The
CQ COMMERCIAL RADIO MAGAZINE

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March 1933

Radiation Cooled Transmitter Tubes

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Antenna Current

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Graph Analysis of Tube Operation

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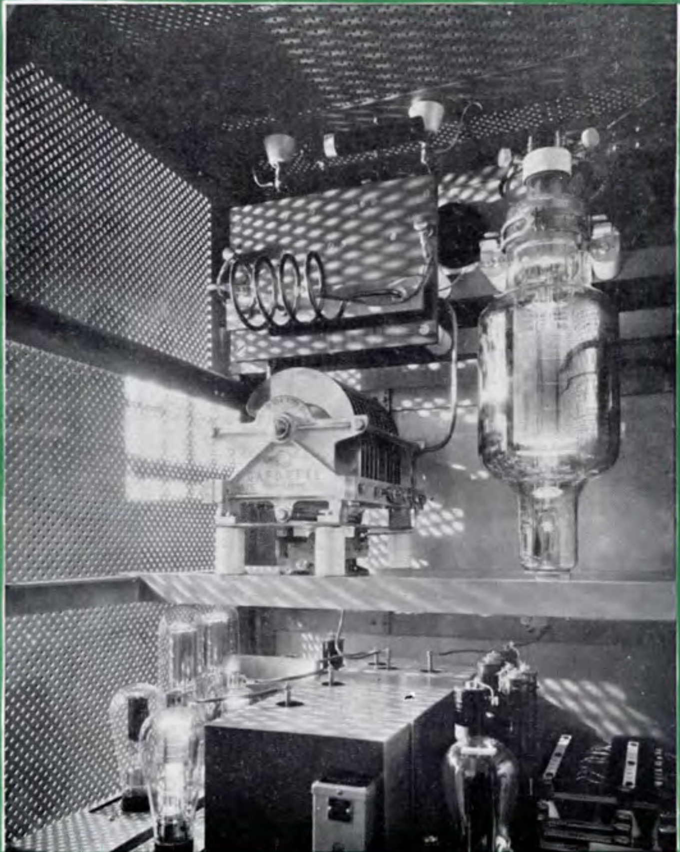
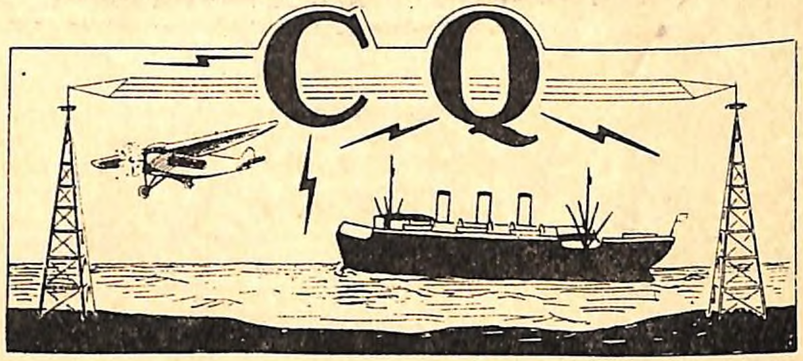
Telephone System on Harbor Craft



Pioneer Radio Operators : The Payload Is Dropping

Tales of The Old Timer : Miniature Transmitter and Receiver



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 **MARCH, 1933** **NO. 7**

Forecast:

In the next issue our readers will find a fine article on short wave receivers which are very popular.

A good article on the use of radio on airplanes. A general description of the type of apparatus that keeps them in touch with ground stations.

An up to date equipment of the most modern type on boats. This will give as much detail as is possible in the space we have available, and cover the technical side as much as will be of general interest.

Several other fine articles of a varied nature are in course of preparation, and the regular features will be found as usual.

If you like our book you may be sure your friends will appreciate your telling them about it, and don't forget we also will appreciate it. THE EDITOR

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DEPARTMENTS:

"I SAW YOUR AD IN CQ." Tell this to our advertisers, it helps all of us

Editorial

The North American Radio Conference is scheduled to be held in Mexico City in April this year. It is certainly to be hoped that the delegates will be able to get together on some common ground in the difficult task of straightening out power allotments. Those to the north of us have their rights, as well as those to the south of us. However, it is certainly common sense that we not be sandwiched in between.

Complaints have been plenty from our Canadian neighbors, and likewise we have complained plenty of what appeared justified to the interference of Mexican border stations.

The conference has the opportunity to do great and lasting good. While of course it is to be hoped that our own delegates will be able to come to agreement in securing for ourselves what is rightly ours, it is also to be hoped they will have the wisdom and fortitude of recognizing what are the rights of our neighbors. It is certain that a just agreement will endure, as it is also certain an unjust one will not.

If it were not for the difficulties, the conference would not be necessary, and the prime duty of the conference must be to come to agreement so that these difficulties will exist no longer.

* * *

Organizations everywhere are undergoing trying times. In periods such as we now have it is most difficult for those of the officers assigned the thankless task of keeping their organizations together. Chief among their tasks is the matter of the financial balance. Certain activities, all costing something, have become matters of fact. With a lightening of treasury funds, dropping off of all membership, and the almost nil effect of new membership drives it is not an easy matter.

Men who in fair weather easily carry on, find the glory or vanity of officership undesirable. Theirs is not always the spirit of work or endurance, but they may have that just as desirable spirit of good-fellowship necessary in milder weather.

It therefore becomes the burden of workers who are willing to spend their time unstintingly, unselfishly to the task necessary to keeping the organizations fresh and active, even in the face of the grossest criticism, as they may be sure will be theirs.

We do not have to look far to see the spirit of the day. The daily newspapers shout and scream from headlines criticisms of what we have become used to recognizing as our leaders. And, after all this is only the reflection of the reader's spirit, drafted by the editors and carried along on the crest of the wave. The printed page may solidify and make definite the purpose, but it certainly depends for support on the response of the reader.

Many organizations with good purpose will find themselves hard pressed in times like these, but if the spirit and purpose is sound they will survive the storm.

* * *

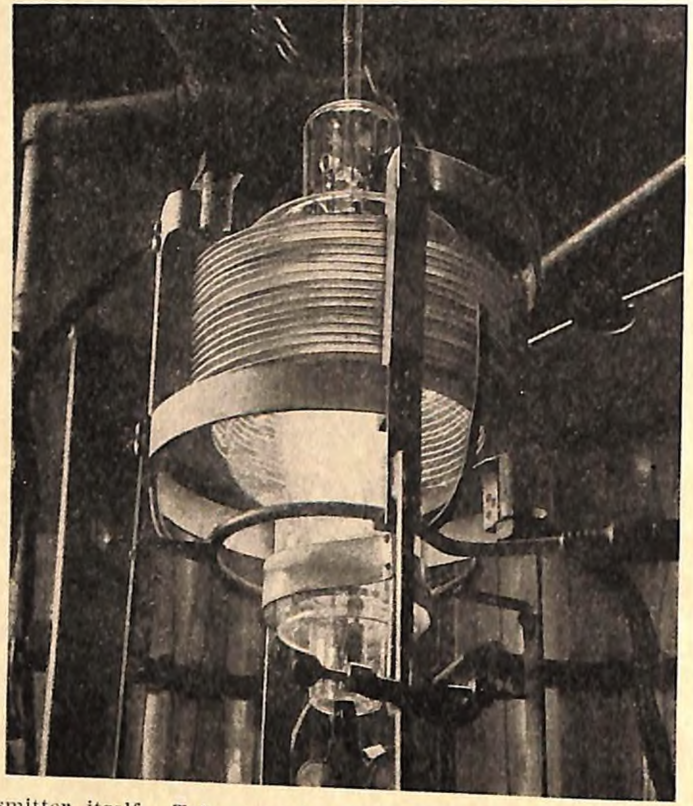
While the general financial structure slowly becomes stagnant, men everywhere look for employment. Our own radio field seems to be little better off than other endeavors. Men who have been otherwise employed, and find that employment no longer are endeavoring to return to the field of radio communication. They find that time has shown certain progress, and they are lacking that ability that would otherwise make them available. Men who have been in the field actively find they are up against it as there are fewer positions to go around. In the meantime the schools continue to train younger members in as large numbers as they are able to bring to their standards.

This may appear on the face of it as a bad situation, as it most certainly is. But, the return of normal conditions will find matters straightened out as usual. Those who are really fitted for the work will find themselves profitably employed. Those who were never intended for it, though forced to direct their efforts toward the radio field, will slowly weed out and into other lines where they are more aptly qualified. The situation is not alone in the radio field. It can be duplicated in almost any other place. As trying as it may seem it can only be borne patiently, and like it or not, we must be patient with those in whose hands is placed the dispensing of what positions there are.

RADIATION-COOLED POWER TUBES FOR RADIO TRANSMITTERS

By H. E. MENDENHALL
Member of Technical Staff, Bell Laboratories

Recent broadcast transmitters developed by the laboratories, with capacities ranging from 100 to 1,000 watts, have required power amplifiers intermediate in size between those of the largest radiation-cooled types and the water-cooled tubes of much higher ratings. Since 100 per cent. modulation is employed in all Western Electric radio transmitters, the output of the power amplifier must be four times that of the rating of the transmitter itself. Tube capacities required for the new transmitters were thus from 500 to 2,000 watts, while our largest existing radiation-cooled tube had a capacity of 250 watts and the smallest water-cooled, of 5,000 watts. Three new power tubes have been developed, therefore, to fill this gap. They are all of the radiation-cooled type with peak power output capacities of 500, 1,500, and 2,000 watts respectively.



The higher the rating of a tube the greater, as a rule, is the plate potential and the greater is the heat developed at the plate, which must be dissipated. Water cooling, being the most effective way of removing heat from metal surfaces, is therefore universally used for the larger sizes. Although it is an effective way of removing heat, water cooling has certain operating and economic disadvantages, since hose connections, a water supply, and possibly a cooling system for the water are needed, and add to the operating and maintenance expense. To avoid these various disadvantages, the three new tubes have been designed to dissipate the heat developed in their plates by radiation alone.

To make this possible several new constructions and materials have been adopted. The amount of heat that can be radiated from a surface varies directly as the area and the radiation coefficient, but as the fourth power of the absolute temperature. Heat is most effectively radiated, therefore, by increasing the temperature of the plate, but with nickel or iron—the ordinary plate materials—the increase possible is distinctly limited by their comparatively low melting point. For the new tubes, therefore, molybdenum was employed for the plate material because its melting point is considerably higher than that of nickel or iron, and with its use the plates may be run at a temperature as high as 1,000 degrees Centigrade, a cherry red heat.

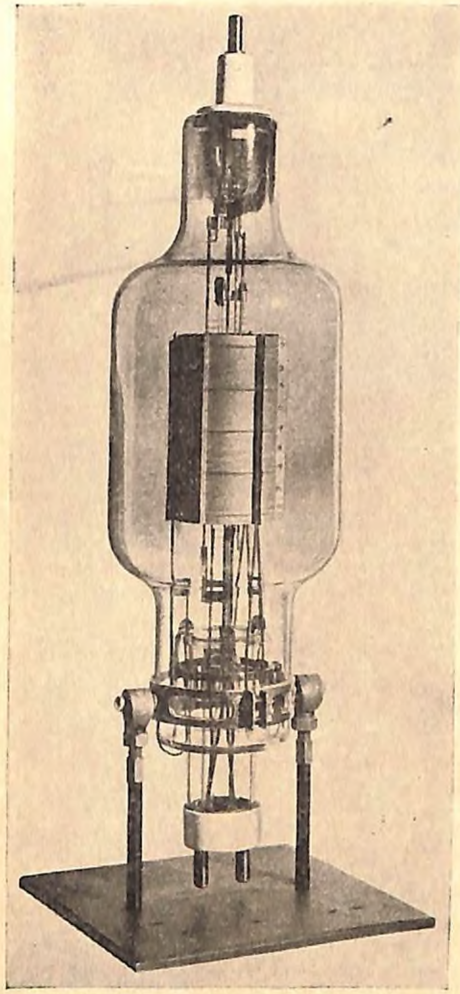


Fig. 1—The 251A tube. Compression springs of tungsten are employed in all tubes to take up the filament expansion

In addition to the gain obtained by the higher temperature, dissipation is further increased by roughening the surface of the plates by carborundum blasting. The emissivity of such a treated surface may be double that of the smooth. A still further gain is made by increasing the size of the plates and by adding radiating fins. The number and arrangement of these fins varies with the rating of the tube. For the smaller size little additional radiation is required by these means, but for the largest capacity the arrangement and number of the fins has been carefully designed to secure the optimum amount of dissipation.

Since the plates are to operate at so high a temperature, both the grid and filament also have to be designed for higher temperatures than are ordinarily used. Molybdenum was employed also for the grids but here another special treatment had to be resorted to. When these tubes are used in radio telephone transmitters, the grid may be carried to a positive potential with respect to the cathode during a portion of each carrier cycle. During this period, therefore, a portion of the electron stream will be diverted to the grid where it will produce secondary emission. Without special treatment of the grid surface the number of secondary electrons emitted may be greater than the number of electrons striking the grid, so that a reversal of the grid current may take place. This secondary emission, and thus the current reversal, also varies widely from tube to tube.

The reversal of the grid current itself gives considerable difficulty to the circuit development engineer, and the superposition of large variations from tube to tube makes the circui problem still more difficult. Both the amour of secondary emission and its variation hav been decreased by spraying the grid with thin coating of carbon. In the manufacture o the new tubes, however, a special treatment for the grid has been employed which not only gives a surface that produces less secondary emission, but decreases the variation to a marked degree.

The high temperature at which the plate is run also affects the type of filament used. Since the radiation requirements of the plate are already severe it is undesirable to dissipate any more heat in the filament than is necessary since most of it must be re-radiated by the plate, which surrounds it. A high efficiency filament is therefore very desirable, but the oxide-coated filaments used with tubes of smaller capacity, although highly efficient, operate at a temperature which is actually 200 degrees lower than the normal operating temperature of the plate. Either pure tungsten or thoriated tungsten would be satisfactory, but since at the same energy input a thoriated filament is about five times more efficient than the pure tungsten, it was selected. Such a filament consists of a core of tungsten containing about one per cent. of thorium dioxide. This is covered by a thin layer of tungsten carbide over which lies a monatomic layer of metallic thorium. This single atom layer lowers the energy required for an electron to escape across the surface, and thus increases the efficiency of the filament much as the monatomic film of barium does in the oxide coated filament already described in the Record.

The highest efficiency is maintained only so long as a monatomic layer covers the entire filament. During normal life it tends to disappear, partly due to evaporation but chiefly due to bombardment by positive ions generated by ionization of the residual gas in the tube. This loss of the monatomic thorium layer is overcome by building up a reservoir of the

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ANTENNA CURRENT

By STEVE KOVACS, V. Pres.

American Radio Telegraphists Association

Since the actual power delivered to the antenna depends both on the antenna current, as indicated by the antenna ammeter, and the voltage at which the current is delivered, the power in the antenna cannot be calculated by the reading of the antenna-ammeter alone. There being no practical means of measuring the voltage at various points of the antenna, the only alternative is the measurement of the EFFECTIVE ANTENNA RESISTANCE. With the value of the antenna current and the effective-antenna-resistance at our disposal we can calculate the power in the antenna from the well known equation $W = I^2R$, where W = Power in Watts, I = Current, and R = Resistance.

While this is a well known formula, for the sake of review, its derivation is given as follows: From the basic formulae of Ohm's Law, the voltage $E = IR$, the power $W = EI$. If we substitute the equalent of E of the first equation into the second, then we have $W = IRI = I^2R$.

