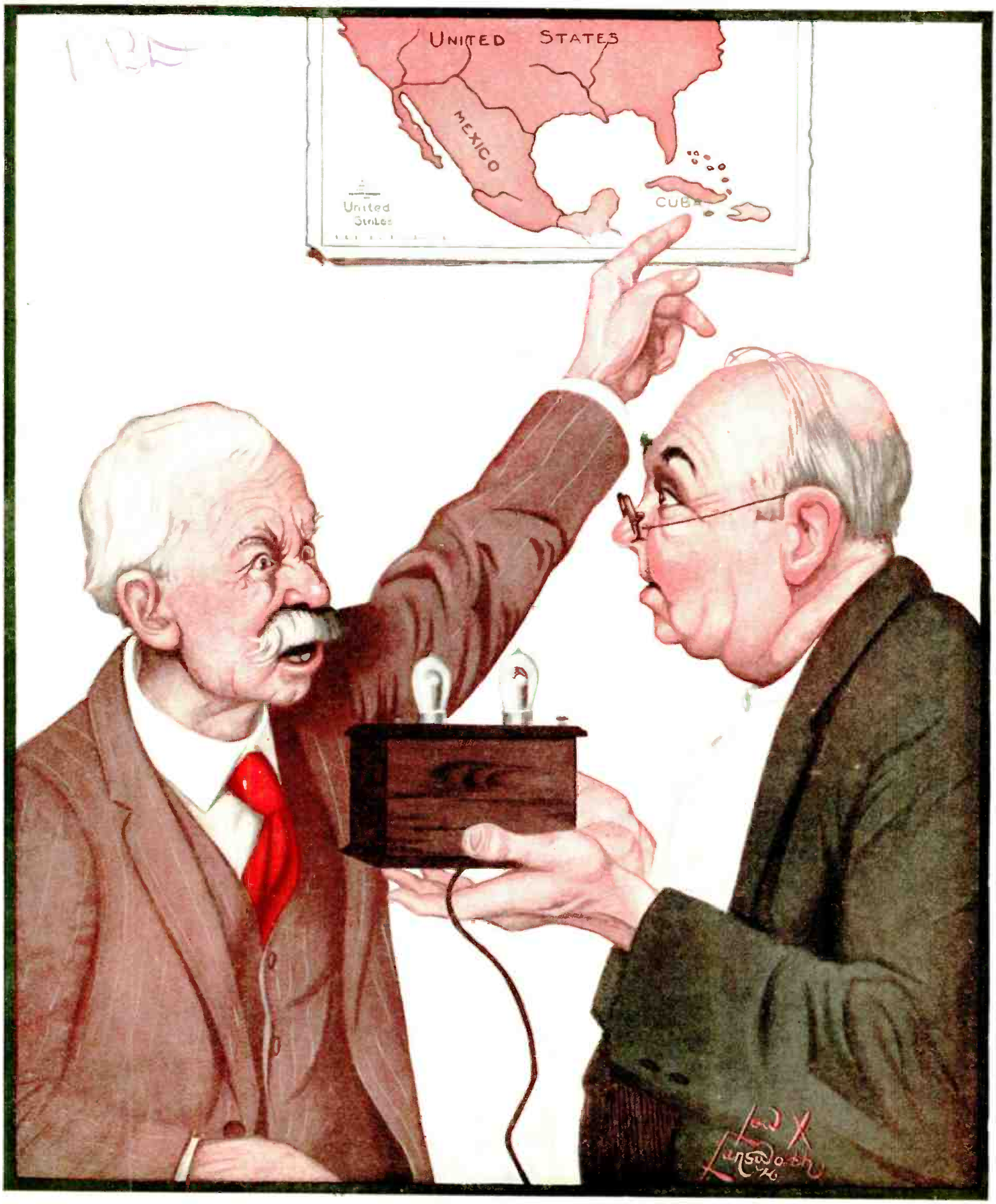
AUGUST, 1926 25 CENTS

RADIO

(Reg. U. S. Patent Off.)



In This Issue— E. M. SARGENT'S "INFRADYNE."
G. M. BEST'S "Socket Power" BROWNING-DRAKE RECEIVER.

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Established 1917
Published Monthly by the Pacific Radio Publishing Co.

ARTHUR H. HALLORAN
Editor

GERALD M. BEST,
Technical Editor

H. W. DICKOW,
Advertising Manager

Branch Offices:
New York City, 20 East 42nd St.
Chicago, 307 N. Michigan Ave.
Boston, 52 Irving St.
Kansas City, Mo., Davies & Dillon, 707 Land Bank Bldg.

Rates:
Issued Monthly, 25c a copy.
Subscription price, $2.50 per year in the U. S., $3.00 per year elsewhere.

Correct Addresses:
Instructions for change of address should be sent to the publisher two weeks before the date they are to go into effect. Both old and new addresses must always be given.

Advertising:
Advertising Forms Close on the First of the Month Preceding Date of Issue.

Member Radio Magazine Publishers' Association
Entered as second-class matter at Post Office at San Francisco, Calif.

Address all communications to

Pacific Radio Publishing Company

Pacific Building, San Francisco, California

VOLUME VIII — AUGUST, 1926 — NUMBER 8

CONTENTS

Forecast of Contributions for September Issue

G. M. Best illustrates and describes the adaptation of the power plant featured in August "RADIO" to a number of standard receivers, both home-made and factory-built. By this means many present sets can be operated from the alternating current lighting mains with but few changes.

W. H. Stirling gives constructional details for a new type of Kolster loop especially intended for locating radio interference on broadcast wavelengths. It is similar in principle to the direction finder used on the radio cars being built for the Department of Commerce.

Chas. F. Felstead discusses "Interchangeable Radio-Frequency Choke Coils" of the plug-in type. Specifications are given for size of wire and number of turns and suggestions are made as to all constructional details.

J. E. Anderson explains how distortion may be minimized in resistance coupled amplification by a proper choice of stopping and by-pass condensers and of grid-leak resistance.

A general discussion regarding the results that may be expected from all types of superheterodyne oscillators is given by G. M. Best. This is illustrated by a large number of circuit diagrams.

E. E. Griffin tells how to make a portable all-purpose testing instrument for use in the shop, field or home laboratory.

L. W. Hatry has a discussion on "Tuned Radio Frequency," wherein he shows various means for eliminating oscillations.

Further operating details for the Infradyne, together with suggestions for the correction of possible troubles that may arise in its construction are given by E. M. Sargent as a follow-up on his article in the August number. He will also tell of some interesting experiences while developing the Infradyne amplifier unit.

Clinton Osborne describes completely the internal construction of the new types of electric phonographs, which are closely allied to radio development.

A. Binneweg, Jr., presents some practical suggestions for amateur constructors, telling how to make many parts ordinarily purchased.

Amateur operators should be especially interested in "Reactance Coupling for Short Wave Transmitters," by L. J. N. du Treil. L. W. Hatry also describes "A Good Ham Receiver."

The fiction feature is "Tuning In on Elwood Grover," by John Eugene Hasty.

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Acme B-Eliminator Kit

Wiring Diagrams with Complete Instructions.

Baseboard
1 Acme B-4 Transformer
2 Acme B-2—30 Henry Chokes
1 Acme Condenser Block
1 Bradleyohm
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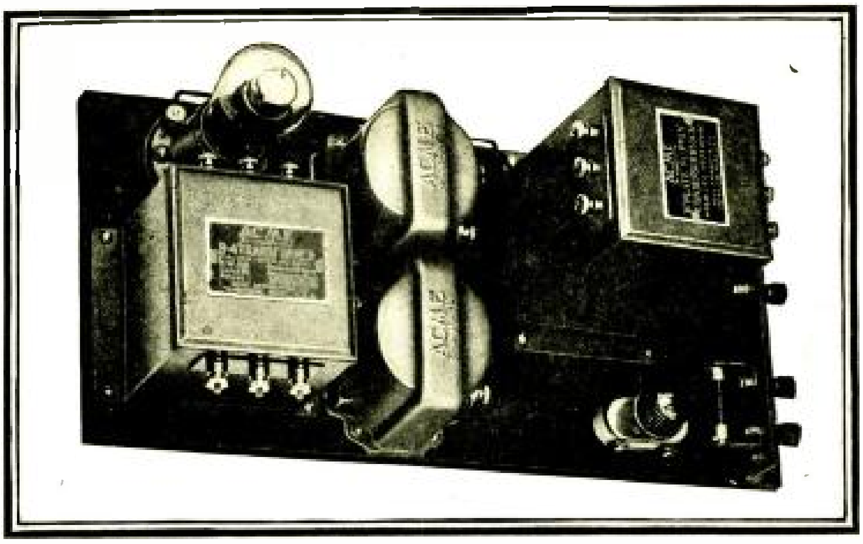
***Photo at right*—Acme B-Eliminator, assembled from kit. *Photo below* of factory-made Acme B-Eliminator, Type E-1—110 Volts, 60 cycle —Type E-2—110 Volts DC—$20.00.**



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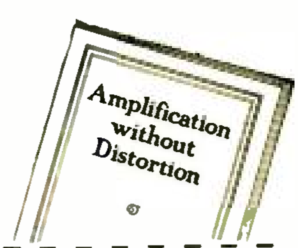

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RADIO

WITH WHICH IS INCORPORATED "RADIO JOURNAL"

VOLUME VIII AUGUST, 1926 No. 8

Radiotorial Comment

AGAIN, for the fifth consecutive year, do we record an adjournment of Congress without the enactment of a new law to supersede the antiquated radio act of 1912. As to reasons and excuses, there are many. But those people who are good at making excuses are seldom good for anything else. 'Tis a sad commentary that the straightforward task of regulating an industry that asks to be regulated should become a political football.

The only readable signal that rose above the noise level of the political clap-trap and static was the general realization, at last, that remedial legislation is imperative. Secretary Hoover can carry on, even with the co-operation and patience of those most affected, for but a short time longer unless he has the stamp of authority behind his necessary assumption of responsibility.

Sufficient study has now been given to the subject of radio legislation so that a suitable law, based upon the best features of the White bill as passed by the House and of the Dill bill as passed by the Senate, may be passed by both houses.

THE improvements in the tone quality and volume obtained from a radio receiver, are the result of a game of see-saw between the designers of audio frequency amplifiers on the one side and the designers of loudspeakers on the other. In the early days of radio telephone reception the quality was limited by the tone range obtainable from audio frequency transformers, hitherto used for the reception of telegraph code by means of a pair of head-phones. The high and low tones of the musical scale were cut off and only the middle register was heard. When better transformers were designed to meet the needs of the early broadcast listeners they began to show up the limitations of the loudspeakers then available.

As loudspeakers were improved, particularly in the shape of the horns used, resistance and impedance coupled amplifiers were developed to deliver a distortionless output. In turn, the cone type of speaker appeared on the market, covering a greater tone range than normally obtainable with a horn. Then the transformer manufacturers began to use permalloy or more iron in their cores and the tube manufacturers developed various power tubes to give greater undistorted volume.

These last improvements have again taxed the capacity of the speakers so that the next move in this see-saw is due from the loudspeaker makers. Parenthetically, mention should also be made of a corresponding advance in the quality and likewise in the power of the transmitting stations. No longer can an organist be accused of not using his foot-pedals or a drummer of being asleep.

Two directions are immediately open for this improvement of loudspeakers. The first is along the lines of perfecting a more compact horn which will not be unduly resonant at one or more audio frequencies, an accomplishment which is illustrated in the tone chamber of the new phonographs. The second, and possibly the more fruitful, is in the development of telephone units whose impedance is designed for use with specified vacuum tubes.

It is a generally accepted fact that the greatest power can be delivered from a tube to a loudspeaker when the impedance of the speaker is equal to or slightly greater than that of the tube. Theoretically the load should be double the tube impedance to give maximum *undistorted* power. As the volume of sound coming from a speaker is proportional to the amount of power delivered to it, it is evident that louder, undistorted music can be secured by matching the loudspeaker to the particular tube used in the last stage of audio frequency amplification.

As the tube manufacturers publish the average impedances of their product this would be a comparatively simple matter were it not for the fact that, as far as we are aware, no loudspeaker manufacturer does likewise. Nor is there any simple and easy method for the average user to determine the impedance experimentally.

Furthermore the impedance depends upon the frequency, being relatively low for the low notes in the musical scale and high for the high notes. Consequently in practice it is best to use a loudspeaker impedance, for the lowest note desired, equal to that of the tube. The higher impedance for the higher notes will take care of itself.

A long series of tests by manufacturers have shown that the maximum undistorted power delivered by a '99 tube whose plate impedance is 16.500 ohms is to a load of 38,000 ohms, by an "A" tube with an impedance of 11,000 ohms to a load of 22,000 ohms, by a "120" or "220" with an impedance of 6,600 ohms to a load of 7,000 ohms, by a "112" with an impedance of 4,800 ohms to an impedance of 11,000 ohms, and by a "171" or "371," impedance 2,100 ohms, to a load of 4,000 ohms. The "171" or "371" is capable of delivering .75 watt under the best conditions, which is about one hundred times as much power as is delivered by the '99 tube at normal plate and grid voltage. This power tube delivers about fifteen times as much power as an "A" tube and about six times as much as the other two power tubes. The amount of power decreases very rapidly as the load impedance is decreased, but only slowly as it is increased above the best values.

These facts emphasize the importance of matching the loudspeaker to the tube whenever optimum results are desired. But before this can be done by the average radio user, either the impedance values of the various loudspeakers must be announced by the manufacturers or statements must be made as to which type of tube the speaker is best adapted. Most experimenters would welcome the former method as a distinct advance in loudspeakers. Otherwise much of the fine data available on tube characteristics is valueless.

An Automatic Multi-Channel Radio Receiver

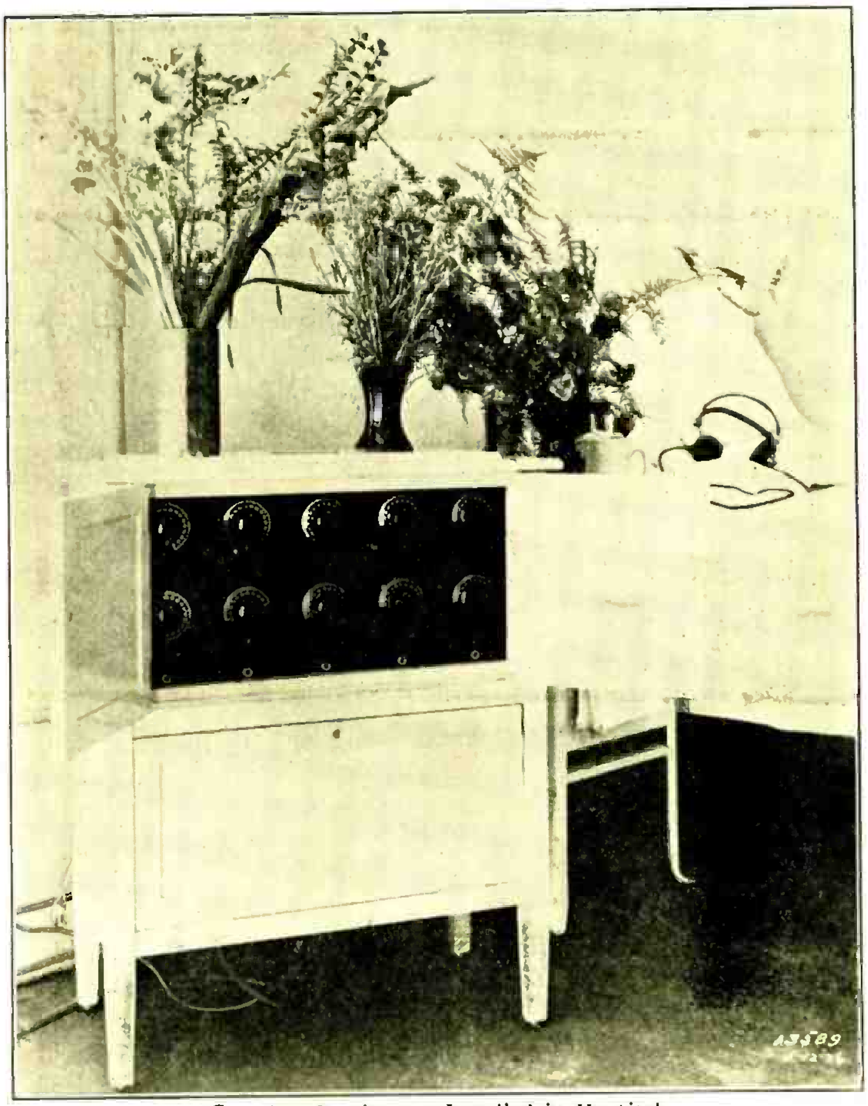
A Unit Developed for Use in Hospitals or Apartment Houses Where a Single Antenna Operates Several Receivers

By Ralph Wight

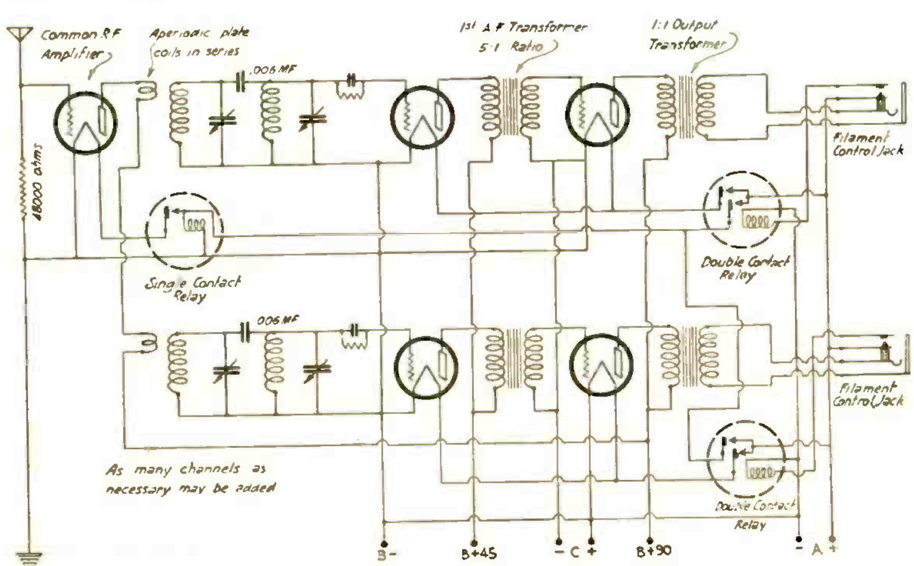
QUITE often, as in the cases of hospitals and sanitariums, there arises the desirability of operating several radio receivers from one antenna and several pairs of headphones from each receiver. To meet this condition, the radio receiver described here has been developed by the Southern California Edison Company for use in the Edison Ward of the Roosevelt Hospital at Los Angeles.

In this particular receiver, five different stations may be selected by the listener by merely inserting a phone plug in the proper jack and as many as seventeen may listen. All may listen to the same station or the number may be divided up among five stations, depending upon the individual program tastes of the listeners.

As will be seen from the circuit diagram, the coupling of the different channels to the single antenna is accomplished by means of a single stage untuned radio frequency amplifier which is common to all channels. Little amplification is expected from this tube, as its primary object is the coupling of all circuits to one antenna. It is, therefore, necessarily untuned. This common amplifier or coupler tube furnishes coupling to the various detectors through aperiodic plate coils, all of which are in series. These plate coils form the primary winding of an intermediate circuit which is tuned to the desired station. This intermediate circuit is then capacity coupled to the tuned grid of the detectors. One stage of audio amplification is added in this receiver, but should more headsets be used, it is quite probable that more output would be required.



Complete Receiver as Installed in Hospital.



Circuit Diagram of Automatic Multi-Channel Receiver.

The operation of the set is entirely automatic. Once the different stations are tuned in on the various channels, they remain set. A jack strip is provided at each bed with a filament control jack for each channel. Inserting a plug in any jack operates a relay which closes the filament circuit of the two tubes on that channel and also operates another relay which closes the filament of the common coupler tube.

Seventeen jack strips of six jacks each are used in this installation. The headphones are in series through jacks which leave the circuit closed when the plug is removed. The filament control contacts are all in parallel. Connections from the receiver to the jack strips are made by a small telephone cable.

From the above it will be seen that plugging in on any channel lights only the necessary tubes and the removal of

(*Continued on Page* 53)

Some Notes On Television

With Description and Illustration of First Crude Results Secured by Means of the Baird Televisor

By H. de A. Donisthorpe

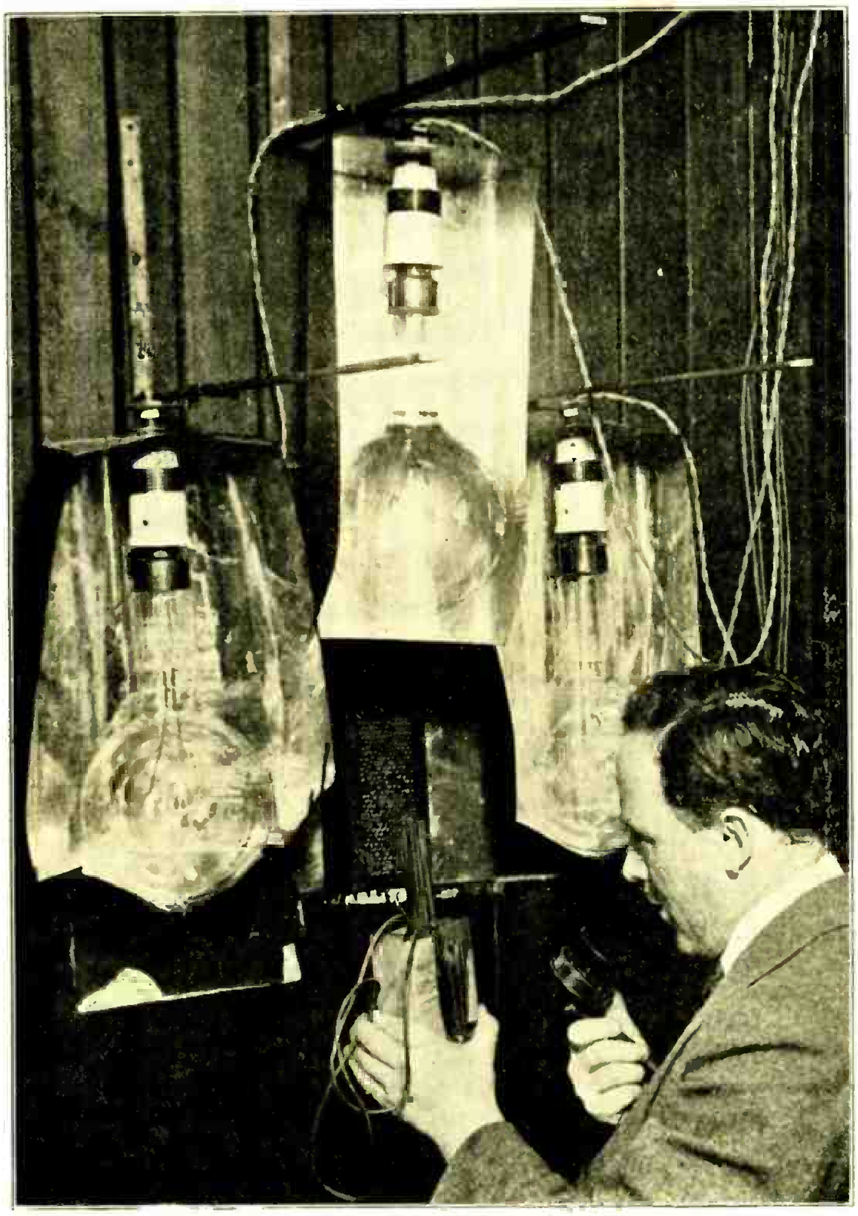


Fig. 2. Transmitting End of Television Equipment.

CONSIDERABLE interest has been shown towards "television," this possibility being enhanced by the ever improving results obtained with the transmission of photographs by land-line or radio. However, it must not be understood that there is any connection between "television," and "photo-telegraphy." Confusion between the functions of these two applications of optics can best be avoided by studying the definition for "television" as taken from a certain Patent Office's dictionary.

"Television apparatus is that capable of transmitting instantaneously to a distance, images of views or objects by telegraphy, or radio." In other words television is seeing at a distance by telegraphy.

Of course in the transmission of photographs there is only the sending of a still picture, such as the photograph of any object, by means of a prepared film, or plate, and there is generally a marked time period required to complete the transmission, which in the case of the transatlantic radio photographs is 25 minutes, and in wire transmission it is 6 minutes.

For the sake of clearness we will first consider the problem of radio broadcasting, since in principle it is similar to the television practice. Here we have sound waves impinging on a microphone where they are converted into electrical oscillations, which is turn modulate the radio waves, which are being radiated from an aerial. These modulated waves, at the receiving station, are converted back into sound waves by the vibrations of the diaphragm of the loudspeaker or telephones, caused by the received electrical impulses.

In the case of television it is only necessary for light waves to be converted into electrical impulses for success to be achieved. However, with light waves we are dealing with vibrations of such high frequencies that what at the outset appears to be a simple task becomes one of considerable difficulty.

The problem of finding an instrument that will correspond to the microphone of the broadcasting station is no easy one, and science has only recently come to the aid of the television experimenters with the evolution of the photo-electric cell. With the discovery of the light sensitive properties of the element selenium many optimistic inventors considered

Fig. 1. Original Picture and Image as Received with Televisor.

that television was within their grasp, but they had quite overrated the capabilities of selenium to respond to the immense speeds of the signalling involved.

The general principle of television, without going into complexities, may be briefly described in the following words: An image of the object to be transmitted is caused to traverse the light sensitive cell. This cell in turn modulates an electric current, which impulses become strong at the high light spots of the image and weak at the shadows.

At the receiving end the modulated current, which may have come over a land-line system, or on the carrier wave of a radio telegraph, controls a source of light traversing a ground glass screen in exact synchronism with the image at the transmitter.

the very early day results of that older science.

Fig. 1 shows two pictures, the left hand side one being reproduced from an ordinary photograph whilst that on the right is a reproduction of the image produced at the receiving end of the Baird televisor.

Television, like radio broadcasting, is liable to electrical distortions. Just as the music from a loudspeaker may become distorted if the apparatus is incorrectly adjusted so may the images of the televisor become unrecognizable. The effect of distortion in the televisor is quite extraordinary in its results, and the human face may have the nose flattened out, or one side of the chin may be higher than the other. The twisted image so produced is not unlike that obtained by standing in front of a concave mirror.

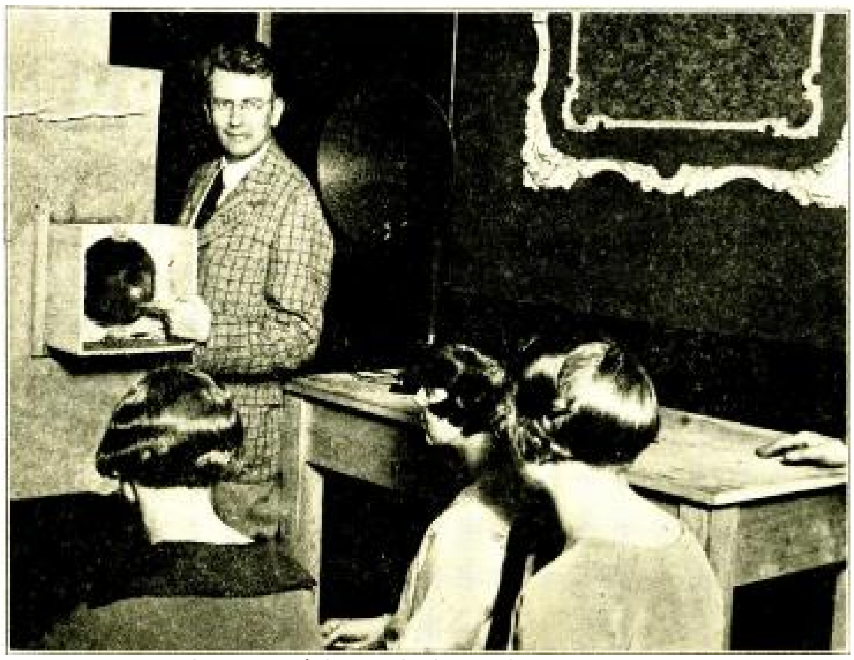


Fig. 3. Receiving End of Television Equipment.

The receiving process is carried out at a tremendous speed, the complete traversal of the screen occupying one-tenth of a second, so that due to the retentivity of the human eye the built up image is seen as a complete image instantaneously by the observer. But for this phenomenon of retention, television, like the cinematograph, could not be accomplished.

The exponent of this new art in England is a young Scotchman, Baird by name, who has evolved an apparatus which at present is capable of transmitting either by land line or radio, the likeness of the human face so that it is possible to recognize it out of a series of received images. At the outset Mr. Baird was only able to transmit shadows which was only a step towards his ultimate aim.

The present instrument, however, can transmit an image of the living human face with light graduations and all the movements faithfully reproduced, and whilst the results cannot be compared with those of modern day cinematography they are at least comparable with

The television apparatus, however, is easy to adjust and the distortion can be remedied in a manner easier than in the case of the loudspeaker circuit, as each effect can be seen with the eye which is a more reliable measuring instrument than the ear.

Electrical interference, such as experienced on a radio receiver with static, is also noticeable on the television apparatus. Here again the effect is a strange one, and the static appears at the receiver as a small snow storm with whirling white flakes passing across the screen. Perhaps, however, this interference is less annoying than the jarring discord experienced with the radio receiver during bad atmospherical conditions.

The author, who has seen the Baird apparatus in operation, cannot but express the opinion that television even today is far from perfection and could not be put to commercial use yet. The results, however, are indeed wonderful and undoubtedly it is only a matter of time before the apparatus will be perfected. Perhaps the present ideas will be modified, and a new method of converting the light waves into electrical impulses may be employed in the final apparatus.

REVIVING THORIATED TUNGSTEN FILAMENTS

The thoriated filament of an improperly used vacuum tube loses its power of emitting electrons and becomes insensitive as a radio amplifier or detector. While this power can be restored by reactivation, as herein described, the fact should not be overlooked that the tube is designed to deliver full efficiency throughout its normal life, provided that it is operated at its normal *A* and *B* voltages. Tests in the laboratory of E. T. Cunningham, Inc., from whom these data were obtained, show that the mutual conductance of a properly operated tube is unchanged during 1500 hours, which approximate two years of average service.

Consequently before giving the details of how tubes may be revived, it is important to emphasize how this necessity may be avoided. The best proof that tubes are being overloaded is the necessity of reactivating them frequently. The increased life and satisfaction obtainable when rated voltages are used, together with the saving in battery current, justifies the use of a filament voltmeter, especially in the case of the 299 and 220 types when the filament voltage should not exceed 3.3 volts.

Aside from the invariable practice of not burning the filament above its rated voltage, another important precaution is not to use high *B* battery voltage unless *C* batteries are provided. Without *C* battery, 67½ volts *B* battery is the maximum safe voltage for 299 and 301A tubes. Care should be taken against reversing *A* or *C* battery connections and against using an insensitive tube with a good one, thus avoiding the natural tendency to overload the tube so as to secure more volume.

Tubes which have internal shorts between elements or in which the vacuum is impaired cannot be reactivated. The former condition may be tested in an unlighted tube by means of a pair of phones and a dry cell; the unlighted tube should show a closed circuit through the filament and an open circuit between the grid and all other elements and between the plate and all other elements. The latter condition is usually indicated by the fact that the filament will not light until the filament voltage is raised above normal, in which case the filament may burn out. Tubes such as the C-11, CX-12, CX-112 and CX-300, which do not use the thoriated tungsten filament, cannot be reactivated.

The emission of tubes which have been only slightly overloaded may be restored by burning them at a slight over voltage on the filament for an hour after

(Continued on Page 52)

The Infradyne

A New and Efficient Ten-Tube Circuit Employing Three Stages of Intermediate Frequency Amplification at 3200 Kilocycles

By E. M. Sargent

WHEN an incoming radio frequency current is mixed in a circuit with a locally generated oscillating current two new frequencies are generated. One, the beat or *difference* frequency, is used in the superheterodyne. The other, the *sum* frequency, is employed in the infradyne so as to get greater distance, better selectivity, and quieter amplification than the writer has secured with any other circuit during his fifteen years' experience in radio construction.

The use of the *sum* frequency has been neglected because of the general belief that this extremely high frequency of 3,200,000 cycles cannot be efficiently amplified. But after building and discarding nearly five hundred models Mr. L. C. Rayment and the writer finally found the means whereby practically the same degree of amplification can be produced at any frequency. The same principles as are used in the infradyne amplifier will eventually be applied to 80, 40, 20 and 5 meter reception.

A receiving set using this *sum* frequency amplifier has the advantages of eliminating arc "mush" or harmonics of double or treble a station's wavelength and in using but one oscillator setting for each station. As the intermediate amplifier is sharply peaked at one wavelength and is very inefficient at any other, noises from the radio frequency tubes are not amplified. Since iron core transformers are not needed to secure r.f. amplification the cost of construction is reduced and any "freaks" due to the peculiarities of the iron are eliminated. Finally the intermediate frequency employed may be used universally, being independent of the overlapping frequencies of local stations.

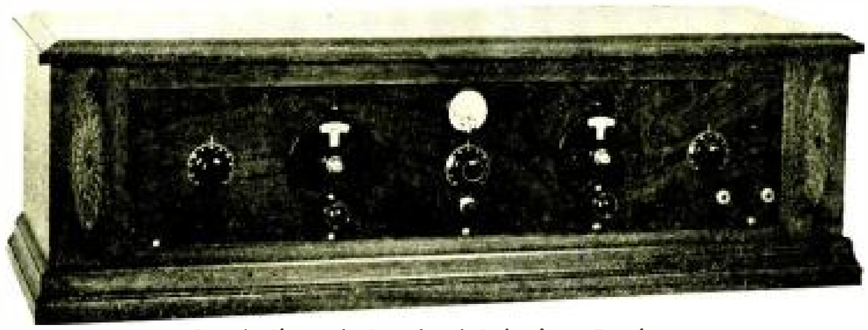
LIST OF PARTS USED BY WRITER

1 Remler Infradyne Amplifier.
1 Continental triple vernier condenser.
1 Remler .00035 condenser.
1 Tapped inductance (see text for constructional details).
1 Gen. Radio No. 301 30 ohm rheostat.
1 Set No. 33 Thorola Doughnuts.
2 National Type B CCW Dials.
7 Benjamin UX Sockets.
1 112 Amperite.
2 1-A Amperites.
1 6V-199 Amperite.
1 30 ohm U. S. L. Rheostat.
1 10 ohm U. S. L. Rheostat.
1 Centralab 50.000 ohm Radiohm.
3 2-in. rheostat dials.
1 Yaxley Filament switch.
1 single closed Electrad jack.
1 single open jack.
1 Jewell No. 135 0-5 D. C. voltmeter.
1 Electrad grid leak mounting.
1 Electrad fixed Condenser mounting.
1 1-megohm Electrad Fused Metallic Leak or Arthur H. Lynch fixed Resistor.
1 2-megohm Electrad Fused Metallic Leak or Arthur H. Lynch fixed Resistor.
1 Electrad .0001 mfd. condenser.
2 Electrad 1 mfd. condensers.
2 Sangamo .0035 condensers, 1 with clips.
1 Electrad .00025 condenser.
Eby binding posts.
1 Formica Walnut panel 3/16x7x30, redwood baseboard ¾x10x34.
2 Amertran De Luxe Transformers.

The infradyne set uses ten tubes, an oscillator, two stages of r.f. amplification, first detector or mixer, three stages of 95 meter amplification, second detector or de-modulator, and two stages of audio frequency amplification. It has two tuning controls, one dial operating a triple condenser to tune the two r.f. stages and another the oscillator tuning condenser. Since the *sum* frequency is used the capacity of one condenser increases while that of the other decreases, thus requiring condensers that turn in opposite directions so that the dials may read in the same direction.

Except for the infradyne amplifier, whose connections and constructional details are given at the close of this article, the circuit arrangement is simple, as shown in Fig. 1. But in order to insure a duplication of the good results secured by the writer it is essential to follow the placement of parts indicated in the baseboard layout of Fig. 2 and the panel layout of Fig. 3.

The importance of following exactly the layout cannot be over-emphasized. A common failing among both amateur and professional set builders is to pay too much attention to wiring diagrams and too little to the layout of the ap-



Panel View of Completed Infradyne Receiver.

