at Elmer Pirky.

"Whaddaya tryin' to do!" snarls the kid, surly-like, as all eyes turn toward him. "Ya think you're goin' t' hang this on me just because I'm a radio amateur and happened to be on board with this Jones guy!"

"Indeed, the idea!" exclaims the old-she-wolf of the Bobolink, ferociously. "What does my Elmer know of Governor Belloc and stories of earth eruptions?" He is too innocent and open-minded even to think of such a cunning deceptive piece of forgery!"

"You're right, old rock jaw," I returns, cooly. "He didn't write it—he hasn't got brains enough."

"Come here and hold out your hand" breaks in the finger-printer, curtly, motioning young Pirky to a small table, where he has a couple of sheets of white paper, together with ink and roller. Reluctantly, Elmer Pirky comes forward, the finger-printer smears his left thumb with ink and rolls it over one of the pieces of paper on the table; then the same with the other.

"Now," I says, when this has been done. "I've got a book here by Arthur Bollard called "Days and Nights on the Isthmus," which it won't be hard to prove belongs to the ship library on the Bobolink. Page 173 has been torn out, as you can see, while here on page 175 is a thumb-print made by dirty, greasy hands. After looking at some prints on our saloon-table sugar bowl, I figure these are the same."

"They are of this Elmer Pirky," replies the finger-printer, who has taken the book. "They are unmistakably identical."

"Sweeto!" I replies. "Here's another copy of the same book, bought by Bone-Shells yesterday morning. This book is a story of the Isthmus of Panama and of the Canal, and on page 173, which has been torn out of the other one, is a copy of a telegram that was sent from the governor of the Canal Zone to Washington, D. C., on the morning of September 18, 1915, the date of the big slide that actually did close the Canal for seven months. And, except for the name of the governor, that telegram is word for word the forged message that was sent out on the morning of July 16. It was copied out of that book!"

"Baww! I never done it!" blubbers Elmer

Pirky, runnin' to his mother. Make him stop! He's a liar and a crook!"

"Indeed, I shall!" snarls the old hag, advancin' on me, menacin'-like. "You have gone far enough, you atrocious wretch! What reason on earth could my darling Elmer have"—

"Little enough reason—simply his and your grudge against me," I cuts in, grimly. "As for the idea of the fake message, I figure it came from the press report I copied and put out in the ship's newspaper a few days before about a small slide in Culebra Cut—then the finding of that telegram reproduced in Arthur Bollard's book"—

"This seems a tangle of circumstantial evidence," interrupts the radio inspector, irritatedly. "I don't see that you have much of a case here, Mr. Jones."

"I'm not quite through yet," I replies; then turning to my motion-picture operator, who has already plugged his projecting machine to a lamp socket, I pick up a strip of film.

"Come here, Zokur," I says to the wiper, showing it to him. "Do you know this?"

"It's mine—you stole it!" yells Zokur II, holding the end of the film up to the light. "It's the picture I took of the big sailing ship we met on the way to Panama!"

"Correct!" I snaps. "Now, as the log here of the Steel Bobolink proves, we had this square-rigger abeam at exactly 9:00 A. M. on July 16th. It's funny you could be below cleanin' drip pans under th' turbine and at the same time up here on the boat-deck taking this picture of the Scharmbeck. But that doesn't matter. Pull down the shades."

The room is darkened, while the operator threads the film, lights his arc lamp, and focuses his objective lens on the opposite white plaster wall. Then there is a click and a whirr and the picture begins.

It isn't much of a film classic, but we can see the big ex-German windjammer standing down on us under a cloud of white canvas, and as she passes by close on our starboard beam, the picture gradually shifts, following her, until most of the boat-deck and the upper part of the wireless shack on the Steel Bobolink become visible in the foreground.

Except for the whirring of the projector and the hiss of the arc lamp, there is no sound in the inspector's office; then a flock of astonished gasps arise, as in the picture Elmer Pirky is seen to slink out of the port door of the Bobolink's wireless house and go shufflin' off guilty-like down the deck, while I come up the ladder on the starboard side and go into the shack.

"Waww!" bellers the kid, as the end of the film flicks through the machine and the plaster-wall screen flashes up in the white light. "My ma told me to do it—she had read the telegram in the book! It was only fooling!"

"Ahem, harrumph! Have some strawberries," I says to Pirky & Co.

And so that was that.

WHAT IS ELECTRICITY?

(Continued from Page 11)

along the conductor, thereby maintaining a difference of potential between two points.