With the use of this equation it is necessary to find R that is, the effective resistance of the antenna circuit. There are two simple methods of accomplishing this. The first is the so-called "half deflection method." In this case the antenna current is noted, then adding resistance in series somewhere between the transmitter and antenna until the antenna ammeter indicated exactly half of the previous current, which means that the effective antenna resistance is double of its previous value, that is we added exactly as much resistance as the effective antenna resistance. By measuring the added resistance we have the value of the effective antenna resistance. When this measurement is made it is advisable to use low power and care must be taken that the power input did not vary while the resistance was added to the circuit. The resistance used must be a straight resistance wire so that its inductance will be minimum, because any added resistance containing more than a negligible amount of inductance will vary the total effective resistance of the circuit by a different value than actual Ohmic resistance making the measurement worthless.

The second method "The resistance variation method" affords us a more accurate measurement by the addition of several different values of resistances whose values are known. As in the first method the antenna current is noted before the resistance is added and when the resistance is in the circuit. Making the measurement with each different value of resistance in the circuit, then each set of values substituted in the following equation will give us the effective antenna resistance:

$$R = \frac{R_a}{\frac{I}{I_a} - 1}$$

— 1 = Constant
R = Effective Antenna Resistance
R_a = Added resistance
I = Antenna current before resistance is added
I_a = Antenna current with added resistance

When these measurements are made the same precautions must be exercised as in the first method. It is advisable to check back by reading the antenna current again after the added resistance is removed and if the power is not the same as before the measurement the obtained values mst be discarded and measurement repeated until satisfied that the power remained constant. The values obtained for R for each set of values substituted must be very nearly the same and they should be averaged. If the values obtained for R vary widely the values must be discarded and the measurements repeated with greater care.

In case of higher frequencies, even though a straight wire is used as added resistance, a slight retuning to resonance will be necessary when the resistance is added, and again when removed.

The formula $R = \frac{R_a}{I/I_a - 1}$ is simply derived from the basic equation $E = IR$. Using the symbols as given above, we substitute I_a, and R_a (which is added to the original R). Then we have the two equations: $E = IR$ and $E = I_a (R + R_a)$. Therefore $IR = I_a (R + R_a)$. Simplifying this last equation we have:

$$IR = I_aR + I_aR_a \therefore$$
$$IR - I_aR = I_aR_a \therefore$$
$$R (I - I_a) = I_aR_a \therefore$$

$R = \frac{R_a}{I - I_a}$ To further simplify we divide both denominator and numerator by I_a then we have

$$R = \frac{R_a}{\frac{I - I_a}{I_a}} = \frac{R_a}{\frac{I}{I_a} - \frac{I_a}{I_a}} = \frac{R_a}{\frac{I}{I_a} - 1} \quad \text{Q.E.D.}$$

The antenna current squared times the effective resistance gives us the power in the antenna, that is, the power output. The input power is indicated on the watt-meter. The transmitter efficiency expressed in percentage is then calculated by dividing the output by the input and multiplying by 100.

In case of tube transmitters the filament consumption is sometimes neglected and is not added to the total input.

The "EFFECTIVE" resistance of the antenna is composed of resistances which manifest themselves in heat losses due to Ohmic resistance, Eddy current losses, Dielectric losses, Corona losses and RADIATION losses.

The Ohmic losses are actually losses and must be kept minimum. These losses are due to the actual resistance of the antenna circuit. Due to the fact that high frequency currents flow on the surface of the conductor only (skin effect) the actual Ohmic resistance offered to R.F. is far greater than that for D.C. This can be minimized by the use of stranded wire which has greater surface. Additional Ohmic resistance losses are due to poor ground and poor connections. These can be minimized by soldering all connections and either using damp ground or counterpoise ground.

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PIONEER RADIO OPERATORS

By DR. LEE DE FOREST

Back again in old Havana, en route for New Orleans, I spent one farewell evening with Horton who was in his best, newly acquired Spanish, patiently instructing El Operario in the intricacies of the triple-pancake tuner. As I walked back from Vedado I turned for the last time to watch the sun sink in a cloud marge of exceptional glory. Through the red scarf of the west the staff of the wireless mast pierced, slender and black in silhouette. "In how many lands," I mused, "far removed, by what strange distant seas, in how many varied cities, now are these wireless masts planted; pinning down as it were, into closer and more intimate contact the texture of the ether to the earth, uniting more and more the fabrics of the upper and the lower worlds, interlinking thought with reality!"

By April, 1905, I was again in St. Louis back from Havana and New Orleans. South West Pass Station at the mouth of the Mississippi was now in course of erection, to prove most useful for testing our big Navy stations, especially Key West and Pensacola.

I found the World's Fair 20 KW station now completely re-installed in the old base ball park at East St. Louis and in daily commercial operation with our like-powered plant out on Oak St., West Chicago, with Kansas City and Springfield, Ill. Static was still mild or absent, and everything lovely. Elated by these successes I found that the officials of the company had already laid down a gigantic program calling for numerous inland wireless stations, extending from Denver and several other Colorado cities clear down into Texas. Our Jersey City factory, under Harry Shoemaker's and Midgley's direction, was working overtime building transformers, sparkgaps, leyden jar condensers, electrolytic detectors, two and three-coil slide tuners, etc. Hundreds of yards of copper tubing wound up into transmitting helixes, miles of phosphor bronze antenna wire reeled up in the storerooms, countless "electrose" insulators for antenna supports, porcelain mushroom insulators for antenna "lead-ins," etc. The spirit of enthusiasm and hustle was everywhere and infectious. Those days of doubtful drudgery, of uncertainty, of dogged plugging of "V's" all day and all night, in brave hope that "the stuff" was getting out, that Old Bill might perhaps be lucky enough to pull it in—all that soul-trying epoch of empiricism seemed securely behind us, at last. And what a relief! We even forgot in our cocky confidence the trials and the tribulations of those poor lonely devils down at Guantanamo, or at Pensacola, where Iredell, a new recruit, had as yet failed to "raise" anybody but Curtis and McLean at South West Pass. And, best of all, the boys were now, at last, getting their pay checks with some semblance of regularity—not more than two or three weeks behind schedule—**usually!**

The St. Louis-Chicago circuit had demanded more operators. Harry M. Reynolds, former chore boy operator about our World's Fair exhibits, was now fully initiated at St. Louis and in training for a Colorado job. Wm. H. Ocker, now promoted to manager, held down the Chicago station by day, while Charley Fischer eased into the night trick. The downtown office required an operator assistant manager, and P. E. Odell, who had been broken in by Elmer Bucher at Nottingham by Lake Erie, came on for that job at the Railway Exchange Building. The ordinary telephone connection out to the West Chicago station proved too slow for getting the messages accurately to and from by voice. So these resourceful lads lashed a small buzzer to the telephone upright in each office, called for the connection, and with small key and a dry cell would clip it off in Morse at 35 words per minute, with absolute accuracy. 'Ere long, however, the zealous monitor of the Chicago Telephone Company was summoned by the operator whose ears the shrilling buzzer had so constantly tormented.

Investigation revealed that the wireless operators were putting one over on the majestic Mistress of Conducted Speech. Forthwith the inoffensive buzzers were ripped off, under penalty of having the telephone disconnected. Thereafter, nothing daunted, Ocker and Odell set to whistling dots and dashes, almost as fast as by key and buzzer—whenever difficult or code words were to be dispatched—until weariness of puckered lips induced them to prosaic speech again. Such resourcefulness was too much even for the Bell System, whose censor admitted he could find no regulation prohibiting a subscriber from whistling, humming, or singing over the telephone. But news of this shortcut to telephonic accuracy quickly spread through the entire overland wireless system. And small weak buzzers hooked up to dry cell and key could be discovered, upon search, concealed in almost any telephone desk drawer. "Merely Morse practice sets"—should any telephone snooper chance in to enquire!

But the wire telephone, as well as the wire telegraph, had never just cause to harass the progress of wireless. We used both aplenty, especially when a new station was being initiated. And after summer and static set in in earnest the wire companies might well have declared that electricity in all its forms was of great service to them—even the "thunderbolts of heaven." I doubt not that lightning, especially the distant and heat varieties, have brought into their coffers far more revenues than have the Western Union and Postal ever lost by burn-outs and interrupted service. And perhaps it was this early use of their service, surreptitious or paid for, which first set the gods of the Telephone Company thinking that possibly they should tie to, or tie up, this strange new thing, "the wireless."

But be that as it may the growing popularity of our rapid and cut-rate wireless service for several brokers' houses with branches in Chicago, St. Louis, Kansas City and Omaha soon set thinking other possible users of this novel, seemingly miraculous utility. I had not long been back at my desk in St. Louis before Odell wirelessed me (there were no interlopers, no RCA, in those happy days, and so no need for secrecy) that President Felton of the Chicago and Alton R. R. had made enquiry as to whether it might be possible or practical to transmit by wireless to an express train en route. Instantly word flashed back that this doubtless

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THE PAY LOAD IS DROPPING

Word has gone out that the advertising revenue for broadcast stations is dropping. For a time it seemed that this would not follow the trend of other business, but would hold its own on account of added facilities and other progress.

The revenue reported by the National Broadcast Company for January for the sale of time on the air was $1,839,345. This compared with $2,634,447 for the same month in 1932. The Columbia Broadcast System reported receipts of $950,057 for the sale of time for the month of January, 1933, and this compares with $1,348,842 for the month of January, 1932.

The year 1932, according to estimates of the total revenue by the major systems of the country, was by far the highest, giving $39,106,776 for 1932; $35,791,999 for 1931; $26,815,746 for 1930; and $18,729,571 for 1929.

Little did Lee de Forest dream in 1916 when he broadcast the election returns of that year from New York City, that some day by the identical method this enormous industry would be built up, or for that matter was it ever in the mind of Clarence D. Tuska of Hartford, Conn., when he also amused his amateur radio friends with a broadcast of phonographic music in the fall of 1916, when other amateur wireless men were doing the same thing.

Merlin H. Aylesworth, President of The National Broadcasting Company

The first real commercial step in this direction was made on November 2, 1920, when the Westinghouse Electric and Manufacturing Company opened and operated Station KDKA, at Pittsburgh, Pa., with the election returns showing that Harding had been elected president of the United States. Mr. H. P. Davis, at that time vice president of Westinghouse, deserves the credit for the first regular schedule broadcast station in the country as his efforts made it possible.

By the summer of 1921 many broadcasting stations had been planned in all parts of the country and radio sets were selling fast although of the old crystal receiver type. This strong wave of popularity set the American

William S. Paley, President of The Columbia Broadcasting System

Telephone and Telegraph Company thinking and they soon had their station WEAF on the air in New York City. Other stations of course were already in operation all over the country by this time.

After several years of broadcasting and expense the telephone people saw they were spending considerable money on their station and getting not only the good-will they intended from their station, but also plenty of complaints from their listeners as to the class and style of their programs. It seemed in 1922 as though the Telephone Company after having weeped plentifully for having signed away their rights to the manufacture of radio receiving sets in their agreement with the Radio Corporation of America in 1919, would finally get some revenue from the sale of radio transmitting sets through their subsidiary, the Western Electric Company, who were turning out a fine broadcast transmitter and finding ready sale of the apparatus to hundreds of customers all over the country. But the upkeep of Station WEAF was taking most of the profit from these sales, and in order to get some profit they decided a few years later to "sell time on the air."

To quote Merlin H. Aylesworth, president of

the National Broadcasting Company, in a talk at the Harvard Graduate School of Business Administration season of 1927-1928:

"Station WEAF, in New York City, establishing at the very outset of its career a high efficiency and artistry in its programs, commanded a far greater audience than any new station could possibly aspire to. And now, 'space' or time on the WEAF programs, which had become a national institution, was being offered to those who had expressed a desire to engage in broadcasting on their own account. Thus the ideal of toll broadcasting came into being, marking a definite step forward in the economic solution of the problem. Facilities for broadcast transmission, and more important still, an assured audience, were now made available for those who wished to utilize them."

This was undoubtedly the first commercial step carried out in a thorough going business way, and sales campaign to sell space on the air by broadcasting stations.

Slowly, but surely the chain form of broadcasting took form soon after this. The telephone company had devised a method of using their telephone wires for the spread of their programs to other nearby cities. First the New England territory, then Philadelphia, and Washington. After that westward as far as Chicago. In 1925 the first really national feature was put on the air, when on New Year's night of 1925 the Victor program was given to the entire country.

The latter part of 1926 when the chain system of broadcasting was firmly established, the telephone company realizing that at last they were assured revenue from the leasing of telephone wires, the National Broadcasting Company was organized by the General Electric Company, the Westinghouse Electric and Manufacturing Company, and the Radio Corporation of America, and Station WEAF was purchased. In 1927 the sponging up process began when the stations already operated by the Radio Corporation of America, in Washington and New York, the Westinghouse Electric and Manufacturing Company in New England, Pittsburgh and Chicago, and the General Electric Company

Main transmitter room of station WEAF. Modulating and frequency control at left, 50KW amplifier in center, power control equipment at right

in Schenectady along with other independent stations that were already taking programs for a consideration, were welded into one chain, and time offered for sale as a unit.

In April, 1924, the Radio Corporation of America claimed:

"The ten broadcasting stations owned and operated for the benefit of the American people by the Radio Corporation of America and its allied interests, the Westinghouse and General Electric Companies, represent an investment of approximately $2,000,000 and a yearly expense of approximately $1,000,000. Such has been the progress of radio broadcasting, that whereas in 1921 only two broadcasting stations were operated in this country, in 1923 over 500 stations were reaching out through the air to deliver the message of radio to 3,000,000 homes and 10,000,000 people in the United States."

By 1928 the National Broadcasting Company had 49 associated radio stations connected by

Control room of 50KW transmitter of WABC

telephone wires with a total mileage of 11,770, and 530 miles for special service to three additional stations, and claimed to be reaching 30,000,000 possible listeners, and at that time the Columbia Broadcasting Company had 16 associated stations.

By January 2, 1932, the National Broadcasting Company was offering for sale as a unit 87 broadcasting stations in all parts of the country, and were offering space for sale in 61 cities on the Red Network, and 53 cities in the Blue Network. The Red Network was the combined so-called Orange Network at $12,720 an hour, and the Gold Network at $12,620 an hour. The Blue Network was the combined Orange Network at $11,430 an hour and the Gold Network at $11,330 an hour.

During the progress of these networks by both the Columbia and NBC systems other fields have been absorbed. It was found necessary to enter the theatrical field for talent, and the music field for the production of music, as well as the writing fields for theme productions. Such well known music houses as Carl Fisher, Inc., and Leo Feist, Inc., had been absorbed by the Radio Music Company, a subsidiary of the National Broadcasting Company, although in January, 1931, these music units were put back on the independent basis as explained by E. C. Mills, president of the Radio Music Corporation, when he declared that the combination had not been entirely satisfactory, the Radio Music Corporation having been organized in 1930 for the purpose of taking over the older music publishing firms.

At one time it was indicated that the Columbia interests were in negotiation for a one-half interest in the Paramount-Publix Corporation, a $150,000,000 corporation now in receivership. The negotiations never came to anything however, and both interests continued independent.

