

RADIO

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WORLD

The First National Radio Weekly
672d Consecutive Issue—Thirteenth Year

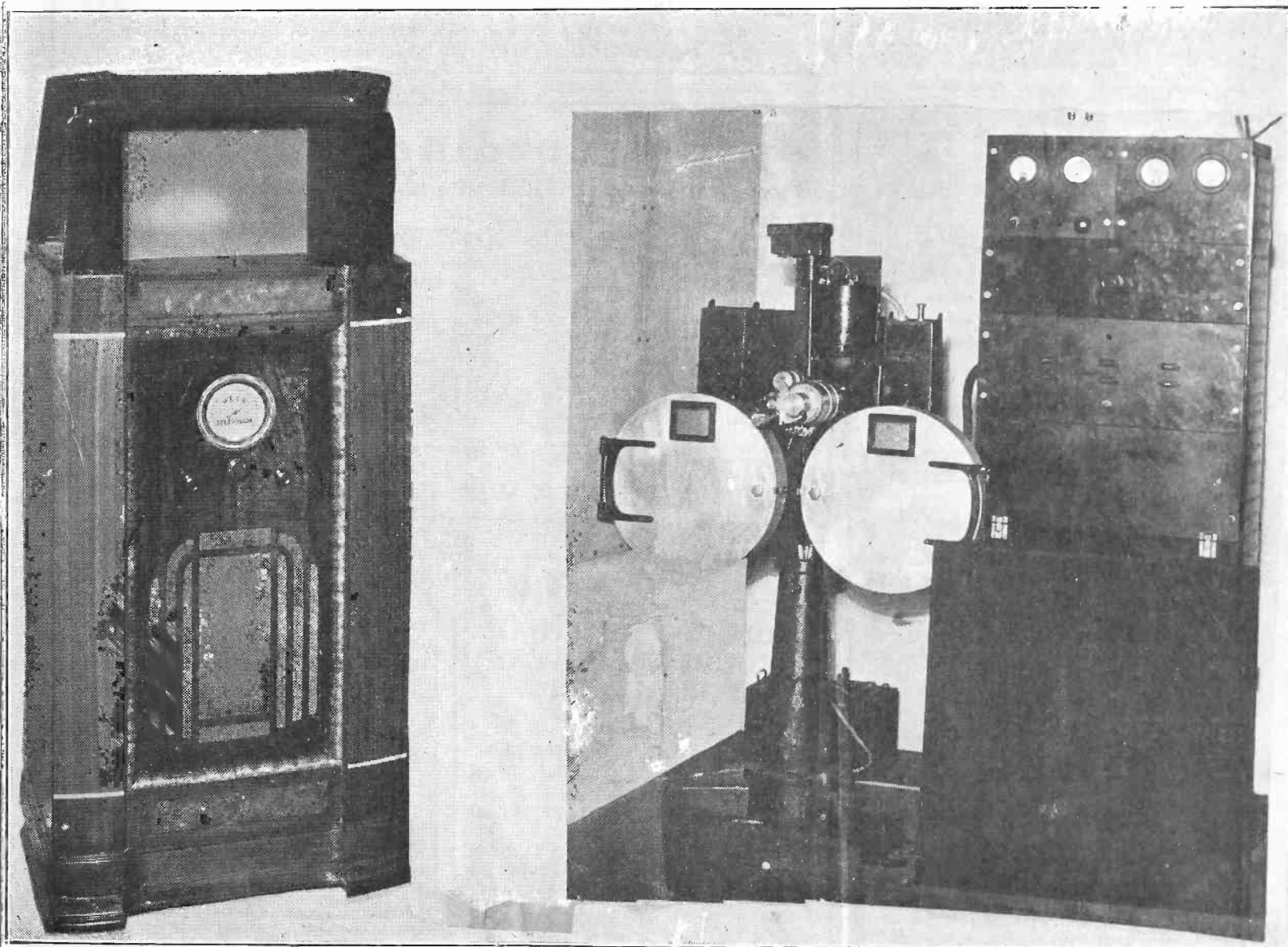
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A console type all-purpose receiver is shown at left. The folding panel at top has the viewing screen. When sound alone is to be received, the top is closed, presenting a flat, horizontal surface for the photo-electric pickup of the filmed sound track. Both receiver and pickup

This brings in sound and television, all waves. The top is closed, presenting a flat, horizontal surface for the photo-electric pickup of the filmed sound track. Both receiver and pickup are the property of the Peck Television Corporation of Canada. See page 6.

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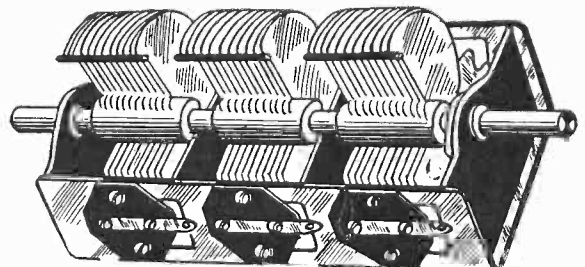
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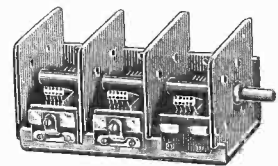
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Placing the Speakers

Avoidance of Acoustic Feedback and Echoes

By Morris N. Beitman
 Supreme Resistor Company

IN installation of public address equipment care must be exercised in placing the loudspeakers. Poor placing of the speakers in relation to the microphone results in the much undesirable feedback. If some of the sound from the loudspeakers reaches the microphone, either through direct radiation or from reflection from walls, and approaches in intensity the original input sound, an echo will be noticed. A further increase in the intensity of the returned sound will result in a number of oscillations. Either of these two faults is objectionable and should be remedied.

If the speakers are made directional away from the microphone, the direct feedback may be eliminated. However, many times the acoustics of the place in question are such as to necessitate some major alteration in order to solve the feedback difficulty. Sometimes carpets are installed, and at other times it may be necessary to cover some walls or ceiling with sound-absorbing material.

Use of Different Microphone

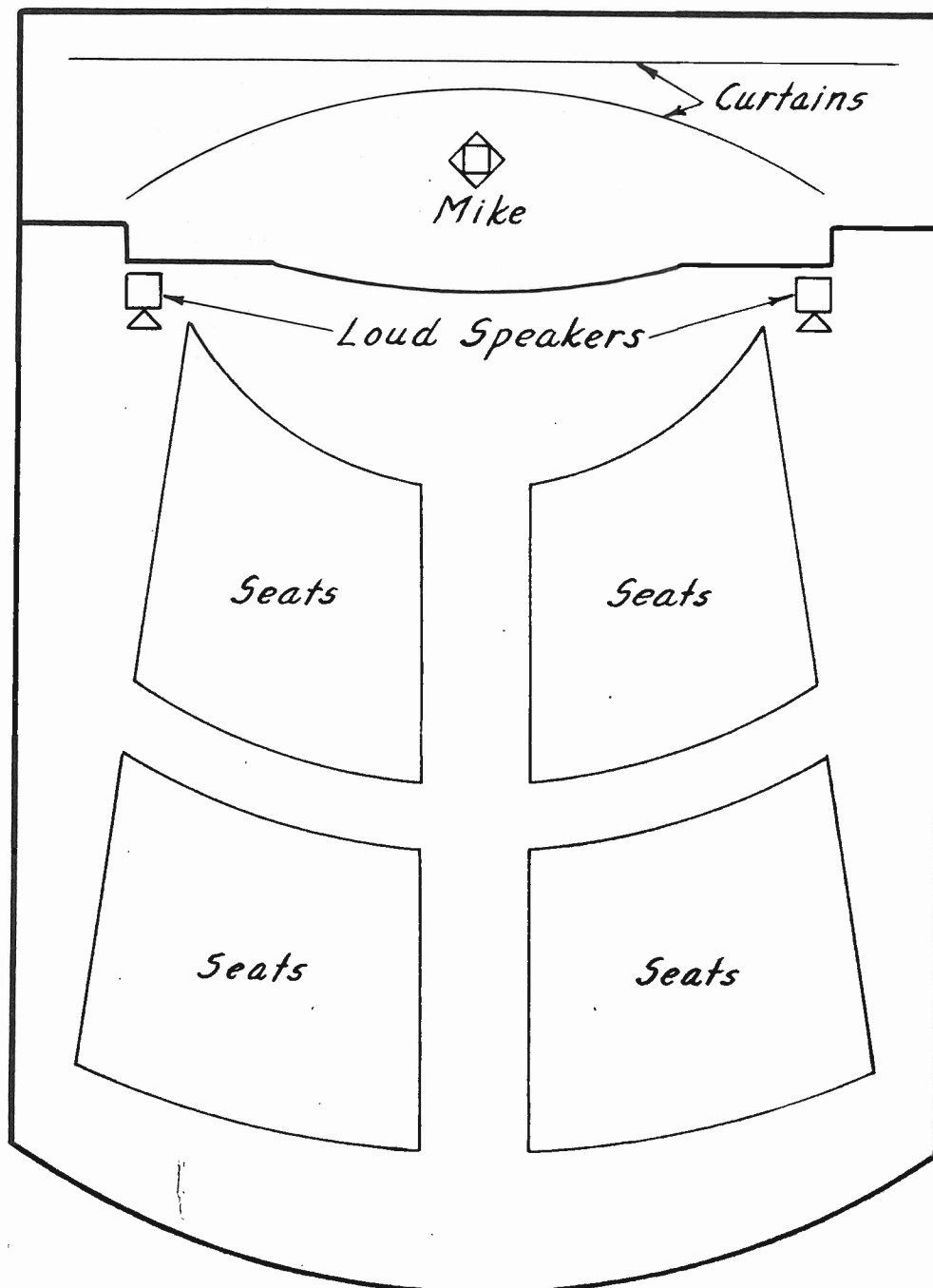
If the original microphone used is of the two-button type, the substitution of a more directional response mike such as the condenser or velocity type may solve the problem. Reduction of the gain in the amplifier will, of course, stop the feedback, but this action may occur at a volume level too low to enable the amplifier to be of much use.

The number of speakers selected for the particular use and the respective placing must be such as to make the program sound natural. It certainly would not do to have the loudspeaker in a back part of a long and narrow hall. In such a case the listeners in the rear part would hear the natural voice of the speaker and the amplified equivalent at a considerable period of time apart.

Use of Baffle

It is by far the best procedure to use as few loudspeakers as possible, usually one or two prove entirely satisfactory. The loudspeakers should be so placed that the sound from them all and the voice of the person on the stage should reach the large majority of the audience almost at the same time. Of course, this will necessitate the condition that the loudspeakers should be about the same distance from the audience as the orator.

(Continued on next page)



The New Service "Gun" Oscilloscope Is Trouble-Hunting Weapon of First Rank

By Nathan Perles

THE recent introduction upon the general market of a commercially produced cathode ray oscilloscope has been a real step forward for the radio fraternity as a whole. This newly merchandised equipment makes use of a 906 type cathode ray tube which contains a 3 inch screen that is ample for the purpose of measurement. In addition, the apparatus includes two separate power supplies (one for the cathode ray tube and one for the amplifier), vertical and horizontal amplifiers and a saw-tooth timing frequency generator. Five vacuum tubes are used.

The cathode ray oscilloscope is a new device in the field of radio servicing equipment. Its operation is extremely simple, being merely a voltmeter that also records time. Its essential elements center around the cathode ray tube, which has been improved upon very materially. The cathode ray tube has of late been referred to as an electron gun since it functions similarly to a gun. The diagram shows the essentials of the electron gun as developed at present.

Effect on the Eye

In the process of an understanding of the electron gun one may consider the cathode as emitting electrons which are accelerated by the high voltage anodes. The electrons strike the fluorescent screen at the end of the tube, thereby creating light. The course of the electrons is controlled by the two sets of deflecting plates, one for horizontal deflection and one for vertical deflection. The amount of deflection, which controls the location of the light spot on the screen, is a direct function of the voltage at any particular instant on the deflecting plates. If this action is repeated twenty or more times per second, the retentive power of the eye will so affect the tracing on the screen that the spot's entire tracing will be discernible and the complete pattern rather than the individual spot points will be seen.

Saw Tooth Oscillator

Focusing of the light beam on the fluorescent screen is accomplished by adjusting the voltage on the anode nearest the cathode. The intensity of the light is controlled by the negative voltage applied to the grid.

The external voltage under test is connected as a common practice to the vertical deflecting plates, so that the base of the pattern will be horizontal. However, unless some means is provided for moving the beam simultaneously in a horizontal direction, the rising and falling spot will trace a vertical line only. Since this would merely give an indication of the maximum voltage available, and besides might injure or ruin the viewing screen, a means must be provided for simultaneously deflecting the beam horizontally. For this, the so-called variable frequency saw tooth oscillator is necessary.

The saw tooth refers to the wave shape of the oscillator and is required because of the necessity of having the horizontal deflection increase more slowly than it decreases. In fact, the return sweep is practically invisible. The frequency of the oscillator must have a definite relationship to the frequency of the voltage under test. For example, to examine one cycle, the saw tooth oscillator must be the exact frequency of the voltage under test. If the saw tooth oscillator is one-half of the frequency of the voltage under test, then two cycles will be shown together on the screen.

With the saw tooth oscillator that is provided in this RCA Manufacturing Company product the minimum number of cycles for the highest frequency is six, being obtained when a 90,000 cycle voltage is observed with the saw tooth oscillator set at 15,000 cycles. Higher frequencies may be examined by connecting directly to the vertical plates and using an external timing oscillator.

Amplifiers

The sensitivity of the cathode ray tube is such that a voltage of 75 is required for either a vertical or horizontal deflection to one inch. Because many voltages used in radio circuits are very small, an amplifier has been provided for each set of deflecting plates. Both amplifiers use a 57 type tube and have a high gain and wide frequency range. The gain is approximately 40 and the frequency range is 20 to 90,000 cycles plus or minus 10 per cent.

Designing an amplifier circuit of such wide frequency range is a difficult engi-

neering problem. Its solution greatly increases the flexibility of the equipment.

The high voltage anode of the cathode ray tube requires 1,000 volts or so d.c. for proper operation. D.c. voltages are also required for the amplifier. The 879 tube is used in a half wave rectifying circuit for providing the necessary anode voltage for the 906 cathode ray tube. The type 80 rectifying tube, connected up in a full wave circuit, provides plate and grid voltages for the two 57 tubes. While a single transformer is used for both rectifiers, individual filter circuits are provided. The transformer is over-sized to prevent stray magnetic leakage that would otherwise affect the operation of the cathode ray tube.

Adaption to Service Work

The cathode ray oscilloscope may be used by the service man for many of his jobs. For the first time he may actually see the wave form of the current and voltage present in various parts of the circuits that he has under consideration. This means, of course, that the proper operating conditions for tube and circuits may be readily determined and adjusted.

One of the first and perhaps most important uses which presents itself is that of visual alignment of receivers. For this application a test oscillator that is capable of being modulated is necessary in addition to the cathode ray oscilloscope. Thus we have a source of radio frequency voltage which is modulated at any audio frequency. The frequency of this source may be adjusted to any r-f or i-f point within the range of the equipment. If this source of voltage is applied to any of the i-f or r-f stages of a radio receiver there will appear across the output circuit of the detector an a.c. voltage depending in amplitude upon the selectivity curve and gain of the receiver. If this voltage is applied to the vertical deflecting circuit of the oscilloscope and the timing axis adjusted to the same frequency as the modulation on the oscillator frequency, the response curve will appear upon the screen as the single humped curve shown in the sketch. If the response curve of the receiver is double humped, it will appear on the screen in that fashion. These curves represent proper alignment but if the transformers are improperly aligned, an irregular curve will appear upon the screen that is similar to the irregular curve shown in the sketch.

It is important when aligning receivers that the voltages that are applied to the equipment are not excessive so that overloading does not occur.

Synchronized Timing

One of the most annoying troubles which may arise in a radio receiver is overloading in the audio amplifiers and this represents another problem for the service man. The point at which overloading occurs and the stage in which it first appears may be readily checked with the oscilloscope. If the input of the receiver is connected to a test oscillator, modulated with 400 cycles, and the voice coil of the speaker connected to the ver-

Speakers Made Slightly Directional as Precaution

(Continued from preceding page)

Usually two speakers are used and are placed above and a little to the right and left of the stage. A good example of this practice is illustrated in Fig. 1. A number of heavy curtains is drawn close behind the microphone on the stage. The speakers are placed as suggested above and are made slightly directional forward to reduce feedback. Carpets are placed in the aisles and the curving back wall is lined with sound-absorbing material to prevent reflections.

Unless the speaker is of the directional horn type a baffle will be needed. Otherwise the wave set up from the back of

the cone will interfere with the wave set up in front, with the result that little or no sound will get out. The baffle increases the air path between the front and back. To be satisfactory for the lower notes a very large baffle is needed, but one of about 40 inches square will usually prove satisfactory. If the speaker is mounted in a cabinet, quite often the reproduction becomes somewhat distorted.

Loudspeakers in permanent installation should not be conspicuous. For temporary application speakers may be mounted in suitable portable cases for carrying purposes. These cases may also serve as baffles.

tical deflecting circuits of the oscillograph, the wave form of the receiver output will appear on the screen. For this test, the timing axis should be adjusted for 200 cycles and synchronized by means of a synchronization control. Two cycles of the 400 cycles receiver output will now appear on the screen. If the test oscillator output is slowly increased, a point will be found where the output wave form will vary from its original shape. Probably the peaks of the waves will become flat. This indicates an overload condition. By connecting the output of the various audio amplifier stages progressively to the vertical input of the oscillograph, the stage which overloads first may be found.

Many other uses undoubtedly will present themselves to the service man. The instrument in general may be considered a tube voltmeter and by means of the timing axis supplied with the instrument, the wave form of this voltage may be observed.

Utility in Amateur Work

The most important aspect of the ham phone station is the degree to which the r-f carrier signal is modulated. If this degree is low, poor efficiency results, while a degree of modulation that is too high is creative of distortion. It is accordingly of great use for the amateur to adopt the cathode ray oscilloscope since it will indicate this factor directly.

While the percentage of modulation of a phone transmitter is observable from the antenna current ammeter, this can indicate an approximate value only under the best conditions. With the cathode ray oscillograph, the measurement of the percentage of modulation is a simple matter. Two methods are possible, both are satisfactory. If a coil is connected to the vertical input circuit of the oscillograph and coupled to the tank circuit of the transmitter, a wave form shown in the last two sketches will result on the screen, dependent on whether the modulation frequency is constant or not. For this use the timing axis should be adjusted to some sub-multiple of the modulating frequency. The frequency of modulation must remain fixed in this instance if the image is to remain stationary on the screen. With these connections the wave form of the modulation is readily observed and corrections to the transmitter can be made if improvement is in order.

