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Radio-Craft

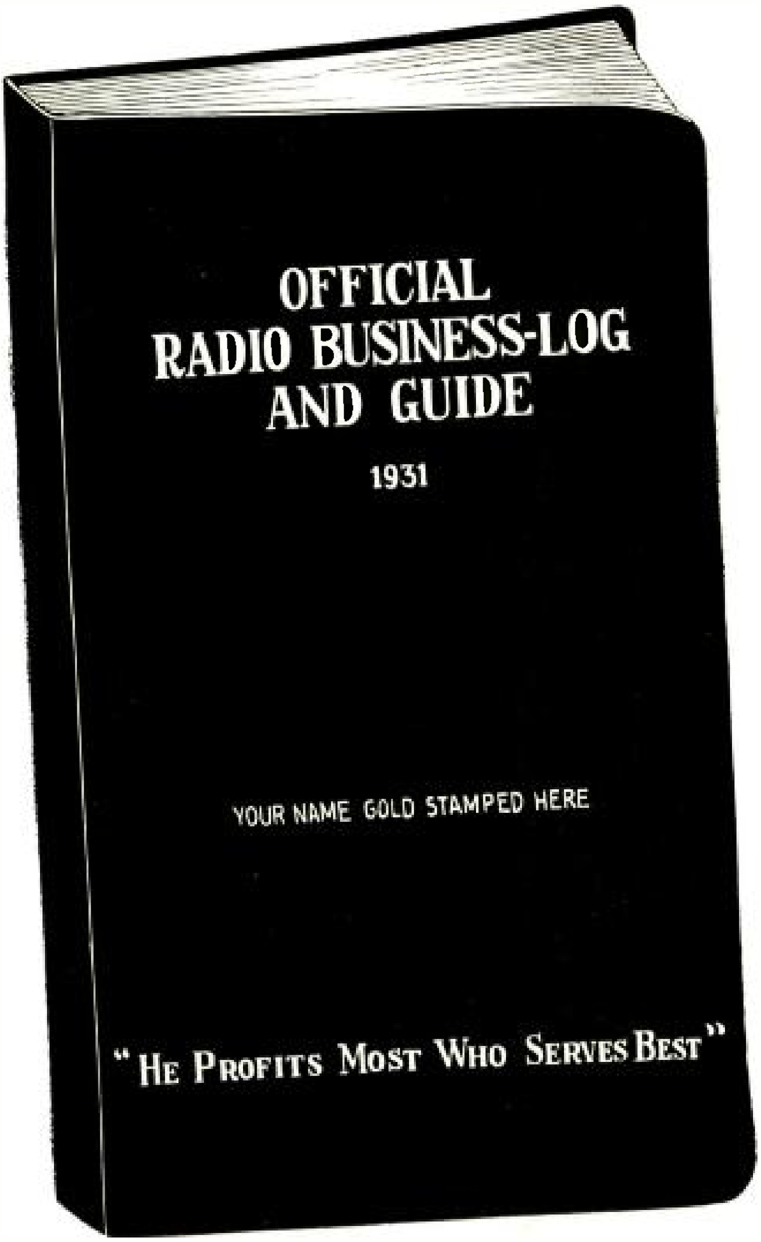
FOR THE

SERVICE MAN - DEALER - RADIOTRICIAN

HUGO GERNSBACK Editor

The Radio Sextant

See page 664



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Radio-Craft
FOR THE SERVICE MAN · DEALER · RADIOTRICIAN
HUGO GERNSBACK, Editor-in-Chief

JOHN F. RIDER, Editor Service Dept.

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VOLUME II
NUMBER 11

1931
MAY

Contents of This Issue

In Forthcoming Issues

MULTIPLE RADIO AND SOUND INSTALLATION. No hotel is now complete without radio, as well as light and water, connections in every room. The methods of obtaining centralized radio reception and distribution of programs, in use in big new hotels, will be explained and pictured.

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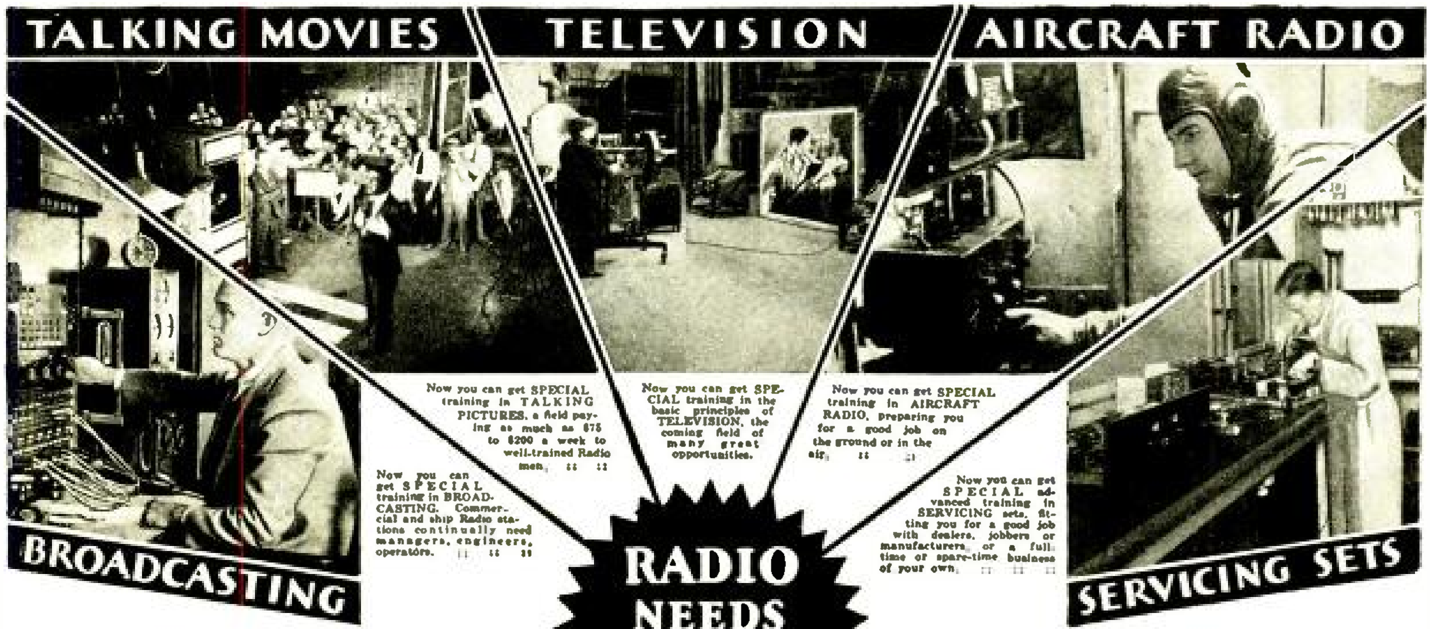

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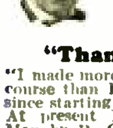

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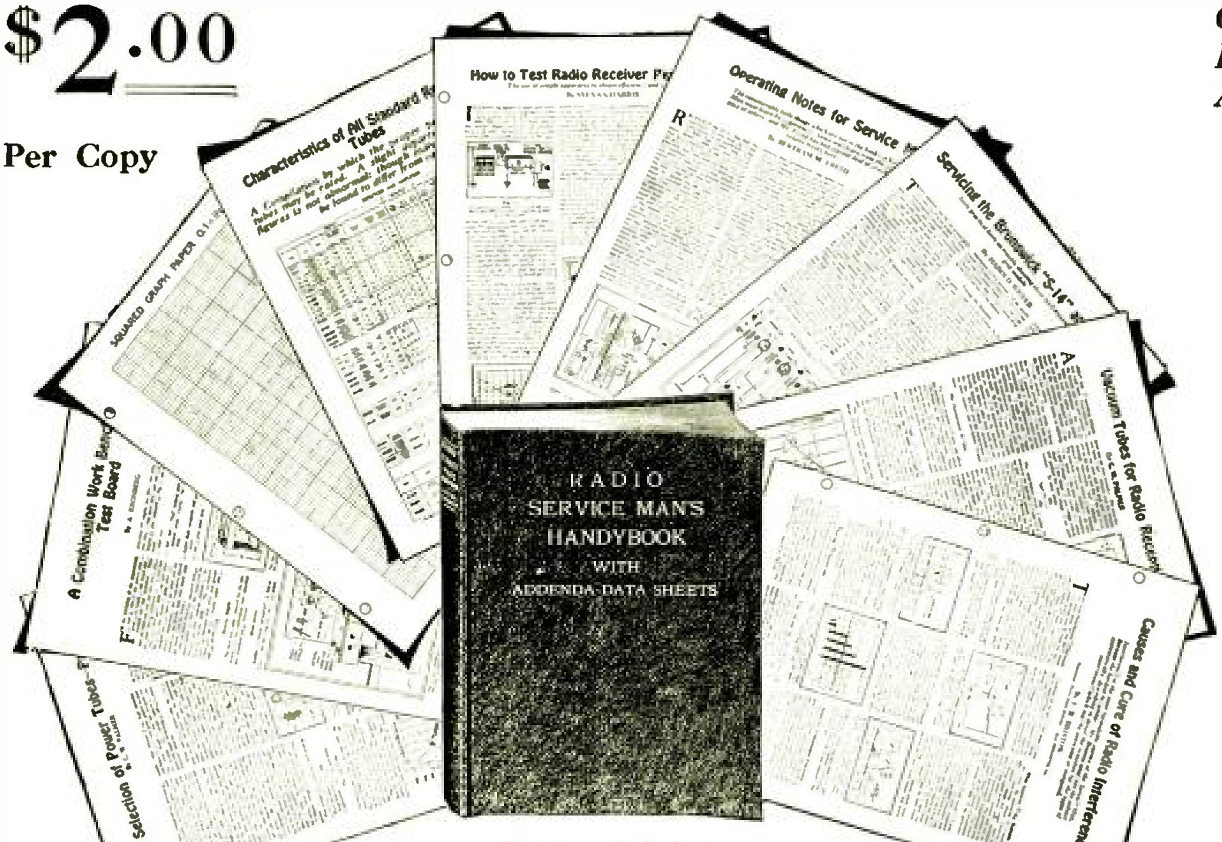

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MAY
1931
VOL. II—No. 11

Radio-Craft
FOR THE
SERVICE MAN · DEALER · RADIOTRICIAN

"Takes the Resistance Out of Radio"

Editorial Offices, 96-98 Park Place, New York, N. Y.

HUGO GERNSBACK
Editor

Money In Amplifiers

By Hugo Gernsback

IN the same mail, the other day, I received two letters: one from a young man who is "through with radio," as he claims that there is no longer any money in it and that he did not see any future in it. The other letter came from another reader, in a small Mid-western town, who wrote us for some technical information and, in closing his letter, mentions the fact that last season he made over two thousand dollars in installing public-address audio amplifiers.

It seems to us from the latter letter, and from many others that are constantly being received, that there is still a good deal of money to be made in radio, if you have a little ingenuity and go after business. Radio, like any other trade, is not a miracle worker and will not drop money into the lap of those who wait for it to come to them. You must go after it and make an effort. The coming summer season should prove a particularly rich ground for the ambitious radio man who wishes to make some real money; and this will be less difficult than it might seem.

Audio amplification, or the so-called public-address system, is still in its infancy; and many installations are yet to be made, where they are urgently needed. A little educational talk with the right prospect will invariably effect a sale. And it should be noted that a sale here usually runs into quite some money, and the profit for the radio man is very satisfactory.

Audio-amplifier public-address systems can be used with great benefit in many places today, for all sorts of different purposes; and the writer is safe in saying that the surface has not as yet been scratched.

Recently a manufacturer of amplifiers compiled a representative list of applications of public-address units, and the list here is only a partial one:

Airplanes, amusement parks, apartment houses, auditoriums, athletic fields, bathing beaches, banquet halls, baseball parks, brokerage offices, cabarets, charitable institutions, churches, clubs, conventions, dancing schools, encampments, factories, fairs, filling stations, flying fields, football games, hockey matches, home entertainments, hospitals, hotels, ice skating rinks, merry-go-rounds, motor cars, open-air assemblies, orphan asylums, paging systems, polo games, railroad depots, race tracks, regattas, receptions, restaurants, roller skating rinks, sanitariums, schools, stores, summer resorts, swimming pools, veterans' homes and carnivals.

During the summer time there will be large rewards for the industrious radio man who can make installations of public-address systems in amusement parks, athletic fields, baseball parks, fairs, hotels, summer resorts, and the like. There is hardly a place today where people gather, in which a public-address system cannot be installed to advantage. Summer hotels, particularly, need entertainment for their guests; and it is a simple matter to hook-up an amplifier system to the radio, which is already there, in order to bring dance music and other entertainment to the ballroom, etc.

Then, of course, no public-address system is complete without its phonograph unit. While the radio is satisfactory in most cases, it is often necessary to supply entertainment in the form of dance music (which cannot always be obtained, at any hour on the radio) and it is here that the phonograph, with its electrical pick-up connected to the amplifier system, works wonders by means of a simple throw-over switch. Incidentally, additional profits are to be made by the radio man in supplying such an electric-phonograph installation in conjunction with the audio amplifier system.

The list which we have given above is of course incomplete; for every day new and ingenious uses are found for audio amplifiers.

Last summer, at one of our Atlantic beaches, an enterprising radio man hired a motorboat and installed in it a powerful amplifier system. He ran the boat back and forth for a few miles and gave the bathers, not only music that was audible above the roar of the surf, but music that could actually be heard well for half a mile. Between numbers, he filled in with announcements which stated that the program was being given through the courtesy of a local department store; and he had no trouble to sell this advertising time to a number of merchants of the seaside resort. The installation did not cost a great deal and the enterprising radio man actually cleaned up a very neat sum during the summer; so much, indeed, that he will extend his activities during the coming season to other beaches as well, by operating two more motorboats with their attendant amplifier systems, all purchased from the profits made last season.

This is only one of the more successful ideas whereby a great deal of money can still be made out of radio, if you only know how to go about it. The rest is easy.

Service Men's Department

This department is about the Service Man, for the Service Man, and largely by the Service Man. Its contributors are practical men, and we invite every Service Man in the country to tell about his own experiences of all kinds.

Edited by JOHN F. RIDER

RESISTANCES AND COLOR CODES
By John F. Rider

WE have recently completed a listing of the colors used to designate the resistances used in radio receivers. Unfortunately, there is such a plurality of colors employed by different organizations, to designate similar resistance units, that a listing is not possible at this time. We make mention of this fact in order to clarify the idea that the resistance color codes employed by some manufacturers are the same for a number of manufacturers. Such is not the case. Any one listing is applicable to that manufacturer only.

A somewhat similar situation exists in the color coding of connection cables. In this respect, however, greater similarity is to be found, at least among a number of radio receiver manufacturers; although this number do not by far constitute the major portion of the organizations who make radio receivers. Furthermore, the color-code designations described as general have been found to be more applicable to old rather than the recent models. However, we wish it understood that the statements to follow are general, and not specific for all radio manufacturers.

Investigation of a large number of radio receivers and wiring diagrams, representing the products manufactured between 1927 and the end of 1929, show that the "B+" cables were of four colors, namely "Brown," "Red," "Maroon and Red" and "Maroon." In some receivers, which made use of four different values of plate potential, the highest was "Brown" and the lowest was "Maroon"; with the other colors for the intermediate and low voltages respectively. Now, very few receivers make use of four different values of plate voltage and "Brown" as the highest "B+" lead was not common. The most frequent combination starts with "Red" as the maximum "B+" and employs the remaining colors for the intermediate and the lowest voltages respectively, following the color sequence named. Brown is not used. In some instances "Pink" replaced "Red"; in fact "Pink" as the maximum high-voltage "B+" lead is used in the majority of the Zenith receivers. The combination of "Red," "Maroon and Red" and "Maroon" is popular in a very great number of RCA and Victor receivers; being used for the highest, intermediate, and low plate voltages respectively.

The filament circuits in the receivers which use red and the colors akin to red in the plate circuit, make use of "Green," "Blue," "Yellow," "Black with Yellow tracer" and "Black with Brown tracer" colors. In turn, the receivers which make use of "Pink," "Yellow" and "Blue" for the plate circuits, indicating from highest to lowest "B+," employ "Brown," "Red" and "Green" in the filament circuit. With very few exceptions, Zenith is the major organization to employ "Yellow" in the plate circuit. As a general rule this color is associated with the filament circuit and, in battery receivers, was at times used as the "A+" cable.

MR. JOHN F. RIDER, who passes upon all the material submitted for publication here, in the Service Men's Department, is a radio engineer of the first rank who has devoted much energy to the popularization of technical knowledge. None excel him in the art of making difficulties clear; he is a practical instructor, and the author of books known by all Service Men.

It might be of interest to quote color code standards adopted in 1927 and the radio receiver manufacturers who were member companies at the time. The majority of the new wiring diagrams show color codes, but quite a large number of the old receivers' schematics are without such data. (The data are secured from the NEMA Radio Standards Handbook.)

For conductors that are individual to one circuit only: "A+," Yellow; "A—," Black with Yellow tracer; "B+" Max., Red; "B+" Int., Maroon and Red; "B+" Det., Maroon; "B—" Black with Red tracer; "C+," Green; "C—(low), Black and Green; "C—" (max.), Black with Green tracer; Loud Speaker (high side), Brown; Loud Speaker (low side), Black with Brown tracer.

The manufacturers who were members, as recorded in the NEMA Handbook, are: Acme Apparatus Co.; Amrad Corp.; Atwater Kent Mfg. Co.; Colonial Radio Corp.; Crosley Radio Corp.; Dayfan Electric Co.; Freed-Eisemann Radio Corp.; Charles Freshman; A. H. Grebe & Co., Inc.; Howard Radio Co.; Kellogg Switchboard and Supply Co.; Wm. J. Murdock Co.; Philadelphia Storage Battery Co.; Radio Corporation of America; Steinite Radio Co.; Sterling Mfg. Co.; Stromberg-Carlson Tel. Mfg. Co.

Although the Victor organization is not listed, a large number of their receivers are wired according to the aforementioned standard code. As a contrast, the color code in a large number of the Atwater Kent battery models is somewhat different from the standard listed, and is as follows: "A+," Red; "A— B—," Black; "B+," max., Brown; "B+" low, Yellow; "B+" Intermediate, White; "C—," Green with Yellow tracer.

The use of the Red for "A+" and the Black for "A—" is common in a large number of battery receivers made by many manufacturers; it is also true of a large number of the Federal series-filament A.C. receivers. In fact, these receivers correspond to the listing shown for the Atwater Kent battery receivers, with the sole exception of the use of a Blue wire for the "C—" and of Green for the power tube's filament circuit, which is A.C. operated.

It is also significant to note that a combination of color codes was used in some of the early Freshman receivers. The maximum "B+" cable was Blue with White tracer, and the low "B+" cable was Brown. In some of the D.C. electric receivers, the maximum "B+ lead was according to the NEMA standard, with the exception of the detector plate lead which was Black with Red tracer.

Old Amrad receivers used a combination of Red, Blue and Brown for the high, intermediate and low plate voltages. Yellow, Green and Slate were the colors used in the filament circuits.

Stewart Warner made use of Black, Black and Yellow, Black and Red, and Brown for the filament circuits in a large number of A. C. receivers and Gray, Red and Maroon for the three values of plate voltage; with Gray as the highest and Maroon as the lowest. At times Green was "B—" and in other cases Green was used in the filament circuit.

Fada, as a general rule (although not so in every case), follows the standard as set forth in the NEMA Handbook.

It might be well to mention that Red as used in the Zenith receivers is invariably associated with the filament circuit, being "A+" in battery receivers and one of the filament circuits in the electric receivers.

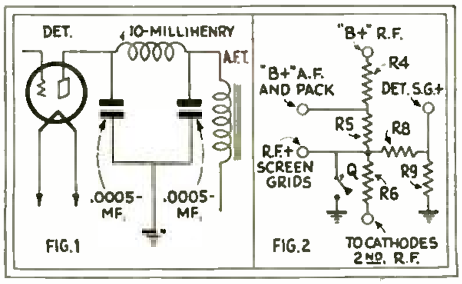
As a summary, we would suggest that the color code for any one type of receiver manufactured by an organization be recorded and checked against several types of receivers made by that organization. Since no one code is common to all, it is necessary to compile color codes according to the manufacturers and according to years or the types of receivers. This is now being done by the writer and will be offered at some future time.

Operating Notes for Service Men

What kind of noise annoys a Service Man? The kind that is always in the last place he looks for it. Here are a few hints on trouble-shooting and kindred subjects.

By BERTRAM M. FREED

A RECENT case of noisy reception on a Stromberg-Carlson "54" receiver proved puzzling for a time. The interference was definitely proven to be due solely to some internal defect. The aerial was disconnected, then the ground; the first R.F. screen-grid tube



Left, Stromberg-Carlson "654" detector output. Right, Colonial "33AC" voltage-divider connections: R4, 11,000 ohms; R5, 60,000; R6, 50,000; R8, R9, 750,000 each; Q, "quiet button."

was removed, followed by the second and third. However, the clicking and sputtering remained. When the '27 detector was extracted, the noise ceased; a new tube, known to be perfect, was inserted but with the same result. Noisy bypass condensers were then suspected but discharge and substitution tests did not disclose the defect. The resistors were then examined, and it was found that the double voltage divider was blistering. Rocking the divider revealed the source of the trouble. The resistor sparked in operation, and caused the sizzling and frying sounds.

On another occasion, the same complaint was encountered. The voltage divider was very wisely removed, but the condition persisted after a new one was soldered into place. A thorough test and examination this time showed a noisy bypass condenser in the detector filter; which is composed of an R.F. choke bypassed by two very low-capacity (.0005-mf.) fixed condensers (Fig. 1). This showed up when this unit was shorted out while the set was in operation.

A similar condition of interval noise and fading was encountered on a Freshman "Q16" receiver. At the slightest vibration and for no cause (seemingly) whatsoever, the set would die out or become very noisy. A check of the entire receiver and tubes showed up nothing; so the set was disassembled piece-meal to determine the cause. All socket prongs were carefully cleaned with a strip of emery cloth and bent into proper position; every soldered joint and connection was sweated and resoldered. The resistors were tested by pulling on them and by kneading the flexible wire-wound resistor, which made and broke circuit. A new one was soldered into place. (It happened to be the '22 biasing resistor. On another occasion, the fault has been due to others.) After mounting the receiver into position, the complaint was eliminated. What was really the exact cause of the trouble is hard to say; but duplicating this procedure is practically sure to clear up fading and noisy reception on the "Q16."

Correct Placing of Receiver

A novel experience with a Victor "45," a short time ago, enabled one service company to "kill" a great number of complaints that had been hanging fire for a long time. This set had a loud hum and, in the reproduction of voice (especially bass tones) an echo was heard. Packs and tubes were changed to remove the hum, and this was soon reduced to a minimum; it could not be entirely eliminated, as this model has a low hum level. However, the echo furnished another problem. Interchanging dynamic reproducers did not clear up the difficulty. The acoustics of the room was then taken into consideration. A large tapestry was

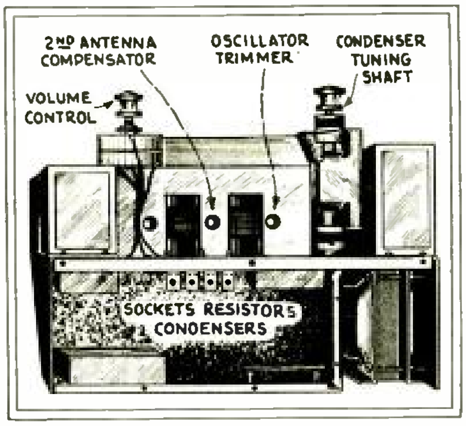


Fig. 3

Bottom of Majestic "50" chassis, showing two compensating condensers (C5, right, and C9, left). Adjustments are best made with a good oscillator.

hung on the wall opposite the set to offset any sympathetic vibration; the windows in the room were then made secure to prevent any vibration of the panes, panels or sashes—but to no avail. The next move was to move the receiver into another room to determine whether the shape of the living room was at fault, but the same effect was observed. While the Service Man was shifting the receiver, he noticed that the echo and remaining hum disappeared as he swung the cabinet away from the wall. This furnished the missing link, so to speak. The set was then taken back into the living room and installed cater-corner. Since then, similar complaints have been taken care of in short order and now all sets, when installed, are placed either cater-corner or about a foot from the wall.

To remove the new Colonial Midget "Model 36" from its cabinet for repairs, it is necessary first to remove the dynamic reproducer; or the tuning dial will be bent out of shape. This dial is fitted into a rounded groove cut for it, and part of the speaker housing overlaps the dial. In replacing the chassis, the speaker must be worked in along with the chassis, for the consolette cabinet is very small.

A Colonial "33AC" receiver recently gave several Service Men something to talk about. The complaint was low volume; the set was aligned, tubes changed and the aerial checked, but only two powerful broadcasters could be heard. On a test for voltages, it was found that there was none on the screen-grids. This, however, was blamed on the meter; for no set they had ever run across worked without screen voltage. Examination finally revealed an open section (middle) of the three-section voltage divider located under the sub-panel of the chassis near the two R.F. screen-grid sockets (Fig. 2). This section has 60,000 ohms resistance; but replacement was made with an Electrad "Type B" of 25,000 ohms, resulting in a corresponding increase in volume and selectivity.

Majestic Superheterodynes

Since the advent of supers on the commercial market, perhaps the easiest of all to balance and align is the Majestic "50" series. A good many of these sets are on the market and many have been sold. Since service material on this model appeared late, and no information could be had concerning the many balancing and adjusting screws, many Service Men mistook I.F. adjustments for tuning-gang verniers, and oscillator trimmers for antenna tuners, etc. This set has only one I.F. stage and, consequently, is simpler to adjust than many other supers. The very best work is done with oscillators and output meter; but a good job may be done without the use of

(*Continued on page 683*)

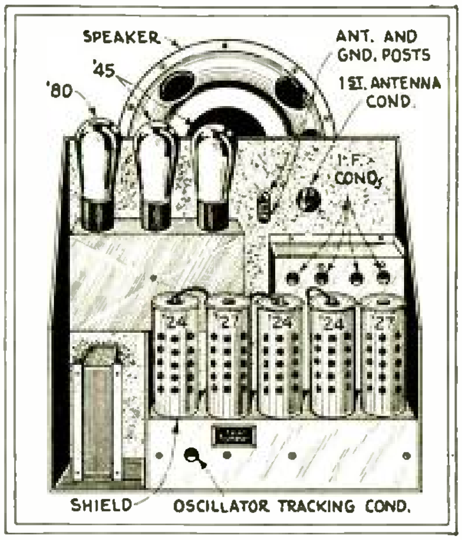


Fig. 4

Behind the Majestic "50" chassis. From left to right: 1st R.F., oscillator (a De Forest 427); 1st detector; I.F.; 2nd detector. (See Data Sheet 35, February 1931 RADIO-CRAFT, for fuller details.)

Leaves from Service Men's Note Books

The "Meat" of what our professionals have learned by their own practical experiences of many years

By RADIO-CRAFT READERS

LOOKING TO DYNAMIC SALES

By J. E. Kitchin

ON all six-volt battery-operated sets, which pass through my hands, I am now tapping the filament line and bringing it to a pair of terminals mounted on the chassis. These are to accommodate a six-volt dynamic speaker and, if I can later induce the set owner to purchase a dynamic, installation is made easier by the presence of the terminals. The line should be tapped at the proper point, so that the filament switch controls current to the speaker, as well as to the tubes; a separate switch for the speaker field is then unnecessary. As one side of the "A" battery is usually grounded to the chassis, only one wire need be used.

I recently corrected a fault, which had been pronounced "normal operation" by a service firm handling only A.C. sets. When the volume control of a screen-grid battery-operated receiver was turned half on, the volume increased; and then it decreased as the control was advanced to full on. It should be remembered that the voltage recommended by the manufacturer must be used; otherwise the correct curve expected from the taper of the potentiometer will not be produced. In this case, a screen-grid voltage of 67 was being applied, instead of 45.

ALL AMERICAN-MOHAWK "C6"

By Willard A. Yoder

WHILE there were comparatively few of these receivers put into circulation there are enough, perhaps, to warrant a few words of explanation to any readers who might be called upon to service one.

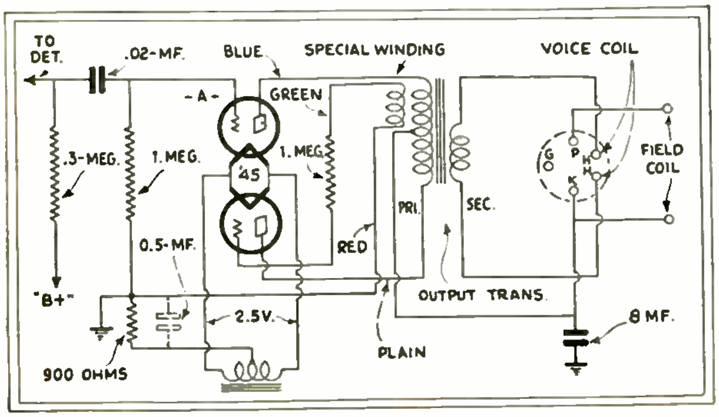
The R.F. end is simple enough and contains no unusual features; but, by glancing at the accompanying diagram, one can easily see how much trouble and inconvenience the audio circuit might cause the Service Man if its connections were not anticipated or understood.

It will be noted that the output transformer is of special design, containing an additional secondary winding which supplies to the grid of tube "B" signal energy in proper phase relation to that of tube "A."

Also note that, while to remove tube "A" will make the system inoperative, to remove tube "B" will not stop tube "A" from passing the signal on to the speaker.

Should it become necessary, for any reason, to remove or replace the output transformer, care should be taken to see that the various leads are connected as indicated in the diagram. The colors refer to a small tracer, woven among the strands of wire making up the leads of the several windings. Failure to observe these precautions will result in greatly reduced volume and poor tone quality.