Such artists as Maria Jeritza of the Metropolitan Opera Company of New York; Fritz Kreisler, world famous violinist, and Sergei

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A GRAPHICAL ANALYSIS OF TUBE OPERATION

Characteristic Curves - The Load Line

By E. H. RIETZKE

President, Capitol Radio Engineering Institute, Member, The Institute of Radio Engineers

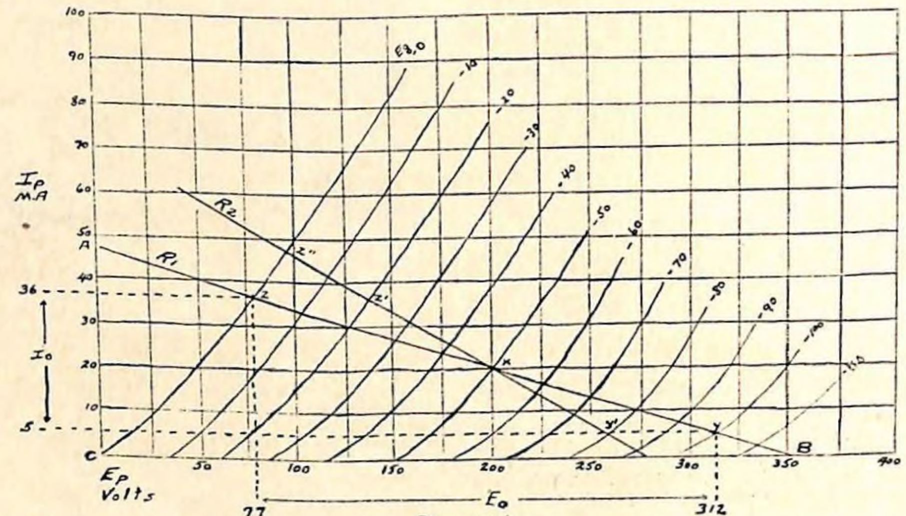

Diagram 1

It is very desirable in the design of a circuit, for either radio or audio frequency operation, or when studying the performance of a tube, to have some means of graphically showing the operation of the tube under various conditions of plate voltage, grid bias, grid excitation, load impedance, etc. Such a graphical analysis will enable us to not only properly design the circuit to match the tube, but also to determine the limitations of the various tubes under the desired operating conditions and thus enable us to select the proper tube to obtain the maximum of results. This can be done by the use of a family of characteristic curves and the "Load Line," which is determined by the load impedance.

Normally we wish to determine the correct grid bias for the plate voltage to be used, the maximum permissible grid excitation voltage, the correct plate output impedance, the maximum power output obtainable, the percentage of distortion under the various operating conditions, and other related characteristics.

It is somewhat difficult to determine all of these values from the simple individual characteristic curves. However, in the method to be described these determinations can be made with considerable accuracy for all types of tubes. Diagram 1 shows a family of E_pI_p curves. These curves are plotted individually by varying the plate voltage over sufficiently wide limits while taking measurements of plate currents for different values of grid bias voltage. As indicated, each curve represents the E_pI_p characteristics of the tube for a fixed value of grid bias, the curves being drawn for each 10 volts of negative bias from 0 to —110 volts. Assume that we wish to use a simple resistance load for this tube, that we wish the low limit swing of plate current to be 5 mils, (this is assumed from the fact that inspection shows the plate current curves for the higher negative grid voltages bend sharply below this value of current), that we wish to operate the tube with an actual plate potential of 200 volts and a grid bias of —50 volts. We also wish to have a maximum grid swing from the grid bias voltage of —50 to 0 bias voltage.

The above conditions arbitrarily fix the operating point at X where the —50 volt curve intersects the 200 volt E_p line. The inclination of the load line, R_1, is determined by the plate load resistance as is also the value of plate supply voltage necessary to allow an actual plate potential of 200 volts. According to Ohm's Law, R = E/I. In the plate circuit of a vacuum tube where the A.C. components of E and I are represented by the variations in E and I, dE and dI, then

$$R = \frac{dE}{dI} \text{ and } \frac{1}{R} = \frac{dI}{dE}$$

Now if we plot E and I as co-ordinates, as in Diagram 6, plot E and I to the same scale, (which is not done in Diagram 6), and draw a line through point x at any inclination so that it intersects both the E and I axis, we form a triangle ABC. Now according to trigonometry, AC along the I axis is the opposite side of the angle ABC and BC along the E axis is the adjacent side of the angle. Therefore $\tan \ominus = \frac{AC}{BC}$. But AC = dI and BC = dE.

$$\text{Therefore } \tan \ominus = \frac{dI}{dE}$$

$$\text{But } \frac{1}{R} = \frac{dI}{dE}$$

$$\text{Therefore } \tan \ominus = \frac{1}{R} \text{ and Cotangent } \ominus = R.$$

By definition the "Slope" of a line is equal to the Tangent ⊖ and the "Inclination" of a line is equal to the angle which corresponds to the Tangent which in turn corresponds to $\frac{1}{R}$. Thus the slope or inclination of the "load line" depends directly upon the value of the load resistance.

It has previously been mentioned that in order to graphically obtain these results E and I must be **plotted to scale.** This is very seldom convenient, I usually being given in milliamperes and E in volts. In the equation, $R = \frac{E}{I}$ if we express I in milliamperes, (Amperes x 10^{-3}) and E in volts, then the answer obtained, R, must be multiplied by 10^3 to obtain ohms. For example,

$$R = \frac{E}{I} = \frac{1000 \text{ (Volts)}}{100 \text{ (Mils)}} = 10 \times 10^3 \text{ or } 10{,}000 \text{ ohms.}$$

In this case if milliamperes are plotted against volts in the graphical representation, then Tan

$$\ominus = \frac{1}{R \times 10^{-3}} = \frac{1}{10} \text{ or } .1.$$

The angle corresponding to a Tangent of .1 is 5° 43′. Therefore the load line would pass through the operating point at this inclination with respect to the voltage axis.

Now in Diagram 1 we have arbitrarily drawn the load line through the operating point x, through the limiting values of y and z as given and then extended on both ends to intersect the E and I axes. From this line we can determine the following:

First: When the grid voltage is varied plus and minus 50 volts around the —50 volt bias the plate voltage varies between the limits as shown by the perpendiculars dropped from points y and z. Thus the total voltage variation, dE_p, is shown as E_o and is from 77 volts at zero grid to 312 volts when the grid is at —100 volts, or 235 volts.

Second: During this grid voltage variation the plate current varies around its normal value of 20 mils with no excitation to 36 mils with 0 grid and to 5 mils with the grid at —100 volts, a total variation as shown at I_o of 31 mils.

$$\text{Third: Since } R_L = \frac{dE}{dI}, \text{ then}$$

$$R_L = \frac{E_o}{I_o} = \frac{235}{.031} \text{ or } 7580 \text{ ohms.}$$

$$\tan \ominus = \frac{1}{R \times 10^3} = \frac{1}{7.58} = .132.$$

Thus if the graphical representation of this problem was drawn to the proper scale, the load line R_1 should pass through point x at an angle of 7° 30′ with respect to the horizontal axis.

Fourth: The load line bisects the E_p axis at 350 volts, thus with this value of load resistance the plate supply voltage must be 350 volts to give the proper operating voltage at the plate.

Fifth: With a sinusoidal form of input the power output will be equal to:

(Continued on Page 26)

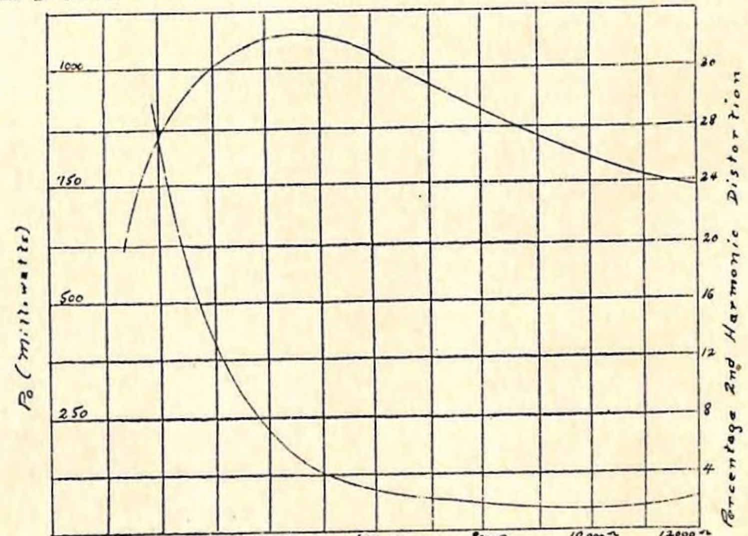

Diagram 2

A MINIATURE COMBINATION TRANSMITTER AND RECEIVER

By PIERSON A. ANDERSON*

Ultra high frequencies until recently considered interesting from the experimental point of view but of relatively little commercial value, have suddenly come to the foreground and are destined apparently to prove themselves of tremendous value in many fields of radio communication.

Fig. 1—This view indicates the compact design of the "Transceiver."

In the past, we have always striven to achieve maximum distance with minimum power. Now, due to the congestion of radio channels, it is realized that for many purposes a limited range is essential to permit duplication of radio channels at short intervals. Due to the quasi-optical nature of ultra high frequencies, we have a means of communication which possesses this feature and yet provides reliable communication within these limits.

To illustrate what can be done, I will describe the "Transceiver," a recent development of the RCA-Victor Company, Inc., of Camden, N. J. This device is a complete miniature telephone and telegraph transmitter and receiver of extreme reliability, and yet of such a small size and light weight that it can be carried by one person and put into operation in a matter of a few minutes.

The unit itself weighs approximately 8 pounds and overall is 3¾" wide by 9" high by 12" deep. All controls are on the 3¼" by 7⅝" front panel as shown in Figure 1. The panel arrangement is clearly shown in this figure. The meter indicates filament and plate voltage. One small knob controls the filament voltage and the other

(Continued on Page 33)

*RCA-Victor Co., Inc.

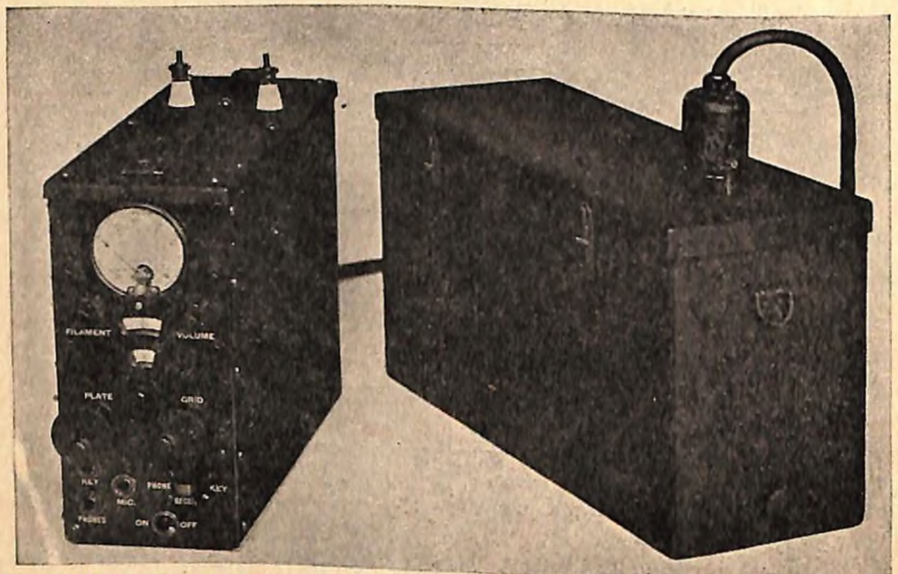

Fig. 2—Complete equipment comprising the RCA type ET-5000 "Transceiver."

Tales of the Old Timer

SAILING

By WILLARD BLISS

The Old Timer was in his favorite corner of the static room by the window where he could look down at the river. He turned to the Young Romantic and said, "Now, there's something you don't see so much of nowadays."

The Young Romantic leaned over him and looked down. "What, what do you mean? I don't see anything."

With nose-tilted scorn the Old Timer answered, "Huh, you wouldn't. I mean that sailing ship down there being towed up-river. Boy, if you were to see her at sea, you would see something. And that reminds me . . .

"I'm thinking again of that little packet I've been telling you about. Remember how I was telling you of the weather we were having? Well . . . we kept on our way, plunging and rolling across the Atlantic with never a day of decent weather. The gale in which we left Norfolk was succeeded by other gales. Day in and day out it blew; the continual whine of the wind in the rigging was heard all day and heard all night. There seemed to be never a let up from the howling of the wind and the wash of the seas as they came aboard us. We went to bed wet and we got up wet. We slept in wet bunks with the water, a foot deep, swishing around the deck below the bunks. When a fellow stepped out of a bunk, he stepped into water, icy cold water. We waded through water out to the cold iron deck and forward to the galley or the skipper's room where it was fairly dry and there we would put on shoes and socks or boots. It all depended on whether you had boots or not.

"We were having trouble down below as her engine was a cranky old coffee-grinder, that wheezed and groaned from numerous steam leaks in the piping. An engineer was always putting on a patch here or a patch there or slapping on smooth-on to stop a leak. The boilers were hard steamers with tubes letting go one by one. Trying to keep a fire up with wet coal and seasick Chinese firemen drove the engineers crazy. An engineer had to do most of the oiling of the engine himself as the Chinese oilers were incompetent and seasick like the firemen. All that the Chinese wanted was to finish their watch below and get back to their fo'c's'le where they could lie down and hit the pipe.

"I used to spend some time down in the engine room; it was a place to get warm, to shake off the bitter cold of the decks. You couldn't get very dry down there what with escaping steam from leaky pipe-lines but at least it felt warm. I was down there this morning helping the engineer to oil her I was going over the cranks while he worked the top grating on the crossheads when he called me, 'Hey, Sparks, come up here.'

"I looked up and saw him motioning to me to climb the ladder and join him on the grating. I gave a crank a last shot of oil, put down the can and climbed up to him. I found him crouched on his haunches, one hand on the rail flung out to steady himself against the roll of the ship. His face was drawn, sharp lines of fatigue, and then this new shock. He was staring intently at the port forward engine column. These columns are massive iron pillars at each corner of the engine that hold up the cylinders and rods. I squatted down beside him and followed his intent gaze. Then I saw what it was that was frightening him.

"The column had started a crack. A crack that was barely noticeable now. Just a faint line of cleavage running across the surface. But as I watched it I saw it widen perceptibly. We continued to stare at the slowly widening crack, at the possible doom that confronted us. For if this crack continued to spread and split the column apart, it meant the end of the engine; that meant the end of the ship. For a crack like that was widened momentarily by the vibration of the pounding engine. It would be spread farther apart as the engine exerted malevolently its power on the weak spot. The crack would widen; the engine would throw itself toward the crack; Hell only knew what might happen.

"The engineer snapped out of his bewildered concentration, turned and said, 'Come on, kid. Run up on topside and get a couple more fellows. We gotta try and put a strap on this and stop that crack from goin' any farther.'

"I scurried up the ladder. Who to get? The chief was useless, no use grabbing him, he would only stagger down below and befuddle the work with counter-orders. Get the donkeyman for one. He was OK and just the guy. Tell the captain, he was always one to work. Get the other assistant engineer. Fine. That was enough, anymore and we would simply be in one another's way. I went back down into the engine room after calling the last man and found the gang already at work. All were apprehensive for they knew the danger we were running. The job itself was simple but to get the job finished before it happened, that was the trick.

"The job was to drill and tap some holes on either side of the crack. Place a suitable drilled strap over the crack and bolt it down. Sure, easy job. But what the hell were we going to drill with? No electric drill on that packet. Try to drill by hand with a breast drill into steel. Before you got your holes finished the damned engine would be sitting in your lap. There was only one way with our few tools that the job could be done. That was to rig up timbers and use an old-man, a ratchet-drill. That would be a slow job. For an old-man each time it turns around takes a little bite out of the steel. Oh, sure, the job would be finished eventually. But would we finish it before the engine let go?