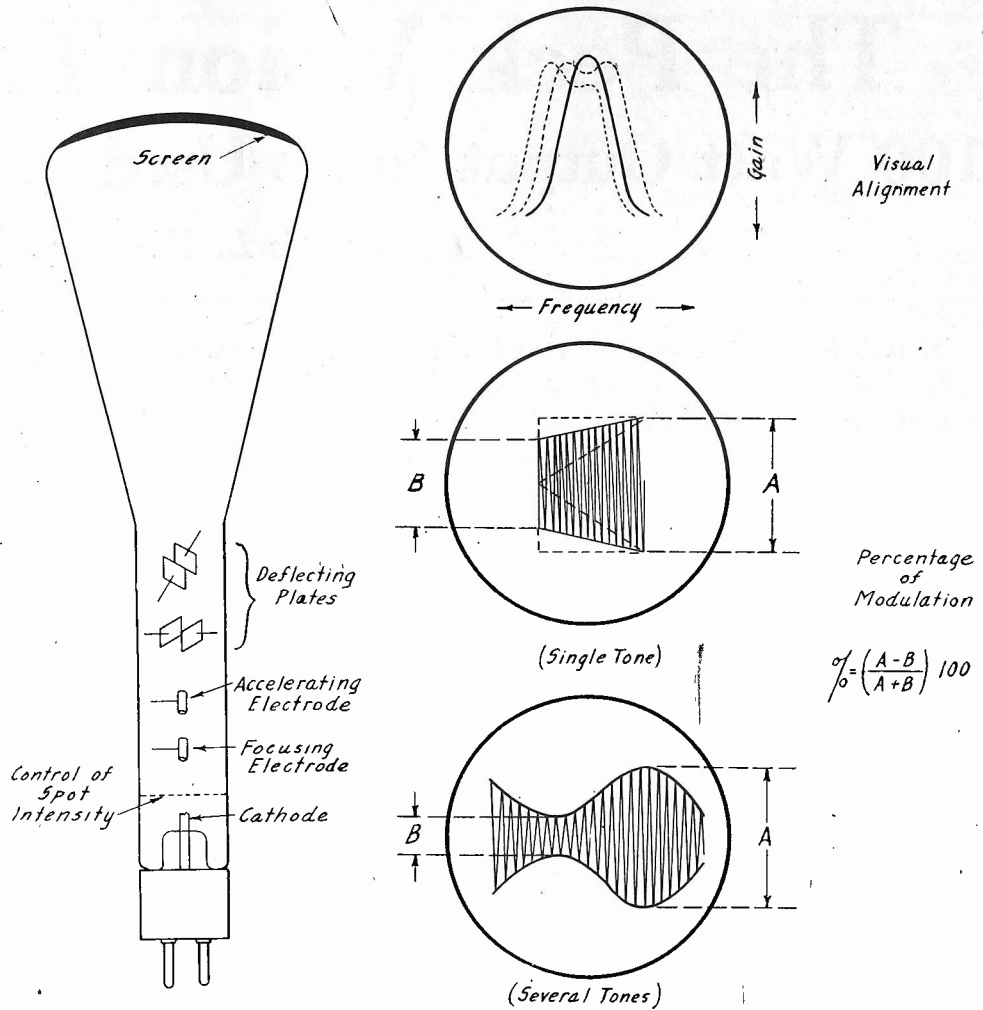
If it is desired to monitor the percentage of modulation and obtain an image on the screen which does not move as the modulation frequency is varied, the second method is perhaps preferable. Apply the r-f voltage as before and in addition supply to the horizontal deflecting circuit a voltage of about two volts from the speech amplifier equipment. A picture similar to the last sketch will then appear on the screen. For either of these two methods of measuring the percentage of modulation the following formula applies:

$$\% \text{ modulation} = \left(\frac{A - B}{A + B} \right) 100$$

Other Uses

Though the uses mentioned above are by themselves sufficient reasons for the existence of cathode ray oscillographs, there are many other applications to which the ingenuity of the individual may be directed. Among these other uses might be mentioned the direct measurement of distortion, observation of wave shapes, resonance, curves, etc.

In addition, the educator will find the cathode ray oscilloscope a powerful ally in the teaching process connected with electricity and especially with radio. The teaching of tuned circuit theory is not a simple matter and visual observation of experiments with tuned circuits was vir-



The newest cathode ray tube's internal structure involves a hot cathode which emits a profusion of electrons, a grid which controls their profusion, Anode No. 1 which focuses the electron beam, Anode No. 2 which accelerates the beam to affect the tube's sensitivity, and then two sets of deflecting plates that serve to move the beam around on the screen. To the right of the tube are several uses of the tube and the picture that appears upon the screen in that connection. Those shown reflect the measurement of resonance curves and of modulation percentage.

tually impossible until the introduction of the cathode ray oscillograph unit. Until the present time, such equipment has been a cumbersome and expensive item, but

with the introduction of the apparatus mentioned herein, a really flexible, portable and inexpensive outfit is made available.

Radio "Mailbag" Serves Byrd as Sole Calendar

Schenectady, N. Y.

Leaves on the Little America calendar and hours on the Antarctic clock have been told off by short-wave radio during the past year, it was disclosed when Rear-Admiral Richard E. Byrd radioed W2XAF of the General Electric Company to that effect. The periodical "mailbag" programs which have been dispatched to Little America from Schenectady every two weeks for more than a year have not only been serving as a source of communication between the men on the expedition and their friends and relatives at home, he declared, but have been comparable to an arm 10,000 miles long which was extended from upstate New York to the camp at Little America, there to mark the passing of another day or to tear off the calendar sheet which brought the expedition closer to its objectives and its ultimate return.

Inhabitants of more temperate sections

of the earth are likely to forget that the sun is a much more complicated time-piece in the Antarctic than it is farther north, Admiral Byrd said. During the long winter night, of course, it does not appear at all, while at the other extreme there are periods of constant daylight, tapering off into days when the sun will dip below the horizon for a short time only. Even during these times, the interiors of Little America quarters are dark or are lighted artificially and all of the natural phenomena conspire to confuse the keeping of any calendar that depends on the usual alternate days and nights.

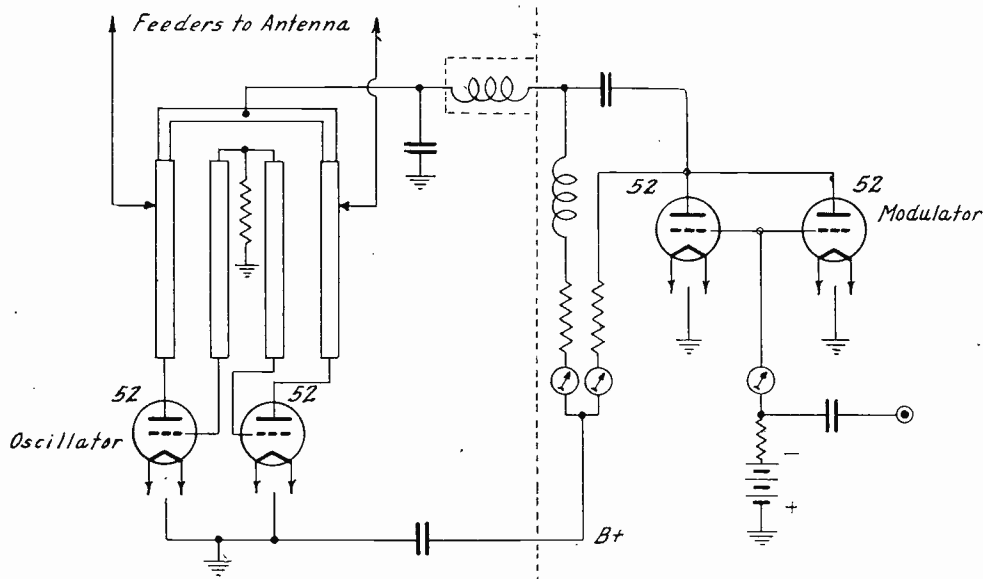
Although the activities at Little America are drawing to a close, the mailbag programs will be broadcast from W2XAF on alternate Sunday nights at 11 o'clock until the expedition reaches New Zealand on its return voyage, or about a couple of months hence.

The Peck Vision Transmitter

100 Watt Output to Be Used in Montreal Station

By Francis L. Wendey

Although the frequency will be high, around 41 mcg, the impending Montreal television station will use 100 watts output, to give high "hop" to the carrier, and will beam the carrier by spaced reflecting antennas.



The transmitter to be used for sending quality television from Montreal. The output of the video amplifier is connected between the right-hand post and ground. The Lecher wire tuning system is used, with long transmission line, multiples of half wavelength. The Heising system of modulation is used.

THAT technical impediments are not holding television back, but rather the imposing nature of the problem of supplying satisfactory entertainment and distribution, is the view of numerous experts. There are a few systems that provide good pictures, including both mechanical and electrical methods. The mechanical method consists in using a scanning wheel or drum, the electrical method of using a tube. If the amount of light is to be any criterion, it is safe to say that the best mechanical system affords more illumination than the electrical system.

In line with the solution of the program problem it has been found advisable to create a pickup for movie film, utilizing also the sound track, so that sound and pictures are sent out and received. It is considered likely that in the beginning the films will be acceptable, provided some arrangement can be made with the film owners whereby their products may be used. This is one of the problems of the non-technical type and may be classed as economic, as the movie interests sense that introduction of television might diminish the attendance at the movie theatres. To the same end, RCA may not be so keen about pressing forward with television, although it has a good system, because one of its subsidiaries collects millions of dollars a year under patents for sound on film as used in the talkies, while another subsidiary manufactures acoustic radio receivers, and television might hurt the income from these sources.

A Sop to the Movies

If movie film is to be used it is believed

that it will have to be of a type that will do the movie interests some good. Also it is obvious that the old films for which they have no further use, of the type that can be rented for home projection for instance, would not have a very high degree of attraction for a television audience. However, the teasers now shown in the movie theatres, snatches of films to be exhibited the following week, could be put on the air by television to the vast benefit of the theatres.

This is particularly applicable because television will be sent on carriers of such high frequency that distance penetration will scarcely prevail, although more than merely neighborhood coverage of course is to be expected. At present, as if by agreement, or because experience has taught the advantage, movie houses solicit patronage by mail in their immediate neighborhood, telling of the pictures and stars to be seen and heard next week.

The advance snatches of next week's pictures are not without interest to moviegoers, moreover might be used as a compromise, so that some complete pictures could be offered as well, perhaps special shorts. The movie film method might, after all, constitute what stations refer to as "fill-in," the main interest being in the sending of scenes and close-ups of spontaneous origin.

Spontaneous Scenes Difficult

It is now possible for a small group of persons to stand before pickup apparatus and be televised, with reception results fairly good. Heads and other "large objects" come over well. The systems that

have the best illumination of course can provide scenic results from film, even the broad acreage of a ball field or rodeo, and naturally can show a projected picture, one of satisfying dimensions. As an example, the Peck system, invented by William Hoyt Peck, using an ordinary automobile headlight of the 21-candlepower, 6-volt type, can show a nice picture 11 x 14 inches, or by using an arc light, a far greater sized picture.

The television station that will open in Montreal, Can., next month, under the executive direction of Emile Fontaine, a leading radio executive, will be Canadian-built and operated. The film scanner will be used and 24 pictures a second will be sent, using 60 lines per picture, at first, though later 120 lines will be introduced. Since the Peck system utilizes all the available light on a lens the doubling of the number of lines will quadruple the illumination for the same size projected picture or enable twice the size picture at the same illumination as prevailed for 60 lines.

The Peck receiver, which satisfies requirements for sound as well as pictures, and is all-wave, is particularly interesting because it embodies something that really works and is devoid of experimental appearance. This, in other words, is such an instrument as one would be asked to put in his home, to produce pictures of the size indicated, provided there were any pictures to be received.

The Console Receiver

As intimated, various economic aspects not directly related to television have delayed the introduction of quality television transmitters to which the public were to be invited to tune in, and the companionship of receiver and transmitter is only natural.

The console of the receiver has a collapsible top, so that when one is not viewing television, but just listening to regular acoustic programs, the top surface is flat and horizontal. When the console is thus adjusted, in fact, the idea that this is a television receiver might not occur to one, except for the insignia on the dial, quite large enough for easy observance, in line with the trend of the times.

The speaker has the usual baffle, as indicated by the grille, and the tuning in of the high-frequency carrier of television also tunes in another carrier on which the sound modulation is present. The separation is sufficient so that the noise of the television signal is not heard in the speaker, nor does the sound modulation constitute interference with the television modulation. The band width for television is 150 kc and that for sound is up to nearly 10,000 cycles. In other words, the sound amplifier is high fidelity. Of course the television amplifier is highest of high fidelity, and Mr. Peck has perfected a method, concerning which the merest detail can not be broached yet, for getting the full 150 kc modulation through, without lag or distortion.

Standard Movie Film

The film scanner uses the standard 35-millimeter film. Mr. Peck's special scanning disc revolves on a horizontal plane over the film. Farther up is the light source, focused on a circle of reflecting

lenses on the disc. There are 24 lenses, tilted 6 degrees of arc, one in respect to the other, to account for the 60 lines and the 360 degrees of the circle. A special synchronous motor of 1440 r.p.m. drives the disc. The continuous motion of the film past the light accomplishes the vertical scanning, the lenses on the disc the horizontal scanning. The lenses have silvered backs, so that the light is reflected, making possible the use of more than 80 per cent of the focal point total light, instead of a very meagre percentage, in fact, a fraction of 1 per cent as in pin-hole scanning.

The signals from the scanning system are passed through an amplifier for television and another amplifier for sound. The output of the television amplifier is fed to a modulator that is associated with the oscillator in the actual transmitter. The circuit diagram of the transmitter is given herewith.

The voltage on the push-pull modulator (52 tubes at right) is 3,000 volts and that on the radio-frequency oscillator is 2,000 volts. The percentage modulation is 100. The frequency of transmission, around 41 mcg, is held constant by the loading.

Lecher Wire Line

The Lecher wire system of tuning is used, the short-circuiting element being shown at left top, in plate to plate lead. Through the copper tubing of the shorting device very heavy current flows, many amperes, and heating becomes very serious, unless precautions are taken.

The transmission line is long and is used at the near end for voltage or current feeding, as desired. This long-line loading is believed to be the reason why frequency constancy results without the use of crystal control. The two arrows denote connection to the radiating element (beamed antenna). The beaming is through spaced antennas for reflection, indicating outlet to spaced reflector wires requiring no connection to the radiator save through the field pattern.

This is substantially the transmitter that will be used in Montreal. It is intended to have a very high elevation, atop a mountain-peak hotel, and beam the wave to Quebec city by the antenna reflector method using spaced wires. Patterns in other directions will be developed also, as it has been found from experiment that, despite the high frequency, substantial power output is advisable (the diagram is for a set of 100 watts) and also the extra benefit, equivalent to greatly increased power, as derived from beaming, is practically necessary.

Mr. Peck is now in Montreal in a consulting capacity in connection with the construction of the station and is being assisted by Joseph L. Cassell and Joseph Francis Dusek.

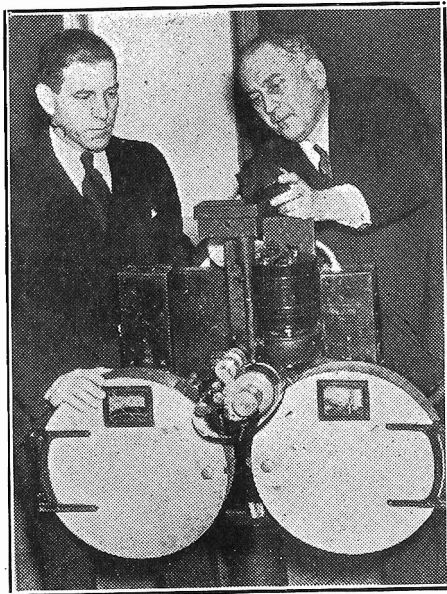
The Peck system was demonstrated recently to students of the science department, New York University School of Commerce.

Result of Hard Work

All the apparatus is of a practical nature, as the result of use of hands as well as head, and there have been some startling surprises in the way of amendment of theory to meet the hard demands of practice. One of these problems has been the safeguarding of a saw-tooth wave form all the way through, and it has been found that transformers advertised as suitable for saw-tooth wave handling have actually been practically killers of the saw tooth, or you might say dental devices that remove the nerve. And, in a broad sense, the problem of television is to keep this wave nerve alive and intact.

Specialists in transformer design have submitted samples, some of which ran into hundreds of dollars in cost, supposed to satisfy the requirement of flat-top wave

Famous Inventor Demonstrates



(Wide World)

C. C. Clark, chairman of Science Department School of Commerce, of N. Y. University at Washington Square, and William Hoyt Peck (right), who is showing the light source of the transmitter of the Peck television apparatus. The television equipment had its first demonstration as a visual aid in the classroom.

form, but the measured result of passage through the transformer was that practically a sine wave came out, though a saw-tooth wave was put in. This is a pernicious form of magic, rather technical in nature perhaps, but all boiling down to the one same result, that the picture shown did suffer badly. All aims are to make the picture as good as possible, and though scientists are working in numerous directions to achieve this end, it is clear enough that the two prime requirements are abundance of light and introduction and retention of flat-topped wave with saw tooth scanning.

Saw-Tooth Vital

The flat top is necessary so that the quality of the picture will be excellent for the same reason that flat-top amplifiers (of less exactitude) are used in high-fidelity sets. Safeguarding of the sidebands is the object, and of course in television the side bands extend very high in frequency, and the contrasts depend on the passage of the band width unattenuated.

Theorists find it agreeable to suppose that with a transformer the flat top can be retained but practical experience seems to contradict the possibility, and uncannily bright minds have ascertained the reason why a transformer does not deliver the goods according to the letter of the promise.

The saw-tooth requirement holds of course for any type of scanning, electrical or mechanical. With the oscillograph tube, which is admittedly the more fascinating field of experimentation, it had been feared that the saw-tooth requirement would be too stiff, but by using a saw-tooth oscillator for sweep control, a familiar method, plus holding the timing axis linear, a rather new development, the result actually is achieved, though with some lag due to the inertia of the fluorescent substance. This refers only to the electrical scanning system and perhaps rids the electrical method of a theoretical bugaboo. Advocates of one school

of practice may gloss over their own ineptitudes while being keen about discussing the flaws in the other system, or, when flaws cannot practically be found, inventing objections that lend rancor to the debate.

Scientists and Boys

The saw-tooth requirement in connection with amplification is therefore the serious one, and though some, like Mr. Peck, have achieved amplifiers that pass 150 kc and that permit retention of the lows as well as the highs, it is generally agreed that wider knowledge of a system of full attainment of so difficult a goal is indeed desirable. Therefore it is not strange to find scientists of exalted standing doing just the same thing as a boy working on a radio set on the kitchen table, that is, putting parts together in a circuit with a soldering iron, and making some measurement of the result. The soldering-iron scientists are doing more for television than the rapid calculators and inventors of new mathematical symbolism.

Television, as stated, is far enough advanced to justify the erection of some stations, other factors than technical ones intervening to retard a new attempt to get things started. Fears that the demand for attractively-appearing talent would be too tremendous are not valid, as no start ever would be made with so many stations that the beautiful artists would outnumber the lookers-in.

Five years or so ago an attempt to break the ice was made too soon. Nobody had anything worth looking at, except perhaps Bell Telephone Laboratories, using a photo-cell system never intended for public offering. The installation, some one with a mind for figures surmised, would cost at least \$5,000 to duplicate in production. Besides, these fine results were not put on the air.

Clean Shave Now

Columbia Broadcasting System was on the air then with television of a sort, but nothing of credit to so great an institution. The scanning methods were, frankly, impossible at the receiving end, and the studio technique was such that improper regard for the requirements of photo-cell placement and sensitivity resulted in many of the beautiful women being shown as wearing beards, when one looked at the peephole at the receiving end. However, the results as obtained to-day by RCA Manufacturing Company, Philo T. Farnsworth, National Television Corporation and Peck Television Corporation are beardless.

National Television has shown some trusted friends results of studio pickup, so that somebody in another room stood before the televisor and spoke into a microphone, enabling reception of sound and picture in the projection room. Attention to this prime necessity of spontaneous origin of events, instead of too much reliance on the "canned" variety represented by movie films, is most encouraging to a prospective television market. This is not to say that the firms do not offer possibilities of great value, but only that not too great reliance should be placed on them as media that will enable a renescent television to expand and thrive.

The depression need not be mentioned too much in connection with the promotion of television. It is admittedly very hard to sell to the public stock in a television company, but the television activities to-day are not financed by the public's money, the corporations being either closely held, if exclusively television in nature, or being subsidiaries or parents of subsidiaries, and engaged in fields allied with sound and radio, where television is regarded as a necessary experimental incident, to enable meeting competition when the introduction of commercial television on a quality scale takes place.

Ultra-Short-Wave Therapy

Depth Heating Is Featured at Waves Around 10 Meters

By *E. v. Lepel*

President, Lepel High Frequency Laboratories, Inc.