In the primary cells (batteries) the alkalies (electrolytes) produce hydroxide molecules, with an excess of one electron each, through disassociation. When two dissimilar metals are immersed in the electrolyte such as copper and zinc, the negative ions (molecules with an excess electron) proceed to the zinc plate maintaining it at a negative potential. Similarly in secondary cells (storage batteries) spontaneous dissociation takes place, in this case, however, the action may be reversed by passing electric current through the cell in the opposite direction and restore the electrolyte to its former state.

When we apply E. M. F. to a conductor we cause some of the electrons to leave their nuclei and proceed at a great velocity in the direction of the force. Being free from its proton it is attracted to all protons on its way and this **electric field** (attraction) is moving with it. The electron also has a magnetic field which is in a plane perpendicular to its electric field and therefore to its direction of motion.

In spite of the fact that the electron moves at an enormous velocity, after leaving its orbit around the proton, it travels but a very small distance before it collides with some atom, and it either rebounds or dislodges an electron from the atom and itself becomes attached to the atom. Thus the actual electron flow is very slow. Due to these frequent collisions heat will be generated and the agitation of the molecules or atoms increases, the orbital electrons velocity becomes greater and their orbits around the nuclei larger. The attraction therefore is weakened between the electron and the nucleus while the centrifugal force becomes greater due to its higher velocity and the greater orbit. At some temperature this condition reaches a point where the centrifugal force overcomes the attraction and the electron flys off into space.

If a metal is heated in vacuum or in some gas at low pressure some electrons will leave the metal unobstructed, but if oxidization is permitted the oxide will form a tough skin on the metal's surface and the electrons are unable to leave the metal

The electrons emitted by the metal form a cloud around it and if a positively charged plate is introduced in the vicinity the electrons will be attracted thereto. The two element thermionic-valve operates on this principle. The electrons travel from the filament to the positive plate, that is, the electrons travel from negative to positive. We shall see that **electron flow is current flow**, and opposite to the old supposition the **current flows from negative to positive.** The proof is simple.

With the use a two element tube or a three element tube with its grid and plate connected together, the filament is heated to some temperature where emission takes place. Now if we make the plate increasingly positive in respect to the filament the current in the plate circuit will increase. As the plate voltage is increased we reach a point where an increase in plate voltage will not be accompanied by an increase in plate current, which means that all electrons emitted by the filament are absorbed by the plate, and since no more electrons can be attracted to the plate no increase in the plate current is possible; but if we now increase the filament temperature the electron emission becomes greater and a further increase in plate voltage will be accompanied by an increase of plate current, again to a point where all electrons are absorbed, this is called the saturation point, and further increase of plate voltage will not cause any further increase in current We will note, however, that as the plate voltage is increased the plate will heat more and more. Since the small current cannot be responsible for the heating of the plate, we can conclude that the electrons velocity is increased with the increase of the plate potential and they strike the plate with a greater force and these numerous collisions of the electrons with the plate cause the heat. From this it is quite evident that **electron flow is current flow and the electron flow is from negative to positive.**

So we find that **electricity is** mainly **the elec-**

trons' relation to the protons. But now a new question arises: "What is an electron?" "Is the electron a particle of matter? or is it a wave packet?" There are evidences to prove either. Then again: "Why can electrons flow from lead or zinc through copper-oxide to copper, but cannot flow from the copper through the copper oxide to the lead or zinc?" And "what limits the current flow to one direction in the electrolitic rectifiers?"

These questions will be discussed in a coming issue of the "CQ."

SIMPLIFICATION OF RADIO RANGE BEACON POSITION AND QUADRANT IDENTIFICATION

(Continued from Page 26)

rection containing the T-L antennas, it is necessary to send only two cardioid signals, the dot and two dots. With but two identification signals there are two opposite courses shown at the "C" radio range, figure 4, along the line containing antennas f and g, along which there is no differentiation in the identification signal, the dot and two dots being about equal in intensity on each course. However, the pilot can determine which of the two courses he is on by deviating to the right and noting which off-course signal predominates. Thus, if his compass shows he is flying north and he obtained an increase in the N signal when deviating to the right, he is on the course extending north of the beacon; if he had been flying north and deviated to the right and obtained an increase in the A signal, he would have been on the course south of the beacon.

Simple Set of Rules

A simple set of rules which might be followed in all cases, having given the location of the four antennas with respect to the points of the compass, would be:

1. When the antenna system is laid out so that the lines of direction between diagonally opposite antennas coincide with the four cardinal points of the compass, then the 1-dot signal shall be sent in a westerly direction, 2 dots east, 3 dots north, and 4 dots south.

2. When the antenna system is laid out so that lines between diagonally opposite antennas do not coincide with the four cardinal points of the compass, then the 1-dot signal will be sent in a westerly direction along the line of direction of the two diagonally opposite antennas extending the most nearly east and west. In the special case where the antenna system is laid out so that the lines between diagonally opposite antennas are at an angle of 45° with respect to the four cardinal points of the compass then the 1-dot signal shall be sent in the northwest direction.