"We couldn't stop the engine and so stop the crack from spreading. We had to keep it turning slowly so that we would keep steerage-way. If we stopped the engine, then the ship would fall off into the trough of the sea. That would play hell with us.

"We tore up and out of the engine room, back and down into the engine room bringing timbers. We got in one another's way in our eagerness to put the timbers in place. Yelling and cursing at one another. 'Get the hell out of the way, you damn fool. Can't you see I gotta get in there with this piece.'

"'Get to hell outa the way yourself. Don't you see I gotta get in first?'

"Hasty, angry and nasty words were hurled at one another. The captain, excitable as usual, was storming around trying to boss the job. Hell, we couldn't pay too much attention to him at that time. If he got in our way, he got shoved out of the way. There was no ceremony and no gentleness down there. We were working against time. Working against that crack, that we could see widen before our eyes. Working against disaster.

"We managed finally to get the timbers in place. Mounted the old-man against the column. Slowly, slowly began to cut out the holes. Oh, how slowly that drill bit into the steel. Little shaving by little shaving fell out. The crack widened. Little shaving by little shaving.

"Hooray, one hole finished. Into place with timbers and drill for another hole. Again the slow, tortuous biting at metal. The inexorable biting of the drill racing against the inexorable splitting wider of the crack.

"Only two men could work at the actual drilling. We others stood on the floorplates and strained our eyes upward to watch the crack widen, widen. Watched the other men turn the drill slowly, slowly. Damn it all, couldn't they speed up the drill? Couldn't they bite that metal out faster? Our teeth ached as we involuntarily bit at the steel. Inaction was worse than anything else.

"There, there, they are drawing it out again. That means another hole. Cheer up, you guys. Only two more holes to go. Timbers and drill placed again for another hole. Fine. We'll win, we'll win. The rachet turns slowly again. Little shavings of metal creep out of the hole, up the drill, fall off down to the engine room floorplates. The shavings fall on our upturned faces. The shavings are hot but we don't feel the burn. All our senses, all our feeling is concentrated on that hole.

"There goes the third hole. We calculate the speed of the crack, in which one could insert a heavy knife blade. We were cool now. Yes, we would win. This is the last hole. That drill is biting faster now. Relaxed and confident we watched them on the last hole. There, that's through.

"A rapid threading of the holes. Quick insertion of the bolts. Turn them tight. A squealing of pain as the two opposite bolts take up the strain. There the bolts were home, tight.

"We relaxed from the strain, sat plump on the wet floorplates. The men who had done the drilling, sat on the platform content to rest—for a minute. We came to life again, took down the timbers. The engineer came down from the grating and eased the engine to a faster speed. He walked over to the bilge-pump, which worked off the low pressure engine, cocked his head and listened. 'Say, that pump ain't working right. She's sucking air, not bilges.'

"Now what? Now that we were aware of it, we could feel the pump laboring. The engineer lifted up a floorplate. Beneath it water was swishing back and forth. The engineer cursed, 'Hell. Something else gone haywire. Most likely the bilge strainers are clogged from slowing down the engines. Well, you guys, here's something else for you. Into the bilges you go diving.'

"The captain pursed his lips, made faces while he thought. He clapped me on the shoulder, said, 'Come on along, son. Let's go and find some more trouble. I know where it's at.'

"I followed him up the ladder to the engine room entrance where he picked up a sounding rod that was hung there. We went out on deck and aft to the hold where we had stored our extra bunker coal. He unscrewed the cap on the sounding tube, let the rod fall away down the tube to the bilges. Drew it up and looked at the telltale wetness. Disgustedly he turned and said, 'I thought so. Looka this. Just what I expected. Bilge-pump clogged, bilges getting higher all the time, a sinking ship. What the hell, just one sweet thing after another here.'

"I, dumblike says, 'So, now what?'

"'So now what! Oh, it just means that you and me and everybody else gets down there and starts throwing coal around to uncover the bilge strainers. Clear the strainers so we can pump bilges again. Then move the coal back. That's all.'

"He ordered me, 'Go on, get going. Round up everybody that's loose and bring back all the shovels, pails, whatever the hell that's loose, that we can use moving this coal.'

"I went into action again, ran around the ship and mustered everyone, Chinese and white. We got down in the hole and started shovelling coal. Did you ever shovel wet heavy coal? It isn't quite as dirty as dry coal. No dust. But it sure is heavy.

"Swing your back into it. Bend and kick the shovel into the black pile. Up and swing. Throw the coal to your side. Working against time again. Have to clear those bilges. Water rising. Ship sinking. Bend and kick, swing and throw. Make a tiny hole in a black pile of shining coal. It seems just a waste of time and strength. A fellow can't push this stuff away. One little shovelful, it's so small. You don't seem to make any impression on the mound. There's just as much coal there as there was before I bent and kicked, swung and threw. Back gets weary; muscles ache; body cries stop. Can't stop, can't stop, gotta beat the water. Water's getting higher. The coal, I suppose, is getting lower. Bend, kick, swing, throw. Your mind dulls; your body rings in time with the poetry of bend, kick, swing, throw.

"A voice on deck drifted down, 'Hey, you. Come up and look at this.'

"The noise broke the rhythm, down goes the shovel, glad to get rid of it and rest for a spell. I climbed up the ladder to the deck. 'Well, whatsmatter now?'

"The captain said, 'Matter, matter? Oh . . . nothing new in trouble. I just called you up to take a look at this.' He swung his hand out, pointed astern of us.

"There she came. A beautiful sailing ship. Most all her sails set, drawing on every one. White canvas straining, billowing out. Skipping lightly over seas in which we wallowed. She danced as she came abeam of us. Every line and sail taut. A thing of grace. Sweet, slim lines of strength. One's eyes followed from the outflung bowsprit, up, up to the sheer towering height of her sails. Followed down the taut straining lines to her clean deck. Your eyes rested gratefully on the sweet cleanness of her. Went aft to the helmsman swinging the wheel. Poised at the wheel in oilskins, he bent and swayed with the motion of her. Turned the wheel back and forth as he eased gently the sweet, fast-running ship, past our wallowing, strained tramp."

A Telephone System for Harbor Craft

By W. K. ST. CLAIR
Member of Technical Staff, Bell Laboratories

In the past when a captain of a tug boat or other small craft left his dock to proceed on an assignment, he immediately severed communication with shore, and might proceed on a long trip which changing conditions made useless or be ignorant of the need for his presence in an emergency occurring at another place. It is, of course, possible to equip such small boats with radiotelephone to permit conversation between harbor craft and shore or from craft to craft. Whether or not this is desirable is a matter of economics. Several of the telephone companies are contemplating the inauguration of shore-to-ship radiotelephone service in some of the large harbors of both the Atlantic and Pacific coasts. At Boston the New England Telephone and Telegraph Co. has opened its station on a trial basis, largely for the benefit of the fishing fleets which operate in nearby waters. It is expected that the fishing fleets thru this service will be able to concentrate where the fish are running and that the companies may keep in touch with the boats, advising them when to run in to port to take advantage of favorable price conditions.

The equipment aboard ship is described in an accompanying article. At the shore station is equipment similar to the ground-station transmitter and receiver used for airplane communication, but modified somewhat to meet the special requirements of harbor service, and to provide for connecting the radio circuit to the land lines of the Bell System. The control equipment has the same general functions as that employed for the trans-Atlantic telephone, but is much simpler. Thru land lines to the toll office, the radio link is connected to the local and long-distance telephone system.

A simplified schematic of the shore station is given in Figure 2. Speech to be transmitted to a boat passes from the land circuits through a volume control for regulating the input to the radio transmitter, through an amplifier, and then through a hybrid coil. Here the main speech channel passes through the front contact of a relay to a transformer, which couples the circuit to the radio transmitter. When the relay is unoperated, the transmitter is blocked through a back contact, but part of the voice current passes from the hybrid coil to the transmitting amplifier-detector which operates the transmitting relay so that transmission may take place. This amplifier-detector is a vacuum tube and relay device arranged to be more sensitive to pulsating currents, like speech, than to disturbances like line noise which have a comparatively unvarying envelope. At the same time that the transmitting amplifier-detector operates the transmitting relay, and so permits transmission, it also operates another relay which blocks the receiving circuit.

Incoming speech, from the radio receiver, passes through a repeating coil combination and then through a volume control for adjusting the speech to the land lines. Part of the incoming speech, however, is shunted from the repeating coil combination to a receiving amplifier-detector. This is a voltage operated trigger device, using a gas-filled detector tube, and designed to be fast and positive in its operation. At the first impulse of incoming speech this apparatus operates a relay which opens the circuit to the two relays already mentioned, so that the transmitter remains blocked and the incoming circuit clear. When speech is not being transmitted, the transmitting circuit remains blocked, to prevent re-radiation, and the receiving relay is closed so that incoming signals may be heard.

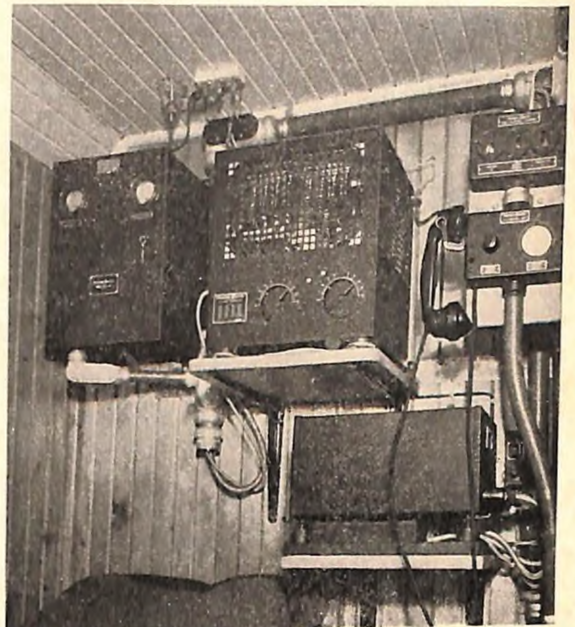

Fig. 1—An installation of harborcraft radio on a trawler out of Boston

The receiver is equipped with an automatic gain control which adjusts the amplification according to the level of the incoming carrier. When no carrier is being received this control raises the gain to its maximum value, thus greatly magnifying all incoming noise. To avoid transmitting this noise over the land lines a piece of apparatus known as the "codan"—made from the initial letters of the words indicating its function "carrier operated device, anti-noise"—is used to insert a large loss in the receiver circuit when no carrier is being received. By the use of this device, practically no radio noise is received at the amplifier detector or at the subscriber's station when the distant carrier is not being received.

Provision is made to enable a ship to talk with another ship as well as with the land station. Such communications must pass through the shore station, however, because two frequencies are employed for harbor communication; one for transmitting from shore to ship, and one, from ship to shore. All ship transmitters are tuned to one frequency and all ship receivers to the other. To make ship to ship communication possible, a key-operated transfer circuit is provided at the shore station, which permits the incoming voice currents to be bypassed directly to the radio transmitter. This connection is under the control of the technical operator.

The control apparatus, mounted on a panel in front of the technical operator, includes attenuators for regulating the transmitted and received volumes and the sensitivity of the amplifier detectors, a direction indicating meter to show whether speech is being transmitted or received, a volume indicator available for either received or transmitted speech, as a meter for plate voltage, and keys for starting the transmitter and for talking and monitoring on various parts of the circuit.

The shore transmitter, known as the 9-C, is designed to deliver 400 watts of carrier power at any frequency between 1,500 and 6,000 kc, and will maintain its frequency to better than .025 per cent. This equipment may be located at some distance from the control and receiving station, or it may be in the same building. If in a separate building, a short-wave radio receiver at the control station is used for monitoring the output of the transmitter.

Power for the radio transmitter is furnished by the rectifier associated with it, and both the transmitter-rectifier and the radio receiver are arranged for operation from the usual alternating current mains. A motor generator set, with the necessary filter equipment located on the same mounting, furnishes filament and plate supply for the voice-frequency control equipment, the monitoring receiver, and for the codan as well.

The service at Boston, operated by the New England Telephone and Telegraph Co., makes use of the site and buildings at Green Harbor formerly owned by the Laboratories. From this point, on the shore of Massachusetts Bay some 30 miles southeast of Boston, it is expected that it will be possible to communicate with ships from Point Judith, on the coast of Rhode Island, to beyond Cape Ann on the northern Massachusetts coast, and from these points some two or three hundred miles easterly over the ocean. Within this area are located most of the important fishing banks.

Two "beam trawlers" cast off from their wharves in Boston early in June for their first trip with the new radio equipment. This service should be helpful to other craft than those engaged in the fishing business. Pilot boats, tow boats, oil tankers, coastal steamers, private yachts, coast guard boats, and similar small craft are all potential candidates for this service.

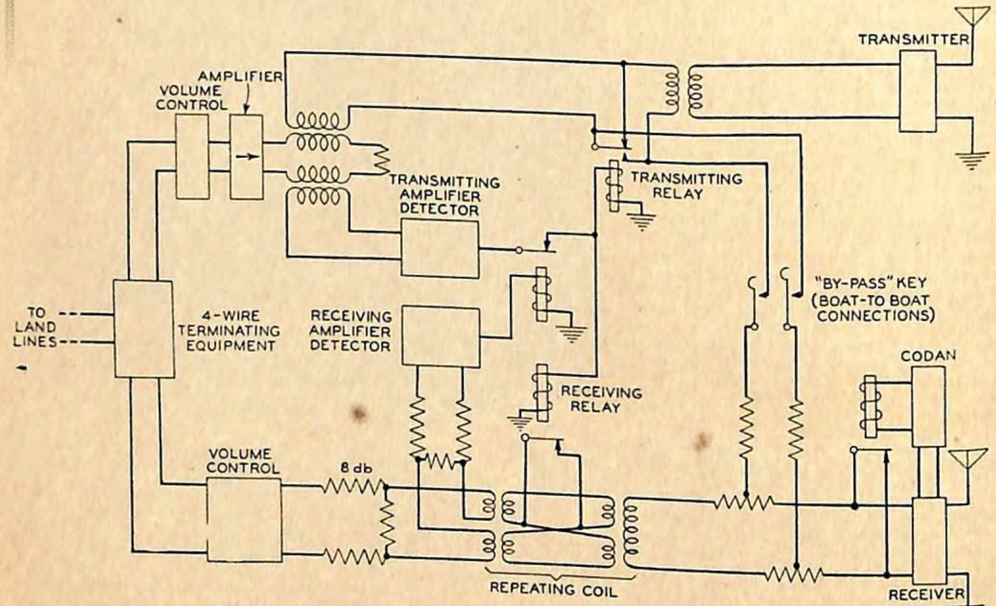

Fig. 2—Simplified schematic of shore station circuits

THE PAY LOAD IS DROPPING

(Continued from Page 11)

Rachmaninoff, pianist and composer, have for periods along with hundreds of others transferred their entire professional management to the National Broadcasting Company's Artists' Service. The Columbia system has at all times tried to match artist for artist in the entertainment field with the NBC.

In early Congressional hearings on the ramifications of the broadcasting field, Senator Dill expressed his opinion as follows:

"I think the building of high powered stations operated cleared channels is going to cause public sentiment to compel Congress to make all radio stations a public utility."