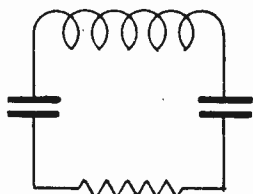


Fig. 1

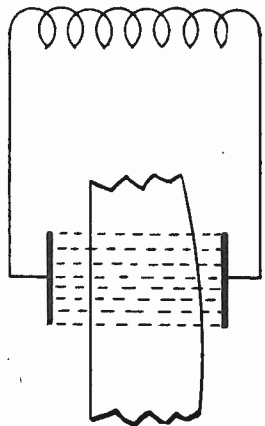


Fig. 2

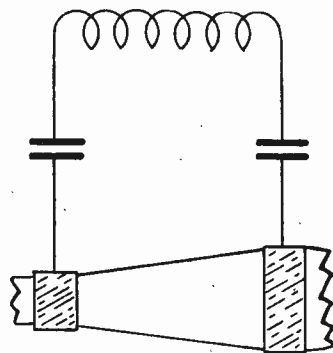


Fig. 3

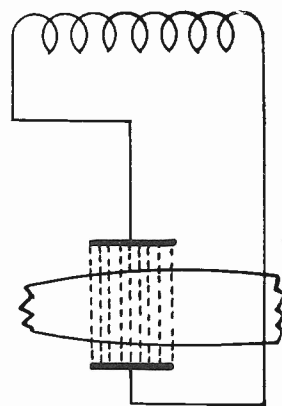


Fig. 4

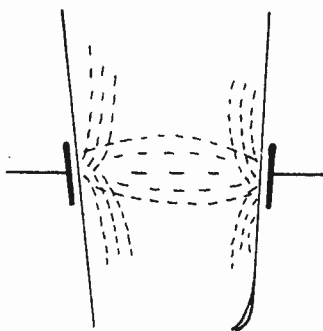


Fig. 5

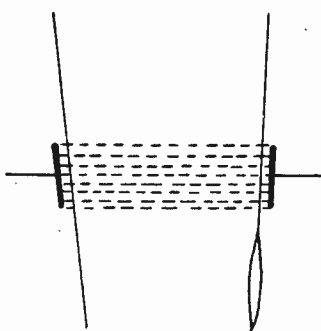


Fig. 6

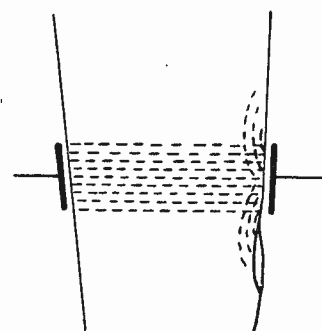


Fig. 7

FIG. 1.—The resistor represents the ohmic resistance of the human body for a 300-meter wave. The condenser fields are inactive for treatment.

FIG. 2.—The 10 meter wave, with condenser field active for treatment.

FIG. 3.—Contact needed for long-wave conduction.

FIG. 4.—Electrodes equally spaced from the skin for 10-meter wave.

FIG. 5.—Electrodes close, but not contacting the skin, which is heated, but there is little depth effect.

FIG. 6.—Electrodes equally spaced 1 inch from skin. Heating of the skin is small. There is uniform heating throughout.

FIG. 7.—Unequally distant electrodes result in the electrode nearer the skin producing stronger heat.

THE principles involved in the recent development of short-wave and ultra-short-wave therapy require a certain amount of clarification, owing to the many points in this new field which differ from the well-known principles of long-wave diathermy.

In the following paragraphs it is intended to present this interesting subject from the physicist's standpoint so that it may be understandable both to the doctor and the layman.

In long-wave diathermy treatments the heating effect produced in the body is due to the conductivity of the tissue to electric currents. Due to the tissues' variation in conductivity or, in other words, due to the variation in ohmic resistance, the amount of heat produced in the various layers of tissue varies. The heat pro-

duced is solely due to an electric current passing through the tissues.

In short-wave and ultra-short-wave therapy the production of heat is based on an entirely different principle. To make this clear, Fig. 1 shows heat produced in an ohmic resistance inserted in a long-wave circuit, and Fig. 2 represents a circuit in which heat is produced by the action of a condenser field upon a dielectric substance such as the human body.

Only Air Doesn't Heat Up

It becomes clear from looking at Fig. 2 that no metal contacts the tissue. The tissue, however, becomes heated due to the action of the condenser field, thereby showing some losses of electric energy occurring in the tissue. These losses occur because of the inability of the tissues

to undergo the very rapid change of direction and intensity of the condenser field without heating up. The only substance in a condenser field which does not heat up even under the shortest waves is air. Any other substance than air will heat up to a certain extent when exposed to such a field. The amount of heat which is generated in a condenser field of a given frequency varies considerably according to the nature of the substance placed in such a field.

Nearly perfect non-conductors, like glass or very dry wood, mica or ebonite, can become very hot in the action of such a field, in spite of the complete absence of any conductivity for electric currents.

Substances like the human tissue, which have a certain electric conductivity, heat up much faster than pure insulators, due

to the combined effects of electric conductivity and poor dielectric qualities. This means that the heat produced in the human tissue is never entirely based on the pure condenser effect and never entirely on pure ohmic conduction losses.

Current Through a Leg

When considering the human tissue, matters become much more complicated than when considering pure insulators and the wavelengths used for treatment play a very important part in the case of human tissue.

If the aim is only to produce heat in the body, as for instance in a human leg, this can be done by applying ordinary diathermy currents by means of fastening one electrode at the ankles and the other one at the thigh, as suggested in Fig. 3. The current in such a case travels through the leg, taking the path of least resistance, and the blood circulation plays a great part in distributing the heat generated in certain parts of the tissue relatively uniformly over the entire limb. Short-wave current would not therefore take precedence over long-wave diathermy for this particular treatment because the effect would remain practically unchanged whether we use a short- or long-wave diathermy machine.

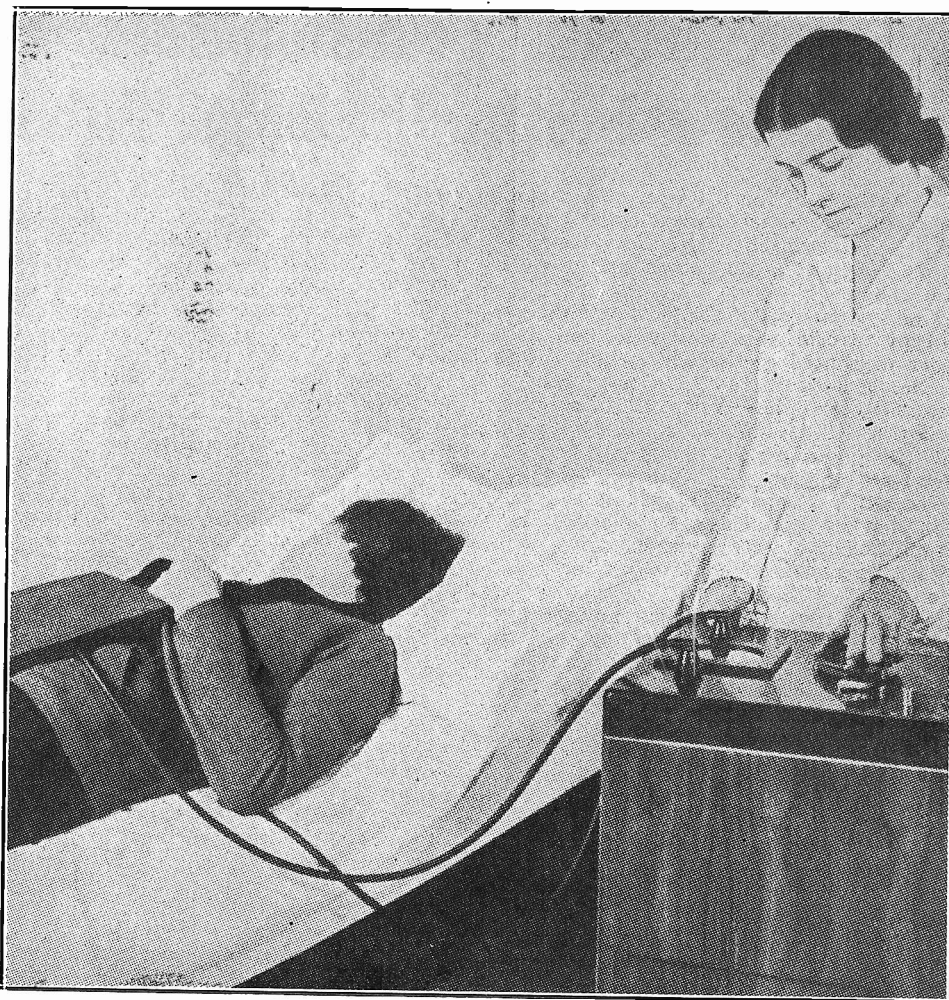
Short-wave oscillations by the condenser method, however, may be used for obtaining the same result of heat in a leg if the leg is placed between two condenser electrodes in such a way that the electric field traverses the leg, as shown in Fig. 4. The long-wave and short-wave methods differ in this specific case in that the first method sends an electric current through the tissue and the heat is generated by ohmic losses, while in the second case the electric field traverses the tissue and the heat generated is mainly due to dielectric losses.

When Distance Is a Factor

If the wavelength is made properly short, the dielectric losses will become more pronounced and the ohmic losses less pronounced than if a longer wave were used. The best wavelength for this purpose would be the one in which the heat generated is due 50% to ohmic losses and 50% to dielectric losses. This would be the wavelength at which to obtain the highest obtainable heating efficiency. The two methods also differ from another viewpoint: In ordinary diathermy, uniform general heating through the entire limb can only be obtained after a relatively long period of treatment, because the current does not travel uniformly through the total amount of tissue, while in the case of the proper short-wave treatment the heat generated in the limb is much more uniform from the very start and therefore the total duration of treatment will generally be shorter to secure the same results, using the same amount of energy.

It is the writer's opinion that in short-wave therapy we have not to be concerned so much with the proper wavelength for a specific treatment but mainly with the distance between the condenser electrodes and the area in which we want to create a deep seated heat, and with the choice of the right size of the electrodes, which will often have to be very small. Whether the heat is generated in a localized area of the body at depths, or is generated on the surface, depends upon whether the electrodes are spaced a half inch from the surface of the tissue or whether they are spaced much nearer to the body. Whether we concentrate the field effect on the desired area or spread it out much further depends on the smallness of the electrodes, provided that the electrodes are at least a half inch away from the skin.

The smaller the electrodes and the larger their distance away from the body the shorter must be the wavelength for a certain desired field effect.



An abdominal treatment through the clothes of the patient. The rubber pad electrodes of selected sizes are held in place by sand bags if necessary. Small size bakelite condenser electrodes so constructed that there remains an air space of approximately half an inch between the metal and the body of the patient are another option.

Unconscientious manufacturers and others often demonstrate their equipment with very thinly insulated electrodes, placed in close proximity to the skin, to persuade the doctor that there is a large amount of energy available from that specific machine.

Deception of Skin Heat

To make it clear how little electric energy is really needed to give an intense heat sensation in the skin, the writer recommends that the reader attempt to hold an ordinary 25-watt incandescent bulb tightly in the hand when it is burning. This simple experiment will make it clear that 25 watts of electric energy if spent over an area equivalent to the human hand, in contact with the skin, becomes intolerable after a very short space of time.

In the same way, a very weak and absolutely insufficient short-wave equipment can be fraudulently demonstrated to a doctor if the application on the electrodes is such that most of the heat is spent right in the skin. As a matter of fact, even the very small amount of 10 watts cannot be borne very long if the size of the electrodes is 2" x 3" and if their insulation is very thin. Furthermore, this undesirable and very misleading heat effect right under the skin becomes so much more unbearable the longer the wavelength supplied.

This means that with a 15 to 28 meter wavelength, as produced by many of the machines at present on the market, the sensation of heat under the skin surface is more intolerable than with a 10-meter wavelength, using the same output energy because, if the same size electrodes are used in both cases, the distance between

the body and the electrodes can be larger with the 10-meter wavelength than would be possible with the 15 or 28-meter wavelengths. The 10-meter wavelength thus makes energy available at depths which, in case of the longer wavelengths, is spent in the subcutaneous tissues.

Reduced Electrode Size

As the wavelength becomes shorter, the size of the electrodes can be reduced and therefore more energy concentrated on very small areas. The very smallest electrodes can be spaced far enough away from the body, and still deliver sufficient energy to cause heat at depth, if the wavelength used is short enough. The total available amount of energy which can be used for a concentrated heating effect in a relatively small deep-seated diseased area, depends for this reason very largely upon the shortness of the wavelength employed. On the other hand, it would unreasonably raise the price of the equipment if the wavelength were made shorter than required in order to pass the available energy of a machine through a given small size electrode, properly spaced from the body.

Unfortunately, it requires a much more costly machine to produce the same amount of energy at ultra-short wavelengths than at 15 meters or 30 meters, which means that a 100-watt high frequency output at 10 meters represents a much higher priced machine than a 100-watt output at 30 meters or a 100-watt output with ordinary long-wave diathermy.

The difference in the action of the field upon the body in the two cases: A—electrodes close to the body, B—electrodes one-half or one inch distance from the

(Continued on next page)

Direct-Current Transmission By New Method, Using Tubes

A new system for the transmission and distribution of direct-current electric power has been developed, using electronic devices, including Thyatron and Phanotron tubes.

The system of constant-current direct-current transmission was described in a paper presented at the winter convention of the American Institute of Electrical Engineers, in New York City, recently by Dr. C. H. Willis, B. D. Bedford and Dr. F. R. Elder, on behalf of General Electric Company.

The work described represents the first time that such transmission has been accomplished in a commercial capacity, even in test, by means of electronic tubes.

The features are:

Constant-current direct-current system. Power flow is in one direction only at the will of the operator, but can be transmitted in either direction.

Amount of power flow is under the control of the operator.

No wattless power is transmitted.

A short circuit results in a reduction of power flow on the circuit involved.

Power can be transmitted by either overhead or underground lines any distance desired.

A circuit of this type can be tapped at any point to furnish power or to take power.

Systems of like or unlike frequencies can be operated together to feed any other system of like or unlike frequencies.

Overhead systems of this type should be more reliable, and less disturbance will be caused by lightning.

The system cannot become out of phase or out of synchronism with the system feeding it or with the system receiving power.

A Leading Load

Alternating current is at present almost universally used for power transmission, despite difficulties such as connecting together systems or even connecting generating plants.

Most loads of power systems are of

lagging power factor, but with the new system all the load on the generating stations will be slightly leading.

At Schenectady a circuit was arranged for the transmission of 150 kilowatts of power, maximum peak of 15,000 volts and 10 amperes. In one of the factory buildings in the Schenectady works there has been made an installation in which connection is made to a 13,800-volt, 60-cycle, three-phase, alternating-current bus of the New York Power and Light Corporation with a circuit for transmitting a constant direct current of 200 amperes at 15,000 volts. This circuit includes about 15,000 feet of underground conductor, and is connected back to the 13,800-volt bus, after being inverted from direct- to alternating-current of the proper characteristics.

Rectification Used

In this 3,000-kilowatt constant-current direct-current circuit, a group of condensers and reactors is so connected to the 13,800-volt bus that constant-current alternating current is obtained; the circuit being tuned so that this current is 200 amperes, the voltage varies with the load. The alternating current is then rectified by means of six Phanotron tubes. (If two-way transmission is desired, Thyatron tubes are used.)

If a short circuit occurs on the direct-current line, and if the constant current of the system is 200 amperes and the regulation of the line is 10 per cent., then the current flow into the short circuit will be about 20 amperes. The voltage on the direct-current line drops to that point necessary to cause 20 amperes to flow in the short circuit.

As soon as the short circuit is removed, normal current flows in the normal direction, the rectifier furnishes its share of the current, the inverter receives the current, and the current is inverted and furnished to the receiver system as constant-potential alternating current.

If, when the line is operating under normal conditions, the cable is short-cir-

cuted by means of a single-pole knife-blade switch, the voltmeter reading drops practically to zero but the current remains constant. If the switch is then opened, the voltage returns very promptly and at all times the current remains constant.

Fewer Insulators, Better Safety

In still another demonstration an insulator normally used on an 11,000-volt alternating-current line is employed. Two such insulators are usually used on such a line, but in the demonstration there is only one.

If an attempt is made to arc over the insulator by short-circuiting it with a small wire, the arc-over of the insulator cannot continue. It is indicated that overhead lines can be built with fewer insulators than are now required for alternating-current power since, while they may arc over because of a lightning flash, the dynamic current of the system is limited and the arc will extinguish itself. Each insulator thus becomes a lightning arrester to clear the line of any high-voltage transients.

For many years the transmission of power by means of direct instead of alternating current has seemed desirable, but practically the only work of this nature was by a French engineer, Thury, who installed a number of systems in Europe.

It remained for the development of the vacuum tube and of electronic devices of various kinds—of Phanotrons and Thyatrons of large capacity—to make possible the new tools which can be used to advantage in improved distribution of power.

ELECTRICAL CODE STANDS

Continued NRA-code operations of radio manufacturers under the present electrical code but with definite allocation of radio receiving set and other manufacturers into distinct radio and electrical industry groupings was arranged at a conference in Washington of NRA with code committees of RMA and NEMA. No revision of the electrical code is in prospect. Therefore, the present wage and hour labor provisions, trade practices, etc., of the electrical code and the general code operations, reports, etc., promise to continue indefinitely.

Depth Heat Vital in Radio Therapy

(Continued from preceding page)
body, is illustrated in the Figs. 5 and 6. Fig. 7 shows an insulated electrode in close proximity to the skin and the other one inch away. In this case, intense heat under the skin is produced at the nearer electrode. Very little energy remains for depth effect.

Careful Choice Advised

The doctor must be extremely careful in choosing his machine if he wishes to avoid making his investment entirely unworthy. Very few of the machines at present offered in this country satisfy the essential conditions above mentioned. Most of the machines on the market operate with waves not shorter than 15 meters, because it is cheaper to build them that way. In addition, many of these machines are not equipped with adequate power. A very good and easy test, if no other methods of measuring the energy are available, is for the doctor to use the electrodes which come with these machines and place a spacer of at least a half inch between each electrode and his skin. To his great surprise he will then,

in most cases, feel no heat at all, neither in the skin nor at depth, showing that such a machine is unsuitable for depth effect.

Even a small and relatively inexpensive short-wave machine should be capable of producing at least 120 watts at a wavelength of about 10 meters in order to be sufficient for most local treatments, while more expensive machines should give at least 140 watts or more at a wave range of between 8 and 12 meters. It is, in the writer's opinion, no more an open question whether wavelengths below 8 meters give any specifically better effect. The fact that a large number of experiments have been carried out in the medical field with wavelengths as short as three meters has not brought about any proof that some specific effects can only be obtained within narrow wave limits.

Heat Depth

The effect desired in all cases is a greater or lesser amount of heat at depth, and the only question to be considered, as far as wavelength and wattage are concerned, is whether sufficient energy can be con-

centrated upon a relatively small deep-seated area.

In the writer's opinion, general fever work can be done just as well with a 20 or 30 meter wavelength as with a 10 meter wavelength, or even better.

The many statements which have been made by research men in this field to the effect that various substances can be heated more efficiently by a 5 meter wave than by a 3 meter wave or by an 8 meter wave are theoretically quite true.