The writer ran across one of these sets wherein the output tubes were connected in parallel; which serves to remind us that, in the event of failure of the original transformer, one of the more conventional components of proper characteristics, may be substituted, if the former type is unobtainable.



The unusual output arrangement of the Lyric "C6" receiver comprises two power tubes which are not truly in push-pull, but have a similar effect. Compare with the Museum audio amplifier on page 675. (The lower '45 is tube "B" in the text.)

OSCILLATION IN BOSCH '28

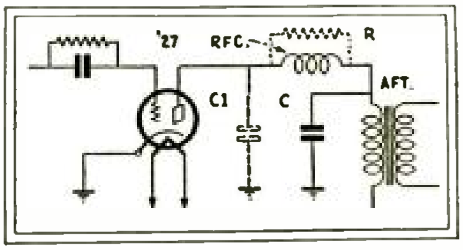
By Floyd L. Rittman

THE trouble, to start with, was oscillation of the radio-frequency amplifier. I went through the usual procedure in neutralizing; but when I had finished the radio-frequency amplifier would still oscillate in the middle of the dial scale. It was perfectly neutralized on both high and low frequencies but in the middle it whistled merrily. Upon close examination it was found that the oscillations were in the detector circuit, and not in the radio-frequency amplifier, as at first believed.

This was an entirely different matter and the detector circuit was subjected to close scrutiny. It seemed funny that the detector should oscillate, because there was no feed-back or regenerative circuit.

As the diagram shows, the detector plate by-pass condenser C is on the audio transformer side of the radio-frequency choke and therein lies the whole trouble. This particular choke happened to be just right, so far as inductance was concerned, to act as a tuned plate coil and cause the detector to oscillate in the middle of the broadcast band.

The solution is simple, once the trouble has been found. By connecting a .00025- or a .0005-mf. fixed condenser C1 from plate to ground on the detector tube, the choke is taken from the radio-frequency circuit and the oscillation stops. The additional capacity will not affect the tone quality enough to be noticeable. The dotted lines on the sketch show where the additional capacity is tied into the circuit.



It is always good practice to let the output R.F. component get back to ground as soon as possible. (Resistor R appears in the service manuals of the Bosch "28".)

I have obtained quite a few tips from RADIO-CRAFT, and I thought other Service Men might be interested in this experience; as the same trouble might, I believe, be encountered with other makes.

AN EMERGENCY BATTERY

By John J. Nothelfer

RECENTLY, the writer was called out of town to service a battery-model console radio set. Upon arriving, a day ahead of the promised date, I found that the storage battery had been taken away to be recharged, and it would be returned early the next day. The idea of coming back the next day over the rough country road was unpleasant; and that of using the car battery seemed the solution.

Upon trying to loosen the clamps on the battery, it was found that they were too tight; the pliers would never loosen them, and the required wrench had been left home. Having a roll of No. 14 rubber covered lead-in wire, I drove the car as close as possible to the window nearest the set; and the wires were connected to the battery terminals. In this manner six-volt direct current was obtained, and the set was tested and repaired in the usual manner.

SOME SET PECULIARITIES

By Walter I. Warner

OTHER Service Men may be interested in these few kinks: In replacing the dial-drive cable on a Majestic, the gang is removed from the chassis by unsoldering five wires and taking out the three bolts in the bottom of the gang. The dial assembly comes with it; it is then easy to put on the cable.

In Fada models "50" and "70," trouble may be found from open grid suppressors of the wire-wound type. If they are replaced with carbon resistors, the trouble is remedied.

Noisy volume controls, in Victor "R-32" and "RE-45" may be made smooth by rubbing the resistance wire with a pencil eraser, or putting vaseline on the wire itself.

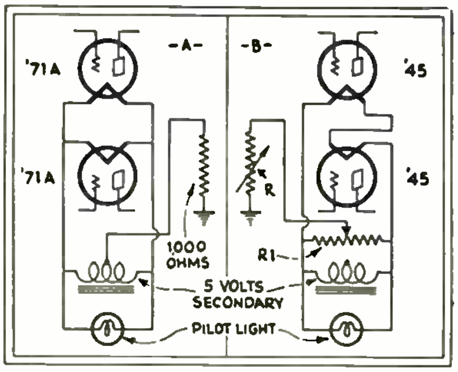
Some Majestic models become noisy, or cut off while in operation, as if the aerial were broken. Look for wires coming unsoldered from the R.F. bypass condensers in the chassis.

MAJESTIC SETS
By F. G. Poli

THE Majestic "70-72" series, exceedingly popular two years ago, has now arrived for its share of service by the independent Service Man. This article is written with the thought of saving him much time in locating the most common faults found in these receivers.

First, we will take the speaker. Assuming that the two power tubes are evenly balanced, and that a flat, buzzing signal is emitted, the following will usually be found: grit between the polepiece and the voice coil: the sealed edge of the cone partially open; the voice coil off center at the apex; or the small tabs holding the voice coil to the cone may have loosened.

We have had several receivers of this model in our shops, with no filament voltages in the radio-frequency and detector stages; as a rule, the cause was found to be pitch oozing out of the transformer and causing a high-resistance joint at the filament lugs. This is remedied by using a hot soldering iron on the terminals and boiling out the pitch; which may be wiped off with a rag and a new joint made.



The combination of series-filament tubes in push-pull is not completely balanced; but the circuit tends to equalize the effect of differing grid biases.

REWIRING MAJESTIC SETS
By Bertram M. Freed

MUCH has been said and written about extra dividends for the Service Man. There is, in many a home, a set which is giving the owner a good deal of satisfaction but is not up to date; among these will be found the Majestic "70, 71, 72" series. This model used '71A tubes in push-pull; usually the quality of reproduction is not faultless. It is a simple task to rewire the last push-pull stage so that the filaments are in series; a pair of '45 tubes may then be employed. The winding will supply sufficient current to operate these tubes satisfactorily.

The biasing resistor for this stage is located in the pack; it may be replaced, at R, by a "Type C" Electrad resistor, which may be adjusted until the tubes get the proper bias. The resistance value will depend upon the plate voltage available: if the voltage is about 200, place 35 to 40 volts on the grid; if it is above 220, 45 to 50 volts will be needed. Line voltages and the efficiency of the rectifier vary in different sets.

A HOT AERIAL—OZARKAS
By N. W. Smith

ONE morning a service call was received from a man who wanted to know if we could fix a radio that had caught fire inside the cabinet. I thought that fire inside a battery set was unusual; so I immediately went to his home. He lived alone, in one room, and the aerial of bare wire was strung about the place on porcelain nail-knobs; an A.C. extension cord, from a light fixture in the center of the room, was supported by one of the knobs. The "B" eliminator was turned on and off at the light socket and, each time, the cord was moved a little until the insulation was frayed. On the night of the fire the A.C. cord had touched the bare aerial wire and shorted to ground through the set; and the first radio-frequency coil started to burn before the fuse in the building blew out.

An Ozarka "89 A.C." had a hum above the usual level, and other Service Men had found no success in reducing it; so the owner had packed the chassis to return it to the manufacturer. After agreeing to charge nothing if the hum was not reduced, we tried by-passing, chokes, filtering, etc., with no luck. Finally, we removed a terminal strip, to trace the leads, and found a 28,000-ohm resistor connected to the 1.5-volt center tap but no lead from the other side. Putting a wire on it, we tried ground and other connections; when it was connected to the first-audio and radio-frequency "B+" terminal, the hum almost disappeared without decrease in set volume. The owner was well pleased.

Heater elements of the electric-bowl type make good A.C. current ballasts for reducing motor current drain. They pass about 6 amps.

The Service Man's Open Forum

His Opinions on Conditions and Practices in the Radio Business

SHOULD THE SERVICE MAN BE AN ELECTRICIAN?

Editor, RADIO-CRAFT:

Having been in the service game for a number of years, I would like to pass along a few hints to the so-called "kids" who are just breaking in. The thing to do, first of all, is to get a good thorough training in radio construction and repair, before you start to practise on a customer's set. A customer has always high praise for a Service Man who knows his business, and who can locate the trouble in a jiffy, so to speak.

A good set analyzer is of prime importance; that lesson I learned from sad experience when I started in. Although tubes can be tested in an analyzer, it is very handy to have a separate tube tester; about half of the troubles encountered in service calls are defective tubes, and it is a good thing to test them before using the analyzer.

And another thing: use your head more than your instruments. By applying a little common sense and your eyes and ears, most troubles are easily located.

A customer who has paid some hundreds for a set, and stands tearfully aside while you tear at the wires and parts, feels that his pet will never be the same again. Although there are Service Men who like to strew the set on the customer's floor, I prefer the shop job, as you can work in peace without having to answer a lot of seemingly-foolish questions.

As for the Service Man's being an electrician, it all depends on how much money the Service Man wishes to make. It is not necessary for him to be an electrician, but, on the other hand, he can increase his earnings and trade by being able to do both. I happen to be both a service man and an electrician and, time and again, I have installed floor plugs when a customer has expressed a preference for a certain corner in a room which had no outlet available for the radio.

A. G. LOFBACK,
106½ *First St., South,*
Virginia, Minnesota.

(While the Service Man's work does not cover the same field as that of the electrician who installs other appliances, lights, etc., the two trades are more than touching now. We have radio sets with motors, drawing considerable current, and often requiring rearrangement of the house wiring, remote controls, etc. It is necessary, therefore, for the Service Man to go beyond his former activities. There is a growing tendency for cities to require that all radio installations be checked by a licensed electrician, to assure that they are safe from the standpoint of the wiring code—as New Orleans has just done, over the protests of the radio trade. Perhaps the conditions may be met by a special type of license, for the radio electrician who does not go beyond his particular field, but is competent to see that an installation is safe as well as satisfactory from the radio standpoint.—EDITOR).

SPECIFY ALL PARTS

Editor, RADIO-CRAFT:

While I have long been a reader, I have not written before; but I think I should compliment you on the finest magazine in the field for the Service Man. I like the fact that fiction has no place in its pages

(Continued on page 690)

SILVERTONE "F," "FF," "G," "H" AND "J"

The Silvertone, it will be remembered, is the trade name of a line of radio receivers sold by Sears, Roebuck & Co., Chicago, Ill. The "Model FF" and "J" are two of the older sets dating back to 1926, which were manufactured for this company by King Mfg. Co., Buffalo, N. Y.

These two complete diagrams, shown below, have been selected as representative of the circuits followed in the following models: "F," "FF," "G," "H," "J." A few words will serve to distinguish them:

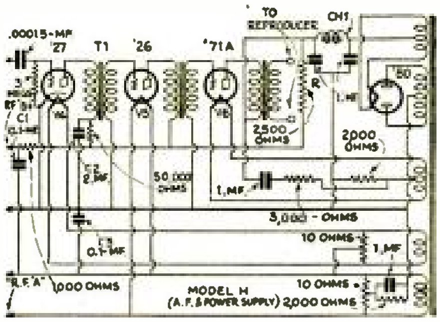
The "Model F" Silvertone radio set is a 5-tube receiver using four '01A's and a power tube which is either a '12A or '71A. It is a battery set of the neutrodyne type, with single control. The grid condenser has a value of .00015-mf.; and the grid leak of 3 megs. The detector plate by-pass capacity is .006-mf. The detector grid leak does not shunt the grid condenser, but returns directly to the positive side of the detector filament; and between this point and the "A" supply lead is a 2-ohm resistor. This detector filament lead and the positive filament leads of the two audio tubes connect to a 1-ohm resistor; which is also wired to the "A+" post, as well as a 10-ohm rheostat to complete the positive "A" circuit of the two R.F. tubes. This rheostat is the volume control. The off-on switch is in the "A—" lead, which is grounded. The R.F. tube circuits are designed to operate at 90 volts on the plate. The first and the second audio stages have independent "B" and "C" supply leads. The reproducer connects directly in the plate circuit of the last tube.

When this standard 5-tube neutrodyne battery set is made all-electric, it becomes the "Model FF" shown below. The color code of the battery cable is as follows: Yellow, "A+"; blue, "90 V.+; maroon, "45 V.+"; blue-red, "B+1st A.F."; black-green, "C—1st A.F."; black-yellow, "A—"; brown-green, "C—power"; black-red, "B—"; green, "C+"; red, "B+power."

Consulting the diagram of the "Model FF," the resistor values are as follows: R1, 10,000 ohms; R2, 3 megs. (red); R3, 2,500 ohms (large, black); R4, 1,000 ohms (brown); R5, 50,000 ohms (gray); R6, 3,000 ohms (green); R7, 2,000 ohms (small, black); R8, 300 ohms, wire-wound; R9, R10, 20 ohms, each.

The capacity values are as follows: C1, C2, C3, tuning condensers; C4, C5, neutralizing condensers: C6, 0.1-mf.; C7, .00015-mf.; C8, .006-mf.; C9, C10, C11, C12, C13, C14, 1-mf., each.

Turning now to the "Model G," we find that it is substantially the same as the Model F; except that there has been added a stage



of R.F. amplification, making six tubes in all. Other details are as follows.

There is in the antenna circuit a fixed .001-mf. condenser; one side of this is connected to the chassis; the other to a binding post, to which the ground may be connected, to reduce noise or increase selectivity. Across the filament leads of the first R.F. tube is shunted a fixed 0.1-mf condenser; another of the same rating being similarly connected in the filament circuit of the third R.F. tube. Three neutralizing condensers are incorporated in the design. The grid condenser is a .00015-mf. unit; and the 3-megohm grid leak connects to the positive side of the tube filament. The two A.F. tube filament positive leads are connected together and return to the "A+" connection through a 1-ohm resistor; the detector's positive filament lead returning, through a 2-ohm resistor, to the juncture of the tube filaments and the 1-ohm resistor. The "A+" of the three R.F. tubes returns to the battery through a 5-ohm rheostat. All the "A—" leads connect together and are grounded. In series with the plate supply lead to the three R.F. tubes is a 1,000-ohm resistor; by-passed to ground through a 1-mf. fixed condenser. The cable color code for the "Model G" Silvertone is the same as in the "Model F" battery set.

Two all-electric versions of the basic 6-tube circuit used in the "Model G" receiver are the Models H and J; the latter having a push-pull output.

The slightly more complicated circuit of the "Model J" Silvertone is shown in full. Condensers C1, C2, C3, C4 (which are to be balanced at 720 and 1400 kc.) are the regular tuning capacities; C5, C6 and C7 are used to neutralize the R.F. circuits. C8 may be used for obtaining added selectivity; its capacity is .0001-mf., C9, C10, C11 are 0.1-mf.; C12, .00015-mf.; C13, C14, C18, 3mf.; C15, C16, 1 mf.; C17, 2 mf.; C19, .006-mf.

The resistors in the "Model J" radio set have the following values: R1, 10,000-ohm potentiometer; R2, 3 meg.; R3, 1,000 ohms; R4, R10, 20 ohms; R5, 50,000 ohms (gray); R6, 2,500 ohms (black); R7, 10,000 ohms (blue); R8, 1,000 ohms, (brown); R9, 3,000 ohms (green); R11, 300 ohms.

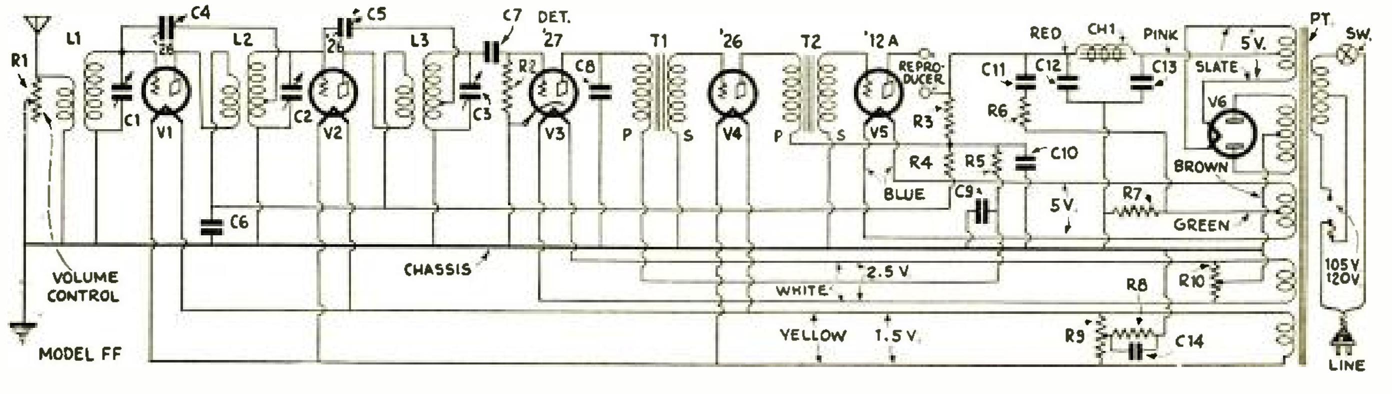
Following are the approximate operating voltages of the A.C. Silvertone models: Filament potentials; R.F. amplifier stages, 1.4 volts; detector, 2.4 volts; first A.F., 1.4 volts; power tube, 5 volts. Plate potentials; R.F. amplifier, 140 volts; detector, 35 volts; first A.F., 140 volts; power tube, 180 volts. Grid potentials; R.F. amplifier, 9 volts; detector, zero; first A.F., 9 volts; power tube, 35 volts.

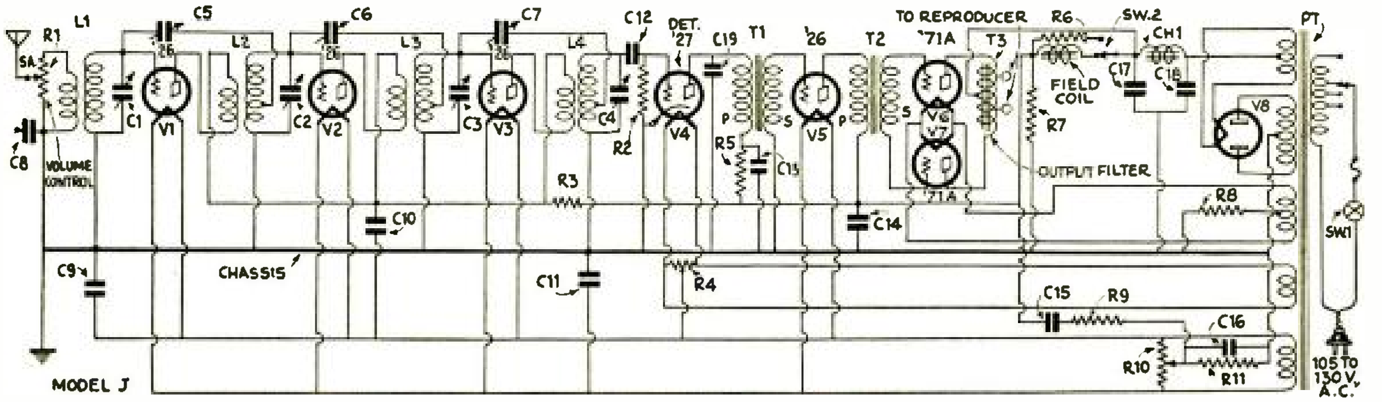
Loss of volume or noisy operation in any of these models may be due to a faulty volume-control resistor.

A toggle switch (Sw.2) connects a 2,500-ohm resistor R6 into circuit when the field coil of a dynamic reproducer is not utilized as the second filter choke.

The power transformers for the "Models H" and "J" receivers are not interchangeable.

Thanks are extended to Mr. R. Hartwell Allen for the use of references in the preparation of this Data Sheet.

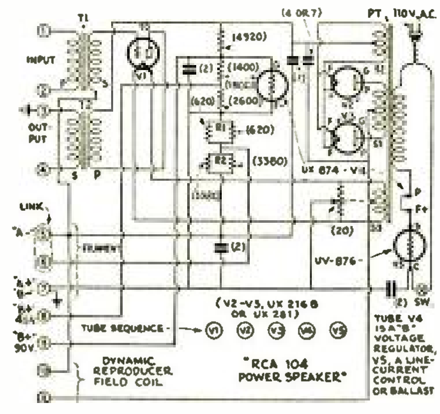




RADIOLA "28" SUPER AND "104" POWER SPEAKER

Condenser C1, in the principal diagram below, is the loop-tuning condenser, in the input circuit to the first R.F. tube (V1); this may be balanced by an experienced Service Man, in accordance with standard practice for superheterodyne circuits, to match the constants of the loop antenna, by the compensating condenser C4 (at the left of the loop socket, looking from the front). Condenser C2 tunes the input to the first detector, V2 (the numerical sequence of the tubes, when plugged into the catacomb sockets, is: V2, V4, V1, V5, V3, V6, V7, V8, as indicated by the numbers immediately beneath these in the diagram, which correspond to the numerals stamped in the bakelite top plate.) Condensers C1 and C2 are ganged, and are under the control of the left tuning drum; condenser C3, tuning the circuit of oscillator V3, is adjustable by means of the right drum. The first R.F. stage is neutralized by means of condenser C5 and the center-tapped loop; this condenser is mounted on the bakelite strip carrying the main terminal lugs. The primary of the first I.F. transformer is tuned to the intermediate frequency (40 kc.) by means of condenser C6; this I.F. circuit is neutralized by condenser C7 (inaccessible). The dotted rectangle denotes the shield can of the catacomb; everything inside this line, except the filament connectors, is under seal (to break which cancels all factory repair obligations). The remaining condensers inside the catacomb are also inaccessible; so is the grid leak, R3.

Low volume, howling, noisy or intermittent operation may be due to defective tubes. Noisy or intermittent operation may also be due to a loose screw holding the filament connection busbar (underneath the "whiskers" or catacomb leads). Noisy or poor operation may be due to a defective phosphor-bronze spring on the loop or in the loop receptacle; or a break in one of the flexible leads. Short "C" battery life may be due to a defective tube (grounded grid); or a loop spring grounding to the frame. Lack of signals may be due to an open safety resistor (Lamp V9). For test, its three leads may be bonded together; or an auto lamp substituted (first making sure that the 2-mf. condensers, C12, C15, are not shorted). If condenser C12 or C15 is open, circuit oscillation and low volume may result. Noisy or intermittent operation may be due to one of the variable condensers' pigtails being open or grounding against the frame. The loop *must* be centered in the receptacle to take a vertical position. Interchanging tubes (except the power tube) may greatly improve operation. The



metal markers may cut through the insulation of the wires and short to other parts of the circuit.

Noisy operation—particularly during adjustment of either rheostat; and more especially when energized by the "Model 104" power speaker—may be due to imperfect contacts.

To insure satisfactory operation of the "28," by keeping the filament potential below 3 volts, a "pin-jack" voltmeter should be permanently plugged into the tip-jacks provided for this purpose. To improve the pick-up in shielded localities, an outdoor antenna may be inductively coupled to the receiver by placing one or two turns of the lead-in quite near the loop, L. Since the magnetic reproducer connects directly into the plate circuit, it must be correctly poled.

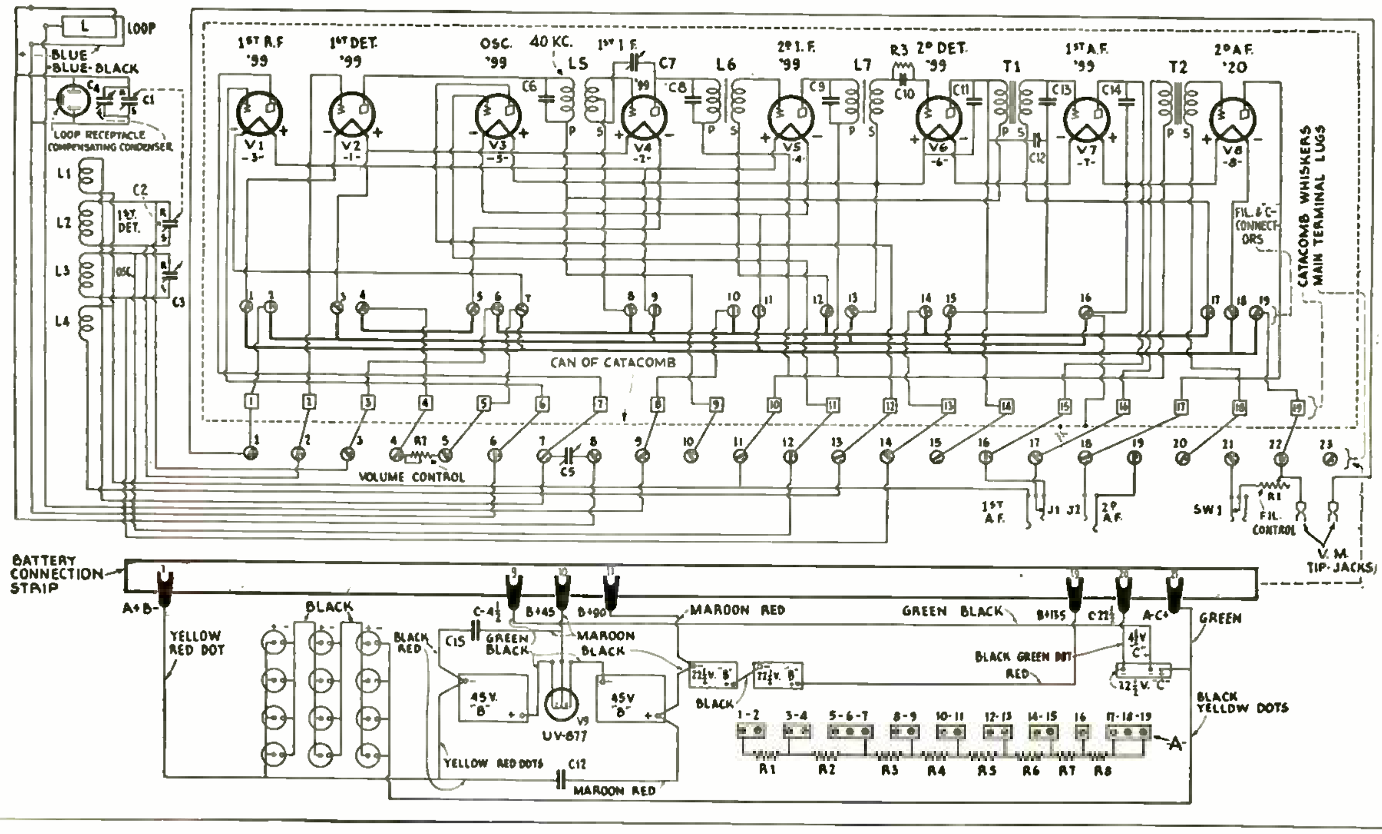
When current is derived from an A.C.-operated power unit, such as the "104" speaker, the filament-connector busbar underneath the catacomb whiskers (heavy lines in the diagram) must be replaced by a resistance strip (A in the diagram). The low-resistance rheostat R2 is then replaced with a resistance cartridge of 350 to 375 ohms, each section of strip A having the following resistance respectively: R1, 190 ohms; R2, 390 ohms; R3, 163 ohms; R4, 155 ohms; R5, 130 ohms; R6, 120 ohms; R7, 115 ohms; R8, 50 ohms. When R2 has a value of 250 ohms (as in the "Radiola 32"), the connecting strip A will have these values: R1, 271 ohms; R2, open; R3, 236½ ohms; R4, 197 ohms; R5, 183½ ohms; R6, 154½ ohms; R7, 145½ ohms; R8, 50 ohms.

When the "28" is A.C. operated, the low resistance cartridge of the filament-control rheostat R1 is replaced with a cartridge having a resistance of 185 ohms.

THE "104" POWER SPEAKER

Before connecting the "104" to the "28," the strap marked "link" must be removed. Replacement resistance and capacity values shown in the diagram of the "104" are the figures in parentheses. In some models, the secondary S3 may be center-tapped, the potentiometer not being used. Resistor R1 may be a single unit of 310 ohms; and R2, another of 1690 ohms. In normal operation, tube V4 will glow pink or violet; and V5 will be dark but hot. Keep the ventilating stack over this tube.

After connecting the "104" to the "28," the two filament leads should be shunted by a fixed capacity of 20-mf. or more (such as an electrolytic unit.) The "A" potential will be about 32 volts; and the battery-type filament voltmeter is no longer required. All voltage terminals should be by-passed by 2-mf. fixed condensers. A 30- to 50-henry choke, connected across main terminal lugs 10 and 195, may be necessary to stop "fluttering"; although changing the '99's usually is sufficient. When the "104" is used, tube V8, in the '20, is not needed; and the "Battery Switch" jack must be shorted—off-on control being obtained through a conveniently placed light-line snap switch. If the power speaker is too close to the "28," howling will result.



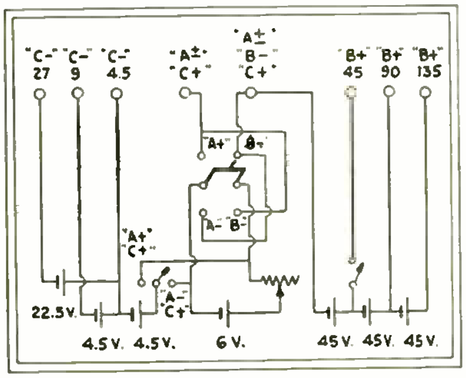
Favorite Testing Equipment of Service Men

And methods for its use to the best advantage in and out of the shop

BATTERY SWITCHING ARRANGEMENT

By J. E. Kitchin

SERVICING battery-operated receivers requires different combinations of "A," "B" and "C" batteries. The usual method employs a row of terminals to which leads



An arrangement of battery supplies for the service bench where D.C. receivers are generally in use. The switch adjusts for return of "B—," to "A+" or "A—."

from the batteries are brought; the necessary interconnections being made by pieces of wire across the proper posts. A quicker and neater way is illustrated, and uses Carter or Yaxley switches, mounted on a small panel with the terminals.

The S.P.S.T. switch in the "B+45" lead is to disconnect the screen-grid voltage when testing receivers employing a potentiometer shunted across the battery; this stops a small drain when not in use. The resistance in the filament battery circuit is for use when testing "dry-cell" tube sets, making unnecessary a constant moving of the storage battery clips to obtain 2, 4 or 6 volts. A Pilot "Resistograd" is satisfactory and will cut down the voltage to 1.1 volts for "WD 11" and WX 12" tubes. The writer lives in a "battery-operated" district, and finds the small panel described is very convenient.