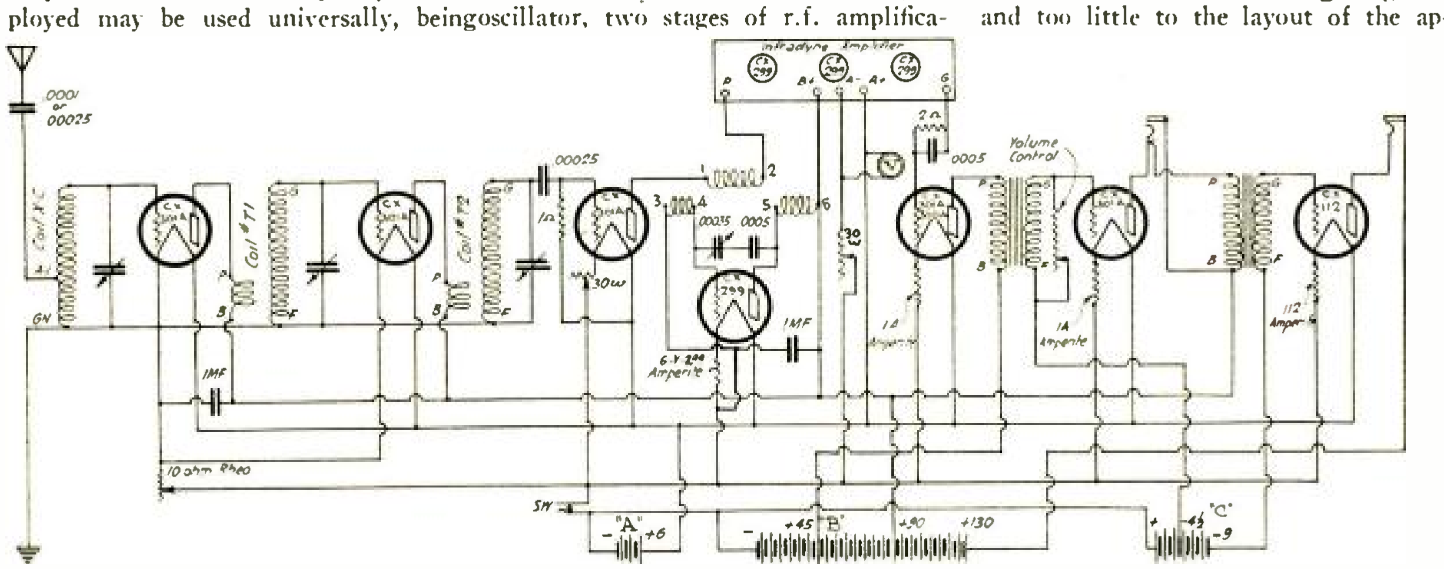
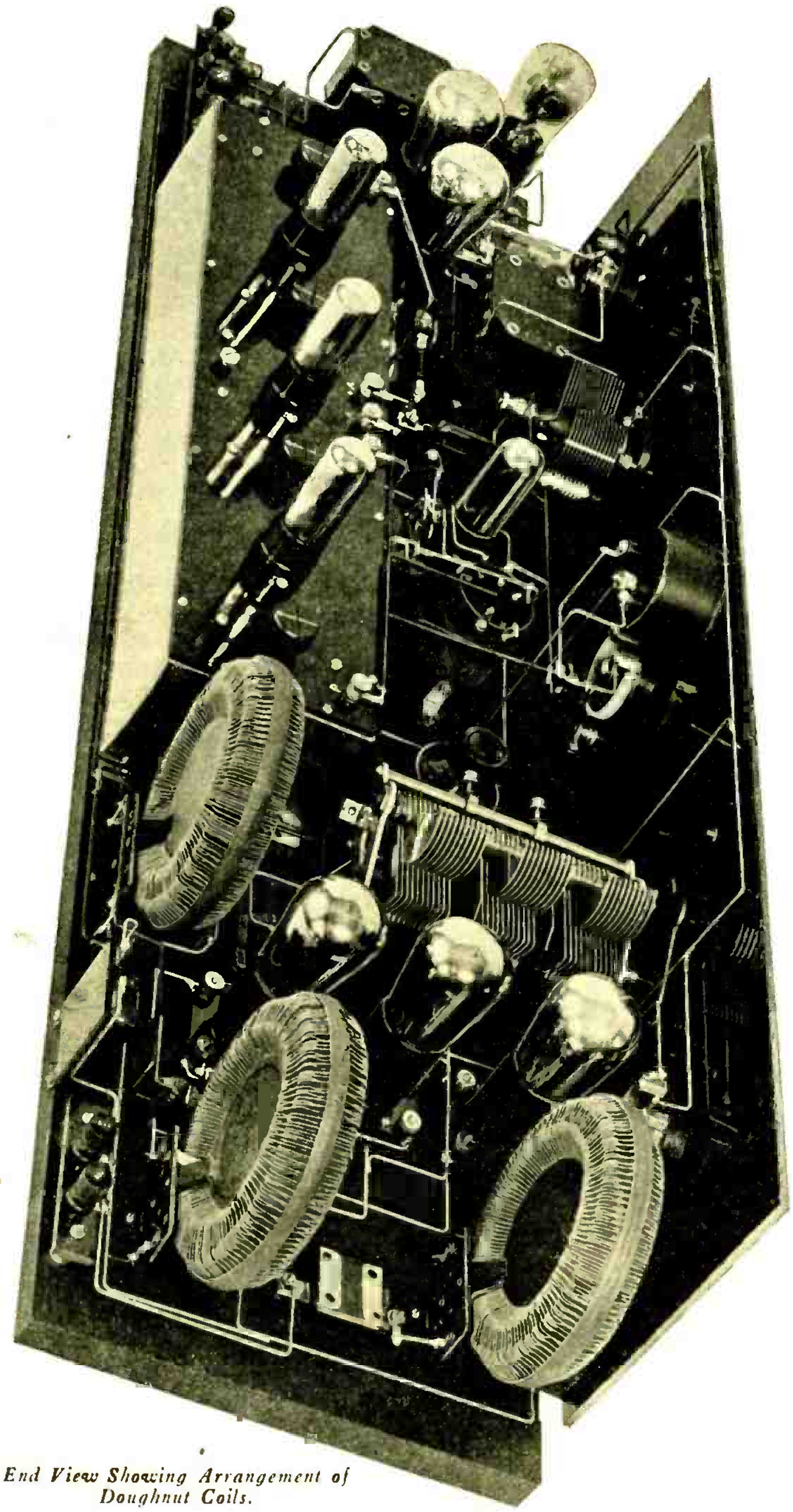


Fig. 1. Circuit Diagram of Infradyne Receiver. (*Correction: 6V-299 should be 6V-199*).



End View Showing Arrangement of Doughnut Coils.

paratus. A wiring diagram would be sufficient if the radio currents really travelled only in the paths in which we are accustomed to think of them as travelling, but we all know that they take short cuts via stray inductive and capacitive fields. The writer has made a detailed study of these fields insofar as they affect the set here described, and the layout is the result of this study. It would not be an exaggeration to say that with the same parts and hookup, but with a different arrangement, it would be a different set entirely and might exhibit several annoying freaks. This is true not only of the infradyne but of the super-heterodyne, the neutrodyne, or any other multi-tube set.

Another thing; do not try to put the infradyne in your phonograph or in a suitcase. Borrow a leaf from the book of Zenith, Kellogg, Stromberg-Carlson or any of the others who have found that a multi-tube radio set has to contain a certain number of cubic inches of space in order to give good results. Make your infradyne large enough to give it a chance to produce the results of which it is capable.

The two National dials included in the list of parts are specified because of instructions given later for setting this dial in relation to the condenser position. Any other dial that reads in the same direction can be used if the panel drilling is changed to suit. The Thorola toroid coils have been used throughout all our experiments and seem to line up perfectly with the Continental condenser. No doubt there are other toroids that will also work, but not having tested any others the writer is not in a position to name any alternates. It is important that toroid type coils be used, however, as neutrodyne type coils will not give the same selectivity.

The tapped inductance can be very easily constructed by the builder. It consists of three coils wound on a piece of bakelite tubing 1½ in. in diameter and 2 in. long, as shown in Fig. 4. These coils are of 14, 14, and 8 turns respectively and are all wound with the same direction with No. 24 d.s.c. wire. There should be a space of 1/16 in. between the two 14 turn coils and of 3/16 in. between the 14 and 8 turn coil. Commencing with the 8 turn coil the terminals should be num-

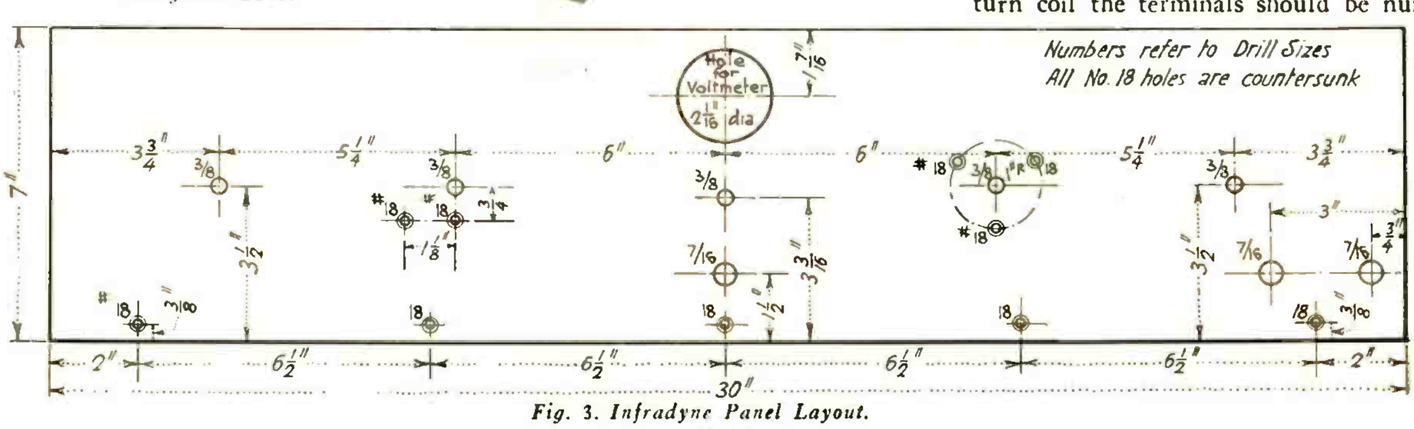


Fig. 3. Infradyne Panel Layout.

bered from 1 to 6 as shown in the sketch of Fig. 4, *1* being the outside and *2* the inside terminal of the 8 turn coil, *3* the terminal of the 14 turn coil nearest the 8 turn coil and *4* the other end of this 14 turn coil, *5* the inside terminal of the second 14 turn coil and *6* the outside terminal of this coil.

These numbers correspond to those used in the wiring diagram. To insure operation of the set these directions for coil winding should be followed exactly,

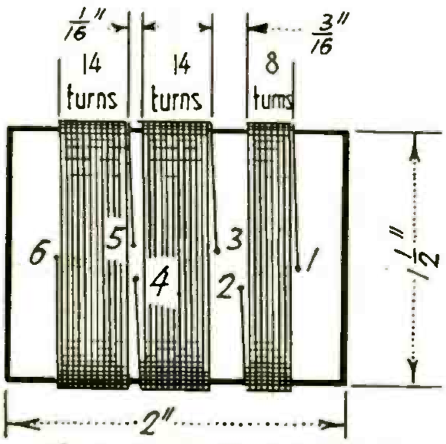


Fig. 4. Constructional Details of Tapped Inductance.

particularly as regards their all being wound in the same direction. This tapped inductance should be mounted in the position of the oscillator coupler as shown in the baseboard layout, Fig. 2.

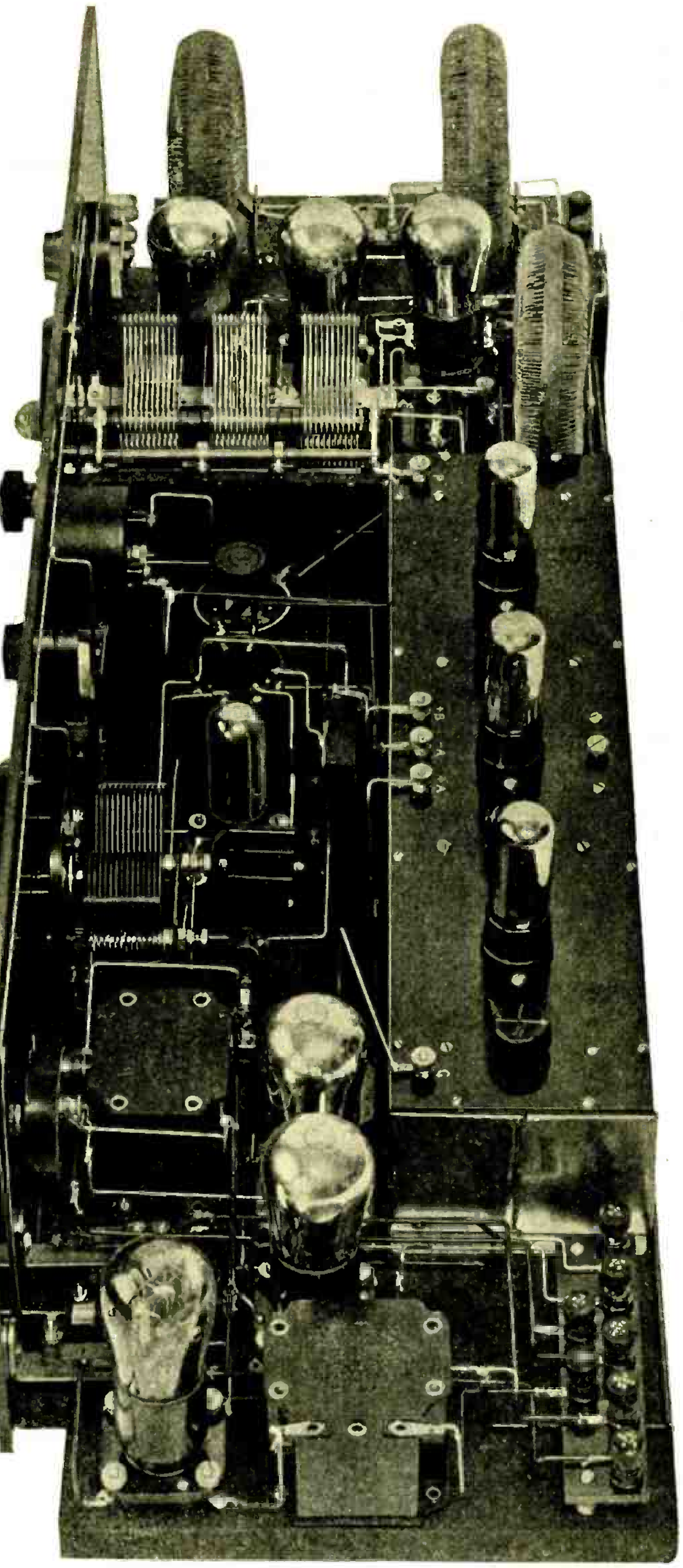
Although the drawings are in the main self-explanatory, there are several minor details in regard to building up the set which should be mentioned. No shielding is desirable or necessary. The arrangement of the parts and wiring is such that there is no tendency toward body capacity.

Do not use rosin core solder if you wish to avoid the possibility of making any "rosin joints." Run the plate lead of the first detector and the grid lead of the second detector as directly as possible. On the binding post strip there are no posts for $+C$ or $-B$. These were left off to make more room for the others and to make possible the use of a Jones battery cable and plug instead of binding posts if desired. The $+C$, $-B$, and $-A$ should all be connected to the $-A$ post.

The bypass has purposely been left off the primary of the first audio transformer as the set operates a little smoother without it. If one is used it should not exceed .0001 mfd.

Operating Directions

AFTER the circuit has been checked over carefully, insert the tubes in their proper sockets and connect up the *A* battery. Turn on the filament switch and advance all rheostats enough to see that the tubes light. Examine the Amperites to see that they are all in their right places and that none are burned out. Everything being in good order so far, leave the set turned on and the



Rear View of Infradyne Receiver.

$-A$ connected, disconnect the $+A$ wire and touch it in turn to the 45, 90, and 135 volt posts, meanwhile carefully watching to see whether any tubes light. This is a test to see whether any *A* and *B* wires have been unintentionally crossed.

Next, turn both the three-gang condenser and the oscillator condenser so that the plates are fully meshed. Set the triple condenser dial at 100, and the oscillator dial at 12°. Then turn both to about 60. Turn the four vernier knobs on the infradyne amplifier to the marks where they were "lined up" at the factory. Turn the adjusting screw on the amplifier so that it is almost all the way out.

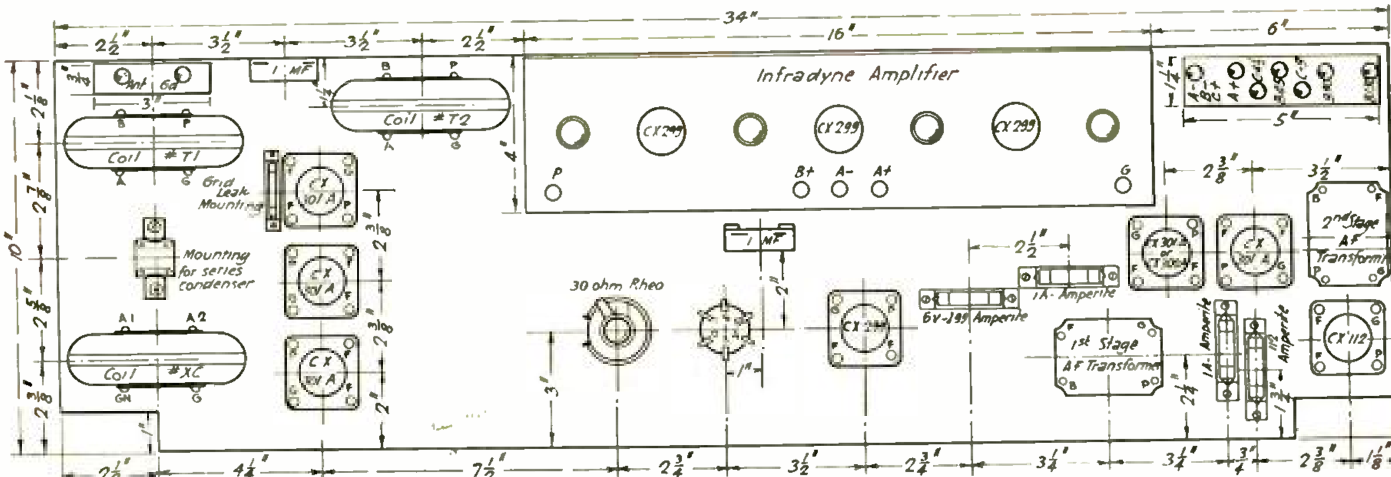


Fig. 2. Baseboard Layout for Infradyne.

The set is now ready to operate. Connect the antenna, about 50 ft. long, and a good ground and hook up the batteries. Turn the first detector rheostat (on baseboard) all the way on, turn rheostat on first two tubes (left hand one on panel) to about 30, turn intermediate tubes up to 3 volts, and leave the volume control at 0. Plug the loudspeaker in the second stage. The set is now tuned to about 315 meters and if there are any local stations near that wavelength they can easily be found by moving the dials slightly. Tune the set exactly like a super-heterodyne, that is, "cross" the dials continually using both hands to tune with. The dials will run almost together over the full scale. The rheostat on the first two tubes is best operated rather low and is used as a regenerative control, care being taken not to throw the tubes into oscillation.

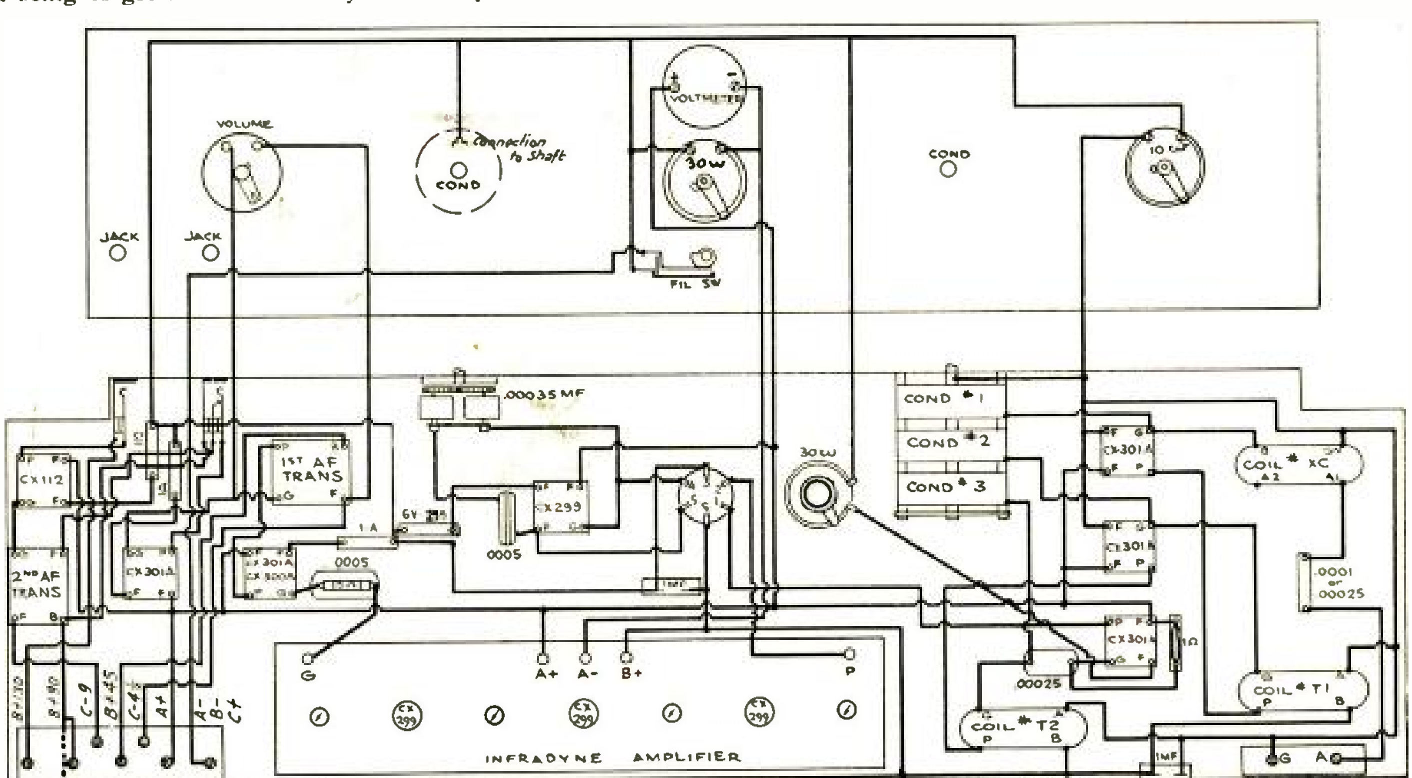
With the set adjusted as above, tune in and log a few locals, then try to find some station about 150 miles away, the idea being to get some moderately weak station for a test signal on which to further line up the set. When such a station has been found, set the two main tuning dials and leave them, and try a slight readjustment on the vernier knobs on the amplifier unit. The first three will probably be best at their original settings but the right hand one may differ some on account of different detector wiring. After the best setting on the verniers has been found, tighten up the adjusting screw on the amplifier with a screwdriver. Do this slowly, as this is the adjustment (with the filaments at 3 volts) that brings the amplifier up to the peak. Tighten this screw until the amplifier breaks into oscillation, then back it away again until the oscillation stops, and leave it there. That finishes the adjustment of the intermediate amplifier, and once adjusted it should not be disturbed again.

The rheostat on the baseboard should now be slowly backed down, the signal strength being carefully noted during the operation. As the rheostat is turned down the signal will decrease until a point is reached where it will rapidly increase again. Passing this point will sometimes throw the tube into oscillation, but will usually only result in another decrease in strength. The rheostat should be left in a non-critical adjustment near this amplification peak. If the peak cannot be found, turn the rheostat all the way on and leave it there.

Next is the lining up of the "front end." This is very important, and upon the care with which it is done will greatly depend the selectivity of the set. To start with, adjust both sliding vernier plates on the triple condenser so that they are in the half way position. Then turn up the panel rheostat to get good volume and tune in some moderately loud station, preferably not a local, and at about 60 or 70 degrees on the dials. Set the oscillator dial right on the station and leave it there.

Swing the triple condenser slowly

(*Continued on Page 46*)



Pictorial Diagram of Connections. (Correction: 6V-299 should be 6V-199).

Servicing the Receiver

Detailed Suggestions for the Procedure to be Followed by the Radio Trouble Shooter

By E. F. Kiernan

SYSTEM is the keynote for the radio repairman. Irrespective of whether the troubleshooter assails one set or a hundred, he should map out his procedure before lifting the cover of a set.

To begin with, a tool-kit is necessary, even though it be but a single battered pair of pliers. However, pliers in a variety of types are found in a well appointed kit. Side-cutters that really cut are a necessity; diagonals for reaching tight corners will save much time and temper; long-nosed reach that vagrant nut; while the special types may be had to form eyes on bus-bar, etc. A set of socket wrenches, spintites, including one for knurled nuts, is a great time saver and, incidentally, doesn't damage the nuts. A knife is useful for innumerable purposes from de-insulating wire to reaming out a hole in a panel.

Screwdrivers should range from a fairly large one about ten inches long with a blade ¼ in. wide, down through three or four sizes to a blade ⅛ in. wide to catch the small set-screws, etc. One long slim-bladed driver with a 3/16 in. blade 12 or 15 in. long is very handy to reach in amongst a litter of wires, coils, and parts.

The soldering iron should be a good one; beware of brass tips as they corrode easily and will not remain tinned. One with removable tips in a variety of shapes is quite handy. A half-pound ball peen hammer is about right, also a center-punch to go with it. Files are very necessary at times, and variety is desirable including: rat-tail, square, half-round, and flat mill. The 8 in. length is OK. For those who can afford them, a set of needle files is a luxury but often pay for themselves at a single sitting.

For a hand-drill, the equivalent of a Millers Falls No. 5 is good, provided an auxiliary chuck fitted with a handle, to take drills larger than number four, is secured also. To match the hand-drill, a set of twist-drills numbering from 1 to 60 plus a ¼, 5/16, and ⅜ in. fills the bill. A 4-in. taper reamer running from ⅛ to ½ in. with the shank, if square, ground round, helps bridge the gaps in the drill set. End-wrenches to fit 8-32, 6-32, and as many adjacent sizes as the purse will permit prove extremely valuable in places where the socket wrenches cannot be used. They should be thin, and can be made from 1/16 by ½ in. tool steel with the aid of a sharp mill file. Tempering will increase the wearing qualities.

A machinists' vice with 3 in. jaws is large enough for most needs. Some sort of a measuring device should be had; a 12-in. combination steel square is very good, but is expensive. By grinding the point of a 6-in. three-cornered file to needle sharpness and fitting a handle to the other end, a durable scriber can be made that is constantly useful. So much for tools proper; of course the list may be extended indefinitely, to the bottom of the pocketbook.

Testing equipment may be bought outright or improvised. Voltmeters and ammeters are easily obtained specially made for radio purposes; they have one drawback, i.e., the price. However, a collection of auto headlight bulbs and a 25-watt 110-volt house lamp may be substituted for meters. By calibrating the lamps in terms of brilliancy from known values, a fairly accurate knowledge of a battery's condition can be gained by testing with a lamp of the proper voltage. Then again, small pocket meters reading up to 50 volts may be had for a dollar or less. For testing open circuits and shorts, a 75-ohm pony receiver and a dry cell will do. When it comes to testing tubes, grid leaks, condenser capacities, etc., the cheapest way is to have a set of duplicates, and substitute. Tube testers, ohmmeters, and wheatstone bridges come pretty high. A headset with quick detachable plug should be provided also.

With our tools and equipment at hand let us suppose we are turned loose on a set. What ails it? no one knows; it simply don't work. If it is on location, that is, installed and at one time in operation at some point, we first expose the interior of the set, by raising the cover of the cabinet, taking off the back, or whatever operation is necessary. The *A* battery circuit is then closed and the temperature of the tube filaments observed. A little experience will soon enable the observer to judge as to whether or not the *A* battery is up. If the tubes fail to burn at normal brilliancy with all the variable resistance in the circuit cut out, the *A* battery should be looked to and tested; storage cells with a hydrometer, dry cells with a meter or lamp. When the *A* battery is OK and the tubes don't light normally, there is just one thing to look for i.e., too much resistance in the connections between battery and tubes. Some likely places to inspect are: the leads from the battery to the set (the wire may be too small for the load), the clips that make the connection on acid batteries, rheostat arms and resistance elements, corrosion at soldered joints, loose contacts in sockets, and pins in tube bases. See that the polarity is correct.

The *B* batteries come next. The

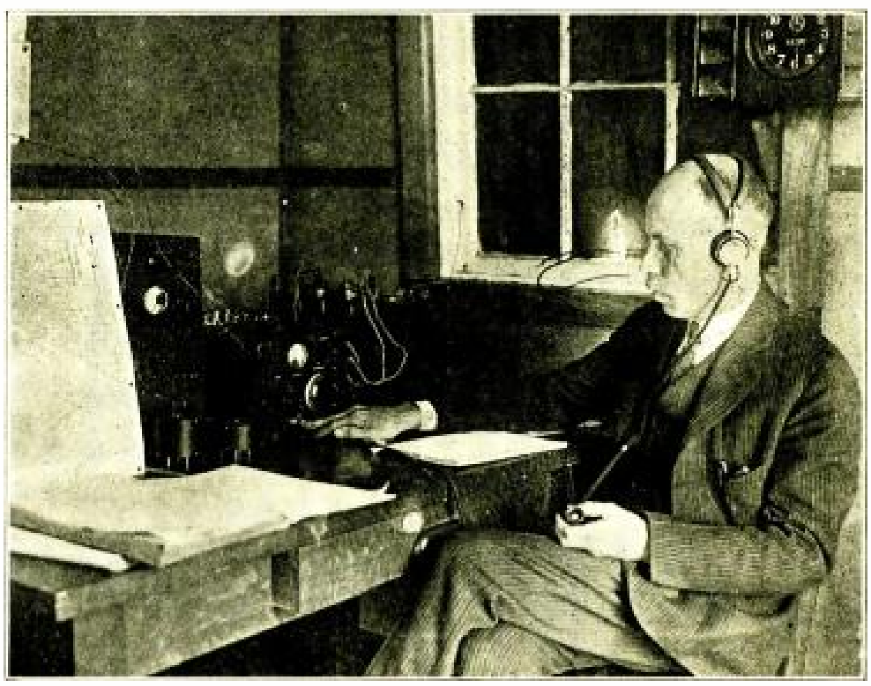


PHOTO BY UNDERWOOD & UNDERWOOD

Dr. A. Hoyt Taylor, of the Naval Research Laboratory, who supervised tests between 8000 and 27,000 kilocycles from the U. S. S. "Memphis," Call NISS, during a recent transAtlantic Trip. Many U. S., Australian and New Zealand amateurs were worked and much data secured on High Frequency Radio Phenomena.

blocks should be tested for voltage and the connections checked. Disconnect the loudspeaker (assuming there is one) and connect the headset in its place. Note that the antenna and ground connections are tight.

The headphones are then draped somewhere near the ears, not too near, and the set tested for signals. If no local broadcaster or other transmitters are on, a buzzer will supply plenty of noise from a bell-ringing transformer, providing the locality is wired for a.c. A great deal can be learned from what comes, or fails to come, out of the phones. When the set is provided with jacks, the phones are first inserted in the plate circuit of the detector tube. In the case of a regenerative receiver the wetted end of a finger touched to the grid terminal of the detector tube will produce a click in the phones and a second click when the finger is removed, if the tube is oscillating. The second click will be absent if the tube is not in oscillation. If no sound comes from the phones as they are connected to the set, either the *B* supply is shorted, or the plate circuit is open. By disconnecting one lead from the *B* supply and snapping it against the terminal, a spark will be noticed if the circuit is shorted.

Supposing we hear some kind of a noise in the phones, the controls on the receiver should now be manipulated in an endeavor to locate signals. If no response is obtained, the rotating tuning elements should be inspected while they are being handled. Note the alignment of condenser plates, the condition of pigtails or other leads to moving parts, the state of wired connections (especially soldered joints), and the absence of any needed setscrews, nuts, etc. A short circuit between condenser plates will generally be announced by a click in the phones. The short may occur between the pigtail connection to the rotor, and the stator plates. A careful going over, as above, will often reveal the defective condition. If the procedure thus far produces no results, the antenna and ground connections should be thoroughly inspected for open circuits, faulty joints, poor insulation, etc.

When the set is located within a few miles of a powerful transmitter, results will be obtained even though the antenna and ground are not in A-1 shape. This is not the case when the location is several hundred miles from a station. The conditions of location, type of set, etc., should govern the care with which the *A* and *G* should be gone over. Plug attachments, which screw into the light socket, are used on some receivers to replace the *A* and *G*. Better results are generally obtained if the plug is used as an antenna connection only, with the set grounded as usual.

The tubes remain to be examined. They should either be tested in a regular instrument for that purpose, any radio shop will do this gratis, or new tubes substituted. Of course, if upon first opening the set one or more of the tubes fail to light, it would be common sense to substitute new ones, after the filament circuit has been inspected and the proper voltage applied to it. It is very easy to slip up on connections, so it is very essential that the battery leads be checked carefully before new tubes are inserted and the circuit closed.

A point has now been reached where it will be necessary, provided the set still refuses to function, to disconnect the accessories, remove the "insides," and make an exhaustive test of each part until the faulty condition or part is located.

To begin with, a wiring diagram of the hook-up must be secured. If need be, one can be traced from the set itself; care is needed to make a clean-cut drawing that can easily be deciphered. Begin on the wiring and go over it thoroughly from the antenna circuit to the output terminals. Soldered joints, especially on bus-bar, should be examined closely and pressure applied in such a way as to test the solidity of the joint. Incidentally, it is quite a trick to make a dependable joint when the bus-bar is concerned.

In many instances one end of a length of bus-bar is soldered fast and the other sprung slightly to meet the other point of contact. The bar is held in place until the solder sets, and thus leaves the two joints under a continuous strain. Unless an unusually large amount of solder is used, one or the other joint will in time give way. Sometimes the fissure is too minute to be detected upon casual observation, therefore it is necessary to attempt to separate the joined parts in order to test the connection. solder cannot be relied upon for any great amount of mechanical strength. The annealed, round, tinned bus-bar is preferable to the hard drawn square bar. Many builders prefer the flexible insulated cable (sold under various trade names) or annealed solid copper wire covered with Spaghetti.

The sockets should be looked over to make sure the spring contacts have a good bearing on the tube prongs. Any superfluous chunks of solder or quantities of paste should be removed wherever found. The writer has on several occasions removed with a rag numerous spare grid leaks, thereby increasing the output of the receiver remarkably. The soldered connections made to those types of grid condensers that are not impregnated with bakelite should be made well up on the clips that support the leak. Otherwise the heat from the soldering iron often causes the paste flux to "crawl" all over the condenser, forming a leakage path varying from zero to ten megohms or so, in value.

Next comes an individual test of each coil, condenser, transformer, etc., for shorts and open circuits. The leads from the pony phone and dry cell may be fastened to two slim bladed screwdrivers which serve as the testing electrodes. Where a coil is shunted by a condenser it is necessary to break one of the leads joining the two. With the tubes out and the antenna, ground, batteries, and speaker disconnected, there is generally enough of the circuit missing to allow the parts to be tested without getting a "back circuit" through some other part of the set. However, when a part is apparently faulty it should be completely disconnected from the rest of the set and thoroughly tested before it is replaced by a new one.

When testing for breaks it is well to give first attention to audio transformers as the primary winding frequently burns out. Radio transformers having one winding over the other with a thin layer of insulating material between, may short where the leads from the outer winding come off to the terminals. The cotton or silk is never sufficient protection where the two wires cross, as pressure may squeeze the covering apart, allowing the conductors to touch.

Where rotor supports, tap terminals, etc., are located around one end of a coil tube, shorts between these points and the outer turn of the winding are often caused by pieces of solder, paste, or crowded conditions. These parts should be gone over carefully. The telephone jacks used on some receivers are fertile spots to look for shorts. Two of the leads may be touching at the rear of the jack where the soldering lugs are located. The presence of an abundance of soldering paste is sure to cause trouble as the insulation between the spring contacts is only about 1/16 in.

Supposing the defective part has been located; the next move is to replace it. This is sometimes a lengthy job and care is necessary to produce a satisfactory result. To facilitate the rejoining of the connections and other appendages which must be loosened in the process, it may be well to make a sketch locating and labeling the leads plainly. Another good way is to obtain a quantity of small price tags and put one on both sides of each break. The tags are numbered in duplicate. It would sometimes necessitate too long a delay, especially in the case of some factory built sets, to obtain duplicate parts. Standard equipment obtainable locally may be substituted, often with improved results, especially in the case of older types of receivers.

After the new part has been securely fastened in place, the leads may be fastened on, removing the tags as the connections are made. A careful checkup from the wiring diagram should precede the re-installation of accessories and a further tryout. Methodical procedure is the only way to avoid trouble.

The government of Jugo-Slavia will erect a high power broadcasting station near Agram. Belgrade has about 700 receiving sets.

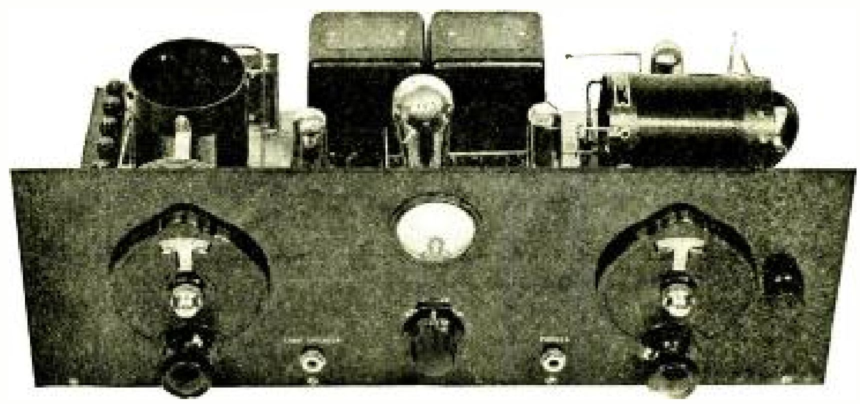
A Complete Socket Power Receiver

Constructional Details for an "A", "B" and "C" Battery Supplanter and For the Latest Type of Browning-Drake Receiver

By G. M. Best

THE ADVENT of improved apparatus, together with changes which greatly improve the operation of the *ABC* battery eliminator described in December 1925 and May 1926 RADIO, has resulted in the development of a hum-free *A* and *B* current supply unit capable of operating any type of receiver now in use with small tubes, and which will supply the necessary *C* biasing voltages for the grids of the tubes.

In designing the new power plant, as it will be called, the primary consideration was availability of apparatus, simplicity of assembly, and constancy of voltage output even with a considerable fluctuation of line supply voltage. No makeshift apparatus, or specially constructed parts will be necessary, and a factor of safety for the rectifier tubes of at least 50 per cent is included, so that the life of the rectifiers will be considerably longer than their normal rating. To accompany the power plant, and furnish the reader with plans for a complete up-to-date type of receiving set, operated without batteries, a Browning-Drake four-tube receiver has been constructed in RADIO's laboratory, and embodies the new and improved Browning-Drake coils and condensers, together with associated equipment of latest design and excellent performance.



Panel View of Browning-Drake Receiver.

The completed receiver is shown in the pictures, and a complete description of how it may be assembled will be given after a theoretical discussion of the power plant. Fig. 1 is a schematic wiring diagram of the receiver and power plant, the dotted line representing the dividing line between the two units, which are assembled separately and connected together by a flexible cable.

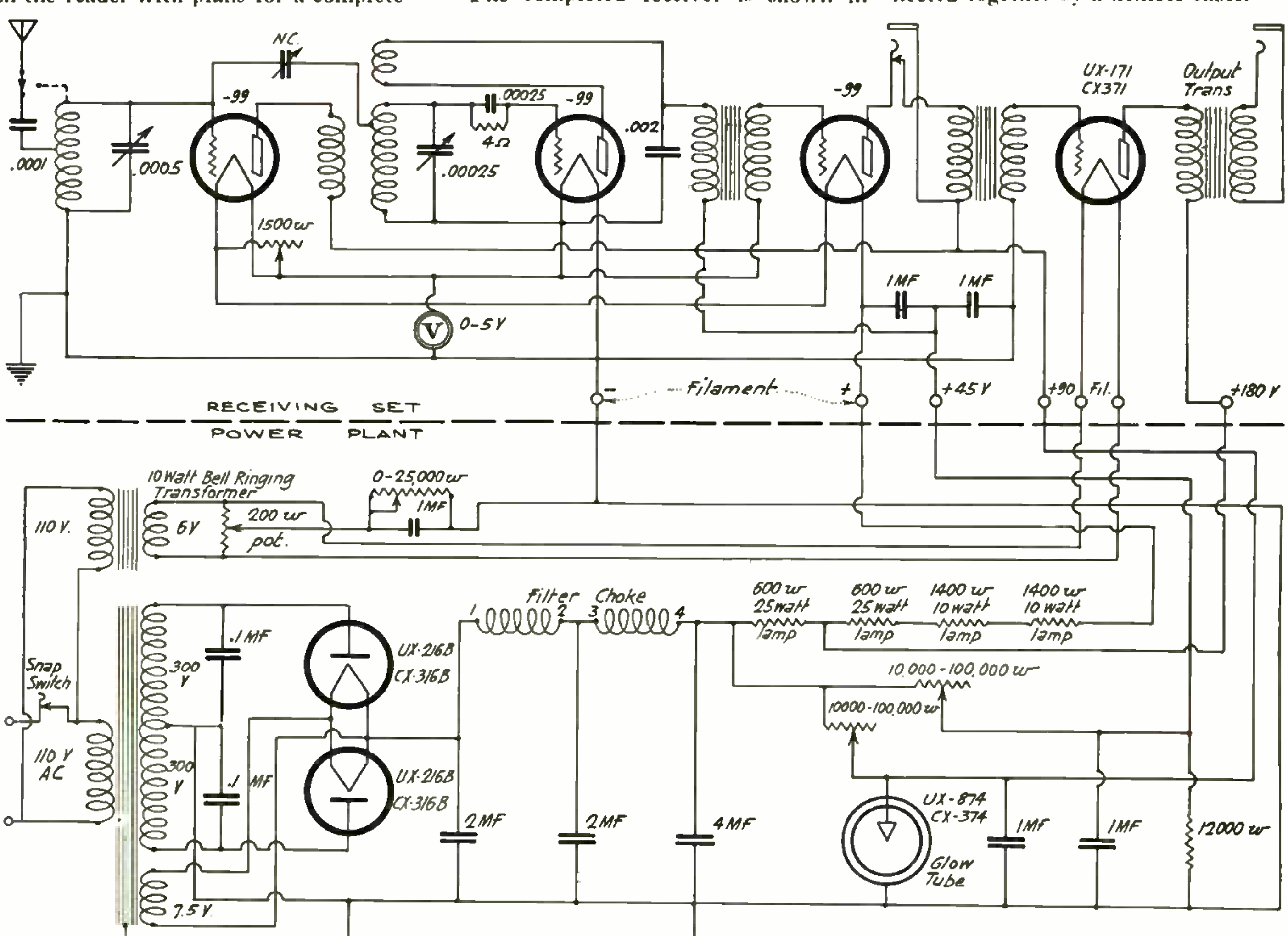


Fig. 1. Schematic Wiring Diagram of Receiver and Power Plant.