Quite Some Power

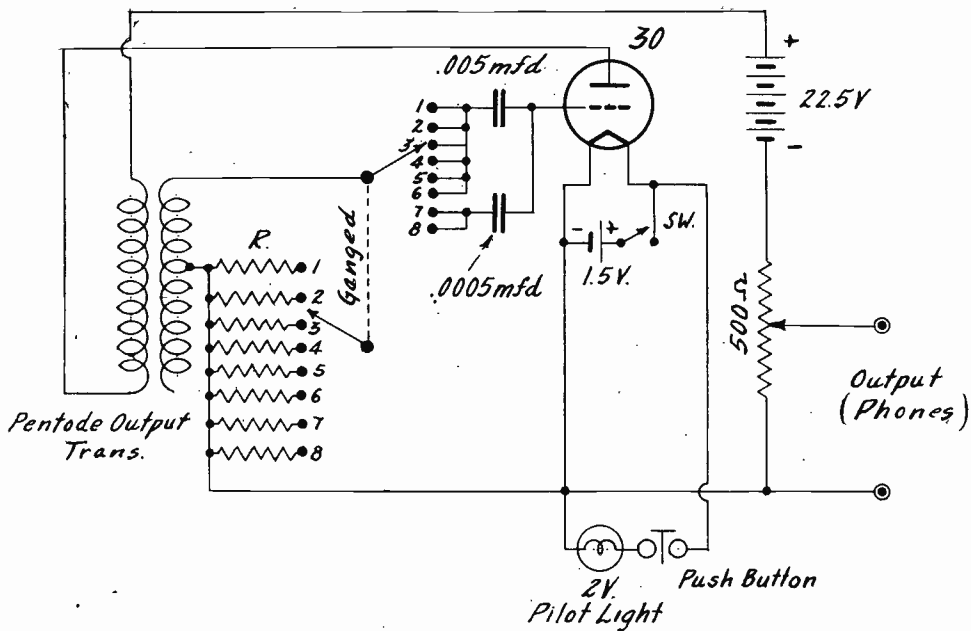
Unfortunately, these experiments have so far been done in vitro and there has not been sufficient material collected to clarify their statements in vivo.

The Lepel High Frequency Laboratories equip their smallest model short-wave machines with an energy output of 140 watts, at a wavelength of 8.5 to 10.5 meters. The therapeutic heat effect produced by this energy, and with this range of wavelengths, is expected to satisfy every requirement in which local treatments are indicated.

Testing a Person's Hearing

Audio Oscillator Used with an Attenuator

By Edward M. Shiepe



A simple audio frequency oscillator that can be used to test hearing.

In the light of these observations it is recommended to those radio enthusiasts who are experimentally inclined that they might rig up such an apparatus and conduct exhaustive tests similar to those indicated. It is not at all too imaginative to hazard the statement that there might be a relationship between the condition of the auditory mechanism and the contributory body organisms that affect the operation of this delicate device. Accordingly, if it is possible to measure the fluctuations in hearing ability of a person, it might be readily discovered that a particular organ has caused the particular result. It is believed that as time goes on, there will be a definite and valuable tieup between radio and medicine and here is a wonderful opportunity for the amateur scientist to tread virgin domain.

The device may also be used for generating audio frequencies for public address amplifier testing, an output meter being used, either of the direct-reading voltage type, or the decibel gain-attenuation type.

THE recent introduction of high fidelity receivers has once more brought to the forefront of discussion the point of variation in hearing among different individuals. And it has been continuously pointed out that hearing abilities vary from the standard range of 32 cycles per second to about 10,000 cycles per second. Because of this variation in individual hearing it is an interesting experiment to be able to gauge this ability of various persons and so the apparatus shown here was built.

It will be seen that the equipment utilizes a 30 type radio tube that is energized by one dry cell and one 22.5 volt B battery. Audio feedback is accomplished by means of an output transformer and variations in audio frequency are obtainable through the insertion of different grid condenser-leak combinations. Thus the following audio ranges are possible:

Switch position	Approx. audio frequency
1	60
2	125
3	250
4	500
5	1,000
6	2,000
7	4,000
8	8,000

It will be noted that the frequencies are doubled, step to step, with one small exception.

How It Is Worked

In the application of this apparatus the subject is placed in a quiet room and listens to each frequency while it is gradually reduced in intensity by means of the 500-ohm potentiometer until the signal is no longer audible to him. This point is then indicated to the operator of the equipment and a reading of the potentiometer resistance or voltage output then represents the minimum intensity of the particular pitch at which the subject's hearing ceases. This procedure with all the pitches will result in a curve that can be plotted to represent the hearing of the subject under consideration.

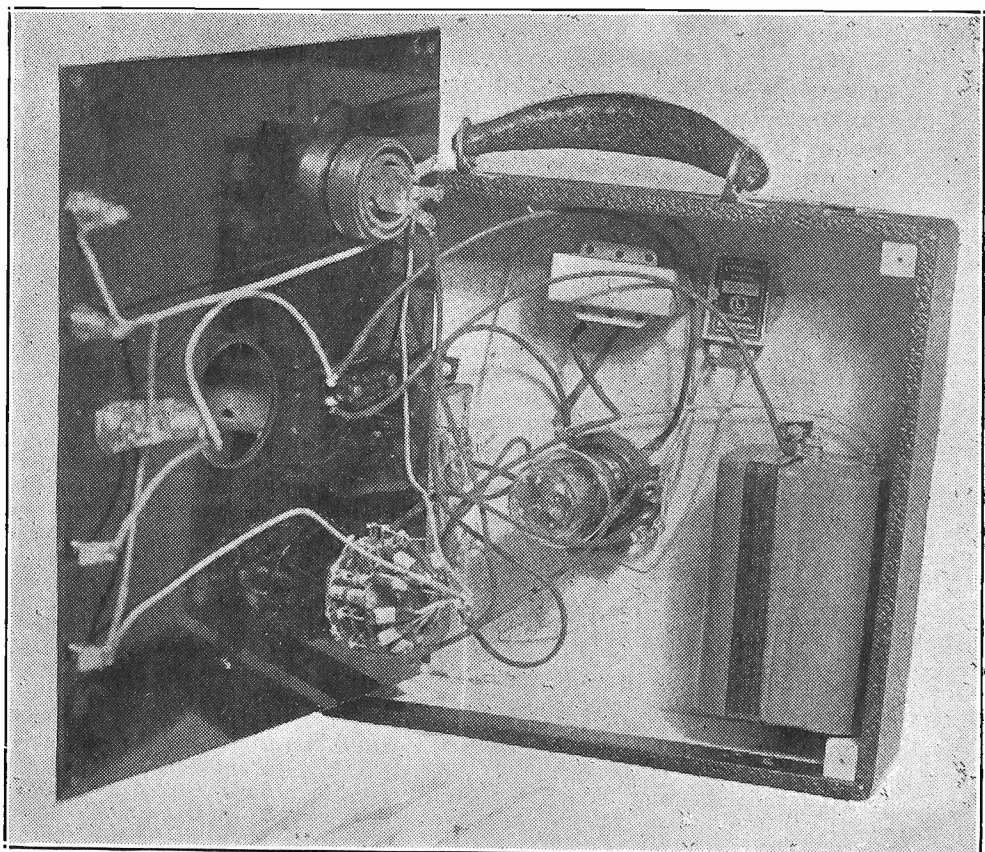
A corollary of this test is that these

measurements may be compared with such data as age, health, weight, etc., of the individual being treated, so that it might be possible to obtain a definite relation between hearing and age, health, weight, etc. This, of course, would be a highly valuable study and could be made to result in some very useful information. It might even be possible to forecast the future health of the subject if a number of these tests at various periods had been taken for this individual, taking careful note of various factors such as nervous state, temperature of room, kind of weather outdoors, etc.

Bell Telephone Gets

3 Broadcast Frequencies

The Bell Telephone Laboratories, cradle of a great many of the most important developments in communications, has something up its sleeve that is connected with radio broadcasting. For, according to the minutes of the Federal Communications Commission, construction permit and license were issued to cover the new special experimental station that the Laboratories desires to operate at Whippany, New Jersey, on 560, 900 and 1340 kilocycles with a power rating of 5,000 watts.

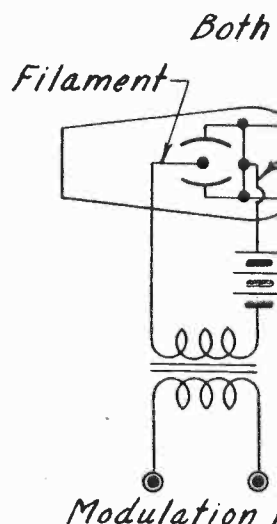
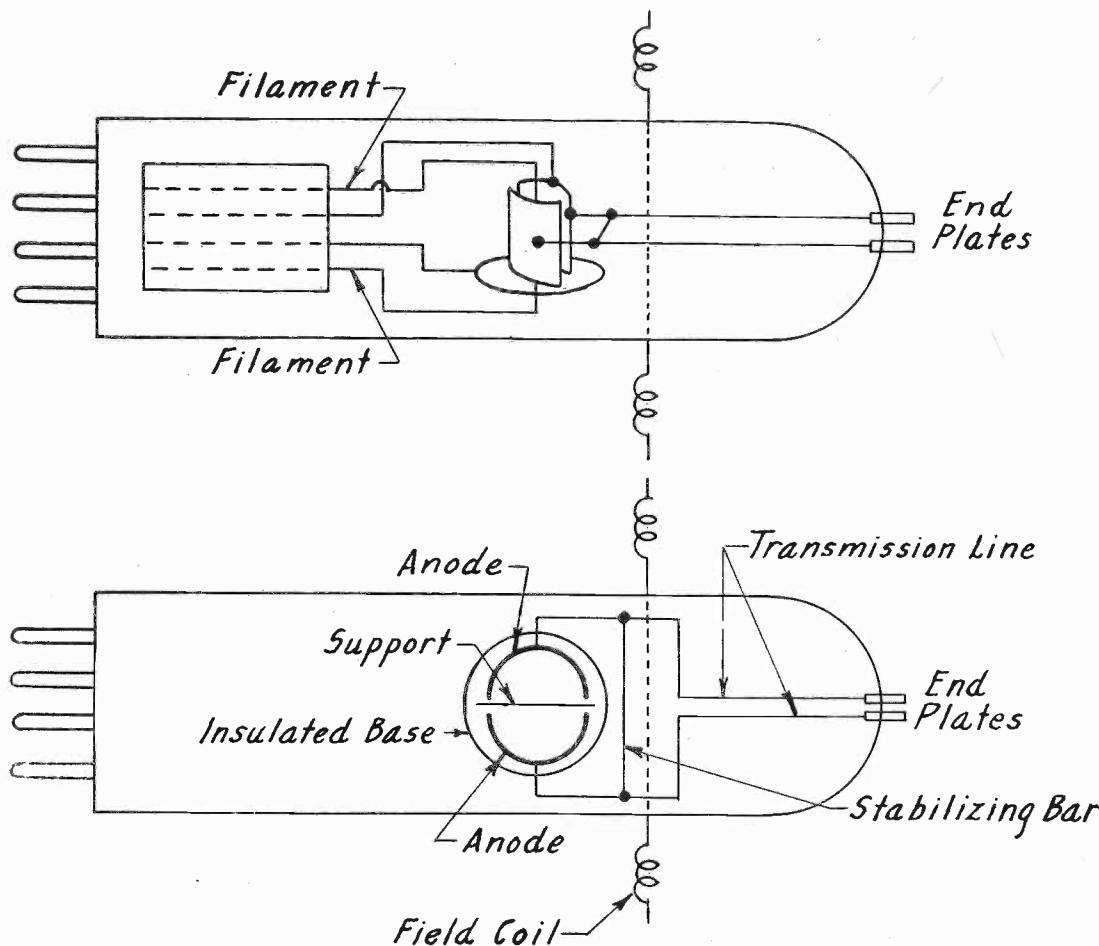


An interior view of the apparatus as constructed by the author.

THE SPLIT-ANO

Tube Reliably Sends Wa

By Her



Modulation in the produced by connect age in series with an audio transform many of which audio input or mod onstrations a high nograph pickup wa

A generalized depiction of the end-plate, split-anode magnetron for generation of waves below 10 centimeters, roughly, under 4 inches. The transmission line consists of the two parallel wires leading from the anodes to the end plates. The necessary extension to the actual radiating surface has to be considered.

NUMEROUS articles are being printed about the generation and reception of micro waves, as well as some demonstrations being given, but the crux of all activities seems to be the use of a special tube, so that, however fascinating experimentation might be for the non-professional, or any one without laboratory association, duplication seems to be out of the question for a while. About the best that can be offered is the opportunity to experiment with the 955, which is stated to sustain oscillations to 0.5 meter, or 50 centimeters, and this of course would constitute micro-wave experimentation, although not as low in wavelength as some would desire to go. No doubt some experimenters would be able to cause oscillations to persist at wavelengths lower than 0.5 meter, even with this tube.

An exception to the requirement of a special tube is the use of a standard tube that has cylindrically disposed elements, e.g., 22, 32, 35, 56, 76, 37, 27, 42, 43, 58, 57, 53, 38 and 24A, and having the grid voltage positive, plate voltage negative or zero. The frequency is determined by this grid voltage, since the time of transit

of electrons is thus governed. However, the power will be small, the tube life short, and the wavelength limited to around 40 centimeters, or not much below the lowest wave for the 955 acorn tube.

End-Plate Magnetron

The circuit used thus with positive grid constitutes the Barkhausen-Kurz oscillator. By the way, the Institute of Radio Engineers habitually elects a foreigner to the vice-presidency, and this year Georg Heinrich Barkhausen fills that post.

The type of oscillator that overcomes the difficulties of ordinary tubes or circuits where the time of transit of electrons from grid to plate is slower than the high frequency of generation at stake is known as the electron oscillator.

The magnetron tube has been known for a number of years, and consists of a tube affected by an external magnetic field, a system improved nearly six years ago by a Japanese who used split anodes. At present there is much experimenting going on with this type of tube, especially with a new improvement, the presence of

auxiliary end plates, and fittingly called an end-plate magnetron.

It was this type of tube Dr. Irving Wolff demonstrated in operation recently before a gathering of service men in New York City, even though the wavelength used was 9 centimeters, which is lower than any wavelength that will concern the repair problems of service men for some time to come.

Efficiency Measurements

This tube is operated at an efficiency of 12 per cent., where the efficiency consists of a comparison of the generated energy to the sum of the anode and end plate dissipation. The methods of making this measurement are set forth by Mr. Wolff, E. G. Linder and R. A. Braddock in the January, 1935, issue of "Proceedings" of the Institute of Radio Engineers.

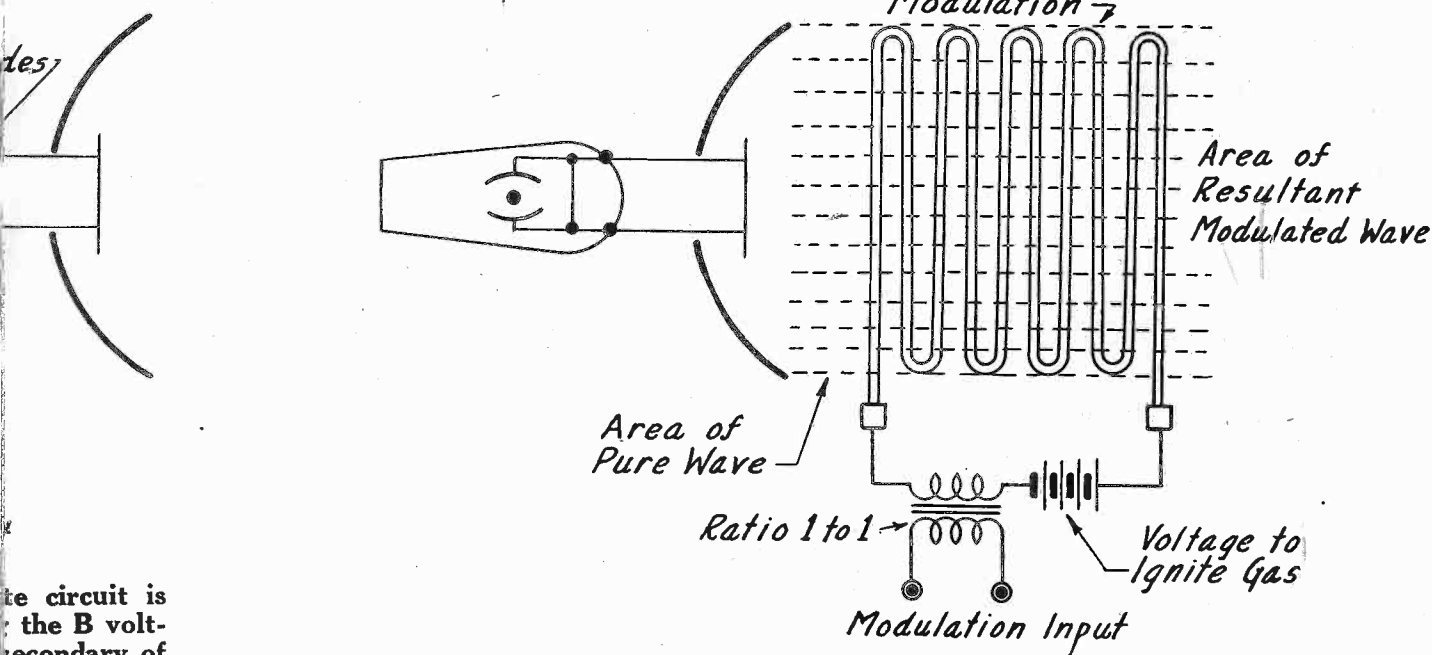
"The power generated in the oscillating circuit was determined by a heat radiating method. A thermocouple, connected to a galvanometer, was fastened against the glass bulb near the region of the plate for indicating the temperature. The magnetron was then set into oscillation and the galvanometer deflection noted. The direct-current plate power input was measured. Oscillation was then stopped by detuning the transmission line with consequent increase in plate temperature because the energy absorbed by the oscillations was no longer being taken away.

"Plate potential was next reduced un

THE MAGNETRON

Waves Under 10 Centimeters

Bernard



the circuit is the B secondary of the primary connected to the ground. In demodulation the secondary is connected here.

The galvanometer gave the same deflection as when oscillations were taking place, indicating that the temperature of the plate was the same. The direct-current power being absorbed was measured again. The reduction in plate power which was necessary to maintain the plate at the same temperature represented the energy going into oscillations. The difference between the direct-current plate input when oscillating and when not oscillating is the power generated."

Avoidance of Heat Changes

For this method to apply the heat radiation pattern must be the same for oscillation and non-oscillation, which is not quite true of the split-anode end-plate magnetron, so for the measurements an ordinary split-anode magnetron was used, for then the radiation pattern is the same. For the other tube, as may be assumed, the end plates during the oscillation become hotter than the regular plates.

Other methods of measurement were used, including pickup by a half-wave antenna of known constants throughout, using a calibrated indicator. A third method consisted of lighting lamps of known wattage.

The object of the end plates of the tube is to pull the electrons along the transmission line. A positive potential is applied to the end plates, and also a positive potential to the normal plates, but a critical ratio of voltages must exist between

Ion modulation is shown. The radiator is set up as usual, with parabolic reflector. The unmodulated wave is sent out. In the beam path is put a corrugated gaseous-discharge tube, a potential applied to it separately that will cause the colorful glow. In series with this voltage feed is an audio transformer secondary. Modulation is introduced across the primary. The glow tube is thus made to change the absorption, reflection and index of refraction of the unmodulated beam. Modulation arises mainly from absorption of the r.f. by the ionization variation created by the modulation, otherwise by using the gas tube as a reflector, causing variation in refraction.

them, the absolute values variable under wide limits, so long as the same ratio prevails. This suggests the same condition as exists in the dynatron oscillator, where wide absolute differences in voltages may be used, so long as the ratio, about 3 to 1, screen compared to plate, prevails.

The transmission line consists of the two wires leading to the terminals at top of the bulb, plus whatever extension of such wiring is introduced for placing the antenna proper in the focal point of whatever reflector is used.

Parabolic Reflector Used

The demonstrations recently given were of beam transmission, using a parabolic reflector, something like the copper reflectors used on heating coils, only larger. The dimensions of the reflector itself are a matter of choice, the larger the parabola the better the beaming, and with a diameter of about 5 feet the result was something less than a parallel beam, rather a narrow V pattern.

Therefore the leads from the anodes to the end plates are part of the transmission line, and the total length must correspond

to the wavelength being generated. From the shorting bar to the antenna the distance should be a multiple of a half wavelength. For 9 centimeters this length would have to be 4.5, 9, 13.5, 18 etc. centimeters, these constituting the required correspondence. It is obvious that the transmission line will achieve electrical lengths exceeding the length of the fundamental, hence there is peril of long-wave parasitic generation.