In 1928 the National Broadcasting Co. was reported to have paid $2,000,000 to the Telephone Company for wire bill in connecting their stations for national broadcast. It may be assumed that at the present time the bill is closer to double that amount now.

Bill number 2783 was introduced in the Senate and hearings were made on it under the title "A bill to provide for the forfeiture of patent rights in case of conviction of monopoly," but this actual conviction which was supposed to apply to 3,500 patent rights evidently never took place as the forfeiture certainly never did.

Early in 1932 a resolution for the survey by the Radio Commission of the extent of commercial advertising programs over the radio was

The Antenna Structure of Station WABC at Wayne, N. J.

introduced in the Senate by Senator Couzens, with one subtitle of the bill "What can be done to control or perhaps eliminate commercial radio advertising," and the survey duly made by the Commission.

In June, 1932, while the matter of monopoly charge against the Radio Corporation of America was still pending, it was expressed at the Radio Commission that if the matter of radio contracts with foreign countries were brought up, "It will probably mean the setting of hearings to ascertain whether the Radio Corporation is a monopoly under the meaning of the radio law in view of the fact that its subsid-

Antenna Towers of Station WEAF at Bellmore, Long Island, N. Y.

iary, the National Broadcasting Company, has valuable broadcasting facilities to which it might not be entitled if the Radio Corporation were proved to be a monopoly."

What radio broadcasting means today to the American Telephone and Telegraph Company may well be judged by the report filed with the Federal Radio Commission early in 1932 covering the activity of 1931. It stated that program circuits measuring 44,000 miles had been furnished to 12 networks in the country which used 90,000 miles of wire. Of this 32,500 circuit miles were furnished to seven permanent networks operating 16 consecutive hours daily, 6,500 miles to temporary networks and 5,000 miles to permanent networks for special programs requiring facilities in addition to existing ones. In addition 34,000 miles of telegraph and teletypewriter circuits were used to co-ordinate the program circuits. It was also stated that its radio channels across the Atlantic and to South America handled about 185 programs in 1931.

The Bureau of Foreign and Domestic Commerce issued a bulletin under the title of "Broadcast Advertising in Europe" early in 1932 which covered the European status of broadcasting for the middle of 1931 in which it was stated by Frederick M. Feiker, director of the Bureau: "In certain countries commercial broadcasting is definitely prohibited; in others the restrictions upon owners are such as to discourage their general use In Europe existing regulations are, with a few significant exceptions, unfavorable to the development of this form of publicity. Commercial programs are the exception, not the rule. Hence the possibility of effective coverage of the continent by broadcast advertising is limited, and changes from existing systems will probably be infrequent."

NEXT RADIO CONFERENCE

The next Radio Telegraph Conference, sometimes called the International Radio Conference, will be held in Cairo, Egypt, in 1937. The last one was in Madrid, Spain, in 1932.

WIRELESS AT SEA

Estimates place the number of ships equipped with wireless in all parts of the world at 16,000 according to W. A. Souter, who recently addressed a Rotary Club at Newcastle, England, and a total of 15,000 lives were saved at sea by the use of this wireless equipment.

AIRWAYS NOTES

From Pueblo, Colo., a city of 50,000 and at one time supported mainly by the great steel mills of the Colorado Fuel and Iron Works—now affected by the well known depression—we hear of two airways radio stations. One operated by the Department of Commerce and another by Western Air Express. Pueblo is served by (WAE) Western Air Express with airmail and passenger service, divisional headquarters at Denver, on a line operating from Cheyenne, Wyo., to El Paso, Tex., and from Pueblo to Amarillo, Tex., direct.

The Department of Commerce station (KCAR) was placed in service March, 1932, with all equipment of the latest type, and is truly a model station. The main transmitter is of the usual 2 KW power and used chiefly for weather broadcasting on a frequency of 302 KCs and may also be keyed for CW. In addition to this a 500 watt CW transmitter is used for point to point work on various high frequency bands.

Every effort has been made to make it as flexible as possible for operation by using the most improved type of equipment together with best methods of control. Besides regular routine they are ready, at any time, to handle two way communication with transport planes in their sector should they be called upon to do so.

A radio range is the latest addition to this station incorporating a new feature not found in other stations of this type. The individual range transmitter has been eliminated by coupling the loops for beam transmission to the main 2 KW transmitter through a link circuit into the usual goniometer and a tuning unit for each loop. For weather broadcasts this transmitter is switched over to the main antenna and upon completion returned to the range radiating system. Installation of the range has recently been completed by Mr. Madra, of the Department of Commerce, and tests are now under way to check the accuracy of the courses. The letter "H" is being used as the station identifying signal and regular operation will probably be announced in the near future.

The personnel consists of five operators with Mr. Eastman in charge assisted by Delay, Day, Estegrin and Merchant.

The Western Air Express station (KGSR) is one of a chain serving the above outlined route and equipped with a 50 watt fone, 150 watt CW transmitters and three receivers. This is the usual amount of equipment found in many commercial airways stations with exception that most of them use a 400 watt fone transmitter. One receiver is used to standby for planes in flight while the other two are used to cover two or three frequencies for point to point work on CW. Due to the well known skipping encountered in high frequencies it is necessary to shift from one band to another to facilitate consistent communication between ground stations throughout the day and this has been found the most successful means in accomplishing such. Frequencies used by WAE are, 5692.5 KCs for day fone, 3072.5 nite fone. For CW work three frequencies are used, namely, 8015, 6530 and 2720. Pueblo KGSR is open 16 hours each day with Wm. Ziegler and Willis H. Farnum holding down the two tricks.

Other stations along the line are Cheyenne (KGTT) with a 50 watt phone transmitter, operator C. W. East, assisted by the field manager, Mr. Hollister, who made the grade in obtaining an aeronautical ticket. Next is Denver (KGSP) which is equipped with a 400 watt fone, 150 watt CW and a 15 watt airport transmitter. The latter being used only to communicate with planes approaching the airport and operates on a frequency of 237 KCs. Four receivers are required to handle routine matters. Denver operators are, John Blackman, Frank Campbell and Jack Smyser. The latter recently announced the arrival of a seven pound baby girl.

To the south of Pueblo WAE planes are covered by (TWA) Transcontinental and Western Air at Albuquerque, N. M., and Amarillo, Tex., and (AA) American Airways at El Paso, Tex.

New radiophone equipment of the latest aircraft type with 50 watt transmitters and superhet receivers is replacing the 10 watters and present superhet receivers on eight Super Universals flying this route. Tests have proven the new gear far superior than the old and installation is well under way under the supervision of Roy C. Fell, technician, at Denver.

It has been nearly four years since the radiophone made its debut on aircraft of the transport lines for reliable communication with pilots in flight and due to the rapid adoption of this means of communication by the numerous airlines together with the narrow band of frequencies allotted by the Radio Commission it became necessary to develop some system whereby all could use the ether a sufficient length of time to permit the necessary contacts with their respective pilots in flight. To accomplish this a method has been followed whereby each line and each division is allotted certain periods during every hour for ground to plane contacts, usually five minutes every half hour, except in emergencies when schedules need not be observed. During these schedules the station on either side of the plane will call. The pilot chooses the station he hears best giving his position and other information he may have for the ground station. All communications are made as brief as possible to permit time enough to clear other ships on the same division. There may be as many as four or five in the air at the same time on one division which must be cleared in five minutes. In this way one frequency may be alloted several airlines, without interfering with one another, by observing their respective schedules. An example of this is that 5692.5 KCs has been allotted WAE, National Parks Airways and United States Lines. These three lines comprising a total of six divisions then would occupy the full hour if each division is assigned ten minutes per hour.

In many instances have radio aids been instrumental to airmail and transport planes such as guiding the pilot to a safe landing through fog, advising him of bad weather ahead and numerous unforeseen incidents that might occur while flying the run.

With such aids as the radiophone offers the air traveler we still hear of skeptics who think air transportation is still in the dangerous stage, but, in reality what other mode of transportation is safer?

Veteran Wireless Operators Association News

(Note: All communications to the V. W. O. A. should be addressed to William J. McGonicle, Secretary, 140 Vanderbilt Ave., Brooklyn, N. Y.)

The eighth annual cruise of the Veteran Wireless Operators Association was held on the evening of February 11, 1933, at the Hotel Taft in New York City. The cruise was attended by 250 members and friends of the association. It was indeed a pleasant surprise for the arrangements committee to witness the excellent response to the change in policy to one consisting of a dinner and dance.

The "Night of Knights" was replete with surprises and highlights. The Gold Medal of the association for 1932 was awarded to Ray E. Meyers, who distinguished himself as radio officer of the polar submarine Nautilus. (The details of Ray Meyers' work are included in the 1933 year book of the association, a copy of which may be obtained for 50 cents from the secretary.) Upon being presented the gold medal by President Muller, Ray responded with a message of thanks, during the course of which he related many interesting incidents of the trip across the Atlantic in the Nautilus as well as occurrences in England while they were there preparing for the journey into the Arctic. Mrs. Meyers, Ray's mother, was present and expressed her appreciation of the honor bestowed upon her son.

A testimonial scroll was awarded to Moichiro Hida, radio officer of the Japanese SS Oregon Maru, in recognition of the exceptional ability displayed by Mr. Hida in connection with the SOS of the SS Nevada, an American vessel. Mr. N. Fujimura, Japanese consul at New York, accepted the testimonial in Mr. Hida's behalf. Mr. Fujimura thanked the association in most eloquent fashion for the honor bestowed upon his countryman. A correspondent of a leading Japanese daily was present and after the affair cabled his home paper in Tokyo the news of the testimonial award.

A testimonial scroll was posthumously awarded to the radio operator of the ill-fated SS Nevada, William R. Robertson, who lost his life in the performance of his duty. The testimonial will be forwarded to Robertson's next of kin.

Testimonial scrolls were also awarded to: David Ljungh, radio operator of the SS Ovidia which sank in mid-Atlantic in November, 1930. The work of Mr. Ljungh resulted in the successful transfer of the entire crew to the rescue ship, Mauretania.

J. B. Courtney, radio operator at Managua, Nicaraugua, during the earthquake which shook that city in March, 1931. It was through the heroic efforts of Mr. Courtney that the news of the disaster reached the outside world.

A. W. Esten, radio operator of a Pan-American airplane which crashed into the sea off Gloucester, Mass. The combined efforts of Mr. Esten and the pilot brought about the rescue of the twelve persons aboard the plane.

Robert McCarrick, radio operator of the SS Doris Kellogg which burned at sea in December, 1932.

Arthur F. Wallis, radio operator aboard the U.S.S. Scorpion when that ship was stationed in the Mediterranean. The work of Mr. Wallis in communicating with the outside world during the earthquake which wreaked havoc at Messina, Italy in 1909, won for him a medal from the Italian government. The association rathed belatedly recognizes this exceptional feat by the award of a testimonial scroll to Mr. Wallis The names of S. M. Craigie and C. B. Courtney, fellow operators of J. B. Courtney at Managua and the Messrs. Farman, Shore, Robinson and Haynes of the radio staff of the Mauretania, are placed on the roll of honor of the association.

The inimitable Don Jorge Clark was for the nth time the master of ceremonies. He had the pleasure of presenting such well known entertainers as "Goldy and Dusty" who entertained with songs and chatter; the Tastyeast Jesters who presented an entertaining skit which included many songs; Anthony Frohm, who rendered some excellent vocal numbers; Mr. Hudson, of Southern Radio, who tap danced to the applause of the assembled guests.

Many of the entertainment features were furnished through the courtesy of the Bamberger Broadcasting System (WOR) and the National Broadcasting Company for which the association publicly thanks them. The public address system was furnished by Mr. J. R. Poppelle, chief engineer of WOR.

A large representation was present from Washington among whom were F. P. Guthrie, RCA representative in Washington and L. W. McKee of the Department of Commerce. Colonel Samuel Reber of RCA and a life member of the association was a happy participant. W. S. Wilson, resident agent of the association, came up from Wilmington, Del. Many were present from Camden, Philadelphia and Baltimore.

A message of greeting was presented the audience from David Sarnoff by electrical transcription. The message was recorded in Continental code.

The association looks forward to a continuance of the splendid support accorded the eighth annual cruise.

RADIO AT THE WORLD'S FAIR

AN APPEAL

Fellow veterans (and how!); fellow Fle's, fellow technocrats, and Bellow Falls . . . attention!

The V. W. O. A. (Very Well Organized Affair) will be represented at the World's Fair. There will be a replica of the operator's monument on display, probably sponsored by Mr. Aufenanger's Institute. A placard or sign will be placed suitably near inviting anyone interested in the Wetterans to enquire further from the officer in charge. And he, my dear boys and girls, will be none other than. So if the Chicago section begins to go way ahead of the parent organization, it will be my fault, and it will be just too bad.

But in return for this I need your help. One of my jobs is to build up a display of the growth of Wireless, in apparatus and picture, and there is still much to be excavated. Brother Guthrie has helped manfully, and in the few remaining weeks can't others do the same? Pictures of old installations, with dates; any old apparatus, especially old American Marconi or

(Continued on Page 32)

American Radio Telegraphists Association News

All communications for The American Radio Telegraphists Association should be addressed to James J. Delaney, secretary-treasurer of the association, 20 Irving Place, New York City.

Authorized representatives are as follows:
Boston, Richard J. Golden; Charles W. Marsh
Miami, D. W. Scott, P. O. Box 2254
New Orleans, Forrest H. Flanders, Y. M. C. A., Box 314, 936 St. Charles at Lee Circle
Great Lakes, Arthur H. Freitag
Port Arthur, (Gulf representative), Hoyt S. Haddock
Baytown, Texas, Ralph E. Knudsen
Beaumont, Clyde B. Trevey
Seattle, Rollie B. Weiss
San Francisco, Oliver Treadway
Los Angeles, M. L. Schaefer

Gulf Notes

D. F. O'Brien, SS Illinois, arrived in Port Arthur again from the west coast. D. F. says, "The trip was fine but old W. P. A.'s towers surely look good to me."

* * *

Mr. and Mrs. Ralph O. Ellis who have recently entered the realm of matrimony are extended the heartiest congratulations and best of wishes by the fraternity.

* * *

Friends of K. P. Braswell and wife are pleased to learn that they now have a little place to themselves. We wonder if this is an indication that they are now ready to "raise a lot of ducks, and cows, and geese, and 'everything'."

* * *

Chas. A. Luck, SS Tustem, has not been heard from in some time. Has the Tustem decided to go to the bone yard for a while, Luck?

* * *

R. C. Harper, who has been sojourning on the SS Beach Maru for some time, spent a month at home and gained 14 pounds. Marriage certainly agrees with that boy!

* * *

It seems strange that we do not have more real friendships in our profession. I mean real friendships that are worthy of mention such as exists between L. R. McMahon, SS J. N. Pew, and J. R. McMurray, SS Sun. Oh well, after all may be it is the **Mc** that does it!

* * *

We're expecting to see ole R. P. Soucasse, SS Sunoil, at the top of the ladder one of these days. That boy really believes in proficiency and advancement—and is he eating up extension courses, and how! He has already finished several and is going to dive into another soon.

* * *

We're happy to learn that the Stanford family have all recovered from the flu and that H. A. is back at work. He is now aboard the Gulfmaid.

* * *

A. H. Phelphs has left SS Reaper and gone gone on the farm where he hopes to improve his health. We wish you a speedy recovery, Phelphs.