The Power Plant

THE POWER plant consists of a transformer, with 120 volt primary, 600 volt secondary with center tap, and a 7.5 volt secondary for lighting the filaments of the rectifier tubes, which are connected so that 300 volts is applied to the plate of both tubes. Each tube rectifies half the alternating current wave, and the output of this rectifier system, which is called a full-wave rectifier, will be approximately 220 volts at 120 milliamperes, the normal maximum permissible drain from the UX-216-B, CX-316-B rectifier tube when used in a full-wave circuit. With smaller current drains, the voltage output will be higher, rising to 300 volts at a few milliamperes. The rectifier output is connected to the input of a two-section filter, one section of which is specially designed to be resonant at 120 cycles, so that the 120 cycle fundamental ripple of the pulsating d.c. output of the rectifier will be removed. The remaining section of the filter is of the "brute-force" type, and removes the harmonics of the 120 cycle fundamental, so that the output of the filter is pure direct current, without noise of any kind.

As the rectifier load is limited to 120 milliamperes maximum at 220 volts, we cannot light the filaments of .25 ampere storage battery tubes, nor could we operate more than two .06 ampere dry cell tubes, of the '99 variety, in parallel, so that series operation of all the tubes except the power stage is necessary. The filaments of the three type 99 tubes, which require .06 amperes (60 milliamperes) each at 3 volts, are connected in series, so that a total of 9 volts at 60 milliamperes is needed for normal operation. Having a source of direct current up to 220 volts at 120 milliamperes, and using but 9 volts calls for a high resistance in series with the three tube filaments to limit the current to 60 milliamperes, this being placed between the positive d.c. source and one end of the series filament circuit.

As the filament supply draws but 60 milliamperes from the rectifier, we have another 60 milliamperes available for plate current. The r.f. and 1st audio amplifier tubes will require about 6 milliamperes at from 80 to 90 volts, so by the insertion of a high resistance between the plates of the tubes, and the positive of the rectifier, the voltage is cut down to the proper value. This makes 66 milliamperes drawn from the rectifier. The detector tube requires 1½ milliamperes at 45 volts, and this is obtained through another high resistance connected between the rectifier positive terminal and the plate of the detector, making a subtotal of 67½ m.a. as a rectifier load.

The power tube used in this particular model is the new CX-371, UX-171, which has a filament requiring .5 ampere at 5 volts, and draws from 20 to 25 milliamperes of plate current at 180 volts. A.C. filament voltage is supplied from a step-down transformer, which has a 6-volt secondary, and as the secondary is not center tapped, a 200 ohm potentiometer is shunted across the secondary and the slider is adjusted until the electrical center of the circuit is obtained. Assuming that the power tube draws 25 milliamperes, at 180 volts, the voltage being cut down through a 600 ohm resistance, our total drain from the rectifier is now say 93 milliamperes.

For the purpose of stabilizing the detector tube, the detector plate voltage is obtained from the voltage drop across a 12,000 ohm resistor placed in series with the variable high resistor shown in the

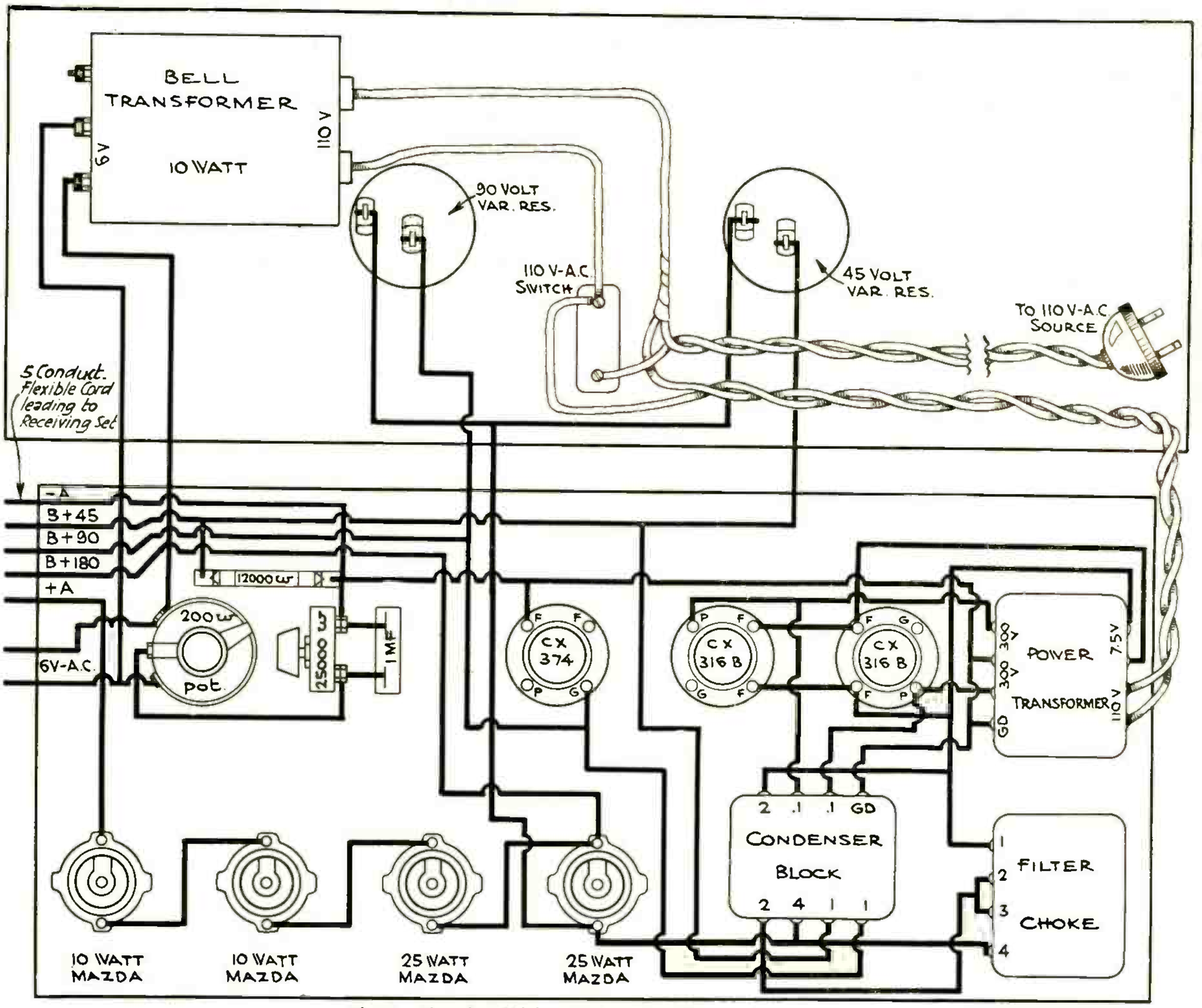


Fig. 2. Pictorial Wiring Diagram of Power Apparatus.

diagram, so that a few milliamperes additional will be drawn from the rectifier, making about 95 milliamperes in all so far.

In order to regulate the voltage output of the rectifier, particularly with reference to the plate voltage of the r.f. and a.f. amplifier tubes, a voltage regulator, or glow tube, is shunted between the positive and negative 90 volt rectifier taps. This tube has the ability to absorb direct current in such a manner that the voltage across its terminals is always 90 volts, within certain limits, so that when the receiver load, or line voltage fluctuates, the tube compensates for these changes, and maintains a constant current supply to the plates of the tubes. In normal operation the current drain of this tube will be 10 milliamperes, so that our total current drain is 105 milliamperes, and the output voltage of the filter circuit will be about 225 volts.

To obtain *C* voltage for the tubes in the series filament circuit, the tubes are arranged so that the voltage drop across the filament of any one tube furnishes the necessary *C* voltage for some other tube in the circuit. In this manner, the 1st a.f. grid is negative with respect to its filament by the voltage drop across the r.f. tube filament, and the latter tube grid is 3 volts negative with respect to its filament by the drop across the detector filament. The detector grid is connected to its positive filament, and needs no *C* voltage. For the power tube, *C* voltage is obtained by means of a resistance placed in series with the negative *B* voltage lead from the slider of the potentiometer to the negative *B* terminal of the rectifier. This resistance is adjusted so that with normal plate current the voltage drop through the resistance is about 40 volts, which is the correct *C* voltage for the power tube.

LIST OF PARTS USED FOR POWER PLANT

- 1 Silver-Marshall Type 330 Power Transformer.
- 1 Silver-Marshall Type 331 Uni-Choke.
- 1 Silver-Marshall Type 332 Condenser Bank, 4, 2, 2, 1, 1, .1, .1, mfd.
- 2 Variable resistances, 10,000 to 100,000 ohms-Clarostat.
- 3 X-base Na-ald sockets.
- 1 General Radio 200 ohm potentiometer, Model 301.
- 1 Centralab 25,000 ohm resistor, heavy duty type.
- 1 Electrad 1 mfd. by-pass condenser.
- 1 Thordarson 10-watt bell ringing transformer.
- 1 Cutler-Hammer Filament Switch, for a.c. line.
- 1 Electrad 12,000 ohm Fused Metallic Leak or Arthur H. Lynch fixed resistor with mounting.
- 4 Porcelain lamp sockets for standard mazda lamps.
- 2 10-watt, 120-volt Mazda lamps.
- 2 25-watt, 120-volt Mazda lamps.
- 1 Bakelite or Formica panel, 7x19x3/16 in.
- 1 Baseboard, 7x18x½ in.
- 1 6-ft. section Premier battery cable. 6-ft. twisted lamp cord.
- 2 UX-216-B, CX-316-B half wave rectifier tubes.
- 1 UX-874, CX-374 Glow tube.

The actual construction of the power plant is shown in the pictures. Fig. 2 shows a pictorial wiring diagram, with all parts clearly indicated. The power transformer, filter choke and condenser bank are arranged in three uniform metal cases, at one end of the baseboard, with the two rectifier tubes and the glow tube in the center. On the panel, which is used for the sake of appearance and convenience, are mounted the two variable resistors, the 6-volt step-down transformer and the 110 volt a.c. snap switch.

The four mazda lamps comprise the fixed resistances in the filament circuit. Rather than use expensive wire wound resistances, two 25-watt and two 10-watt mazda lamps are placed in series, providing a total resistance of 4000 ohms. Should it be desired to change the resistance by a small amount, lamps of smaller or greater power consumption can be used, the 10-watt lamp having a resistance of 1400 ohms, the 25-watt of 600 ohms, and the 40-watt lamp 400 ohms. These lamps will safely dissipate a great deal more power than is required in the circuit, and as none of them cost more than 35 cents, their economy is obvious.

The 200-ohm potentiometer, *C* biasing resistance for the power tube, and its associated shunt condenser are mounted at the right-hand end of the baseboard. All connections of the receiving set are made through a 5 conductor battery cable, with the exception of the 6-volt a.c. circuit for the power tube, which is carried through a piece of twisted No. 18 lamp cord, to prevent introducing noise into the other connecting wires.

A panel drilling template for the power panel is given in Fig. 5, and the baseboard should be fastened to the bottom edge of the panel with a few flat head wood screws. Before fastening the panel to the baseboard, wire as much of the power apparatus as is possible, using a good grade of insulated, semi-flexible wire. Take care that no bare wire leads remain exposed, as the power plant is capable of giving an inquisitive person an unpleasant jolt, and although harmless, trouble can be easily avoided by exercising the proper precautions. The power transformer is provided with a flexible cord, with one side of which the snap switch on the panel is placed in series. One of the primary terminals of the 6-volt transformer is also connected to the power transformer side of the snap switch, and the other 6-volt transformer primary lead is connected to the other side of the 110-volt line, so that the snap switch is the main control of the input, and turns everything on or off without extra adjustments.

The list of parts includes those pieces of apparatus which were used in the experimental model. It is absolutely essential to the success of the unit that

Power Plant with Mazda Lamp Resistance Bank.

a 600-volt transformer with center tap be used, and to employ two half-wave rectifier tubes of the type specified. Any lower voltage for the transformer secondaries, or the use of lower powered rectifier tubes, will mean that insufficient voltage will be available for the 371 type power tube, and the values of fixed and variable resistances will have to be changed.

A 25,000-ohm variable resistor is specified for the *C* voltage resistance in the power tube circuit, as it gives sufficient latitude in adjustments to accommodate other power tubes having smaller plate current drain, such as the CX-UX-112.

In testing one of the experimental power plants, it was found necessary to increase the capacity of the filter condenser placed at the mid-tap of the filter choke to 4 mfd., in order to entirely remove the 120 cycle hum from the loudspeaker connected to the receiving set. Filter chokes vary in inductance, and while the combination of 2, 2, and 4 mfd. shown in Fig. 1 is normal for the chokes specified, if a noticeable hum remains when all connections are made, the extra 2 mfd. condenser should be added between the negative high voltage lead and terminals 2-3 of the filter choke.

Browning-Drake Receiver

THE RECEIVING set construction is not difficult, and presents nothing new to the experienced radio fan. The list of parts designates those actually used, and the panel drilling template shown in Fig. 4 gives the location of the antenna tuner and regenaformer assemblies, which are of the improved type, with space wound, enameled wire coils, and 270 degree variable condensers. On the panel are mounted the voltmeter, volume control resistance, phone and loudspeaker jacks, and the two variable condensers. A hole is provided for the tickler shaft, and the holes for the condenser shafts are made purposely large in order to permit the use of any type of vernier dial desired.

In assembling the receiver, mount the panel apparatus first, and temporarily fasten it to the baseboard, in order to obtain an idea of the space required by the panel equipment which projects over the baseboard. Fasten the audio transformers to the rear of the baseboard, placing the binding post strip at one end, and the sockets in the order shown. The detector tube is located in the rear of the regenaformer, with the 1st and 2nd audio and the r.f. amplifier next in line, the latter tube being nearest the antenna tuner. Use a cushioned socket for the detector, to prevent noise.

The output transformer or coupling impedance, whichever is used, is placed at the front of the baseboard near the panel, so that the power tube output leads will be short. Two 1-mfd. fixed condensers are mounted at the rear of the baseboard, these being necessary to make the set absolutely free from hum, or disturbing noises. The condenser bank used in the filter circuit of the power plant has two 1-mfd. condensers, which are shunted across the 45 and 90 volt *B* taps to the receiver, but the additional condensers which are placed in the receiver are advisable, to get rid of all the noise.

The series filament wiring, *C* voltage

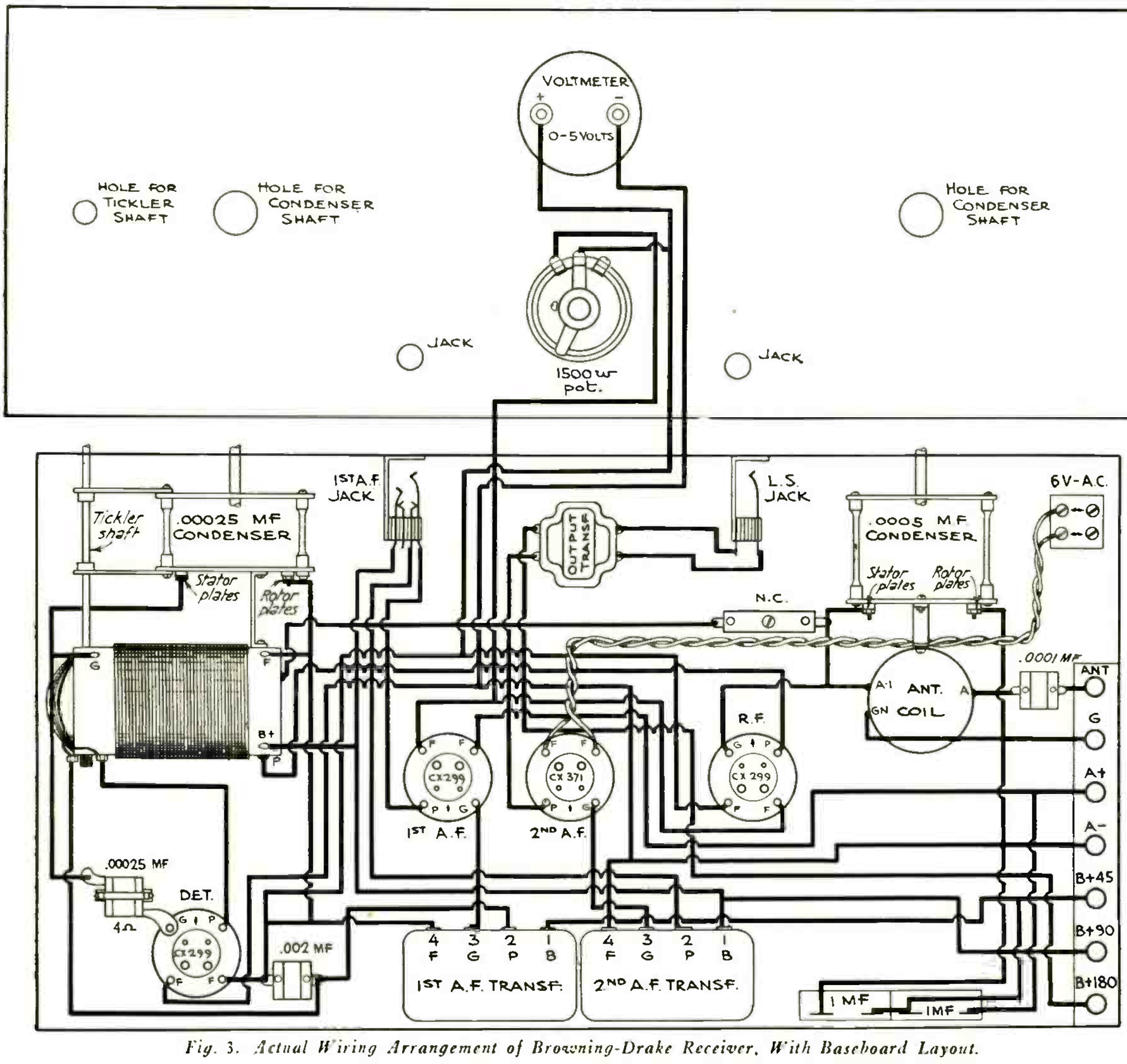


Fig. 3. Actual Wiring Arrangement of Browning-Drake Receiver, With Baseboard Layout.

leads, and positive *B* voltage wires are all insulated, being bunched together in the form of a cable. Run each wire between the various points designated in the pictorial diagram of Fig. 3. After all leads mentioned above are finished, they may be laced together with twine, so as to form a compact, rigid cable which will make a neat appearance.

The high frequency leads, and the grid and plate wires for all four tubes, are run in bare bus bar wire, with as much separation as possible. One or two of the wires will be somewhat longer than is customary, but they do not seem to affect the operation of the set, and no trouble should be experienced from them.

Amplification control for the r.f. tube is obtained by shunting the filament of the tube with a 1500 ohm potentiometer used as a variable resistance. When adjusted to a sufficiently low value of resistance, it will shunt most of the current around the filament, and reduce the gain of the tube to any desired amount. It is noiseless in operation, and serves to by-pass any current in excess of 60 milliamperes which might be passed through the r.f. tube filament due to the plate current from the 1st audio tube being added to the main filament load.

A voltmeter having a 5-volt scale is shunted across the detector filament, and serves to indicate conditions in the filament circuit, as well as to bypass two or three milliamperes around the filament, and keep the current to approximately 60 milliamperes. While the current, when measured at the positive end of the series filament circuit, is 60 milliamperes, if 6 milliamperes of current is consumed by the plates of the three tubes, this current is added to the original 60 milliamperes, and we have 66 milliamperes in the negative filament lead returning to the rectifier. As 66 m.a. might in time injure the filament of the tube, the voltmeter consumes about 3 milliamperes in indicating the voltage, and is an effective shunt.

PARTS LIST USED FOR BROWNING-DRAKE RECEIVER

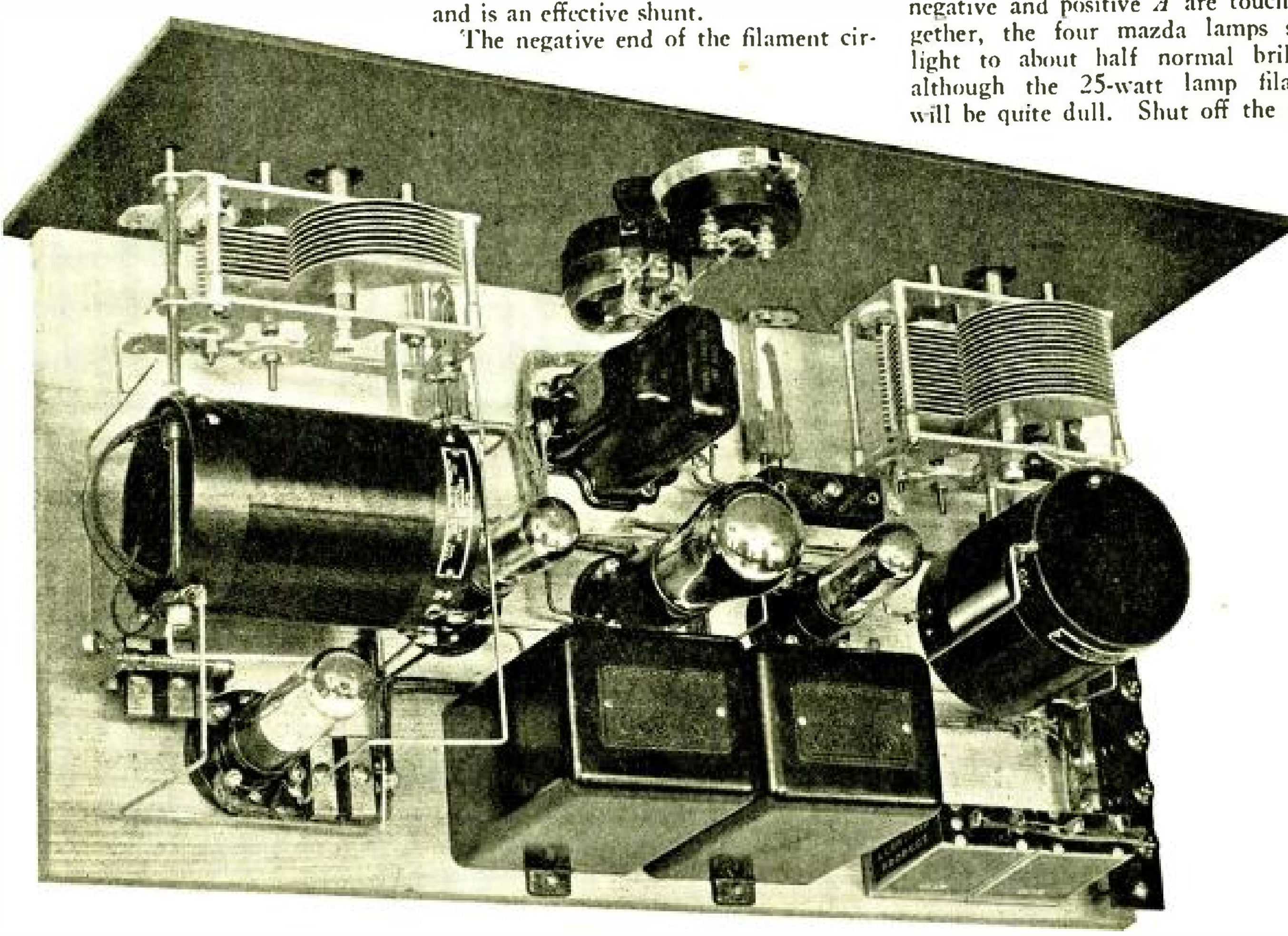
- 2 National Tuning Units.
- 2 Silver-Marshall Type 220 Audio Frequency Transformers.
- 4 Na-ald sockets, for UX base tubes (one spring cushioned).
- 1 Yaxley single-spring jack.
- 1 Yaxley three-spring jack.
- 1 Federal No. 25 potentiometer—1500 to 2000 ohms.
- 1 Weston Model 506 Voltmeter, 0-5 volts.
- 1 Output Transformer—General Radio Type 367, or Silver-Marshall No. 221.
- 1 Electrad .00025 mfd. mica grid condenser, with grid leak mtg.
- 1 Electrad 4 megohm Fused Metallic Leak or Arthur H. Lynch fixed resistor.
- 2 Electrad 1 mfd. by-pass condensers.
- 1 Eby binding post strip—7 posts.
- 1 .0001 mfd. fixed mica condenser—Electrad.
- 1 XL Model N neutralizing condenser.
- 1 Electrad .002 mfd. fixed mica condenser.
- 1 Bakelite or Formica panel. 7x20x3/16 in.
- 1 Baseboard 10x19x½ in.
- 1 Terminal block for 6 v.a.c. connection, or two binding posts.
- 3 UX-199, CX-299 tubes.
- 1 UX-171, CX-371 tube.
- 1 Corbett Model C cabinet.

The negative end of the filament circuit is grounded to the ground binding post of the receiver, and another ground should be added in the power plant, as shown in Fig. 1. A ground terminal is provided on the power transformer, and it is connected internally to an electrostatic shield placed between the primary and secondary windings, preventing r.f. disturbances in the a.c. power line from reaching the receiver.

The neutralizing condenser in the r.f. circuit is connected in the conventional manner. The National Tuning Unit has a neutralizing tap to which this condenser is connected, but the circuit may be neutralized by connecting the grid of the r.f. amplifier to a small brass plate about the size of a half dollar, and bringing the plate near the secondary of the regenaformer, until sufficient capacity between the plate and the coil is had, to properly neutralize the set. This was described by Glenn H. Browning in a recent issue of *Radio Broadcast*.

Operating Suggestions

AFTER wiring the Browning-Drake receiver, check the connections in accordance with the diagram. After verifying the wiring, insert the three 99 tubes in their sockets, and you are ready to test the power plant. Connect it to the 110 volt line and with the 5 conductor cord terminals ordinarily connected to the receiver well separated, turn on the current. The filaments of the two rectifier tubes should light, and when the two cord terminals marked negative and positive *A* are touched together, the four mazda lamps should light to about half normal brilliancy although the 25-watt lamp filaments will be quite dull. Shut off the power



Rear View, Showing Baseboard Assembly.

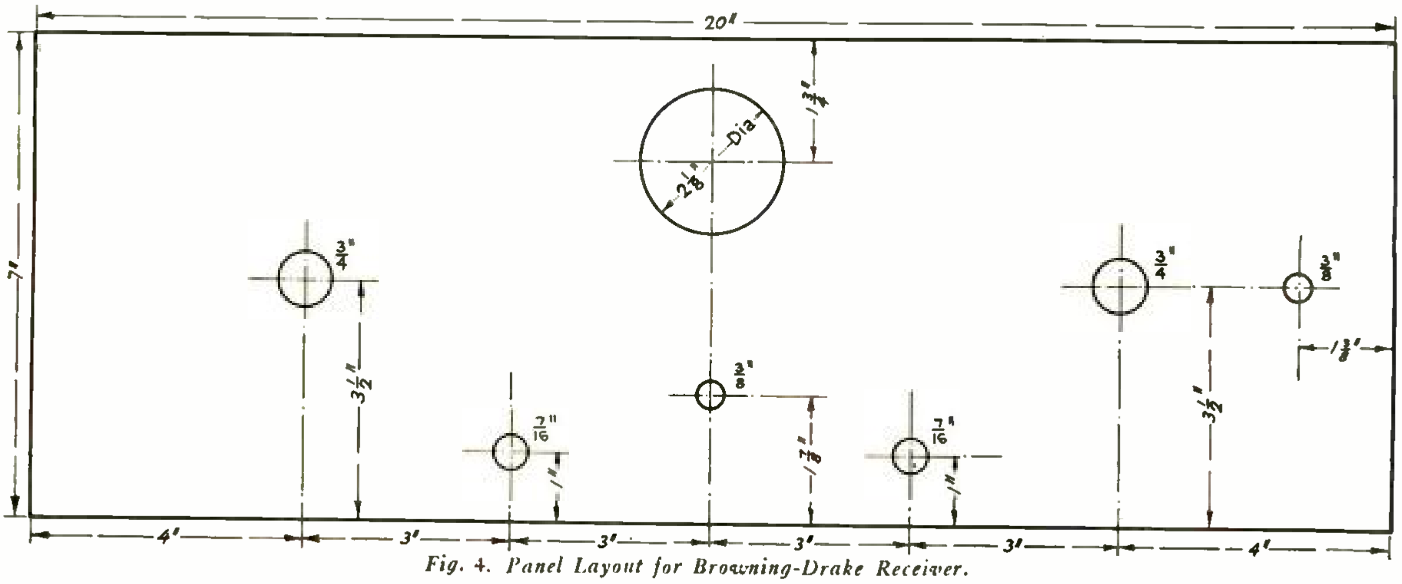


Fig. 4. Panel Layout for Browning-Drake Receiver.

plant and connect the two *A* supply leads to the *A* negative and positive binding posts in the receiver. Turn on the power supply again, and the filaments of the three tubes should light. The voltmeter should indicate about 3.6 volts, and as soon as this indication is noted, the power should be turned off.

Now insert the CX-371 tube in its socket, and connect the 6 volt filament leads to the small terminal block mounted on the receiving set baseboard as well as connect the positive 180 volt *B* lead from the power plant. Turn on the power, and the filament voltmeter should now read about 3.3 volts, as the power tube is drawing 25 milliamperes load and will lower the rectifier output voltage accordingly.

A milliammeter having a 25 mil. scale is very handy at this point, for it should be inserted in the positive 180 volt lead, and the 25,000 ohm *C* biasing resistor in the power plant adjusted until the plate current is between 20 and 25 milliamperes.

The resistance in the circuit will usually be from 2000 to 3000 ohms, which is only a small part of the total resistance available, but in case a type 112 tube was used, with lower plate current values, a higher resistance might be required. When the power tube is turned on, the 25-watt mazda lamp nearest the filter will glow brighter than the other 25-watt lamp, as there will be more current flowing through it.

Now connect the 90 volt *B* lead to the receiving set, first cutting in all the resistance in the clarostat, and if the milliammeter is available, place it in the circuit to read the plate current. Gradually adjust the Clarostat in this circuit, cutting out resistance by screwing the knob in until a current of from 5 to 6 milliamperes is flowing. At this point it will be noted that the glow tube is operating, and the main cylinder or cathode is glowing with a pinkish hue. It will be found by watching the milliammeter that quite a wide variation in resistance adjustment in the 90 volt lead will make no change in the plate current flow, as the glow tube absorbs more and more current from the rectifier when the resistance is lowered, always keeping the voltage across its terminals at 90 volts.

If the glow discharge in the tube is only at the wire in the center, then the connections to the tube socket are wrong and should be reversed. The cylinder is connected to the positive filament spring of a standard UX base socket, and the wire or anode is connected to the grid spring, so that if these are reversed, the tube will not operate properly. It will be found that if the resistance is lowered to a certain amount, the glow tube will absorb 50 milliamperes or more, and the current to the receiver in the 90 volt lead will drop. This is not the proper operating point, and resistance should be cut in until any further increase in resistance makes an immediate drop in the plate current.

The final connection is to the detector *B* tap, which should be 45 volts. The milliameter should show 1.5 milliamperes in this circuit, and rotating the tickler coil in the receiver through its full range should show a sudden fall in plate current when the detector tube oscillates. When all *B* voltage taps are connected, the filament voltmeter should read 3 volts. If it shows less than this amount, it may be necessary to substitute a 40-watt lamp for the 25-watt lamp second in line from the filter. If a greater amount, turn the Clarostat in the 90 volt lead so that the glow tube absorbs a slightly greater amount of current, and the voltage will drop to the

(*Continued on Page 48*)

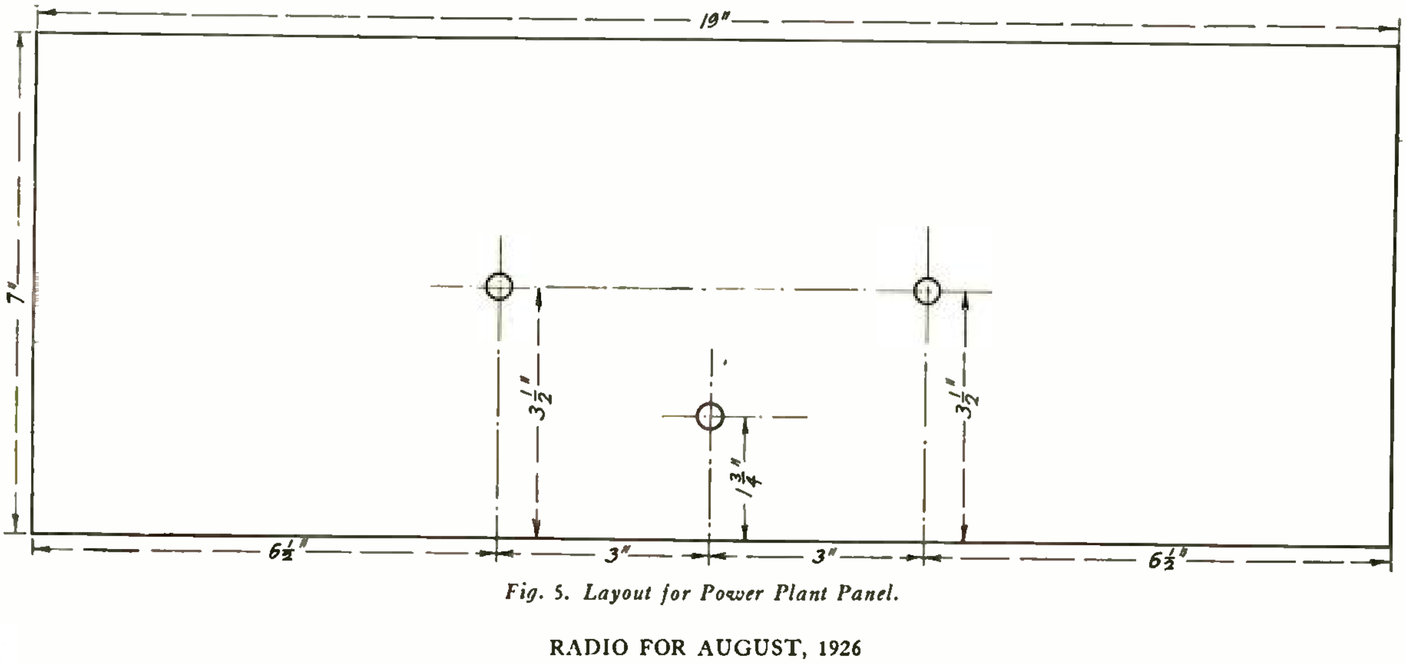


Fig. 5. Layout for Power Plant Panel.

"You men aim to stick up the West Mail here at Rocky Gap?" yelled Joe.

The West Mail

By John C. Bonno

JOE BARTRY, operator at Rocky Gap, snapped shut the switch on the relay key and turned to his radio. Rocky Gap, a lonely signal station in the foothills of the "Rockies," was maintained by the St. Paul and Western Railroad as a precautionary measure against landslides. The five-mile cut through the mountains at this point, although in all other respects a marvel of railroad engineering, was occasionally blocked by slides and cave-ins which tied up traffic and resulted in serious wrecks.

The position of operator at this station was consequently one of importance and trust, although, needless to say, an extremely solitary one. But that which attracted the present operator, as attested to by his sunken cheeks, was the health-giving mountain air.

The nights had been interminably long and lonesome at this station before the advent of the radio. Formerly there had been nothing with which to relieve the monotony of such an existence except such papers and magazines as he could borrow from Hap Downing, operator at Perryville. In Perryville, the junction town where the long climb into the foothills began, was stationed Hap Downing, friend of Joe Bartry. Lately their long standing friendship had been somewhat strained by Hap's constant claim to super feats of reception on his one and only super radio.

Joe manipulated the controls on his own radio and tuned in some familiar music. Picking up his violin he began an accompaniment.

The telegraph key began to click with the familiar call of Hap at Perryville. Joe answered and received the message, "Got Havana coming in fine." Joe smiled. Hap was without a doubt the biggest radio prevaricator in seven counties. With the ease of long practice he sent back, "Tie that outside. I'm getting Hong Kong," and resumed his accompaniment to the same local station.

Again the key began its clicking. Hap again. This time on business. The West Mail had cleared Perryville on time. Joe moved the station semaphore to green and settled back comfortably. It was a thirty minutes' run from Perryville to Rocky Gap and most of it up grade. Plenty of time to enjoy another selection.

The music had stopped. Over the air came a voice. "This is station KOZ. Broadcasting a Special Police Report. At 3:00 a. m. Monday morning the three Gornan brothers escaped from the state penitentiary. A reward of one thousand dollars is offered for the capture or information leading to the capture of these men. Description of the men follows. Gyp Gornan — brown hair—grey eyes—height, about five feet, ten inches—weight, about 180 pounds. Prominent characteristics—broken nose—carries left shoulder higher than right. Jimmy Gornan—brown hair—brown eyes—skeeeeeeeeeeeeeeeeee-burrrrrrrrrup.

A whistle pierced the surrounding stillness. The West Mail was entering the cut. The fast train thundered by the lonely station a glimpse of flame and blackness.

Joe signalled the next station west that the West Mail had cleared Rocky Gap. When the Mail cleared he was practically through for the night. After that there was comparatively little traffic through the Gap. He again turned toward his radio and the hopeless task of locating a distant station. His ever present and consuming ambition was to equal Hap's constant boasting; but the range of his set would not permit the reception of any other than the usual stations.

The telegraph key again began to click. Hap's pound. Joe answered. Suppose he was getting Moscow now, thought Joe.

"Getting Syracuse. Some—"

Joe cut in. "I'm getting Chili. Fire just went out." Hap sure was a lyin' fan. If he was getting the stations he claimed; he was lucky but he didn't have to rub it in.

A faint glimmer of an idea dawned upon Joe as he considered Hap's weakness. Maybe—. He would try it. There was a heap of electrical junk in

(*Continued on Page 50*)

How Much Amplification Do You Use?