A bar is connected across the transmission lines at the anodes proper, or it may be said that the bar is connected from anode to anode. This prevents the creation of the long-wave parasitics.

Voltage Constancy Important

The waves longer than the intended wavelength of transmission are shorted by this strap, but the location of the bar at a voltage node avoids such a short for the required wavelength of transmission, and enhances stability. However, the current here will be maximum. Hence this is a current-fed transmission line, and in view of the very high frequency, above 3,000 mcg, naturally the resistance of the

(Continued on next page)

(Continued from preceding page)
circuit must be very low, and therefore the bar and line highly conductive.

The bar is part of the small looped circuit that is tuned to the transmission frequency. It must be recalled that at these very high frequencies, or centimeter waves, the inductance of a tiny stretch of wire is appreciable, hence when one sees diagrams of coiled affairs representative of inductances, the realities may be straight bars of wire.

The tube is of the filament type, and it is naturally important to maintain the filament voltage constant, and the high-voltage d-c supply also. This follows because voltage changes affect the frequencies, a fact noted even at 50 kc in ordinary oscillators, not to mention 3,000 mc in special oscillators.

To effectuate constancy for the filament a steadying device is used, either of the constant-current type, which indirectly holds the voltage across the filament constant, or of the constant-voltage type, to the same effect. The d-c component of the plate current may be held constant, or the applied plate voltage, to establish frequency stability, a fact perhaps not generally accepted, but a fact nevertheless, since frequency constancy exists when the voltage is not changed, or should conditions change the voltage, if the circuit is so treated that the current change is no different than it would be through a pure resistance. Otherwise stated, the frequency constancy is complete when the circuit is made to behave like a pure resistance.

Ion Modulation

It is hard to keep the frequency as constant as desired, and experiments are being continued along this line, but meanwhile it has been found that the method of modulation, if properly selected, aids the goal. When plate circuit modulation is used there is some frequency modulation, as well as amplitude modulation, as might have been expected, and because the two are mathematically the same it might have been assumed that there would be no performance difference, but the tone quality of the speaker output was better with ion modulation.

This method consists of exciting a gaseous-discharge tube independently, and placing the tube in the line of radiation of the beam, the voltage being sufficient from the external d-c source to ignite the tube. The mercury arc type is popular with scientists, but helium, argon, neon and the like work well, too.

The ionized gas in the tube is acted upon by the desired modulation, and the gas tube has the unmodulated or pure carrier passing through it. Hence the unmodulated beam is intercepted by a medium which changes the absorption, reflection and index of refraction of the beam.

Synthetic Fading

Except for the million-fold greater density, the ion tube may be compared sensibly to a synthetic ionosphere (Kennelly-Heaviside layer), and it becomes possible to produce synthetic fading. This should aid in the attempts to find some real cure for fading, by simplifying the working ground, and enabling the prompt production of the phenomenon, rather than reliance on the vagaries of bountiful nature.

While the whole field of establishing satisfactory electron oscillators of reasonable power output is still experimental, it so happens that the detecting circuit or receiver is presenting problems. Given the generation, to what use is it to be put? The receiver then becomes of equal importance, and as the sending may be considered to have been advanced ahead of the receiving, the detecting may be given first importance for the moment.

The crystal detector is used largely, but

has its drawbacks. Iron pyrites crystal proved good, but the point of maximum sensitivity is hard to find and hard to hold, and moreover the contact has to be due to slight pressure, possibly to hold down the equivalent shunt capacity arising from the crystal. The reception, when well established, is quiet.

Tube Detectors

Experiments with tube detectors have produced much noise, although progress has been made in gaining satisfactory response from a tube. The plate bend type of detection is used, and quietest results have been had with the tube biased almost to cutoff, a condition approximating the limitation of the electrons in the magnetron plates to just barely grazing the plates. This grazing process seems to be a rule of good conduct with electron oscillators and detectors.

It has been found that the most sensitive point for any one frequency in the crystal operation is the most sensitive for any other frequency, allowing however for the fact that the pressure at contact has to be less for the micro-wave region.

Tube detectors of the positive-grid type have been used, also, but at lower frequencies, since the voltage would have to be tremendous on the grid for the purposes of 9 centimeters, in fact, the grid would be incinerated. But a magnetron of reduced size, having split anodes, was more successful. The way this was worked is shown in a diagram. The plate potential may be selected so that operation of the tube is on the upper or lower bend of the characteristic. The sensitivity is greater if the static field is adjusted so that the electron rotation period is equal to the period of the impressed magnetic field. This condition results in the most sensitive detector so far found for these purposes, but since sensitivity and noise go hand in hand, perhaps it will be found expedient to operate the tube at a less sensitive point so that the ratio of the signal to the noise will be higher.

The Photograph on Next Page

The end-plate magnetron tube was used in the transmitter demonstrated recently by Dr. Wolff, of the RCA Victor Company, at a meeting held under the joint auspices of Wholesale Radio Service Company and RCA Manufacturing Company, in celebration of Wholesale's having been awarded an exclusive mail-order jobbing franchise for the Atlantic Coast for RCA parts. The transmission was on 9 centimeters, and reception of phonograph music used as modulation of the carrier was enjoyed in the same room, with reflections from parabola, flat conductor and walls demonstrated. The meeting was held at the Hotel Pennsylvania, New York City, and was attended by 2,300, a close count shows. The photographic reproduction on the opposite page shows what the gathering looked like.

Westinghouse Announces Small Rectangular Meters

A line of moderately priced direct current, radio frequency and rectox miniature instruments designed to harmonize with radio and communication equipment is announced by Westinghouse Electric and Manufacturing Company. Only one large hole in the panel is required for mounting and all visible mounting screws are eliminated by using mounting clamps. For ease in connecting and to save space, soldering clips are standard for electrical terminals of these instruments. These RV instruments have a scale length of 2.4 inches, are accurate within 2% (rectox types 5%) and flange dimensions measure 3 x 3 3/8 inches with zero adjusters on the outside. Vertical decorative lines give the dull matte Moldarta cases distinctive appearance.

The d'Arsonval, or permanent-magnet moving-coil principle of operation is used. Numerous refinements in the design of this movement have been made such as, soft iron pole tips welded to the permanent magnet in accurately aligned fixtures; improved springs; and an entirely new method of supporting the iron core in a die-cast bracket which also supports the jewel bearings in perfect alignment. Provision is made for the use of extremely strong cobalt-steel magnets for super-sensitive microammeters. The permanent magnets are made of high-quality tungsten steel or cobalt steel, heat-treated and aged.

LITERATURE WANTED

- C. L. Davis, Favorite Hotel Bldg., Piqua, Ohio.
Oscar Swanson, 1923 36th St., Des Moines, Iowa.
Joseph Dickes, 1730 Frankford Ave., Phila., Penna.
David Shartsis, 1210 Elder Ave., N. Y. C.
Walter H. Crafts, 3050 W. Euclid Ave., Detroit, Mich.
Charles Duboc, 1243 W. 616th St., Kansas City, Mo.
Robert R. Ewing, 610 1st N.E., Madison, S. Dak.
M. B. Erickson, Rixford, Penna.
Frankel, Western Reserve Academy, Hudson, Ohio.
Wm. Donald Fowble, 472 N. Salisbury St., W. Lafayette, Ind.
F. J. Hansen, Box 234, Charlottetown, P. E. I.
Morris Hashmall, 1141 E. 165th St., N. Y. C.
O. Holt, Box 122-H, N. Crafton, Mass.
Geo. W. Hibscher, 618 N. 23rd St., Billings, Mont.
Clinton B. James, Bryn Athyn, Penna.
R. G. Leonard, 617 W. Linn St., Marshalltown, Iowa.
J. L. Layton, Box 173, La Fayette, Ga.
J. L. Larson, 3505 13th Ave. So., Minneapolis, Minn.
Harry F. Leeper, 1346 Barrett Ct., N.W., Canton, Ohio.
P. Lorino, 36 Lindsey Ct., Hialeah, Florida.
Wm. E. Nye, Stewart-Warner Sales & Service, 148-150 Albert St., Ottawa, Ont., Can.
Axel E. Nelson, 3114 Federal Blvd., Denver, Col.

CORPORATE ACTIVITIES

HOWE SOUND COMPANY: For 1934: Net profit after taxes, depreciation and other charges, but before depletion, was \$1,691,141, which equals \$3.57 a share on 473,791 \$5 par capital shares, as compared with \$827,449, or \$1.74 a share, in 1933. Quarter ended Dec. 31: Net profit was \$318,812 before depletion, which is equal to 67 cents a capital share, as compared with \$361,771, or 76 cents a share, in preceding quarter and \$450,158, or 95 cents a share, in final quarter of 1933.

Second New Canadian Vision Station Reported

It may be prophesied that television will take place on a moderate scale before long. Not only is the Peck Television Corporation of Canada about to get a station going in Montreal, but overtures are reported to have been made to National Television regarding a station at Windsor, Ont., Can., across the border from Detroit, Mich., for both television and high-fidelity acoustic broadcasting.

The fact that Canadian stations so close to the border and within reach of many United States residents are being considered for erection is not to be taken as an accident. The power lines are tied in for sufficient distances to enable synchronization

for practically the entire distance that the high-frequency television carrier may be expected to penetrate. Some of the folk at the present writing, snowed in amid rustic surroundings within 50-mile radii of Montreal and Windsor, may be worrying about something other than looking at a television picture in their homes, but when the fact is established that the pictures can be brought in well, it is expected that a large number of persons who have been more or less associated with thrift will find the necessary \$150 or so for a television set, and some of the vast money already estranged from the television roof will begin to come home.



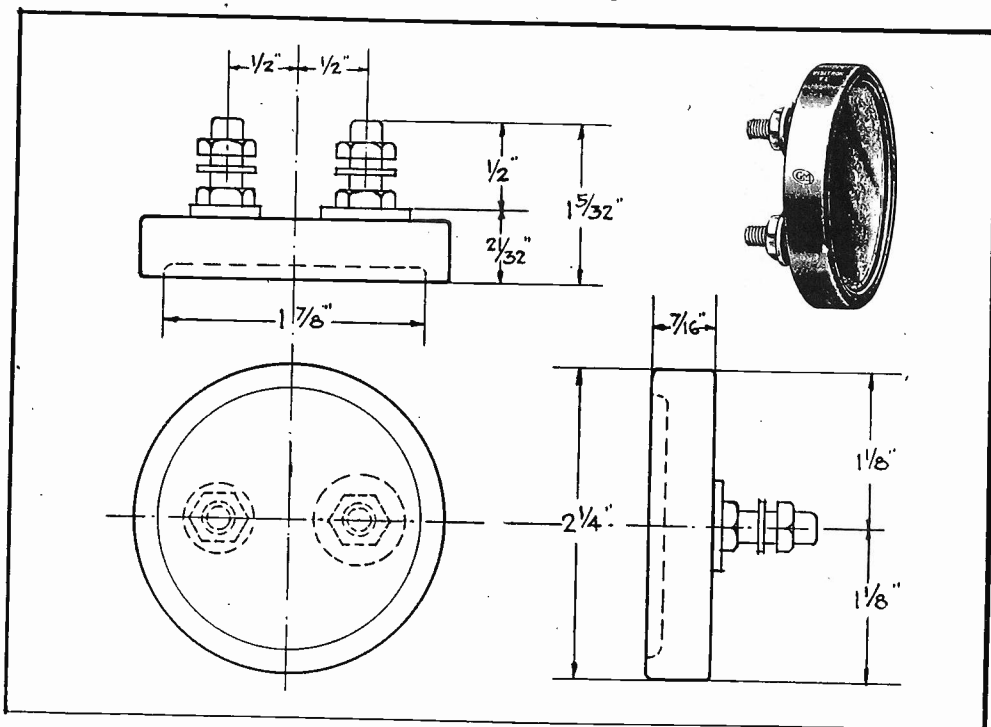
MEETING OF
SERVICE MEN AND DEALERS
WHOLESALE RADIO SERVICE CO.
R. C. A. VICTOR CO.
HOTEL PENNSYLVANIA JAN. 31, 1935

CRUCKER & BALICE
100 WEST 43 ST
N. Y.

The G-M Photo Cell

Crystalline Substance Commercialized in the Type F2 Model

By A. J. McMaster



Details of the construction and view of the finished product.

A COMMERCIAL photo sensitive cell is manufactured by the G-M Laboratories, Inc., of Chicago, Ill. A description of their Type F₂ cell is of interest.

It is made of an iron disc of 2 inches in diameter with a film of annealed selenium on it (the active material) upon which a translucent metal film is deposited. The exact nature of this translucent metal film was not divulged by its manufacturer for patent reasons, although we suspect it is "sputtered gold."

A photograph of the cell together with its dimensions is seen in the sketch.

The active disc is mounted behind a glass plate. The nickel plated brass is drawn (spun) over and so hermetically seals it against moisture, etc.

The terminal studs project from the rear of the cell and serve both for electrical connection and for mechanical mounting. For laboratory uses a simple bracket can be provided mounting the cell in the required position.

Current vs. Illumination

The current output of this cell varies with the amount of light affecting the active surface, the kind of illumination, and the resistance of the external circuit with which the cell is connected. This relationship is substantially linear for low values of illumination and for low values of external circuit resistances.

For higher values of these parameters, the relationship may be designated by a curve approaching saturation.

In some of the many commercial applications in which these types of cells may be used, it is desirable to use more than one cell to reduce the required sensitivity of the load device, i.e., the meter or relay. Upon testing this thought, it will be found that in some instances the connection of two cells in parallel is advantageous. In

other cases a series arrangement produces the maximum current output, the determining factors being the resistance of the load and the light level or illumination range at which the device is to be operated.

Thus, to take a specific example, let us assume that it is desired to operate a microammeter over its full scale for a variation of illumination of 0 to 100 foot candles. It is possible to obtain a meter having almost any full scale reading, but the lower the maximum scale reading the more costly and less rugged is the instrument.

If we were to choose an instrument of 480 ohms internal resistance, it would have a full scale of 180 microamps. to operate from one cell. However, with two cells in series, the meter could have a full scale of 240 microamps. and resistance of 480 ohms. Likewise, a 240 ohm meter, with 240 microamperes full scale would operate with one cell, or a 320 microampere meter having a 240 ohms resistance would be satisfactory with two cells—either in parallel or in series. If a 60 ohm 350 microampere meter were available it also would serve with one cell.

The Relationship

In general, it will be found that at any value of illumination, the current output of a single cell into a load resistance of R, is the same as that of two cells in series into a load resistance of 2R. For low values of load resistance and low values of illumination and the output of two cells in parallel is approximately twice that of a single cell.

It is sometimes convenient to examine the effect of various load resistances on the output at fixed illumination in selecting the proper type of meter or other load device. It is noted when variation

of output current with load resistance is observed for varying illumination that at low values of illumination, the single cell and two cells in series produce nearly the same output, especially at low load resistances. Under the same conditions two cells in parallel give nearly double the current of one cell. However, at higher values of load resistance, the series connection of two cells is to be preferred. Above 375 ohms load, the series output for 50 foot candles is greater than the parallel output. At 200 foot candles, the series output is greater than that of the cells in parallel at a load resistance greater than 150 ohms.

The voltage output of the cell is determined by the potentiometer method which requires no current drain from the cell. As one would expect, the voltage of one or more cells in parallel is the same, and the voltage of two cells in series is exactly twice that of one cell at the same illumination.

The Light Recorder

Since the open circuit voltage is not a linear function of illumination, this characteristic is seldom used for quantitative purposes. There are instances, however, in which the non-linear relationship may be useful, as in the case of daylight or sunlight recorder. In such an instrument a wide range of illumination must be covered, and by using an automatic balancing potentiometer recording instrument, the upper portion of the scale is condensed, giving much better percent accuracy at different points on the scale.

Curves showing illumination is foot candles plotted against:

(1) Maximum power output at any illumination with optimum load circuit resistance.

(2) Current output corresponding to maximum power output at any illumination (this is not maximum current).

(3) External load resistance for various power output at any illumination are of value.

The usefulness of these curves is readily apparent when selecting a sensitive electro-magnetic relay for operation on the output of one or more of these types of cells. Since it is desirable to secure the maximum power transfer to such a relay in order that sufficient contact pressure be obtained, it is necessary to know what resistance the relay should have and what current and power will be obtained for a given amount of illumination.

Application to Relay

As an example, let us assume that a relay is to be operated at 200 foot candles. With a single cell, the external load resistance for maximum power transfer at this illumination is 170 ohms, the current output is 388 microamperes through the 170 ohm load, and the power output is 25.6 microwatts.

If two cells are used in parallel, the optimum load resistance is 85 ohms, the current through this resistance is 766 microamperes and the power transfer is 52 microwatts.

If two cells are used in series, the optimum load resistance for maximum power

(Continued on next page)

Short Circuited Turns As a Method of Band Changing

By Robert G. Herzog, B.S. in E.E., and Sidney Wald, B.S., E.E.

MANY commercial long and short wave receivers, even among the more prominent ones, use a peculiar method of shifting from one band to another. This method is the shorting of several turns of the tuned coils, which, while it produces the desired effect of reducing the inductance, also introduces losses by increasing the effective resistance materially, as well as lowering the Q of the coils. It is needless to say that this decidedly reduces the gain.

The conventional tuned circuit shown in Fig. 1 is in effect a series circuit where an emf (represented by the voltmeter in Fig. 2) is in series with the resistance R_s and the reactance L_s of the secondary, each represented separately. This emf is induced through the coupling between the preceding plate or antenna circuit. The magnitude of the voltage is:

$$E = \omega MI_p = 2\pi f MI_p$$

f = frequency of signal.

M = mutual inductance between primary and secondary.

I_p = a-c component of current flow in primary.

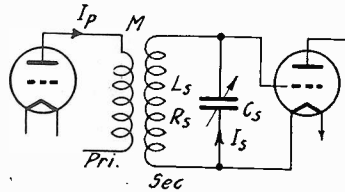
Negligible Reaction

If M is small the reaction of the secondary upon the primary will be negligible and E will be independent of the secondary constants. (Actually, at resonance E decreased due to the coupled resistance introduced in the primary which decreases the primary current I_p somewhat.) Under these conditions the secondary current, I_s , is a maximum at the resonant frequency, when

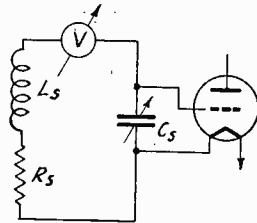
$$\omega L = \frac{1}{\omega C}$$

The secondary current I_s will be

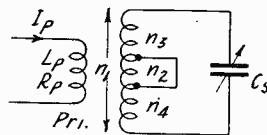
$$\frac{E}{R_s} \text{ at resonance.}$$



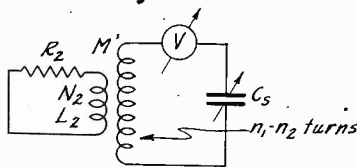
Conventional Tuned Grid Input Circuit
Fig. 1



Equivalent Circuit of Fig. 1
Fig. 2



Showing Portion of Secondary Short Circuited
Fig. 3



Equivalent Circuit of Fig. 3
Fig. 4

An analysis of the conventional tuned circuit into its equivalent electrical circuit.

But $E = \omega MI_p$

$$\therefore I_s = \frac{\omega MI_p}{R_s}$$

The voltage developed across the condenser at resonance is the secondary current multiplied by the reactance of the condenser. This is the voltage applied to the grid of the tube:

$$E_g = \frac{I_s}{\omega C}$$

$$\therefore \frac{\phi MI_p}{\omega CR_s} = \frac{MI_p}{CR_s} = EQ$$

where $Q = \frac{1}{\omega CR_s}$ and $E = \omega MI_p$.

Thus, if there is an internal emf in a closed resonant circuit, the voltage developed across either the inductive reactance or the condenser will be Q times the applied emf, E .

The Shorted Turns

Let us assume that due to the action of a band changing switch a number of turns N_2 is short-circuited in the center of the coil.