Boston Notes

Speaking in language which appears to be popular in these hardy times, Mackay Radio is muscling in on the trawler racket in Boston. The trawler "Trimount," heretofore unequipped with radio, set sail with a Mackay radiotelegraph set, the first and only Mackay outfit in the large radio-equipped trawler fleet. If the apparatus proves satisfactory, the "Shawmut" and "Boston" of the same company will be fitted out with Mackay transmitters. Radiomarine operators, the jealous things, are whispering around that however well the Mackay radio sets function, Mackay operators, new to the rigorous life aboard a fisherman, may not function so satisfactorily.

* * *

Here's a story for your next banquet. An operator in these here parts went up to take a radiotelephone examination around Christmas time. One question stumped him and in desperation he answered it thus: "God knows! Merry Christmas." When he received his corrected papers the unanswered question was marked thus: "God gets a hundred. You get zero. Happy New Year."

* * *

Boston operators would do well to keep their licenses endorsed for radiotelephone. The city of Boston will shortly add radio to its police department and in the near future there may be civil service examinations for at least ten radiotelephone operators. According to talk around town, present plans are for three short wave stations and fifty or more radio-equipped police cruising cars. The cities of Somerville, Arlington, Newton, Fall River and the Massachusetts state police patrol already have short wave radio police systems. Marine ops should not overlook this fast growing radio field.

* * *

The trawler "Gertrude M. Fauci," one of the three Boston fishing vessels equipped with radiotelephone, achieved plenty of publicity when it rescued the crew of the schooner "Don Wilkie" recently. Boston newspapers got in touch with the "Fauci" by means of radiotelephone and learned the details of the rescue. Although the 'phone set actually played no part in the rescue, newspaper headlines screamed, "Radiotelephone Reveals Daring Rescue at Sea."

* * *

The collier "T. A. D. Jones," bound from Boston to Norfolk, was reported missing for five days during a stretch of bad weather the last of January. She finally arrived in port in rather a battered condition, for which her owners must be exceedingly thankful. The "T. A. D. Jones" is one of those vessels for which radio is considered unnecessary, although she carries 30 or more souls in the crew. If she had never turned up it is possible the owners would realize that sailing without radio protection is short-sighted economy, to put it mildly.

* * *

Changes in radio personnel on Boston ships have been few during the past month. Most of the boys are sticking close to their jobs.

American Radio Telegraphists Association News

New Orleans Notes

Two more torpedo boat destroyers of the Great War have been converted for the Standard Fruit banana trade. These are the U.S.S. Dale and the U.S.S. Osborne . . . and have been re-named Masaya and the Matagalpa. The duties of the radio operator will be combined with those of a mate, on both ships. Judging from exterior views, we would say that the Boston Trawler Fleet would ride like the Rex in comparison. Both of these vessels are slightly over 300 feet long and have about 6 inches more beam than a canoe.

* * *

Forrest H. Flanders, ARTA representative at this port, has recently been assigned the SS Munbeaver . . . and so must temporarily relinquish an active part in organization work.

* * *

Until a new representative for this district is appointed, please send all items for this column direct to the "CQ" offices in New York City. Let's keep New Orleans Notes alive, gang . . . and back your new ARTA representative 100 per cent!

New York Notes

Simon Golden, after a short stay on the beach, was assigned to the Astral of Socony.

* * *

Vernon Minzie, returning after a three and a half months' trip in the City of Dalhart, is once more on the beach, a resident of The Lynmore.

* * *

Jack Kennedy was assigned to the Frederic Kellogg of the Standard Shipping.

* * *

Our old friend and scribe, Karl Baarslag, was handed the Steel Age but had to be relieved after a short coastwise trip due to illness in the family.

* * *

W. D. Thomas, now second in the Manhattan, will take out the Washington when she is commissioned in May.

* * *

Christopher Kelley, after one trip with the Cerro Ebano, Standard Shipping, is once more on the beach at New York.

* * *

Herman G. Michaelson, recovered from his long illness, was assigned to the Pan Bolivar.

* * *

George C. Ahrens relinquished his berth in the Tydol No. 2 to one of the boys at 75 Varick Street for a relief trip.

* * *

Ralph Nodar and Eric Potts have served in the SS Dixie of the Southern Pacific Line for three and a half years. Ralph has lately completed his elementary examination with the Capitol Radio Institute and Eric is not far behind.

What has become of Percy A. Scambler? He has not been seen in several months.

A new acquaintance, also a student of the Capitol Radio, is Frank L. Aciero, serving now in the El Mundo.

John J. Kenyhertz took a trip off from the Amapala, giving a job to T. C. Ault who has been on the beach since June.

ANTENNA CURRENT

(Continued from Page 8)

Eddy current losses are due to metallic objects in the induction field of the antenna, such as the metal supporting towers themselves, stays and guy wires. These metallic objects are cut by magnetic lines of force and eddy currents are generated. Eddy currents are also generated in the antenna circuits itself in the center of the conductors where no R.F. current flows. This can be minimized by the use of hollow tubing wherever it is practicable. Metallic objects within the antenna induction field must be minimum consistent with good construction.

Dielectric losses are due to insulators, dry ground, trees and shrubberies, wooden or brick buildings and wooden supporting towers themselves in the immediate vicinity of the antenna. Even the air is an imperfect dielectric and its constant varies with its condition. This latter cannot be remedied. Dry ground dielectric losses can be avoided by the use of counterpoise ground. The antenna vicinity should be kept clear of trees, shrubberies and buildings. The wooden supporting towers cause dielectric losses comparing with eddy current losses in metal supporting towers, therefore the metallic towers are favored for their greater tensile strength.

Corona losses are due to brush discharge caused by high voltages built up especially at the open end of the antenna. This can be minimized by the use of corona shields on the insulators which spread the electric strain over a greater area and the corona losses are thus decreased, in addition to this it decreases the possibility of the insulator breaking down. Corona discharges can be further minimized by using antennae of high capacity approaching the fundamental LC value. All sharp turns should be avoided.

The RADIATION LOSSES are the only useful losses and they should be kept maximum. This is the actual power isolated in the atmosphere. It can be increased by increasing the antenna capacity approaching the fundamental LC value for the frequency it is to be used for.

Another important factor in antenna efficiency is its effective height. The greater its effective height the greater is the range of the system. In case of a flat top antenna the effective height is nearly that of the flat top above ground. On ship antennae the effective height varies as the ship is loaded or light, at the same time its capacity varies therefore its effective resistance also changes.

In summing up, the efficiency of a transmitting system cannot be calculated from the antenna current alone, but it will indicate comparative efficiency under different conditions.

A GRAPHICAL ANALYSIS

(Continued from Page 13)

$$P_o = \frac{E_o I_o}{8} = \frac{235 \times .031}{8} = .91 \text{ watt or 910 milli-}$$

watts. It should be particularly noted that since the co-ordinates of Diagram 1 are **not** plotted to the same scale the inclination of the load line as shown is **not** 7° 30′. In this diagram the scale of milliamperes to volts is 2.5 to 1. Therefore the angle of the load line as shown with respect to the voltage axis should be 2.5 times that of the correct angle as found by calculation from the load impedance. Thus in the diagram a protractor shows the inclination of the load line R_1 to be 18° 45′. By laying out the scale of the graphical representation of the problem in question to a convenient ratio, the actual angle by which the load line intersects the operating point can be determined directly from the load impedance. This method of determining the inclination of the load line is correct in the case of either a resistive or reactive load.

Another method of drawing in the load line at the correct angle is to locate any two points and then draw the line through these points. One point of course will be x. With a purely resistive load circuit we can locate the E_p intersection as follows from the value of plate current at x and the value of the load resistance. Assume that with point x (Diagram 1) located arbitrarily from the known characteristics of the tube we wish to determine the output and operating conditions with a load resistance of 4000 ohms which we will designate as R_2. With no excitation the normal plate current of 20 mils flows through R_2 giving a voltage drop across R_2 of 4000 x .02 or 80 volts. Thus the point of intersection of the E_p axis will be at 200 + 80 or 280 volts. The load line R_2 is then drawn as shown.

Now with the same limitation that the plate current shall not swing below 5 mils, it is seen that the grid voltage can only be allowed to swing 30 volts on each side of its normal value, that is, from —20 to —80 volts. This will permit almost exactly the same total plate current variation, $I'_o = 31$ mils. However, the plate voltage variation will only be from 137 volts to 260 volts, a total of 123 volts. Thus,

$$P'_o = \frac{E'_o I'_o}{8} = \frac{123 \times .031}{8} = .477 \text{ watts or 477}$$

milliwatts. This is only slightly more than one-half the power output obtained with R_1 but since it can be seen that the variations of E_p and I_p are practically symmetrical around x there will be very little distortion.

Now if we employ the same grid excitation voltage as with R_1, that is, swing the grid from 0 to —100 volts, then the plate current swings from 0 to 46 mils and the plate voltage from 93 to 280 volts, a total of 187 volts.

$$\text{Then, } P_o'' = \frac{E_o'' I_o''}{8} = \frac{187 \times .046}{8} = 1.07$$

watts, somewhat greater P_o than with R_1 and the same excitation voltage. However the plate current varies from 20 mils to 0 on one grid swing and from 20 mils to 46 mils at point z″, a total of 26 mils, 6 mils more than on the opposite grid swing. This will result in considerable second harmonic distortion which may be calculated quantitatively as follows:

$$\text{Distortion} = \frac{\tfrac{1}{2}(I_p \max + I_p \min) - I_p \text{ normal}}{(I_p \max - I_p \min)}$$

$$= \frac{\tfrac{1}{2}(.046 + 0) - .02}{(.046 - 0)} = \frac{.023 - .02}{.046}$$

$$= \frac{.003}{.046} = .065 \text{ or 6.5 per cent.}$$

This is considerably greater distortion than could be tolerated in broadcast work where the generally accepted maximum is 5 per cent. Of course with the grid swinging negative the plate current, due to the reduced μ under such conditions would probably not reach exactly zero but for practical purposes it may be considered as such.

In the case of the condition shown by R_1 where the load impedance is 7580 ohms and the grid excitation variations from 0 to —100 volts, the plate current varies around the 20 mil point from 20 to 5 and from 20 to 36. Then,

Second Harmonic Distortion

$$= \frac{\tfrac{1}{2}(.036 + .005) - .02}{(.036 - .005)} = \frac{.0205 - .02}{.031}$$

$$= \frac{.0005}{.031} = .016 \text{ or 1.6 per cent.}$$

This is ordinarily considered a negligible percentage of distortion and the excitation could even be increased if a slight power increase was desired. However, as soon as the grid is allowed to swing positive the grid current flow changes the operation conditions and the harmonic percentage will increase rapidly. The slight amount of distortion present is caused by the excitation voltage swinging down into the curved portion of the $E_p I_p$ characteristic. This is shown on the diagram.

Where the load impedance is reactive and not a simple resistance all of the above described conditions do not apply. (This assumes that the actual resistance in which the power output is dissipated is coupled to the tube through a transformer or by means of a choke and condenser.) However, if we can assume that the D. C. resistance is negligible and that the impedance is entirely reactive it is not difficult to rearrange the principle of the load

(Continued on Page 32)

CORRESPONDENCE SECTION

Dear Editor:

Have been away from the seaboard for several years now, and am thinking of returning there. Will you kindly advise me what conditions are in the shipping field, and what the chances of my again connecting with a job, as ship operator? J. C. K.

* * *

Dear J. C. K.:

Our first impulse is to tell you to stay where you are, but that would probably not satisfy you, so we will go further.

Right now there are few positions to be had. Not many of those on the "beach" are able to connect. Many of them are the best, but that means nothing now. There simply are not enough jobs to go around.

The largest supplier of radio help to ships is trying several experiments. They are keeping a pretty accurate record of what runs each man has had. If he has been going along pretty regular he is in for it, as they figure he should have stacked up some reserve to carry him, and when men are asked for they send out the fellows who have had long stays out of work.

Another policy they are trying, not with the greatest success, by the way, is trying to get ops to take a little vacation of their own. In this way to give another fellow a crack at some work. Many of the boys can see it one way, but wonder how sure they will be of getting on again. Also, if they do get on, will they have a long stay, or just a short run. Some of the men have gone so far as to complain to the shippers that they are being encouraged to quit their jobs under pressure.

The marine field is not in the best condition. Right now the boats are not even sure that the $27,000,000 for mail carrying . . . subsidy, will go through. It has gone half way to be sure, by getting in the post office budget, but then the Treasury-Post Office bill which will finally put this through is tied up. Ship men think this should be double the size, as they believe if the country is to have ships for emergency as originally planned when the shipping board began what is practically over now, getting rid of all its vessels left over since war days.

They point out that it took $3,500,000,000 to do the job when Uncle Sam had to have the ships in a hurry, and say it is foolish to stop at $27,000,000 now when the ship concerns need it most on account of little freight being available. One of the main wrangles seems to be that Congress believes the ship concerns are not playing the game fair. That they are letting their help go, substituting lower priced help, and generally cutting down their expenses, but just relying on the so-called subsidy for an operating profit. The $250,000,000 Construction Loan Fund which went to shippers who have played along with the shipping board, and built newer and bigger up-to-date boats when money was advanced to them in the form of loans has not convinced Congress that a greater amount should go in this direction.

It's a fight to the finish for any man to get a job these days as radio operator aboard a boat, and many men have already decided they are finished so far as the sea is concerned, but there are still more men by a long shot than there are jobs for them as wireless operators.

EDITOR

Dear Sir:

I have always followed all radio magazines, but not one has such a worthy cause as yours. It seems queer to me that amateur operators are just as well qualified for television work on extreme high frequencies. This is to my mind a branch of the commercial field and should use commercial fone men, although with the present regulations most all the television stations are using friends that have an amateur license. Yours very truly, L. S. A.

Dear Editor: I have followed with keen interest the various issues of CQ and must say that I enjoy reading the articles very much, and I am pleased to note the interest shown by so many operators during the last few months.

Have been in the operating game since '22 and have been thru the experiences mentioned in previous issues of CQ. My experience in both broadcast and marine work has convinced me that an organization properly managed for the operating personnel is a big step toward the raising of the standard of the profession.

Respectfully yours,
W. H. B.

Commissioner Lafount has recently proposed the following order, that section 15 of the rules and regulations governing the issuance of radio operators' licenses be suspended until July 1, 1934, in so far as it requires employment, service or examination as a condition precedent to obtaining a renewal of the same class of license. If the recommendation is approved it will be possible for any person holding a valid license (operator's) to obtain a renewal thereof without examination irrespective of whether he has been employed or can show service during the license term. Mr. Lafount has proposed this temporary modification of the commission's requirements and hopes the commission will adopt it at an early date probably by the time this issue of "CQ" goes to press. This, it is hoped, will prove beneficial to the unemployed operators. Signed A. H. F.

Dear Sir:

The writer has been employed at two 50 KW stations (BC) and believes it unfair to receive but small compensation for services rendered. Along with the regular hours of watch have put in many hours of overtime, swept floors, attended to furnaces, done errands and other varied duties without any additional pay. With the responsibility and regular hours of watch it is much to the disgust of one having to do with other side work. These stations can afford to seek 500 KW permits, install expensive apparatus and experiment night after night, yet the operator is least considered. I hope something can be done regarding such conditions. Signed, AN OPERATOR

Radiation-Cooled Power Tubes for Radio Transmitters

(Continued from Page 7)

metal in the tungsten carbide layer, and by so completely exhausting the tube that little gas remains to be ionized.

The formation of the surface layer of thorium and of the reservoir in the filaments of these tubes is accomplished during the evacuation process as is common practice in the manufacture of all vacuum tubes employing the thoriated type of filament.