AN EASILY-MADE SERVICE KIT

By Lloyd Manuel

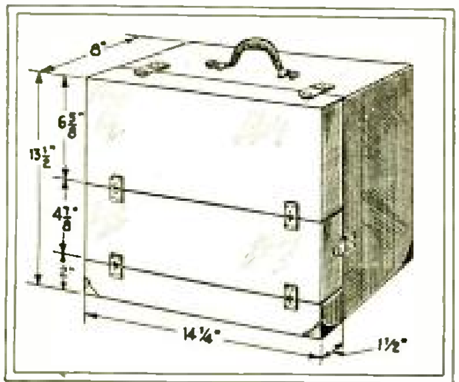
RECENTLY, this writer acquired a Crosley "4-29" portable set as a trade in; since both audio transformers were "shot," it was of little value.

However, with very little work I made a service kit which is ideal for my purpose, and I believe that it pretty nearly hits the nail on the head for the average Service Man.

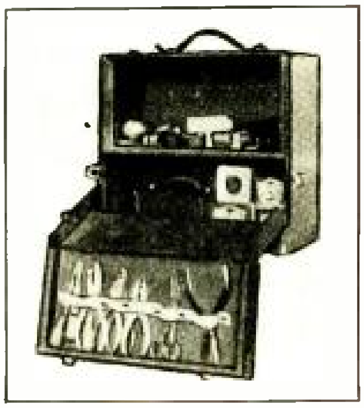
With the equipment which I carry and which serves every ordinary need, the weight is not excessive.

Below is a list of tools which the little box holds: 1 ratchet screwdriver; 2 ordinary screwdrivers; 2 small screwdrivers; 1 electric iron, flux and solder; 1 pair diagonal pliers; 1 pair long-nose pliers; 1 pair flat-nose pliers; 1 pair scissors; 1 small monkey-wrench; 1 balancing wrench; 1 Readrite set analyzer; 50 ft. hookup wire; and small odds and ends.

The front, as will be noted opens downward and splits. On the upper section, pliers and screwdrivers are arranged in tape slots. The upper platform is devoted to odds and ends; while in the lower part I keep my set analyzer.



The case of an old portable receiver, which accommodates itself handily to use as a service kit. It is of a convenient size to carry.



From a photograph of the service kit, as it appears when the case is opened. There is a place for every tool and accessory, as well as the analyzer.

There is enough room in the top for a vertical and removable partition. Various tools could be secured to this partition; and five assorted tubes might be carried behind it.

The dimensions of the case are illustrated, for those desirous of building one for their use, in the absence of a discarded portable.

INCREASE THE METER'S RANGE

By John J. Nothelfer

MANY good Weston or Jewell meters, designed for the old RCA battery-model receivers, can now be bought very cheap in some of the salvage stores. The fan who cannot afford to buy a new voltmeter, or milliammeter, can make use of an old instrument by a few changes and convert it into a volt-ammeter of all ranges; with great saving to his purse, since these meters can be bought for around a dollar to a dollar and a half.

As the diagram shows, the case is removed from the meter and a small piece of insulated stranded wire is soldered to the resistance terminal which leads to the armature at the bottom of the meter. (Care should be taken not to solder to the terminal that leads to the terminals of the

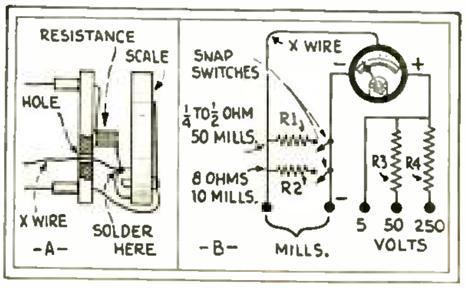
A voltmeter, with its case removed, undergoing the operation described by Mr. Nothelfer, which gives access to the basic milliammeter unit.

meter). A small hole is drilled in the bakelite back, and the wire is drawn through. The case is then replaced, and the meter is ready to be mounted on a small box.

Various meters have different internal resistances and draw more or less ohms per volt, so the correct resistance values cannot be given. (*In another article, such information will be found. See page 682.—Editor.*) The Jewell and Weston meters mentioned, however, have a resistance of 125 ohms per volt. So, for each volt to be added, a resistance of 125 ohms should be used.

The meter has already a 5-volt scale, with a 625-ohm resistance built in. To increase the voltage of this meter to 50, a total resistance is required of 50 x 125 = 6250. The meter already has 625 ohms resistance; subtract this from 6250, and the additional resistance required is found to be 5625 ohms. A fixed resistor of this size is quite hard to obtain; and a good substitute is one of variable type, with 6000 ohms maximum, adjusted to the required length.

To obtain milliampere readings from the meter, the wire which was soldered to the armature is used with the terminal of the meter which connects directly to the other winding of the armature. Resistance wire from old, heavy rheostats will answer nicely as a shunt.



A diagram, showing the connections to the meter illustrated above. With the action used, R3 is 5625 ohms; R4, 61,875.

An A. C. Beat-Frequency Oscillator

A device for the well-equipped Service shop, and for the laboratory of the careful experimenter

By H. G. CISIN

THE A.C. beat-frequency oscillator is an easily-built instrument of great utility to Service Men and to all those engaged in the testing, repair or manufacture of audio-frequency apparatus. It is also a useful device for experimenters, for broadcast stations and for owners of amateur transmitting stations.

Its purpose is to make instantly available a source of audio frequencies throughout the entire audio range. This particular oscillator can be used wherever alternating current is available, as it can be built for either 60 cycles or 25 cycles. No batteries whatsoever are necessary. When completed, it constitutes a precision instrument, comparable with the finest commercial oscillators, and having the important advantage that it can be built for but a fraction of their cost.

Uses of the A.F. Oscillator

In the testing and manufacture of loud speakers, this oscillator performs an extremely useful function. It is ideal for determining loud-speaker response and also for the determination of paper-rattle frequencies. It can be used in the comparison and selection of loud speakers, and also to determine the frequencies which cause the voice coil of a dynamic speaker to hit the pole pieces. These offending frequencies can then be filtered out, thus improving speaker performance.

The beat-frequency oscillator can be used by the owner of an amateur telephone transmitter to determine the frequency-characteristic of his amplifier. When used to modulate an R.F. oscillator, the beat-frequency oscillator can be utilized to perform "overall-gain" and "fidelity" tests on any radio receiver.

It enables the talking-picture Service Man to study the effects which different frequencies have on the acoustics of the theatre. It is useful, in servicing electric phonographs, to feed the oscillator into the amplifier, in place of the pickup; thus locating faults in the reproduction.

In fact, it may be considered as an absolute necessity for the Service Man who wishes to perform efficient work on audio-frequency apparatus.

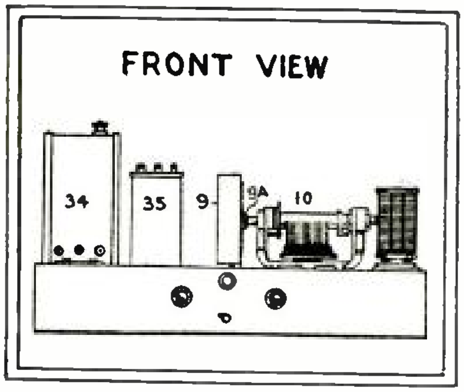


Fig. 2

This oscillator may be built behind any kind of panel; its output is taken from two binding posts at the rear.

Principle and Construction

In the A.C. beat-frequency oscillator, the measuring frequency is obtained by beating the outputs of two R.F. oscillators against one another; the resultant frequency is rectified by a detector and then amplified. The range of this oscillator is from approximately 30 cycles to above 10,000 cycles.

It comprises (Fig. 1) two oscillators (4A) and (13), a detector (17), and an A.F. amplifier (26); all these tubes are of the '27 type. An '80-type full-wave rectifier tube (38) is used. The frequency of one oscillator (4A) is fixed at 100 kilocycles; while the frequency of the other (13) can be varied to 20 kilocycles away from the fixed frequency. Both oscillators are coupled to the grid circuit of the detector tube. This system of coupling the oscillators to the detector, supplying it with a low voltage from each oscillator, is such that the tendency of the two oscillators to pull into synchronism, as zero beat is approached, is eliminated. The detector output is fed to the amplifier by an impedance-coupled system of the "autoformer" type; with the result that constant amplification is attained over a wide range of frequencies.

The two oscillator coils (1) and (6) are long-wave units, each having two fixed windings and a rotor. They are of the plug-in type and of low-loss design, having a confined magnetic field of extreme uniformity. The midget condenser (12) is used to correct any slight inaccuracies in the fixed condensers (11) and (2), or in the coils in the plate circuits of tubes (4A) and (13). The variable condenser (10) is used to tune in the desired audio frequencies over the entire range. Minimum harmonic generation, with highly satisfactory wave-form, can be obtained by keeping the coupling of the rotors of coils (1) and (6) at a minimum. *If the coupling is too tight, the percentage of harmonics will be large.*

Four automatic ballast resistors are used to regulate the flow of filament current. Volume is controlled by the variable resistor (24). The "B" supply is furnished by a power compact; a separate transformer serving for the filaments of the four '27 tubes. A standard voltage divider is used.

In appearance (Fig. 2) the A.C. beat-

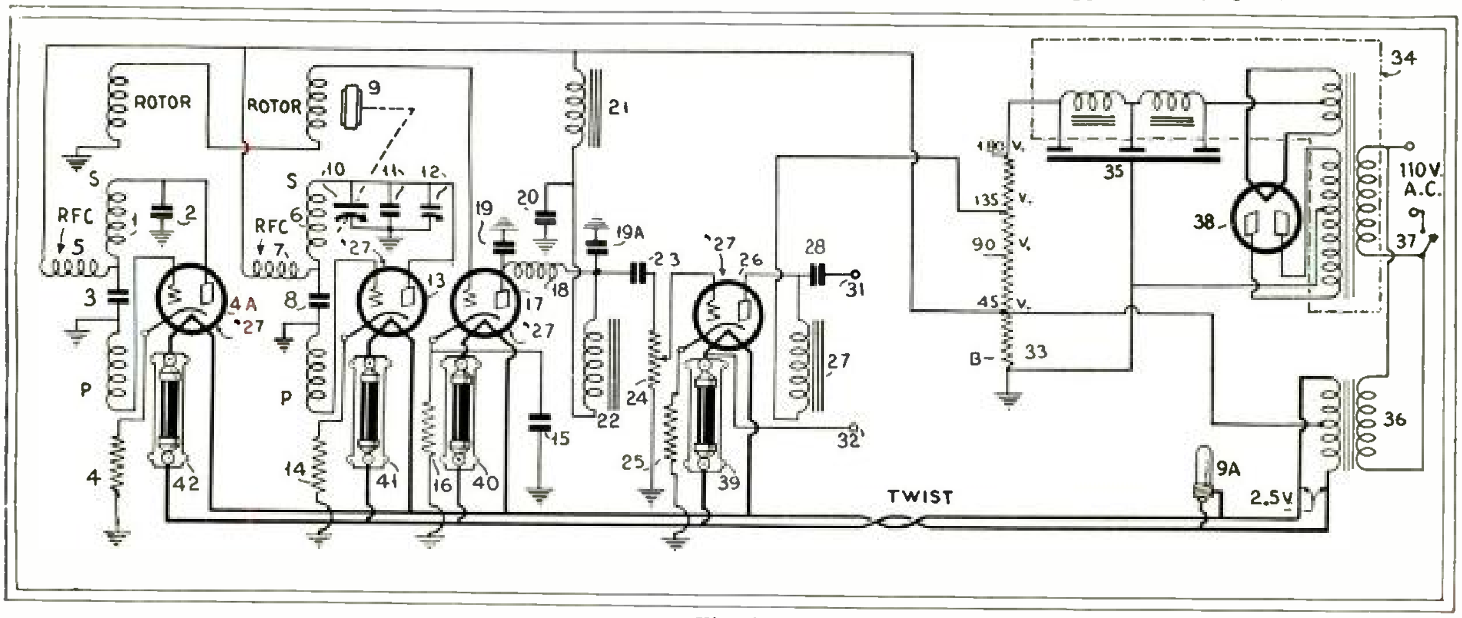


Fig. 1

The complete circuit of the beat-frequency oscillator: as its name indicates, the pure audio note is produced by heterodyning the variable frequency of the oscillator 13 against the fixed frequency of the oscillator 4A. The fixed-tune capacities 2 and 11 should be closely matched.

frequency oscillator resembles the conventional radio receiver. It is assembled on an aluminum chassis, with a great many of the parts below the deck of the chassis and with all wiring underneath and out of sight. The five sockets are mounted from below, with only their circular portions showing above the deck.

Details of the Assembly

The chassis is bent from sheet aluminum and cut out as indicated in the "chassis details" illustrated (Fig. 3). It is placed face downward on the workbench, and the various parts shown in the bottom view (Fig. 5) are mounted in their correct positions. The sockets are mounted first, then the filament transformer (36) and the choke (21); next the voltage divider (33), the four resistors, the various fixed condensers, the four ballasts and finally the three R.F. chokes. The binding posts are mounted on the rear chassis wall, and the power switch (37), the midget variable condenser (12) and the volume control (24) on the front chassis support.

The values of the capacities shown at (2) and (11) are .00035-mf. each; it is essential to use components of precision here. The value desired may be attained by the use, instead of each of the single condensers shown, of a .00025-mf. midget in parallel with a .0001-mf. Very small components are obtainable in units of great precision for this service; those specified are best adapted.

After mounting the various parts below the deck of the chassis, the latter is turned right-side up; and the drum dial and the variable condenser are mounted (Fig. 4). The dial's base fits into the slot cut into the chassis, thus bringing the center of the drum level with the shaft of the variable condenser; a hole is drilled in the front support of the chassis for the drive-shaft. The two audio chokes (22) and (27) and the power pack (34) are mounted next; then the block condenser (35) and, finally, the coil sockets (1) and (6).

The wiring is quite simple. The primaries of the power compact (34) and the filament transformer (36) are connected in parallel, with the switch (37) on the power-source side; so that, when the switch is open, both pieces of apparatus will be disconnected from the line. The filament circuits are next wired in, taking care to twist all pairs of filament leads. Grid, plate and cathode circuits are then wired in, and also all by-pass condensers. Wiring the "B" supply completes the entire job.

In wiring in the oscillator coils (1 and 6), their 60-turn rotors are connected in series in the grid circuit of tube (17). The 396-turn winding of each coil is connected in the plate circuit of its respective oscillator tube, with the 99 2/3-turn slot winding in the grid circuit.

In adjusting the oscillator, the first step is to determine whether the tubes are oscillating; this is done by touching the grid connections at the sockets and obtaining the grid clicks. Then turn the variable condenser (10) to minimum capacity and adjust the midget condenser (12) so that no signal is heard in the 'phones or speaker. At zero of condenser (10), tubes (4A) and (13) should be tuned to the same frequency; namely, 100 kilocycles.

After the above adjustment has been made, all desired frequencies will be obtained as condenser (10) is tuned in. Using three or four standard tuning forks of different pitch, it is possible to plot a curve and accurately calibrate the beat-frequency oscillator, so that, by referring to the dial reading, the frequency given out by the oscillator will immediately be known.

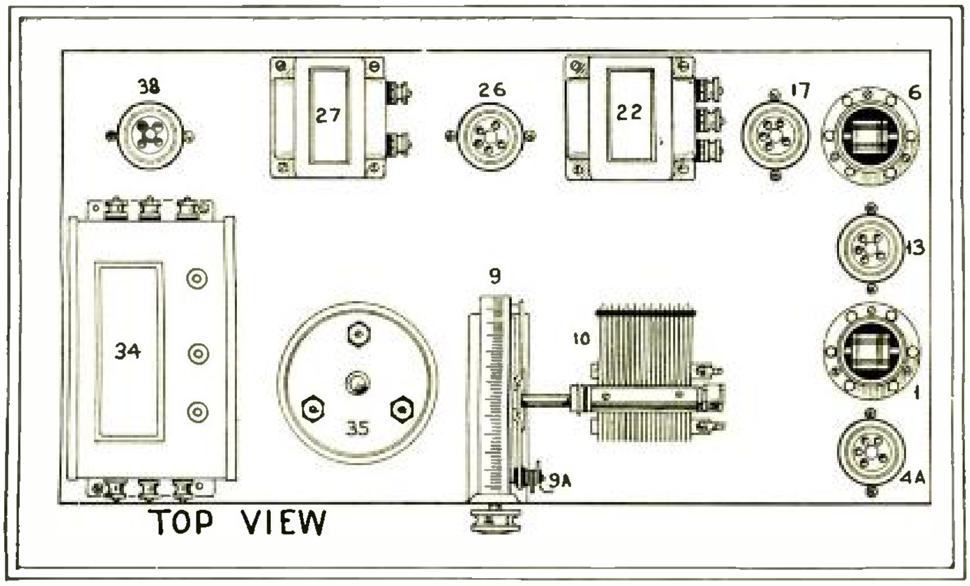


Fig. 4
The drum dial 9 fits into a cut-out in the deck of the chassis, as shown in Fig. 3 below. A chart of frequencies, corresponding to dial readings, should be prepared by comparison with notes of known pitch.

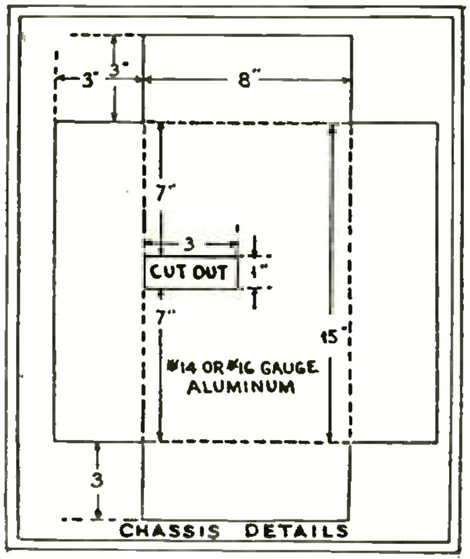


Fig. 3
The chassis mounts every part of the beat-frequency oscillator; it is cut from a single sheet of metal, as shown, and bent to form a pan.

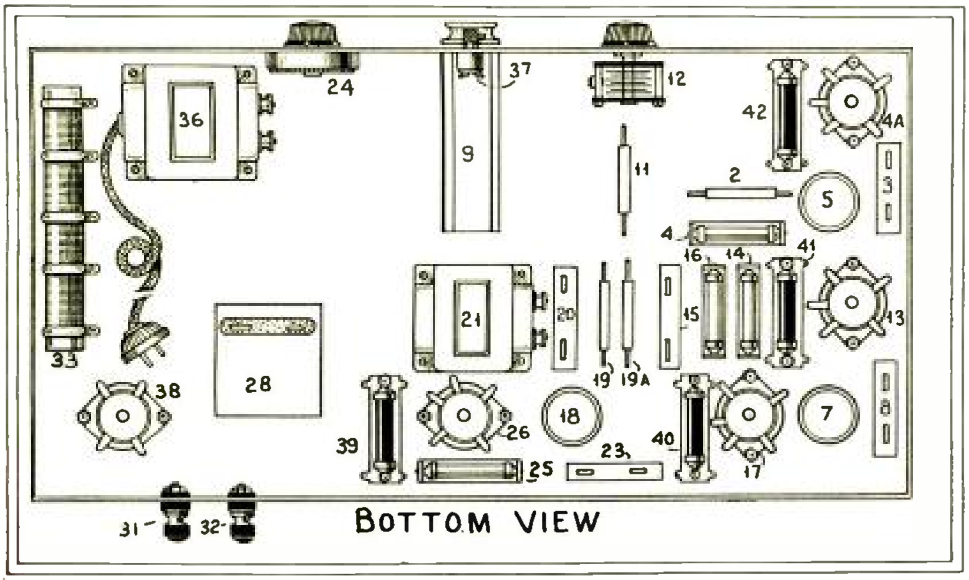


Fig. 5
The greater number of components are mounted under the chassis' deck; the capacities 2 and 11 may be obtained most precisely, by paralleling two midget components for each.

List of Parts

One .0005-mf. Hammarlund "Mid-Line" variable condenser, type ML-23 (10);
Three Hammarlund R.F. choke coils, type RFC-250 (5, 7, 18);
Two Silver-Marshall plug-in long-wave coils, type 111-E (1, 6) and
Two Silver-Marshall coil sockets, type 515;
One Silver-Marshall illuminated drum dial, type 810-L (9), with 2½-volt dial light (9A);
One Silver-Marshall midget condenser, type 342 B (12);

(Continued on page 683)

Late Fashions in Methods of Detection

The principles utilized in recent commercial receivers, and power grid-rectification, which is coming next

By C. H. W. NASON

ALTHOUGH the writer had long been aware of the fact, that in the detector circuit lies the answer to most problems of distortion, it was not until he undertook a serious investigation of television reception that he became aware of the true magnitude of the problem. Recent developments in commercial receivers have given us the "linear power" detector; the "multiplex" detector, which is a circuit re-arrangement of the "diode" or two-element Fleming valve, followed by a low-gain A. F. stage; and now the power-grid detector, due to F. E. Terman of Leland Stanford, Jr., University. Terman, in a series of articles in *Radio Broadcast* and in the *I. R. E. Proceedings*, gave a clear analysis of the problem, but failed to connect with the popular imagination; although he demonstrated the vast superiority of his over previous methods as to sensitivity and fidelity. His most recent data, appearing in the Dec., 1930, *I. R. E. Proceedings*, are reviewed here.

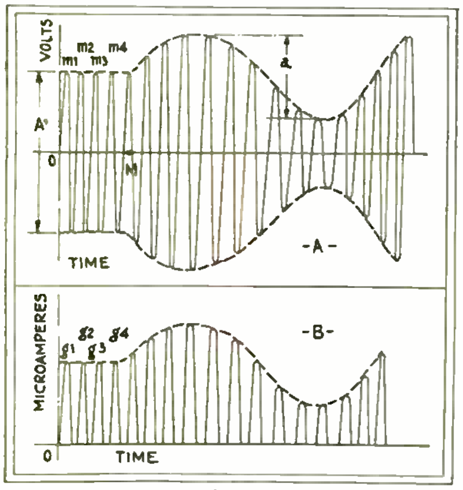


Fig. 1

Above m-m1, unmodulated R.F. carrier; the ratio a/A is the percentage of modulation. This wave is, theoretically, "detected" into the half-wave form below, where g-g1 is the rectified carrier.

Theory of Detector

The theory of detection, although simple, is rather difficult in presentation. For this reason, we will skip over the high spots and give but a brief outline of the systems, together with an explanation of their operation.

Fig. 1-A shows a modulated wave plotted against time. The average value of each R. F. cycle is zero, and no effect would be obtained were we to apply the signal to a pair of phones or a loud speaker. If, however, we are able to eliminate entirely—or even partially—one side of each wave, we obtain a pulsating direct current; the pulsations varying in amplitude according to the modulation.

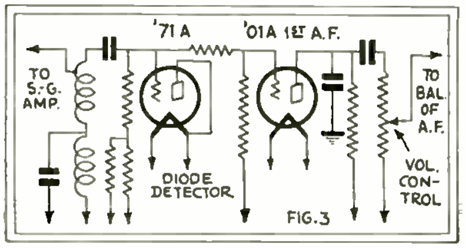
Theoretically, this amounts to a complex current comprising a direct current and both a high- and a low-frequency current. This high-frequency component means little to us; for we must merely evolve a method of bypassing it to ground around subsequent apparatus. This is done by the condenser shunting the input of the first A. F. transformer, or by R.F. chokes, in a manner familiar to all radio fans.

The direct-current component is here useless; although it is of value in measuring apparatus. (The Tube Voltmeter utilizes this component.) It is the low-frequency component, or variation, in which we are interested; since this follows more or less faithfully the modulation impressed upon the carrier wave at the transmitter.

The Diode Detector

"Rectifiers" are so known because they exhibit the property of *unilateral conductivity*. That is to say, they will pass current in one direction only. Such a device will bring about the relative condition exhibited in Fig. 1-B.

In Fig. 2 are shown the essential circuit and the characteristic curve of a "diode," or two-element tube, in a radio circuit. Note the fact that the curve assumes a *linear*, or straight-line, form as the voltage increases. An alternating current, such as



The "diode" detector and following amplifier, as used in the Philco "Transitone" set.

that shown in Fig. 1-A, would assume the approximate form shown in Fig. 1-B when passed through such a device.

The marked curvature, at low values of applied voltage, causes distortion unless the input level is maintained high enough to avoid excursions into the curved range. In other words, we must maintain operation on the straight-line portion of the characteristic.

In the Philco-Transitone receiver, shown in schematic in Fig. 3, a 71-A tube is connected as a diode; the plate and filament being tied together. The diode acts here as an automatic volume control of the "Wheeler" type, described in an earlier article by the writer, (Page 287, November, 1930, issue of RADIO-CRAFT.)

The peculiar input circuit, common to all diode detectors and shown in this set, is made necessary by the high damping (or low input resistance) of the tube when operated in this fashion. The high damping factor, limiting the gain in the previous R. F. stage, the low output efficiency (not to be confused with rectifying efficiency) and other factors all contribute to the need for a high gain A.F. amplifier, as evidenced by the three stages following.

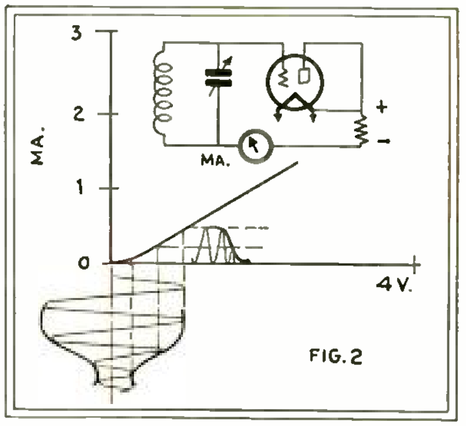
Diodes have the advantage of a long-range of straight-line operation, as compared with the curved portion of the characteristic.

Bias or Plate-Circuit Rectification

Not many years ago we employed "soft" detector tubes, followed by several stages of low-frequency amplification. These "grid-leak" detectors were strong on sensitivity, but for many reasons, were weak as to quality. These gave way to the "bias" or "plate-circuit" detector, so called because rectification is obtained in the plate circuit of the tube, and due to the characteristic formation of the grid voltage—plate current curve. A look at Fig. 4 should be sufficient. Here the graph of plate-current variation with changing grid voltage is shown for a particular tube. In the same manner as before, we apply a modulated radio-frequency wave to the input circuit, in order to swing the grid voltage about the fixed bias in the manner shown. Note that the fixed bias is such that the plate current, with no signal impressed, is close to zero. The fact that the signal variations operate over a substantially linear portion of the curve leads to a low degree of distortion.

Should, however, the depth of percentage modulation swing the grid too far into the curved area, distortion will be inevitable; this will arise through the fact that the upper half of the modulation cycle will remain an image of its original form in the unrectified carrier, while the lower half will be misshapen. The percentage of distortion under these conditions is readily calculable mathematically.

Some other disadvantages arise. For example, the plate impedance of the tube operated in this fashion is high, requiring a high inductance load if the low frequencies are to be reproduced. The attempt to fulfill this condition may result in a bulky and expensive transformer, deficient



The characteristic operating curve of a "diode" detector (plate and filament joined).

in the highs. This must not, by any means, be taken as a "grouse" against plate-circuit detection as a whole, but as a statement of the facts as they exist.

High-Level Detection

From what has gone before, it may be seen that all detectors suffer from distortion due to curvature at the characteristic. The sole means of avoiding this is operation at a carrier voltage so high that even large depths of modulation permit of no excursion into the non-linear area. Completely modulated signals are rare. Even the true "100%-modulated" stations reserve the maximum modulation for rare *fortissimo* passages. Thus the danger is not great.

It is possible, with a detector so operated, to obtain sufficient voltage in the plate circuit to overload a power output tube. Several commercial receivers operate with signal levels at the detector input sufficient to achieve this amplification, either by means of a high-ratio transformer or, in rare cases, with resistance coupling.

With the trend of broadcasters toward high-percentage modulation, it is essential that every factor causing distortion be investigated. Terman and Morgan have discovered that, when properly proportioned as to circuit constants and voltages, the grid-circuit detector accepts a much greater signal variation before excursion into the area of curvature occurs.

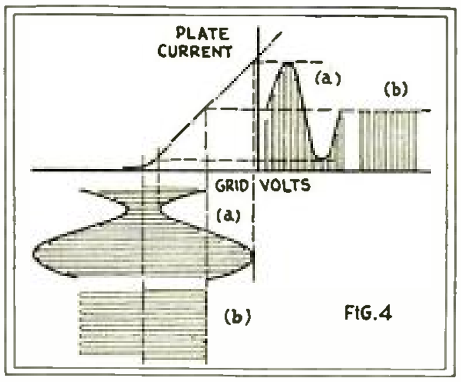
Power Grid Detection

The grid-leak detector operates by virtue of the variation in grid current with grid voltage; and rectification of the carrier takes place in the grid circuit of the tube. Early grid-leak detectors operated with low plate voltages and small signal input. Operation was entirely along the curved portion of the grid current—grid voltage curve. Such detectors give non-uniform response and, in certain instances, are termed "square-law" detectors; the implication being that the output varied as the square of the input, a two-fold variation in the depth of modulation resulting in four times the low-frequency output. The distortion thus created is obvious.

Fig. 5 indicates the flow of grid current in a heater tube of the "equipotential cathode" type. It is unnecessary to show graphically the effect of the signal, as a reference to the prior figures will suffice. It is well to note that the area of curvature, under optimum conditions, is small compared with the range available over the straight portion.