A Simple, Accurate Method of Figuring Voltage Amplification of Audio Frequencies in Various Types of V. T. Amplifiers

By Raymond B. Thorpe

THE PURPOSE of an audio frequency amplifier is to increase the useful electrical energy delivered from the plate circuit of a detector tube to a loudspeaker. This may be done by supplying local energy from a *B* battery to one or more amplifying tubes whose plate-to-grid circuits are coupled by means of a transformer, high resistance or impedance. Although this local reinforcement of energy is quite inefficient, the average amplifying tube consuming about sixteen times as much energy from the *B* battery as it delivers in the form of audio frequency currents, it is relatively inexpensive.

As it is customary to express the energy gain in terms of voltage amplification the gain in voltage units *VU* of any amplifying device may be defined as the ratio of the output voltage to the input voltage, multiplied by the square root of the ratio of the input to the output impedances. Thus if the impedances are equal in a device which gives 30 volts output for 2 volts input its gain is 15 V.U.

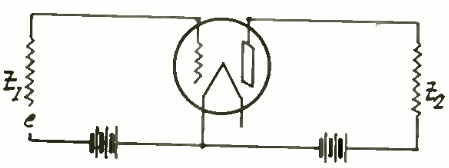


Fig. 1. Vacuum Tube Amplifier Circuit.

Fig. 1 shows a typical vacuum tube amplifier circuit whose power is transferred from impedance Z_1 to Z_2. For maximum amplification it is necessary that Z_1 should be about equal to the impedance of input grid circuit and that Z_2 should approximate to the output plate impedance of the tube. The former is very high, being over one million ohms at frequencies less than 10,000 cycles, while the latter is around 10,000 ohms.

In Fig. 2a the gain from one grid to the next for a tube having an amplification of μ and a plate resistance of r_p will be $\mu Z \div \sqrt{r_p^2+Z^2}$ ......(1). As the input voltage e_g results in an effective voltage of $\mu\ e_g$ the circuit may be simplified as in Fig. 2b. According to Ohm's Law this voltage causes a current of $\mu\ e_g \div \sqrt{r_p^2+Z^2}$ ....(2) to flow in the circuit and the voltage across Z is Z times this current or

$$Z\ \mu\ e_g \div \sqrt{r_p^2+Z^2} \quad\text{..........}(3).$$

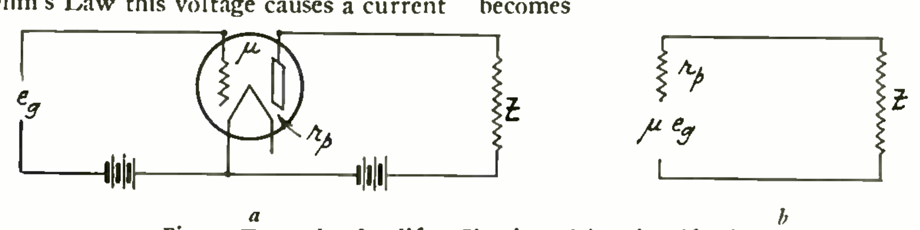


Fig. 2. Two-tube Amplifier Circuit and its Simplification.

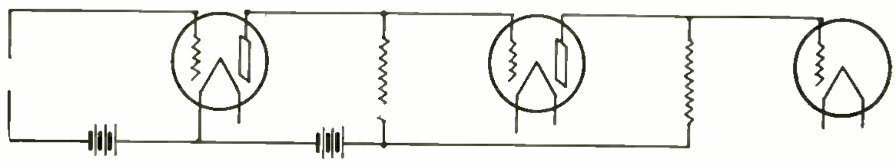


Fig. 3. Generalized Form of Multi-Tube Amplifier Circuit.

In a multi-stage amplifier of the usual sort, as indicated in generalized form in Fig. 3, the voltage input to the first tube is e_g and that to the second tube is the voltage across Z, as just figured. Consequently the gain or ratio of voltage in the second grid to that of the first grid is $\mu\ Z \div \sqrt{r_p^2+Z^2}$ ....(4).

Transformer Coupled Amplifier

In the practical application of this method to a transformer coupled amplifier, as in Fig. 4, assume that the input voltage to the first tube is 1 volt, that its amplification constant is 8, its plate impedance is 10,000 ohms, and that the transformer has a 1:3 ratio, and an inductance of 10 henries or an impedance of 3140 ohms at 50 cycles. ($Z=2\pi f L =6.28 \text{x} 50 \text{x} 10=3140$ ohms, neglecting the small resistance component).

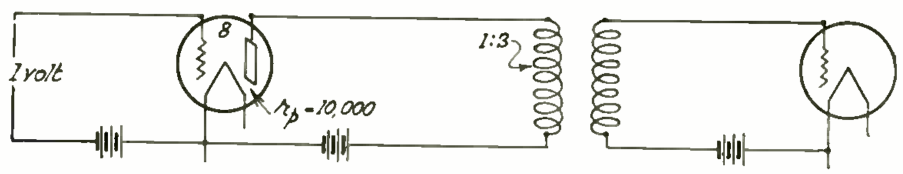


Fig. 4. Transformer Coupled Amplifier.

From equation (3) the voltage across the transformer becomes
$8\times 3140 \div \sqrt{10{,}000^2+3140^2}=25{,}120 \div 10{,}482=2.5$ volts (approximately). Assuming no transformer losses this would give $3\times 2.5=7.5$ volts delivered by the secondary.

At 1000 cycles this transformer will have an impedance of $6.28\times 1000\times 10=$ 62,800 ohms as compared with 3140 ohms at 50 cycles. Again substituting in equation (3) the primary voltage then becomes
$8\times 62{,}800 \div \sqrt{10{,}000^2+62{,}800^2}=$ $502{,}400 \div 63{,}589=7.9$ volts on the primary and 23.7 volts on the secondary.

To obtain exact values of amplification at very low or very high frequencies requires considerable experimental data regarding the transformer constants and it is almost as easy to measure the actual amplification as to calculate it. The exact value for very low frequencies when distributed capacities are not involved is equal to

$$[\mu N \sqrt{(2\pi f L)^2+R^2}] \div \sqrt{(r_p+R)^2+(2\pi f L)^2},$$

where N is the turns ratio and R the effective resistance of the transformer, which varies with the frequency.

Resistance Coupled Amplifier

Fig. 5 shows a resistance coupled amplifier in which the tube impedance $r_p=$ 10,000 ohms, the out-put resistance $R=10{,}000$ ohms, the coupling condenser $C=.001$ mfd. and the grid resistance r_g for the second tube is 100,000 ohms. Assume also that the tube has an amplification constant of 8 and that the input voltage on its grid is 1 volt. Due to the amplification constant the voltage acting in the plate circuit will be 8 volts. Neglecting, for the moment, the portion of the circuit from the condenser on, we see that this potential of 8 volts will be acting in a circuit of 20,000 ohms resistance, the resistance of the *B* battery being negligible. The resulting current will be $8 \div 20{,}000=.0004$ amperes and this current flowing in resistance R will result in a voltage of $.0004\times 10{,}000=4$ volts.

If, however, we are to take account of the resistance r_g this must be modified slightly. Assume for the moment that the frequency is so high and condenser

C so large that the impedance of the condenser is negligible. Then the resistance r_g is essentially in parallel with R and the combined value of the two is found, by the simple method of dividing their product by their sum, to be 9091 ohms. Computing the voltage across this combined resistance in the same manner as in the sample case above, we find it to be 3.8 volts.

FREQUENCY	100	1000	5000
Gain of Fig. 5	.249*	2.10	3.43
Gain for R=100,000, C=1 mfd., r_g=1 megohm	7.20	7.21	7.21

*A "gain" of less than 1 V.U. represents an actual *loss* of energy.

Notice that by changing these constants we have not only improved the gain at every frequency but have almost eliminated the difference in gain between low and high frequencies.

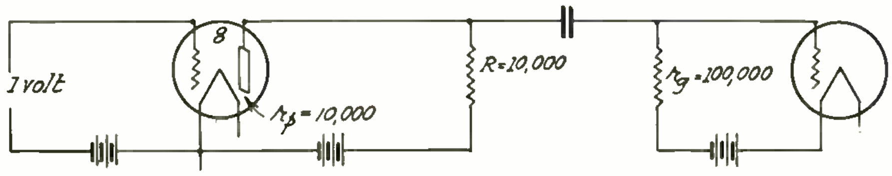


Fig. 5. Resistance Coupled Amplifier.

Since we have neglected any drop in voltage across the condenser C all this voltage appears across r_g and therefore also on the grid of the second tube. We have therefore found the gain of this stage of amplification to be 3.8 V. U.

This is somewhat less than the 4 volts which were obtained when r_g was neglected and it is obvious, therefore, that r_g should be large as compared to R in order to avoid a loss due to its presence. We must be careful, on the other hand, not to make r_g too large, since in that event an occasional positive swing of the grid may charge the grid circuit and block the in-put while the charge is slowly leaking off.

In obtaining the results above we neglected the impedance of the condenser C (.001 mfd.), which is by no means negligible at the lower frequencies. Any condenser has an impedance $1/2\pi f C$ where f is the frequency and C is the capacity in farads, its effective resistance being neglected. Therefore, our condenser will have an impedance of 1,590,000 ohms at 100 cycles. This is in excess of the value r_g itself and will cause a considerable drop in the potential between the terminals of R and those of r_g.

The complete equation for the gain of a resistance coupled stage having an output resistance R, coupling capacity C, and grid resistance r_g is

$$\mu Z r_g \div [(r_p+Z)\sqrt{X^2_C+r^2_g}]$$

where

$$Z=1\div\sqrt{\left(\frac{1}{R}+\frac{r_g}{X_C^2+r_g^2}\right)^2+\left(\frac{X_C}{X_C^2+r_g^2}\right)^2}$$

and $X_C=1/2\pi f C$.

For practical use it is sufficient to note that if we are to expect as good amplification at low as at high frequencies C must be made very large so that its impedance will always be small as compared to R and r_g. Improvement can also be obtained by increasing these last two factors. A far better set of values in this case would be R=100,000 ohms. C=1 mfd., r_g=1 megohm. As proof of this statement the exact gains are given below at 100, 1000 and 5000 cycles for the values of Fig. 5 and for the better values given.

The constructor of a resistance coupled amplifier must bear in mind, of course, that the resistance R placed in the plate circuit causes a substantial drop in voltage due to the plate current so that the steady potential of the plate is considerably lower than that of the positive B battery terminal. The result is to substantially increase the value of r_p, since the plate impedance of a vacuum tube increases as the plate voltage falls. If its normal value as obtained with the B battery applied directly to the plate is to be maintained it will be necessary to increase the B battery potential by an amount equal to the normal plate current times the resistance R.

In the case of a vacuum tube whose normal space current is 4 mils, if we make R=100,000 ohms, the B battery should thus be increased by 100,000$\times$.004=400 volts higher than normal to keep r_p at its normal value. Fortunately it is not necessary to do this since almost as good amplification may be obtained by using approximately normal B battery voltages and relatively small C battery voltages.

Having done so, however, we at once find ourselves in difficulties if we wish to calculate the gain of such an amplifier, since we now have no knowledge of the proper value of r_p for our equation. This need may be supplied by a curve showing the relation of plate impedance to plate potential for small or zero grid voltages for the particular type of vacuum tube used. We may then get rather close to the desired result by allowing for the drop of potential in R as determined by measuring the current in it by means of a milliammeter in the plate circuit. Suppose that with a 90-volt B battery 0.6 mils current flows in the plate circuit, R being 100,000 ohms, we know then than the drop in R is .0006$\times$100,000=60 volts so that the net potential on the plate is 90-60=30 volts. From our curve we may then find the value of r_p for a plate voltage of 30 and use it in our calculations.

Impedance Coupled Amplifiers

IMPEDANCE coupled amplifiers involve a slightly different problem. Fig. 6 shows such an amplifier in which we will again assume a 1 volt input, an amplification constant of 8 and a plate impedance of 10,000 ohms for the first tube. Coupling is obtained by inserting a choke coil L into the plate circuit and providing the coupling condenser C and a grid resistance r_g. It is similar to the resistance coupled case except that an inductance L replaces the resistance R.

One of the problems of the resistance coupled case, that of discovering what plate impedance to use in our calculation, is immediately solved, since the resistance of the choke coil will be comparatively small and we may safely assume that the voltage on the plate of the tube is the same as that which we would obtain with transformer coupling or, as a good approximation, that it equals the B battery voltage. We may, therefore, use the corresponding value of plate impedance.

The problem of determining the voltage across L is exactly the same as in the transformer coupled case and if we again assume L=10 henries the resulting voltage across it will be 2.5 volts at 50 cycles as was found in the transformer case above. Unlike the case of the transformer coupling, however, there is no increase of this voltage from this point on, but rather a decrease due to the drop in voltage through the condenser C and the effective reduction in L produced by r_g. These reductions will not be serious if C and r_g are made rather large, in fact, the problem is exactly the same as that discussed under resistance amplification from this point on.

If it happens that we are not concerned with these exact values at various frequencies, we may arrive at a very approximate value for 1000 cycles by neglecting C and hence assuming that the resistance r_g=100,000 ohms is in parallel with L directly. In this case we can easily show that our gain for L=10 henries will be 7.18 V.U. For those who wish exact values for any frequency and circuit constants the proper formula is $\mu Z r_g \div [(r_p+Z)\sqrt{X_C^2+r_g^2}]$ where

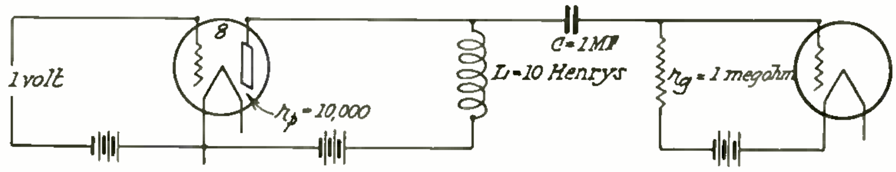


Fig. 6. Impedance Coupled Amplifier.

$$Z=1\div\sqrt{\left(\frac{r_g}{X_C^2+r_g^2}\right)^2+\left(\frac{1}{X_L}-\frac{X_C}{X_C^2+r_g^2}\right)^2},$$

$X_L=2\pi f L$ and $X_C=1/2\pi f C$.

Thus far we have assumed in each case an amplification constant of 8 which is near the normal value for standard tubes. In consequence we have found the transformer coupled case using a transformer of reasonable turn ratio (3 to 1) to be 24 V.U. approximately, while that of the resistance and impedance coupled cases is on the order of 7 to 8 V.U. It is not true, however, that this proves the transformer coupled amplifier to be three times as good as the resistance or impedance coupled amplifier since it by no means requires three stages of the latter to equal the former. It is very easy to see from the above calculations that a second stage of resistance or impedance coupled amplification would bring the total gain up to from 49 to 64 V.U., since the 7 or 8 volts appearing in the grid circuit of the second tube will result in a similar multiplied voltage on the grid of the third tube. This means that the gains of successive stages of amplification are multiplied, not added, to get the overall result when the gains are expressed in voltage units.

Thus far the case of resistance and impedance coupling does not look very encouraging as compared to transformer coupling. However, it happens that by properly controlling the vacuum tube constants we may gain considerable advantages in resistance or impedance coupling which are not reflected by similar improvements in transformer coupling so that the two systems become more nearly equal in over-all performance. The principal improvement is in the matter of amplification constant. If the amplification constant is increased to 30, for example, it may be possible to obtain as much amplification from a resistance or impedance coupled stage as from transformer coupling using $\mu=8$.

It would seem off-hand that large amplification constants might also greatly increase the gains in transformer coupled amplifiers. But this cannot be done without also increasing the plate impedance, so that the problem of suitable transformer design becomes very acute. It is the sad experience of any one who has tried transformer coupling with high-μ tubes that the bass notes of a musical program are immediately dropped out. Since at the cost of a few extra dollars the desired amplification can be had without the sacrifice of quality it appears foolish to try this means of increasing the gains.

Conclusions

BRIEFLY, the method of the foregoing calculations has been first to determine the voltage across the impedance Z of Fig. 3,—whether Z be a transformer primary, a plate resistance R_1 or a choke coil L_1 and then to determine the effect of that voltage on the rest of the circuit. This effect is a multiplication in the secondary of the transformer although a great number of turns may cause high frequency losses due to distributed capacity. In the case of resistance and impedance coupled amplifiers both the grid resistance and the coupling condenser cause a loss of voltage which is quite negligible if a 1 megohm resistance and a 1 mfd. condenser are used.

A study of the fundamental equation (1) shows that the gain in a tube depends upon the product of its amplification constant μ and the ratio of the load impedance Z to the total impedance of the plate circuit $\sqrt{Z^2+r_p^2}$. When Z is very large as compared to r_p this ratio approaches unity and the amplification very slowly approaches μ as a maximum, the last large increases in Z producing only small increases in the gain. Z increases with the frequency, but due to the small increase of gain for large increases in frequency, the amplification for the higher audio frequencies is fairly uniform if the transformer has a high inductance. When Z is very small compared to r_p, the ratio approaches that of Z/r_p and the amplification will vary almost directly with the frequency.

If a high impedance tube is used, much of the advantage gained through the use of a high impedance transformer is lost as their ratio becomes smaller. So a low impedance tube in combination with a high impedance transformer should give the best results.

A low impedance tube generally has a low amplification constant, thus limiting the gain or results from a high B battery voltage and current, which is expensive. Furthermore high impedance in a transformer is obtained only by the use of many primary turns and heavy or expensive cores. So the cost becomes the limiting factor.

Similar considerations affect the design of an impedance coupled amplifier, except that a high impedance choke is more readily secured than a high impedance transformer. For good results the quotient obtained by dividing the inductance of the coil in henries by the μ of the tube should be 25 or more. If this quantity is less than 10 the frequency characteristics of the amplifier will be relatively poor.

In resistance coupling, the insertion of plate resistance R immediately causes an increase in r_p, assuming that the B battery potential is kept constant. Substituting R for Z in equation (1) we have $\mu R/(R+r_p)$..........(5).

If now every increase in R results in an increase in r_p it is obvious that much of the advantage of increasing R will be destroyed by the increasing plate impedance. However, resistance coupling offers a compensating advantage in the fact that R is independent of frequency and therefore equation (5) represents a gain which is absolutely independent of frequency. If we have chosen a suitably large condenser C and a suitable value for r_g as mentioned above, our resistance coupled amplifier will present a very good frequency characteristic. In general about 1 mfd. and 1/2 megohm are to be recommended respectively.

It is hoped that the preceding paragraphs will have cleared up much of the mystery which surrounds vacuum tube amplification at voice frequencies. A study of what happens at intermediate frequencies and at radio frequencies may be undertaken in another article.

DETECTOR TUBES

Although any of the tubes commonly used for radio reception may be used with satisfaction in the detector socket, some tubes give better results than others and best results are secured by adapting the grid leak and condenser values to the tube used. In general, the return lead from the grid circuit should be connected to the positive side of the filament, except in the case of the new 300-A and the old 300 tubes.

For the C-11 and CX-12 tube a grid leak of 2 megohms and a condenser capacity of .00025 mfd. is recommended. The normal plate voltage is 22.5, although 45 volts will give slightly greater signal strength.

For 299 tubes the only change is a higher grid leakage resistance, 3 megohms for ordinary signals and more for weak signals. Microphonic noises may be minimized by using a cushioned socket and by maintaining the filament voltage at its rated value of 3.3 volts, as the tendency of the filament to vibrate often becomes more pronounced at reduced filament temperatures. Flexible connecting wire to the sockets should be used. The advantages of a cushioned socket are frequently lost by the use of stiff connecting wires.

The 301A tube also takes a 2 megohm grid leak and .00025 mfd. condenser. It gives satisfactory detector action on any plate voltage from 22½ to 67½ volts. Its possible microphonic action is minimized by operation at its rated filament voltage and by the use of cushioned sockets, soft sponge rubber being the most satisfactory cushioning material. The cushioned socket is almost a necessity if a power amplifier tube is used in the output stage as the greater intensity of sound vibrations from the speaker subjects the detector to increased vibrations and may at times cause it to "sing" or "howl."

The new 300-A tube is a special alkali-vapor detector whose sensitivity is at least as great as the most critically adjusted old 300 tube, whereas this sensitivity is now attained without critical adjustment of either filament or plate voltage. It is also less subject to micro-

(Continued on Page 58)

Unfailing "B" Power From the W. E. Amplifier

Instructions for Obtaining "B" Current and Biasing Voltage From the Western Electric 25-B Power Amplifier

By E. E. Griffin

THIS article is intended for the present or prospective owner of the Western Electric type 25-*B* power amplifier. In the metal case of the amplifier unit is contained one stage of power tube audio amplification, and a one tube rectifier and filter system, the complete diagram of connections being given in Fig. 1.

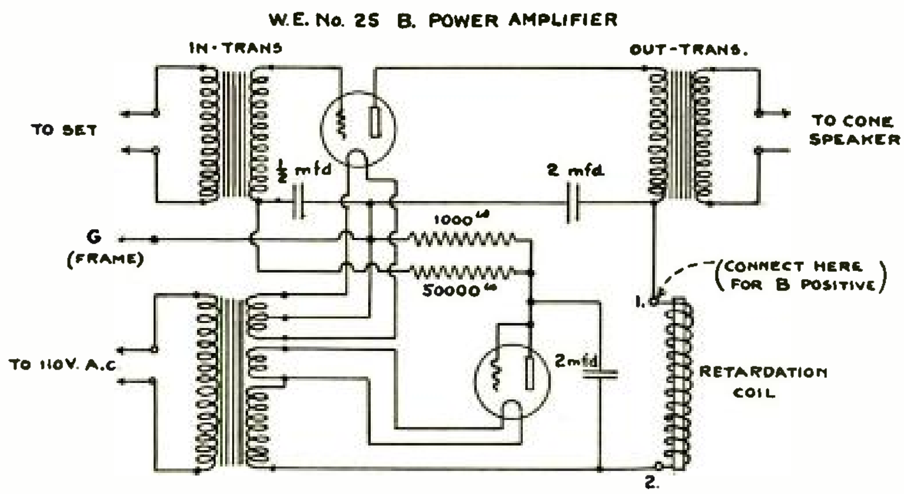


Fig. 1. Diagram of Connections of Power Amplifier.

The output of the power transformer is rectified by the single tube and filtered by a choke coil and two capacities of 2 mfd. each, supplying the amplifier tube with a plate voltage in the neighborhood of 350 d.c. Negative bias for the amplifier tube is obtained by utilizing the voltage drop across a 1000 ohm resistance placed in series with the negative return lead from the amplifier to the filter. The filaments of both tubes are supplied with low voltage a.c., the power transformer having a separate five volt winding for each tube in addition to the high voltage secondary winding which supplies the rectifier system. Both tubes used are the W.E. type 205-D, the rectifier tube socket having its grid and filament posts connected together to increase the tubes' output as a rectifier.

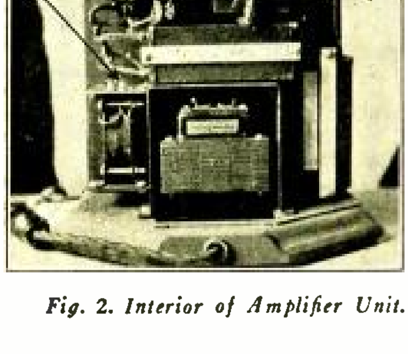


Fig. 2. Interior of Amplifier Unit.

Since the rectifier and filter system constitutes an excellent *B* eliminator, it is a simple matter to use this supply for the operation of the receiver with which the amplifier is used, no changes in the wiring of the amplifier unit being necessary; and within certain limits, without affecting the operation of the amplifier. In Fig. 2 is shown a rear view of the unit with the case removed. At the top are the input and output transformers, below is the power transformer, and at the left hand side is the retardation coil. On the top of this coil are two posts marked *1* and *2*, post *1* being the filtered positive side of the rectifier system. The negative return connection is made to the opposite end of the 1000 ohm resistor away from the *G* post.

The actual output obtainable from these connections with the amplifier and cone in operation is given in the curve of Fig. 3, no noticeable change in tone or volume being apparent until over 40 milliamperes current is drawn, thus showing that there is quite sufficient current available for the average receiver without impairing quality of reproduction.

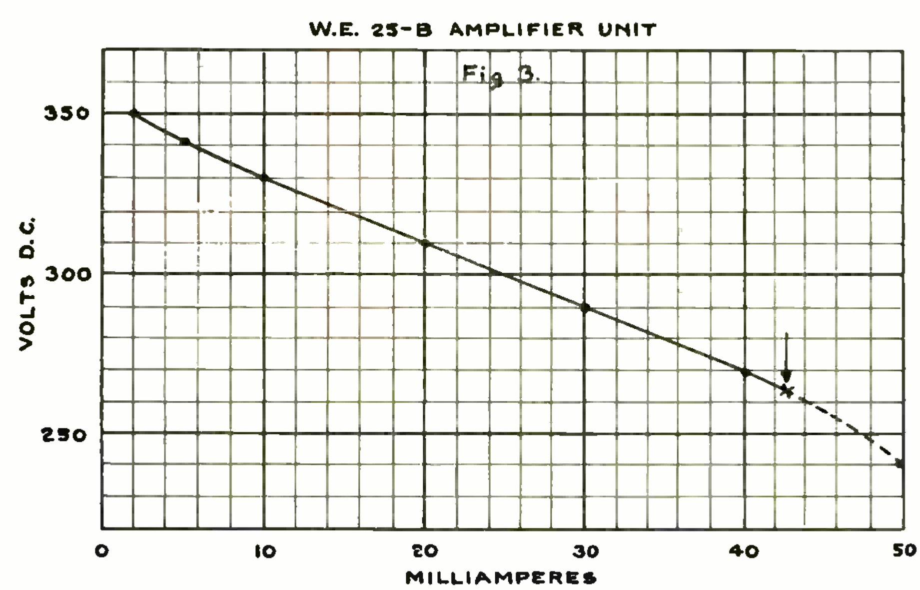


Fig. 3. Output Curve of Amplifier.

To reduce this high voltage to the 90 volt value ordinarily used in receivers,

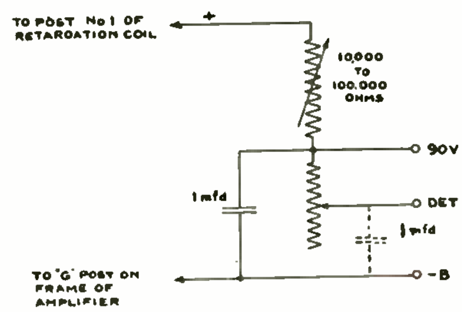


Fig. 4. Diagram of Connections for Voltage Reduction.

the conventional form of resistors and by-pass condensers may be used as in Fig. 4. The values of resistance necessary will depend upon the total current drain of the receiver, the simplest method of determination being to measure the *B* current drain of the receiver when connected to batteries; then connect the receiver to the amplifier and use a resistor that gives a corresponding current drain from the amplifier. Two variable resistors, one for the 90 volt tap and one for the 45 volt tap are preferable, Clarostats being recommended. If fixed resistors are used, a set requiring 5 mils current will call for a resistance of 50,000 ohms; 10 mils 25,000 ohms, and 15 mils 17,-500 ohms, the Allen Bradley being recommended. Variable detector voltage in either case will require a maximum resistance of 100,000 ohms, and should be connected as per diagram. The 1 mfd. by-pass condensers may or may not be necessary, depending upon whether the set has by-pass condensers already installed across these points.

The 4½-volt *C* battery on the receiver may also be discarded if desired, grid biasing voltage being obtained from the drop across part of the 1000 ohm resistance of the amplifier. This resistor is mounted directly beneath the two tube sockets, and has a total drop across it of about 25 volts, the end connecting to the grid and plate of the rectifier tube being negative and the end connecting to the G post being positive. To utilize this for *C* bias voltage on the receiver it is only necessary to connect the —4½ *C* lead from the receiver to a point on the resistance approximately one-fifth of the total length of the resistor, connection being made nearest the end that runs to the *G* post. The frame of the amplifier or *G* post in this case must be used as the negative *B*, and its connection should be made to the negative *A* battery.

This method of obtaining negative bias through the drop of a resistance is applicable to any form of *B* eliminator when it is desired to do away with the *C* battery. In the amplifier, if such connection is not desired, the negative *B* terminal should be taken from the end of the resistor which connects to the grid and plate of the rectifier tube, and should be connected to the negative *A* battery as is customary.

Fig. 5. Power Amplifier with Added Apparatus.

Fig. 5 illustrates the power amplifier with all added apparatus necessary for adapting it as a *B* eliminator mounted inside of the metal container. Since the frame and container connects to the negative side of the amplifier system, it is necessary to insulate all added parts from the frame. This is easily accomplished by cutting a piece of bakelite to the size of a side panel and securing it flat against the inside. The binding posts and variable resistance knob may then extend through holes in the metal container. the holes being large enough to prevent shortcircuiting. Resistor holders and condensers are mounted on the back of the bakelite, there being sufficient room for them to the right of the tube socket. In this form the complete amplifier with *B* supply for the set is as compact and portable as before.

The question naturally arises, how long will the rectifying tube stand up under the increased current. To this question the writer has no answer except that so far no failures have appeared. The type 205-D tube is rated by the manufacturers as having a maximum continuous plate capacity of 15 watts, and considering the average current of the amplifier as 25 milliamperes; connected to a set drawing 15 milliamperes the total would be slightly less than 14 watts, so it is assumed that no harm will result with an additional drain up to 15 mils. This is neglecting the fact that the grid and plate are connected together. For those interested additional data on this type of tube is as follows:

Filament Voltage, 4.4.
Filament current, 1.6 amperes.
Plate voltage as amplifier, 350.
Plate voltage as oscillator, 350.
Grid voltage as amplifier, 25.
Plate current, 25 milliamperes.
Plate to Filament impedance, 3000 to 4500 ohms.
Amplification constant, 6 to 7½.
Maximum safe plate voltage, 350.
Maximum intermittent plate watts, 20.
Watts output as an oscillator, 5.

RADIO IN AUSTRALASIA

By IVAN M. LEVY

In Australasia radio broadcasting is making excellent progress, for now there are about 130,000 licensed broadcast listeners, and the number is increasing every month. Australia is a country of vast distances; its area is greater than that of the United States, and the crying need is for more powerful broadcast stations. I notice in all the United States lists of broadcast stations in Australia that the information is utterly out of date, and owing to the fact that letters are frequently received from the Pacific Slope reporting reception of Australian broadcasting an accurate list of the Australian stations should find interest in the Western States.

The Australian broadcast stations are as follows (the A class being the more powerful):

NEW SOUTH WALES—2BL Broadcasters Ltd., Sydney, 353 meters; temporary power about 1,500 watts, which will be greatly increased shortly. Class A.

2FC, Marmer & Co. Ltd., Sydney, 1,100 meters; power 5 kilowatts.

2KY Trades Hall, Sydney, 280 meters; low power. Class B.

VICTORIA—3LO Broadcasting Co. of Australia Proprietary Ltd., Melbourne, 371 meters, power 5 kilowatts. Class A.

3AR Associated Radio Ltd., Melbourne; 484 meters, power 1600 watts. Class A.

QUEENSLAND—4QG Queensland Government, Brisbane, 385 meters; power 5 kilowatts.

SOUTH AUSTRALIA — 5CL Central Broadcasters Ltd., Adelaide, 395 meters; power 5 kilowatts. Class A.

WESTERN AUSTRALIA — 6WF Westralian Farmers Ltd., Perth, 1250 meters; power about 1500 watts. Class A.

TASMANIA—7ZL, Hobart, 410 meters; low power to be greatly increased shortly. Class A.

All the above-mentioned stations transmit day and night, every day in the week, including Sundays.

The power stated in the list, in some instances is not guaranteed, for the actual rating is not published by the owners of the stations. Therefore the figures given in such cases are only a rough estimate.

The evening musical program in Australia generally commences at 8 o'clock. I have observed that the California newspapers are widely astray as to the difference in time between the Eastern Australian States and the Pacific Coast. As a guidance to those who are in the dark in this respect I must explain that when it is 8 o'clock in the evening in Australia it is 2 o'clock in the morning of the same day on the Pacific Coast of the United States. New Zealand is an hour and a half ahead of the Eastern States of Australia (which embrace Brisbane, Sydney, Melbourne and Hobart). Adelaide, which is in the state of South Australia, is two hours behind New Zealand. Therefore when the New Zealand stations commence their evening entertainments at 8 o'clock the time on the Pacific Coast is 12:30 in the morning of the same day.

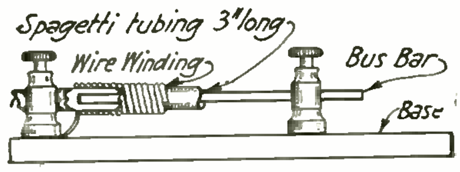
In New Zealand we are still suffering from the disadvantage of a "flivver" broadcasting service as the new Radio Broadcasting Company of New Zealand which owns and operates all the broadcast stations in this country has not yet installed any of its up-to-date high-power stations. The first is expected to commence operations in Auckland within a few weeks. The steel masts, imported from a bridge-manufacturing company in Canada, have just arrived in Auckland. The Auckland station is to have an output of 500 watts, little enough, but it will be incomparably greater in power than the existing makeshift stations. The number of licensed broadcast listeners in New Zealand is about 3,000; seemingly many are waiting for a better broadcast service before taking up radio. In New Zealand there is a population of about a million and a quarter while in Australia the population is nearly seven millions. according to a recent census.

ERRATA NOTICE: Typographical mistakes in W. C. Eells' article on "Simplified Inductance Calculations" in July RADIO require a re-statement of the first problem and solution. The problem should be: How many turns of No. 26 d.c.c. wire wound on a 2 in. coil are necessary to give an inductance of 200 microhenries? From Table II the number of turns per inch is found to be 39 and by substitution in equation (1) $C=(2)^3(39)^2 \div 200 = 60.84$. From Table I, by interpolation, the value of d/l corresponding to 60.84 is found to be 1.0375. Where $l=2 \div 1.0375 = 1.93$ in. and the required number of turns $nl = 39 \times 1.93 = 75.3$ turns.

Radio Construction Pointers

By Paul Oard

IN BUS-BAR wiring jobs, it is sometimes desirable to provide a margin of safety where wiring from one circuit crosses that of another circuit, by using Spaghetti tubing on some of the leads. If a short length of tubing is used at the cross-over, and the particular bus wire is in the nature of a long straight length, there is a chance that the spaghetti will move away from the cross-over, allowing a short circuit. A drop of solder placed at each end of the length



Holding Spaghetti Tubing in Place.

of spaghetti, as shown in the illustration, serves to overcome this possibility, and permits one to use very short lengths, just sufficient to cover the cross-over.

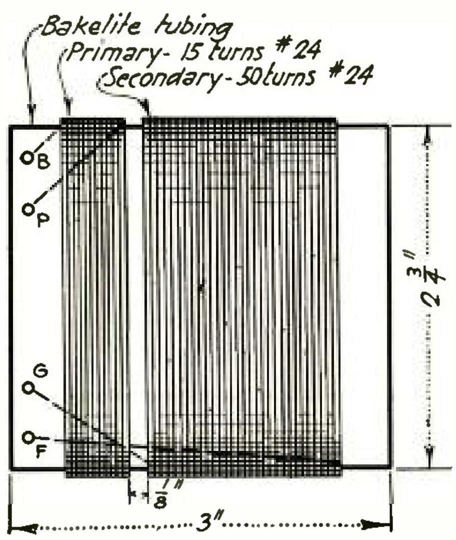
T. R. F. Coils

PROBABLY the most widely used radio receiver today is that incorporating the so-called tuned radio frequency circuit with two stages of tuned radio frequency ahead of the detector. The first sets of this type used a single-layer solenoid winding. From this type evolved a number of low loss coils, many of them "self neutralizing," and not requiring the small neutralizing condensers which are a part of the Hazeltine Neutrodyne circuit. Some of them are efficient only on the lower wavelengths, where they are operating with a lower ratio of capacity-to-inductance. But as capacity is increased with regard to the inductance in the circuit on the higher waves, this efficiency drops off rapidly.

Where tuned radio frequency is used, a simple test as to the efficiency of these coils is found in the inability to bring in "background" over the entire range of the dials. "Back-ground" is the slight rolling and hissing sound that is heard in the speaker or headset, when the dials are set so that each tuned radio frequency unit is in resonance on one particular wavelength. Inefficient coils will bring in this back-ground on the lower bands, but at around 350 meters this back-ground becomes fainter until at 400 meters it will disappear altogether. With the decrease in back-ground, received signals likewise diminish in strength. Back-ground should not be confused with induction or man-made static such as artificial electric disturbances. It is inherent in all tuned radio frequency sets that are efficient, and is one form of regeneration, corresponding to the roll and hiss obtained in the single circuit receiver employing a tuned plate and which occurs just before the circuit breaks into violent oscillation.

In the attempt to secure self-neutralizing coils, this back-ground is ofttimes lost. In a well designed neutrodyne receiver, where neutralizing condensers are used to prevent over-oscillation, in addition to this back-ground note, there is a decided "thump" as the dials come into resonance with each other, especially noticeable when there are no stations on.

A self-neutralizing coil which brings in back-ground over the entire range of the dials, and produces this "thump" can be made by tightly winding No. 24 insulated wire on a form whose outside diameter is from 2¾ to 3 in., by 3 in. in length. The illustration shows the method of connections.



Coil Construction for T. R. F. Circuit.

The coils should be so mounted that the angle may be varied from 45 to 55 degrees, neutralization being accomplished in this manner. A five-tube circuit made up with these coils, spaced 5 in. apart between centers makes as efficient a set as may be purchased, and will compare favorably with the better makes of neutrodynes on the market, and in actual test, proves superior to a number of sets employing peculiar shaped inductances. If the job is done right, using .00035 condensers, back-ground is constant over the entire range, the "thump" is likewise present, and extreme selectivity and sensitivity may be looked for.

Direct Wavelength-Reading Dials

SLOWLY but none the less surely, receivers now coming on the market are beginning to adopt types of dials in which space is either provided for writing in the call letters of stations received, with their wavelengths, or by direct calibration of wavelengths stamped onto the dial before the set is shipped from the factory. The new types of vernier dials which carry in their housing small windows through which wavelength and station calls may be jotted down are typical of this trend.

The average plain style of dial has a flat surface between the knob and the bevel of the dial, on which the scale is engraved, which is generally wide enough to allow of the placing of a curved sheet of bristol board or similar material on which notations may be made. This method of logging stations is applicable to all tuned radio frequency receivers, whether one, two or three dial, the super-heterodyne one and two dial types, and those types of straight regenerative receivers where the tickler is fixed, and variation of inductance is accomplished through means of a shunted variable condenser, without the use of an inductance switch in addition.