A special high-vacuum exhaust system is used to remove all traces of gas from the tube, and during the early stages of the operation the tungsten carbide layer is formed by glowing the filament in an atmosphere of hydro-carbon gas. The pressure of the gas, the temperature of the filament, and the time of glowing are all so regulated that the quantity of carbide formed is accurately controlled. Following this the hydrocarbon gas is removed and the lengthy process of freeing the glass and metal parts from occluded gas is begun. The entire tube, while the vacuum pumps are running, is first baked in an electric oven at a temperature just beneath the collapsing point of the glass. The metal parts are then heated by high frequency induction to a considerably higher temperature than that of normal operation. Some ten hours of continuous exhaust are necessary to gain the desired freedom from occluded gases.

During the assembly of the tube a few milligrams of magnesium in an annular mounting have been attached to the central glass supporting structure near one end of the tube. Just before sealing off the tube from the exhaust station this magnesium is vaporized. The vaporized magnesium condenses on the lower portion of the glass wall of the bulb where it forms a mirror that acts as an absorbent of any gases that may be formed during the operation of the tube. At the time of flashing, the magnesium also reacts with small amounts of oxygen or water vapor that may be present and removes them.

After the tube is sealed off the exhaust station, the filament is operated at a temperature well above its operating value, and during this period, as well as during the previous heat treatments, the tungsten carbide reacts on the thorium dioxide in the core of the filament. This results in the reduction of a certain amount of the oxide and the building up in the carbide layer of a definite quantity of metallic thorium. Both the temperature of the filament and the time of heating are accurately controlled to form the right amount of metal. During the life of the tube this metal gradually diffuses outward and maintains the monatomic layer on the surface. All the steps of the process are so controlled and the operating temperature of the filament so adjusted that there will always be an adequate supply of thorium to replace that lost by evaporation or ion bombardment throughout a life of several thousand hours.

All three of the new tubes incorporate the molybdenum plates and grids and the thoriated tungsten filaments, and are subjected to the same manufacturing processes in respect to them. They differ from each other, however, in many other respects. The two larger tubes, the 279A with an output capacity of 2,000 watts and the 251A with an output capacity of 1,500 watts, are of the cylindrical anode type. Both anodes have vertical radiating fins as aids to increase anode dissipation. The 279A tube employs a greater number of these fins than does

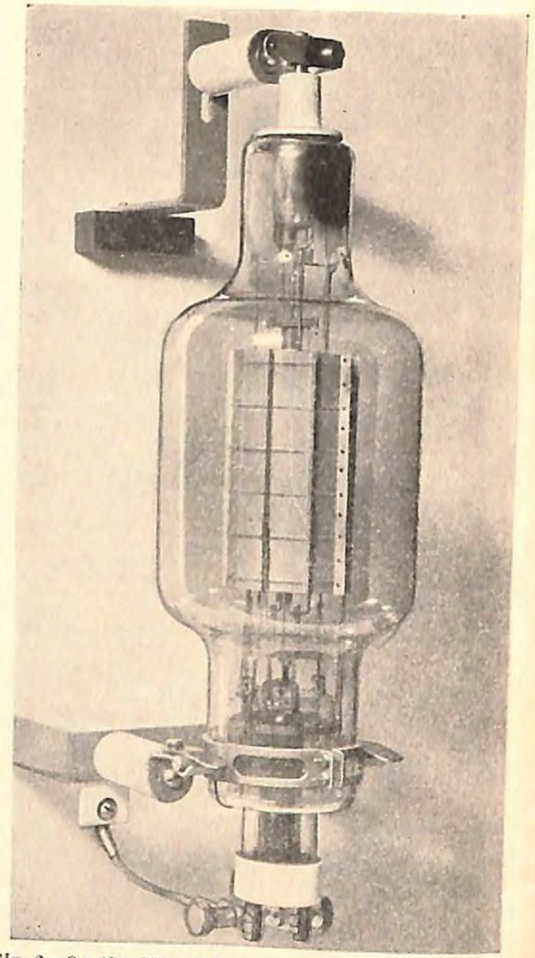

Fig. 2—On the 279A tube nine radiating fins have been designed to obtain maximum radiation

the 251A tube. This was necessary due to the greater energy dissipating requirements of the larger tube. Its anode is made of nine sections with a radiating fin at the contact surface of each pair. The development of this anode, and of the assembly tool in which all of the sections are held while they are riveted together, presented a number of mechanical and physical problems. The cylindrical plate construction gives unusually low inter-electrode capacities, which make the tubes suitable for high frequency applications. At reduced power ratings they may be used for frequencies as high as 40 megacycles. These tubes are employed as required in the 71A amplifier unit, used at the final amplifier state in the 500 watt and 1,000 watt broadcast transmitters. They are also used in various point-to-point radio telephone systems, such as ship-to-shore and airplane-to-ground systems.

One interesting feature of the 279A tube is a new type of structure for tensioning the filament. Instead of employing a separate tensioning spring for each filament V, a central compression spring is used to tension all four V's. This unit spring is supported by the center rod of the filament assembly, and is specially insulated and shielded. The insulator at the upper end supports a platform member which in turn supports the two whiffle trees or rocker arms. The platform has only point contact with the top insulator so as to give it a universal joint action, enabling it to rock freely in any direction. The universal joint action of the top platform, in addition to the whiffle tree action of the two rocker arms, insures uniform tension on all legs of the filament from a single spring. A weighted jig is used to depress the spring to the proper tension and hold the top platform and cross-arms in their correct relative position during the assembly of the filament hooks. The free ends of the filament hooks, which are in contact with the filament, are looped back like a safety pin.

The smallest of the three tubes, the 270A, has a continuous output rating of 500 watts. Its electrical characteristics have been so adjusted that with grid modulation its rated output as a radio-frequency amplifier can be obtained with a maximum instantaneous grid voltage of zero with respect to the cathode. Since the grid does not have to go positive to obtain full output, the input circuit requires practically no power and may employ tubes of minimum rating: a feature of which advantage is taken in all of the new broadcast transmitters. In obtaining this desirable electrical characteristic it was not possible to employ the cylindrical type of construction. The anode is in the form of a flattened cylinder with its principal area in the two plain parallel plates.

Notable improvement in the precision of glass working has been obtained in this tube. The anode is first sealed, accurately centered, into one end of the bulb with a special lathe type of seal-in machine. After the seal is cooled, the filament grid structure is sealed in the other end on the same machine. There is no central mechanical tie between the plate structure sealed in one end, and the filament-grid structure sealed in the other, and the process must be so accurate that the two structures are exactly coplanar and coaxial.

All of these tubes have been placed in manufacture in the Vacuum Tube Shop. In their development a wide variety of physical and mechanical problems have had to be solved, and many members of the vacuum tube development group have contributed to the ultimate success obtained. In co-operation with the technical staff of the Vacuum Tube Shop, the special processes and tools required for the manufacture of these tubes have been worked out so that the manufactured product is realizing the design capabilities of the tubes.

F. R. C. FINDINGS ON VISUAL RADIO CORP.

(Continued from Page 20)

to sort out the light intensities representing picture elements, sound elements and synchronization elements. From here on the new system is to follow usual methods. The light intensities representing sound are to be made to act upon photo-electric cells which in turn are to produce a variable electrical current to be converted into sound. The light intensities representing synchronization are to be made to produce an electrical current through the medium of photo-electric cells and this current is then to be used to synchronize the motor of the receiver with the transmitter. The light intensities representing the original picture are to be used directly in making up the picture transmitted.

There are features inherent in the above described system that appear to offer extreme difficulties in the way of practical application of the system. The angular displacement of corresponding apertures in the transmitting and receiving discs must be almost exactly the same at all times as a difference in position of as much as the width of one aperture would cut out the sound and synchronization light intensities (Jobson, R. 21). As a matter of fact the amount of difference would have to be less than 1/4320th of the circumference of the discs (R. 22). Another feature, the apertures that expose photo-electric cells to light intensities representing picture elements must be cut off at regular intervals while other apertures expose photo-electric cells to light intensities representing sound, and this cut-off must be sharp. The carrier current must go up sharply at the beginning of a dot or impulse carrying a picture element, or the transmitted picture will lack definition, and it must go down sharply as that impulse is cut-off for another impulse carrying sound transmission (Jobson, R. 23). If the cut-off is not sharp, the picture will lap over into the sound, and the sound will lap over into the picture, with resulting distortion in both (White, R. 64).

The applicant has a "balanced control unit" designed to maintain volume level without manual aid and to maintain close synchronization (R. 12). Neither the principles upon which this device is based or the manner in which it operates is disclosed in the evidence. On the other hand it appears from the testimony of Edwin L. White, commission engineer, that there is no known method of synchronizing motors so perfectly that they will remain in step at every position (R. 63). Synchronous motors which seem to be the nearest approach to a solution of the problem maintain average speeds but at the same time gain a little and lose a little from time to time, or in other words "hunt," due to mechanical inertia.

It appears that the sharp cut-off involved in applicant's system would require a very wide frequency band, probably four times the band used in the ordinary strip scanning method (White, R. 64). The transmitter as designed would transmit some 43,000 dots a second (R. 23). The current involved in producing 43,000 dots a second would go through a complete cycle for each dot, that is from minimum to maximum and back to minimum. The modulation frequency would therefore be 43,000 cycles, and on the basis of double side band transmission a band of 86,000 cycles would be required (R. 23). In addition to this basic frequency a number of harmonics would have to be added to give the sharp cut-off between picture and voice impulses. These would ordinarily add to the frequency band required. The applicant proposes to filter out all harmonics necessary to keep within a 100 kilocycle band and then to superimpose any harmonics needed to supply definition in the transmitted picture on the modulated frequency in the receiver (R. 24). No method by which this may be accomplished is shown. In this connection it appears that the applicant has made no investigation to determine the effect of nearby carriers beyond the band actually occupied (R. 24).

It seems fair to state that the applicant's

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THE ART OF COPYING BEHIND

(Continued from Page 21)

cult. If you have not received properly guided instruction in this connection, trying to learn to copy behind is wasted time and effort—just like trying to teach a child to run before he has learned how to walk. It cannot be done.

The ability to copy code at a reasonable distance behind should be acquired by every radio operator who is ambitious to advance in his chosen field for the reason that it not only renders reception much easier but he turns out a better, neater copy with a degree of certainty never enjoyed by the operator who is compelled to copy "letter-for-letter." Another important thing—such ability does more than anything else to promote speed, and speed is essential. We are living in the Speed Age—no effort is being spared to "speed up" everything; steamships, railroads, automobiles, airplanes—every time we pick up a newspaper we see that a new speed record has been established somewhere. So, may I suggest that **"Speed Is the Thing"!**

In order for you to understand why it is virtually impossible for the improperly trained radio operator to copy behind, I suggest that you tune in your short wave set on the amateur band and listen to the transmissions of improperly trained senders most of whom have taught themselves, or tried to, rather with the aid of a manual, which is of as much value in learning code as is a phonograph in learning the fundamentals of music.

Try to copy ham stations. Many lack consistency in "timing," "spacing," "character-formation," "speed." One will send, for example, the letter "a" as he has learned it from whatever source—"dit space dah." Likely he has read some course or manual which began by telling him, parrot like, the old error, that the space between parts of a letter is equal to one "dit." So, he makes all his signals according to instructions. His "a" may just as well be "et" and his "b" may be "ts" and on and on in the same irregular, inconsistent hodgepodge of confusing signals with no suggestion of rhythm. Mind you, this does not mean all, as there are many who are excellent in every way.

Of course, one accustomed to sending such a conglomeration of dits and dahs, may eventually learn to receive—a little. Hearing "et" he will think maybe it is "a" and he will write it so. If he finds later that the word is "get" instead of "ga" he will make the necessary correction unless he becomes bewildered and believes he is copying " m e e t " for "ga." This happens right along. When the average ham hears something like this—"meetste" written down "letter-for-letter," he shouts with joy because when he "decodes" it he has the word "gave" just as plain as could be.

Here is a very necessary thing to know about the dits and dahs of which Continental code consists. A dit is short—as short as you possibly can make it, whether sending two words per minute or fifty words per minute. It always is made the same way. There is no other way to make it. There are no slow and fast dits any more than there are long, short and medium dahs. A dah is exactly three times longer than a dit, regardless of speed.

So long as you believe there are variations in the length of dahs and that dits may be made slow or fast, as the mood strikes, you will not make any progress toward becoming a skilled operator.

Examine the dit characters—e, i, s, h, 5., and the dah characters—t, m, o, 0. They will serve to illustrate our fundamental principle. When **transmitting the word "his"** at, say ten wpm., you make the four dits of the "h" as fast as you can, without cramping your arm or squeezing the key, uniformly, thus (. . . .) not like this (. . . . .) or (. . . ..) or (.. . ..) then you allow the space of four dahs to intervene before making the "i" thus (..) not (. .) and the space of four dahs before making the "s" thus (...) not (. . .) or (.. .).

When you start out to send ten wpm speed, maintain that speed. Be consistent. If you allow the space of two dahs between two letters, three dahs between two more and four or five between two more, your speed is inconsistent, uncertain—irregular and hard to copy.

Bear in mind always that your sending speed is increased and decreased by the length of your spaces, not by the speed of your individual signals. At ten wpm., you will send the word "his like this—"h - - - - i - - - - s." At twenty wpm., you will send it thus—"h - - i - - s." At thirty wpm., thus—"h - i - s." Beyond that speed you can soon learn to regulate your over spacing if you have patiently come up from the five to eight wpm rate uniformly and developed your "timing sense" which is as necessary to code transmission as it is to music. You must practice until you can time your signals automatically—without having to "think" about it.

The first necessity is uniformity in making dits and dahs. There is only one length of dah (-) not (—) or (———). The joining of your dits or dahs in parts of a letter must be uniformly done or you make something else than what you intended. Example the letter "v." If made thus (. . . -) is "st." If thus (.. . -) is "ia." If (. . . -) is "eeet." If thus (. .. -) it is "eu." So you will readily understand that "v," like all the signals of Continental code, can be transmitted but the one way thus (. . . -). Change that way and you transmit something else.

By learning everything RIGHT in the beginning and making each signal the same way until you form the HABIT of transmitting it that way, you will soon acquire the ability to send without having to "think"—consciously of what you are doing, and when your sending has been consistently developed in conformity with this principle you will experience less difficulty in receiving because you will have formed the right mental impressions of the signals.

It is quite obvious then that specific intelligent direction is necessary—a well graded track for the railroad cars, a well defined channel for the river, and a specific course of procedure for the radio operator. If my premise is correct, then, we must consider the physiological and psychological factors of telegraphing with a view to approaching our task with a concrete purpose.

For 20 years I have been preaching the one purposeful slogan to my students, and may I not suggest it to you? "If you are going to be a radio operator, be a good one!"

Had you chosen Medicine, Law, Engineering, Designing, or any of the professions instead, you naturally would want to study and follow the best authorities in these respective fields, and soon they would teach you that your greatest reward consists of what you are able to put into, rather than to take from your work. Excellence is its own reward. If you are conscientious and sincere in your efforts you will take pride in, not from your work, and whatever emoluments may accrue as a result of your conscientious endeavor, nothing will be of so much value to you as that pride—that satisfaction, if I may so term it. Talk to any man who has excelled all others in his chosen

field of endeavor and he will instantly verify what I tell you.