Values of Condenser and Leak

The relation between the grid leak's resistance and the grid condenser's capacity for a minimum distortion should be such that Xc/R is equal to or greater than $m\sqrt{1-m2}$, where Xc is the condenser reactance at the highest desired modulation frequency and m is the modulation factor. This is necessary if smoothing-out of the high frequencies is to be avoided. The condenser charge must be dissipated more rapidly than the amplitude of the carrier is changed under modulation. For broadcast purposes this calls for a grid condenser of .0001-mf. and a grid leak of 0.25-meg. Simple enough.



Characteristic curve of a plate-rectification or bias detector, showing the operating grid-bias point; note that the plate current is nearly cut off.

The maximum allowable signal carrier for a given plate voltage is about a third, and not more than half that permissible with the tube biased as an amplifier. The maximum plate voltage is determined by the heat-dissipating properties of the tube.

A means of avoiding the effect of high plate current is shown in Fig. 6.

With no signal, the plate voltage is dropped through the resistor R so that the plate current is at a safe value. The incoming signal provides a negative bias, lowering the plate current. This cuts down the drop through R, and allows the full plate voltage to be effective.

The '27 and '24 tubes should be operated as follows, with the grid return directly to the grounded cathode.

'27	'24
Ep 180 volts	Ep 180 volts
Cg .0001-mf.	Esg 72 volts
Rg 0.25-megohm.	Cg .0006-mf.
	Rg 0.25-meg.

The efficiency of rectification (B) in either case is about 85%. The grid circuit's load

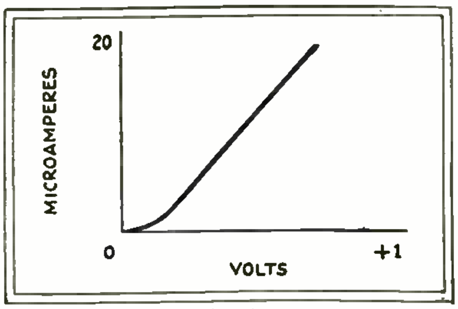


Fig. 5

The operating characteristic of a grid-leak detector; showing how grid current flows with the changing amplitude of the carrier.

resistance is equal to R/2B; about 150,000 ohms with an 0.25-meg. leak. This is higher than with the old types of small-signal grid-leak detector.

The advantages are, a higher sensitivity with low grid circuit damping, and at least as great an undistorted output as with "bias" detection; as well as better response at both high and low frequencies. High inductance loads are unnecessary, and the screen-grid tube may be transformer-coupled.

ADDITIONAL NOTES ON BAND PASS TUNING

By C. H. W. Nason

SINCE the appearance of the writer's original article on band selectors (in March RADIO-CRAFT), many readers have requested additional information. For the benefit of those bashful ones who may not have written yet, although consumed with curiosity, data here provided cover a band selector combining inductance and capacity coupling, and another utilizing direct magnetic coupling between adjacent coils. The latter

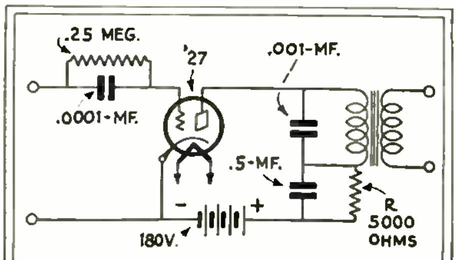


Fig. 6

A suggested circuit for power grid-rectification; R limits the plate current when no signal is impressed on the grid.

method is particularly adaptable to interstage coils. The large capacity in series with the plate tuning condenser should be a low-loss fixed condenser; it serves to keep the direct current away from the gang condenser.

Here we have a combination of inductive, capacitative and magnetic coupling in a single receiver. (Fig. 7).

The greater part of the inquiries concerning the original article mentioned the use of the fixed R. F. (Dubilier "S. G. Duratran") transformers; lack of selectivity seemed to be the main cry. The writer suggests the use of extremely high voltages with the '24 tubes, when coupled by these devices; for instance, 250 volts on the plate, 180 on the

(*Continued on page 684*)

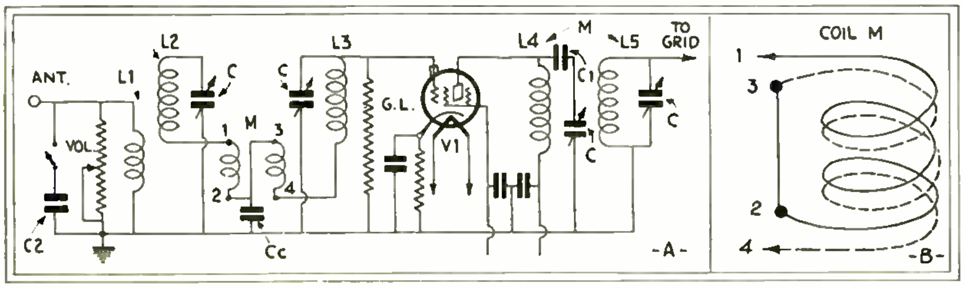


Fig. 7

Details of a band-selector circuit, utilizing a combination of capacitative and inductive coupling in the antenna, together with mutual-inductance coupling in the interstage circuit. At least four tuned circuits, as shown, should precede an untuned amplifier. The detail of the first coupling coil M (left) is shown at B (right).

Soon—The Cold-Cathode Vacuum Tube

THE hope of producing a vacuum tube, to be operated by some method less crude than the application of heat, has long been in the minds of inventors. While the present A.C. tube eliminates the use of a storage battery, the same result might have been obtained by the application of a gas flame; as in some of the earliest of the experiments of Dr. de Forest, nearly thirty years ago. But, without a means of heating, how is a continuous electron flow to be maintained in a vacuum?

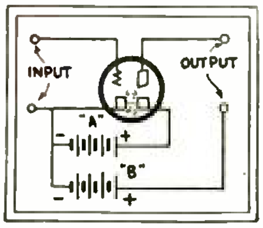


Fig. 1

A German inventor had the idea of using a neon tube as an amplifier; the glow between its plates corresponding to the usual filament.

A problem which has always exercised radio inventors is that of doing away with the filament's "A" supply, or minimizing it. It is true that this may readily taken care of where power is available; but a power line is even less portable than a storage battery.

Some years ago a German engineer produced a tube in which, instead of a heated filament, an ionized glow discharge was employed to produce a field between cathode and anode (plate) which could be acted upon by a control grid (Fig. 1). Several modifications of the design have been made, to increase its efficiency.

The latest topic of discussion, in this field, in the European papers, has been the photo-electric radio tube of Baron Manfred von Ardenne, one of the most original of German experimenters. It does not appear that practical operation has yet been obtained from it, so far as economy goes; although the principle was successfully demonstrated.

However, an American attorney and inventor, Adolph A. Thomas, nearly four years ago filed a patent application on this idea; and patent No. 1,788,553 was issued on January 13 last, covering ten claims on the use of a photoelectric amplifier, singly or in multiple.

"The coincidence," remarks Mr. Thomas, in a letter to the Editor of RADIO-CRAFT, "is

(*Continued on page 685*)

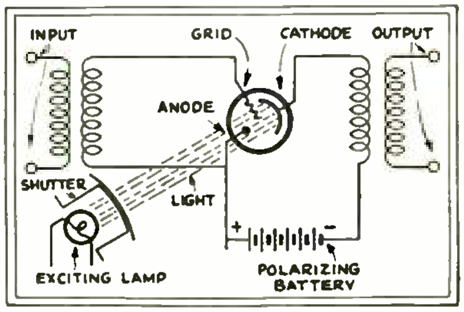


Fig. 2

The principle of the photoelectric triode, or vacuum tube; instead of being heated, its cathode is lighted from a lamp.

Thyratron Tubes Promise Many Valuable Applications

By W. C. WHITE*

THE high-vacuum tube has, for industrial application, certain serious limitations. A very heavy price, in the way of power loss, must be paid for the current that it carries. The current through the tube is governed by the electron emission and the space-charge effect; which latter is simply another way of expressing the voltage loss in carrying the current through the tube. To make the cathode hot, so that it will emit electrons, requires electric power. This entails loss of the order of 10 to 150 watts per ampere of current through the tube.

Considerable voltage is also required to carry the current across the space; the order of magnitude being several hundred to a thousand volts for one ampere. From this, it will be seen that currents of more than a few amperes cannot be handled economically by means of a high-vacuum tube.

Therefore, it is apparent that the most promising application in the industrial field for the high-vacuum tube is in various control operations where some of its unique characteristics, rather than its output, are the determining factors.

Taking up next the Thyratron tube, its striking characteristics are the greatly-decreased amounts of power required to heat the cathode, and a marked reduction in the large voltage drop which is characteristic of the high-vacuum tube. This is brought about by the introduction of a very slight amount of gas or vapor into the bulb, which eliminates what we have termed "space-charge"; which is, in reality, the mutual repulsion between the electrons, due to their negative charge, that has to be overcome by the use of considerable voltage and which introduces a power loss. The positively-charged mercury vapor or gas molecules mingle with the electrons, neutralizing this space-charge.

This neutralization of the space charge allows a very different design of hot cathode. Instead of having to utilize what might be termed an open type of cathode for the electrons to leave the hot surface easily, it permits us to use an enclosed type of cathode, with just a few holes for the stream of neutralized and negative ions to pass through.

ENGINEERS tell us there are interesting possibilities in the "Thyratron" tube; they look to the day when it will be possible to eliminate the line losses inherent in A.C. transmission, by applying the thyratron to produce direct current at a potential of several hundred thousand volts. In this article, a vacuum-tube engineer explains the remarkable efficiency of the thyratron, at frequencies lower than those classed as "R.F." and hints at industrial uses. Radio readers may speculate as to its use for more economical power audio amplification.

This means that the heat may be kept in and conserved, whereas the electrons and positive ions may be allowed to travel to the anode. This is accomplished by surrounding the hot cathode with heat insulation and heat reflectors, with only relatively small holes to allow the passage of the current.

By such means, we have to "pay" only about one watt per ampere for our current through the tube, rather than the 10 to 150 watts per ampere.

Also, this neutralization of the space-charge, which results from the introduction of mercury vapor or gas, eliminates the high voltage necessary to pass the current through the space; and, instead of a large voltage increasing with the amount of current to be carried, there is a constant voltage loss of only about 10 to 20 volts.

It is, therefore, apparent that for the handling of relatively high currents, such as we have in the broad field of electrical engineering, the gaseous type of electrostatically-controlled tube is much better suited than the controlled high-vacuum type.

It is true that a thyratron tube has certain limitations. While the high-vacuum type of tube can handle currents up to the frequency of a million cycles per second, the thyratron valve in its present form is limited to a few thousand cycles per second. Also, the thyratron cannot control direct current in the same simple way as the high-vacuum tube; that is, it lacks the feature of "continuous control." However, it so happens that, just as the high vacuum tube fitted remarkably well into the radio communication field, the thyratron tube appears to fit admirably into the industrial engineering field.

As a good example of this a thyratron tube built to about the same size and costing the same amount as the UX-250 will handle approximately fifty times the current.

These are the reasons which give us complete faith in the application of the thyratron type of tube in the broad industrial engineering field to the same amazing extent that the high-vacuum type of tube, developed around the "pliotron" idea, has dominated the radio communication and broadcasting field.

(From an address before the Schenectady section of the A.I.E.E. on January 16, 1931. Illustrations of the thyratron, and a brief explanation of the principle involved, will be found in the September, 1930, issue of RADIO-CRAFT, on page 150.)

* *Vacuum Tube Engineering Department, General Electric Company.*

Design of Radio-Frequency Transformers

As modified by the problems which have been introduced by the multi-stage screen-grid amplifier

By SYLVAN HARRIS

FROM the viewpoint of the designer of a radio-frequency amplifier which is to be part of a radio receiver, when he has once determined the number of tuned and untuned stages he wants to use and the amount of amplification he must have, there remain really only three problems that he must solve. Assume therefore, that the circuit arrangement of the amplifier is settled and the particular tubes chosen: the designer then must determine—

(a) the proper voltages to use on the tubes and the manner of obtaining these from the power-pack;

(b) the system of controlling volume and the location of the volume-control elements in the circuit;

(c) the actual design of the radio-frequency transformers.

The determination of the tube voltages is more or less determined by the manufacturer's ratings; which often must be somewhat modified by considerations of power-pack load, cross-modulation effects, grid-circuit overload, etc. The selection of the system of volume control is apart from the design of the amplifier proper; that is to say, the system to be chosen is one which will have no effect on the tuning of the amplifier, but will exert its control over sufficient range to enable the operator to reduce the volume of the most powerful broadcaster to zero.

Such matters are of course, quite intricate, but the analysis of each of the several problems can be made somewhat more or less independently of each other; and, after all, perhaps the most important problem of all is that of designing the radio-frequency transformers.

We need hardly consider the tuning condensers at all. The design of these circuit elements is practically fixed. The economies of condenser design have practically fixed the number and size of the plates and the general arrangement of the frame structure; so that there is not much that can be done in this matter.

Inductance Found by Experiment

Consequently, the first part of the problem of radio-frequency transformer design is to calculate the inductance required to enable us to tune over the broadcast range with the particular condenser capacity we intend to use. Of course, knowing the required inductance value, only, is not sufficient; a coil must be constructed which will have this inductance. This can best be done by cut-and-try methods, backed up by a certain amount of experience along this line.

In radio-frequency amplifiers designed around screen-grid tubes, which have very high plate resistances, the proportioning of the tuning inductance to cover the tuning range involves only the secondary of the coil. In other words, with the tuning condenser connected to the secondary, and with the coupling between the circuits quite loose because of the high plate resistance of the tubes, the tuning range is determined almost wholly by the secondary circuit, and independently of the primary. (Of course, the separate capacities of the primary and secondary coils, as well as their mutual capacity, have an influence on the tuning range; but this effect should be interpreted as a variation in the secondary inductance rather than as a coupling between the two circuits.)

At any rate, let us suppose we have determined all these things; we have fixed the tube voltages, the tuning capacity and the *secondary* tuning inductance. We must now consider the design of the *primary* circuit of the R.F. transformer. Fig. 1 shows the simple circuit of a tuned R.F. amplifier using screen-grid tubes. The first thing we must determine about this circuit, in order to assist us in our work of transformer design, is how much voltage amplification per stage this amplifier can handle.

We all know that, if we have too much gain per stage, the circuit will oscillate, because of the feed-back through the tubes, between the plates and grids. Of course, we are using screen-grid tubes, in which the grids are supposed to be screened from the plates; but it must not be forgotten that this screening is not 100 per cent effective. Furthermore, there are other means of coupling between stages which are conducive to regeneration and oscillation; so we must be careful not to make the gain per stage too high.

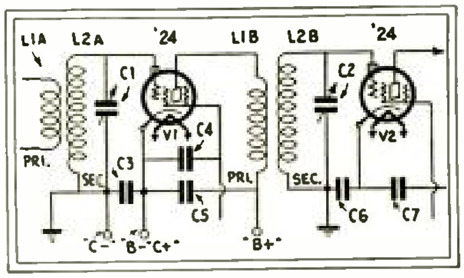


Fig. 1

In the standard screen-grid amplifier stage, the high plate resistance of V1 necessitates a high impedance in L1B and, therefore, loose coupling into the tuned circuit L2B-C2.

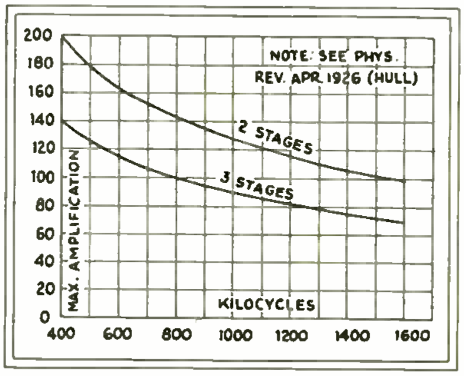


Fig. 2

The theoretical limit of screen-grid amplification; on the basis of 1000 micromhos of mutual conductance, and .02-mmf. grid-plate capacity in the screen-grid tube.

Limit of Amplification

Fig. 2 shows the maximum gain per stage which can be used, assuming that the only source of feed-back is that which occurs *within* the tube between plate and grid. In other words, if this were the only coupling we had between stages, the gain shown in Fig. 2 is the maximum that could be used without having the circuits oscillate. If there is external coupling between the stages (as for example, in coupling resistors or condensers) the maximum amplification that can be used is less than that shown in Fig. 2; how much less, depends upon the amount and the kind of external coupling.

At any rate, as we can see in Fig. 2, we cannot expect a gain per stage of much more than 80, in a three-stage amplifier

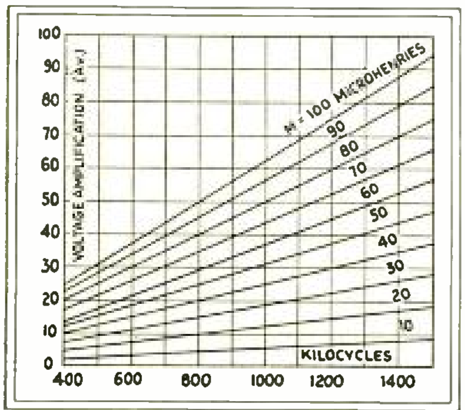


Fig. 3

The maximum voltage amplification of a stage, plotted against the mutual inductance of an output transformer of good quality. The closer the coupling, the more unequal the gain.

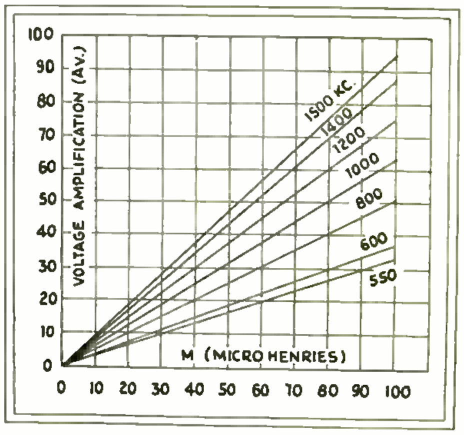


Fig. 4

The curves of amplification here correspond to those of Fig. 3; but are plotted against frequency, to show the greater efficiency at the low-wave end of the broadcast band.

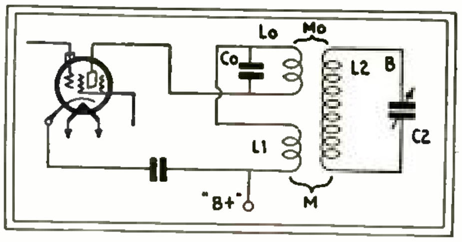


Fig. 5

A transformer designed to bring about more even gain throughout the range of broadcast frequencies. Lo-Co is tuned to about 500 kc., or 600 meters; L1 is smaller.

using type '24 tubes. This may seem quite large; as a matter of fact it is large. It is extremely difficult to realize a gain per stage of even 70 or 80 over the broadcast range, except in an amplifier which is very well made, shielded, choked and bypassed with extreme care. This, of course, is out of the question in commercial radio receivers, on account of the cost involved. As a matter of fact, *in well-designed commercial receivers, we can generally count on obtaining perhaps half the maximum possible gain;* a limit due to the interstage couplings external to the tubes.

The maximum possible gain is a *function* of the mutual conductance of the tube; that is, the greater the mutual conductance, the greater the possible gain. (See the article, "Mutual Conductance and its Associates," March, 1931, RADIO-CRAFT.—*Editor.*) On the other hand, the greater the number of stages, the lower the maximum possible amplification. The same is true of the grid-plate capacity of the tube; to double it reduces the amplification thirty per cent.

We must now consider how much gain per stage we actually obtain in a typical circuit.

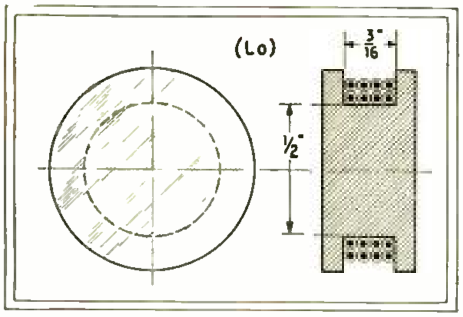


Fig. 8

The slot-wound primary loading coil Lo of the circuit shown in Fig. 5, as applied to a standard R.F. transformer. The diameter of the coil is very small.

Of course, the actual gain depends on the mutual conductance of the tube, the resistance of the tuned circuit (or the coil's "dissipation constant" Q), and the coupling between the primary and secondary (M). The Rp of the tube also has an effect on the gain, but this effect is quite small in screen-grid tube circuits.

Mutual Inductance of the Coil

In Fig. 3 we have curves which show the relation between the mutual inductance of the transformer and the voltage amplification obtained at different frequencies. The value of the coil's dissipation constant Q (which is 6.28 x *f* x L/R2) is here assumed to be 100; which is a fair value for commercially-designed coils of good quality. On the basis, it can be seen from Fig. 3 that, at 1000 kc., we can expect an amplification of about 32 per stage if the mutual inductance is 50 microhenries. The curves show that, as we increase the mutual inductance, the gain goes up steadily. This means that, if we double the primary turns, we will double the gain; because the mutual inductance varies as the primary turns.

Another thing, which Fig. 3 teaches us, is that the voltage amplification increases as we increase the frequency. This can, perhaps, be seen more clearly by plotting the curves in a different manner, as in Fig. 4; here the voltage amplification is shown plotted against the frequency, for various values of mutual inductance. For example, if the mutual inductance is 50 microhenries, we can expect a gain of 32 per stage at 1000 kc. as before. However, if we keep the

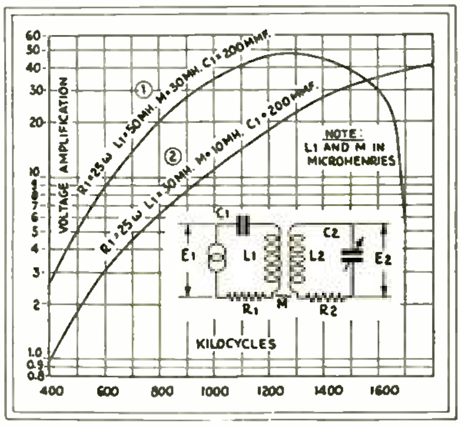


Fig. 9

Curves obtained from a commercial antenna transformer; in (2), the primary is smaller and the coupling is looser. Note that the vertical scale is logarithmic.

mutual inductance constant and increase the frequency, (tune to a lower wavelength), we see that the gain rises steadily. This is the frequency-characteristic which we obtain in all radio-frequency amplifiers employing the simple two-coil R.F. transformer. At high frequencies the gain is great, and at low frequencies it is small; and, the greater the mutual inductance, the steeper the curve.

Problems of Multi-Stage Design

It must be remembered that the curves shown here are for a single stage. With two stages, alike in design, the total amplification at any frequency is the square of the amplification of one stage; if there are three stages, the total amplification is the cube of that of one stage.

This means that, if we plotted the curves of Fig. 4 for three stages instead of one, we should find the curves very much steeper; and the difficulty which designers find in R.F. amplifiers would be more obvious. In a three-stage amplifier, the R.F. amplification at 1500 kilocycles may be as high as three to five times that obtained at 550 kilocycles; or even more, depending upon the particular design. It is on this account that attempts have been made to design R.F. transformers which will give reduced amplification at the higher frequencies, and greater amplification at the lower frequencies.

It is necessary, at the outset of such a design, to provide for keeping the coupling sufficiently loose; so that the reaction of the primary circuit will not appreciably affect the secondary tuning. This is a very necessary requirement, in order to make it possible to tune the amplifier over the entire broadcast range, while avoiding resonance effects, due to the primary, which would

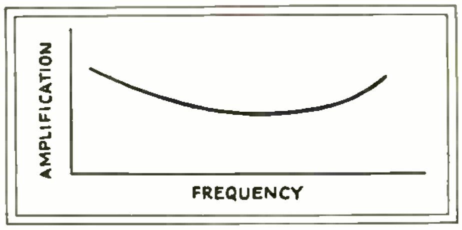


Fig. 6

The characteristic curve of the transformer of Fig. 5, due to the decreasing reactance of Co as the frequency rises.

make the tuning of the secondary uncertain at certain frequencies; such sometimes occur in the tuned circuit coupled to the antenna, when very large antenna capacities are used, or when the antenna coupling is very tight.

This being the condition—that the coupling between the primary and secondary must be loose—it is clear that the way in which the amplification varies with frequency will depend mainly upon the design of the primary circuit. Returning to Fig. 3, it will be obvious that the amplification is dependent upon the mutual inductance between the primary and secondary. Hence, if we can make this mutual inductance vary in any way which we desire, we may likewise be able to control the amplification accordingly.

A Compensatory Coil Design

This is what is done in actual practise; in one design, illustrated in Fig. 5, a local tuned circuit in the primary, consisting of a loading inductance Lo shunted by a condenser Co, is placed in series with the regular primary L1. The secondary L2B is of the usual design.

The self-inductance Lo is quite large compared with the inductance L1; so that at low frequencies (as at 550 kc.) L1 has little effect in comparison. Lo and Co are so proportioned that this local circuit is resonant at about 500 kilocycles, *just above the*

(*Continued on page 680*)

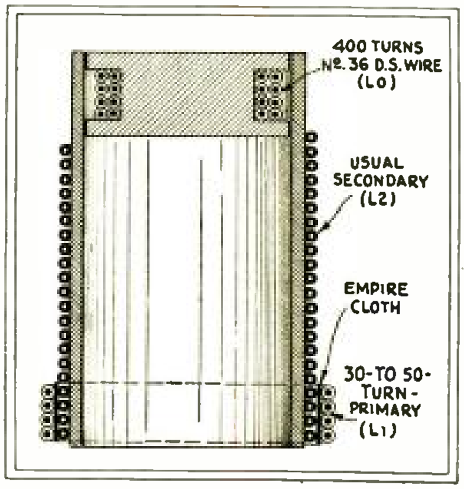


Fig. 7

The completed radio-frequency transformer, designed to overcome the disparity in amplification at the ends of the band. Lo is to be shunted by a 40-mmf. capacity.

New Radio Devices for Shop and Home

In this department are reviewed commercial products of most recent interest. Manufacturers are requested to submit descriptions of forthcoming developments.

NEW READRITE SET ANALYZERS

By H. G. Cisin, M.E.

TWO new set analyzers, Models "600" and "700," which definitely meet the requirements of the average Service Man at a very low cost, have just been placed on the market by the Readrite Meter Works. The "Model 700" is an extremely compact device. The outside dimensions of the carrying case are only 10¾ by 7¾ by 3¾ inches. The analyzer contains a D.C. voltmeter, an A.C. voltmeter and a milliammeter. The D.C. voltmeter has three ranges: 0 to 60; 0 to 200; and 0 to 600 volts.

The A.C. voltmeter has also three ranges: 0 to 10; 0 to 140; and 0 to 700 volts. The milliammeter has two ranges, one for a 20-mill. reading and the other for 100-mill.

The instrument is equipped with a six-position bi-polar selector switch; by means of which readings may be obtained of "C" volts, "C" volts reversed, "K" volts, "K" volts reversed, plate voltage, and screen-grid control voltage. A 4½-volt battery is supplied with the analyzer, to provide "C" bias, for grid tests, continuity tests, etc.

There are two sockets on the panel of the analyzer, one for four-prong tubes and the other for five-prong tubes. There is a "grid-test" push-button and pin jacks are available for the individual use of all meters, externally, in every range. There is a screen-grid pin jack, and there are two pin jacks for connecting the external battery.

The cable leading from the analyzer terminates in a handy five-prong cable plug, small enough for making tests within automobile and midget radio sets, with which a four-prong adapter is furnished. An adapter is also supplied for testing the second plate of '80-type rectifier tubes.

By referring to handy charts supplied with each analyzer, it is possible to make accurate external measurements of resistances over a wide range of values and also to measure all the usual capacities encountered in radio receivers and amplifiers.

The "Model 600" Readrite set analyzer contains the same equipment as the "Model 700"; but the apparatus is arranged in a tray and installed in a slightly larger carrying case, with a space below the tray 4¾ by 6¼ by 13¾ inches, which is suitable for carrying tools, spare tubes, etc. The tray is so contrived, that it may be taken out of the case and placed on the workbench.

Both of the new models are contained in handsome black leatherette cases, substantially constructed and equipped with nickeled corner protectors. In addition to being compact, the analyzers weigh very little, and can be carried long distances without causing fatigue. This feature will be welcomed by those Service Men who do not own an automobile.

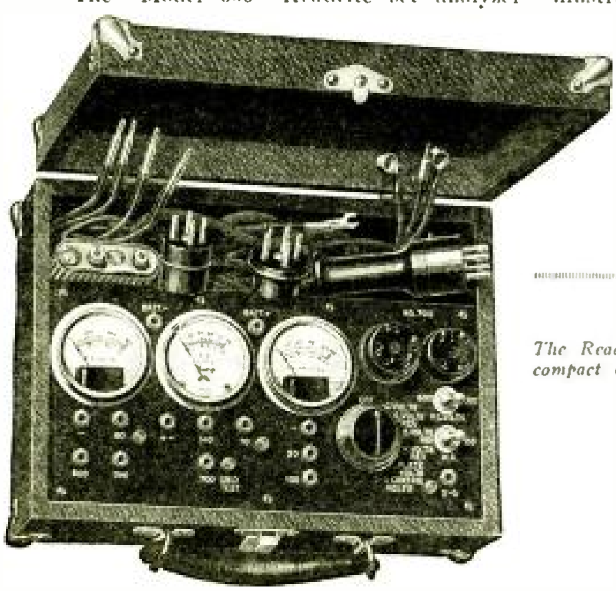


Fig. A (left)

The Readrite "Model 700" set analyzer, a compact apparatus for all purposes, at low cost.

A CONVENIENT RESISTOR INDEX

STANDARD resistance coding has long been an obvious necessity for efficient service work on radio receivers; and this need has been taken into consideration by the Radio Manufacturers Association in adopting standards for the significance of colors.