The picture shows the method of treatment. It is advisable to jot down on the log dials only those stations which are dependable in reception, writing down the wavelength directly under the call letters, obtaining this, of course, from the program magazines. Glue is used to fasten the logging cards, though if a neat and readily renewable system is desired, two small holes, tapped say 4/36

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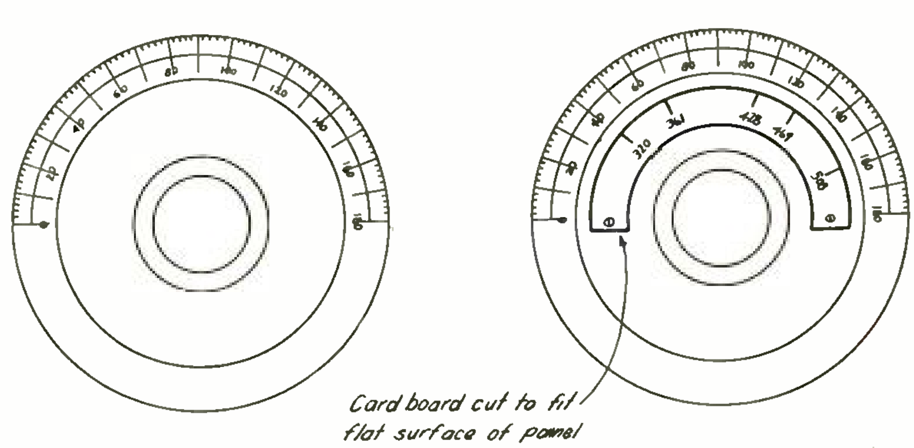


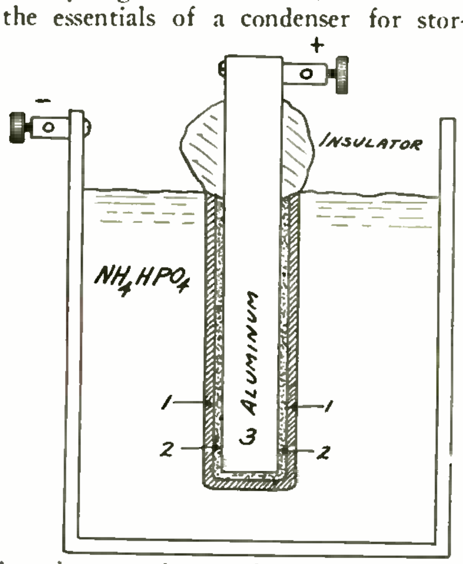
Conversion of Dial to Read Directly in Wavelengths.

Electrolytic Condensers

By C. William Rados

AN ELECTROLYTIC condenser of high capacity can be made by immersing aluminum, magnesium or tantalum plates in some electrolyte such as a solution of sodium and ammonium sulphate, of ammonium citrate, of potassium permanganate or of other salts. This type of condenser is well known among electrical engineers as the Mershon condenser and has been used in crude form by amateur radio operators for years.

Its theory of operation is illustrated in the accompanying sketch when *1* indicates the gas film or di-electric which is formed when a strip of aluminum is immersed in a solution of ammonium diphosphate; *2* indicates the oxide film which is formed; *3* is the aluminum anode and the salt solution the cathode. Thus we have a pair of conductors with their surface relatively close together but separated by a di-electric which has a very high resistance. These are all the essentials of a condenser for storing electrostatic capacity.



The choice of electrolytes is somewhat dependent upon the voltage at which the condenser is to be operated. The critical voltages for various electrolytes are shown in the following table from the 1909 volume of "Electro-chemical and Metallurgical Industries":

CRITICAL VOLTAGES AND ELECTROLYTES

Sodium Sulphate	40 Volts
Potassium Permanganate	112 Volts
Ammonium Chromate	122 Volts
Potassium Cyanide	295 Volts
Ammonium Bicarbonate	425 Volts
Sodium Silicate	445 Volts
Ammonium Diphosphate	460 Volts
Ammonium Citrate	470 Volts

This critical voltage is the maximum electromotive force which the condenser will stand without a large leakage current. Notice that the compounds listed are all cheap and available commercially. The ammonium salts are the cheapest.

With the aluminum condenser the capacity varies inversely as the voltage. This means that if the voltage is doubled, the capacity is halved. A short list follows:

VOLTAGE OF FORMATION

50 Volts	14.2 MF. per Sq. In.
100 Volts	5.1 MF. per Sq. In.
200 Volts	2.58 MF. per Sq. In.
400 Volts	1.29 MF. per Sq. In.

"In passing from a lower to a higher voltage the thickness of the gas layer increases and arrives at a new value in a few minutes. However, in going back to a lower voltage, it takes many months before the thickness of the layer reduces to its first value." Thus the capacity is not the same with reversed currents. To have equal capacities both ways, both electrolyte and plate must have equal areas and must be formed at the same voltages.

The only condenser of this type available to the amateur was the Amrad, which is to be put on the market again. In this condenser, the anode (positive) is made of a very large metal surface so as to get as great a capacity as possible. As an electrolytic condenser will arc violently from exposed metal to surface of electrolyte, the anode is carefully covered with insulating material from just below the surface of the electrolyte to its terminal binding post. A layer of oil prevents evaporation. Remember that the film di-electric can be healed after a puncture, as the gas will form again. Very effective condensers of this type may be made with aluminum pie-plates.

A satisfactory ground connection for a portable receiver can be made by connecting to an insulated wire stretched on the ground, instead of to a poor or metallic ground, such as a rod driven into a wet spot.

"AND IN THOSE DAYS—"

By C. Sterling Gleason

AND IT came to pass that, at the dawn of the reign of Super-Power, there dwelt a novice. And in knowledge of the art of Marconi was he as a little child, to be led. And there were many who would lead and guide him, even his neighbor, who possessed a feeble crystal set, and his brother-in-law, to whom belonged a modest blooper, and the iceman, who spoke loudly of his simple reflex, and even him who dwelt across the highway, whose great neutrodyne which he had builded with the labor of his own hands was the envy and the despair of all around, and who was indeed a radio oracle of great wisdom, whose every word was to be treasured as rubies.

And there stirred in the breast of the novice the seeds of ambition, to create for himself a receiver of great worth and surpassing excellence, that all might marvel thereat. Wherefore he amassed all manner of diagrams, and parchments, and pamphlets, and gathered plans and specifications of every kind, against the day of building. And after many days of searching, from the multitude of circuits one was chosen, because of its many advantages, as set forth in the columns of the "Morning Howl," for this wonder of engineering skill held within itself "all the goodly points of the superheterodyne, neutrodyne, pliodyne, reflex, and radiola, as has been spoken of old: greater selectivity, greater volume, greater distance, greater battery economy, and greater 'radiobility'."

And he pondered secretly night and day over the description, and upon his

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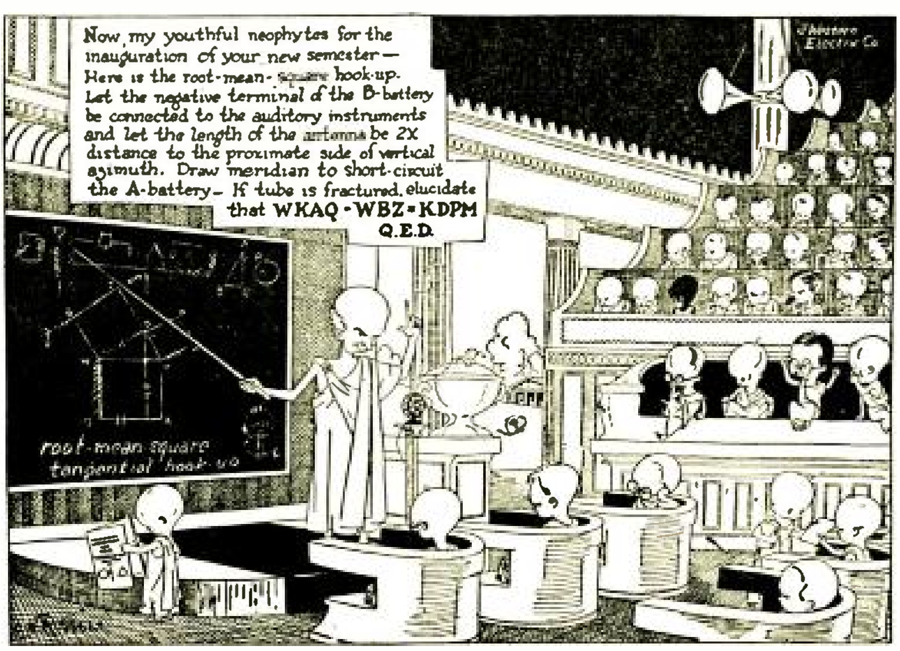


Electrified History—Professor Euclid opens school in Greece

Controlling Regeneration

By L. W. Hatry

REGENERATION is accomplished by feeding back part of the energy from the plate circuit of a vacuum tube into the grid circuit, thus amplifying the energy in the grid and making the tube more sensitive. If this feed-back is not limited in some way, it soon becomes excessive and the tube starts to oscillate. The various methods of control whereby a tube reaches maximum regeneration without breaking into oscillation constitute the major difference between many circuits.

The usual method is to vary the mutual induction between the plate and grid coils by means of a movable tickler coil. The average broadcast listener finds difficulty in logging his stations when using this method. A simple scheme devised by the writer to partly obviate this

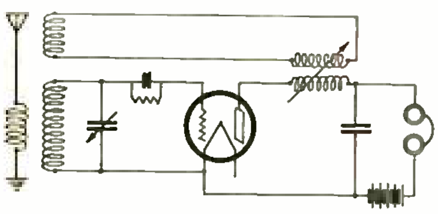


Fig. 1. Link-Coupled Regeneration.

difficulty is shown in Fig. 1, which gives a greater constancy of dial readings than is generally possible.

Aside from such mechanical movement of the tickler coil to vary the coupling, control of regeneration is also secured by variable resistances or reactances so as to vary the mutual induction between fixed grid and plate coils.

One such scheme of resistance con-

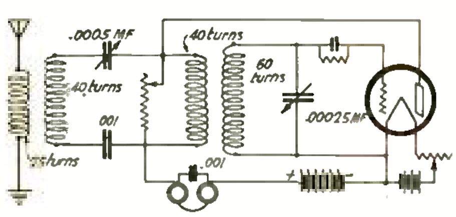


Fig. 2. Resistance Control of Regeneration.

trol is shown in Fig. 2, a derivation from the tuned-link circuit. For continuous satisfaction this circuit requires some form of variable resistance which will stand the wear of constant use. The double coupling and two-tuned circuits make it selective. Another method is shown in Fig. 3, the resistance being in series with the *B* battery so as to vary

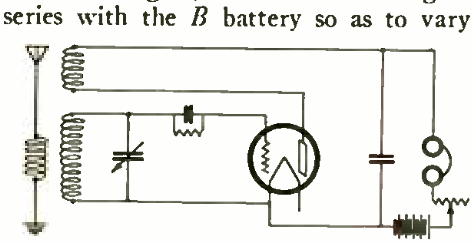


Fig. 3. Series Resistance Control.

the amount of current used. This is satisfactory for a radio frequency amplifier but not for a detector, due to the greater feed-back in the latter.

The usual method of inductive reactance control by means of the tuned plate circuit is now seldom used because of difficulty in adjustment of the variometers employed. Control of the amount of energy by varying the opposition of the r.f. path by means of a variable condenser is shown in Fig. 4, which may be

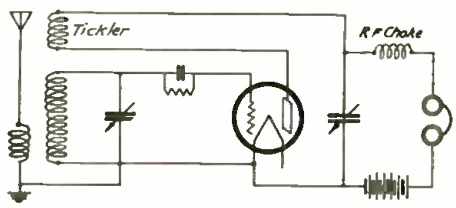


Fig. 4. The Weagant Circuit.

ascribed to Weagant. The condenser in the plate circuit directly controls the amount of current in the feedback coil by controlling the plate current opposition.

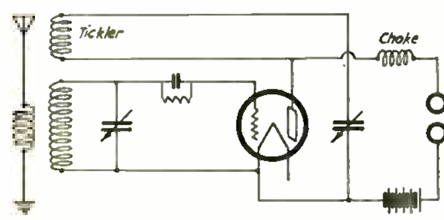


Fig. 5. The Schnell Circuit.

The so-called Schnell circuit of Fig. 5 is well adapted to the short wavelengths below 100 meters where the high frequency current prefers the controllable condenser path to the headphone route. It is not well adapted to broadcast reception.

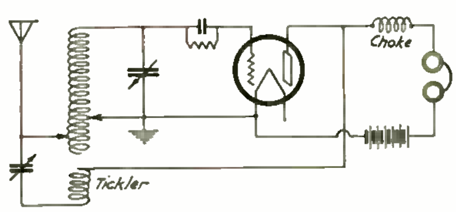


Fig. 6. The Reinartz Circuit.

The Reinartz circuit of Fig. 6 makes the antenna coupling coil a part of the plate circuit. It is therefore a particularly bad "squealer." The Cockaday circuit of Fig. 7 combines the DeForest ultra-audion with an absorption circuit

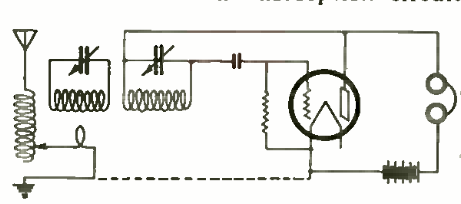


Fig. 7. The Cockaday Circuit.

and successfully employs a very loose-coupled antenna to improve selectivity and to minimize radiation. Its chief disadvantage is the possibility of body capacity effect. The main reason for the excellent results it gives is the tuned antenna.

The maximum transfer of energy occurs when the antenna circuit is in resonance. Consequently it not only improves selectivity but increases volume. To avoid "messing" the secondary tuning use a small antenna coil and tune the antenna circuit with a separate tapped coil.

INTERNATIONAL RADIO NOTES

From H. DE A. DONISTHORPE

The Spanish government contemplates the erection of a station at Prado del Ray, near Madrid, to broadcast musical and educational programs on a wavelength of 3800 meters.

A 50 kw. station is to be erected at Langenberg, near Cologne, Germany, taking the place of two relay stations and thus conserving wavelengths which are beginning to become as scarce in Europe as in America.

The experiences of a diver as he walked along the bottom of the Thames River with a microphone inside of his helmet were recently broadcast by the British Broadcasting Co.

Amateurs at Cairo, Egypt, propose to erect a transmitting antenna on top of the Pyramid of Chephren 472 ft. high. The transmitter will be installed within the tomb of Rameses. A number of receiving antennas were mounted on the pyramids during the war for listening to enemy messages.

JAPANESE STATION JOAK

JOAK, which has been operated by the Tokyo Hoso Kyoko (Tokyo Broadcasting Bureau) since July, 1925, is a 1000 watt station operating on a wavelength of 375 meters. It has been heard in Hawaii, Alaska, the United States and Australia, but is operated primarily for service to subscribers residing within a radius of 1000 miles from Tokyo. These subscribers pay one yen per month to the Bureau and one yen per year to the government which supervises programs and rates. There are nearly 200,000 subscribers, the number increasing at the rate of 600 per day.

Programs occupy about seven hours a day between 9 a. m. and 10 p. m. In addition to news and market reports Japanese and foreign music, and radio plays, especial attention is given to educational features such as household economics, courses in English, and lectures on scientific, historic and literary subjects.

Making a Quartz Crystal Oscillator

By Paul F. Byrne and S. A. Sollie

THE USE of a quartz crystal as a means for maintaining a constant frequency of output from a vacuum tube oscillator, such as is used in radio transmission, depends upon its piezo-electric property of mechanical vibration when subjected to the pressure of an alternating electric field. Each crystal has a definite frequency or frequencies of vibration, depending upon its dimensions. These may be so chosen that any desired frequency may be obtained.

Its principle of operation is illustrated in Fig. 1, an oscillating vacuum tube circuit whose frequency of oscillation may

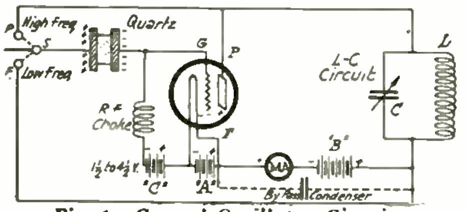
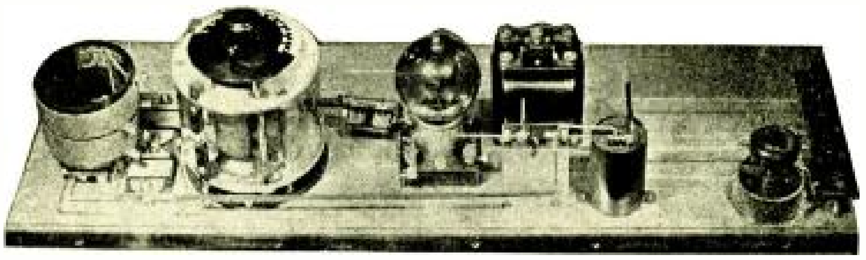
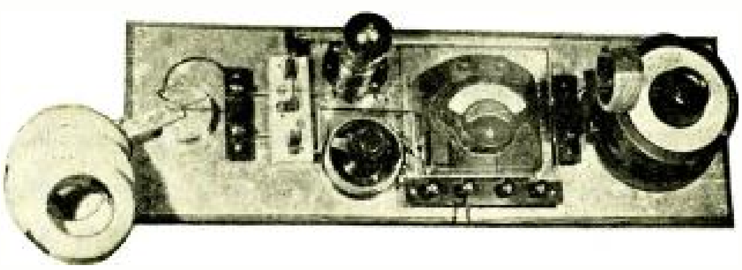


Fig. 1. Crystal Oscillator Circuit.

be changed by means of the variable condenser in the *LC* circuit shown in Fig. 1. The quartz crystal is placed in the grid circuit which may be connected to either the plate or filament of the tube by means of the switch *S*.

When *S* is connected to *P* a constant space current flows from the filament to the plate as long as the *LC* circuit is detuned from the crystal's frequency of vibration. This gives a positive charge to the plate side of the crystal and a negative charge to the grid side, thus placing the crystal under a mechanical strain due to the pressure of the electric charges and preventing the circuit from oscillating. But when the *LC* circuit is tuned to resonate at the same frequency as that of the crystal's





Experimental Crystal Oscillator, with Intermediate Amplifier.

oscillation the crystal faces become charged alternately, changing the charge on the grid and thus changing the plate current. Then the circuit breaks into continuous oscillations of a frequency equal to that of the crystal's normal period.

Likewise a connection to *F* is used when low frequency oscillations are desired. The grid-biasing circuit *GAF* frequently forces oscillations otherwise unattainable.

The practical use of the oscillating quartz crystal in controlling the frequency of a transmitter has been described so often as to require little elaboration here. But as less information is available upon the actual preparation of the crystal the methods employed by the authors should be of interest to other experimenters.

Having selected a piece of clear quartz crystal free from coloring matter, cracks or other flaws and large enough to cut out at least a ½ in. square, the first problem is that of cutting and polishing to the desired dimensions.

The most reliable cut was found to be one taken in the *XZ* plane as shown in Fig. 2, giving stronger fundamental oscillations than cuts taken at other angles. One crystal is capable of having several fundamentals, depending upon the angle of cut. The sides and faces of the rectangular prism cut must be parallel to one another and to the *XZ*

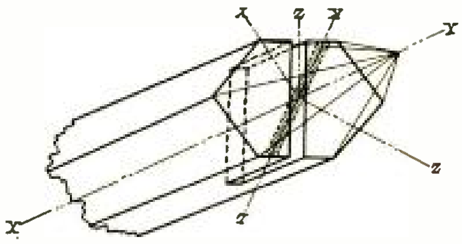


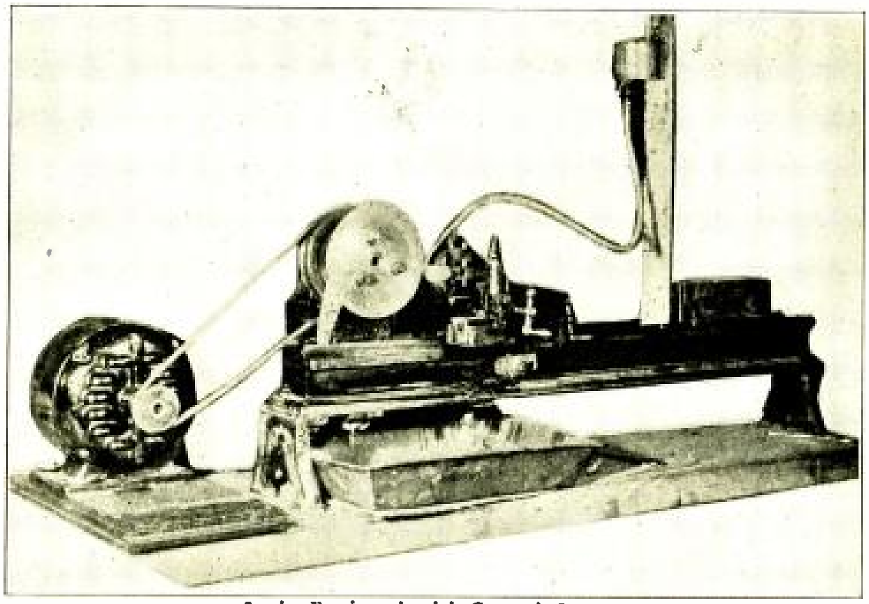
Fig. 2. Method of Cutting Crystal.

plane of the piece from which it is cut. The fundamental wavelength at which the crystal will oscillate is equal to 104.6 times its thickness in millimeters.

The cutter consists of a motor-operated steel disc with which the crystal is pressed in contact and upon which there is a continuous flow of grade 220 carborundum dust mixed with a heavy oil to have the consistency of molasses. The disc may be a 6 in. Disston circular wood saw whose teeth have been ground off and which has been subsequently casehardened. The crystal holder, which is shown in the picture, is provided with means for accurate adjustment of position, both in the plane and at right angles to the plane of the cutting disc so as to insure parallel faces.

The crystal must next be polished

(*Continued on Page 61*)



Lathe Equipped with Crystal Cutter.

QUERIES *and* REPLIES

Questions of general interest are published in this department. Questions should be brief, typewritten, or in ink, written on one side of the paper, and should state whether the answer is to be published or personally acknowledged. Where personal answer is desired, a fee of 25c per question, including diagrams, should be sent. If questions require special work, or diagrams, particularly those of factory-built receivers, an extra charge will be made, and correspondents will be notified of the amount of this charge before answer is made.

Please publish a one-tube receiver with a range of from 50 to 610 meters. Would like to be able to add a stage of high ratio audio amplification when desired. —W. M., Lebanon, Oregon.

The diagram you wish is shown in Fig. 1.

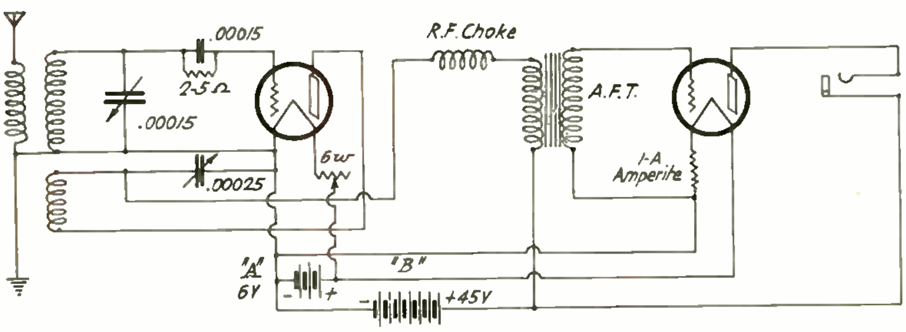


Fig. 1. Short Wave Receiver with Stage of High Ratio Amplification.

The audio stage is also shown in case you wish to add it in the future. This type of circuit was described in detail by F. J. Marco in May 1926 RADIO.

Have a Western Electric Cone speaker and would like to know if the new Type 371 power tube would be better to use with this speaker than the Type 112 power tube. Would also like the wiring diagram of their 25-B amplifier.—J. S., Oakland, Calif.

The circuit of this amplifier together with a description of how to modify it to supply *B* voltage for the receiving set is given in Mr. Griffin's article elsewhere in this issue. The type 371 tube would give more power than the Type 112, but due to the fact that the plate current of the former is of the order of 20 milliamperes or more, you will require an output transformer between the tube and the loudspeaker. The direct current might burn out the speaker windings if allowed to pass through them over a considerable period of time. The power amplifier has an output transformer and is equipped with a power tube which will supply the speaker with all the volume you could possibly desire.

I have a Best Eight-Tube Superheterodyne with 7 Type 199 tubes and a Type 112 power tube. Could it be possible to substitute the Radiola A-C package to take the place of the A and C batteries? —J. M., San Francisco, Calif.

The Radiola A-C package is a special set of resistances designed to connect the Radiola Type 104 Loud Speaker to any of the standard Radiolas so that they may be operated from rectified alternating current instead of batteries. It is not advisable to try to operate your set with these resistances. In the December 1925 issue of RADIO complete details as to the rewiring of the Best Superheterodyne for use with an *ABC* Eliminator were given. This diagram is reproduced in Fig. 2 with such improvements as are advisable. The power plant is identical with that used in the a.c. operated Browning-Drake receiver described in this issue and is the one recommended for use with any set equipped for alternating current operation.

What are the impedances of Western Electric Loud Speakers Type 518-W, 10-D, 540-AW and 548-AW? In my push-pull amplifier the output transformer impedance is 25,000 ohms and is connected to a 540-AW speaker. Should I use a compensating transformer and of what turn radio or impedance.— R. R. W., Philadelphia, Pa.

The normal impedance of the 518-W receiver at 1000 cycles is about 2000 ohms. The impedance of the receiver element in the 10-D speaker is the same, but there is an output transformer with 2000 ohm secondary and a primary impedance of about 15,000 ohms. The impedance of the 540 AW speaker at 1000 cycles is about 10,000 ohms but at 100 cycles it drops to about 2,000 ohms. The same is true of the 548-AW, the receiver element in the speaker being the same as the 540-AW. The secondary of the output transformer in the Western Electric Push-Pull amplifier was designed to work directly into a 518-W receiver. The impedance of this secondary is considerably below 10,000 ohms and no other transformer or compensating device is needed. You cannot work the 518-W receiver with its low impedance directly into the output of a vacuum tube in the last audio stage of a receiver without a step-down transformer, which is provided in the 10-D speaker. The 518-W receiver was intended to work with the Western Electric 10-*A* amplifier, which is provided with an output transformer.

I have a Western Electric 3-tube Airplane set. What kind of tubes should be used in it? Will the set radiate? Will a C battery decrease the plate current consumption?—J. A. M., San Francisco, Calif.

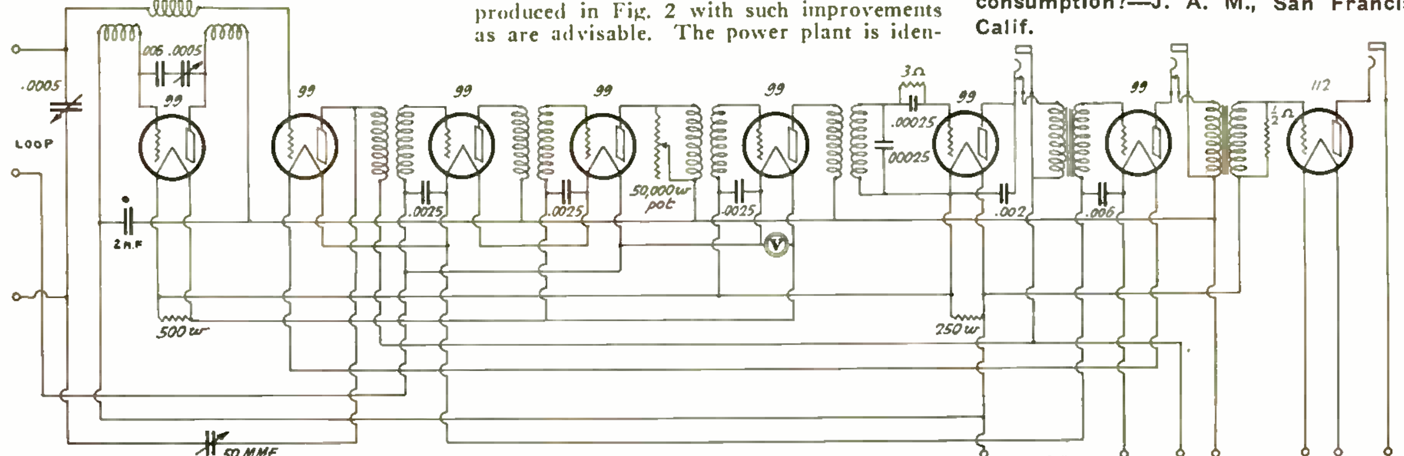


Fig. 2. Best Superheterodyne Wired for Operation From ABC Eliminator.

This set is a detector and two-stage impedance coupled amplifier with single circuit non-regenerative tuner. As it does not oscillate it will not radiate energy. It was designed to use the Type VT-1 tubes and there are fixed resistances mounted in the set to limit the current to 1.1 amperes at 6 volts. The best substitute would be the Type UX-201-A, CX-301-A which could put in the same sockets.

You can easily obtain a fixed filament resistance of 2 ohms to place in series with the positive *A* battery to limit the filament voltage to 5 volts at .75 amperes. The addition of a *C* battery will decrease the plate current consumption of the amplifier. The grid return of each audio tube goes through a one-half megohm grid leak direct to the filament. Disconnect the two wires leading from the filament end of the grid leaks and connect them together. This common wire goes to the negative 4½ volt *C* battery and the positive *C* battery is connected to the negative *A* battery. The range of this set is very limited, for it was designed to operate only over a very short distance, and unless the tuner is re-wired to make the set regenerative, it will only receive local stations.

Have a set of Sangamo intermediate transformers. Could they be used in Best's Superheterodyne by omitting the condenser shown across the filter transformer in the conventional circuit diagram? J. L. B., San Diego, Calif.

These transformers may be used in the circuit without difficulty, and as the transformers are already tuned, no extra condensers are needed.

Please show how to reflex the Browning-Drake circuit. Could the secondary of an audio frequency transformer be used as an r.f. choke?—E. H. V., Golden Valley, North Dakota.

A three-tube Browning-Drake reflex circuit is shown in Fig. 3. The secondary of an audio frequency transformer has a great many henries inductance and is unsuited for use as an r.f. choke.

I built the Silver All-Wave Regenerator described in January RADIO, and have difficulty in tuning to waves above 450 meters. How can this trouble be remedied?—R. L. L., Cairo, Ill.

The winding data given in the article was for a different sized condenser than the one specified. The following table gives the number of turns for the various coils, for the three wavelength ranges most commonly used:

190-650 meters—	Large stator	84 turns
	Small stator	25 turns
	Rotor	24 turns
90-210 meters—	Large stator	32 turns
	Small stator	14 turns
	Rotor	10 turns
50-110 meters—	Large stator	14 turns
	Small stator	10 turns
	Rotor	6 turns

Where is the best place to insert the key in a transmitter using dry cell plate supply? The reduction of key clicks to a minimum is necessary on account of interference with neighboring b.c.l. sets. —A. C. K., Seattle, Wash.

A very good method of keying, with minimum click interference, is to place a resistance in the negative *B* battery lead, so that the voltage drop across it will be 50 volts or more. Connect the grid return of the tube to the negative *B* battery side of the resistance, and the key should be connected so that when it is depressed, the resistance is shorted out. The effect of the resistance is to place the grid at a high negative potential with respect to its filament, thereby reducing the plate current to a very low value and stopping oscillations. A 25,000 ohm variable heavy duty resistor capable of carrying up to 25 milliamperes is recommended for this type of circuit.

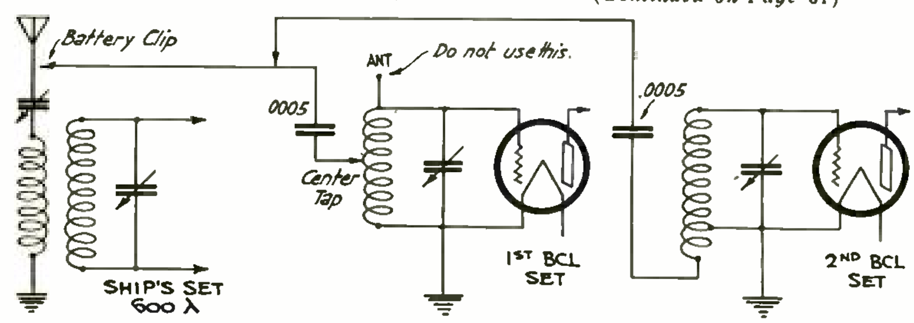
TWO OR MORE RECEIVERS ON ONE ANTENNA

By Mickey Doran

This scheme was described in RADIO last year, but evidently a lot of the gang missed it, for almost every trip some opr. asks me just how it is done. Here's the dope again if the editor will stand for the repeat.

The system is used here with an SE-1220 ship's receiver and two BCL receivers, one in the shack and the other in a room some 20 feet away on the next deck down. All three work at normal signal strength on the one antenna without inter-action except when the two BCL sets are tuned to the same station and then the signal strength falls off in both. Tuned to different stations, everything is lovely and the volume in any one of the sets is equal to what it would be with the set on the antenna separately.

Merely connect a fixed condenser in series with the antenna lead of the broadcast receiver. If the antenna connection in the BCL receiver is taken from the grid end of the first coil, do not use it as it will kill signal strength in the other sets. Take off a center tap as shown in the diagram. The series capacity must be small. Try Micadons or similar condensers from .0001 to .0005 mfds. capacity and use the size which gives the best signal strength in the BCL set without seriously affecting the tuning on the 600 meter set. A .0005 works best here on both BCL sets and changes the 600 meter tuning a few degrees on the dial when they are first cut in but there is no other effect. With .0001 mfd., there is absolutely no detuning of the 600 meter set but the signal strength falls off considerably in the BCL sets.



Three Receivers on One Antenna.

SIMPLE LONG WAVE LOADING COIL RIG

By Mickey Doran

An ordinary D.P.D.T. switch and a 1500-turn honeycomb coil, plus six short lengths of wire will convert any ship type receiver into a good long-wave tuner. Why mess around with a whole flock of honeycomb coils or the usual three-circuit loading coil rig when one coil will do the trick?

Fig. 1 shows the hook-up, the extra wiring being indicated by the heavy lines. The rest of the receiver connections are unchanged. A ground can be connected as shown but is usually not needed as there is a high capacity circuit to ground through the filament battery wiring. Fig. 2 shows the Gibbons circuit which is effected when the switch is thrown to the long-wave side.

A 1500 turn coil will cover all waves from about 7,000 to 20,000 meters with the average ship's antenna, all of the tuning being done with the secondary condenser of the ship's receiver. If the one coil does not tune

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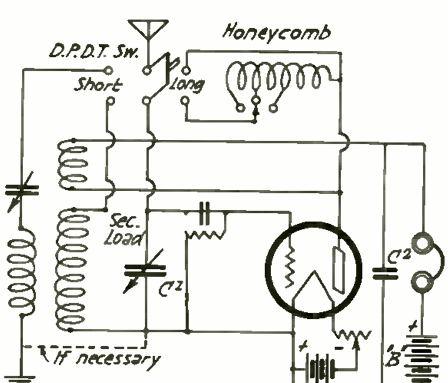


Fig. 1. Simple Long-Wave Loading Coil Rig.

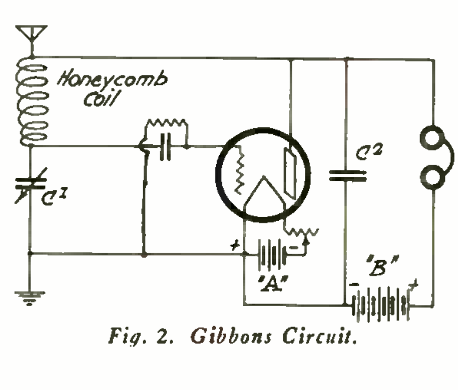


Fig. 2. Gibbons Circuit.

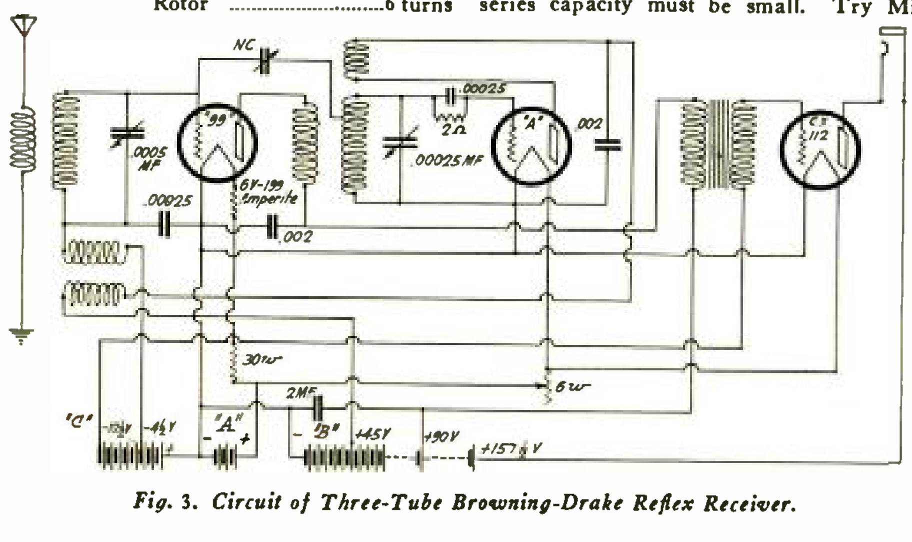
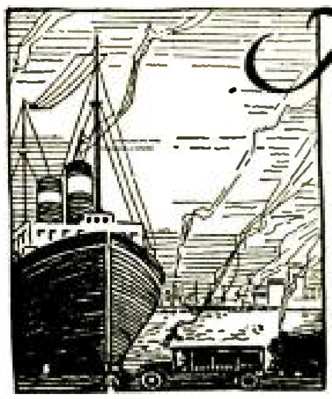
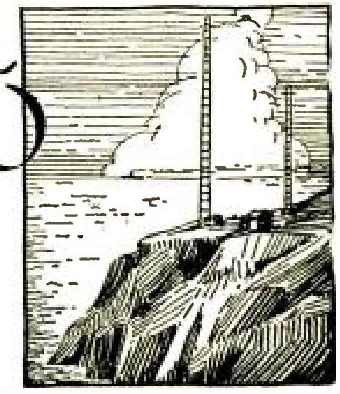


Fig. 3. Circuit of Three-Tube Browning-Drake Reflex Receiver.



The COMMERCIAL BRASSPOUNDER

A Department for the Operator at Sea and Ashore



HELP WANTED—MALE

Volunteer correspondents on each of the steamship routes or in each particular district. Each correspondent is to send in a complete list of press, time and weather schedules on his route along with other information of interest, and then follow it up from time to time with any changes or new developments. We especially request that they mention press schedules, whether QST or not. No operator has any scruples as to pirating press.

This classified (?) ad is published at the suggestion of Mickey Doran, operator of the *S.S. West Carmona,* and author of the "Oriental Radio Notes" which have been running in this department for the last four issues. And this is exactly what we have been crying for ever since we started. Skeds! Nothing is quite as handy to the sea-going radio man.

Doran says that he will take the Orient and North Pacific, supplementing his schedules mentioned above and keeping them up to date. Now who'll take the rest of 'em? Who is going to help us keep the operator right up to the minute so that he won't have to rely on a 1911 Navigation Manual from the Chart Room when he gets into unknown waters?

Doran shoots along some more suggestions. (When this guy gets to going, he goes. It's no job to see that he has the interest of this department at heart.) He suggests that we print these schedules and other real information rather than the personal mention "squibs," Who's Who, etc., if space is valuable, which it certainly is. That if anyone wants to see his name in print let him send in something of interest to justify it rather than the fact that he is eating three squares a day on the *S.S. Nonesuch.*

Well, this suggestion is going to stir up a dispute, I believe. I hope it does. There are quite a few who are interested in Who's Who, and look for it the first thing every month; at least they nearly always mention it in their letters. Nevertheless, it is certain that each name in such a department will only interest a limited few, while space devoted to something else may help many an operator out of a difficulty, and will be of real, tangible value to everyone who reads it and has foresight enough to put it aside for future reference. Let's vote. We'll run "Who's Who" until we find that the majority are in favor of abandoning it. Now that's up to you. Costs you two cents (2c) to vote.