The desired effect, that of reducing the inductance of the coil across C , is dependent on three factors.

1. The presence of short circuited coil, N_2 .
2. The reduction in number of tuned turns.
3. The reduced coupling between the two remaining active portions of the secondary.

It can be shown that factors 2 and 3 are relatively unimportant in contrast with the effect of item 1.

Fig. 3 shows the circuit under discussion. (Continued on next page)

(Continued from preceding page)
er is 360 ohms, the current output is 378 microamperes, and the power transfer is again 52 microwatts. Thus the choice of using the two cells in series or parallel is determined by the resistance which is available in the relay.

From suitable curves the optimum value of the external load resistance may be readily determined at various values of illumination. Thus, with a single cell at 200 foot candles, the maximum power output is obtained with a load resistance of approximately 150 ohms. It will be noted that if this exact value of load resistance cannot be obtained, it is better to use a somewhat higher value rather than a lower value as the maximum power falls off more rapidly with lower resistance than it does with higher values.

If two cells are used in series, the optimum value of the load resistance is about 300 ohms. If two cells are used in parallel, the optimum value is about 75 ohms.

Multiple Cells

The approximate power output of a single cell or two cells in parallel or series may also be read directly from suitable curves. As the illumination increases, the power output rises but not as rapidly for high values of illumination and load re-

sistance as for low values. It is to be noted that the output of two cells in parallel with 60 ohm load is the same as that of two cells in series with 240 ohm load.

The relative spectral response characteristic of the F2 type cell is such that its greatest sensitivity occurs at about 5,700 Angstrom units. Since this cell is often used with a tungsten filament incandescent lamp as the source of light, the response curve of the cell to this light source is the basis for this statement.

These cells may be operated at any temperature not exceeding 120 deg. F. As the temperature of the cell rises the current output for a given load resistance decreases. The voltage output of the cell also decreases with temperature rise.

In protecting the cell against excessive temperature, it must be remembered that the effect of absorbed radiation is to produce a rise in temperature above that of the surrounding atmosphere. Thus, it is necessary to use a heat absorbing filter (such as a water filter) when using the cell continuously in direct sun-light or near high power lamps.

Cell Life

These cells show no deterioration when used continuously over long periods of time under the proper operation conditions. The principal precaution to be taken is

that of protecting the cell against excessive temperature rise. Strong illumination resulting in output currents of several milliamps. is not harmful when this precaution is observed. For instance, a continuous output current of 5 milliamps. for 8 hours shows no diminution whatsoever with the proper heat absorbing medium between the lamp and the cell.

The maximum useful life of the cell has not been determined, although accelerated life tests have been made. When properly used, years of useful service may be expected, since no chemical or physical change occurs as the result of the flow of current.

The mechanical construction of the cell container is such that no deterioration occurs as a result of humidity or the presence of foreign matter such as gases or vapors in the atmosphere. Continuous exposure to a highly corrosive gas at atmospheric pressure for 48 hours has caused no depreciation in cell sensitivity.

In the matter of variation of cell output with respect to time of illumination, it is of interest to note that for practical purposes any such variation is negligible. In other words, if the cell is suddenly exposed to strong illumination, the magnitude of the output at the time of exposure is always within 5 per cent of the value which is observed at some time later.

(Continued from preceding page)

sion. Since we have no further use for the real primary, having derived an expression for the secondary induced voltage, we may turn our attention to the equivalent circuit in Fig. 4. Here the short-circuited turns are treated as the effective secondary of a transformer whose primary is composed of a series of E , C_s , and number of turns $N_s + N_4$. The mutual inductance between the coil N_2 and the primary $N_s + N_4$ is taken as M^1 and may be determined experimentally.

It is shown in texts on alternating current theory that in such a circuit the primary resistance is apparently increased by an amount:

$$\Delta R = \frac{\omega^2(M^1)^2 R_2}{R_2^2 + X_2^2}$$

where $X_2 = \omega L_2$

Neglecting the effect of reduced resistance due to physical reduction of series turns in the primary coil which is very small compared to the increase, ΔR , dividing by R_2 we have,

$$\Delta R = \frac{\omega^2(M^1)^2}{R_2 + Q_s \omega L_2}$$

ω in this equation involves the high frequency which is desired.

Grid Voltage Loss

Assuming a constant E on broadcast and short-wave the loss in grid voltage may be calculated:

$$I_s = \frac{E}{R_s^1 + \Delta R}$$

at short wave setting of switch at the resonant short wave frequency.

(ΔR is the expression computed above.)

R_s^1 is the resistance of the tuned coil taking into account only the number of turns and size of wire.

$$I_s = \frac{E [(R_2 + Q_s \omega L_2)] + ER_s^1}{\omega^2(M^1)^2}$$

The voltage applied to the grid and cathode of the tube is as before

$$E_g = \frac{I_s}{\omega^1 C^1} = \frac{\omega M I_p}{\omega^1 C (R_s^1 + \Delta R)}$$

$$= \frac{E}{\omega^1 C (R_s^1 + \Delta R)} = EQ^1$$

$$\text{where } Q^1 = \frac{1}{\omega^1 C (R_s^1 + \Delta R)} = \frac{\omega^1 L^1}{R_s^1 + \Delta R}$$

On broadcast, E_g was shown to be,

$$E_g = EQ$$

where $Q = \frac{\omega L}{R}$ of the original circuit.

On short waves,

$$E_g = EQ^1$$

where $Q^1 = \frac{\omega^1 L^1}{R_s^1 + \Delta R} = \frac{1}{\omega^1 C^1 (R_s^1 + \Delta R)}$

therefore

$$\frac{E_g \text{ (short waves)}}{E_g \text{ (broadcast)}} = \frac{Q^1}{Q}$$

$$= \frac{1}{\omega^1 C^1 (R_s^1 + \Delta R) Q} = \text{fraction less}$$

than unity.

This shows that for a given condenser setting and induced E , the gain on short waves is less than that at broadcast due to the resistance loss of the short circuited turns.

Radio University

ANSWERS to Questions of General Interest to Readers. Only Selected Questions Are Answered and Only by Publication in These Columns.

When a "Curve" Is Linear

WILL YOU please tell me whether there is really such a thing as a linear detector; if so, what does it mean? Does any straight-line graph represent linearity?—I. L.

The diode detector, if properly loaded, is practically linear, and the closest thing to linearity that obtains in vacuum tube practice. A linear detector is one that results in a given amount of output current changes for directly proportionate input for voltage changes. Suppose therefore that if the input is increased 1 volt the plate or anode current is increased 1 milliamperes, and if the input voltage is increased 2 volts the current is increased 2 milliamperes, etc. That would constitute a linear detector. If there was any amplification (and there is none in diodes) the circuit would be a linear amplifier. The mere fact that a graph is a straight line, in the sense that the points enable drawing the line with a ruler edge as guide, does not necessarily mean linearity in the radio sense. The two variables have to be related to each other so that for any given amount of change in one there is a given amount of change in the other, all over the line, and multiples of one amount of change should produce the same multiples or submultiples of the amount of change in the other. Therefore a ruler-edge graph might be in reality a curve, though it strikes the eye as a straight line, or is in fact a straight line, in the sense that it is the shortest distance between two points. But shortest-distance test is not conclusive, for comparison of one variable to the other might show, even on such a shortest-distance example, that the current change is slower or faster than the voltage change. Therefore there is really a curvature of the characteristic. Hence the straight line is a curve. Take the example of the straight frequency line characteristic in tuning. This obtains only when the frequency difference for the same angular displacement of the plates is the same anywhere on the dial. Only one straight line will represent that on a graph, yet many other straight lines, or shortest distances between two points, could be drawn on the plotting paper, and not one of these others would be what is meant by the word "linear" in radio technique.

* * *

Is Everything Electric?

HAS THE THEORY that nothing exists except electricity been authenticated, and if not, what is the reason that deters the acceptance of that theory?—K. L.

The theory that everything tangible is electrical has not been generally accepted, perhaps due to the reluctance of scientists to accept so broad a theory while experiments are being conducted which may be regarded in a sense as a test of the theory. However, there is a general trend in the direction of authentication and acceptance of the theory, because the further science pursues its studies and experiments, the more it encounters that fact that the phenomena under observation are due to electricity. Thus, the atom being the smallest particle in the chemist's field, the next step was to determine the composition of the molecule and its constitution, and the reason for differentiation in matter. The electron theory accounted for those situations nicely, showing that electrons and

nuclei (positive charges) combined or related in various degrees and revealed the differentiation of matter. The electron was found to be the smallest particle and to consist of nothing but electricity. Moreover, its path was found to be orbital. The electrons rotate about the nucleus. Current flow is therefore explained under this theory as being due to the movements of electrons, and potential that displaces the electrons as due to the detachment or transposition of electrons and nuclei. The positive endowment is sometimes referred to as a "positive electron," although in reality an electron is always negative. Detachment of electrons is called ionization.

* * *

Regeneration Interrupted

IN A SMALL short-wave set that I built I have a resistor as the plate load of the detector and find that regeneration fails over considerable part of the tuning on each band, say, the over higher frequency part. What can be the cause and remedy?—K. W. D.

The effective voltage on the plate is too low. This may be remedied by increasing the applied plate potential or by substituting an audio choke as the plate load, or the primary of an audio transformer. No doubt you are using a screen grid tube, for which a resistive load is practically always recommended, since it is so difficult to get a high enough impedance from any audio coil. However, when regeneration is at stake, it is necessary to preserve a continuous condition that affords regeneration, and to that end an audio choke of highest practical impedance should be used, unless the plate load resistor is reduced to a small enough value to protect regeneration, which is in the same direction of underloading, for audio purposes. Since regeneration is so effective, indeed vital, for a circuit such as yours, sacrifice of other considerations, for the preservation of regeneration, is strictly good practice.

* * *

A Case of Deception

ARE THE ANTENNA eliminators effective, and if so on what principle are they worked?—L. O.

The antenna eliminators are, in the main, deceptive devices, that unwittingly require the user to connect the ground wire to the antenna post for such pickup as the ground lead affords, thus leaving the chassis and circuit returns ungrounded. The same effect can be produced without the purchase of any antenna eliminator simply by disregarding the aerial and connecting external ground to the antenna post. Of course, there will be pickup, and for the broadcast band, where the ground wave may be strong, good reception may result. For short waves, however, the method is not very practical, since the ground wave is quickly dissipated, hence the pickup is small.

* * *

Feeding Through Line

WILL YOU PLEASE explain what constitutes "feeding through the line" as experienced with test oscillators, and why the modulation carried by the oscillator is heard in a set many feet from the oscillator?—W. S.

Feeding through the line consists of the line acting as a transmitting antenna. The oscillation of the oscillator must be

rather high. Then the a-c cable which is not far removed from the oscillating field picks up the generation just as any other antenna would and carries it along. The distance may be much more than a few feet. Instances of oscillation carrying well—or, too well—for several blocks are on record. The receiver has an antenna leadin somewhere near its own a-c cable and this leadin is the pickup antenna, deriving the energy from the a-c cable, or transmitting antenna. A remedy is to reduce the oscillation of the oscillator, as by biasing it more negatively, or reducing the plate voltage, and also shielding the oscillator well. It helps to shield the a-c cable and ground the shield, at least so much of the cable as is between oscillator and the line outlet. Naturally the feeding condition scarcely exists with oscillators that do not derive their power from the line. However, if a-c and d-c lines are used, one for the oscillator, the other for the set, there will still be the same type of feed, and the same remedies would have to be applied. If the original oscillator has to be made lower than deemed practical for other purposes, an amplifier tube may be used following the generating tube. Then the output may be as high as desired, yet the feeding trouble may be eliminated, practically, for the amplifier tube is itself not oscillating. The generator is the "master oscillator" and the amplifier is the driven tube.

DOES THE RESISTANCE of a ground connection change when the ground consists of a seven-foot iron pipe driven into the ground, and the ground is sometimes moist, other times dry, and on some occasions is somewhere between moist and dry?—K. M.

Yes, the resistance increases with increased dryness. When the ground shows signs of becoming dry, saline solution is sometimes poured on the ground about the post and allowed to seep through, to aid maintenance of a low resistance.

Parabolic Reflectors

IN THE CONSTRUCTION of parabolic reflectors, is there some particular diameter that is more favorable than any other for a given frequency, or is the diameter discretionary?—K. C. S.

The practical attainments serve as limitations. The reflector should be as large as convenient, so that the resultant emission will be held close to a beam. Otherwise the searchlight effect would be present. For microwaves, reflectors of the parabolic type with diameters of 5 feet or so are commonly used. The antenna proper is at the focal point of the reflector and the transmission is close enough to a beam for present experimental purposes. The spread may be only a few wavelengths at a few miles.

Cell and Battery

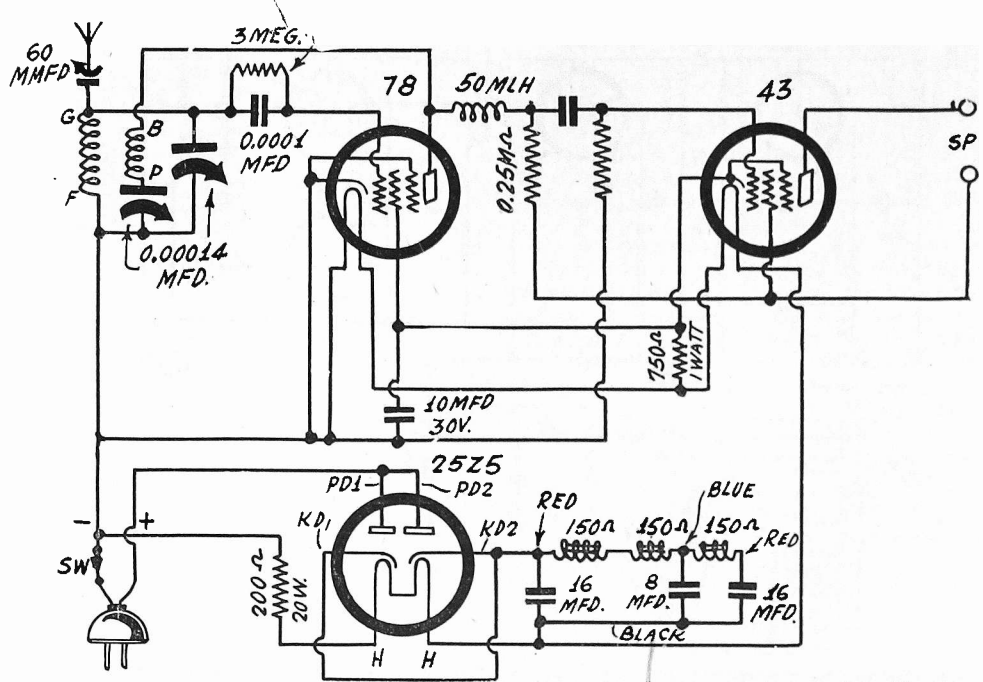
IS IT proper to refer to the No. 6 type 1.5 volt unit as a dry battery, or to the smaller-sized units of the same voltage rating as batteries?—I. L.

No, the unit consisting of the two poles that are energized chemically to produce potential and a source of current is strictly speaking a cell. If two or more cells are used, especially if at least two are in series, the resultant source is called a battery. Some of the small flashlight type cells are advertised as "batteries," but the reason probably is that if the word "cell" were used, prospective lay purchasers might assume that the unit was something different than the circumstances required, and refuse to buy a "cell" when what they needed was a "battery."

The Moon's Effect

IS THERE anything authentic about the effect of the moon on radio reception?—I. M. C.

No. Of course the sun has an effect on



See if you can determine why the tubes do not function in this circuit. Then look up the answer to W. H. P.'s question.

radio transmission and reception and therefore it is only sensible to suppose that the moon also has an effect, although perhaps a lesser one. There have been some interesting articles printed about the moon and radio, but they seemed largely speculative as to conclusions, although some experimental data were compiled. So far as we know there has been no scientific appraisal of the moon's effect, which may be expected to be of a secondary nature, because most of the rays from the moon (including other than light rays) are reflections and refractions.

No Heater Voltage

IN A THREE-TUBE short-wave universal set I built everything seems to check except that I get no action from the tubes. Enclosed is the diagram. What is the trouble?—W. H. P.

The trouble is that no voltage is applied

to the heaters. Trace the heater circuit from just above sw, to the 200 ohm resistor to the 25Z5 heater to the 43 heater to the 78 heater. Note that the left leg of the 78 heater returns to the same point at sw from which we started. This is a short circuit of the heaters, though not affecting the line. The remedy is to stop the top of the 200 ohm resistor at the line marked "+" and not hop over to the negative side.

Mobile and Portable

I NOTICE there is a distinction between a mobile and a portable station, but I do not understand what the different is, as both terms seem to mean the same thing.—K. L. W.

A portable station is one that is operated under a license permitting transportation of the station from place to place, but (Continued on next page)

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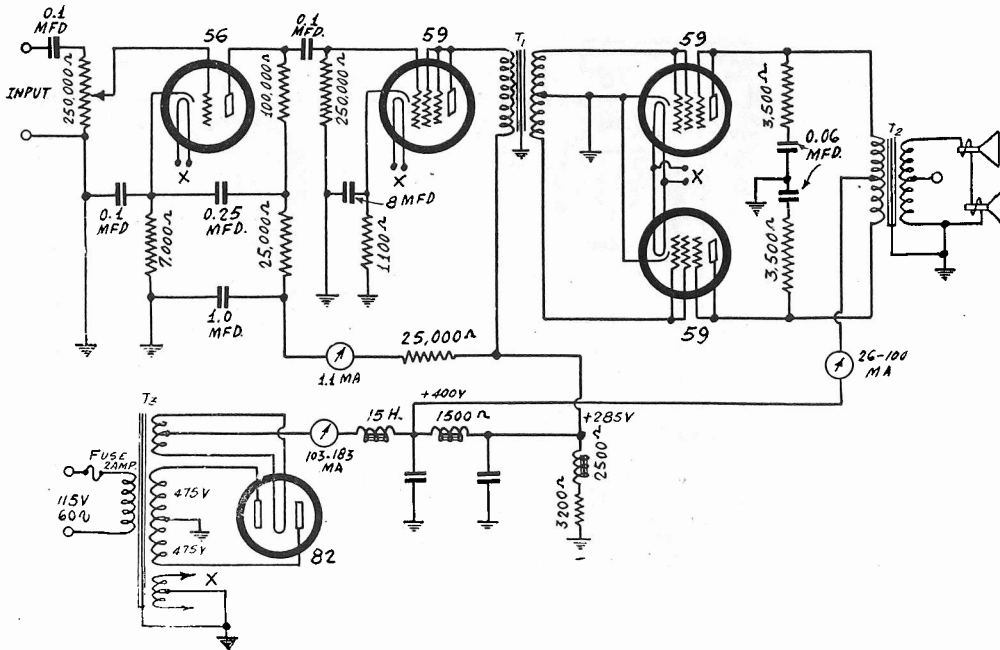
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Two speakers connected in series. If the voice coil impedances of the two speakers are equal the voltage drop across each speaker is the same.

(Continued from preceding page)

under conditions whereby transmission takes place when the station is not being moved about. If the station were on a truck, for instance, transmission would be legal only when the truck was standing still. Furthermore, the time and place of transmission must be arranged beforehand with the Federal Communications Commission. A mobile station is to the same effect, except that transmission may take place while the station itself is being moved, e.g., a transmitter in a flying plane. Some portable licenses were issued to amateurs, but no mobile licenses. Then, when 5-meter transceivers were worked successfully in experiments, their operations in mobile amateur service was authorized, hence amateurs could converse with one another while sender and receiver were in moving automobiles, for instance.

* * *

Television Not Easy as This

WOULDN'T IT BE possible to devise some attachment to put on a regular radio set so that television pictures could be viewed? It seems to me that what may be retarding the arrival of first-class television is just such a simple device as described.—T. W.