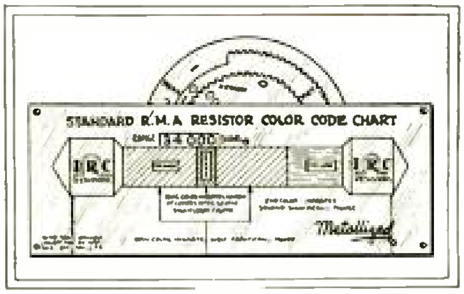


Fig. B

A pocket-size guide, giving direct readings of resistance values according to the R.M.A. standard code.

Its adoption by the larger manufacturers will eliminate one of the stumbling blocks of the Service Man.

A very interesting little indicator, which will fit the pocket of the service kit bag, and which gives a direct reading of the value of any resistor of standard color coding, is illustrated herewith. It has been made by the International Resistor Co., and a limited supply is available for free distribution to Service Men. The chart is printed on a substantial celluloid container, in which three calibrated discs revolve; setting them to the end, band and body markings of a resistor causes the ohmic value to appear in the window.

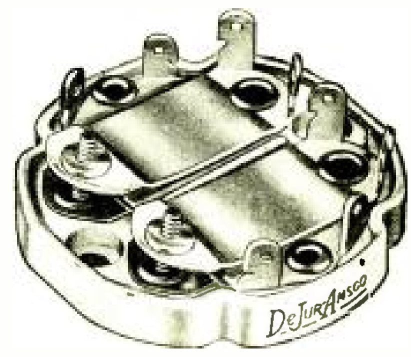


Fig. C

New adjustable condensers, useful for aligning, trimming, balancing and neutralizing. The adjustment is made from the other side.

ADJUSTABLE CONDENSERS

SINGLE and duplex small-space variable condensers of the mica-dielectric type are now available for the service and construction of receivers to which such units are suitable. This product, manufactured by DeJur-Amsco, has the trade name of "Varitor." The most-used model of the "Varitor" has a maximum capacity of 74 mmf. per section, the minimum value is 4 mmf. Five revolutions of the adjusting screw adjust the condenser over its capacity range. The head of the adjusting screw fits into a small hole, and conveniently may be covered with a seal. The construction is of mica, isolantite, and phosphor bronze; connections are made to soldering lugs.

Other values may be obtained up to a maximum as high as 700 mmf.

The "Varitor" is adjustable by means of a screwdriver; and will fit the average coil-shielding can. The over-all dimensions of the duplex are 11/16-inch thick x 2⅜ in. in diameter, for the larger models; the smaller duplex units have a diameter of 1⅞.

GAS-HEATED SOLDERING TOOL

FOR servicing or construction, a new device is the "Torchiron," illustrated in Fig. D, which is manufactured by the Reliance Torchiron Mfg. Co., The point may be heated in an ordinary gas flame; or the iron may be connected to a gas outlet and heated by its own flame, which is not exposed. A needle valve has been designed to mix economically the gas and air. "Coppers" of varying sizes, down to ½-lb, are available. In three to five minutes, soldering heat may be reached; the temperature of the soldering copper is under control of the operator.

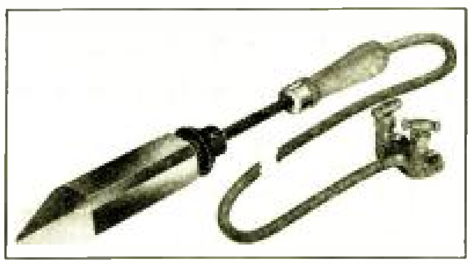


Fig. D (right)

A new type of soldering iron which may be internally heated, with a gas-tube connection.

New Types of Radio Receiving Tubes

Manufacturers announce 6-volt screen-grid; high-gain '24; variable-mu; mercury-vapor '80 and other improved designs.

TUBES available hitherto in the United States have been of comparatively few standard types, so far as those offered to the public were concerned. Slight variations of design existed in the practice of various factories: but the general purpose of the industry has been to obtain interchangeability; and the idea of giving every tube user a wider range of choice—still apparent abroad—was submerged in that of efficient mass production. However, the fact that receivers vary greatly, in the conditions under which they are operated, is forcing the production of more tube types.

For instance, when the automotive receiver invaded the market for commercial radio sets, it encountered the limitations of battery supply. The tendency has been to develop modern receiving tubes for operation from a 2½-volt, A. C., filament-heating secondary. But the automobile industry had standardized on a 6-volt, automatically-charged battery; this was therefore used to operate the 2½-volt tubes, because others were not available.

A few days ago a large tube manufacturer broke away from tradition, and announced the development of a six-volt screen-grid tube, for direct-current operation, though with an indirectly-heated cathode. It is specially intended for automotive receivers; yet lends itself also to operation from D.C. light lines in series-filament circuits.

The "NY-64" is the type number selected by its manufacturer, the National Union Radio Corp., for this tube. It draws 0.4-ampere on the filament, at 6.3 volts (the value in automotive lighting systems), and may be used with 180 volts on the plate, at a screen-grid voltage of 90 and a control-grid bias of 3. With 110 volts on the plate (as from a light-line), the screen voltage is 70, and the bias 1.5 volts, negative. In other respects, the characteristics of the tube are similar to those of the standard '24.

Since the separation of the cathode from the filament implies a biasing voltage between them, it is recommended that this difference in the "NY-64" should be never more than 25 volts and that—in contrast to previous tube types—the heater should always be negative with respect to the cathode.

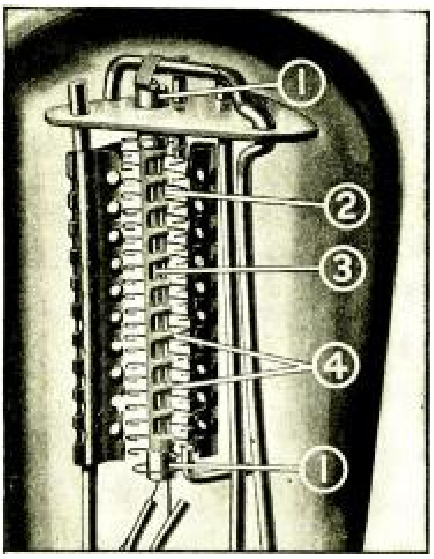


Fig. A
The new De Forest cathode-heater construction—1, cathode tube; 2, 3, filament; 4, "fins."

New High-Gain Tubes

In the design of the midget sets, in which fewer tubes are used, for reasons of compactness and cost, it is most essential that the screen-grid tubes provide as much voltage gain as possible. With this requisite in mind, the DeForest Radio Company has developed and placed in production a special screen-grid tube of much higher amplification constant than the ordinary types. Tubes of this new design have been checked in a number of midget sets, and it has been found that the sensitivity of the average midget set can be doubled by using them. For instance, if a set has a sensitivity of 20 microvolts per meter, with the usual screen-grid tubes, this may be increased to 10 microvolts per meter with the new tubes.

Although the new type was designed specially for use in midget sets, the tubes are interchangeable with the standard '24 tubes and can be employed in any of the present-day radio sets for the purpose of doubling the sensitivity. They are known as the "424 High Gain" type.

The mutual conductance of the De Forest power tubes, also, has been increased; since this characteristic determines the maximum output of the set. On the other hand, this company has reduced the mutual conductance of the standard '27 which it manufactures; since, with the usual "Gm" factor, this tube tends to undesired oscillation in certain positions. During the past year, changes have been introduced in its design, along the lines of more rugged construction, greater cathode emission, and quicker heat-

(*Continued on page 686*)

Practical Hints to Radio Manufacturers

RAZOR BLADES AND VOLUME CONTROLS

MANY customers object to paying anywhere from five to seven dollars for volume-control replacement. One customer says, "It's as ridiculous to waste the complete volume-control mechanism, simply because the graphite-coated strip is worn on the surface in one or more places, as it would be to throw one's razor in the ash-barrel along with a dull blade."

The graphite-coated strip-type volume control soon becomes noisy; usually, at the junction of the metal contact and the strip. The roller must climb over the edge of the metal contact: therefore the pressure is great at this point, causing the edge of the metal contact to wear off the graphite.

Yet, one cannot purchase the graphite-coated strip separate from the control mechanism, although razor blades are bought without the holder.

RUSSELL L. WOOLLEY,
3008 Fifteenth Avenue South, Seattle, Washington.

CONNECTIONS FOR ADAPTER

BECAUSE short-wave and television are becoming increasingly important, I recommend that tip jacks and a switch be placed in the back of each chassis; so wired that it will be unnecessary to remove the detector tube to plug a short-wave tuner into the audio channel.

FRANCIS K. MASSIE,
741 Thirtieth Street, Newport News, Va.

(Perhaps the phonograph jack, furnished with so many modern sets, will afford an opportunity for the makers of short-wave adapters.—*Editor.*)

ALL-AROUND METER

A UNIVERSAL meter, with scales of milliamperes, filament and plate voltages on one dial, is made and sold in England at low cost. I would like to see this done by one of our meter manufacturers; it would make a very compact set tester, which would leave more room in the Service Man's bag.

CHAS. E. HURLBURT,
Middle Haddam, Conn.

LONGER ANTENNA LEADS

SOME manufacturers are getting so Scotch that they are using two wires, leading from the set, instead of two posts for aerial and ground connections. This is all right; but I would say, leave the two wires about six inches longer, so that it will be unnecessary to fish for them with a pair of pliers.

H. B. AULENBACK,
91 Augusta St., Hamilton, Ont., Canada.

CORRECTING THE SCALE

SOME quick means of resetting the tuning dial to give the proper kilocycle reading is desirable; since on most sets it is necessary to pull the chassis. I find that fully 50% of the receivers of various makes come through with incorrect dial readings; and, when the purchaser buys a new log book, a service call is usually the result. Also, I would suggest that the dial light bulb be placed in an accessible location; since it has to be replaced quite frequently.

RUSSELL R. BYERS,
1036 Eugene, Indianapolis, Indiana.

The Radio Sextant--for All Skies

Natural radio waves, very much shorter than any hitherto capable of being utilized, now determine an observer's position in the densest fog or falling rain. These waves, formerly classed as "heat" rays, are now open to a great many novel uses.

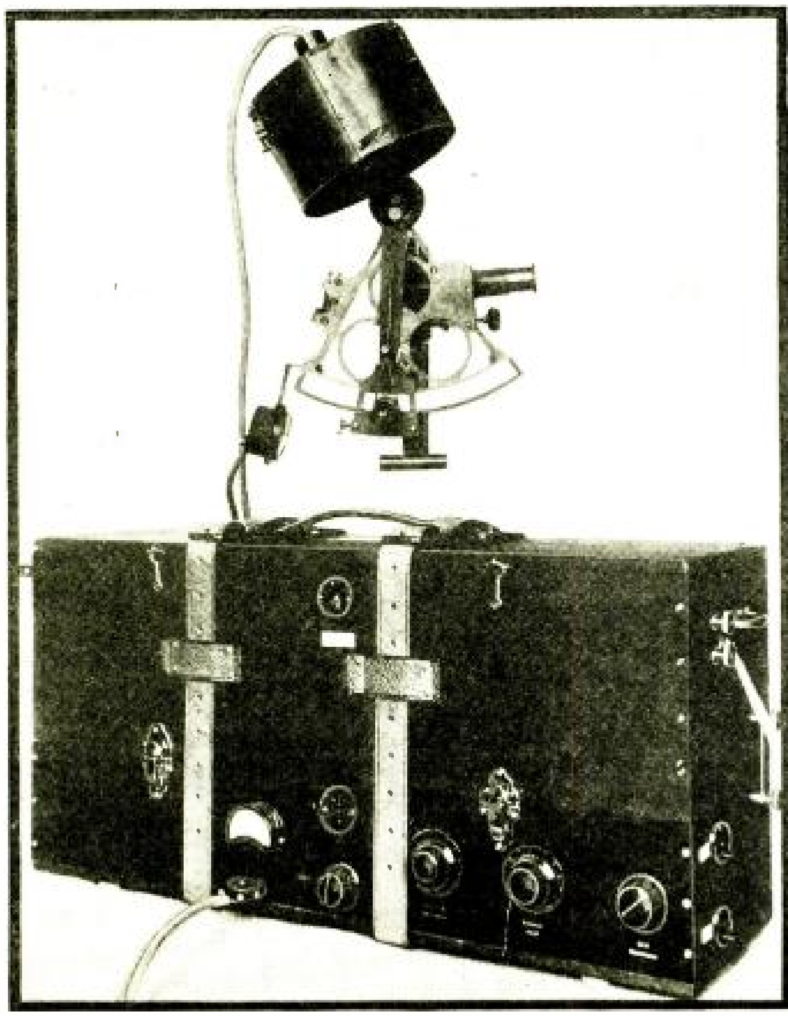
RADIO-CRAFT takes pleasure in presenting to its readers the first description of radio's latest achievement—the new Radio Sextant. This new instrument is remarkable in that it utilizes radio principles for a practical result which was an impossibility before. It is now practicable for a navigator, on board a ship or airplane, to point the Radio Sextant at a thoroughly overcast sky, even during a falling rain or, what is worse, during a dense fog, and so accurately locate the sun—although the latter is invisible to the human eye—that its actual position can be determined with a possible variation of less than one thirtieth of the breadth of the solar disc.

Mr. MacNeil, the inventor of the new Radio Sextant, is an architect by profession; he has worked for a number of years on the instrument, which has recently been tried out on the steamship Mauretania, and in perfecting it had to invent entirely new instrumentalities, including a new light-beam amplifier. He had been told by several prominent radio companies that an amplifier such as he desired is impossible to make; but he, not knowing any better, went ahead and produced one.

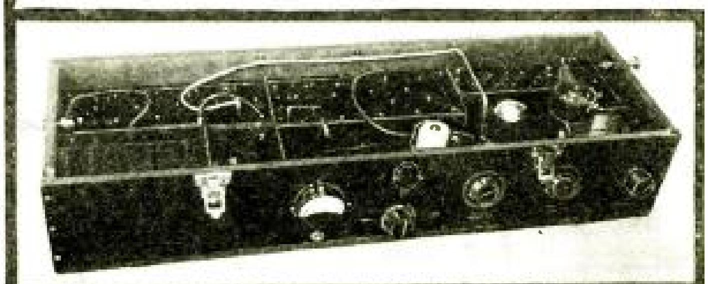
The invention of this instrument shows again that the applications of radio principles have by no means been exhausted, and that new uses can be found almost daily by enterprising inventors and investigators.

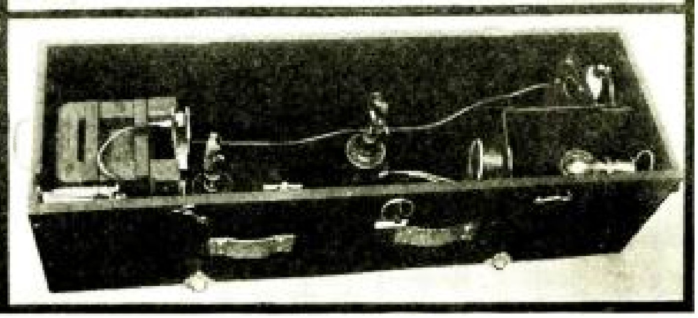
WHERE does the radio waveband end? Radio waves as low as seven meters are being put to commercial use; radio waves down to a quarter of a meter are fairly familiar in the laboratory; and wavelengths of a thousandth of a meter have been created by physicists. Below this there are ten octaves of frequencies (or thirty billion ten-kilocycle "channels") before the electromagnetic waves of light are reached. The higher frequencies, called "infra-red" or "radiant heat," are familiar to all by their warmth-giving properties; but, in that vast range between the lowest radio waves and the longest perceptible rays of warmth, only the scientist has been able to find matters of interest. While the possibility of utilizing these intermediate waves for communication has been discussed, it has created only a very academic interest.

However, a very practical application for them, as they exist in nature, has been found by an American inventor, Paul Humphrey MacNeil, of Huntington, L. I. (New York), who has demonstrated the practicability of observing the position of the sun on a cloudy day—not from its own direct radiation, which is absorbed by the water vapor filling the atmosphere, but by the rays which are thereby caused to emanate from the clouds, in a direction predominantly parallel to the sun's rays. On the bridge of the Cunard liner *Mauretania*, on a recent voyage, Mr. MacNeil demonstrated his apparatus successfully to the navigating officers of the ship, under conditions which rendered ordinary observations impossible. The possibilities of the invention are not confined to finding the positions of ships and aircraft in heavy weather; but even these applications mark the first fundamental improvement in the art of navigation since the design of the chronometer.



Left, the radio sextant with its amplifier and batteries. The first stage (at lower right) has a galvanometer at the left; it throws a light-beam into a sensitive photo-cell whose output is passed into the amplifier, shown with its power supply at the upper right.





Navigation by the Sun

It may be explained that the position of a ship in the open sea, away from the lights and radio beacons of the coast, can be determined with accuracy only by observation of the heavenly bodies. The "dead reckoning" enables the sailor to estimate his whereabouts by the rate of speed maintained in a given direction from his last known position; but this calculation is not certain, because of the mobile characteristics of the element on which he is floating, and the effects of winds and currents. The longer the voyage, the greater the possibility of error. The errors in finding a ship's position, in the

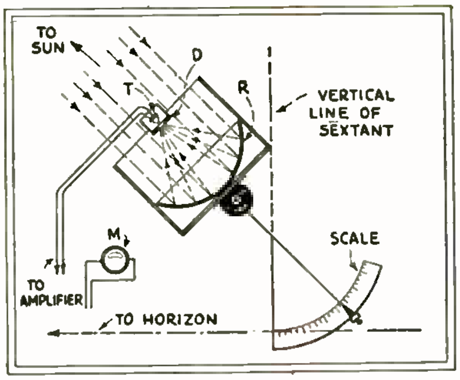


Fig. 1

The principle of the radio sextant; it measures the angle between the sun and the horizon. The meter reads maximum when the image of the sun is concentrated on the perforation in the diaphragm D

old days, may be readily judged from the distortion of the maps and charts then published, as based on the observations of navigators.

To determine the latitude, or distance north or south of the equator, is comparatively easy when the sun, the moon or stars can be observed. Tables are obtainable, from which the height of the sun, of the moon or of any given star above the horizon when it is highest (at actual noon—not noon by the clock—in the case of the sun) may be determined for any given position. A simple observation, with a few corrections for optical reasons, suffices therefore to give the latitude. For instance, at noon on a certain date (the equinox) the sun is in the plane of the earth's equator, and therefore appears overhead on the equator. If, after corrections have been made, it is found that the sun is just halfway between the zenith overhead and the horizon, at any given place, that place is halfway between the equator and the pole, or in latitude 45°.

On the other hand, while observation of the sun may show that the time is actual noon at any place, the longitude can be found only by comparison with the known time at some certain place—such as Greenwich, England. If a chronometer keeping Greenwich time shows that it is 4:00 p.m. at Greenwich, when it is 12:00 noon at the point of observation, it is then apparent that the observer is on the meridian of longitude 60° west of Greenwich. During the past few years the development of radio time signals has made it possible for a navigator to check up on his chronometer several times a day, if necessary; and thus both latitude and longitude can easily be determined within a mile by the use of ordinary instruments—if the sun can be observed.

Finding an Invisible Sun

That *if*, however, is a large one. In stormy or cloudy weather, when no heavenly body can be seen, it is most necessary to know a ship's position yet most difficult to determine it. When the weather is so thick that the sun's disc cannot be seen, the navigator cannot use his sextant.

The invention illustrated here has now overcome this obstacle. As explained above, it does not operate by the direct rays of the sun. Too many experimenters have been defeated in somewhat similar researches by the fact that even the infra-red radiation of the sun is lost in the atmospheric blanket. Mr. MacNeil attacked the problem from a new angle, and has developed a technique by which secondary radiation of wavelengths a thousand times longer than those of visible light, is detected with accuracy sufficient to determine the sun's position in the heavens.

In the ordinary sextant, the image of the sun, reflected from a mirror, is caused to touch the horizon, by adjusting a scale (See Fig. 3A). This adjustment does not depend upon the steadiness of the instrument, but upon the angle between the mirrors of the instrument; and it is therefore possible to make a very close adjustment by turning a vernier screw, and to read at leisure the angle between the lower edge or "limb" of the sun and the horizon.

With the MacNeil sextant, when the sun is invisible to the eye, its position is determined by the position of the instrument at which maximum radiation is received, at the very long wavelength (as light goes; or very, very short as radio is rated) of emission from the cloudy sky. This fixes the axis of the cylinder above the sextant (Fig. 1) at the elevation of the sun above the

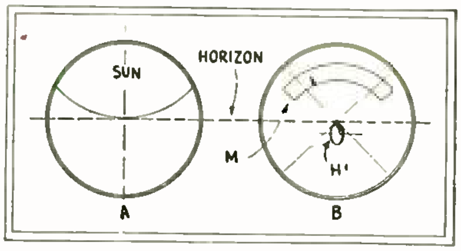


Fig. 3

An ordinary sextant is adjusted till the sun seems to touch the horizon, as at A; the radio sextant till the meter reads maximum, with the horizon properly on the cross-hairs.

horizon; at the same time, the horizon (H) is caused to coincide with the intersection of the cross-hairs in the field of view of the instrument (Fig. 2.) An adjustment is sought, in the light of the observer's estimated position; and then the screw is turned until the horizon appears in its correct place. The sun's elevation is then read off on the scale below, and the usual corrections and calculations of the navigator are carried out. As a matter of fact, this method of measurement eliminates the calculation for variation of the solar diameter.

Should the actual horizon be invisible, then resort to the method of an "artificial horizon" must be sought. This is found by means of a small level in the base of the instrument. The reflection of its bubble (H'—Fig. 2) is brought up to the horizon line; the insertion of a simple slide behind the half-mirror A serving to divert the optical train from the actual horizon to the bubble.

Detection and Amplification

The question at once arises, how does the instrument determine the point of maximum radiation? Full details are not as yet available for publication, because of certain foreign patent requirements; however, this much of the system may be outlined here.

The cylinder at the top of the instrument (Fig. 1) has at its bottom a parabolic mirror R; the parallel rays of radiation falling upon this are reflected to its focus, where a sensitive thermo-couple T is placed. This thermocouple is shielded from the shorter rays of light, and heating radiation, which are found in normal daylight; it responds only to the longer, quasi-radio waves mentioned above. Under their influence, and in proportion to their intensity, a small direct current is generated; this is carried through the cable, emerging from the top of the instrument in the experimental model illustrated, to the amplifier.

The first stage of the latter is still reserved from description; it is stated, however, that the efficiency found here has been previously attained only in the most delicate of laboratory apparatus. A delicate string galvanometer, reflecting a ray of light into a photoelectric cell, carries the impulse: this is then amplified in a conventional vacuum-tube amplifier and led to the meter M of Fig. 1. When this meter shows maximum reading, it is evident that the cylinder of the sextant is pointed directly at the sun.

The diaphragm D covering the thermocouple (Fig. 1) is perforated with an opening equal in diameter to the image of the sun; otherwise the necessary accuracy would not be obtained. This is theoretically capable of establishing the sun's position within twenty seconds of arc (about 1/90 of the sun's apparent diameter) on the cloudiest day; under difficult conditions of demonstration, on a pitching ship in heavy weather, it did so within one minute of arc. The latter angle corresponds to about 6000 feet on the surface of the earth.

The current generated in the thermocouple T may be in the order of one microampere: if the sun's rays were received with even a fraction of normal fair-weather intensity screens over the detecting cylinder would be required. The reading of the meter, as stated above, is taken at its maximum; and no arbitrary figure for this value is required. When the greatest intensity of radiation is found, the observer brings the horizon line or bubble, to the cross hairs of his field of vision (Fig. 3B); and the reading is then taken from the scale beneath the instrument.

It will be observed that the cylinder of the sextant illustrated is adjusted to a high angle, for the sun's position. For different latitudes, this elevation may be altered by means of another vernier scale, for the greatest convenience in observation.

Mr. MacNeil, who is an architect by profession, has been working on this device for several years. Having overcome the funda-

(Continued on page 696)

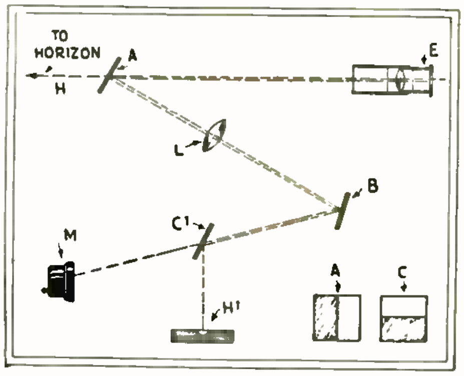


Fig. 2

The optical train of the MacNeil radio sextant; the horizon may be sighted directly at H, or found by the bubble of the spirit level at H1. The mirrors are silvered only partially.

The "L-32" Ultradyne All-Wave Receiver

A highly-sensitive receiver embodying the latest devices of the radio technician

By H. J. COX*

FOR some time there has been a demand for a sensitive superheterodyne capable of tuning in the shorter wavelengths, in addition to the usual broadcast assignments. To meet this situation the well-known "Ultradyne" receiver, conceived in its original form by Robert E. Lacault, has been redesigned. In the improved design, the principles of exceptional sensitivity, selectivity, quality, volume, good appearance, kit construction, ease of construction and operation, and low cost, which were embodied in the earlier Ultradyne models, have been retained by the designers of the "Model L-32" Ultradyne.

It was desired to have an "All-A.C." set design capable of covering the wide tuning band from about 15 to 550 meters. The necessity of changing plug-in coils was recognized; since maximum sensitivity at all wavelengths is desired, and a switching system would constitute a source of undesired loss. The problem finally was solved, in a most satisfactory manner, by designing the R.F. coils to plug into their respective sockets through holes provided in the top of the shielding, as shown in Fig. A.

Perhaps the most important contribution to the success of the design of the "Model L-32" is the dynatron oscillator (V2, Fig. 1). This feature eliminated interlocking of controls on the high frequencies, and critical tuning. (Information on this type of oscillator appeared in the February and March, 1931, issues of RADIO-CRAFT.)

Anyone who has experimented with receivers operating over the wide range of 15 to 550 meters will recall the difficulty of tuning at short wavelengths when the tuning condenser has a high capacity; and, on the other hand, the large number of coils needed to cover the longer wavelengths when the condenser has the low capacity so desirable for satisfactory tuning at the shorter wavelengths.

Double Tuning System

By comparing the schematic circuit, Fig. 1, and the illustration of the placement of the parts, Fig. B, the solution here obtained will become apparent from a few words. When using the "broadcast-band" set of plug-in coils, the small 50-mmf. variable condenser (C1 in Fig. 1, which is controlled by the knob shown at the lower right of the front panel, Fig. A), is connected in shunt to the 250-mmf. main tuning condenser (C2 in Fig. 1 and Fig. B) and acts as a "trimmer" to compensate variations in the circuit. And, the large (250-mmf.) and small (50-mmf.) sections of the two-section oscillator tuning condenser (C3-C4, respectively, in Fig. B) are connected in parallel. Thus, the single-control "equacycle" variable condensers C2, C3, C4, turning through an arc of 270 degrees, in conjunction with the correct set of plug-in coils, cover the waveband from 200 to 550 meters.

When using the other four sets of plug-in inductances, the circuits of two of the variable condensers are automatically opened; this is made clear by reference to Fig. 2, which shows the circuit-closing jumpers on the two "broadcast-band" coils. The operation then is somewhat different: the little "trimmer" condenser, C1, becomes the "antenna tuning" condenser; and C4, the small section of C3-C4, is the only tuning capacity in shunt to L3. Condensers C2,

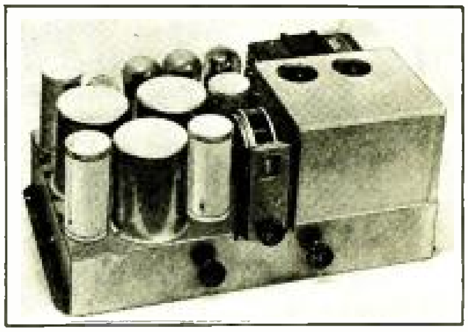


Fig. A
Completed chassis of the "L-32": there are five sets of plug-in coils, which are inserted through the holes in the top of the shield.

C3-C4, all rotate under control of the main dial, but only C4 is effective. Consequently, at the shorter wavelengths, dial (by the main tuning dial and the "trimmer" knob) operation has been selected to obtain maximum sensitivity; while the choice of tuning capacity "spreads" the shorter-wave tuning bands. (At the present time there is no provision for introducing circuit oscillation, to enable CW. stations to be tuned in.)

Another fence to be hurdled was the "intermediate frequency" or, as we like to call it, the "I.F.;" it was found, that with a sufficiently selective antenna circuit to meet present-day broadcast conditions, an I.F. of 245 kc. resulted in minimizing trouble due to double-beat tuning. (Please do not call this effect "double harmonics"; that's something entirely different.)