3. The 2-, 3-, and 4-dot signals shall be sent in directions corresponding to the following degrees of azimuth going clockwise around the beacon from the direction in which the 1-dot signal is sent—2 dots 180°, 3 dots 90°, 4 dots 270° and in the order 1 dot-2 dots, then 3 dots-4 dots.

RADIO OPERATORS ON INDUSTRIAL RECOVERY

(Continued from Page 22)

furnish press service on any vessel unless the radio equipment is of adequate design to tune in such signals as transmitted for the press service and the installation includes a typewriter for the recording of such press service, and if said press service is not subscribed to, only press service transmitted to all stations shall be furnished.

8. No Radio Operator shall be required to transfer from one mobile station to another un-

til he has signed off the articles and accounted for the inventory and records. Not less than fortyeight hours shall be considered as adequate time to transact such business and transfer belongings, and such time shall start at midnight on date of arrival in port.

9. When a Radio Operator is assigned to a vessel in another port his time shall begin at the date of assignment and transportation expenses to the vessel shall be paid in full.

10. No radio equipment, other than the prescribed radio equipment of the Radio Room, shall be installed or permitted to be installed aboard any vessel by any person i.e., broadcast receiving antennas, etc.

11. No Radio Operator shall be permitted to make any alterations or additions to the standard equipment in the Radio Room of mobile stations except to locate and repair defective parts, and the use of Radio Operators personally owned equipment such as receivers, breakinrelays, clocks, typewriters, etc., shall not be permitted or accepted at any mobile station.

12. Each employer shall maintain a list to be known as an employment list, which shall contain the names of all applicants for employment in the order in which such applications are received by the employer. Said list shall be posted in a conspicuous place in the office of each employer, and every Radio Operator whose application is accepted shall have free access to said list during reasonable business hours. All employers of Radio Operators shall abolish the black list or deferred list, and no other subterfuge shall be resorted to in order to deny any Radio Operator employment.

13. At least one member of the Federal Radio Commission shall at all times be a Radio Operator chosen by the Commercial Radio Operating Profession.

14. Any Radio Operator declining to accept or resigning from any assignment shall not be discriminated against by any employer in any manner whatsoever, and at any time any Radio Operator is dismissed from duty by any employer, he shall receive in writing from the employer the reason or reasons for his dismissal, and this reason or reasons shall be a duplicate of the record retained by the employer.

15. Two weeks' leave of absence with full wages as per scale shall be due and payable upon completion of one full years' service at all fixed stations and yearly thereafter.

16. No Radio Operator shall be suspended by any employer for investigation, and no Radio Operator shall be disciplined or discharged until his case has been investigated and he has been proven guilty of the complaint with which he is charged by a board to consist of an equal number of representatives selected by the American Radio Telegraphists Association and complaining employer.

17. All radio watches on class B and C seagoing vessels shall be in accordance with international zone watches as maintained by other leading nations of the world and no radio watches shall be maintained while a vessel is at a dock or when not at a dock if cargo is being handled.

18. All radio watches at fixed stations, which maintain a radio service with mobile stations, shall be continuous during the prescribed hours of such station, and the Radio Operator or Radio Operators on watch at such fixed stations shall not pursue any other duty in connection with such radio watch.

19. No Radio Operator shall be compelled or required as a condition of employment to join the naval reserve or any other military or naval service.

20. All employers of Radio Operators shall abolish the favoritism method of employment and in the future technical ability and seniority shall in all respects determine what Radio Operator is to be employed.

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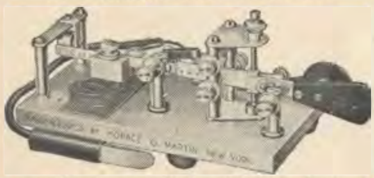

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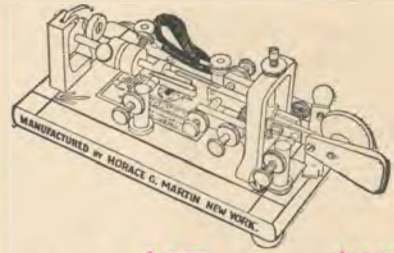

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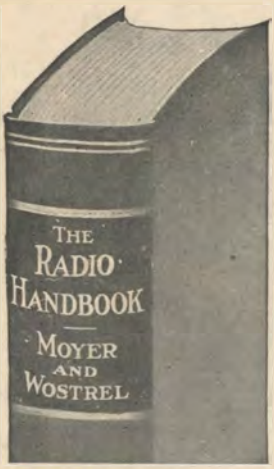

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