The question is incomplete, but we shall make some suppositions and then answer it. Suppose that the receiver tunes in only the broadcast band. In that event it would scarcely be possible to convey a good picture to the observer by any known means, since the modulation band width would be limited, as it now is by law, to 5 kc either side of the carrier, hence it would be impossible to transmit picture detail, which would require, say, 150 kc, or 30 times that available, or about one-seventh the whole broadcast band. So a carrier frequency so high that 150 kc would be a small part of it is selected, and the Federal Communications Commission has allotted experimental television licenses in the 41 mc band. You suggest "some attachment," and this would be practical if the foregoing were true, that is, a high-frequency carrier taken for granted, and the receiver had an extremely high-fidelity amplifier, higher in its fidelity than any receiver has today, since practically flat amplification would be required to well above 100 kc of modulation. Then the attachment would have to a light source. The general experience with "attachments" in regard to radio sets has been bad and would be an ample warning to any undertaking to put tele-

vision into the "attachment" class. Practically speaking, it seems safe to assert it can't be done properly. No doubt the television set of the future will have all the necessary requirements along the lines stated, and there is, of course, no reason why it shouldn't be an all-wave acoustic program receiver, either, since sound will have to be picked up as accompaniment of the television, anyway. Indeed, some experimental all-purpose, all-wave sets of this type already exist.

* * *

Two Speakers

WHEN TWO speakers are used should they be connected in parallel or in series?—C. L.

The series connection is more usual. If the voice coil impedances are equal the signal voltage across each speaker will be half the total. If the speakers have unequal response characteristics the statement still holds, but then the impedances, looking into the speaker are unequal, hence one speaker accentuates one region and the other another region of frequencies.

* * *

Antenna Tower

I AM CONTEMPLATING the erection of a steel tower for my antenna and have in mind a tower that is constructed of four posts 100 feet high with a 2½-inch pipe projecting above that for 12 feet making a total height of 12 feet. This tower to have a ground spread of 12 feet square at the base and will be of the lattice type of construction. I have the alternative of saving about \$50 by erecting a shorter tower—70 feet high—of the same construction. Which tower is preferable?—H. K. M.

If you are interested in receiving only, forget all about towers, since they are unnecessary with the modern powerfully sensitive receivers that work on antenna wires of twenty feet in length strung even indoors. For transmission, an antenna should be erected as high as possible and so it is more advisable to utilize the taller tower. When one can afford a steel tower of this type, he shouldn't economize, since the extra 42 feet might mean several thousand miles more coverage, depending on the character of the surrounding terrain. In the construction of the tower it is equally important that strict attention be given to the character of the ground over which the tower will be erected, since it is advisable that the antenna be situated over a highly conductive ground.

2.5 Meter Wave Promoted to the "Reliable" Class

West Hartford, Conn.

A new octave has been added to the usable communications frequencies of the radio spectrum by experts of Harvard University and the American Radio Relay League. For the first time reliable scheduled communication over a wavelength of 2.5 meters has been maintained for a period of days over a distance as great as 100 miles.

Beginning a recent Saturday afternoon, a series of schedules on the frequency of 110 megacycles were run off with clock-like precision between the special hill-top experimental laboratory of the League, where Ross A. Hull has been doing ultra high frequency research work for months, and Harvard University's Blue Hill Meteorological Observatory near Boston. A unique feature of the performance was that it was accomplished when the longer and more tractable 5 meter waves, which have been regularly used for some time, exhibited very poor conditions.

This is, of course, not the first time that radio transmitters and receivers have been made to work on wavelengths of this order. Members of the headquarters staff of the A. R. R. L. demonstrated the possibility of such operation several years ago. Spasmodic, "freakish" signals have even been heard on somewhat lower frequencies over distances of 50 to 75 miles. But it was not until recently that signal radiating and collecting systems were devised, and the proper technique of their operation formulated, which enabled the performance now being carried on.

This unprecedented work, which is another contribution by radio amateurs to science, is regarded by leading engineers and scientists as the unfolding of a new radio field nearly as great as that of the present standard broadcast band. Experimental work already done, in which transmissions have been made over distances approaching 80 miles, indicate that the next jump to 1.25 meters soon will be made.

NBC Improves Sending by Short Wave Stations

NBC short wave transmitters W3XL and W3XAL, which relay programs of the NBC-WJZ network, have been reconstructed to assure reception for NBC listeners in remote corners of the world.

With increased use of all wave receiving sets throughout the world, the importance of short wave facilities has assumed greater proportions, and the rebuilt transmitter is now available to relay NBC programs also for purposes of rebroadcasting in transatlantic hookups.

Reconstruction of W3XL and W3XAL at Bound Brook, N. J., resulted in a signal gain of sixty per cent. The change brought higher quality broadcasting, with higher modulation and increased reliability. The transmitter building, which also houses WJZ, is located approximately 30 miles from New York City and programs are transmitted to it over special telephone circuits from NBC's Radio City headquarters.

Normally a 6100-kc frequency at 15 kw is used for transmission during the evening hours from W3XAL, while the 17,780 kc band is used for daylight transmission. The W3XL frequency of 6,425 kilocycles at 25 kw is used largely for experimental and special work.

W9XF, located near Chicago, 6,100 kc, 10 kw, has antenna near the transmitter building which also houses WENR of the NBC. W9XF transmits NBC-WEAF network programs during daylight.

Station Sparks

By Alice Remsen

WILL, ALEX AND JACK

LISTENING to Will Rogers confirms the assertion that he is unique in the world; he's just one of a kind—and comes as a refreshing interlude each Sunday. One can say the same of Alexander Woollcott (spelt with two "l's" and two "t's," if you please). His Jerome Kern program was a masterpiece of direction and must have warmed the cockles of Mr. Kern's heart. I could event detect a tear in Mr. Woollcott's effulgent voice. The vision of Irving Berlin walking down the corridor to Mr. Kern's room with a bouquet—probably as large as himself—was a trifle whimsical, but Alexander did the program up well for us; and I for one thoroughly enjoyed it. . . . And Jack Pearl has a new role, that of Peter Pfeiffer. It's hard for this listener to disassociate him from the character of the Baron; however, will continue to listen on Wednesdays at 10:00 p. m., this time WABC-Columbia network. Perhaps the new character will develop unexpected angles and creep into our heart as did the other. . . .

CHANGES AT CBS

New time schedules for two CBS programs, "Fascinating Facts," with Art Dickson and Charlie Morgan. Formerly heard on Mondays through to Fridays at 8:00 a. m., the programs are now being broadcast under the sponsorship of the Delco Appliance Corporation, each Saturday at 5:45 p. m. \$25 will be paid for each fascinating fact submitted by the radio audience and which is accepted for use on the air. Two of the best facts received will be given each week. . . . And "Gossip Behind the Microphone," with Wallace Butterworth, formerly heard at 12:30 a. m., will now be heard at 11:45 a. m., Mondays, Wednesday and Fridays. Sponsored by Norec Toothpaste. . . . Jack Fulton, originally a trombone player in Paul Whiteman's orchestra, now has an orchestra of his own, and is broadcasting daily at 10:30 a. m., sponsored by the J. L. Prescott Company, makers of Oxol.

CBS AND BBC EXCHANGE

The first international exchange of news commentaries between the United States and Great Britain has been inaugurated by the CBS and BBC. Sir Frederick Whyte, K.C.S.I., British diplomat and editor, discusses English and European events for the WABC-Columbia audience each Saturday evening from London at 5:00 p. m.; and Raymond Gram Swing, one of the editors of "The Nation" and former American newspaper correspondent, comments on American events for the British radio audience each Tuesday evening at 10:00 p. m., British time. His talks will not be heard here; only in Great Britain—unless you happen to have a short-wave set. . . . Richard Bonelli, leading American baritone of the Metropolitan Opera, is now a featured soloist with the Chesterfield series over WABC, with Andre Kostelanetz and his orchestra each Saturday at 9:00 p. m. Three of the world's finest voices are now to be heard through the courtesy of Chesterfield—Lucrezia Bori, each Monday; Lily Pons, each Wednesday, and Richard Bonelli, each Saturday. . . . Bonelli was born in Port Byron, New York, and worked his way through school. He won a scholarship to Syracuse University, intending to become

an automotive engineer. Fate willed otherwise, and the world is the richer. . . .

CANDID CAMERAGRAPHS

Muriel Wilson

Muriel Wilson, lyric-coloratura . . . shy Mary Lou, radio sweetheart of Lanny Ross over NBC. . . . In real life, fiancée of Fred Hufsmith, popular tenor of the air waves. . . . A real New Yorker. . . . Born in house in heart of city's Fifth District. . . . Mother is Republican lady boss of said district. . . . Muriel not a bit political. . . . Has wavy black hair, grey eyes, peach-bloom complexion. . . . Was graduated from Wadleigh High School and the American Institute of Applied Arts. . . . Tried business before making singing a career. . . . Was a deputy collector of internal revenue, but wasn't made for such staid work. . . . Began to sing in concert and opera. . . . Now one of foremost radio favorites. . . . Has home just south of West Point, called "The Little House that Radio Built. . . . Very proud of it. . . . Likes experimenting with her rock garden, but hates housework. . . . Hobbies are opera and reading in the winter time. . . . Swimming, tramping and horseback riding in summer. . . . Likes amateur photography all the time. . . . Favorite dish is hot huckleberry pie and chocolate soda. . . . Usually does without it, to keep slender figure. . . . Five feet four inches tall. . . . Weighs 122 pounds. . . . Dresses simply. . . . Dark colors for street. . . . Dainty, filmy things in pastel shades for evening. . . . Loves bright red scarfs, bags and handkerchiefs. . . . Gets real thrill out of earning own living and clipping stock certificates. . . . Does not care for night clubs. . . . Loves country life.

PERHAPS YOU KNOW THEM

Jolly Coburn, popular young orchestra leader from New York's smart Rainbow Room has, to my mind, one of the finest dance orchestras on the air, and his vocalist, Harold Van Emburgh, is the best vocal chorus singer, bar none. I say this without reservation. I've listened to this young man for a number of years. He is never tiresome, has no affectations and possesses a really good voice. What I wanted to say in the first place was—Jolly Coburn's Orchestra is back on the air for the Sparks Withington Company, each Sunday at 4:00 p. m. over an NBC-WJZ network. . . . There will be a special symphony concert broadcast from Germany, on Friday, February 22, at 2 p. m., over a nationwide NBC-WJZ network, in honor of the Handel Anniversary. . . . Jane Pickens, of NBC's charming Pickens Sisters, has been advanced to the role of a prima-donna in "Thumbs-Up," the revue success now playing at the St. James Theatre in New York. . . . The Southwest Broadcasting System now has an enlarged network of thirteen stations in Texas, Oklahoma, Louisiana and Arkansas. Eight of these stations also carry CBS features. Which reminds me—don't forget the Texas Centennial which arrives in 1936. . . . Robert L. Stone, production and sound effects man, formerly employed at NBC, has joined the staff of WOR. Stone is a graduate of Knox College. He has also been a member of the production staffs of stations KVOO and WTIC. . . . WOR has added another new feature to its sustaining series. Each Sunday at 11:00 a. m., Eddy

THE FEDERAL COMMUNICATIONS COMMISSION declares to Congress, in a recommendation prolonged to the usual limits of such official reports, that its answer is in the negative as to fixing the definite percentage of time for religious and educational air programs. Unlike most official recommendations of this nature, the F. C. C. does not regard the matter as closed but suggests that there be held in Washington in the near future a conference of those interested in these non-profit programs and that their recommendations be given most careful attention before any other Federal radio legislation is passed.

Thus educators and religious instructors will have a chance to air their opinions in a matter in which the public really has a wide and ever-extending interest.

Brown, well-known violinist, presents the works of outstanding American composers playing their own sonatas for piano and violin. Cecil Burleigh, John Tasker Howard, Carl Engel, Marion Bauer, and other composers will be heard in this series. . . . Another new WOR feature is a graphologist and psychologist, Madame Olyanova. Sponsored by the makers of Philip Morris cigarettes Mdme. Olyanova is heard each Saturday at 10:45 a. m. . . . Reid's Ice Cream has started its campaign early this year, over WOR. The program consists of Borrah Minnevitich and his Harmonica Bascals and Henry Burbig and the Sizzlers Trio. Each Tuesday at 8:00 p. m. . . .

STUDIO NOTES

Alice Joy, "Radio's Dream Girl," is spending ten weeks in Texas. Alice is broadcasting over the Southwest Broadcasting System. . . . Jimmy Tansey, "Danny" in "The O'Neills," was formerly a singer in a night club. . . . Frank Parker believes in operatic study; he works regularly with an operatic coach when he is in New York. . . . Robert Braine, NBC pianist, composes music when he is "stand by" up at Radio City.

SARNOFF APPOINTS ASSISTANT

David Sarnoff, president of the Radio Corporation of America, announced that he had appointed Henry Kittredge Norton Assistant to the President. Mr. Norton comes to the Radio Corporation from the National Broadcasting Company, where he has served as treasurer and in other capacities.

Ham Clubs Span Seas to Hold Joint Meeting

Schenectady, N. Y. Snow driving against the antenna of W2XAF early one recent morning did create some static but did not prevent the convening of the first joint meeting to be held between the Schenectady Amateur Radio Association and the Zero Beat Amateur Radio Club of Sydney, Australia. It was also the first time on record that two groups of "hams" anywhere had talked back and forth with an ocean separating them.

President N. K. Eaton of the Schenectady club opened the exercises. Others who spoke were G. Movine, Australia; Gerald Gaynor, Schenectady; Alfred Korb, Schenectady; Ray Hutchinson, Sydney; Norbert Sauter, Schenectady; and Harry Bourne, Rugby, England, from Schenectady.

Arrangements for the joint meeting were made by E. S. Darlington of the General Electric Company. This end of the get-together took place in the studios of WGY. The W2XAF frequency was 9,530 kc, and the VK2ME frequency 9,590 kc.

Negotiations are now under way for similar joint meetings between the Schenectady club and amateur radio clubs of South America.

Special!
RADIO PARTS KIT



In a recent clearance sale, thousands of odds and ends radio parts were left. In order to clear our shelves immediately, we made up a special assortment of parts and offered them for sale at from 2 to 3 times below their regular price if bought singly.

As an added gift, we tender the purchaser an all-metal, shelf-a-tray tool chest and a Radio Manual.

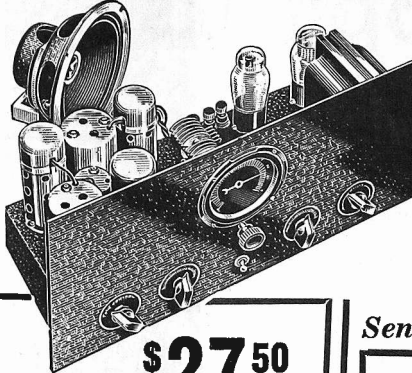
NOTE: Send for pamphlet of many other special parts kits specials.

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FREE Parts List - Data - Schematic

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A 5-tube superheterodyne, all-wave receiver capable of world-wide radio reception. Its range is from 10 to 550 meters. Sponsored by 11 world-famous manufacturers of radio equipment.

Send for 1935 184 Page Radio Catalog

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Kit of Parts
Oxford 6" Speaker.....\$2.50
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A COMBINATION OFFER!
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and "RADIO NEWS"
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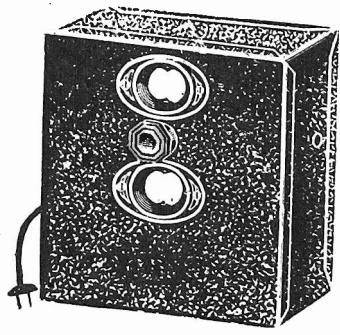
Canadian and Foreign, \$1.50 extra.

You can obtain the two leading radio technical magazines that cater to experimenters, service men and students, the first national radio weekly and the leading monthly for one year each, at a saving of \$1.50. The regular mail subscription rate for Radio World for one year (52 weeks) is \$6.00. Send in \$1.00 extra, get "Radio News" also for a year—a new issue each month for twelve months. Total 64 issues for \$7.00.

RADIO WORLD, 145 West 45th St., N. Y. C.

New Signal Generator Free
with \$6 (One Year) Subscription

NOW for the first time you can get a wired and tested Signal Generator free as a premium with a \$6 subscription for Radio World (52 issues, one each week). Imagine getting Radio World for a year, and also a splendid Signal Generator! Never before have we made so generous an offer as this. Moreover, the offer is revocable without notice. So you'd better act now.



The Signal Generator offered as a premium with a one-year subscription is a serviceable instrument, of durable and accurate construction, and enables the peaking of intermediate frequencies, as well as broadcast frequencies. Moreover, short-wave frequencies can be determined. Determinations in frequencies in kilocycles and wavelengths in meters are made by use of this splendid instrument.

The Signal Generator, PRE-6, has practically straight-frequency-line tuning. It works on 90-125 volts, a.c. or d.c., and is modulated on a.c.

SCALE READS DIRECTLY IN FREQUENCIES AND WAVELENGTHS

MANY experimenters and service men want a really good Signal Generator that serves their purposes abundantly and that costs little. Here it is. Model PRE-6 Signal Generator is given free with a one-year subscription for RADIO WORLD, a most amazing offer, nothing like it ever having been made before in the radio field. And this generator is obtainable in no other way.

The scale reads directly in frequencies of the fundamental (109 to 200 kc, with bars 1 kc apart), and wavelengths of the fundamental (2,700 to 1,500 meters, with bars 10 meters apart). Besides the intermediate frequencies on the fundamental scale, others are on the scale on the next tier from top, including the following imprinted twice: 400, 450, 465 and 480 kc. The reason for these imprints appearing twice is that an automatic check-up on whether the channel measured is tuned exactly to the right i.f. is obtained, when using harmonics, for there is a response in the receiver channel when the generator is turned to one and then another of these two points. Hence no harmonic confusion is possible. Also, 250 and 260 kc are imprinted once on the second tier, for no confusion can result, as second harmonics are used.

GUARANTEED ACCURACY IS 1%

THE upper tier, at the edge, is 109-200 kc, the lower corresponding tier at the edge is for wavelengths. One inside tier has the registrations for the popular intermediate frequencies not on the fundamental. The other inside scale reads 0-180, so that any odd frequency one is interested in may be recorded elsewhere in respect to a calibration in degrees of a semi-circle.

The 335 dial scale is used. The guaranteed accuracy is 1 per cent. This is checked twice in a precision laboratory. The accuracy is not changed when a tube is inserted. The wired, calibrated, tested Signal Generator is supplied less tube. All you have to do is to insert a 30 tube and start making precision measurements.

Send \$6.00 for one-year subscription, and ask for PRE-6. Present subscribers may renew on this basis. Shipping weight, 3 lbs. Enclose postage if prepaid shipment is desired. It's cheaper.

Foundation Unit for this Signal Generator can be obtained by sending \$3 for six-months subscription (26 issues, one each week). The Foundation Unit consists of frequency-calibrated scale, two escutcheons, coil, tuning condenser, wiring diagram, instructions. Order PRE-3. Shipping weight, 1 lb.

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INVENTORS, if you have good ideas, any kind, patented or unpatented, write to us at once. Absolute honesty and reliability guaranteed. This is your opportunity if you take advantage. United I. A. Inc., 14 Water St., Torrington, Conn.

FORD OWNERS—Overhead Valve Speed Units, Winfield carburetors, camshafts Dual-Ratio axle for V-8's. Dime secures sample Speedway Racing Magazine, catalog speed books, crash helmets, English racing, stock motorcycles, accessories. CLYMER, 442 W. Pico, Los Angeles, California.

TO \$8 FOR LINCOLN HEADS; to \$78 for Indian head pennies. All dates wanted. Catalog, 10c. Penny Shop, Dept. 77, Cedar Falls, Iowa.

REWIND OLD TYPE METERS to 0-1 milliamperes. Ohmmeter 1000 ohm per voltmeter. Complete instructions, \$1.00. Link Radio-Experimental Lab., Box 437, Kirksville, Mo.