Novel Heterodyning System

Next to arise was the question of mixing the signal and oscillator frequencies to obtain this I.F., or difference frequency. And here we write a new page in the history of superheterodyne receivers. After consideration of the relative merits and demerits of all the accepted systems of coupling, a circuit has been evolved wherein the signal and oscillator circuits are isolated in nearly every sense of the word! Checking over the schematic circuit, it will be noted that every portion of the oscillator, V2, returns directly to ground—except the filaments, screen-grid and plate. And, by checking further, we find that resistance-capacity filters prevent R.F. energy from backing upward and into the other tubes in the set. As a matter of experiment, the use of an independent "A" supply has proved that no coupling exists via the "A" leads. Except for the two holes

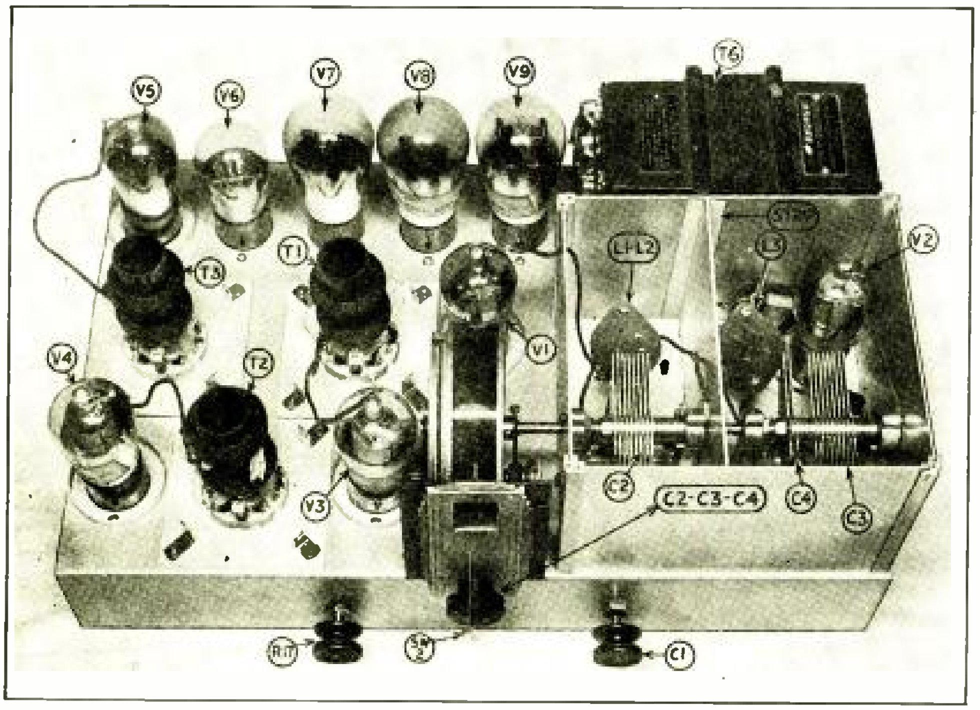


Fig. B
The "L-32" with shielding removed to show positions of parts; the insulating strip in the can at the right increases sensitivity. In this model, the local Sw2 is included, but it is omitted if location does not require it. Complete constructional prints are available.

* *Chief Engineer, Traul Radio Co.*

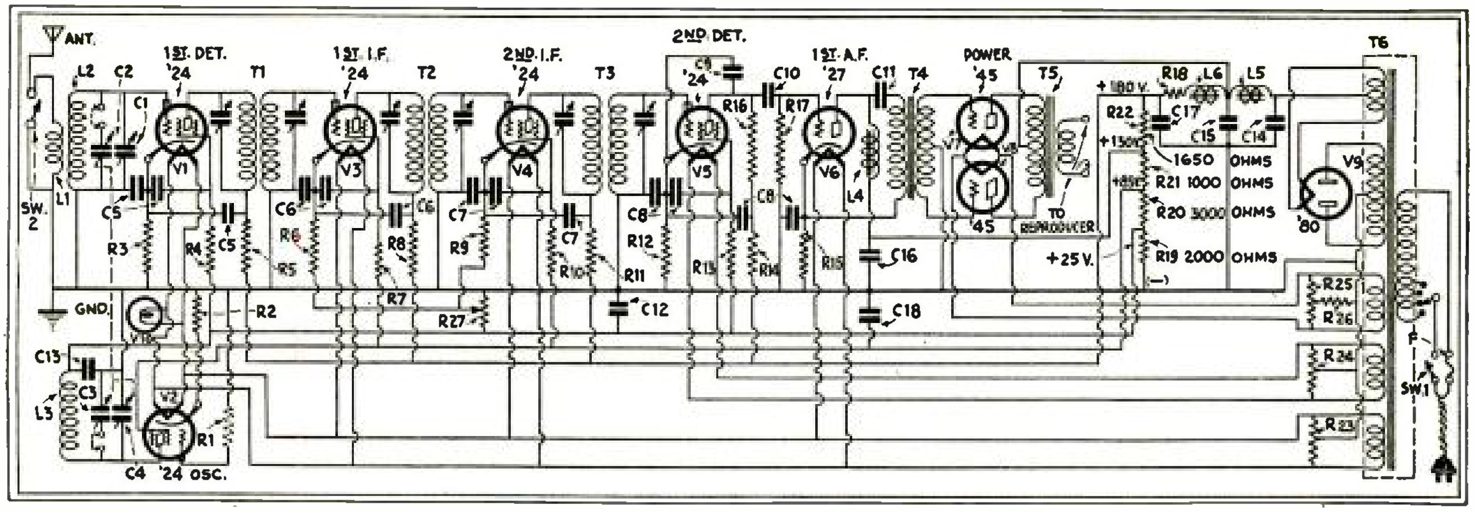


Fig. 1

In the "L-32" Ultradyne, L6 is the 2,250-ohm field of a dynamic reproducer; R18 compensates for differences in the resistances of fields. The "local" switch Sw2 is required, in congested localities only, because of the receiver's high sensitivity. An .00015-mf. trimmer shunts C3.

through which the plug-in coils are manipulated, there is no coupling between the signal-frequency inductance L1-L2, and the oscillator-frequency inductance L3; an aluminum wall separates the shield can into two compartments and thus isolates these coils. A clue to the coupling means may be found in the remark that insulating the aluminum partition from one side of the can will improve the sensitivity of the receiver. This insulating strip, which may be of any convenient material, is shown in Fig. B. (We will leave it to the readers of RADIO-CRAFT to suggest just *how* the I.F. is obtained; the starting point being that the operation is perfectly satisfactory.)

The sensitivity of the "L-32" may be considered with reference only to the input of the I.F. amplifier. Laboratory tests indicate this figure to be ¼-microvolt—for the standard output volume. Most of this sensitivity is due to the use of tuned I.F. transformers.

Design of the I. F. Amplifier

These are shown in the schematic circuit as T1, T2, T3. Each coil is honeycomb wound, the primary being spaced 1 inch from the secondary. The primary is the lower coil, 1½ inches from the aluminum base on which is mounted a two-section trimmer condenser of 70 mmf. size. (These trimmers are adjusted from the underside of the chassis.) To obtain satisfactory results, each I.F. coil must be held to close tolerance limits; and the manufactured units, laboratory tested and rated, meet these specifications. Each I.F. transformer is enclosed in an aluminum shield can, 4½ inches high and 3½ inches in diameter. The mutual coupling between each primary and secondary determines the selectivity of the I.F. amplifier; which will have a "flat top" characteristic without the need for staggering the resonance points of each circuit with consequent loss of sensitivity.

It is quite a trick to handle the tremendous gain of an amplifier system having a sensitivity of ¼-microvolt. An adequate number of by-pass condensers, correct placement of parts, short leads, sufficient shielding, and careful selection of circuit and parts constants, have harnessed this power.

Excellent Audio Channel

Fidelity in reproduction is due, in part, to the use of a resistance-capacity coupling between the screen-grid power second-detector V5 and the first A.F. amplifier tube V6. "Parallel-plate feed," between V6 and the power tubes, is another factor.

Contrary to the ideas of some set builders, the power transformer does not introduce hum by inductive coupling into the circuits of V1 or V2. (The particular power transformer selected is largely responsible for this.) In fact, the hum level is below audibility at a short distance from the reproducer. This condition holds for the entire waveband. The constructor will find that short-wave stations will come in with the same quietness apparent on the longer waves.

The tray or chassis of No. 14 gauge aluminum measures 11¼ x 18½ x 3½ inches high. The overall height of the assembly is 8½ inches.

Each screen-grid tube has its individual aluminum shield can; except for the oscillator, which is in the same compartment as oscillator inductance L3.

The 2,250-ohm field of the dynamic reproducer is used as one of the chokes L6 in the filter system of the power pack; resistor R18 may have the correct value to compensate for variations in resistance of the field coil. The output push-pull transformer, T5, is encased with the reproducer.

Resistor R1 ordinarily is not needed; although at the shortest wavelengths it may not be possible to obtain dynatron circuit oscillation without it. Resistor R2 is not used in the latest models.

Details of Construction

"Variable mu" tubes (described in the preceding issue of RADIO-CRAFT) may be used as I.F. amplifiers in the L-32 Ultradyne. This is recommended only in the near proximity of a powerful station; since the sensitivity suffers somewhat. Only the Majestic '51's have so far been tried by the writer. No circuit changes need be made; merely plug the '51's into the positions for V3 and V4.

Switch Sw2, in the newer sets, is connected as shown in Fig. 1; the antenna post *must* be wired first to the switch contact and then to L1. This system of connecting the local-distance switch has been found most effective.

The volume control R27 *must* be insulated from the chassis; this potentiometer is controlled by the left knob.

Reducing the plate potential of the dynatron oscillator to 25 volts has improved the operation; the screen-grid then has a potential of 85 volts.

A trimmer of .00015-mf. capacity (not shown) shunts C3 for better tracking. It seldom will require adjustment, and is in use only on the upper broadcast band.

The volume control R17 is a potentiometer of the tapered-resistance type. The shaft of this unit carries the off-on switch. Choke L5 is a 15-henry unit. Condensers C14 C15, C16, C17 are electrolytic units of the dry type, and are mounted in a horizontal position on the under side of the chassis.

Although it is not likely that many experimenters will be able accurately to duplicate the coils required for the "Model L-32" Ultradyne, some of the details of their design may be of interest. The primaries and secondaries of the I.F. transformers T1 T2 and T3 are made by winding narrow honeycomb coils, each consisting of approximately 500 turns of No. 32 D.S.C. wire

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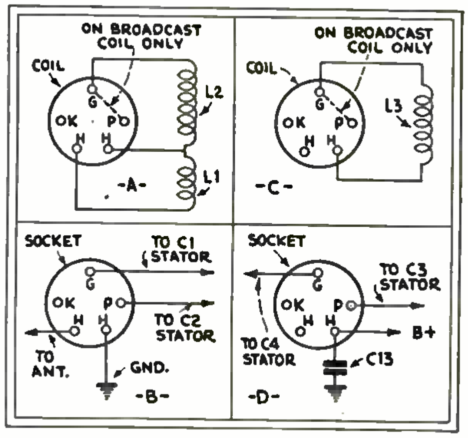


Fig. 2

Detail of antenna coupler at A and its socket connections at B; oscillator coil at C and its socket at D.

The "SWS-9" Short-Wave Superheterodyne

A single, shielded, plug-in unit is easily exchanged to shift the waveband on this A.C. single-control receiver of high sensitivity. The range can be extended up to 550 meters.

By JOSEPH I. HELLER, E.E.*

ABOUT eight months ago, it was decided to start research work on a new short-wave kit set which, when finished, would have the features considered most desirable in a modern receiver; and, also, that certain disadvantages inherent in the ordinary run of short-wave receivers should be circumvented in the new design.

Among the features desired in the new set were control non-critical from every standpoint; coils which could be interchanged with no more trouble than plugging in a pair of phones; not more than one plug-in coil for each waveband, a volume control; and output equivalent, in both tone and volume, to that of expensive broadcast sets. The sensitivity should be above that of other short-wave sets, selectivity sufficient to completely eliminate any chance of interference, the gain at all frequencies substantially the same; and the receiver must tune both short-wave broadcast and C. W. stations with equal facility and efficiency. One requirement, probably more important than any of the others, was that the receiver must operate entirely from the A.C. line; and that the components necessary for this must be built on the same chassis as the receiver, and introduce absolutely no hum.

Simplification of All Controls

The disadvantages, of the ordinary set, to be overcome are as follows: absence of volume control; extremely critical and knife-edged regeneration control; a regeneration control whose setting varies with every frequency; plug-in coils that make necessary a major operation in changing; low output; and, in most cases, two dial controls. This article is intended to cover each point in the design and construction of the "SWS-9 set"; and thereby to enable any experimenter both to see the worth and desirability of the ideas incorporated, and to construct this receiver with a minimum expenditure of time and effort.

Let us take the features desired and show how it was possible to evolve a rather rough idea of the finished set, by merely making sure that all of the desirabilities were included in the design.

First, we have non-critical control. As anyone knows who has ever tuned a short-wave receiver, the regeneration control is probably the most temperamental adjustment ever conceived for use in any set, whether broadcast or short wave. The most sensitive portion of the detector's characteristic is at such an extremely critical point that, by the time a station has been sufficiently well tuned in to be audible, most of the pleasure has been eliminated from the proceeding.

The answer to this problem is to incorporate the regeneration control in such a circuit that it will be isolated from the frequencies being received; by so doing, it may be adjusted at the point of greatest sensitivity. The superheterodyne principle immediately comes to mind; and so it was decided the receiver must be a superheterodyne and thus free from critical regeneration settings. This circuit, too, has other advantages.

The problem of the plug-in coils was a hard nut to crack. It was early decided that they would have to be operated from the front of the set, making it unnecessary to lift or remove any covers or to search around in the dark for sockets. Only one coil must be used. Since the design was a superheterodyne, and absolutely no hand-capacity effect from the coil was permissible, it became necessary to do two things: first, to put both oscillator and detector tuning inductances in the same unit; and, second, this unit had to be perfectly shielded. It will be seen, later, how neatly and effectively this last item was arranged.

Most manufacturers of short-wave receiver kits, for some strange reason, have repeatedly neglected to include volume controls, making it necessary either to detune the set, or lower the regeneration control (the latter expedient being impossible when

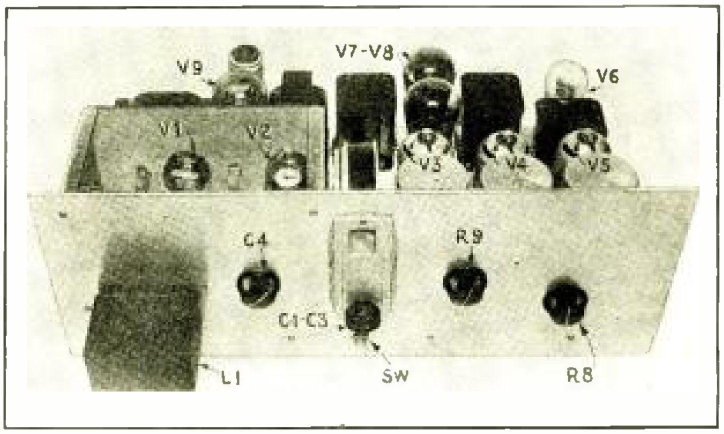


Fig. A

In this front view of the "SWS-9," the single plug-in inductance L1 is seen in its shield. This unit contains both oscillator and antenna coils, the details of which are shown in Fig. 4. The power pack, at the left, rear, introduces no perceptible hum. This set tunes with superb ease.

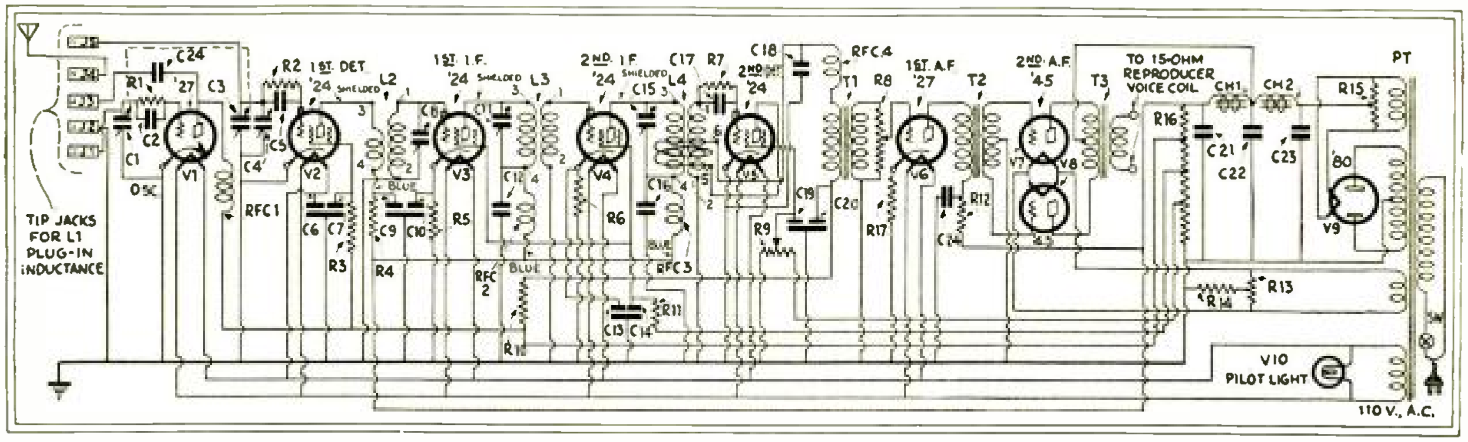


Fig. 1

Schematic circuit of the "SWS-9" short-wave super: the volume control is potentiometer R8, in the first audio input. R9 is a regeneration control for the second detector. The oscillator condenser C1 and antenna tuning condenser C3 are ganged.

* *Chief Engineer, Wireless Egert Engineering.*

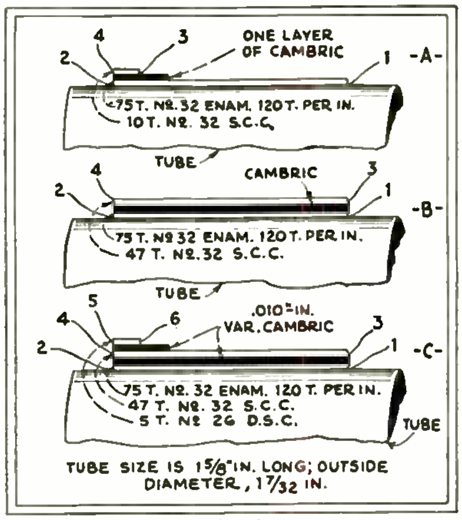


Fig. 2

Specifications of I.F. transformers, in the following order: A, L2; B, L3; C, L4—second-detector, with feed-back coil having terminals 5 and 6.

receiving CW signals. Therefore, a volume control was included in the design.

In order to make the output equal to that of the ordinary broadcast set, it was decided that two type '45 tubes should be used in push-pull, preceded by a single '27 first A.F. amplifier. As a result, it was later found, after the construction and adjustments had been made, short-wave broadcast stations generally came in with the same tone and volume as programs on the ordinary well-built broadcast receiver. This made possible, for the first time, the actual enjoyment of the program for its musical and entertainment value, in addition to the thrill of hearing a distant station.

When correctly used, the superheterodyne circuit is capable of exceptional sensitivity and selectivity. A major factor in obtaining both these effects is the use of the tuned air-core I.F. transformers L2, L3, L4 shown in Fig. 1.

Since very little amplification is necessary at the frequency being received (merely enough energy being required to beat with the oscillator), the gain is the same for all signal frequencies.

The regeneration control takes care of CW, ICW, and voice reception. When considering the problem of hum resulting from A.C. operation, it was believed that, if a perfectly-shielded supply source were placed properly, there would be no pickup of the hum. After quite a bit of experimenting, this result was obtained; and here is a receiver with absolutely no hum, although the power-supply apparatus is mounted directly on the same chassis with the receiver proper.

After listing the desirable points, and their preliminary solution, complete specifications will be given for building the short-wave A.C.-operated superheterodyne receiver which looks like a broadcast set, tunes like a broadcast set and sounds like a broadcast set.

Assembly of the Receiver

Let us begin with the chassis, which consists of an inverted tray measuring 10 x 20 x 2 inches; it is made of 3/32-inch aluminum, bent over on all edges.

In the specifications which follow, both in the figures and in the text, dimensions for holes for audio transformers and chokes are not included; since it is felt that most constructors will prefer to use their own transformers. The placement of the transformers, in the factory model, however, is shown in the photograph reproduced here.

The shield can for the oscillator and first detector tubes and tuning condensers is made of 1/16-in. aluminum and measures 4 7/8 x 5 1/5 x 8 1/2 inches; it is provided with a cover.

The shield can for the inductances of the oscillator and first detector circuits is made of 12-ounce copper and measures 2 x 3 7/16 x 2 1/2 inches deep; into its rectangular opening fits a bakelite plate 2 x 3 7/16 x 1/4-inch thick, which is drilled for five General Radio pin-plugs (four of these being spaced 9/16-in., and the last one, to "polarize" the construction, 1 in.).

Since both oscillator and detector coils are wound on the same tube forms, the

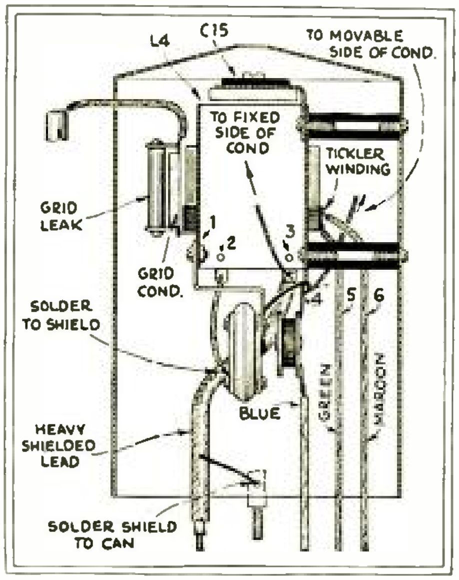


Fig. 3

Details of L4; the tickler winding, 5-6, does not appear on coils L2 and L3. The grid lead is shielded.

coupling between them is rather high. It is therefore necessary to use a high intermediate frequency (1600 kc.) in order to prevent the detector from being blocked by the oscillator.

The specifications for the I.F. coils are given in Fig. 2; note that no two are alike. Care should be taken to wind exactly the specified number of turns in exactly the manner illustrated. It is not believed that any undue trouble will be experienced in the construction of these items; although, if you can buy them ready-made, this is preferable.

A detail illustration of one of the I.F. inductances, L4, serves to illustrate the general construction of all three I.F. transformers. (Fig. 3).

It will be noticed also that the filtering system for each stage is included in all but the first radio-frequency coil. Screen-grid tubes are used for both first and second detectors. In Fig. 4 are given the specifications for the three plug-in coils; these should be made with extreme care, since upon them depends to a great extent the frequency coverage possible with this type of set. In the regular factory model, the shields for these coils are made of 12-ounce copper, suitably bent and seamed, and heavily coated with crystalline lacquer.

The top (over-all) cover is made of steel, .036-inch thick; it measures, inside, 6 3/4 x 10 1/4 x 20 1/8 inches long (added to which is a mounting flange 1/4-inch wide). Holes are drilled in one end for the antenna and ground binding posts. It is heavily covered with black crystalline lacquer; dull black lacquer is used on the inside of the over-all shield, which is bent to shape. All wiring should be made as direct as possible.

Adjustment and Operation

Now a few words as to the adjustment of the receiver; turn all the I.F. adjusting condensers (which can be reached through the top of the I.F. transformer cans) all the way down. Put the tubes into their respective sockets. If everything has been wired correctly, it will be found that, on placing the hand on the first I.F. screen-grid tube and bringing the volume and regeneration controls on, loud "static" will be heard; it may be that a regular long-wave broadcast station will also be heard. Turn all the intermediate condensers out, about half a turn each, and plug in the largest coil. On tuning the main controls over their entire range, a point where a station is heard rather weakly will probably be reached. With the station tuned to the loudest possible volume, adjust all the intermediate condensers with a bakelite screw-driver until the station is as loud as you can get it. (Do not have the regeneration control all the way on; but leave it at some point below oscillation.) Tune very carefully, as the intermediate tunes sharply. If you have had any experience in tuning such receivers, you will find that you will be able to make a rather good job of lining up the intermediates, by merely adjusting for the static level.

The adjustment of the regeneration control should be left at some point which gives maximum response for one station; and

(Continued on page 691)

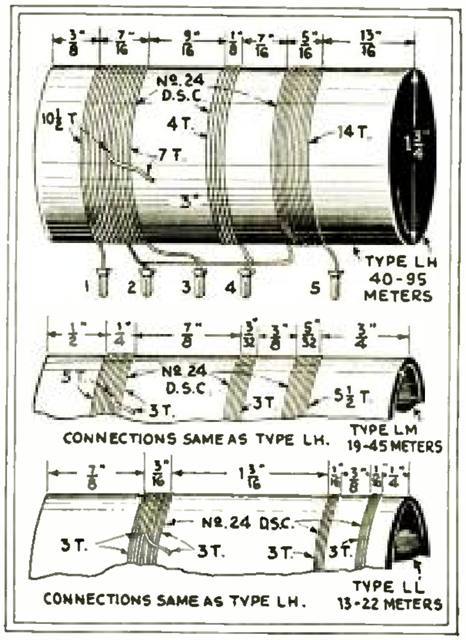


Fig. 4

Winding data for the short-wave oscillator and first-detector inductances, that are combined in one shielded coil unit, L1; this plugs into a front-of-panel receptacle, as shown in Fig. A.

Operating a "Radiola 28" with Two-Volt Tubes

Slight alterations are necessary to convert these favorite old supers to use modern tubes, and give improved output, inexpensively

By F. L. SPRAYBERRY

THE practicability of operating the older series of Radiola superheterodynes with two-volt tubes has been debated among radio men for some time. It was contended that the mutual conductance of the '30 and '31 type tubes is so high that it would be impossible to use these tubes, because of circuit oscillation and distorted audio output. The question then arose, whether these faults could be overcome? With these two requirements in mind—the control of oscillation and a proper output tube—the writer started experimenting with, first, a Radiola "28"; second, a "25"; and, last, an "AR-812."

Initial Experiments

Upon examining the battery cable of the "28," it was decided to remove some of the leads (intended for six dry-cells in series-parallel); retaining only two leads for the filament circuit operating from a 6-volt storage "A" battery.

Seven of the new '30 type general purpose 2-volt tubes and a type '31 2-volt power tube were inserted in the sockets after proper connections to the batteries. Although only the loop was used as a pickup, tremendous volume was obtained. Of course, the power tube became overloaded; and it could not be determined whether the greater part of the distortion was due to oscillation of the intermediate amplifier or to the power tube's overloading.

It was clear that a power tube of greater capacity must be used. Upon examination of tube characteristics, it was found that, with a plate potential of 135 volts, a single '71A or two '32's would give the greatest output; a '71A gives 370 undistorted milliwatts and two '31's 300 undistorted milliwatts. A '71A was first tried, and most of the distortion disappeared; however, there were traces of oscillation when the volume control was advanced.

This presented a real problem though, of course, it could be overcome in several ways by the use of laboratory equipment. But it was realized that, whatever was done must be simple, if thousands of owners of "28's" who have not proper equipment are to be enabled to make the adjustment with little trouble.

Suppressing Circuit Oscillation

It was finally decided to use a series resistor, or grid suppressor (R1, Fig. 1) in the grid circuit of one of the intermediate tubes. This was done, and with gratifying results. After reconnecting the set, it was found that, with both volume control and filament control rheostats turned on full, there was not even a trace of oscillation. Next, it was decided to try two '31-type tubes in the output stage, connecting them in parallel; (grid to grid, plate to plate, and filament to filament); in order to obviate extra wiring, a Lynch "Tubadapta" was used. No reduction in the output was noticed (in fact, none was expected); for the two '31s give approximately the same output as one '71A—providing the same plate voltage is used.

The exact procedure for changing the Radiola "28" will now be given; these instructions should be followed as closely as possible—especially if the constructor has not had previous experience with these receivers.

The chassis of the "28" is first freed from the cabinet, by removing four large nuts from the under side of the cabinet housing the chassis. These are between the battery compartment and the chassis cabinet; they are not the nuts which hold the chassis cabinet to the battery compartment.

Remove the four screws and pull the chassis forward; then take a small screwdriver and loosen the clamp which hold the battery cable to the cabinet. Loosen the two long screws that hold two fixed condensers to the cabinet; then lift up the clamp and pull the battery cable up through the large hole in the cabinet. The chassis and battery cable, with its attached bypass condensers, can now be lifted free of the cabinet.

Remove the wooden slanting panel by unscrewing four wood-screws at the right end, and three at the left, underneath the frame. The panel can now be lifted off the chassis; its removal will give plenty of room to work.

The next thing to do is to straighten out the battery cable; the first step being to cut off all "A+" or positive leads except the yellow-with-red-tracer; and remove all "A—" negative leads except the black-with-yellow-tracer. Next, cut apart all leads that are fastened together; so that you have a maroon, a red-and-maroon, a red, a black-with red-tracer, and a green wire marked "C+." Cut this green lead off short, and tape it up.

The cable will now be as follows: yellow-

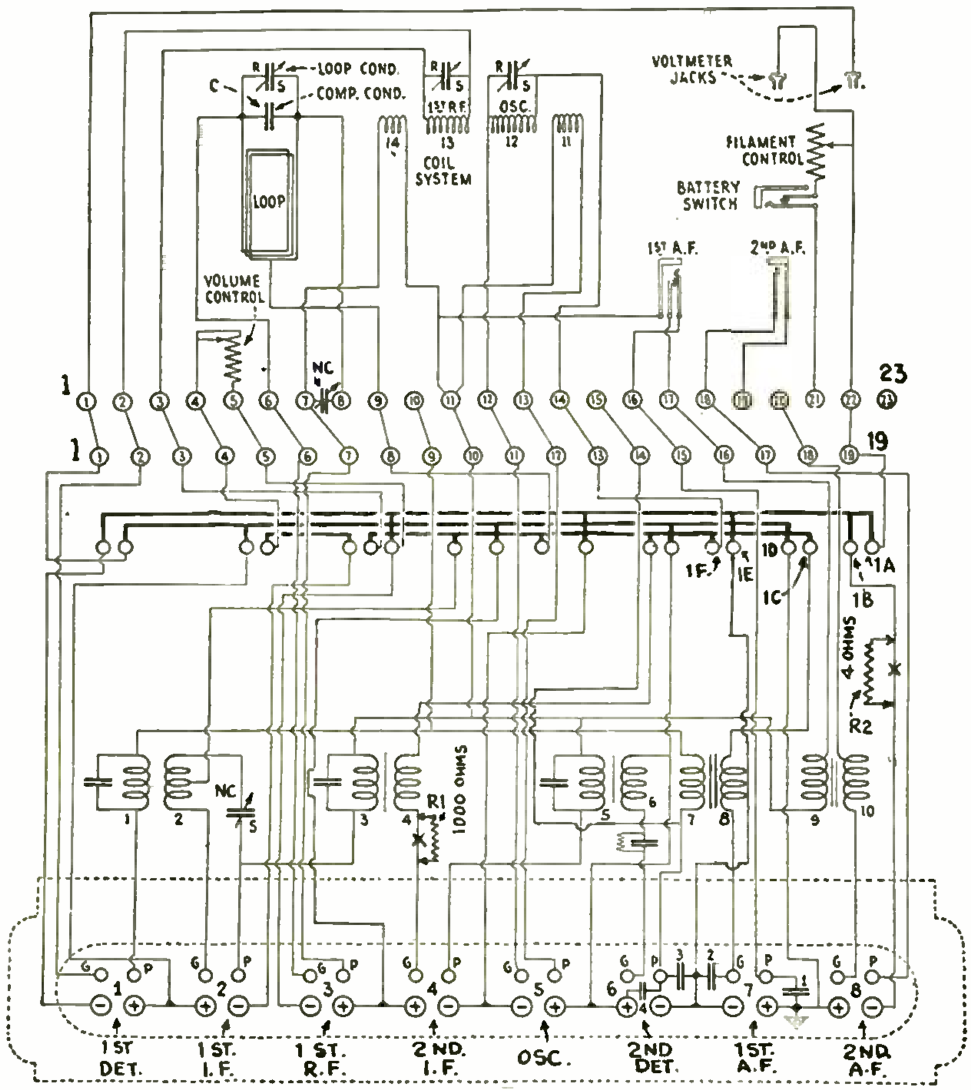


Fig. 1

Schematic circuit of the "Radiola 28" (see also page 653), showing needed changes. A "Type 934" Connectorald may be used externally, instead of opening the catacomb to introduce R1. The numbers of the "whisker" connections, 1-19, are stamped on the under side of the bakelite panel.