"Circuits are always interesting," says Mickie. "For instance I don't believe there has been a circuit in print since about 1915 that held any interest for the commercial operator. Since RADIO first ran my Gibbons long wave rig., I've been thanked by radio by some half a dozen who are using it and a dozen or so more who missed the magazine have asked for a copy.

"I should like to see a good Radio Frequency circuit for the longer waves—600 meters up. KFS has a mighty good RF receiver for these waves but I've never been able to get it."

These are timely suggestions, and should be acted upon. Therefore, we are again passing the buck to you, for it is obvious that if we tried to manufacture circuits just for you to look at, you would soon catch us up on something. You men who have run across something good, or have devised something practical, why not pass it along? We're always fussing about the ship's receiver—well, if anyone of you can improve upon it, let's let the rest of the gang in on it. We'll soon have the radio companies looking to us for advice on how to improve their equipment.

Those two suggestions are enough for this month. Don't be backward about offering your services as a correspondent, for once you get a district lined up it will be easy to turn it over to someone else if you should leave that section. And don't forget to vote upon the abandonment of "Who's Who—" in favor of other material. You can have until September 15 to get your votes in, which is allowing time enough for those who are out at sea and will not get this copy until late. The question: Shall we abandon the column entitled: "Who's Who and Where" so that we may use the space for time, weather and press schedules, technical articles, etc.

We can read a lot of letters in a month; shoot 'em in.

WNU, PX AND WX SKEDS

WNU, controlled by the Tropical Radio Telegraph Co., at New Orleans sends "weather" for the Gulf of Mexico, Caribbean Sea, and Windward Passage at 11:30 a. m. and p. m. every day, after which he sends a little ship traffic then Press to KUS and UR. It is then about 11:45 when he starts on the PX, both morning and night on 3331 meters. All his skeds are on Eastern Standard Time. I have copied him QRK all the way around from New York to San Pedro on one UV-199 tube used in conjunction with the old Independent Type A-1 receiver. His PX usually takes less than 45 minutes to copy as he shoots it out at between 22 and 27 words per min., and as a rule sends from 400 to 450 words, twice daily. Some of you who don't already know this will be pleasantly surprised, as he is QSA and doesn't fool around getting started. Hoping to see all you fellows breaking into print in our new section. Let's Go! Geo. A. Molecey, *S.S. Agwismith,* KDRC.

WKF to ship: "Advise WMW if you will be delayed account of wx."

Ship: "No passenger aboard by that name."

PACIFIC NOTES

By Mickey Doran

All of the night press files over the NPM-NPO circuit are going through on short wave. NPM using a wave near 35 meters usually gets underway between 1:00 and 2:00 a. m., San Francisco time, and can be copied anywhere in the Pacific or Orient. The day files still go through on NPM's 12,180 meter arc, starting between noon and 2:00 p. m., San Francisco time. Although this press is not QST, I have heard it said unofficially that the Associated Press permits ships to intercept it provided a statement is printed on the press sheet crediting the A.P. with the news.

How many ops. are copying NPG's Major Weather Bulletins on 7,005 meters arc at 9:00 a. m. and 7:30 p. m., San Francisco time? I have met several lately who never heard of these schedules. It is good stuff and the ship's report section goes big with the O.M. The code used is explained in Department of Agriculture, Weather Bureau, Circular No. 10 and also on pages 92 and 121 of H. O. No. 205, Radio Aids to Navigation.

NPO's Manila Bulletin press schedule has been changed again. It is now sent on 5,260 meters arc, starting at 10:00 a. m., Manila time, which is 0200 G.M.T.

The following corrections apply to H.O. No. 205, Radio Aids to Navigation. Pages 210-211. JTJ, Kobe, Japanese Weather Bulletins, change time 0530 to 0630. Change first paragraph of notes under List of Stations to read. . . . The observation station is indicated by a letter sent as part of each code group; A indicating Ishigaki jima, etc., the letters A to T inclusive being assigned to the stations shown in the List.

Delete the line reading—"When observations are lacking, four ciphers replace the missing groups," and add the following to the List of Stations:

Code	*Place*	*Lat. N.*	*Long. E.*
U	Kurun, Formosa	25	121
V	Hamamatsu, Japan	34	137
W	Asmori, Japan	40	140
X	Fusan, Korea	35	129
Y	Rasa Island	24	131
Z	Macka, Sagalien	47	142

In the List of Stations, L—Akita, should be changed to read L—Niigata, Japan, Lat. 37 N, Long. 139 E.

On page 91, TABLE XI, add the following:

CODE	MEANING
I	Low area.
J	Semi-permanent low area.

On page 92, TABLE XII, enter the following changes:

CODE	MEANING
O	No remarks.

Change the present code letters O to X inclusive, to read P to Y inclusive, and add:

Z Owing to sparseness of data, center cannot be accurately located.

IMPROVING THE S. E. 143 RECEIVER and A BREAK WHICH WILL BREAK

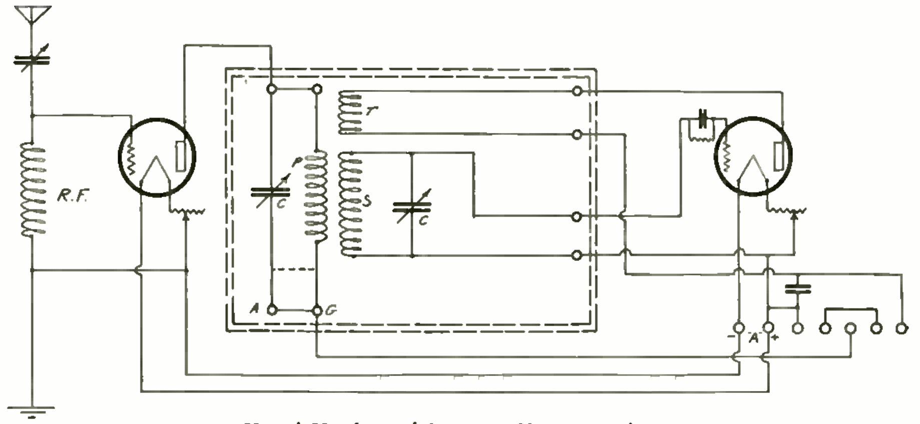
By G. D. KERMICKEL,
ex-S. S. President Garfield

THIS is an ordinary S. E. 143 Navy receiver, using any detecting apparatus that will work on any ordinary receiving set. The big idea in working out this kind of radio frequency stage instead of the usual way of adding tube, coil, condenser, etc., is: It tunes almost exactly the same as it did before; has the advantage of using the large condensers, giving it a larger range of wavelengths on one adjustment of the inductance switch; it consists of less "haywire," six wires being the total to be added; it can be put back exactly like it was before by turning off the radio frequency tube and slightly re-tuning, and it is much less difficult to handle. It also possesses just about the right amount of broadness. I have not found an extremely sharp receiver desirable for 600 meter reception because of the necessity of standing by for calls.

We have been using this hook-up on the *S. S. "President Garfield"* for some time and, though we have tried just about every kind of radio frequency hook-up imaginable, we have settled upon this one as being the nearest to perfection. It is quite a little sharper than before, but the real point is: it brings in signals—both damped and undamped—that could not even be heard before.

On these ships we find it necessary to use long wave loading coils so that we may be able to supply press for the passengers. We have, therefore, shown these coils in the diagram with a shunting switch so that they may be cut out at will.

In operating the set as a radio frequency set, it is best that the coupling switch be turned to the minimum position. In this position there is practically no inter-stage feed back and the set operates as smoothly as it did before and with nearly the same adjustments all around. The circuit is nothing more than an ordinary tuned impedance radio frequency set adapted to the old tuner of a shipboard set.



Usual Hookup of S.E. 143 Navy Receiver.

The Break-in System

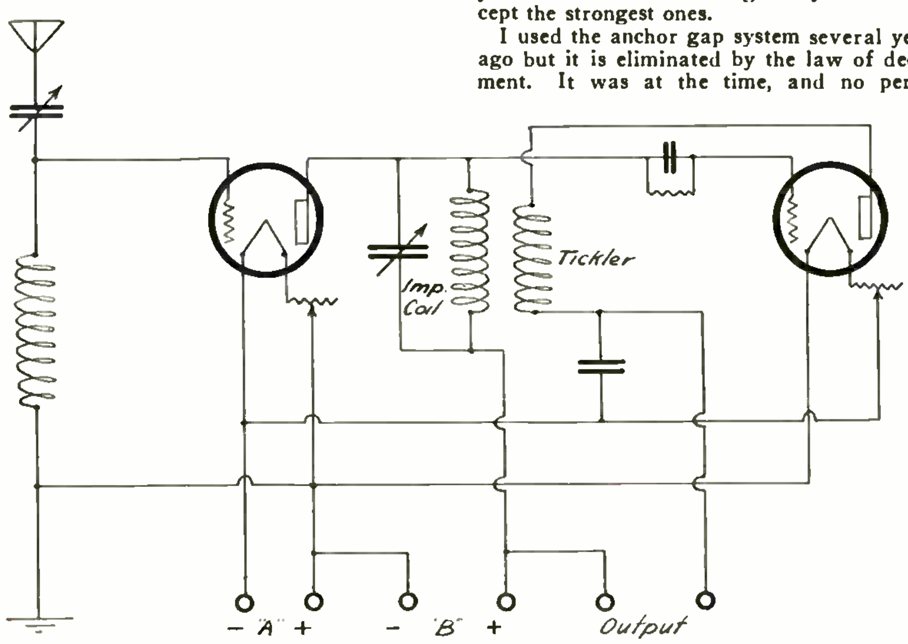
We have been trying for a long time to use a break-in system, but owing to the 500 cycle induction and a lot of other local QRM, along with the difficulty in keeping the tube from blocking, we didn't have much success until we hit upon this scheme. With this hook-up, we are able to get a break on the weakest signals and we have absolutely eliminated the 500 cycle induction.

I am aware of the fact that a break-in system is easy on a spark set where the power is under one K. W., but above that, unless you have the right grid leaks, etc., and a method for getting rid of induction, you will not be able to get any breaks except the strongest ones.

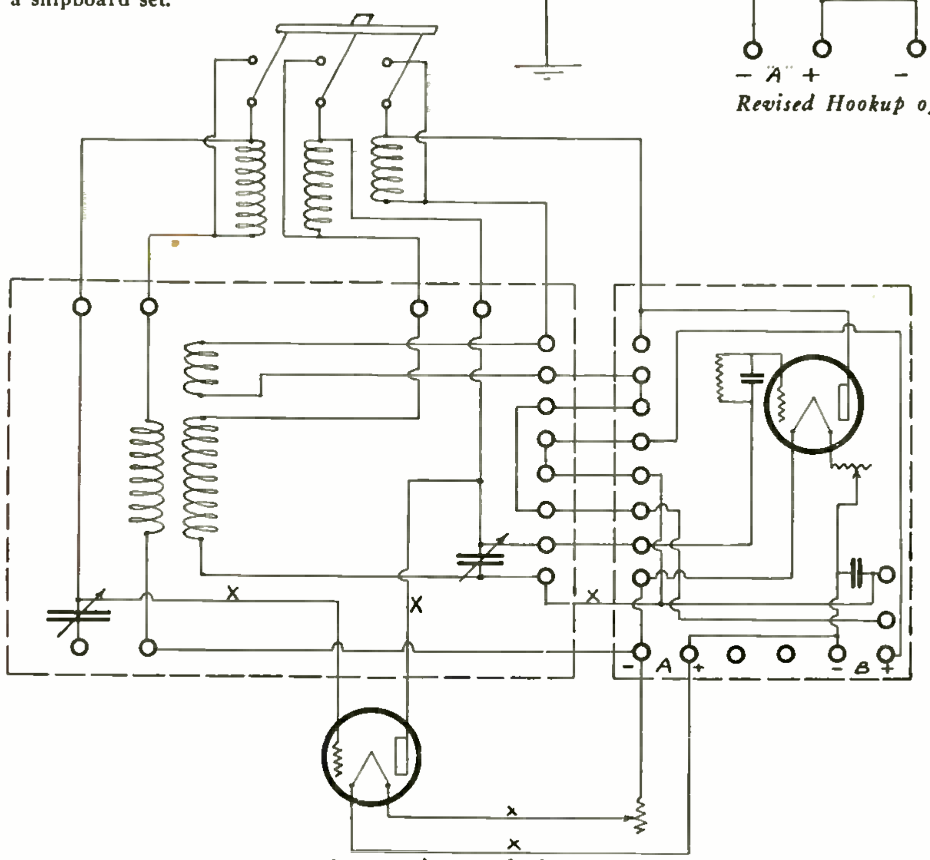
I used the anchor gap system several years ago but it is eliminated by the law of decrement. It was at the time, and no person should admit having used it for fear of having his commercial license taken away from him.

That leaves nothing but the mechanical break-in which is really the only one of merit. Most operators are using bugs now, and they must have a relay anyway. It would be much more difficult to add the other pair of contacts.

So far as I know, the Leach Relay Company of San Francisco is the only company manufacturing break-ins that will work up to 3 kilowatts.



Revised Hookup of S.E. 143 Navy Receiver.



Suggested Break-in Systems.

WHO'S WHO AND WHERE

Lyman W. Packard relieved George Hutchins on the General Petroleum tanker *Lio.* Hutchins is going back to the University.

Charles E. Payne, commercial agent of the Federal Telegraph Company is still very sick at his home. We're all pulling for you, Charlie.

Robert W. Burns (he's Scotch) occupies the radio shack on the *S.S. Coalinga* which is bound for South America.

Dick Clark, at Yakutaga Beach, Alaska, is about to bust the air open with the 2KW arc he is installing up there.

C. F. Lohner, ex WPU, has gone out on the *S.S. Munising,* KFNQ.

(Continued on Page 60)

With the Amateur Operators

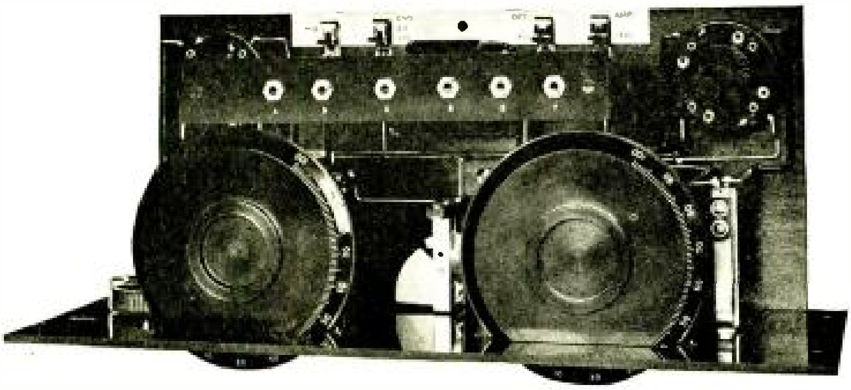
THE GREBE CR-18 SHORT WAVE RECEIVER

A SHORT wave receiver having a range from 10 to 215 meters has just been announced by the A. H. Grebe Co., and will be known as the CR-18. As it is the only factory built very short wave receiver now available, a description of its construction and principles of operation will be of interest to all amateurs, as well as those broadcast listeners who enjoy listening to the short wave relay broadcasting.

The various features of the CR-18 are briefly reviewed, the circuit diagram shown in Fig. 1 furnishing the necessary references. A coupled regenerative circuit is used, of a type best adapted for reception of frequencies up to 30,000 kilocycles (10 meters). The antenna coupling coil is coupled to the grid coil, producing a high transfer of energy without affecting the frequency settings of the secondary condenser dial. The inductances are mounted on rigid supports, and so arranged that they are far removed from the hands of the operator, so that body capacity is reduced to a minimum. They are of the plug-in variety, enabling rapid change from one frequency band to another, and providing for greatest efficiency through any band desired. An isolated grid terminal lowers the minimum capacity of the circuit and insures correct insertion of the coil.

Straight line frequency condensers, having small minimum capacity, are used, and the familiar tangent wheel Grebe dials provide accurate tuning adjustment. Regeneration is obtained by the throttle control method, the feedback from the plate passing through the plate variable condenser and the plate coupling coil to the filament. A fixed non-inductive resistance of 25,000 ohms is used instead of an r.f. choke in the plate circuit of the detector, as the average r.f. choke does not have a r.f. resistance higher than this amount at most frequencies, and produces dead spots on the regeneration curve, which will be absent when the resistance is used.

The pictures will give a good idea of the mechanical assembly of the receiver. Note how the inductance coils are elevated on insulated pillars, away from the rest of the set. The detector and audio amplifier sockets, which are of the cushion variety, are separated by the entire length of the set, minimizing coupling, and shortening the output leads. For fineness in tuning, a separate variable secondary condenser, called the "beat frequency control," is used and as it has a very small total capacity, it permits final adjustments after the finest possible tuning when the main tuning control has been made.



Top View, with Position of Vernier Condenser Shown.

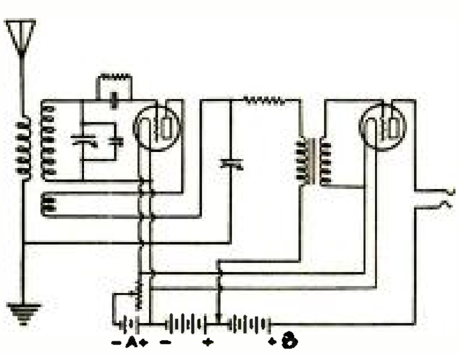
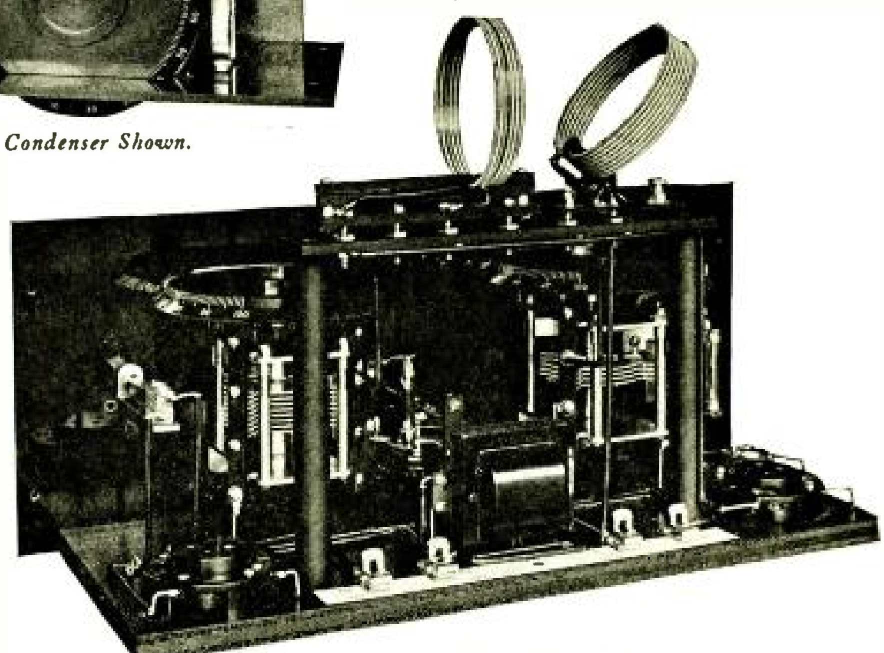


Fig. 1. Schematic Wiring Diagram of Grebe CR-18 Receiver.



Rear View, Showing Details of Construction.

NEWS OF THE AMATEUR OPERATORS

Lieut. W. H. Wenstrom, ex. 5AKT, has been given permission by the Chief Signal Officer of the Army to run some short wave tests on the army transport Chateau Thiery, which sailed from San Francisco on July 3 for the Panama Canal and New York. The ship's call WXF will be used and he will operate on 36.5 meters with 50 watts using a 3 coil Meissner. He wants to establish communication with all possible amateurs.

A-5LO, Bill Barber, 50 Somerset Ave., Cumberland, So. Australia, requested U-6-CKG, Paul Heinley, 823 11th St., San Pedro, Calif., whom he worked June 18th, to advise us of his full QRA.

6BAA, A. Kanaga, 4228 26th St., San Francisco is operating a portable transmitter on 40 meters under 6BVI.

NOTES ON THE TUNED GRID AND PLATE TRANSMITTER

By G. M. BEST

A number of questions in regard to the 6XAO transmitter described in March 1926 RADIO have been received, and are of such general interest that the answers form the basis of a few remarks on the subject of tuned grid and plate transmitter as applied to low power.

Numerous questions about the constructional details of the transmitter have been asked and it develops that the price of two 50 watters is beyond the pocketbooks of many amateurs, who wish instead to use the circuit and apparatus layout for two UX-210, CX-310 power tubes of 7½ watts output. No changes in the assembly of the transmitter would be needed to adapt the set to 7½ watt tubes, and only a few minor changes in the material required would have to be made. Of course, the tube sockets should be the standard X base variety, although the tubes are provided with such long pins that soldered connections, without the use of a socket, are easily made, and save the price of the sockets. The grid leaks will probably need to be nearer 15.000 ohms instead of the 5,000 ohm size used for the 50 watters, and it would do no harm to have a pair equipped with taps so that the best value can be obtained by trial.

The filament transformer may be an ordinary 50 watt bell ringing transformer having an 8 volt secondary. As most transformers of this type have secondaries of 8, 16 and 24 volts, it is possible to use the 16-volt secondary, with the 8 volt terminal as the center tap, and cut the current drain in the secondary to the proper amount with a primary rheostat. If the 8 volt winding is used, no rheostat will be needed, and a pair of 50 or 100 ohm resistances shunted across the secondary will furnish the center tap connection. The suggestion of J. M. Clayton in a recent issue of QST for the use of two Christmas tree lamps in series is an excellent one, where a tapped non-inductive resistance is not easily obtained.

It is not advisable to apply more than 550 volts plate to the CX-310 tube, so that a standard 1100 volt transformer with center tap is the right size for the plate supply. More voltage can be applied if tube life

(*Continued on Page* 59)

A Vacuum Tube Frequency Meter

By G. M. Best

A VACUUM tube frequency meter, or wavemeter as it is commonly called, enables the use of a small milliammeter as a resonance indicator instead of an unsatisfactory flashlight bulb or an expensive thermo-galvanometer. The circuit used in indicating the operating frequency of a short wave radio transmitter is shown in Fig. 1. The cost of parts is about $20, including battery and tube.

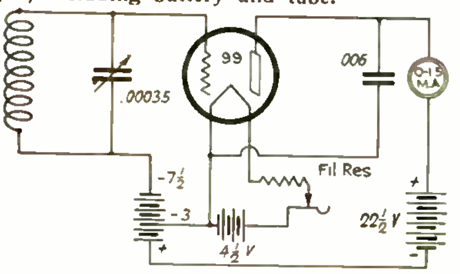


Fig. 1. Wiring Diagram for Vacuum Tube Frequency Meter.

Its principle of operation depends upon the measurement of the plate current for different a.c. inputs. For a given *B* voltage, any amplifier tube whose grid is connected to the negative end of the filament has a standard plate current which depends upon the tube constants. With sufficient *C* battery the grid can be made so highly negative that the plate current drops to zero. If a.c. is fed to the grid when the plate current is thus exactly zero there will be no current flow during the negative half of the cycle and during the positive half of the cycle the amount of plate current flow will depend upon the value of the alternating current. This is in accordance with the rectifying action of a vacuum tube. A milliammeter in series with the plate circuit measures the comparative values of the plate current for different a.c. inputs and thus indicates resonance.

The resonance circuit itself is of the conventional pattern, consisting of inductance coils of various number of turns wound on a 4 in. bakelite form, and a .00035 mfd. straight line frequency condenser with vernier dial. The vacuum tube, which should be of the 99 type, is connected to the *LC* circuit in the same manner as for any radio receiving circuit and the filament is supplied from a 4½ volt large size *C* battery, through an automatic filament resistance cartridge, which limits the current to approximately 60 milliamperes.

The plate voltage is supplied by a 22½ volt small size *B* block, in series with a portion of the *C* battery which is not used. With 25 volts plate, the 99 tube requires 4½ volts negative grid to bring the plate current down to approximately zero, and as the *C* battery used in the frequency meter is of 7½ volts, the unused 3 volt section is just right to make the total *B* voltage available about 25 volts. The 1½ scale milliammeter is now available in the small size, and costs but $9, as compared with $12 for the larger sizes. The large model may be used, but it gives no better results and is more expensive. The r.f. component in the plate circuit of the tube is by-passed through a .006 mfd. fixed mica condenser, so that only d.c. passes through the milliammeter. The tube must always be left connected in the circuit, for the grid to filament capacity is in shunt with the variable condenser and if the tube were removed, the calibration would be changed.

The inductance coil terminals, variable condenser, tube socket, filament switch and meter terminals are mounted on the panel as shown in the picture. The panel is 6x8x3/16 in., and the baseboard has approximately the same dimensions. The batteries are all grouped on the back of the baseboard, and are held in place by friction tape binders. The milliammeter is mounted separately on a small wooden panel or standard, and connected to the frequency meter by means of a flexible cord. As only d.c. passes through this cord, it may be quite long, so that the frequency meter may be placed near the transmitter, and the resonance indicator placed near the receiving set, which is at some distance from the transmitter in most modern amateur installations.

LIST OF PARTS

- 1 Cardwell .00035 mfd. variable condenser.
- 1 National Type B vernier dial.
- 1 Vacuum tube socket for UX base.
- 1 UX-199, CX-299 tube.
- 1 Filament resistance cartridge-Amperite.
- 1 Filament switch.
- 1 7½ volt C battery—Burgess No. 5540, Eveready No. 773.
- 1 4½ volt A battery—Eveready No. 771.
- 1 22½ volt B battery—small size.
- 1 .006 mfd. fixed mica condenser.
- 1 Weston Model 506 1½ mil. scale milliammeter.
- 1 Panel 6x8x3/16 in.
- 1 Baseboard 6x8x½ in.
- 1 Set bakelite forms, 4 in. dia., wound with 1, 3 and 6 turns respectively, for 20, 40 and 80 meter bands.
- 4 Binding posts.

The milliammeter may be used in a variety of other work when not used with the frequency meter. When connected in series with a 100,000 ohm lavite resistance, it makes a crude but very effective high resistance voltmeter, with 150 volt scale, and is very handy for checking the voltage output of *B* eliminators or other circuits where it is undesirable to draw a large amount of current in the indicating device. If the proper shunts are constructed, the milliammeter can be used as an ammeter, without interfering with its use in the frequency meter circuit.

The circuit of Fig. 1 provides an arrangement for a sensitive frequency meter, having a very small decrement, due to the absence of external resistance in the *LC* circuit, and is good enough for all ordinary purposes. Its sensitivity may be greatly increased, however, by the addition of a direct current amplifier, as is shown in Fig. 2. This type of amplifier has a great many advantages, and is little used at present except in very special instances.

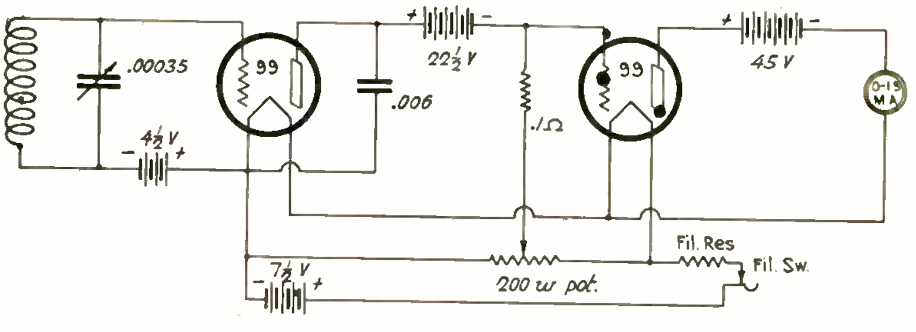
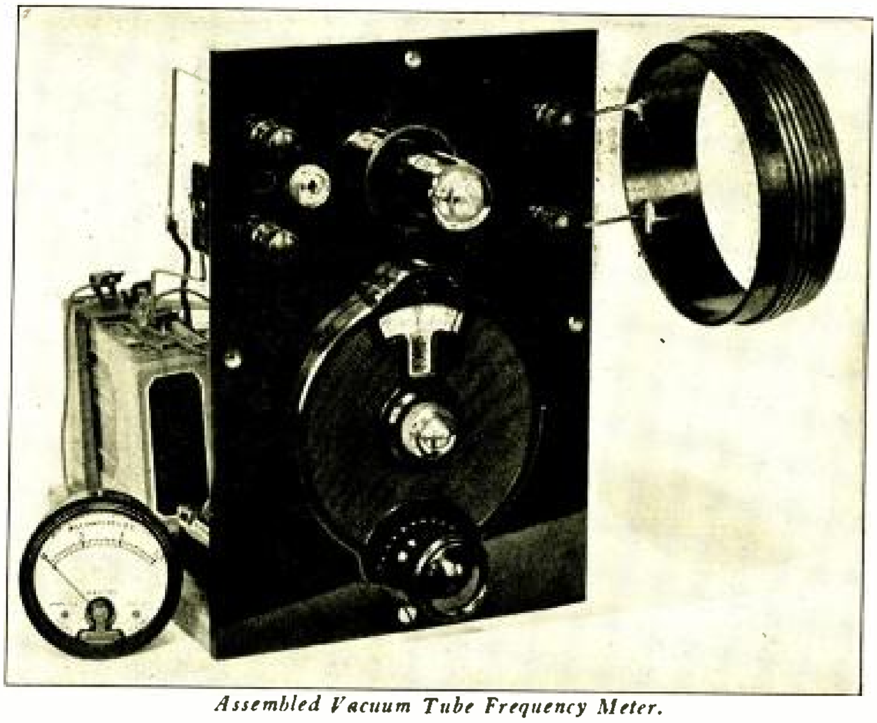


Fig. 2. Direct Current Amplifier Used With Frequency Meter.

Its operation is simple. The rectifier tube, which is the tube next the frequency meter circuit, has the customary 22½ volt *B* battery supply as shown in Fig. 1, but has its return to the filament through a 0.1 megohm resistance which is connected to the slider of a 200 ohm potentiometer shunted across the filament battery. The two 99 tube fila-

(*Continued on Page 46*)



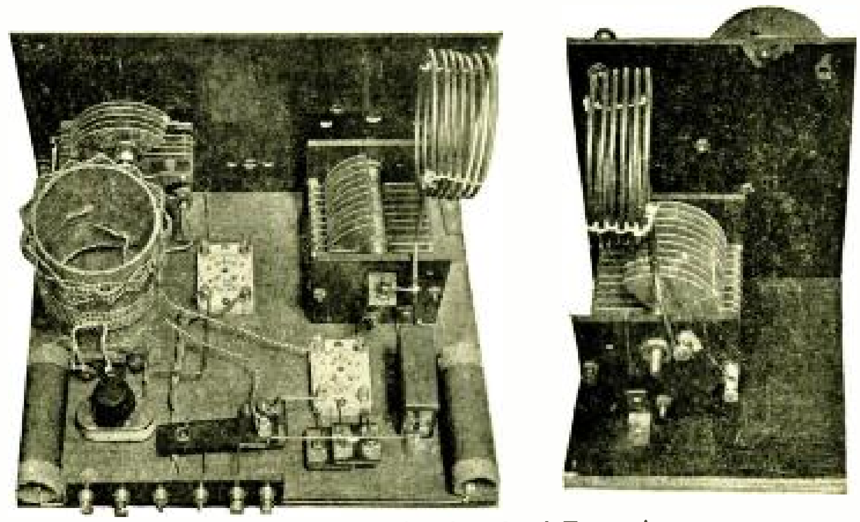
Assembled Vacuum Tube Frequency Meter.

A Low-Powered Master Oscillator Transmitter

By Frank C. Jones, 6AJF

THE STEADY wave essential to good transmission with low power on 40 meters can be secured with a master oscillator-transmitter. That at 6AJF uses two tubes, a master oscillator and an amplifier. Any size of tube from a CX-299 up to a UX-210 can be used with the X-hase sockets. Batteries may be used for the power supply of the smaller tubes and rectified a.c. for the larger tubes. The general arrangement of the parts is shown in the pictures and the circuit diagram in Fig. 1.

The plate coil of the amplifier and the antenna coil were made of 1/8 in. copper tubing wound on a 3 in. cardboard tube. These two coils were then slipped off of the tubing and a waxed linen string tied around each turn on opposite sides of the coils in order to make them rigid. This string has a square knot around each turn of the coil, and it also serves to keep the turns properly spaced. Larger tubing than 1/8 in. would cause eddy-current losses to greatly increase so nothing larger should he used and even smaller would he preferable.



Apparatus Layout for Completed Transmitter.

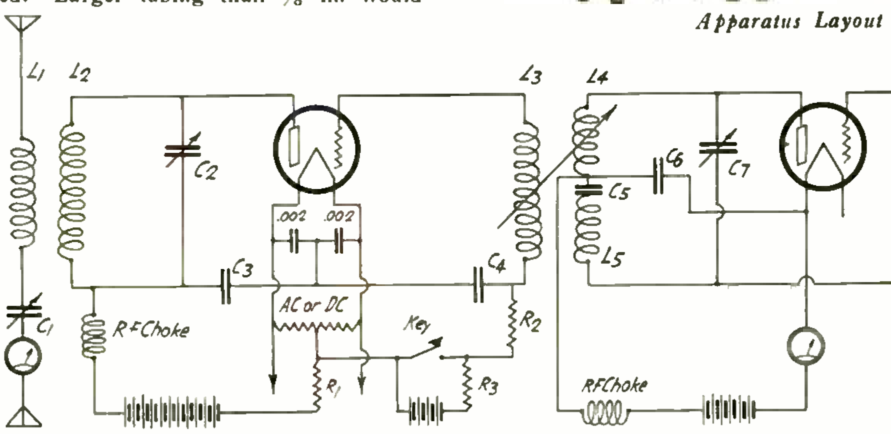


Fig. 1. Circuit Diagram of Master Oscillator Transmitter.

L_1=5 turns (depends on antenna).
L_2=7 turns, 3 in. dia.
L_3=9 turns 3 1/8 in. dia.
L_4=7 turns on 3 in. dia.
L_5=5 turns on 3 in. dia. On same form as L_3.

C_1, C_2=.0002 mfd. var. cond.
C_3=.002 mfd. by-pass cond.
C_4, C_5, C_6=.001 mfd. by-pass cond.
C_7=.0001 mfd. var. cond.

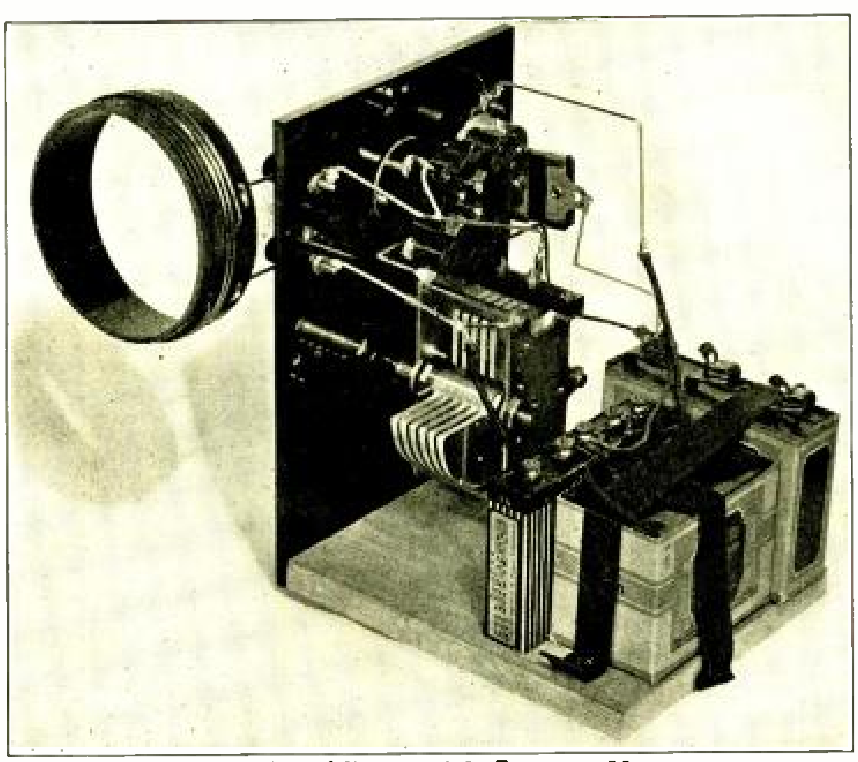
The grid coil of the amplifier is loosely coupled to the oscillator and is a 9-turn basket weave which just slips along on a 3 in. cardboard tube upon which are wound the oscillator coils. The oscillator coils were wound on this cardboard tube near one end and consisted of 7 turns in the plate coil and 5 turns in the grid coil. The coupling between the oscillator and the grid coil of the amplifier is varied by sliding the grid coil up or down along the tube. These coils were made of No. 18 bell wire. With a 201-A tube for an oscillator, the output was very steady and would work with quite low plate voltages, though 90 volts was generally used at all times.

The radio frequency chokes were made by winding 175 turns of No. 32 d.s.c. wire on a 1 in. cardboard tube for each coil. By using a small diameter, the external field of these coils is quite small and then hy putting the chokes into the circuit where the r.f. voltages are low, the losses are a minimum. This is done by feeding the plate voltages through these chokes into the filament side of the plate coils.

The variable condensers should have end plates of hard rubber or other good insulating material. The grid leak was a Bradleyohm so that the best value of resistance could be obtained for the type of oscillator tube used. The dials and other minor details are unimportant though a vernier dial will generally tend to maintain a certain setting of the variable condensers better than ordinary dials as well as making it easier to tune the set. The values of the grid and plate condensers are not critical and can be of any value within reason.

The picture of the rear view of the set shows two condensers across the filament which were put there in case a.c. was used to light the filament of the power amplifier. The grid potential is maintained correct for all values of plate voltage automatically by making use of the IR drop across a resistance in series with the plate battery of the amplifier. This resistance, R_1, for most tubes should be about 1200 ohms. Since for higher powers, several hundred volts of rectified a.c. was to be used, a 50,000 ohm balancing resistance R_3 was inserted in series with the grid leak, which tends to balance out any a.c. hum from the amplifier. This latter resistance has another useful purpose in that the amplifier will howl if it should tend to

(Continued on Page 58)



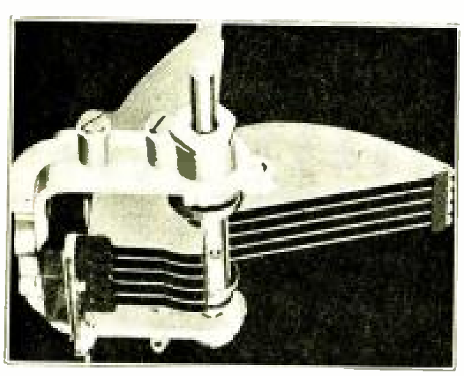
Rear View of Vacuum Tube Frequency Meter

FROM THE RADIO MANUFACTURERS

Weston Model 506 Pin Jack Voltmeter is made in two double range combinations, 160 and 4 volts and 160 and 8 volts, for using with either three-volt or five-volt filaments. Its high internal resistance of 125 ohms per volt allows for a

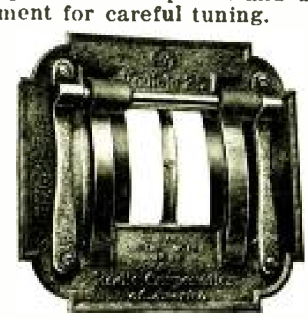
small current drain from batteries. Its pins are adjusted so as to fit into any of the standard meter jacks with which many modern sets are equipped for controlling the filament voltage or into its accompanying high range stand for measuring "B" battery voltages. A pair of extra pin jacks come with each instrument for use in sets not already equipped with them.