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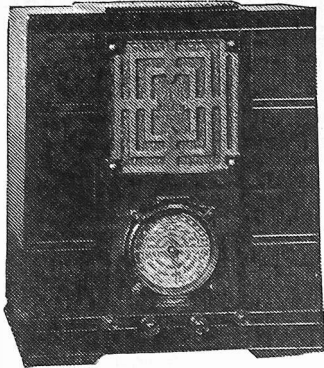
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"ELECTRON TUBES IN INDUSTRY," by Keith Henney. A thorough, authoritative presentation of the practical aspects of electronics. Describes in detail amplifier, rectifier, and other tubes and photocells, and shows how they are being used now in industry. 490 pages, 6 x 9, illustrated. \$5.00. Book Dept., Radio World, 145 W. 45th St., New York City.

"THE RADIO HANDBOOK," including Television and Sound Motion Pictures. By James A. Moyer and John F. Wostrel, both of the Massachusetts Department of Education. For engineers, designers, operators, service men, experimenters. 886 pages, 650 illustrations, flexible. Price, \$5.00. RADIO WORLD, 143 West 45th St., New York City.

ALL-WAVE DIAMOND



DE LUXE TABLE MODEL
\$32.70

quality and selectivity are excellent. Sensitivity is remarkably high as far as consistent with low noise level.

You can buy the chassis, speaker and tubes, or either table model set, or console model, whichever best suits your needs.

Cat. 1008-WCH, wired chassis, with eight RCA tubes (one 6A7, two 6D6, one 75, one 76, two 42 and one 80) and heavy-duty dynamic speaker, 50-60 cycles, 110-125 v. Primary power consumption 80 watts. Chassis 13" wide, 7" high, 8 3/4" front to back. Shipping weight 25 lbs.)..... **\$26.10**

Cat. 1008-WCH-25, same as above, except for 25 cycles (25 lbs.)..... **27.60**

Cat. 1008-WCH-220, wired chassis, etc., for 50-60 cycles, 220 v. (20 lbs.)..... **26.70**

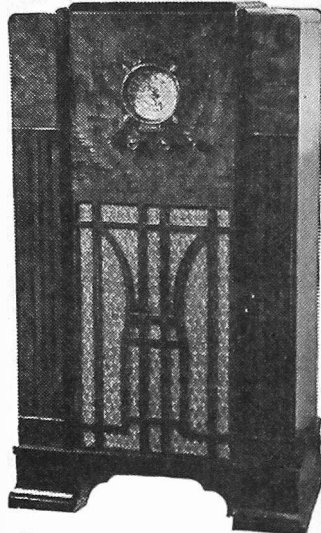
Cat. 1008-WDL, standard chassis in de luxe table model cabinet 14 1/2" wide, 16" high, 9 1/2" front to back (28 lbs.)..... **32.70**

Cat. 1008-WG, table model in Gothic cabinet (28 lbs.)..... **31.50**

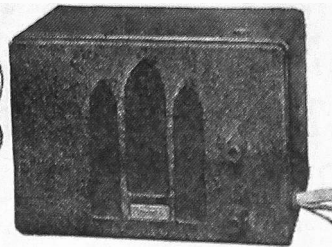
Cat. 1008-WCO, console model, 21" wide, 36 1/2" high, 12" front to back (5 1/2 lbs.)..... **41.70**

Cabinet models as listed above are for 50-60 cycles, 110-125 volts, but are also obtainable for 25 cycles, 110-125 volts @ \$1.50 extra or for 50-60 cycles, 220 volts @ 60c extra.

THE All-Wave Diamond, introduced only a few months ago, has proved the most popular receiver we have ever offered. Customers are completely satisfied, delighted, overjoyed. Not only low price—the lowest, in fact—but performance on full par with that of expensive receivers. We highly recommend the all-wave model to broadcast-short-wave listeners. It is obtainable in two table-model forms, De Luxe, as illustrated, @ \$32.75, with eight RCA tubes, or Gothic, @ \$31.55, or in a console model, as illustrated, @ \$41.70. The set tunes from 150 kc to 22,000 kc (2,000 to 13 meters) by front-panel rotary switching. Foreign reception on short waves is guaranteed. Thus you have world-wide reception. Automatic volume control, tone control, manual volume control, five-band switch, latest RCA tubes, large airplane dial calibrated in frequencies and meters, 8" dynamic speaker, 3-gang condenser, and lowest price are the attractions. The circuit is a superheterodyne and easy to tune. Tone



CONSOLE MODEL
\$41.70



DIAMOND AUTO SET
\$23.95

OUR previous model Auto Set was so good that the model was not changed in three years. Now at last it has been improved upon, certain mechanical refinements introduced, and tubes of somewhat higher efficiency included. Some of these tubes were not manufactured until recently. Also the set now has a. v. c.

Our 1009-T Auto Radio is a six-tube superheterodyne set, using one 6A7, one 41, one 75, two 78's and one 84, and tunes from 540 kc. to 1,600 kc. It is a one-unit receiver, ruggedly built for long life, and is equipped with a dynamic speaker. It has an illuminated vernier airplane type control. The manual volume control and lock are one combination. The power consumption is 4 amperes.

No B batteries required. There is a B-eliminator built in.

This is one of those fascinating auto sets that has single-hole mounting provision, and therefore is a cinch to install. There are only two connections to make: (1) to the ammeter; (2) to the aerial.

The remote tuner is, of course, supplied with the set. And the spark plug suppressors and commutator condenser are supplied also.

The size is 8 3/4 inches wide, 6 inches high, 6 1/4 inches front to back. Shipping weight is 18 lbs.

Order Cat. 1009-T, wired, in cabinet, complete with six RCA tubes. Price, \$23.95

ANOTHER popular receiver is the dual-wave type that covers the broadcast band and one short-wave band. On that one short-wave band are found the most important foreign stations. The coverage of the Model 1042-PD receiver is: broadcast band (550 to 1,500 kc) and short-wave band (5,500 to 16,000 kc). Therefore the short waves are tuned in from 18 to 55 meters, and that is the band on which the most important foreign program transmitters are working. Anybody who has not had his taste of short-wave reception will do well to be initiated with either of these two dual-band receivers. Model 1042-PG is illustrated at right, and is a superheterodyne for foreign and domestic reception. There are also the following valuable features: built-in antenna, frequency-calibrated dial, separate short-wave switch (no plug-in coils), dynamic speaker, figured walnut cabinet with figured Oriental overlays. And the price of Model 1042-PG is only \$19.17 net.

Model 1042-PD, illustrated at left, is the same circuit in a de luxe table cabinet. The two table models have an airplane frequency-calibrated and illuminated dial, and besides can be obtained for battery operation and 32-volt operation. It is a superheterodyne of the switch type, covering the broadcast band and 18 to 55-meter short-wave band. It has automatic volume control and tone control. It is for 105-120 v. 50-60 cycle operation. Primary power consumption 60 watts; shipping weight, 17 1/2 lbs. Net price. **\$20.37**

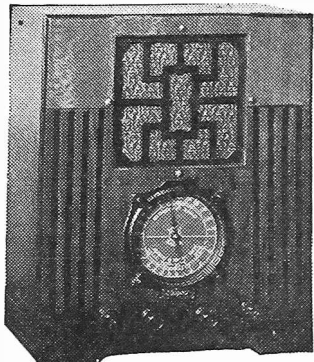
Cat. 1042-PCH, wired chassis, 9" wide, 7" high, 8" front to back; dynamic speaker, five RCA tubes (one 6A7, one 6D6, one 75, one 42 and one 80), 550 to 1,500 kc and 5,500 to 16,000 kc. For 50-60 cycles, 110-125 v. (14 1/2 lbs.) **\$17.10**

Cat. 1042-PG, table model Gothic cabinet. (17 1/2 lbs.)..... **\$19.17**

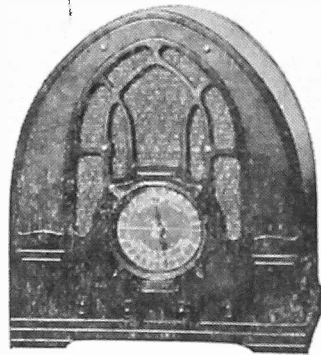
Any of 1042 series, 50-60 cycles, 220 v. @ 60c extra; 110-125 v., 25 cycles @ \$1.50 extra. Cat. 1042-PBCH, battery model chassis for 6-volt storage battery and B battery operation (batteries not supplied); complete with tubes and speaker. (14 1/2 lbs.) **\$21.90**

Cat. 1042-PBG, same as above (battery model) in Gothic cabinet, with tubes, speaker. (17 1/2 lbs.)..... **\$23.97**

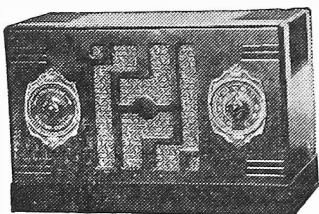
Cat. 1042-PBD, battery model, in de luxe table cabinet. (17 1/2 lbs.)..... **\$24.17**



2-BAND DE LUXE
\$20.37



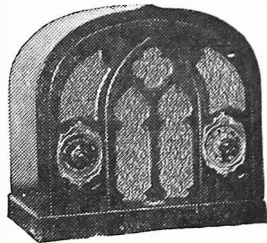
2-BAND GOTHIC
\$19.17



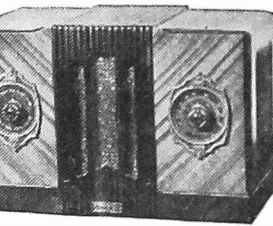
\$13.17

540-1900 KC BROADCAST SET

FOR those interested only in the broadcast band we have a splendid ac t-r-f model DIAMOND OF THE AIR that tunes from 540 to 1,900 kc, and therefore gets some police and amateur calls as well; that has frequency-calibrated and illuminated airplane dial; and that can be bought, complete with tubes, all wired and ready for operation of its self-contained dynamic speaker (left-hand illustration above) at only \$13.17. Order Cat. 1041-XG, for 50-60 cycles a.c., 105-120 volts. The same set is illustrated at right in de luxe cabinet, price \$13.77. Order Cat. 1041-XD. Not only may the receiver be bought already in either cabinet, but separately as a wired chassis, with speaker and tubes (less only cabinet). Besides, there is a model for 25 cycles a.c., 90-120 volts, and another for 220 volts a.c., 50-60 cycles. This is a tuned-radio-frequency receiver, five-tube model, using two 6D6, one 6C6, one 42 and one 80. It will be noticed that the economical and electrically strong 6-volt series tubes are used in the receivers proper. The primary power consumption is 55 watts. Not only is this a fine receiver, but it is made right, and every attention has been paid to detail. The airplane type dial is frequency-calibrated, so that the frequencies are read directly. There is provision for phonograph connection. The wired chassis is Cat. 1041-XCH, complete with speaker, tubes, \$11.97. Shipping weights of 1041 series, 11 1/2 lbs. 25-cycle models, \$1.20 extra. 220-volt models 60c extra.



\$13.77

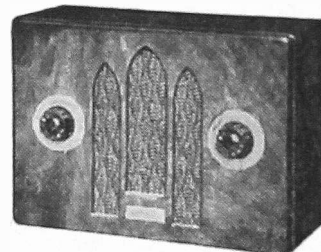


2-BAND OBLONG
\$17.37

The above set is a two-band 5-tube ac-dc universal receiver for 50-60 cycles, 110-125 volts, and is Cat. 1042-U, \$17.37 (10 1/2 lbs.). It uses one 6A7, one 6D6, one 75, one 43 and one 25Z5. Sold complete with RCA tubes. Ranges, 550 to 1,500 kc, 5,500 to 16,000 kc. Approximate kilocycle calibration. Band change by switching.

Cat. 1042-UE is in the same cabinet, etc., but tunes from 150 to 350 kc and from 540 to 1,500 kc. For European use. Price \$18.57, complete with tubes.

Either above, with 220-volt adapter, 90c extra.



AC-DC MIDGET
\$11.37

Model 1040-V. 4-tube universal, ac-dc, 90-120 v., wired receiver, complete with four RCA tubes, and coil for the broadcast band only; contained in attractive midget cabinet; dynamic speaker. Shipping weight, 8 lbs. Net price.....**\$11.37**

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ADAPTERS

Auto adapter, complete with suppressor. Cat. 1040-VATAD.....**\$7.50**

32-volt Farm Light Plant Adapter. Cat. 1040-VFLPA.....**\$5.00**

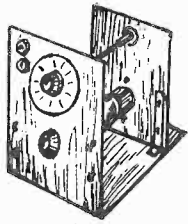
220-volt adapter for ac-dc use. Cat. 1040-V-220.....**.95**

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AT LAST!!! AN INEXPENSIVE 1-TUBE 5-METER KIT

COMPLETE \$2.25 All Parts Mounted and Wired on Back of Rear Panel

For the short-wave enthusiast who is interested in exploring the fascinating 5-meter band (a band which, incidentally, is 4 times as wide as the entire American broadcast band), this simple but extremely efficient 5-meter receiver is recommended. The circuit utilizes the type 19 two-volt twin tube-unity coupling and various other features which result in a very sensitive super-regenerative receiver. Kit includes all necessary condensers, resistor, tube socket, special 5-meter unity coupled coil, dial, knobs, rheostat, wire, hardware, panels, base, etc. Kit, complete, \$2.25. Diagram and complete instructions included with each kit. Send \$1.00, balance C.O.D., or mail entire amount and we pay postage.



THE IDEAL

Type 19 Tube Extra, 60c.

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ACCURATE

Fixed Mica Condensers

Capacities measured on a bridge.

1,000-VOLT RATING

0.002 mfd...	12c	0.0007 mfd...	13c	0.0004 mfd...	15c
0.0015 mfd...	12c	0.0006 mfd...	13c	0.0003 mfd...	15c
0.0009 mfd...	13c	0.0005 mfd...	15c	0.0002 mfd...	15c

Any six of above, 60c; any 12 of above, \$1.10. Any assortment permitted.

ACCURATE

PIGTAIL RESISTORS

1/4-WATT RATING

Bridge Measured

200 ohms.....	9c	7,000 ohms..	10c	50,000 ohms..	11c
500 ohms.....	9c	12,000 ohms..	11c	30,000 ohms..	11c
700 ohms.....	9c	17,000 ohms..	11c	15 meg.....	12c
1,000 ohms..	10c	20,000 ohms..	11c	2 meg.....	12c
2,000 ohms..	10c	25,000 ohms..	11c	5 meg.....	12c
2,500 ohms..	10c	30,000 ohms..	11c	6 meg.....	12c
3,000 ohms..	10c	35,000 ohms..	11c	7 meg.....	12c
3,500 ohms..	10c	40,000 ohms..	11c	8 meg.....	12c
4,000 ohms..	10c	50,000 ohms..	11c	1.0 meg.....	13c

Any six of above resistors, 50c; any 12 resistors, 90c.

Each condenser and each resistor is specially tested and calibrated, and a personally written notation of the resistance or capacity value is furnished. We pay postage sending out these condensers or resistors if you remit purchase price with order.

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"SERVICING RECEIVERS BY MEANS OF RESISTANCE MEASUREMENT"

by John F. Rider

The new printing is ready for delivery. Right in line with the latest type of testing equipment offered by Weston, Supreme, Hickok and Readrite. All interested in resistance measurement method of servicing and who use their ohmmeter or who are purchasing the new type of point-to-point testing equipment produced by Weston and the other manufacturers, and the selective-reference-point type of testing equipment as produced by Supreme, can make very good use of SERVICING RECEIVERS BY MEANS OF RESISTANCE MEASUREMENT.

Still selling at \$1.00

Book Dept., RADIO WORLD

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Generator with Amplifier Stage

In several services low frequencies are commonly given only their wavelength equivalents, and for very high frequencies this is true likewise. So a Signal Generator, that enables determinations in both wavelengths and frequencies is the thing. That service is what the new Bernard Signal Generator Model 333-A renders.

Besides the more general purpose of lining up superheterodynes at intermediate, broadcast and short-wave levels, and peaking tuned-radio-frequency sets, it may be used as an all-wave Station-Finder, constantly modulated. Dual Measurement and Combination Use make this Signal Generator most valuable.

The fundamental frequencies and wavelengths are direct-reading. There are no charts to strain the eyes. The dial is accurately calibrated and the Signal Generator accurately adjusted. These fundamentals are: 83 to 99.9 kc. (1 kc. separation); 140 to 500 kc. (5 kc. separation); 540 to 1,600 kc. (10 kc. separation); 1,400 to 5,000 kc. (20 to 50 kc. separation); 3,010 to 3,600 meters (25 and 50 meter separation).

The bands are selected by turning a front-panel switch. There are four switch stops. The low-frequency band and the wavelength band cover the same range, the same stop being used, though there are two scales for this band, wavelength and frequency.

Any frequencies or wavelengths as listed above are present as fundamentals and are read directly.

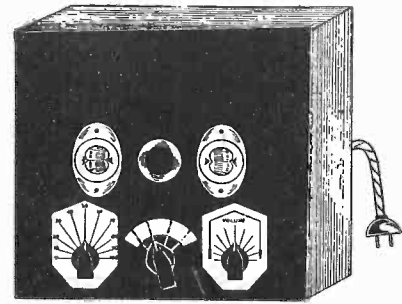
A new method, simple to apply, enables measurements from 4,500 kc. to 99.1 mc., also wavelengths from 3,010 meters to 0.1 meter. The extension of the fundamental ranges is accomplished by a startling method that opens up new possibilities of extensive and accurate measurements.

Model 333-A Signal Generator, for 90-120 volts a.c., d.c. or batteries; designed by Herman Bernard, accurately calibrated and adjusted, for all-wave service, 83 kc. to 99.1 mc., 3,600 meters to 0.1 meter; equipped with output attenuator, on-off switch, modulation switch for d.c. and battery use, Chromium-plated control and band-index scales, positive-contact, low-resistance band-selector switch, a.c. cable and plug, black wrinkle-finish shield cabinet, 34 and 30 tubes, neon tube, and instruction sheet included. Ready for immediate use.

Model 333-A (shipping weight, 7 lbs.)

List Price\$40.00

THREE TUBES!



DIRECT RADIO CO.

145 West 45th Street, New York, N. Y.

NET PRICE **\$19.95**

SHORT-WAVE AND PUBLIC ADDRESS MANUAL

FREE

192 pages, 400 illustrations, costing \$4,000 to produce. And yet a copy of this manual will be sent to you free if you send \$1.00 for an 8-weeks subscription for RADIO WORLD. Existing subscribers may extend their subscriptions under this offer.

Bound in cardinal red leatherette, this manual includes articles on the construction of short-wave receivers from one to nine tubes, inclusive, and all values between, super and t-r-t, with the clearest imaginable illustrations, both photographic and draughting. Besides the usual plain circuit diagram there is a pictorial diagram for each circuit. And all the photographs are brilliantly alluring and informative. Portable short-wave sets, design and winding of coils for short waves and broadcasts (intimately illustrated), list of short-wave stations with meters and kilocycles and hours on the air; trouble-shooting, and forty other topics, all done well.

The public address section contains data on different systems, how to use them, and offers opportunities to turn public address work to profit. Besides, there are articles on testing and servicing not encompassed by the title of the manual—signal generators, broadcast home and portable sets, analyzers, formulas, capacity data. Everything plainly told, simple language, from microphones to speakers.

Send \$1.00 now and get RADIO WORLD for 8 weeks and the manual free. Ask for Cat. PR-SPAM.

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I-F. Transformers FREE With Subscription

Two 465 kc single-tuned i.f. transformers free with six months subscription for Radio World (\$3.00). Order P-1050. Offered while they last.

Order to-day.

RADIO WORLD

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John F. Rider's Vol. IV Perpetual Trouble Shooter

SERVICING during 1934 will be more complicated than at any time during the past 14 years of radio activity. Volume IV is your means of combating the numerous highly scientific problems of design introduced by the receivers sold during 1933.

"I do not hesitate to say that Volume IV is the most important of all the manuals I have issued. Volumes I, II and III found their place in the servicing world as important aids to the service man..."

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