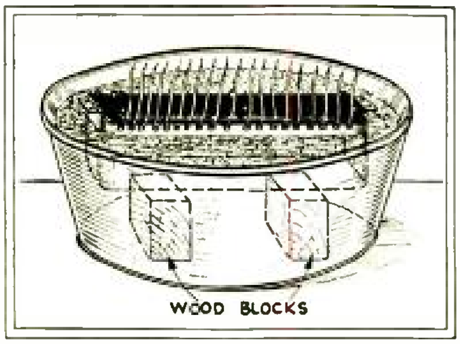


Fig. 2

To remove the assembly from the catacomb, this is placed in hot water until the wax is sufficiently softened (not melted).

with-red-tracer, "A+B—C+"; black-with-yellow-tracer, "A—"; green-and-black, "C—4.5"; black-with-blue-tracer, power tube "C—"; maroon, "B+45"; red-and-maroon, "B+90"; red, "B+135; black-with-red-tracer, "B—" connection for fixed condensers attached to battery cable. (The technician may prefer to keep the original Radiola battery cable intact, substituting therefor a standard 7- or 8-conductor cable.—*Editor.*)

Removing Catacomb

Now remove the catacomb cover, by taking out two machine-screws at each end and three on each side. With a punch, knock out the leaden seals at each end; the catacomb cover can now be removed, revealing a bakelite panel (P, Fig. 3). Pull catacomb unit over towards the rear so that it is upside down.

Remove the battery cable's connecting strip, to get it out of your way; this is done by loosening the screws holding it to the terminal strip. There are seven of these screws: three at the left end, three at about the center, and one at the extreme right.

Next, turn the catacomb unit over, set it in place, and unsolder the nineteen wires (called "whiskers,") connecting the catacomb to the terminal strip.

There are twenty-three connecting lugs on the terminal strip, to which the 19 whiskers from the catacomb connect as numbered, respectively, in Fig. 1. These leads are held in place on the catacomb by means of holes through the bakelite panel; do not remove them from the holes. If they are kept in that order, there will not be any difficulty in getting them resoldered properly.

Remove the 3-bus filament connecting strip, by loosening the 19 holding screws.

The next is the most difficult; the catacomb unit must be removed from its container. This is done by placing it in a pan of boiling water for about five minutes. Do not allow the water to cover the unit more than half-way (See Fig. 2.) Watch it carefully and do not allow it to stay in the water longer than is necessary. After it has been in the water about two or three minutes, insert a screwdriver under the bakelite panel and lift upward; if the unit slips, try the other end the same way. If both ends slip upward, have someone hold the catacomb unit for you (with a cloth at each end, to protect the hands) and pull upward until the unit is free of the container. Turn it over, with the bakelite panel down, and let the beeswax harden.

Then examine the unit; on one side, at the rear, you may find a strip of insulating material, about 1/4-inch wide, held in place by the screws which secure the unit to the panel; it is woven under and over these screws. Work it loose with a screwdriver, and pull it free of the unit with a small pair of pliers; this will expose thin copper strips making connection to the socket terminals.

We are interested in the two strips making contact to the fourth socket; particularly the grid terminal; the plate terminal merely helping to identify the fourth socket. Sixteen of these copper strips are exposed; we are interested in the 7th from socket No. 1, which is the grid terminal of the second intermediate tube. Reference to Fig. 1 will allow you to identify it; be sure of it before proceeding further. After you are certain you have identified the grid terminal of the second intermediate tube, take

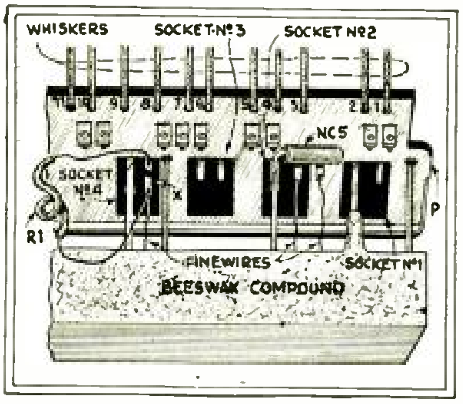


Fig. 5

Introduce R1 between socket No. 4 and grid lead. NC5 will usually require no attention. The assembly must be handled with great care, to break no connections. (Caution: To avoid injury to the eyes, remove the whiskers carefully, to prevent the solder's spattering.)

a small pair of scissors or snips and cut the thin copper strip.

Now check, with a continuity meter between grid of tube and copper strip, to see if you are right. If you are right, solder two 2-inch wires to the two pieces of copper strip, then a 1,000-ohm resistor (R1, Fig. 1) to the two wires connected to the copper strips. Be sure the resistor lies flat, and insulate it from any possibility of contact with the container when the unit is replaced in it. This can be done by wrapping the resistor with insulating paper; or scraping some of the beeswax from the bottom of the container, heating it and pouring over the resistor until this is covered.

Tone and Volume Control

A tone control can be used to advantage on this receiver; it may be one of the types described in the article, "Tone Controls in Commercial Radio Sets," in the January and February, 1930 issues of RADIO-CRAFT. The type recommended by the writer is shown in Fig. 1 of the January 1930 issue, and consists of a variable resistor, R1, connected from the grid of the tube, to "C—" the can, or the filament circuit.

This is easily applied to the "Radiola 28" and it will act not only as a tone control, but also as a volume control.

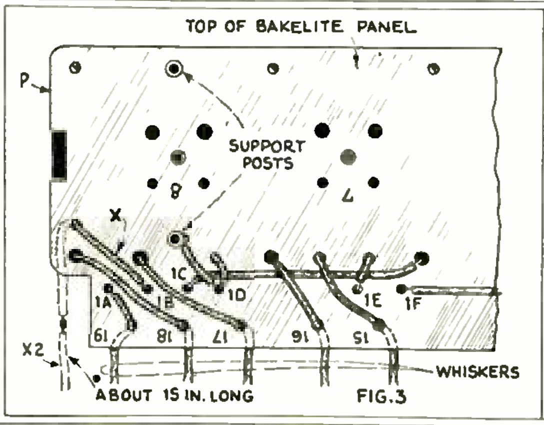
Since this receiver will, in many cases be operated with an external power amplifier connected to the first audio-frequency jack, it is desirable to connect the tone control across the grid circuit of the first audio tube. It will be just as effective here as if it were used in the last audio stage; and you will find that it does not give that peculiar "barrel" distortion effect, as do so many forms of tone control.

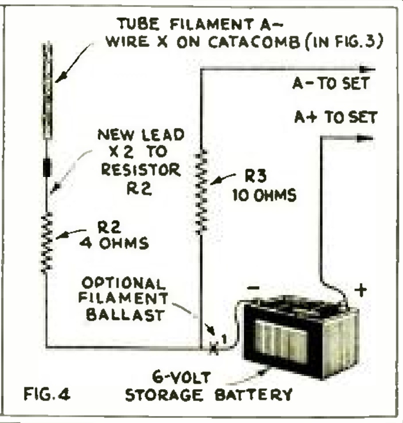
After making connections to the grid circuit of tube No. 4, by inserting the 1,000-ohm resistor in the grid circuit, solder a wire to the grid connection of socket No. 7. The terminals of the latter are in the same relative position as those of socket No. 4; in case of doubt, you can, of course, check between the thin copper strips and the grid terminal.

The wire soldered to the grid terminal of socket No. 7 should be approximately 15 to 16 inches long; and a hole just large enough to accommodate it, should be drilled in the bakelite panel of the catacomb unit. The wire is then drawn up through the bakelite panel and pulled tight.

To complete the tone control, mount a variable resistor at a convenient point on the panel. The writer used a 0-50,000 ohm "Clarostat" for this purpose; although any good grade of resistance unit, with a value between 0 and 500,000 ohms, will serve. The other side of the variable resistor is connected to any convenient point of the

(*Continued on page 688*)





Left, wiring below the aluminum plate, which covers the bakelite panel. The filament lead X is to be taken from post 1B and lengthened as at X2. Right, the schematic circuit for operation from a 6-volt storage battery, with 9 tubes.

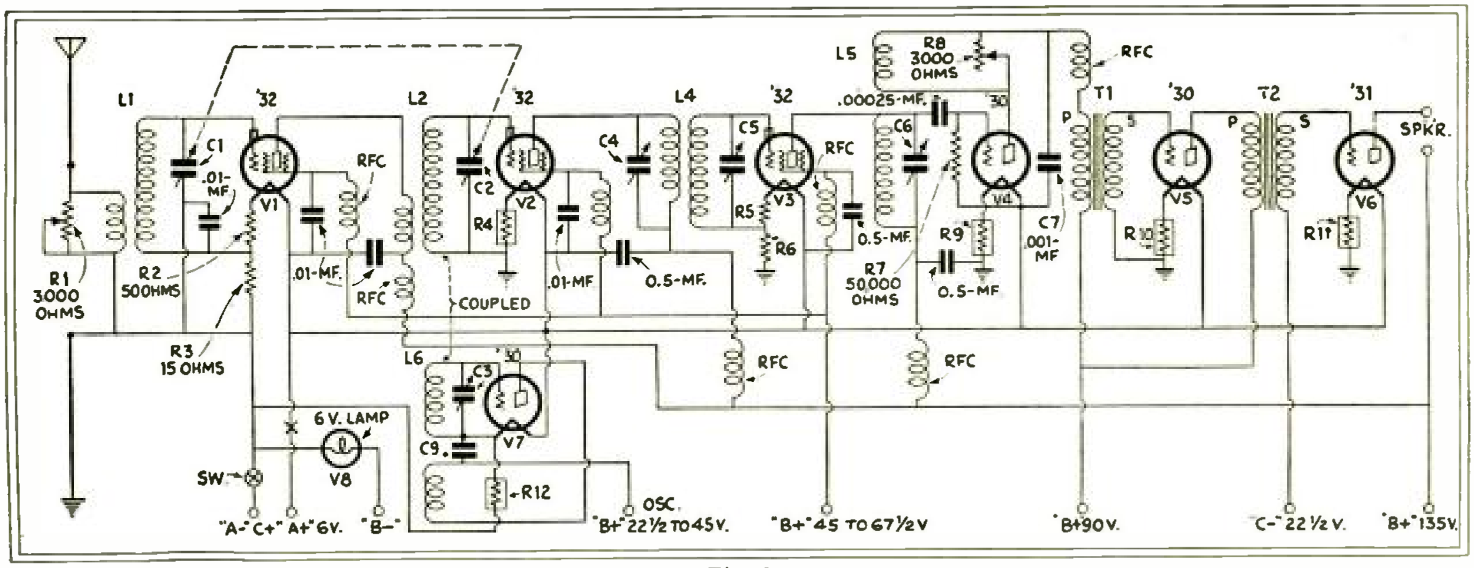


Fig. 1

This circuit adds two stages of screen-grid R.F. amplification to the intermediate amplifier of the "Roll-Your-Own"; a different frequency-changer is employed. Connections for a 6-volt battery are shown.

A Home-Made Super for 2-Volt Tubes

By W. E. SMITH

THE writer had originally in mind to adapt the "Roll-Your-Own" super (described in the November, 1930, and March, 1931, issues of RADIO-CRAFT) to the new two-volt tubes, as he promised in his last article; but, after many experiments, he decided to dismantle the set and rebuild it. The results thus obtained have been very gratifying.

Reception is limited by the noise level only, which depends upon location. Stations have been tuned in from coast to coast, including two in Mexico and one in Cuba. In fact, it was possible to get California nearly every night during the past winter, through the blast of about twenty-five radio stations in this vicinity (*Oak Forest, Ill., a suburb of Chicago*); high-power stations like WLW, KMOX, WHAS and WOC are received at midday on the loud speaker.

Rearrangement of Components

The schematic circuit (Fig. 1) differs somewhat from that shown in the November issue; after quite a few experiments with the dynatron oscillator, it was decided to use an inductively-coupled oscillator of the usual type, with a '30 tube. As will be seen from the baseboard layout (Fig. 2), the arrangement of the receiver has been changed considerably. The oscillator coil L6 and the modulator coil L2 are placed in one compartment shield, 3½ x 5 x 5 inches, one inch apart, with their axes parallel. It may be stated here that the degree of coupling has much to do with the loudness of signals obtained. With a primary of 35 turns, about 22½ volts on the plate of the oscillator is sufficient; 45 volts will increase signal strength, but may not be desirable.

The first R.F. tube V1, the antenna coil L1 and its tuning condenser C1 are contained in one shield, measuring 3½ x 8 x 6 inches; it is essential that this stage, as well as the modulator stage V2, be well isolated, if cross-talk is to be avoided. V1 is a '32 type screen-grid tube, with 135 volts on the plate and 67½ on the screen-grid; the latter electrode is fed through an R.F. choke and by-passed to ground by an .01-mf. condenser. A bias of 3 volts for the control-grid is obtained through the drop in the filament resistor, if a storage battery is used. Otherwise, biasing batteries are used.

The modulator V2 is also a '32, with similar plate and screen-grid voltages, but a control-grid bias of 4 volts.

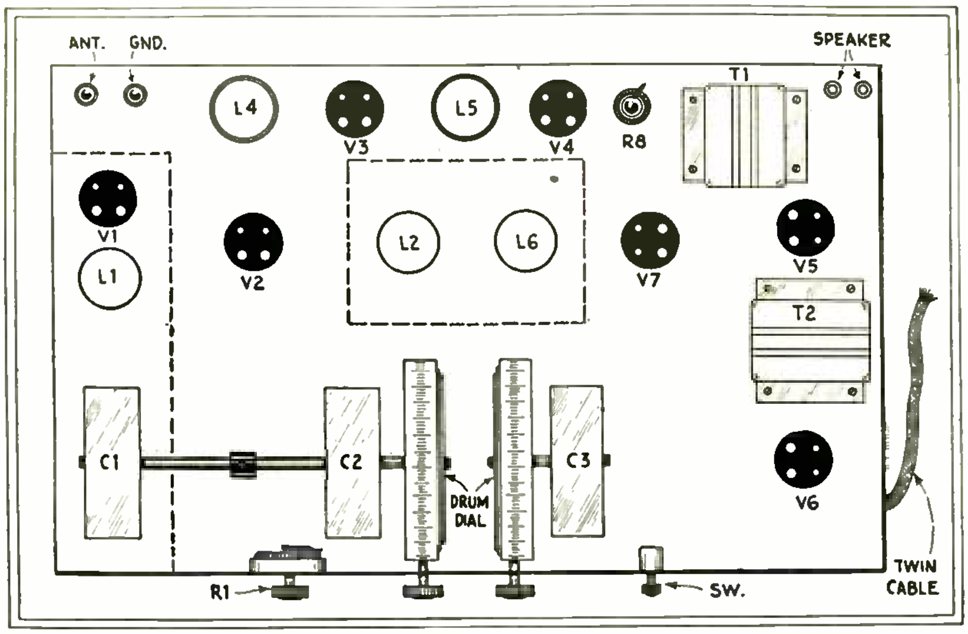


Fig. 2

The layout used by Mr. Smith; the oscillator coupling is obtained between the fields of the two coils L2 and L6. The tubes V2, V3 and V7 have individual shields, as well as the coils L4 and L5.

Details of Coils

The antenna coil L1 has a secondary of 100 turns of No. 30 enamelled copper wire, space-wound on a 1⅜ x 2-inch form, with 12 turns of the same wire, at the low-potential end, for a primary; it is tuned by a .00035-mf. variable condenser.

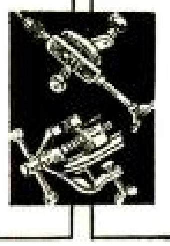
The modulator coil L2 has a secondary of 105 turns of the same wire, space-wound also, and tuned by a similar capacity; its primary is 50 turns of No. 35 enamelled, bunch-wound, as close to the low-potential end of the secondary as possible without touching. A slot for the purpose was made with a hacksaw and a small file.

The intermediate-frequency transformers and the audio end remain as described in the previous articles mentioned above. The second detector V4 has a .00025-mf. grid condenser C8 with a leak R7 of 50,000 ohms resistance. The bypass condenser C7 in the plate circuit is a .001-mf. capacity, and the tickler is shunted by a 3,000-ohm variable resistor R8, of the same value as the volume control R1 in the antenna circuit.

The output tube V6 is a type '31, which should feed into a high impedance load, such as a magnetic or inductor-dynamic reproducer. It was thought unnecessary to include a tone control; as the writer believes

(*Continued on page 693*)

RADIO CRAFT KINKS



REPAIRING SCREEN-GRID TUBES

By Frank C. Atkinson

DON'T throw away a screen-grid tube if the control-grid tip should pull off the top, leaving only the lead sticking up. Clean out the cap, and around the top of the bulb; clean the end of the control-grid wire, and solder to it a short length of fine wire.

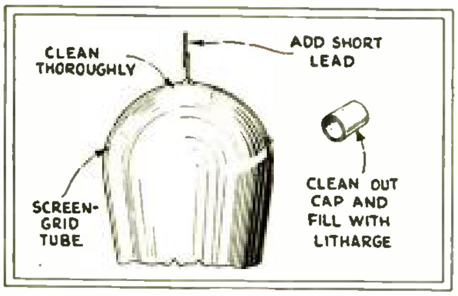


Fig. 1

The loosened cap of a screen-grid tube may be cemented back into place, quite satisfactorily, in the manner shown.

Then, procure from a paint store a small amount of litharge (yellow oxide of lead) and a small quantity of glycerine. Mix a small quantity of the litharge into the glycerine, until a stiff paste is formed; pack the grid cap with this, and run the control-grid lead of the tube through the paste and out from the small hole in the cap. Press the cap down upon the glass, clean away the excess paste; and allow this cement to set for twenty-four hours. Then clean the cap, and solder the end of the wire to it; and the job is finished. You will find the tube as good and as strong as new; I have used this method for some time and it has never failed me.

GANGING AN OLD SET

By E. E. Meeker

MULTI-DIAL receivers may be converted to single-dial control in the manner shown. Four hard-rubber discs (cut from an old panel) are turned $1\frac{1}{4}$ inches in diameter, with a 15/64-inch hole in the center, so that they may be driven tightly upon the $\frac{1}{4}$-inch shafts of the condensers. Then two discs are fitted to the central condenser's shaft; and each is fastened to a disc, on one of the outside condensers, by a strong fish line, which will grip the discs where they have been grooved in the centers of their rims. The condensers may then be aligned, by slipping the belts until a good adjustment is obtained.

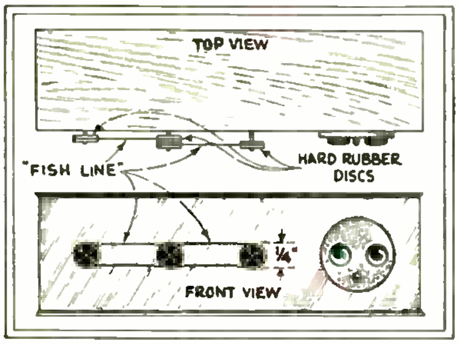


Fig. 2

An old, three-dial set may be converted to single control in this manner. The dial is then replaced on the center shaft.

AN IMPROVED VOLUME CONTROL

By Russell L. Woolley

AUTOMOTIVE radio receivers have, usually, a 50,000-ohm potentiometer, shunted across the $67\frac{1}{2}$-volt section of the "B" supply, to vary the screen-grid voltage. This is a good method of volume control; but the useful range is limited to about half the arc of the slider's movement. The result is that the change in volume from "soft" to "loud" is very abrupt.

This method of volume control may be improved by using a fixed resistor of, say, 25,000 ohms value, connected in series with a variable potentiometer of 25,000 ohms; the useful range is thereby spread over the entire arc.

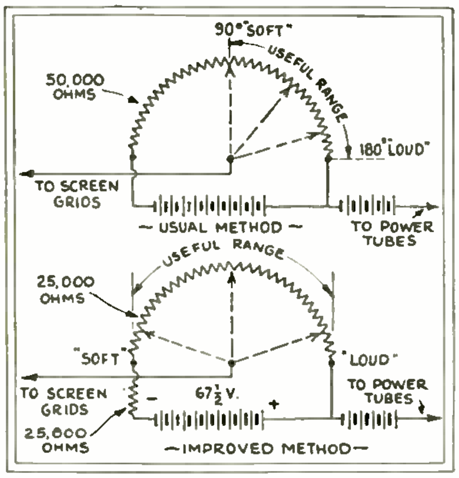


Fig. 3

Just as tuning is spread by adding another condenser, so volume control may be made less critical by a series fixed resistor.

These particular values do not, of course, hold true in every case; conditions, such as the sensitivity of the receiving set, the field strength of local stations, the number of screen-grid R.F. stages, and the screen-grid voltage, determine the value of the potentiometer. The total resistance, however, should be 50,000 ohms.

Inasmuch as a volume control of this type is shunted directly across the "B" supply, a switch should be included, to disconnect it from one terminal of the "B" battery when it is not being used; for otherwise it wastes current.

KEEPING THE IRON CLEAN

By Luther C. Welden

KEEPING the soldering iron clean is half the job of doing a solder job; so it is a good idea to keep two handy accessories on the work bench for this purpose.

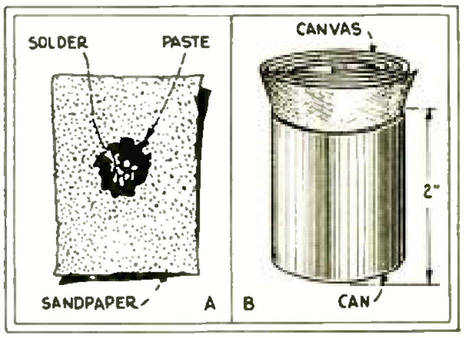


Fig. 4

The two accessories shown make it more convenient to do a good job of soldering.

First, a small sheet of rather fine-grade sandpaper; on which flow a small bit of resin or solder paste and a small amount of solder. Next, procure a small round tin can about $2\frac{1}{2}$ inches in diameter and 2 inches deep. Take a strip of canvas $2\frac{1}{4}$ inches wide, or $\frac{1}{4}$-inch wider than the can is deep. Roll the canvas in a tight roll until it will fit snugly into the can, with about $\frac{1}{4}$-inch extending above the edge; "fuzz" this outer edge.

When the iron is hot clean the tip by rubbing on the sandpaper; it will be well "tinned" at the same time, because of the paste and solder on the paper. Then clean off the surplus paste by passing it over the canvas pad.

An iron holder made of a strip of tin may be fastened to the can.

PUNCH AND JIG FOR METAL WORK

By Eugene Douglass

EVERY set-builder and experimenter knows of the difficulty encountered in drilling or cutting holes of large diameter

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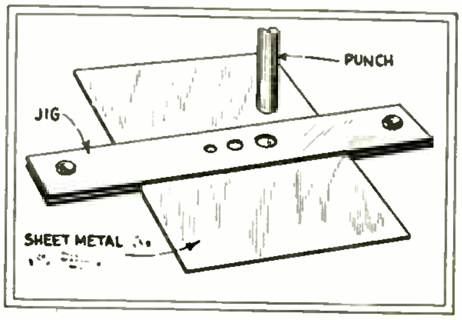


Fig. 5

By means of a set of jigs and punches of this kind, large, clean holes may be punched in fairly stout sheet metal.

The Hows and Whys of the Push-Pull Circuit

(PART IV)

By EDGAR MESSING

THIS discussion of the eccentricities of the push-pull circuit has already developed that unmatched tubes are not such a bugaboo as the public has been led to believe. The next possible cause of unbalance is an unequally-tapped input transformer.

Before going into this discussion it may be pertinent to know what center taps are. The audio transformer, (which the power engineer regards with infinite scorn for its qualities as a transformer) is usually of what is called the "shell" type, illustrated in Fig. 13. The windings are placed around the middle leg, as shown, with the primary nearest the core and the secondary right over it. If the secondary is to be center-tapped, this tap is made at the center of the winding as determined by the number of turns.

This means that the second half of the secondary, while comprising one-half of the number of turns, will be longer in total feet of wire than the first. It will, therefore, have a higher ohmic resistance. More important yet, because it is further from the primary, some of the primary flux will not reach all of the turns; since it is this flux which produces the output voltage, the second half of the secondary will produce a lower voltage than its companion half. We, therefore, have an unbalanced transformer, so far as the voltages and impedances of the secondary halves are concerned.

This will mean that one tube will get a greater part of the voltage across the secondary of the input coupling device. For the sake of convenience, suppose the position of the center tap to be such that *a-c* (Fig. 1) comprises more effective turns than *b-c;* and therefore tube V1 has a greater potential on its grid than tube V2. Assume further that the tubes have the same mutual conductance, that the output transformer is correctly center-tapped; and that the polarities on each grid are negative on V1 and positive on V2. Since we have assumed that the tubes amplify equally, V1, because it has the greater voltage on its grid, will produce the greater voltage in its plate circuit; just as in the case of a higher mutual conductance, discussed in the previous installment (March, 1931, issue, page 548). As before, it will be found that the effect of unbalanced voltages in the plate circuit is very neatly taken care of by the stronger tube; which graciously "degenerates" when required and sociably regenerates when necessary. The net effect, again, is to decrease the grid voltage on V1 and increase it on V2. Thus the inequality is again overcome. The push-pull stage has again proven itself; for we have shown that it compensates automatically for the unequally-tapped input transformer.

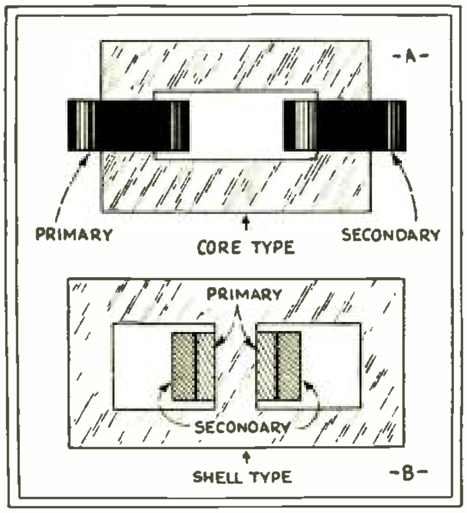


Fig. 13
Two types of transformer, the second more common. The outer part of a winding uses more wire for the same number of turns.

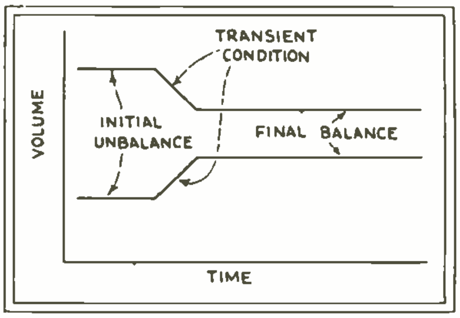


Fig. 14
The result of unbalanced halves of the push-pull circuit. After a very short time, in which re- and de-generative actions occur, normalcy is reached.

These last points, concerning the relative indifference of the circuit to unmatched tubes and unequally-tapped input transformers are interesting, in view of the rather strongly-vested belief that the circuit must be either exactly balanced or worthless. On one occasion, a group of engineers was gathered to discuss the design of a public-address system when, of course, push-pull was decided upon for at least two stages—"and the tubes must be exactly matched," said one chap wisely, at which there was a sage nodding of heads. If memory is at all correct the writer was that ignoramus who had to open his mouth. And it took a very simple study to determine that tubes need not be matched exactly, *if the grid-biasing resistor is left unbypassed.*

But, the argument went on, this very balancing effect, in tending to equalize the output voltages, operates to limit the current through the resistor, and the balancing effect ceases. Then, as it begins to stop, the voltages begin to unbalance again and the cycle must be repeated. This condition, as in alternating-current circuit phenomena, is but transient. The oscillations, whose period is determined by the characteristics of the circuit in which the current flows, die down; leaving an effective balance-point where there is just sufficient degeneration and regeneration to allow enough current through the resistor to keep up the effect (Fig. 14). The result is that the tubes are considerably less unbalanced than their different mutual conductances would indicate.

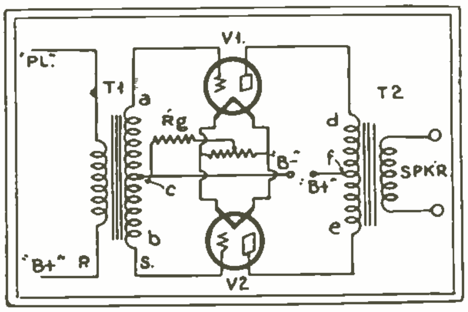


Fig. 1
The now familiar pushpull circuit, with its biasing resistor Rg un-bypassed, for reasons which are explained in the text.