The Hammerlund low wave condenser has a plate spring two and one-half times normal so that they may easily be kept free from dust. It is designed to facilitate reception of wavelengths below 100 meters. Its minimum capacity is 3 m.-mfd. and maximum 100 m.-mfd., cover-

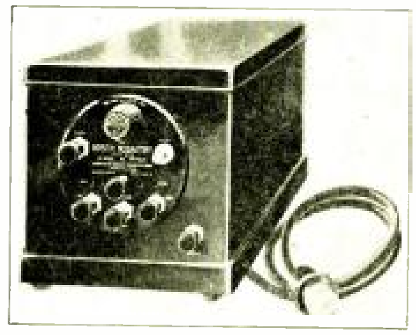


ing a broad wave band. The plates have a straight line frequency characteristic. It has an insulated pigtail connection between the frame and the rotor, the latter being ball-bearing at one end.

The Maxum tuning control is especially designed for use with Radiolas 25, 28 and 30. It permits a simplified and ultra-fine adjustment for careful tuning.



The Bosch Nobattery, operating from the house alternating current, is a noiseless "B" battery eliminator especially designed for use with multi-tube sets having

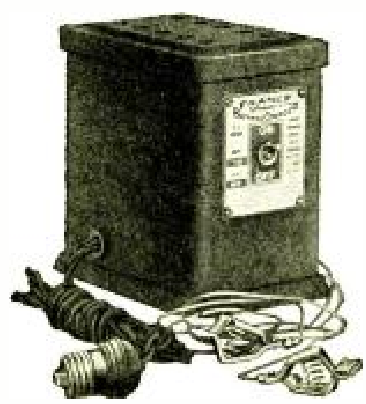


a power tube in the last stage. It supplies up to 150 volts plate current without a.c. hum.

The Vesta "A" unit combines a trickle charger and 6-volt storage battery in one. It is housed in a heavy glass container

through which may be observed the level of the solution and the state of charge, as indicated by 3 colored balls in lieu of a hydrometer.

The France Straight "A" Charger for 6-volt storage batteries uses a 2 ampere rectifying bulb. By means of a simple

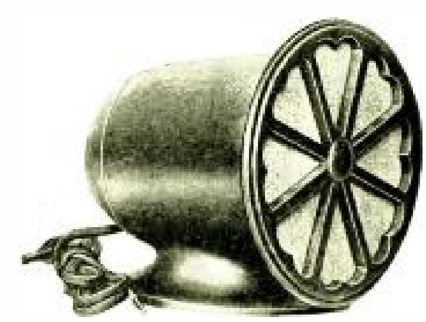


attachment it can be converted into a trickle charger at rates of from .1 to .8 ampere as desired. Its over-all dimensions are 7x5x7 in. and it weighs 14 lbs. It can also be used to charge "B" storage batteries in parallel.

The new Fada 8 embodies four stages of radio frequency amplification, detector and three stages of audio frequency amplification. A power tube in the last stage of audio is always in circuit and the set may be operated with six or seven tubes by cutting out two or one of the

audio stages. The tuning condensers are a combination straight-line frequency and straight-line wavelength, the former for the lower wavelengths and the latter for the higher stations. It operates from either a loop or antenna. It has two operating controls and is equipped with meter for determining filament and plate current. It is housed in either a table cabinet or console.

The Freshman Master Speaker, by its compact construction and triple reflexing, condenses the equivalent of a 24-in. up-

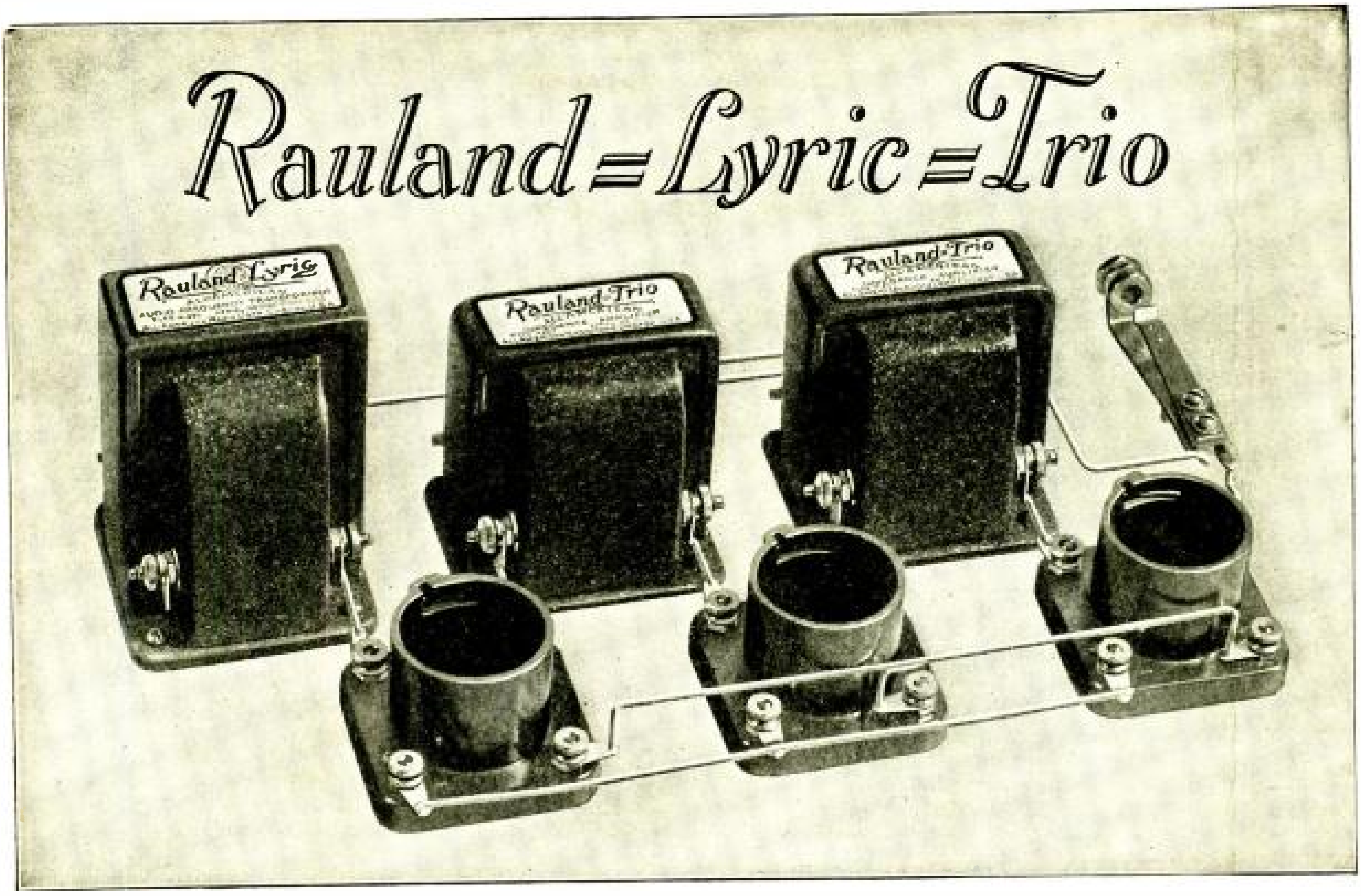


right horn into an artistic instrument only 6 in. high. It is claimed to have great volume and excellent tone quality.

BOOK REVIEW

"COILS AND MAGNET WIRE." By Charles L. Underhill, 494 pages, 6x9; published by McGraw-Hill Book Co., New York City. Price $4.00.

Seldom does a book, not written for the radio man, contain such a wealth of practical information for the radio constructor as does this text. It is a complete treatise on the mechanical phases of coil winding, including all the various properties of the wire and insulating material used. It is in no way concerned with the calculation or determination of the inductive relations of the coil as made. The first 149 pages are concerned with the resistivity, conductivity and temperature effects of all sizes of copper and aluminum wire, containing many tables and diagrams. The balance of the volume is occupied with coil data,—physical dimensions and forms, influence of space factor, cooling, insulation, winding processes and practical construction. Information is given about making all of the various kinds of coils used in radio work as well as those used for other purposes. It is an admirable working guide for the man who knows what he wants to make in the way of a coil.



A remarkable improvement in audio amplification

New unit perfected by All-American Engineers gives you the full, pure, natural tone you have always sought

YOU have always wanted the ideal result in audio amplification—pure, natural tone with good volume. The laboratories of All-American Radio Corporation have developed a new method of audio amplification and now bring to you this long sought ideal result in the—

Rauland-Lyric-Trio

You know the Rauland-Lyric transformer. Its exceptional tone perfection has made it the largest selling quality transformer in the world. The Rauland-Lyric is now used in combination with the new Rauland-Trio (impedance units) to produce the Rauland-Lyric-Trio amplifier—the highest known perfection in three stage audio amplification.

It is well known that any system of amplification using instruments of similar characteristics has inherent disadvantages. Rauland-Lyric-Trio successfully combines the two leading systems—transformer and impedance coupling—coordinated to retain the advantages of both and to eliminate their weaknesses.

This new method consists of a Rauland-Lyric transformer for the first stage, a Rauland-Trio Type R-300 impedance for the second stage, and a Rauland-Trio Type R-310 impedance for the third stage.

Rauland-Trio

This is a triple feature instrument containing an inductance, a capacity and a resistance in one compact impedance unit. Through laboratory tests of utmost precision, absolutely correct balance is maintained between these important factors. You secure full advantage of impedance amplification and overcome the common variance of commercial types of condensers and resistances. Rauland-Lyric-Trio is the last word in audio amplification.

A free book, "Modern Audio Amplification," tells more about this interesting new development. Write for handbook B-90.

ALL-AMERICAN RADIO CORPORATION
4215 BELMONT AVE., CHICAGO, U. S. A.

Station WENR—266 *Meters—is owned and operated by the All-American Radio Corporation*

The Thrill of

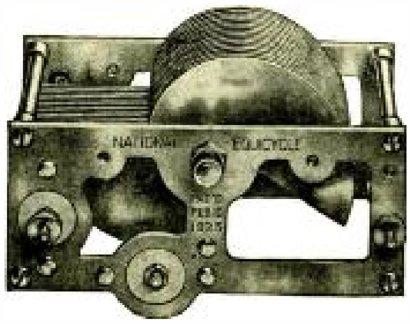
You can't build automobiles on a kitchen table. If you could, they'd be home-built by the thousands.

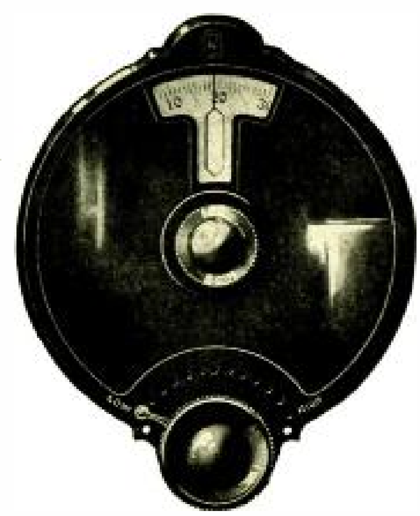
Dependable Radios *are* being built at home by many thousands.

You, too, can build your own set.

The thrill of building your own Radio! of making your own creation work, and work well!

NATIONAL RADIO





For Tuning
The NATIONAL
"Equicycle" Condenser

True straight-line-frequency—but in three-quarters instead of a half-turn—spreading out crowded stations still more, rigid frame, plates—bearings smooth, yet without suspicion of end-play. Made to stand up, to log the same next year as this, and with the same high efficiency.

For Tuning Control
The NATIONAL
Velvet-Vernier Dial, Type B

Gives velvety, even movement of condenser shaft with *variable* reduction ratio of from 6-1 to 20-1. Large, easily operated knob without *any* back-lash—clear yet mathematically accurate dial with simple logging guide—heavy, lasting Bakelite case; easy to mount and gives precise and fine tuning on any set.

These NATIONAL Radio-Set Essentials with the required sockets, panels, wire and accessories,-- may be put together EASILY by you into a modern receiving-set:--sensitive to distant signals,

Send for

NATIONAL

W. A. Ready, President

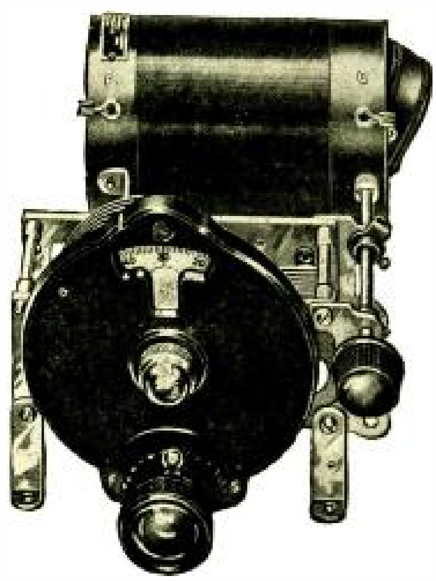
110 BROOKLINE STREET

Building your Own

There is no cooked-up enthusiam or inspirational bunk in this idea. It is real. The writer of this advertisement has experienced it. The manufacturer knows it. That is probably why he went into Radio.

The distributor and the dealer know it. We all shall know it again and again,-new and real each time,--keeping *abreast* of an ever unfolding art,--keeping-ahead of the finished-set mass-production,--building Radio ourselves.

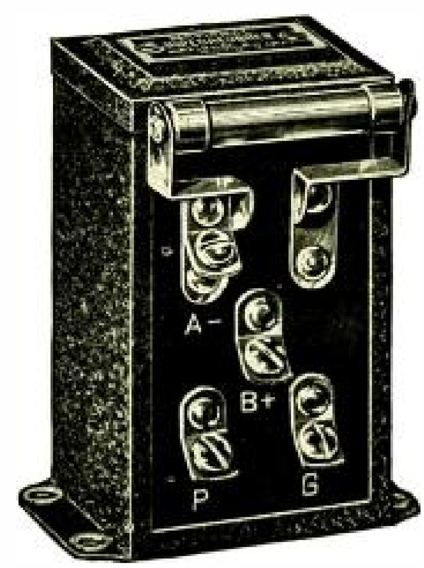
SET ESSENTIALS



For Radio-Frequency Amplification

The Genuine NATIONAL Browning-Drake Radio-Frequency Transformers

With their scientifically computed coil-constants—product of research of G. H. Browning and F. H. Drake at Harvard University. Their theoretically correct space-wound enamel wire coils withstand rough handling; without alteration of characteristics—yet tests show lowest R. F. resistance recorded for coils of this type. Their simple supports make them units with their "Equicycle" Condensers, yet hold them far enough away to prevent absorption losses or increase their resistance.



For Audio-Frequency Amplification

The NATIONAL Impedaformers, Type B

Three to a set—making possible, in the compactest form, true and faithful audio-amplification, from notes too low to be reproduced in phones or cone, to shrillnesses out of reach of our mortal ears. Each Impedaformer cases a high-inductance choke —a .1 Mfd. TOBE Coupling Condenser—a Lynch grid-leak—and the first one an R. F. choke, without which impedance-amplification is like meat without salt.

---

selective in its separation of closely-spaced stations,-capable of lifelike, *faithful* reproduction,--simple to operate. Be sure you get genuine NATIONAL products.

Bulletin 116-R

COMPANY, INC.

Engineers and Manufacturers

CAMBRIDGE, MASS.

SM

The why of S-M Audios

The 330 331 and 332 Power Units

330 POWER TRANSFORMER

This power transformer is designed for Raytheon or Rectron tubes. It has two 300 volt secondaries, a 110 volt, 60 cycle primary and a 7.5 volt filament lighting winding. Rated at 85 milliamperes continuous duty without heating, it will furnish double this current for reasonable periods. **Price, $6.00.**

331 UNICHOKE

The S-M Unichoke is a two-winding high inductance filter choke licensed under the Clough Patent Application. Its current capacity is 85 milliamperes, or double this for reasonable periods. Its filtration when properly used, is guaranteed to be superior to that of other standard power supply filters.

Price, $6.00

332 CONDENSER BANK

S-M No. 332 contains two 1/10th mf., two 2 mf., two 1mf., and one 4 mf. condensers, tested at 700 volts D. C. It is intended for use in "A," "B" or "C" power supply filters. **Price, $10.00.**

Above instruments are housed in uniform one-piece drawn steel cases, black enameled. They are completely shielded, and provided with screw terminals. Size, 4 inches high, 3¼ inches wide and 2½ inches deep (3½ inches over mounting lugs). Weight, three to four pounds.

"THE SECRET OF QUALITY"

This booklet contains laboratory data never before available even to many manufacturers. It is the only authoritative treatise on all types of audio amplification, written in non-technical language, ever published. 10c is the price of this 96-page book. Ask your dealer for a copy.

S-M audio transformers were introduced with the guarantee that they would give the finest quality of reproduction obtainable. So far they have met with overwhelming success. Production has been steadily increased since the first samples brought back enthusiastic reports from editors, jobbers, dealers, and experimenters.

WHY?

There must be reasons—facts behind this landslide of approval of transformers introducing an entirely new thought in audio reproducing systems. These facts, briefly, are presented below. "The Secret of Quality" available at your dealer gives the substantiating details.

FACTS

FREQUENCY RESPONSE CHARACTERISTIC

The curve of the S-M 220 is flatter than that of any other commercial transformer from 32 to 1,000 cycles. In the case of several $10 transformers, the percentage of distortion is several hundred percent greater than that of the S-M 220 over this range. Above 1,000 cycles the response falls off at a carefully predetermined rate to compensate for the reverse effect in broadcast transmission and commercial loud speakers.

FREQUENCY RANGE COVERED

S-M 220's cover a range of from below 30 cycles to 8,000 cycles approximately. This allows reproduction of all common musical notes and their second harmonics—necessary for natural quality. Frequencies above 8,000 cycles are intentionally cut out, thus eliminating hiss, background noise and high frequency oscillation. Practically no other available amplifying devices possess this new characteristic.

NEW PRINCIPLE

S-M 220's are the first audio amplifying devices available to listeners in which the far-from-perfect quality of broadcast transmission and available loud speakers has been taken into account and compensated for. These two factors produce a signal weak on low frequencies and strong on high frequencies. S-M 220's do just the opposite. They possess a falling frequency characteristic — weak on high notes and strong on low notes. This compensates for everyday transmission and loud speaker characteristics of a reverse nature. The result is quality of unbelievable perfection—bass organ notes that shake a room, just as does the original organ itself. All notes, both high and low, are reproduced more faithfully to the ear than with any other available amplifying system.

PHYSICAL CHARACTERISTICS

The weight of the 220 core, of highest grade Silicon steel, is over 2½ lbs. The total weight is 4 lbs. Compare this against an average weight of less than 2 lbs. for five transformers supposedly in the class of the S-M 220, yet selling at from $2.00 to $4.00 each higher. The mean-turn length on the 220 winding is twice as great as several of the transformers referred to. This takes wire —plenty of it. The core cross-section is 1¼ inches.

All this means but one thing—quality—for assuming good average engineering, the quality of an audio transformer is almost always approximately proportional to its size.

HANDLING CAPACITY

The 220's will handle sufficient input energy to obtain maximum power output from a UX171 tube—over six-tenths of a watt. Properly operated, they will develop an output voltage of from twenty to thirty volts. The primary windings will handle 15 milliamperes continuously.

OUTPUT TRANSFORMER

S-M 221 output transformer is designed to deliver maximum power to standard cone speakers at 30 cycles, and decreasing power as the frequency increases. This effect aids in compensating for average speaker characteristics of a reverse nature. S-M 221's will handle the full power output of a UX171 or UX210 tube. They are guaranteed to improve low note reproduction and handling power on any standard receiver when merely connected between the set and loudspeaker.

GENERAL DATA

S-M 220's have a turn ratio of 3:1. Their primary inductance is approximately 100 henries. Their impedance ratio will fit any standard tube on the American market. The 220's and 221's are supplied in drawn steel cases, completely shielded. Guaranteed unconditionally against mechanical and electrical defects—and for absolute satisfaction.

Price, $6.00 Each

SILVER-MARSHALL, *Inc.*

852 West Jackson Blvd., Chicago, U. S. A.

THE INFRADYNE

(*Continued from Page* 14)

across the station's setting three or four times, going five or ten degrees to each side of the center. Notice whether the station comes in sharply at one point and goes out completely on both sides, or whether it tends to come in at two points about 4 or 5 degrees apart. If the former, the front end is lined up and the vernier plates should be left as they are. If the latter, adjust the condenser to half way between the two points, and then try to tune in the station by sliding the vernier plates to new positions without turning the condenser. As the lining up becomes more perfect, the first two tubes may go into oscillation, in which case the rheostat should be retarded a little. One or two adjustments of this kind will line it up, and if the operation is performed at or near 60 degrees it will hold good for the entire swing of the condenser.

The choice of an antenna will be dictated entirely by surrounding conditions. The writer recommends 50 ft. until the operator gets accustomed to the "feel" of the set. Then put a .0001 mfd. condenser in series to prevent powerful locals from riding through on the carriers of other stations near the same wavelength. When the set is correctly operated an antenna of the picture molding variety provides plenty of pickup and will bring in coast to coast stations when conditions are at all favorable.

can be eliminated on 350 and 375 meters respectively, leaving CZE, Mexico City, and KTHS, Hot Springs, Ark. in the clear. KPO, 428 meters, 1000 watts, does not interfere with CFCN, Calgary, 435 meters, or WLW, 422 meters, on a good night.

Because of the selectivity and sensitivity of the set, distance follows as a matter of course. CNRM, Montreal, WMBF, Miami Beach, WGY, WJZ, KDKA, WSB, and PWX as well as 14 Chicago stations and 33 other "W" stations appear on our log sheet for the past few months.

For the benefit of those interested in the circuit of the infradyne amplifier unit, the circuit used is given in Fig. 5 and the coil and condenser data are given below. This is given as a matter of information only. It is impossible to give construction details because of the fact that a difference in placement of the fixed condensers of 1/4 in. or a difference of 1/32 in. in primary to secondary coupling between the coils may make the difference between a unit that will amplify and one that won't. The infradyne amplifier is a most outstanding example of the part played in a radio circuit by the relative positions of the different pieces of apparatus. If exactly the same hookup, capacities, and coils are used and the arrangement kept almost the same, but the connecting wires run differently, the unit will have en-

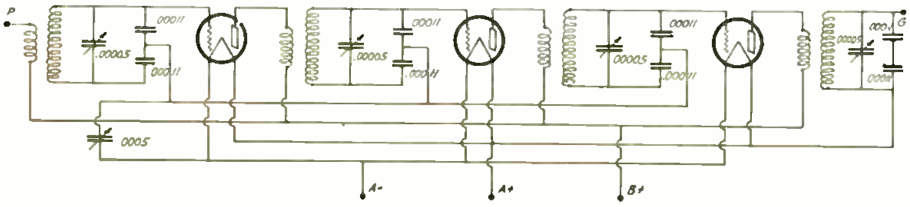


Fig. 5. Circuit Diagram of Infradyne Amplifier Unit.

Perhaps the best way to predict the results that may reasonably be expected will be to give specific instances regarding what has already been done. At Oakland, California, ten blocks from KTAB 240 meters, 1000 watts, KFSD in San Diego, 246 meters can be brought through on any night, using a 25 ft. antenna. KGO, 361 meters, 3000 watts,

tirely different characteristics. Such is radio at 90 meters. The 90 meter transformers are wound as follows: Secondaries on $1\frac{1}{8}$ in. low-loss ribbed form, 35 turns No. 28 d.s.c. wire except coil next to second detector which has 28 turns. Primaries are wound inside secondaries, and consist of 20 turns of No. 28 d.s.c. wire.

VACUUM TUBE FREQUENCY METER

(*Continued from Page* 38)

ments are in series, being supplied from a 5 dry cell battery bank of $7\frac{1}{2}$ volts.

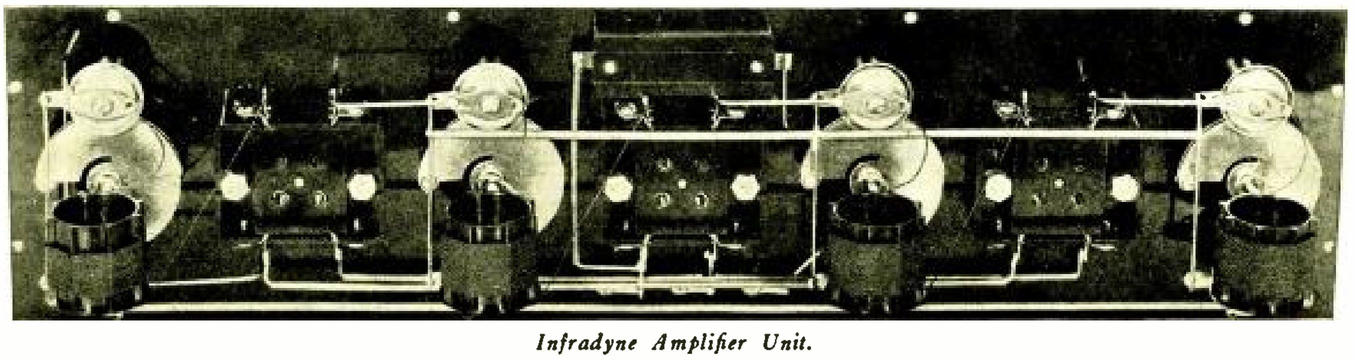
With only one tube, when a.c. is applied to the grid of the rectifier tube, current will flow in the plate circuit, and through the 0.1 megohm resistance to the filament. Another vacuum tube connected to the output of the rectifier tube can be made to amplify the output of the rectifier tube, but in the reverse direction, as will be explained.

In the plate circuit of the amplifier tube is connected a 45 volt *B* battery and a $1\frac{1}{2}$ scale milliammeter. As the drop across the 200 ohm potentiometer is normally 6 volts, when 99 tubes are used, varying the slider of the potentiometer will vary the grid voltage of the amplifier tube from positive to 3 volts negative, according to the position of the slider. With 3 volts negative the plate current will be .5 milliampere, and when near the positive end of the filament it will rise above 1.5 milliamperes. Hence, if the slider is so adjusted that the plate current in the amplifier tube is 1.5 milliamperes, and plate current from the rectifier tube is made to flow through the .1 megohm resistance, the grid of the amplifier will be made more negative with respect to its filament by reason of the voltage drop through the .1 meg. resistance, and the plate current in the amplifier will fall.

The amount by which the plate current drops, in milliamperes, will be governed by the product of the amplification constant of the tube times the voltage drop across the.1 megohm resistance, so that the larger the plate current in the rectifier tube, the lower the plate current in the amplifier tube, and a point can be reached where the amplifier plate current is zero. Hence, with a 99 tube having a *mu* of 6, a rectifier plate current of only .1 milliampere will cause a change of .5 milliampere or more in the amplifier plate circuit, which means that the frequency meter to which the rectifier-amplifier is connected may be moved away from the transmitting set a considerable distance more than that possible with the rectifier alone.

The sensitivity of the outfit can be appreciated from the fact that in the writer's transmitting equipment installation this meter is mounted 20 ft. from the transmitter, on the table with the receiver, and gives almost a 1 milliampere downward deflection when the key of the transmitter is closed.

It should be borne in mind that the resonance indication is always downward. The slider of the 200 ohm potentiometer is first adjusted so that the plate current in the amplifier circuit is 1.5 milliamperes, with no signal being received in the frequency meter circuit. When a signal is received, the needle of the milliammeter will deflect downward, and cannot go below the zero setting, which is an excellent safeguard for the meter, preventing any possible burnout except a dead short between the plate and filament of the amplifier tube.



Infradyne Amplifier Unit.

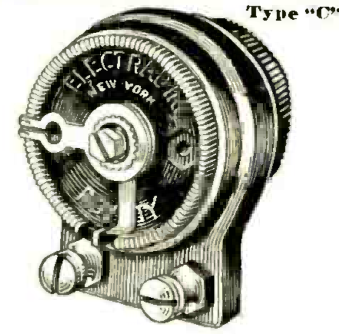
ELECTRAD

Moisture Proof

A Better Resistance Unit

No carbon, paper, varnish or fiber. Metallic resistance element fused to inside of glass tube. Impregnated under high vacuum. Capped with exclusive Electrad ferrule. Noiseless, accurate, non-inductive, non-hydroscopic. Uniform in all weathers and working conditions. Gives clearer reception with greater signal strength. Great current-carrying capacity without over-heating or change of resistance. List price 60c—in Canada, 85c.

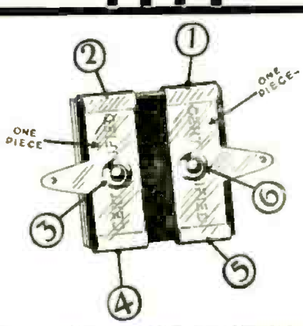
Eliminate Squawks with
ELECTRAD Royalty Variable High Resistances



Type "C"

Enable you to adjust your set instantly for any change in tubes or batteries and maintain perfect reception at all times. Wire-wound, it is practically indestructible. Non-inductive, non-hydroscopic. Electrically and mechanically certified. Nothing to wear out or change in electrical value. Ideal for volume control. Recommended for resistance-coupled, impedance-coupled and transformer-coupled audio amplifiers. Also as a flexible control for detector plate current in B-battery eliminators. Prices: U. S., $1.50 and $2.00; Canada $2.10 and $3.00 for various resistances. Ask your dealer or write.

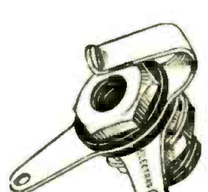
QUALITY CONDENSERS



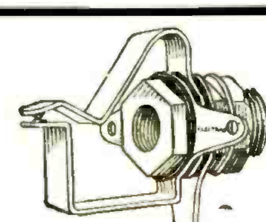
Electrad Fixed Mica Condensers. Uniform pressure insured by rigid binding at six points. Sheet copper, not tinfoil—soldering iron can't hurt it. Guaranteed to remain within 10% of calibration. Standard capacities, all types. Prices 30c to 75c, in Canada 45c to $1.50.

Electrad Certified By-pass Condensers prevent B-voltage fluctuation. Give undistorted amplification. Each condenser certified electrically and mechanically, tested at 1000 volts. Maximum working voltage 250 A. C. Has low power factor, low radio-frequency resistance and negligible D. C. leakage. Prices: U. S., 60c to $3.75. In Canada, 85c to $5.25.

ELECTRAD Certified Jacks


Open

Positive acting spring of phosphor bronze. Sterling silver contact points. Hard rubber insulation. Tinned soldering lugs, placed to make good connections easy. Require less than 1″ behind panel. Prices: U. S., open, 25c, closed, 35c; in Canada, open, 35c, closed, 50c.


Closed

ELECTRAD Inc.

SOCKET POWER RECEIVER

(*Continued from Page* 22)

right point for ordinary operation. With this glow tube in the circuit, small variations in line voltage will not affect the receiver, and it will be remarkably steady at all times.

Testing the receiver is the final step, and consists principally in neutralizing the r.f tube. Having determined that the filament circuit is OK, and all tubes are receiving their proper plate current, connect a loudspeaker to the output jack and upon tapping the detector tube, a loud ringing should be heard. If a violent humming noise is heard, the ground may not be connected, or some of the power apparatus is incorrectly wired. Defective filter condensers, or wrong connection of the filter will often cause this. The 200 ohm potentiometer shunted across the power tube filament should have the slider adjusted to approximately the center of the resistance. If the slider is turned to either end of the resistance, a hum in the loudspeaker will at once be heard.

With the antenna disconnected, but the set thoroughly grounded, adjust the tickler coil until the detector tube oscillates. This can be usually heard by a faint rushing or hissing sound when the tube spills over, or touching the finger to the secondary condenser stator plates will give a loud click when the tube is oscillating. Having established the point where the tube stops oscillating, back off the tickler slightly from this point, and turn the antenna tuner variable condenser through its entire range. If at any point the oscillations occur again, the neutralizing condenser should be adjusted until they stop, and do not occur at any point for any setting of either tuning condenser, except when the tickler coil is advanced again.

If there is any doubt as to whether the set is properly neutralized or not, connect the antenna, and advance the tickler until the detector is oscillating and the received station is heard with a whistle. Turning the antenna condenser dial should change the intensity but not the frequency of the whistle, and if the frequency is radically changed, the neutralizing condenser needs further adjustment. This condenser is mounted in a convenient position so that the adjusting screw can be turned with a small stick which has been whittled to a screwdriver edge at one end, and probably only a very small amount of capacity will be necessary to neutralize the set. If the set tunes broadly, it may be necessary to change the .0001 mfd. fixed condenser in series with the antenna to some smaller value, but this is best determined by trial. On local stations, use as little r.f. amplification as possible, and as much regeneration, within reason, as is practicable, as the selectivity will be better and in extremely congested districts, separation of stations grouped close together will be easier.

It is important that the power plant should be located in such a position that it is not near the detector tube, for unless there is a separation of a foot or more, a.c. hum will be induced from the power transformer into the detector circuit, and no amount of filtering or placing of fixed condensers will cure it. If a console table is handy, the set can be mounted on the top and the power plant mounted in the space reserved for the batteries. Placing the power plant in a box, an inside lining of sheet tin plate or brass is an excellent precaution against noise. This shielding should be grounded. It will not ordinarily be necessary to shield the receiver, since it is not susceptible to body capacity effects.

A word of caution. Do not remove one of the 99 tubes from its socket while the set is in operation and replace it without turning off the power plant, for to do so will result in burning out all three 99 tubes. Do not remove the power tube under like circumstances, as a load of 25 milliamperes will be removed from the rectifier and the filament voltage of the 99 tubes will be about 3.6 each. They would soon lose their filament emission and require rejuvenation. The glow tube in the power plant should never be connected directly across the rectifier output, or it will quickly be ruined. Sufficient resistance should always be placed in the circuit to limit the current consumed to 50 milliamperes, and in this particular circuit it does not consume more than 10 milliamperes.

Do not expect to obtain absolutely humless reception, with the headphones plugged in the loudspeaker jack, as a certain amount of hum is introduced due to the operation of the power tube filament from unrectified a.c., and while this hum is so faint as to be inaudible when using a loudspeaker, it can be heard with the headphones, although it should not interfere with reception of stations too distant to receive on the loudspeaker. The hum is principally caused by the fact that the filament of the CX-371 power tube is made of tungsten, and during the point in each alternating current cycle of the power supply that the current is zero, the temperature of the filament is reduced sufficiently to cause a slight change in the plate current, and this causes a hum in the output. The change in filament current is of course not visible to the eye, as it is too rapid to be seen. If a tube having a slow cooling action, such as the CX-112, UX-210, CX-310, or Western Electric 205-D is used, this hum will be absent, as the filament is slow to heat in starting, and correspondingly slow in cooling.

In constructing the cabinet in which the power plant is housed, it is important to provide proper ventilation, as a considerable amount of heat is radiated from the rectifier tubes, power transformer and associated apparatus.

THE WEST MAIL

(*Continued from Page* 23)

the shed. The previous operator had been an electrician and had run his own electric lighting plant. If it worked it would cure Hap once and for all.

The next night found Joe sitting in front of a conglomeration of batteries, generators, telephone parts, and the like. According to his "Guide Book on Radio and Construction," everything was arranged correctly. He gave the connections a final inspection and then turned on the juice. Stepping up to the telephone transmitter, he announced: "This is station 2LO, London. The next number will be a violin solo by Ernesto Schrechowski."

Joe then began with many flourishes to play "Turkey-in-the-Straw."

Before he had finished, the telegraph key began to click. This time the sending was very irregular as if the sender was excited.

He finished the piece and then answered.

It was Hap. "I got London, London, England," came over the wire.

Joe doubled up in a paroxysm of mirth. This was too good to spoil. Let Hap go on thinking he was getting Europe. He would save the denouement until he could make it more public, in the meantime here was something that would provide him with infinitely more entertainment than any radio. The possibilities were enormous. Tomorrow night he would see that Hap got "Paris," then "Cardiff," then maybe even the "North Pole."

The following evening again found Joe before his broadcasting apparatus preparatory to giving Hap the thrill of listening to Paris.

The relay key kept up its constant clicking. Joe involuntarily listening caught the call CWD—CWD— Spokane. Then a word here and there. "Specie shipment—West Mail."

Joe closed the switch on the transmitter.

"This is station PRPP-Paris," began Joe when the door behind him opened suddenly.

He turned toward the door. Just inside the doorway stood three tough-looking tramps. One, with a nose that looked as if a horse had stepped on it, leveled a gun at Joe and snapped, "Stick 'em up, Bud!"

Joe raised his hands above his head. A hold-up at this station? Why there was nothing here worth the effort of carrying away.

Broken-Nose calmly settled himself in a chair. "Has the West Mail cleared Perryville yet?"

The West Mail, thought Joe, and then he remembered the relay message to Spokane. Specie shipment on the West Mail! The Police Reports from KOZ—a broken nose.

"Has the West Mail cleared Perryville yet?" repeated Broken Nose.

"No," replied Joe.

"Set that semaphore to stop her here," growled Broken-Nose, pointing in the direction of the semaphore lever.

Joe did as he was bid and in passing his broadcasting apparatus he paused thoughtfully. Then he moved as close as he could, without attracting attention, to the transmitter.

There was a chance. The juice was turned on. If Hap was listening in. These men evidently had not recognized the pile of apparatus for what it was.

"You men aim to stick up the West Mail here at Rocky Gap?" yelled Joe.

"Yes and we ain't deaf, Buddy."

"Well the semaphore's set to stop her," continued Joe, louder and louder, "but she may not stop at that. If she don't you guys are out a luck."

"She'll stop, Buddy, and who in h—— are you yellin' at?"

Joe took one more chance and yelling at the top of his voice, "If the West Mail stops at Rocky Gap she'll be held-up sure as my name's Joe Bartry."

Broken-Nose grinned. "Say Buddy you're some little fortune teller, ain't yer?" And evidently putting down Joe's tone of voice for fear went on, "Now be a nice little boy and—"

The key clicked. West Mail clearing Perryville 10:44.

His warning had been in time. If only Hap had been listening in. Nothing could be done now except wait. They would all know in thirty minutes.

Broken-Nose sat up as the key silenced. "That Perryville?"

"Yes," answered Joe.

"West Mail?"

"Yes."

"Allright, youse guys. Tie this bird up and then we'll get outside for the fireworks."

After Joe had been securely lashed to a chair the three men left the station.

Minutes passed. Had Hap got the message. The Mail was due any minute at the cut.

A piercing whistle.

The Mail at the cut. He could hear the labor of the exhaust as she pulled the last part of the long grade from Perryville. She ought to be in sight of the semaphore now, but there was no slackening of speed, no grinding of brakes. Instead it sounded as if she was being stepped up. There was a thunder and flash and the West Mail sped by the station window.