You send and write with your hand. The motive power of your hand is supplied by the muscles of your fingers, wrist, forearm, upper arm, neck, shoulders and back. The controlling power of the muscles is supplied by the nerves, which are amenable to the BRAIN. This process is physiological: Muscle, nerve, brain. Anything, whatsoever, lack of training or disease, that interferes with this functioning process impedes the physical operation necessary to telegraphing and results in annoying reactions which we usually term nervousness, however manifested. Nervousness is an effect—not a cause—just as headache, rheumatism, catarrh, insomnia, neuritis, backache and many other disturbances are effects. Any corrective or remedial measures applied to effects are futile.

Your brain is an organ just as are your heart, liver, kidneys, etc. Your organs do not function without direction any more than do your watch, radio, automobile, etc. Back of everything is MIND, the director.

Hypothetically, mind has two divisions—conscious and sub-conscious. Without previous contacts and training, mind is purely instinctive in its functioning. With physical contacts, experience and training, mind becomes intellectual, also. When an intellectual process (telegraphing, for example) until you can perform it without "thinking" consciously of it, that is skill. In other words, skill is the acquired ability to do a certain thing without having to think about it—swimming, typing, driving an automobile, talking, writing, walking, etc. If you had to think, consciously, of everything you do, it would require half a day to dress yourself and the other half for you to undress. The greater part of your day's duties are executed without conscious thinking. When you are compelled to apply conscious thought to a task, you must necessarily do it slowly and cautiously until, by repetition, you "get the hang of it," then you can do it faster and better.

We are born with instinct, but we have to acquire intellect. That is why many of us fall so short of what we ought to be. We don't have to learn to become sleepy, thirsty, hungry, angry, to be attracted by the opposite sex, to fight when provoked, etc., but we do have to learn to control these instinctive urges. The outstanding difference between the civilized, educated man and the savage lies in the intellectual control of the instincts. The savage exercises no such control. He fails to understand, like an untrained child, why he should not have what he wants. There is much room for thought here, which I cannot, because of the nature of this article, dwell on consistently.

We learn to telegraph, hence it is an intellectual process. When we succeed, through certain procedure, in tying it up with our instincts, it becomes what we term "second nature," just as do most of our other acquirements. When, through a process of co-ordinative training, we can transmit and receive code without conscious thought as to how many dits make the letter "h" and how many dahs make the letter "o," and varying combinations for other signals, we become skilled proportionately. Lack of skill simply means we have not yet acquired the ability to co-ordinate our facilities. Trying, in a "hit-or-miss" manner to force untrained faculties to co-ordinate is like trying to force a savage chieftain to read, write and act the part of a gentleman. That is why so many ambitious code students become so nervous that in many instances, under pressure, they collapse.

The foregoing is for the purpose of conveying to you that poor concentration, lack of receiving, writing and sending ability, inability to copy a few words behind and make a clean, accurate copy, are effects, only. Trying to handle effects is futile. We must deal directly with fundamental causes.

(To Be Continued.)

F. R. C. FINDINGS ON VISUAL RADIO CORP.

(Continued from Page 29)

evidence does not show solutions for either of the above problems. The applicant's chief of operations testified, nevertheless, that the system had been developed to a point whereby both sound and picture were being transmitted over the same wire, and received (R. 12). His direct testimony in this regard is qualified, however, by a statement indicating that a complete unit for radio reception of sound and picture had not been constructed, and also by a further statement to the effect that their control board had only a picture monitor (R. 30).

The frequency band from 2200-2300 kilocycles is designated in commission regulations, Paragraph 318, as available for experimental visual broadcasting on the condition that no interference is caused with the radio service of any other nation on the North American Continent or in the West Indies. In this connection it is to be noted that the frequency band from 2200-2300 kilocycles is assigned to Canada and Newfoundland for general communication purposes in the so-called North American agreement, Treaty Series No. 777-A.

The proposed new station would probably have an interference range of from 500 to 1,000 miles (White, R. 59). Since applicant's location, Watsontown, Pa., is only about 170 miles from the southern portion of Ontario, Canada, the operation of the proposed station would prevent the operation of Canadian stations at night in that part of Canada (R. 60). It also appears that it would be possible for the new station to cause interference with existing stations located in Quebec (R. 59). There is one United States station licensed to use the 2200-2300 kilocycle band. This station is located in Kansas City, Mo. The distance from that location to Watsontown would probably prove adequate to prevent interference in the service area of either station (R. 62).

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A GRAPHICAL ANALYSIS

(Continued from Page 26)

line to meet the changed conditions. First, the plate voltage will practically equal the supply voltage because we have assumed a negligible D. C. drop through the impedance circuit. Thus with a purely inductive circuit, the plate voltage of 200 volts as indicated in Diagram 1 would also be the supply voltage required instead of the values of 280 or 350 as shown.

However with the inductance and frequency such that the load impedance would equal 7580 ohms, the other conditions as shown by the load line R_1 and the inclination of R_1 would be as indicated. The plate current and plate voltage would swing between the limits indicated. If the inductive reactance of the load circuit is 4000 ohms then the conditions as indicated in R_2 will exist.

We know that in a highly inductive circuit such as the primary of a transformer or an output choke, a varying current tends to reach an average value and to then vary around this point. If there is no distortion introduced in the output, that is, if the operating conditions are such that the plate current variations are symmetrical around the normal operating point, the average current during grid excitation will be the same as the plate current without excitation. This is the condition approximated in R_1, Diagram 1. The operating point remains unchanged.

Now, if we replace R_2, 4000 ohms, with an inductive reactance of the same value and swing the excitation voltage over the same limits, 0 to —100 volts, we will get considerable positive rectification, that is, the plate current averages greater than the value shown at point x because the increase to 46 mils at z" is greater than the decrease to zero. Thus, while maintaining the constant bias of —50 volts there is a slight rise in the average plate current which, following the —50 volt bias line shifts the operating point to a slightly higher value of plate voltage. That is, at the point of the excitation cycle where the excitation voltage is zero, the zero point of the A. C. component of plate voltage will be slightly to the right of point x. If conditions are such that negative rectification takes place, that is, if the D. C. component of plate current is less than the plate current without excitation, then the operating point shifts to the left and the zero value of the A. C. component of voltage is less than the steady value without excitation.

While for some purposes it may be desirable to actually determine the amount of variation of the operating point, it is usually sufficient to know that it does shift and the direction in which it shifts in order to compensate for the variation because this variation of point x indicates distortion.

It will be seen that by the use of the load line and family of curves it is very easy to calculate the values of power output and second harmonic distortion for all values of grid excitation voltage and for any desired range of load impedances. With a number of these values determined over considerable ranges it is a simple matter to show graphically just how the tube will operate under any possible conditions. For example, with several values of load impedances, power output in milliwatts can be plotted against percentage of distortion, a separate curve being plotted for each value of load impedance. Or both the output in watts and the percentage of second harmonic distortion can be plotted against load impedance for a maximum value of grid excitation. Thus without any previous knowledge of the operation of a certain tube or its suitability for a specific purpose complete details of its operation can be obtained graphically from a single set of measurements and the application of comparatively simple mathematics. One such set of curves is shown in Diagram 2 worked out from the characteristics of Diagram 1.

An examination of this diagram very clearly brings out a number of theoretical points which we have discussed. First, we see that the point of maximum power output is with an output load impedance of approximately 4500 ohms. Therefore the internal tube impedance, R_p, must be approximately 4500 ohms. The power output falls off rapidly when the load impedance is less than the internal tube impedance and much more slowly when R_L is greater than R_p.

Second, the point of minimum second harmonic distortion is at approximately 9000 ohms or $2R_p$. This agrees with theory which states that the maximum undistorted power output is obtained with a load impedance equal to double the internal plate-filament impedance of the tube.

The curves of Diagram 2 were plotted from values of power output and distortion calculated when the grid excitation was varied around point x from 0 to 100 volts negative, various values of R_L being taken from 2000 ohms to 12,000 ohms.

It must be remembered that in the above discussion all values of grid excitation voltages were given in peak values. The effective or R. M. S. values are .707 times the peak values.

RADIO AT THE WORLD'S FAIR

(Continued from Page 23)

United Wireless; clippings or stories of the early days—all will do much to help with the story. And **above** all we need a story, **and pictures,** and A SET OR TWO, describing the early amateur sets: (1) before 1909 and (2) in the period between 1909 to 1914 . . . the rock-crusher days . . . when radio was wireless. Who can help out with this? I expect an avalanche of letters in reply to this, addressed to G. H. Clark, 153 East 24th St., New York City. You wouldn't fool me, now would you!!!

PIONEER RADIO OPERATORS

(Continued from Page 9)

could be done, and we were the boys who were qualified to try it, and just rarin' to go.

And so the Alton Limited, "Daylight Flyer" was put at our disposal at St. Louis. Leslie White and I ran a twisted lamp cord alongside the bell cord from one end of the train to the other. The little receiving set was located in the drawing room of the observation car. The ground wire extended out of the window and was clamped to the truck below. East St. Louis was scheduled to start sending "V's" and test messages from the time the train was scheduled to pull out of the train shed until she reached Springfield. We weren't overlooking any unexpected run of good luck! And "Chi." was to begin pounding for us when the train reached Dwight, Ill. So important were these tests that Ocker had run down from Chicago the preceding day to be Willie o' the Cans on that momentous run. We all knew that Ocker would bring in the signals if there were any such along the right-of-way. District Passenger Agent Dudley Walker and other officials of the Alton were on board to see there was "no faking"—keenly interested, but a bit skeptical that wireless could catch up with their crack, mile-a-minute flyer.

(To Be Continued.)

A MINIATURE COMBINATION TRANSMITTER AND RECEIVER

(Continued from Page 14)

control the volume when receiving. The two larger knobs and dials control the plate and grid tuning. Provisions are made to lock these dials. Jacks are provided for the microphone, telegraph key and head set. A three position switch, by a clever circuit arrangement, permits instant switching to telephone or telegraph for transmission or reception.

Four Radiotrons are used in this set; two RCA 230's acting as oscillators for transmission or as oscillating super-regenerative detectors when receiving; an RCA 231 which acts as a modulator when transmitting and as a second audio stage when receiving, and another RCA-230 used as a first audio stage when receiving, or as a speech amplifier for voice transmission, or as an audio oscillator for ICW transmission. The maximum power output is about .2 of a watt.

The power supply is obtained from a special battery box, the overall dimensions of which are $7\frac{3}{4}$" high by $5\frac{1}{2}$" wide by $13\frac{1}{4}$" long. The battery box, including the battery, weighs approximately 15 pounds. This battery supplies filament, plate, bias and microphone current. It is so designed that each section has approximately the same life. This battery will operate the equipment for eight hours of continuous service. Of course, for intermittent service, a considerable increase in life is obtained. To increase the portability feature, a smaller two-hour battery may be substituted. A dynamotor operating from a 6 or 12 volt storage battery is also available, as well as a power pack operating from 110 volts AC. Figure 2 shows the complete equipment for battery use.

For portable use in the field, it may be mounted on a tripod, as shown in Figure 3, in which case a half-wave "Hertz" antenna is used, consisting of two $\frac{1}{4}$" brass tubes of the correct length. By the use of sliders of similar tubing in this bi-polar arrangement, adjustment may be made to the required dimensions. Here a variation of 1" is equivalent to about a 10 foot change in an antenna such as is commonly used in the broadcast band. Different types of antennas may be used to meet the requirements of various installations. Usually in planes, we use a transmission-line of the voltage-feed type, fed to a half-wave "flat top."

On the ground the range varies up to about three miles, depending upon the topography of the terrain, or structual interference. As either end of the span is elevated the range increases. Under good conditions, 50 miles between a ground station and a plane have been readily spanned, although such distances are not to be expected under normal conditions.

Atmospheric conditions apparently have no effect at these frequencies. In one test, during a very severe electrical storm, no static cracks were heard. No difference in transmission during daylight and darkness has been observed. There are, of course, no fading effects since only the so-called ground wave is useable.

This equipment has been used for communication between moving automobiles—automobiles to planes—plane to plane—plane to ground and between groups of mounted men. This equipment is being successfully used for the control of ground crews in forest fire work. One of these instruments is installed in the Chief Fire Warden's plane and by the use of radio, the fire warden can direct ground crews equipped with similar Transceivers and furnish

Fig. 3—Complete "Transceiver" equipment mounted on tripod for field service.

them with accurate information as to the area and direction of the fire's advance, which could not be easily determined from the ground.

This equipment is most suitable for use by broadcast stations in picking up special events such as golf tournaments, etc., by the motion picture industry for use on location as aids to the motion picture director, for aircraft student instruction, railroad train communication between the front and rear ends of long freight trains, and particularly for use by police and fire departments as it provides a ready means of communication from the police cars to headquarters.

The above applications are but a few of the new uses which are becoming apparent daily.

F. R. C. FINDINGS ON VISUAL RADIO CORP.

(Continued from Page 31)

The applicant's representative indicated a willingness to accept any frequency that might be available. Also, an informal request for authority to do preliminary work with a 50 watt station was made in connection with the hearing.

Conclusions and Recommendation

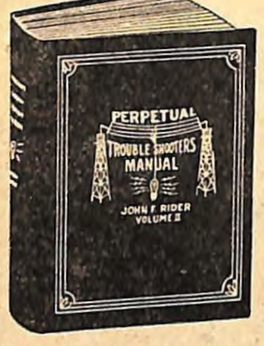
The applicant has not made a strong showing as to technical ability or as to financial ability. The permit requested is obviously desired for the development of a particular transmission system. The evidence regarding that system does not show that it has been developed to a degree that would justify the commission in authorizing the construction of a station. As a matter of fact the evidence raises a serious question as to whether the applicant's plan is workable. It also appears that the particular frequency requested is not available for use at applicant's location.

In view of the foregoing it is recommended that the application of Visual Radio Corporation for a construction permit be **denied.**

R. H. HYDE,
Examiner

Submitted January 28, 1933.

"EVEN BETTER THAN VOLUME ONE!" . . .



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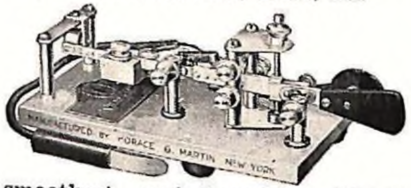

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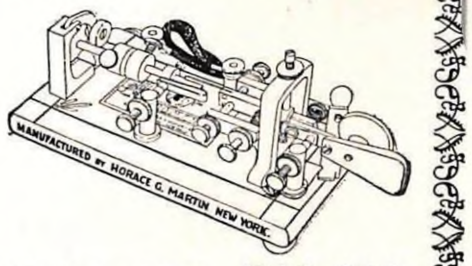

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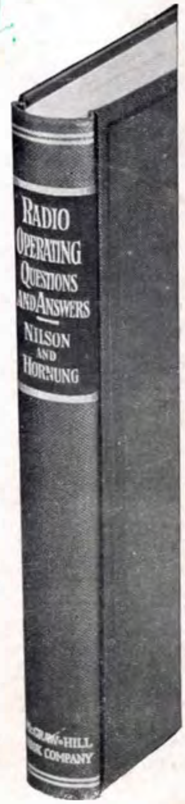

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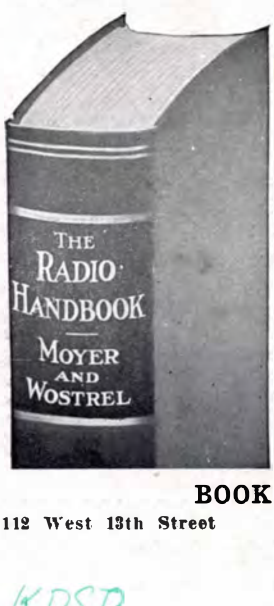

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