Joe relaxed in his bonds. They had received his warning. The Mail was through.

Realizing now after the suspense that he had best release himself, he began to struggle with his bonds when the noise of an auto peculiarly distinct in this fastness came to his ears. The sound grew louder and seemed to stop outside. Two

men entered. Joe recognized one as the Sheriff at Perryville.

They greeted him, and after releasing him, congratulated him on the capture of the Gornan brothers.

"We got the three of them down the road," stated the Sheriff. "That reward ought to come in right handy for you."

The reward. He had forgotten about the reward. He could now afford a super-set and be able to really log the stations Hap claimed he did.

REVIVING FILAMENTS

(*Continued from Page* 10)

the *B* battery voltage has been disconnected. This should be 4 volts for the 299 and 220 tubes, 7 volts for the 300A, 301A and 371 tubes, 6 volts for the 313, and 9 volts for the 310 and 316 *B* tubes. This process speeds up the "boiling out" of the thorium from the body of the wire while the surface evaporation is slow without an applied plate voltage.

Tubes which have been badly overloaded may not improve under this process and "flashing" may be necessary. This consists in burning the filament for 10 to 20 seconds at 12 volts for the 299 and 220 tubes and at 18 volts for the 301A, 300A and 371, and then burning the filament for thirty minutes at the voltage above specified for the treatment of slightly overloaded tubes. If the emission is not restored at the end of thirty minutes, continue to burn the filament up to two hours, taking emission readings every thirty minutes.

The emission readings may be taken by means of the circuit arrangement shown in Fig. 1, which is also used to

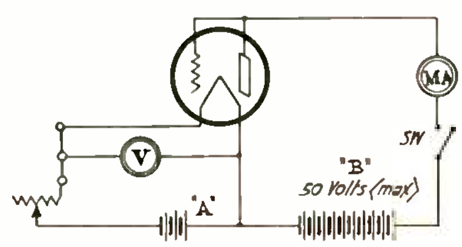


Fig. 1. Emission Test Circuit.

determine definitely whether the tube needs reactivation. The tube is first inserted in the socket and the filament voltage adjusted to its rated value. The switch *SW* is then thrown so that the plate current may be read on the milliammeter, paying no attention to the change in filament voltage which will occur when the emission current flows. For 299 tubes with 45 volts on the plate first read the plate current with 3 volts on the filament. Then *momentarily* increase the filament voltage to 3.5 and again read the plate current. If it increases more than .2 milliamperes the filament is not fully active. If the increase is less than this the tube is in good condition. The procedure is the same for the 301A tube except that filament voltages of 4 and 6 are used.

Either direct or alternating current may be used for the "flashing" treatment. With direct current the proper voltages may be obtained from a large storage *B* battery which should be subsequently recharged and only one tube should be flashed at a time.

Alternating current of the proper voltage can be secured from a toy or bell-ringing transformer provided with 2-volt taps. The circuit diagram is shown in

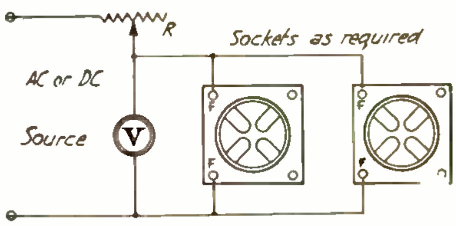


Fig. 2. Reactivation Circuit Diagram.

Fig. 2. The voltmeter should be left permanently in the circuit in parallel with the tubes. Naturally it should be of the a.c. type if a.c. is used.

Rapid reactivation, sometimes within ten minutes, can be accomplished by using voltages higher than those recommended. But this very materially shortens the life of the tube and such reactivation is seldom permanent. Furthermore the higher voltages greatly increase the percentage of tubes burned out, a small percentage occuring even with the recommended treatment.

Many of the standard types of tube rejuvenators use excessive voltages with the frequent result that the tube is permanently damaged or its useful life is shortened. The use of a voltmeter to set the applied voltages to the proper values is essential to good results.

MULTI-CHANNEL RADIO RECEIVER

(*Continued from Page* 8)

the last plug from any of the jack strips cuts off the filaments of all tubes. With this arrangement, it is not necessary to have someone tune the receiver, nor is it necessary to turn it on or off. The only attention required is the charging of batteries. Charging equipment is provided for both *A* and *B* batteries in the bottom compartment of the cabinet. All batteries, etc., are concealed and the cabinet is normally kept locked to prevent tampering with the tuning of the various channels.

No filament rheostats are shown on the diagram, but separate rheostats for each tube are required, the size depending on the type of tube. Standard *A* tubes are used in this set. The relays are Western Electric telephone relays.

This receiver has been in operation for several months and has been entirely satisfactory.

If you are troubled by unauthorized persons tampering with your set in your absence, a "key switch," such as is used on the fronts of stores, for the use of night-watchmen, may be used to control the filament current of the set.

"AND IN THOSE DAYS"

(*Continued from Page* 30)

brain was engraved every detail, and in his mind's eye rose in perfection the shining receiver of his dreams. And when he heareth one say, "I turned back the tickler and there was 2LO clear as a bell," he only smileth and saith unto himself, "What is this compared with that which mine ears shall hear when I shall have completed mine own handiwork?" For doth not hope spring eternal in the human heart, even as the dandelion in the front lawn, or the rattle in the new flivver? And in fancy he heareth the voice of the announcers of far distant stations as yet heard by none of those about him, and seeth his wall adorned with many acknowledgements from far countries.

Now in the fulness of time it came to pass that at payday the coffers of our novice were filled with much gold and silver. And he payeth the rent and the butcher and satisfieth the greed of the eternal light-water-gas trinity, yet there remaineth still a few talents, and with these jingling cheerily in his pocket, he goeth out in search of all that which he needeth to construct this marvel of his desire.

He goeth first into the radio store nearest his own domain, and maketh known his wants and demandeth to be made known unto him the price of all things necessary to his building. And the dealer writeth all upon a scroll and giveth him his own price on each, and bestoweth upon him many good wishes and applause cards. And the novice likewise visiteth many other radio stores in that city, even to the great department store wherein the radio section displayeth all the latest wonders of the cabinet-maker's art, and all manner of fine engraving, and unto the radio counter of the great chain store of the red front which is well known throughout the land. And he compileth a mighty list of all the various prices, in complexity and completeness like unto the directory-of-the-telephone.

Now it so happeneth in that day that a neighbor spake unto him on the subject of prices, telling him in secret of a store where all prices are cut to the quick, or to the bone, even unto radiotrons. He telleth of the many bargains to be found; even of a meter he hath there bought at but half the common price, and so great the sensitivity thereof that on a new 45-volt *B* battery it registereth 48 volts; and even of the genuine tubes which hath cost him many shekels less than the prices set before the people by the great lords of radio trade. And the novice rejoiceth himself greatly, and saith unto his neighbor, "Here indeed is where my talents shall serve me manifold, and I shall practice such economy as was never heard of in the land of my fathers even by the great Hoover, or the mighty Coolidge himself."

And so he goeth forth unto the nethermost parts of the city to find the place whereof his friend speaketh. And he sees from afar off the sign of the store, even Gyp & Gyp. And he knoweth the place by the description thereof by his friend, for in the windows there glistened many shining articles of radio use, all fallen greatly from their former price. And from the great $150 Tonadyne at $99.50 to the little Crossup at $9.95, and from the priceless 203-A in the window to the lowliest binding post behind the counter, all bear price-cards, telling of the enormous savings resulting to the buyer thereof.

So our novice entereth therein, to enquire after the prices of all that he desireth. And he rejoiceth exceedingly when he learneth the great reduction of all. For the sockets of which the ordinary price is seventy-five mites cost him but sixty, even those of the Mudmold brand. And instead of the "Orthotonic" transformer of his specifications he buyeth a "Dynavox," which the dealer assureth him to be equal in volume to three of the ordinary, and to have an absolutely *flat* amplification *curve* from 300 to 1800 cycles (at which he marvelleth greatly, such the technicality of the term). And he saith, Give it me, for thereby I save four whole shekels. And even the rheostats share in the economy, for doth he not pay but forty-five mites for the eighty-mite rheostat, and even for one more powerful by tenfold, which containeth 200 ohms instead of 20? Thus he shoppeth, and great the saving resulting.

And it came to pass that when he builded, most diligently did the novice labor, and drill, and solder, and engrave, despite the burned finger and the many scars on the kitchen table. But patience (aided by the use of the "Easywyre" picture-diagram) must triumph, and now is the golden dream realized. With trembling fingers he attacheth each wire to its appointed binding post, and in each socket placeth a shining Punkatron. He pulleth the master switch, and timidly turneth the large knob of the "single master control," and adjusteth all the "auxiliary verniers," and lo! from the mighty horn of sounding brass poureth a quantity of sound, to be compared only to the calliope of the circus, or the jazz band of the hall of dancing. And when the music is stopped and the announcer announceth, he heareth many other voices, and there are all the other local stations, each clamoring to be heard. And the builder rejoiceth mightily, and calleth all his tribe and all the neighbors to hear this creation of his hands. And his chest expandeth and his countenance beameth, and he alloweth little Johnny to remain long after the hour of his retiring soundeth, nor doth he cry out when friend wife causeth the tube which he hath bought as a spare to fall to the floor, and there to be shivered into many fragments. And happiness reigneth triumphant within him.

Now even unto the ninth day he sitteth before his instrument, and tuneth, and detuneth, and twisteth and twirleth, and many the midnight watt he burneth, and yet no far-away call hath he logged, not even the 5000-watt station in the nearby city, nor the 500-watt station in the suburbs.

And in the faintness of his heart he calleth upon all his friends, and upon his neighbors, even those in the nearby apartment house, to make known unto him the causes whereby his loudspeaker doth not speak the tongue of the far-distant station. And many are the opinions, and criticisms, and counsellings,—to cast forth its transformer, to replenish its *A* battery, to replace its Punkatrons with Bunkatrons, to purge it of its *C* battery—but all are in one opinion together: that the marvellous receiver our novice hath constructed possesseth not "pulling-power," to bring in the distance; even, saith a few of the more candid, that it is a "flop," a "fizzle," and not to be mentioned in the presence of the wise. And there is much weeping, and wailing, and gnashing of teeth, and tearing of hair in the house of our novice, until friend wife dareth not even mention the word "radio" in the presence of her lord. And gloom reigneth; the bulbul in the figtree is hushed, and the dulcimer is heard no more in the flat.

But at length our novice groweth desperate, and saith, "Behold, I will wait upon him who knoweth the most inward secrets of these things called "radios"; he departeth from the bosom of his family, he taketh the set which he hath builded out of its beautiful cabinet, and he taketh his treasure to the dwelling of the radio dealer nearest him, in his own neighborhood. And he demandeth that it be made known unto him all concerning his work and the reasons for its shortcomings.

And the dealer taketh the set into his store, upon his own counter, and yet groaneth inwardly, for who hath the tact and the diplomacy to tell unto the builder of a set its faults and its misconstructions? But he speaketh bravely, and wisely, and maketh known unto the unhappy one wherefore the receiver receiveth not long-distance, and explaineth all thereof; how the power of a receiving set lieth not in the number of its tubes, but in the quality of its design; and how the virtue of a rheostat is found in not the number but in the suitability of its ohms to the purpose at hand; and why the coil of one hundred turns is not necessarily better than that of seventy-five; and how clarity of tone is greatly to be desired above sound in such great quantity that the ear-drum shrinketh back and is pained; yea, and he attempteth even to explain the true meaning of the term "self-neutralized," and how a little regeneration in the detector tube is to be preferred to overly-much in the other tubes; he even maketh him see how lack of "whistling" is not necessarily an attribute of a good set. All these things, and many others, he saith unto the novice, and setteth before him, and the novice is mightily impressed.

And the dealer explaineth unto him the economy of buying that which is good before that which is cheap. He computeth, and lo! whereas that which had been bought costeth fifty talents of gold instead of the sixty-five of the ordinary purchasing, thirty-five and some odd shekels of silver must now be gathered to replace and renovate the receiver into that which is to be desired. And the novice perceiveth the error of his ways, and bitterly repenteth. And he saith unto the dealer, "Do all for me which thou considereth well upon my set, and spare not the expense thereof, for thou art an honest man, and quality I desire, let the cost be what it may."

And the dealer doeth even as he is commanded, and when all is completed, the work is all that mortal man might desire, so that even brother-in-law must admit its excellence. The novice payeth with joy the reckoning against him, and he taketh the marvelous work to his own place, and connecteth to it once more all its accessories. And with trembling hands he again turneth the dials. And now no longer doth he hear a goodly number of stations as a great company making clamor, but only that to which his dial is attuned. The music, moreover, is sweet, and the announcer roareth not, nor doth the piano tinkle.

And behold the wonders!—every dial number hath a separate station, and one only, and there is heard that station at all times no matter what its distance, for hath not the dealer equipped it with the new marvelous condenser which thus changeth the former conglomeration into an orderly array, even as the call-book publisher who arrangeth all calls into a list, wherein one findeth his own call next that of the ham in the next state, and all radiocasters are unto themselves? And when the locals (which term now applieth to all stations of the call "K" or "W") have signed off, lo! there appeareth not one but several stations speaking in many tongues; and when the novice heareth pronounced the name of each station and findeth each to be far distant across the great sea, happiness is indeed rampant; he rendeth the air with shrieks of joy, so that even the corner policeman cometh to investigate and remaineth to marvel. Once more the bulbul singeth merrily in the fig-tree, and the lute and the dulcimer maketh merry his dwellings.

In this manner doth our one-time novice find that in radio, as in many other things of life, happiness is to be found not in all that which glittereth brightly but in the pure gold of perfect radio parts, tarnished though it may seem by the excessive price thereof. And through the learning of this well-found moral (placed strategically near the end of this narrative), peace cometh to him at last, for what shall it profit a man if he spendeth his whole pay-check and yet hath only the makings of a set which rejoiceth not his own heart but bringeth riches to the repairman?

MASTER OSCILLATOR TRANSMITTER

(*Continued from Page* 39)

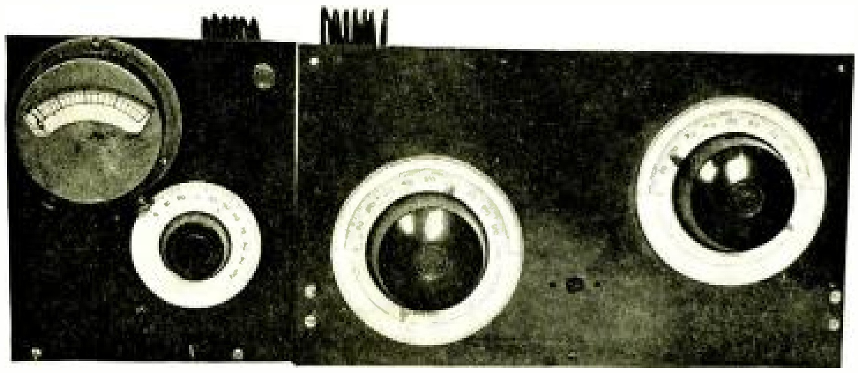
start oscillating itself and notify the operator that the grid coil is too large or that there is too much feed-back inductance.

The resistance, R_3, is used in keying and can be of any value such as a 100,000 ohms, since it prevents a direct short circuit on the high negative grid keying battery when the sending key is depressed.

The oscillator is normally left running all during the transmission since it is only a UX-201-A tube with about 90 volts of *B* battery for the plate supply. When the key is open, the keying battery places a high negative potential on the grid of the amplifier which shuts the plate current off in effect and reduces the output into the antenna to zero. As soon as the key is depressed, normal grid voltage is applied to the amplifier and normal output is obtained. This method does away with the horrible key click which always occurs when using *B* battery or pure d.c. for plate power supply. The idea of using a small keying filter and keying in the negative lead isn't so good since the note slides and warbles all over.

The antenna coil and series condenser are similar to those used in the power amplifier and to indicate resonance, a hot-wire meter is used. This meter was remade by using a piece of fine resistance wire, about No. 38, in place of the regular heating element. The meter will deflect with only a few milliamperes of current flowing through it and so can be used when tuning the set up and then shorted out with a short piece of wire in order to eliminate the added resistance in the antenna circuit.

Tuning up the set is quite simple, the oscillator first being turned on and checked by listening in on a receiver to see if it is oscillating. The wavelength can then be checked by a wavemeter which will cause the oscillator to stop oscillating or greatly increase the plate current reading in the milliammeter when in resonance. The amplifier is next turned on and the plate tuning condenser and antenna condenser varied until the antenna meter shows a deflection. When the amplifier is tuned to the same wave as the oscillator, the plate current in the latter will increase since power is being taken from it. The coupling between the oscillator coils and the amplifier grid coil must not be too close, or the oscillator will quit functioning. All that is necessary to reduce power is to cut down on the amplifier plate voltage, and then go ahead and try for low-power records



Front View, Showing Antenna Panel.

DETECTOR TUBES

(*Continued from Page* 26)

phonic action and gives greater volume on weak signals. It takes a 2 megohm grid leak and .00025 mfd. grid condenser, *the grid return being connected to the negative filament* for best results. Maximum quality of reproduction is secured with 45 volts on the plate, although any voltage down to 22.5 may be used. The filament rating is 5 volts, .25 ampere. Due to its greater sensitivity it will indirectly improve the selectivity of a set by enabling the use of a shorter or more loosely coupled antenna without sacrifice of volume. It may be operated in parallel with other 301A amplifier tubes without change in rheostat size or it may be separately operated from a 10-ohm rheostat.

The 300 tube is likewise designed exclusively for detector service, but requires careful adjustment of the filament between 4.25 and 5 volts and of the plate between 16.5 and 22.5 volts for maximum results. It thus requires a separate rheostat of from 2 to 4 ohms resistance and a potentiometer across the filament terminals, the —*B* return being connected to the slider. This tube operates to the best advantage when the grid return is connected to the negative filament terminal, the ionized gas in the tube causing sufficient grid current to obtain detection with the conventional .00025 grid condenser and 1 to 2 megohm grid leak.

RADIO LAW NEEDED

The opinion of the Attorney-General that the Department of Commerce is without authority to control broadcasting by the allocation of definite wavelengths is not expected to seriously affect conditions before Congress passes proper laws next winter. An industry which has been virtually self-regulating for five years can co-operate with the Department in stabilizing conditions. There will undoubtedly be isolated attempts to come on the air without proper authorization, but these will probably not be sufficiently important or numerous to disrupt existing conditions before adequate relief can be afforded. But every effort should be made to impress upon Congressmen the need for regulatory legislation.

TUNED GRID AND PLATE TRANSMITTER

(*Continued from Page* 37)

and danger of burn-outs is no object. The auto transformer used in the primary circuit has also been a stumbling block for some of those who have built the transmitter, and if it is impossible to obtain one through a local Westinghouse agent, the power can be reduced to any desired input by placing an ordinary porcelain lamp socket in the primary circuit, and inserting therein different sized mazda lamps. The base of a burned-out lamp, with the terminals connected together, makes a good short circuiting plug when full power is used. I recently saw a novel installation of this sort where five lamps were used, and connected to a tap switch so that the power input could be varied instantly by a turn of the switch. This is particularly handy when working local stations, and minimizes interference with nearby BCL's. The Allen-Bradley Co. also make a primary rheostat for this work, with a stepless control.

In regard to tuning the transmitter, if a wavemeter is handy, a calibration curve can be easily made, and the settings for the grid and plate variable condensers determined for the entire condenser scale, with any given set of coils, in the same manner as calibrating a BCL receiver. Adjust the grid tuning condenser to about 10 degrees, and move the plate condenser back and forth until the tubes oscillate. During all these measurements, it is advisable to operate the tubes on the lowest power setting, as no power is being radiated. After finding the point of oscillation for the first setting of the grid tuning condenser, measure the wavelength with the wavemeter and advance the dial to 20 degrees, again adjusting the plate tuning condenser until the best point of oscillation is found. In this manner a number of points can be located and a curve drawn on cross section paper, so that any wavelength setting can be selected and the condenser dials set without delay. Of course, the final wavelength adjustment depends on the antenna, and while the transmitter can be made to oscillate on any given wave from 10 to 100 meters or more, with the set of coils specified, the antenna must be designed for the waveband in which most of the transmitting is to be done.

If the antenna is to be operated so that the 3rd harmonic falls in the 40 meter band, the transmitter can usually be made to radiate a large percentage of its possible power output at any wave from 37.5 to 42.5 meters, so that if bad QRM is had at one wave, a change can quickly be made to some other point in the band where the distant station is not experiencing interference with reception. At 6XAO, the settings of the grid, plate and antenna condensers are logged for 15 different frequency settings about 100 kilocycles apart, and the change is made in about 5 seconds by resetting the three dials.

POSTAGE ON QSL CARDS

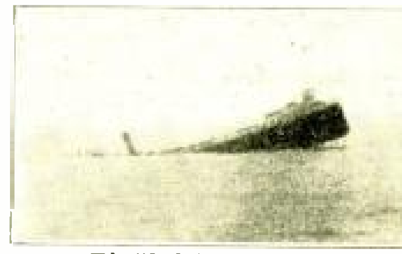
A recent change in the foreign postal rates has created considerable confusion among amateurs sending QSL cards to foreign countries, and the following information will be of assistance in sending cards, whether they be of the government printed variety, or private mailing cards.

South American countries, except Venezuela	2 cents
North American countries, except within U. S., where government postcards are 1 cent	2 cents
Australia	3 cents
New Zealand	2 cents
Africa	3 cents
Europe, except Great Britain and Spain and Spanish Colonies	3 cents
U. S. Possessions—Gov. postcard	1 cent
Private mailing card	2 cents
All other countries not listed above	3 cents

THE COMMERCIAL BRASS-POUNDER

(*Continued from Page 36*)

Through an error we put the wrong caption under the picture of the *Ann Arbor* No. 5, last month. We intended to show a picture of the *Lakeland* in a sinking state. The No. 5 seems to be pushing along pretty nicely, smashing up ice in great style.



The "Lakeland" Sinking.

John P. Matthews, graduate of R.C.A. school in New York, and formerly 9DZW, is now signing WLH on the *S.S. Sancon* on the Great Lakes this season.

T. W. Kelso and L. V. Davenport changed jobs this last trip into San Pedro, Davenport coming off the *Olympic* and taking the *Cascade* out and Kelso vice versa. Davenport had been on the *Olympic* twenty-two months and is rounding out five years' service with E. K. Wood Lumber Company.

Harry R. Maule is at WTK and not at WDK as reported in the June issue of this magazine.

Richard J. Loosen is on the *S.S. William A. Reiss* this season.

We have been wondering about the QRA of that good fist on the *S.S. Pere Marquette No.* 15. He is a new CB by the name of George Krivitsky. Nice mit for the summer QRN OM.

George Brown started the season out of Buffalo on the *S.S. Stephen M. Clement*.

The op. on the *S.S. John P. Reiss* may wonder where we got his name when he sees this, but we are going to print it anyway. It is none other than Joe Decker. Hw?

A few years hence:

Modern Ham working DX: "Gee, you look tired tonight OM."

Instructor: "Define lightning."

Student: "It's a bunch of static going somewhere and in a hurry to get there."

By 6DDN, Willis L. Nye, Burlingame, Calif.

1ac, 1am, 1ao, 1aga, 1asu, 1bca, 1ky, 1yb, 2ae, 2ahm, 2ar, cgb, 2ev, 2fx, 2ij, 2kg, 2ld, 2mu, 2no, 2ta, 2wr, 2za, 3bu, 3cjn, 3ef, 3tw, 3zh, 4ac, 4ah, 4bx, 4da, 4dq, 4qg, 4xi, 4xo, 5agu, 5aky, 5amn, 5ato, 5atv, 5awk, 5dx, 5ef, 5ex, 5fn, 5ge, 5jd, 5jl, 5mb, 5nq, 5or, 5ql, 5qs, 5tk, 5yb, 5za, 5zaz, 8apm, 8bau, 8bbl, 8biq, 8bof, 8cd, 8cf, 8cfh, 8ix, 8lq, 8mu, 8oq, 8pl, 8qf, 8qd, 8rh, 8xd, QRA? cd-8, g-9y, hu-fx1, 6aff, 6asr. Aussie: 3qa, 4cm, 4rb, 5ay, 5lo, 7ab. Porto Rico: 4si. Can: 5go, 5oe, 4gt, 5cr. NZ: 1ae. Pse QRK 6ddn 22 watts input.

By U6AE, G. W. Carter, 1607 W. 45 St., Los Angeles, Calif.

U. S.: 1aao, 1ahv, 1amd, 1cmx, 2ahm, 2aky, 2cje, 2gk, 2kg, 2mu, 3afq, 3fy, 3op, 4pk, 4vq, 4xe, 8aqg, 8arw, 8arg, 8chf, 8cgr, 8cli, 8aue, 8bce, 8bjg, 8buy, 8cau, 8cdv, 8cng, 8dqz, 8dgj, 8eq, 8sf, 8sv, 8xe, m9a, m1j, mjh, hu6cfq, hu6ddl, hu6oa, hufxl, a2cs, a2cg, a2lm, a2yi, a3kb, a3lp, a3wm, a4rb, a4am, a4cm, a5ay, a5da, a7cs, a7dx, z1ax, z2ac, z4ac, pi1au, pi1cw, pi1hr, pi3aa, picd8, o2ah, o2ar, o2ld, o9tc, ss2se, fea, bxy, xam, kio, wiz. QRK 6ae? All crds QSLed. Tnx.

QUARTZ CRYSTAL OSCILLATOR

(*Continued from Page* 32)

upon a revolving plate covered with a paste of very heavy oil and No. 2F carborundum. It is then freed from grease by cleaning in carbon tetra-chloride.

Finally it is mounted for use between two smooth metal plates of the same area as the crystal faces, a small rubber band sufficing to hold them all together.

After the crystal is placed in the circuit it is calibrated with a calibrated wavemeter. If its fundamental is higher in wavelength than that reached by the wavemeter its fundamental is equal to the difference in frequency in cycles between any two adjacent harmonics. It will be necessary to take the average of several readings to get an accurate value. If the fundamental is lower in wavelength than the band covered by the wavemeter an intermediate oscillator may be used.

Considerable care and time must be taken while testing a crystal to avoid skipping the resonant point while tuning the *LC* circuit due to the time lag in the crystal's oscillation, this sometimes being as long as one-half second. The average crystal will not handle more than four watts, two watts giving the most stable operation. The output can of course be amplified to any desired amount.

LONG WAVE LOADING RIG

(*Continued from Page* 34)

low enough, simply tap the coil as shown in the diagram. Three taps will cover everything from 4,000 meters up.

Some Navy type receivers have a variable by-pass or bridging condenser in the phone circuit as indicated by C_2 in the diagram. Such a condenser is in shunt with the long wave tuning system and changing its capacity will, of course, affect the long-wave tuning.

The signal-static ratio with this type of long-wave rig is excellent, even violent QRN crashes being converted into a squashy sound that does not kill signals! Selectivity and signal strength are equal and often better than that obtained with other long-wave circuits.

To shift from, say 600 meters to a long wave, merely throw the switch and put the variable condenser on the setting of the long wave station desired. Simple, eh?

By 9APY, 3337 Oak Park Ave., Berwyn, Ill.
(Heard on 40, 80 and 150 meter bands)

1aco, 1amd, 1beb, 1bnm, 1pi, 1qb, 1xv, 1yb, 2agt, 2ahm, 2cje, 2clg, 2nf, 2nz, 2uo, 2wc, 2aso, 3bd, 3qf, 3zm, 4cu, 4dt, 4eo, 4iv, 4le, 4pf, 4rr, 5ada, (5anl), 5arh, 5awf, 5avf, 5er, 5sw, 5wk, 5yb, 6bhz, 6bls, 7hd, 7ya, (8ahc), 8aof, (8bbl), 8bfo, 8buy, (8dks), 8dme, 8dmz, 8qb, 8xe. Canadians: c-3jw. Card for Card Fellows.

By J. D. Ryder, 1100 Westwood Ave., Columbus, Ohio.

Australia: 2bb, 2bk, 2cg, 2cs, 2dj, 2ij, 2ip, 2je, 2kb, 2lk, 2mh, 2rc, 2tm, 2yi, 3bd, 3bh, 3ef, 3el, 3kb, 3ls, 3tm, 3wm, 3yz, 4an, 4ar, 4cm, 5ay, 5da, 5kn, 5lo, 7cs, 7cw, 7dx, 7hl. **Brazil:** 2ae, 5ab, 9qa. **Chile:** 2ah, 2ar, 2ld. **France:** 8ix. **England:** 2sz. **Hawaii:** 6axw. **Italy:** 1gw. **Mexico:** 1g, 1k, 9a, jh. **Portugal:** 1ae. **New Zealand:** 1aa, 1ao, 1ax, 2ac, 2bx, 2xa, 4aa, 4ac, 4am. **Miscellaneous:** noh, noeg, nmr, npm, nitz, nao, nidk, wnp, fbio, rxy. Pse report mi sigs.

RADIO CONSTRUCTION POINTERS

(*Continued from Page* 29)

thread, can be so arranged that with a small machine screw and washer, the cards can be replaced when soiled.

This system, once that a number of stations have been written in on the card, removes all guess work in locating the same station again, and allows one to hunt for new stations, where the wave-length is known, with absolute certainty, and without the necessity of referring to the old log chart, calling in case of a three dial set, for three separate references. Having located, say, KGO at 361 meters, and KPO at 428 meters, it is a comparatively easy matter to locate an unlisted station that is operating on 400 meters. And also, where there are in the family a number of non-technically inclined folks who want a station, and do not care to play a game of radio hide-and-seek, this system is one that will be hailed with relief.

A Baby Variable Condenser

RECENT circuits call for small variable condensers with capacities of .00005 mfd. or thereabouts. A simple one may be made by using a piece of round bus wire as one plate, a short

A Baby Variable Condenser.

length of spaghetti as the dielectric and insulating medium, and a length of bare wire wound around the spaghetti as the opposite plate. Insulated magnet wire may be used, if more convenient.

Improving the Loud Speaker

THE TONE quality of a loud-speaker can ofttimes be improved by connecting two in series and operating them simultaneously. The writer has found that a cone type operated together with a horn type of speaker gave a richness of tone and faithfulness of reproduction that was superior to either operated singly.

Bettering Socket Contacts

A point of possible trouble in receiving sets is found in the contact between the socket springs and the prongs of the tube. Most tubes are tipped at the prongs with soft solder which in time oxidizes and this corrosion, where tubes are left in place over a considerable period of time, is sometimes sufficient to create a poor contact and cause trouble in microphonic noises.

If the socket springs at the point of contact are smooth, they should be removed from the socket, and placed in a heavy vise that is provided with rough faced jaws, and considerable pressure applied at the point of contact. If a suitable vise is obtainable, this will result in a series of corrugations which will bite into the soft solder on the ends of the prongs sufficiently to remove any oxide coating and present a shining surface. After this, turning the tubes in the socket once every couple of months will insure a trouble proof socket insofar as contact is concerned.

One of the better known sockets on the market uses springs that provide this filing contact, and trouble from oxidization at the point of contact between the spring and the prong is unknown.

Facing Material for Panels

INLAID linoleum is a somewhat novel panel material, which can be used as a facing over a wood, metal or bakelite backing, and which is capable of a high finish and a pleasing effect. It should preferably be of a solid color. It can be fastened against a panel, either with glue or by means of small machine screws and washers. From two to three coats of shellac, carefully applied with a bristle brush, with a rubdown between each coat with fine steel wool or sandpaper, are used to impart a high finish. The radio parts should be self-insulated and the high frequency parts should not come in direct contact with the panel itself. Present day assembly units lend themselves to this method readily. This is a good way to utilize an old bakelite panel which has been bored full of holes.

A Substitute for Coil Forms

EVERY old timer remembers the old United two-coil tuner which was in vogue back around the year 1912, and the arguments that were staged as to whether or not the manufacturers used rolling pins to support the windings. While this point has not been settled to the writer's satisfaction, nevertheless rolling pins do make excellent winding forms for radio frequency windings. The five-and-ten stores carry an undersized hardwood rolling pin that will make up two or three supports, depending upon the amount and size of wire used. The dielectric loss of unvarnished wood is fairly low and affords considerable mechanical strength.

Straight side glass water tumblers also make an efficient winding form. For the glass panel enthusiast, who wants all the workings of a receiving set to be in plain sight, the combination of a glass panel, glass sub-base and glass winding forms is an unbeatable arrangement. The wood form may be fastened by means of wood or machine screws, and the glass form by means of glue.

NEW RADIO CATALOGS

International Resistor Co. of Philadelphia, Pa., have issued a technical data folder telling of the uses and operating characteristics of Durham Metallized Resistors as grid leaks, amplifier couplers, power absorbers and voltage regulators.

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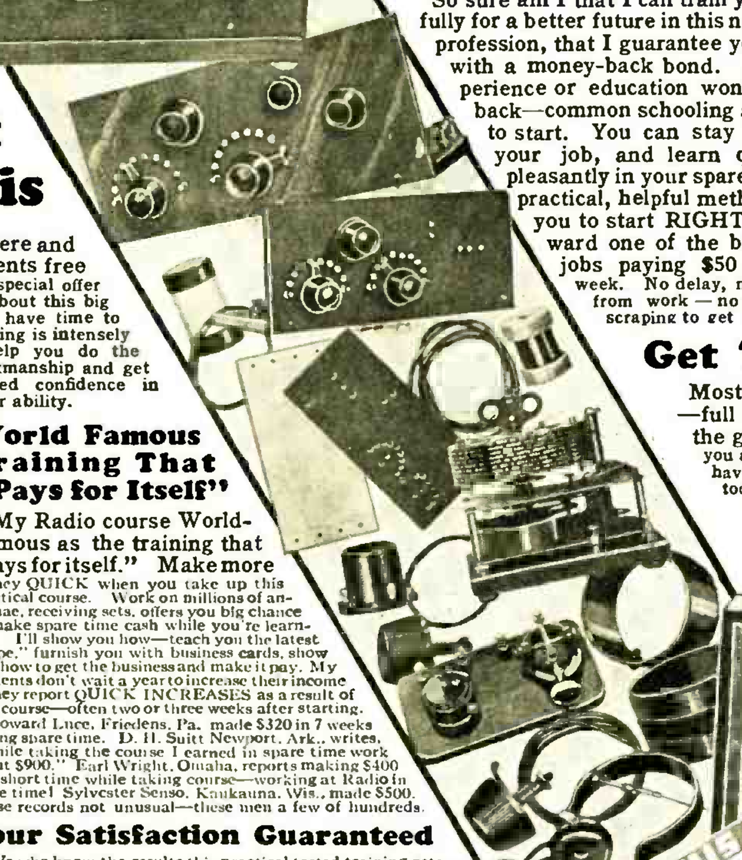

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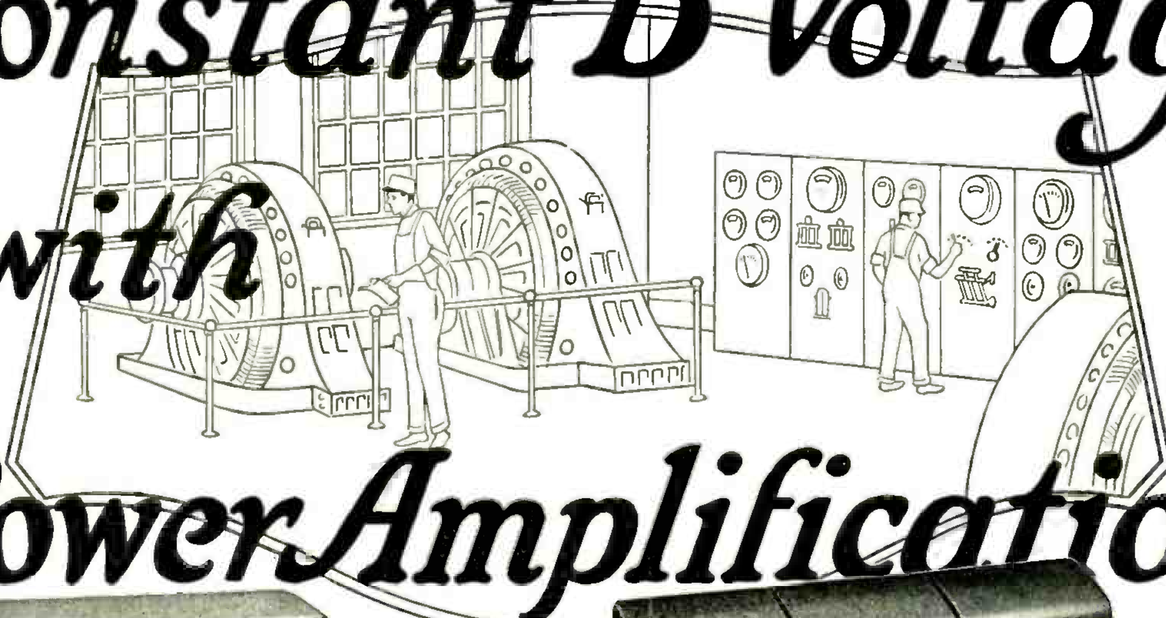

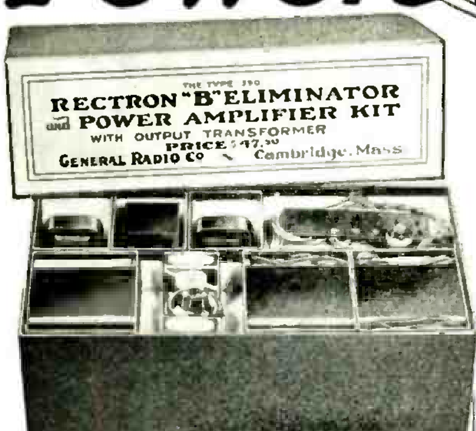

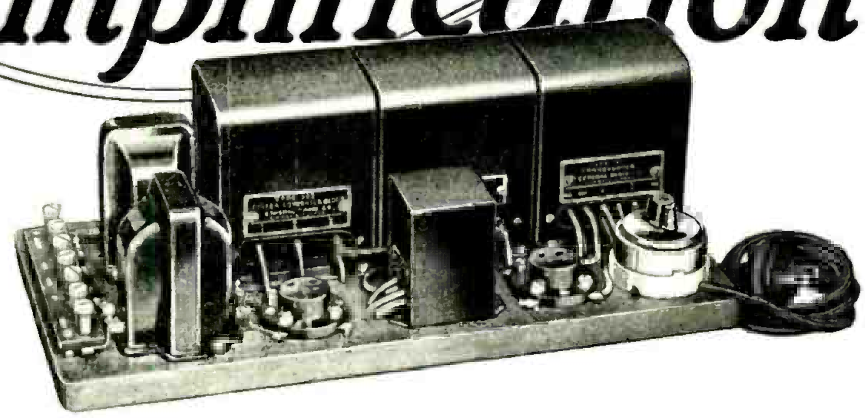

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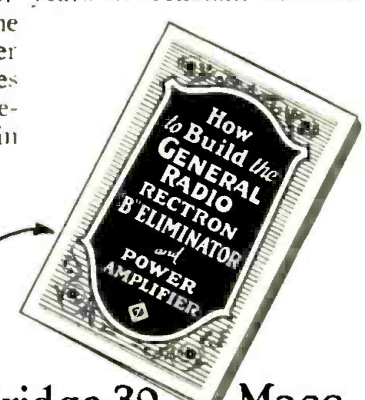

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