The next point, after admitting they are unbalanced, is to learn what effect the unbalance has on the output. If we have a good output transformer (so that all the current through the primary produces voltage in the secondary and none is wasted to cause trouble) than, even though half of the transformer (the side nearest the tube with the highest mutual conductance) carries more current, the secondary does not recognize this fact and does its duty as it sees it. It must be kept in mind that these situations of unbalance have been examined with respect to the effect on the *fundamental* or undistorted component of the signal. What happens to the distortion harmonics will be seen later.

The condition we are next to discuss is the third point of possible unbalance—an off-center-tapped *output* transformer.

In Fig. 11, V1 and V2 represent the instantaneous fundamental voltages produced across the load by the tubes of the push-pull circuit. For the sake of avoiding needless complexities we shall assume that the tubes have equal mutual conductances and that the signal voltages on their grids are equal. Rg is the grid biasing resistor, which is connected to the middle of the output resistor through the "B" supply. R1 and R2 are the two halves of the output transformer and, for the example we are considering, we will have the former greater.

V2, we may say, produces two currents; one which passes through Rg and R2 and one through V1, R2 and R1. V1 likewise produces two currents, one traversing R1 and Rg, the other, R1, R2 and V2. The magnitude of the current produced through Rg by V1 is determined by the sum of the impedances Rg and R1. Similarly, the current produced through Rg by V1 is governed by the impedances Rg and R2. Since R2 is less than R1, V2 needs overcome a smaller resistance than V1 and, therefore, V2 sends through the middle arm a greater current than the opposing current produced by V1. The result is that there is a net current through the middle arm, from *a* to *b*; which tends to make the ground side of Rg and, therefore, the grid of each tube more negative.

Since the voltage on the grid of V1 is made more negative, and that of V2 less positive, the former is being regenerated and the latter is being degenerated. This means that the voltage across the load represented in Fig. 11 at V1 will be a little larger and that represented at V2 will be smaller than under any condition wherein Rg is bypassed and no degenerative or regenerative action allowed to take place. The net effect will be that the currents through Rg will oppose more exactly; and it would seem that the two currents will so manipulate themselves as to reach a point of equilibrium with a certain amount of regeneration and degeneration existing.

So it seems that, no matter what we do to the push-pull circuit—whether we unbalance the tubes, the input transformer or the output transformer—the circuit earnestly tries to make up for our ill treatment.

(Our readers will note that engineers have a fondness for push-pull ahead of the power stage where quality is the first requirement. See below.—*Editor.*)

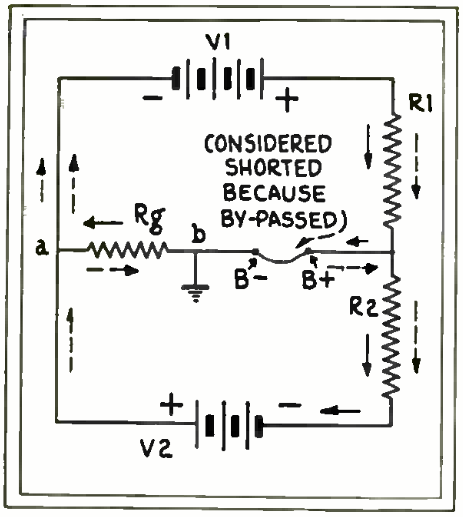


Fig. 11

This equivalent circuit, reprinted from a preceding installment, shows how the push-pull circuit automatically corrects unbalance in either input or output.

A Perfect-Quality Demonstration Receiver — Part II

In the preceding (April) issue of Radio-Craft, appeared a description of the radio-frequency and detector stages of an elaborate receiver designed especially for the Science Museum of South Kensington, England, in which fidelity of reproduction, with large volume of output, was the desideratum. The full circuit was given in that installment; but an abridged version of it, omitting the power supply and the numerous bypasses, is given here in Fig. 3.

Audio Stage Connections

A portion of the amplified A.F. output of V3A is fed, through a potentiometer control, to the grid of V3B. This potential, after amplification by V3B, is in reverse phase to the output of V3A. The result is that the signal output passes similarly through the next two pairs of amplifiers, until it is applied in the output transformer OT, to produce in the output circuit of high-power tubes V5A and V5B, the desirable effects of push-pull operation. (This method of shifting phase in a resistance-coupled amplifier, through the use of a phase-shifting tube, such as V3B, was described at considerable length in the "Cooperative Laboratory" section of the July, 1930, issue of Radio-Craft).

The plate circuit conditions of tubes V4A and V4B may also be "monitored" by observation of the milliammeters 1A, which are kept continuously in the plate circuits of these tubes; the current being determined by the settings of the potentiometers R3. (See Fig. 1, in April Radio-Craft.)

Milliammeters 2A indicate the plate currents passed by the high-powered output tubes (which have negative grid biases of 150 volts and plate potentials of 1,000 volts), as determined by the settings of the potentiometer R4. The meters M indicate any flow of grid current.

With the output transformer switches in the position A2, the reproducer is out of circuit; when it is switched to position A1, other dynamic reproducers might be put into use; in position A3, magnetic reproducers or phones might be put into use.

It will be observed that A. F. transformers, with their peculiar response characteristics, have been avoided. In order, therefore, to obtain push-pull amplification, "paraphasing" has been employed. This requires very careful adjustment.

In fact, reports in the British radio press indicate that, faithful as the receiver and its reproducer are, the latter is too powerful for its hall and, therefore, it might be desirable to substitute smaller units placed at proper intervals. Perfection in reproduction is indeed elusive.

Elaborate Power Supply

One power transformer, PT1, supplies only the filament potentials for the power-audio unit, each tube having its individual current-supply winding. Another, PT2, delivers high voltages to two rectifier systems, V7, and V6A-V6B.

The very-high-voltage output of V6A-V6B is applied to an impedance-type filter system and through the primary of the output transformer, to the plates of the high-power output tubes and, through another impedance-type filter system, and suitable filter and coupling resistors, to the preceding audio tubes, V4A and V4B. The voltmeter 2V indicates the output potential of this unit.

The moderately high-voltage output of V7 is applied, through another impedance-type filter system, to the "B" voltage terminals 17, 18, 19, 20 and 21. The voltmeter 1V indicates the total output of this unit.

One of the most interesting parts of the circuit is found in the arrangement of the power transformer PT3 (see Fig. 2); its secondary S3B delivers an A.C. potential of 10 to 14 volts. This is rectified, reduced to the correct value for the field winding of the dynamic reproducer, as indicated on the voltmeter V3; and any residual A.C. is filtered by a 2,000-mf. condenser. A somewhat similar arrangement involving, however, more complete filtration, is employed in connection with the output of the 6-volt secondary S4B; the rectified A.C. output of this winding is reduced to the correct value, as determined by voltmeter 4V, and becomes the hum-free "A" supply for the detector tubes V2A and V2B.

It will be observed that the light-line potential is approximately 230 volts. This is perhaps the most common value in England, where this circuit was designed.

Characteristics of Tubes

The tubes, too, exhibit the touch of English engineering, and are not available in America. Perhaps the nearest comparisons

(*Continued on page 694*)

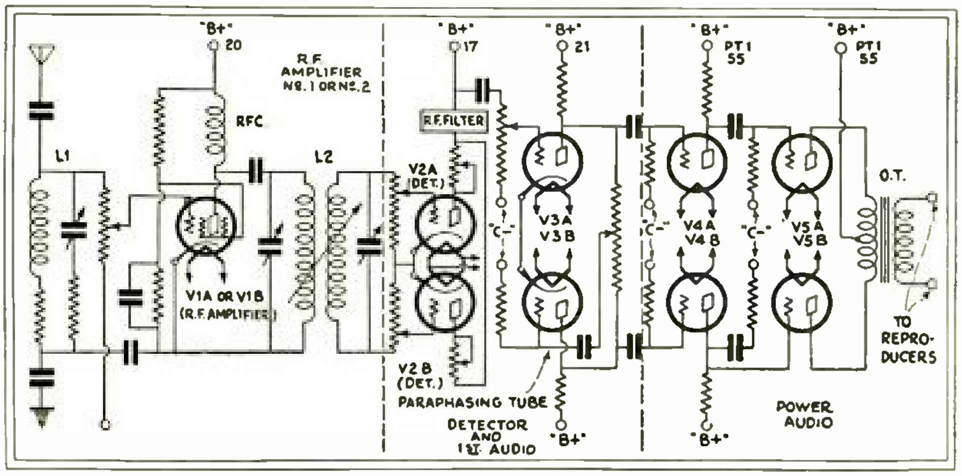


Fig. 3

The circuit of this elaborate receiver is here simplified to show the fundamental relations of its stages, omitting the elaborate filters and power supply. Note the connections of tubes V3A and V3B.

The Radio Craftsman's Own Page

What our experimental readers have found out for themselves

Letters concerning hookups asking further details, etc., should be addressed to the writers of these letters, directly

EMERGENCY SUBSTITUTION

Editor, RADIO-CRAFT:

During a call to a home where a Radiola "33" was out of service, because of two burnt-out '26s, I found no replacements on hand. There were, however, a good many '01As and, knowing that this tube works well far below its rated voltage, I plugged in two of them in the R.F. sockets. The clearness and volume was amazing, and there was none of the hum which I feared.

WILLIAM MULLEN,
513 Washington Street, Quincy, Mass.

(The substitution of tubes as different, in filament characteristics, from the original as the '01A from the '26 cannot be recommended; though the margin on which tubes will work is surprisingly high. It is presumable that the increased resistance in the circuit put a heavier voltage than the original 1.5 on the other '26s, as well as the '01As. In this matter, the action is the reverse of that resulting when a '24 is substituted for a '22, as described by Mr. Freed on page 521 of RADIO-CRAFT for March, 1931; the reversal of ratios between the resistance of the winding and the resistance of the external load changes the voltage across the latter. Still, as an emergency measure, such an experiment is often satisfactory to the user. One set owner, we are informed, replaced '26s with '01As as a temporary measure, and the latter worked satisfactorily for months.—*Editor.*)

S. W. ANTENNA COUPLING

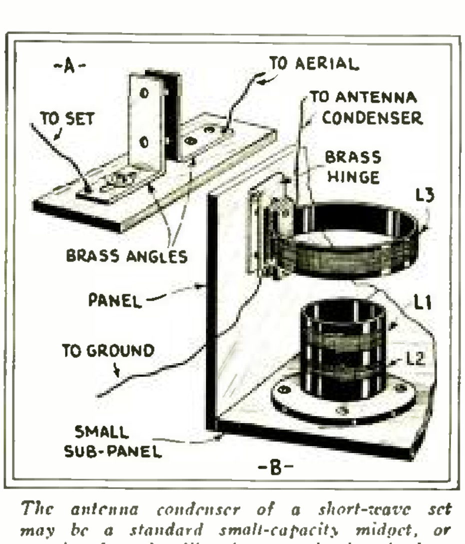
Editor, RADIO-CRAFT:

I have built the novel short-wave circuit, described by Mr. Cebik in the February issue of RADIO-CRAFT; it is the best I have yet seen and I believe that it has wonderful possibilities. I wish to thank Mr. Cebik for the hours which I have put in experimenting with this circuit. There is a little kink which I do not quite understand, this being the arrangement of the antenna coupler and condenser.

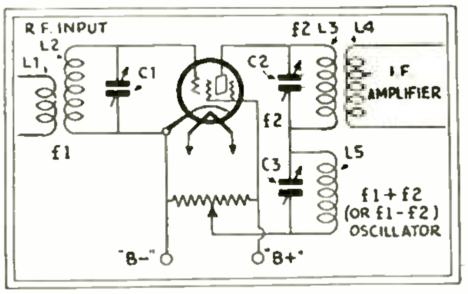
C. L. FOSTER,
36 West Vesper St., Akron, Ohio.

(The antenna condenser in a short-wave set, as pointed out in the article cited, may be left to the option of the constructor; a low-capacity midget may be used, for convenience in setting, or a semi-adjustable condenser of the neutralizing type. Many short-wave workers use simply two brass angles, one fixed and one movable on a small piece of insulating material [Fig. A]. The capacity required for best results depends on the constants of the antenna used; it is usually but a few micromicrofarads.

The primary coil used in this receiver, as explained in the text, was separate from the plug-in coils, and adjustably coupled. This type of coupling is familiar enough with horizontally-mounted coils; but may require a slightly-stiffer hinge for vertically inserted coils like those described [Fig. B]. All these matters, in an experimental set, are left to the constructor's preference and the arrangement of his receiver.—*Editor.*)



The antenna condenser of a short-wave set may be a standard small-capacity midget, or a pair of angles like those at A, though these are less easily adjusted. A method of coupling to the aerial with plug-in coils is shown at B.



Mr. VanLeuven suggests the use of a dynatron frequency-changer, as shown above, instead of a separate oscillator, for experiment in superheterodyne circuits.

A DYNATRON FREQUENCY-CHANGER

Editor, RADIO-CRAFT:

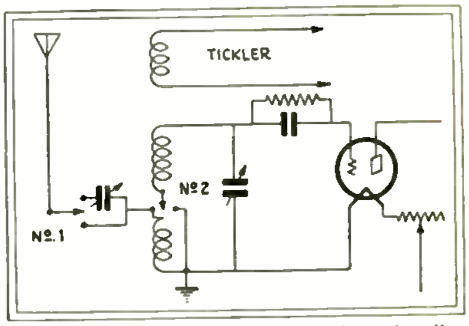
The article on the dynatron oscillator by Mr. Pollack suggests an idea that should prove valuable in radio and a step in the right direction.

Since the negative resistance of the dynatron cancels some of the positive effective resistance of the tuned circuit, and since the presence of the screen-grid in a '24 tube permits the adjustment necessary to bring the plate circuit to its proper characteristics for dynatron purposes, regardless of grid potential (up to a certain limit) why not use this principle in a superhet?

In the circuit suggested, the '24-type tube is used as a bias detector, with R.F. signal input; the circuit C1-L2 is tuned to the signal at the frequency F1; the series output impedance C2-L3 is tuned to the intermediate frequency F2. The other series impedance C3-L5 is oscillating at the frequency F1+F2 (or F1—F2).

Of course, care must be taken to prevent the output circuit from oscillating by making the L/CR ratio of the output as small as possible. Also, to assure oscillation in C3-L5, this ratio must be made as large as possible; that is, by a large inductance with the least amount of ohmic resistance and a capacity with the least maximum value that is necessary to cover the tuning band.

A. F. VAN LEUVEN, JR.,
461½ East 38th Street,
Los Angeles, Calif.



Mr. Pfeiffer cuts down the number of coils which it is necessary to plug in, with an S.P.D.T. switch at No. 2. An anti-capacity switch on the panel might be more convenient.

A WAVEBAND SWITCH

Editor, RADIO-CRAFT:

Believing that Craftsmen will be pleased by an idea that will cover a wide band of frequencies with fewer coils, while using a variable tickler to produce regeneration, I submit the arrangement shown. About one-third of the coil is utilized as the primary, and either the whole winding or two-thirds of it as the secondary, by throwing switch No. 2 to the desired position.

The aerial condenser, when put in circuit by switch No. 1, will be used mostly at the shorter wavelengths, or in congested locations; a midget variable is best for this use.

I use the switches on a piece of bakelite, about 1½x5 inches, placed inside the cabinet on the subpanel. This makes the leads as short as possible, and the changes can be made in a moment if the cabinet is of the usual type. I feel sure that experimenters will be pleased with results on the higher frequencies, if good tuning controls are used.

ED. PFEIFFER,
Harrison, Nebraska.

(The problem of all double range coils of the type shown, is to avoid the effect of the "dead end" of the coil on the inductance of the remainder, as well as the capacity of the switch. The arrangement shown should be more effective on short waves than a mere tap.—*Editor.*)

HIDDEN MELODIES

Editor, RADIO-CRAFT:

In connecting up a set lately, I found that music could be heard before the speaker or any other reproducer was connected,

(*Continued on page 695*)

"It is worth more than fifty dollars to any man"

Says Johnny, the Radio Man, *DUPO, ILLINOIS*

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Furnish sufficient information, and draw a careful diagram when needed, to explain your meaning; use only one side of the paper. *List each question.*

Those questions which are found to represent the greatest general interest will be published here, to the extent that space permits. At least five weeks must elapse between the receipt of a question and the appearance of its answer here.

Replies, magazines, etc., cannot be sent C. O. D.

Inquiries can be answered by mail only when accompanied by 25 cents (stamps) for each separate question. *Other inquiries should be marked "For Publication," to avoid misunderstanding.*

KENNEDY SET—TUBE TESTER—PHILCO 95

(116) Mr. E. T. Pauletto, Harbor Beach, Mich.

(Q.1) Referring to the diagram of the "Model 826B" Kennedy radio receiver, Data Sheet No. 36 (in the February, 1931 issue of RADIO-CRAFT), it would seem that the plate of the first A.F. tube, V5, receives the same negative potential as the grids of power tubes V6, V7; to the grid voltage supply lead of which the first A.F. plate is connected. This does not check with the table of tube voltages, which states that the plate of V5 is 155 volts positive; please advise whether the circuit as shown is correct?

(A.1) This portion of the circuit of the Kennedy "Model 826B" was reproduced incorrectly; the correction is shown in Fig. Q116A. Mark the original diagram to show a break at X, and a new line run as shown dotted.

(Q.2) In the March, 1931, issue of RADIO-CRAFT, page 527, an interesting tube tester is described in an article by Vincent Campbell. However, I am not able to obtain readings that even approximate those shown in the table. What is wrong?

(A.2) It is probable that incorrect readings are due to the use of a tester wired exactly in accordance with the diagram (Fig. 2) which failed to show one lead of the wiring. The grid connections of the sockets should be connected to the left arm of the D.P.D.T. switch, as illustrated at B in Fig. Q.116.

(Q.3) The diagram of connections for the Philco "Model 95," etc., shown in Data Sheet No. 37 (which appeared in the March, 1931, issue of RADIO-CRAFT) indicates that the grid return lead of the push-pull power tubes is brought to the "B+" side of the power pack. As this does not appear to be in accordance with standard practice, perhaps a correction is in order; please show the required changes.

(A.3) The grids of the power tubes, V7, V8, are shown connected to the positive side of the power pack in this diagram, it is true. The corrected wiring is shown at C in Fig. Q116. Here the lead from the center-tap of the secondary of T1 has been broken from the positive side of the circuit at "X," and brought to the lead connected to resistor R23.

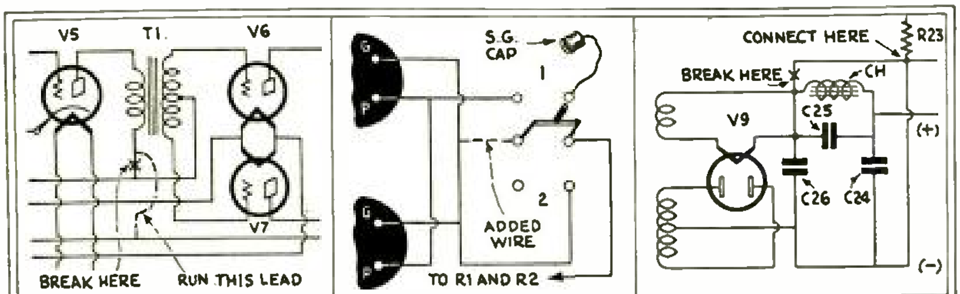


Fig. Q.116 (left). Corrections to be made to diagrams: A (left) Kennedy "826-B"; B (center) tube tester; (C) (right) Philco "95."

INDUCTOR-DYNAMIC REPRODUCER—ALIGNING CAGE

(117) Mr. August Schoenhoefer, Richmond, Va.

(Q.) Is there an outstanding reason for the use of an "inductor-dynamic" type of reproducer in radio sets of the 2-volt-tube type? It seems that manufacturers favor this type of speaker, rather than the more usual magnetics and electrodynamics, in use with battery and electric sets?

(A.) The use of an electrodynamic reproducer, requiring a considerable exciting current for its field coils, would dissipate the economy obtained by the use of a 2-volt receiver for battery operation. This consideration was sufficient to rule out this type of speaker, except where there is a source of excess voltage which can not be utilized in the receiver proper (as in D.C. line operation). The next resort was to the inductor-dynamic, as capable.

This type of reproducer has been selected by many designers of 2-volt sets because of the high "sensitivity," or high volume output at low levels of input power, of this type of reproducer.

Those who wish to look up references on the theory and design of the inductor-dynamic type of reproducer, will find the desired data in the articles, "A Novel Dynamic Reproducer," by Clyde J. Fitch, in the July, 1929, issue and "The Inductor-Dynamic Speaker," in the September, 1929, issue of RADIO-CRAFT.

It is purely a "magnetic" reproducer. It does not have a field coil; and the "voice coils" correspond to the usual two (or four) magnet windings of the ordinary magnetic reproducer. However, in the latter instrument electromagnets are in permanently fixed relation to the armature, and operate to vary the strength of the field of permanent magnets. In the inductor-dynamic construction, the voice-coils, or electromagnets, are mounted on the moving armature. In addition, the armature does not approach and recede from the permanent magnets; instead, it swings past them. Thus, the armature is not limited in its swing (as when reproducing a low note) by the pole-tips of the permanent magnets. This mechanical action is clearly shown in the illustration on page 668 of the June, 1930, issue of RADIO-CRAFT.

(Q.2) What is meant by the term "aligning cage," and how is the device made?

(A.2) An aligning cage is used by some radio manufacturers, to prevent the disturbing effect of radiations from powerful local stations, and the static radiations of electric machinery, from affecting the tests and adjustments which are made upon receivers in the final stages of production.

Through the courtesy of the RCA Victor Co. we show, in Fig. Q.117 the arrangement of an aligning cage, recommended by them. Though a powerful station broadcasting on 1,260 kc. might cause enough interference to prevent correct alignment of the set at the 1,264-kc. point, an aligning cage can be used effectively in a service shop, as at the factory, to reduce this interference, and it will permit accurate alignment of the instrument in the shortest possible time.

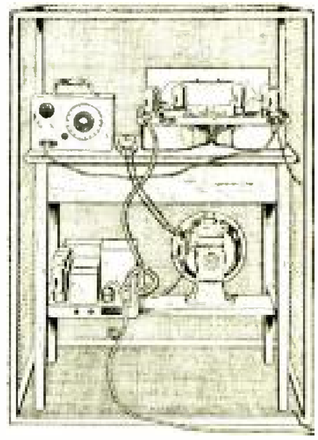


Fig. Q.117 (right) The aligning cage, used in factories, may be of value in a service shop where there is interference.

The cage illustrated is built of light material, such as would be used for screen-door construction. The entire set of equipment includes amplifier, speaker and suitable plug connections, oscillator and necessary meters. If it is undesirable to use a separate amplifier and speaker, the cage can be constructed large enough to accommodate the entire cabinet.

Although the cage must be built to fit the available space, it should be large enough to permit swinging the chassis, to couple it to the oscillator. The screening should preferably be of copper, 12 meshes to the inch. The sides are carefully bonded together to give maximum screening effect, and the entire screen is grounded. In all cases the open side of the cage should be placed away from the interfering station.

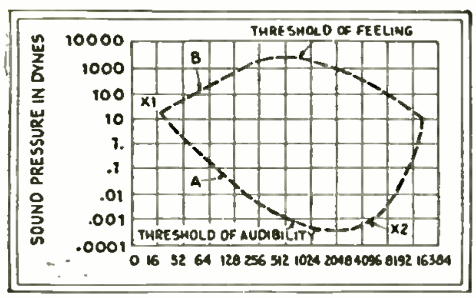


Fig. Q.118. The area enclosed by dotted lines indicates the range in frequencies of normal human hearing. (See page 632, June 1930 issue.)

SUPERSONIC RECEPTION

(118) Mr. Fred Briand, Sydney, Nova Scotia, Canada.

(Q.) Please show an arrangement for picking up sounds beyond the range of the human ear (such as the sound of insects walking); and amplifying them to headphone volume.

(Q.) Your inquiry presents several difficulties in its very nature. Amplifiers will not step up

(Continued on page 679, opposite.)

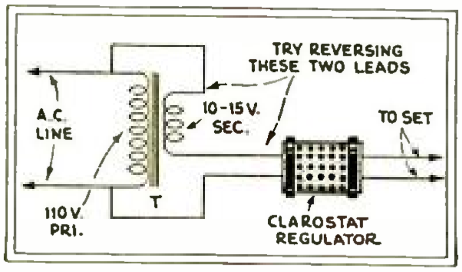
Boosting Low Line-Voltage

By S. H. ANDERSON

SO much has been said and done about high line-voltages, that the man who is unfortunate enough to have a low line-voltage is left without even a hint as to the solution.

Low voltages not only reduce the sensitivity of the receiver but actually injure the tubes; especially the power and rectifier tubes. Low filament temperature brings about arcing, which generally ends the tube's useful life.

A very simple and inexpensive line-voltage booster may be made from an ordinary filament transformer or a bell-ringing transformer (which may be had for about $1.00). The voltage of the secondary winding is added to the line-voltage; by connecting them in series with each other as shown in the diagram. It may be necessary to reverse the connectors of the secondary leads;



A step-down transformer T may be used to aid low line-voltage; a 0-150-volt A.C. meter will show the proper connection.

because, if they are opposing the primary, the voltage will be reduced instead of increased.

By selecting a secondary winding of, say, 10 or 15 volts rating you boost the line-voltage by so much, and make it possible to get normal operation again.

The rating of the transformer may be quite low, because it has only to supply the small load of the booster voltage; the line-voltage is still fed direct and is not transferred through the transformer. For example: When the line-voltage is down to 100, the transformer adds, say, 12 volts and brings the new supply up to 112 volts. The transformer has supplied only 12 volts at a current of about one ampere (average drain of receiver); which is only 12 watts.

But here comes the caution: this arrangement continues to boost when the line-voltage returns to the normal 115 and, even when the line is high, the transformer raises it further. This is easily overcome by connecting a Clarostat automatic line-voltage regulator between the step-up transformer and the receiver. When the booster voltage is normal, the regulator passes it on without change; but, when the voltage begins to get too high, the regulator warms up and its resistance changes to compensate.

By this combination of booster transformer and Clarostat regulator, we get normal line-voltage all the time.

SIX HUNDRED MILLIONS

RADIO sales during 1930, in the United States, amounted to between $550,000,000 and $600,000,000, according to the statement made to the radio trade convention at Indianapolis by Bond P. Geddes, executive vice-president of the Radio Manufacturers Association, a few days ago. This was exceeded by the $835,000,000 sales of the big year (1929) but compares favorably with previous years. The industry starts the year, Mr. Geddes said, with a very small amount of surplus products and a clear field for new developments. The farm market, receivers for business offices, automotive radio, a trend toward the idea of two radios (or more) in a home, and the extremely large replacements required are all encouraging to business in the radio field at this time.

TRADUCING THE TRANSDUCERS

"PICK-UP" is a cumbrous expression. One might as well speak of a loud speaker as a "put-down," although the expression "loud speaker" itself is ugly enough in all conscience, and badly needs the attention of a competent etymologist.—*Wireless World.*

NOT FROM SCOTLAND

PHOSPHORESCENT dials, to be put on the British market, are announced by a London radio manufacturer.

Had an Aberdeen firm hit on this method of saving dial lights, the English humorists would have been busy for a month.

RADIO-CRAFT'S INFORMATION BUREAU

(*Continued from page 678*)

currents of supersonic or super-audible frequency until they can be heard; because the disability is in the nature of the human ear. In addition to the inertia of the moving parts of the ear, there is also an inertia in the microphone and in the headphones or reproducer which prevents instruments of ordinary type from responding to frequencies which are too high to be heard.

If you will examine Fig. Q.118, showing the response of the ear to sounds of different frequencies, you will see that at about 12,000 cycles consciousness of sound ceases. This is an absolute cut-off point; at a pitch which differs in various individuals, of course. Some cannot hear above 5,000 cycles; some are able to hear up to 20,000.

It is possible to amplify currents of much higher frequency, such as those used to carry television images. But the sound could not be heard by a human ear, even if a loud speaker could reproduce it.

It is possible to feed it into a television amplifier and produce a peculiar pattern; just as music does, in an experiment introduced by Mr. H. Gernsback three years ago. It is possible to take a record of the sound on an oscillograph. Also, by heterodyning this high frequency, with another close to it in frequency, audible whistles or beats might be produced; but these would not be the original sounds. Experiments of this kind have been carried on in laboratories; but they cannot well be performed at home; if only for lack of a microphone or pickup with sufficient freedom of motion to vibrate at the frequency of the high stridulations of insects

Design of R. F. Transformers

(*Continued from page 661*)

upper wavelength of the tuning range of the amplifier. The mutual inductance Mo (between the coil Lo and the secondary L2) is opposed to the mutual inductance M, between the primary L1 and the secondary L2. In other words, *Lo and L1 are arranged to "buck" each other.* Now let us see what happens:

Suppose we tune to a long wave: L1 has little effect because it is a small inductance; the signal current in the local tuned circuit LoCo is quite large, because we are near the resonance frequency of the local circuit.

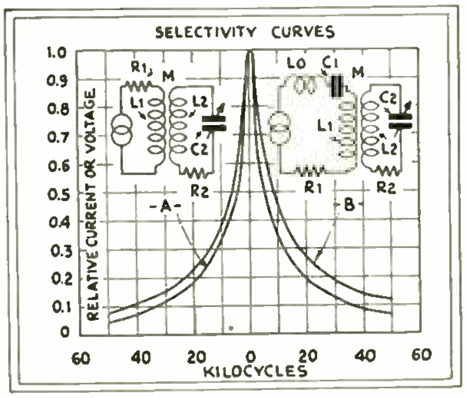


Fig. 10

Selectivity curves at 1000 kc. of interstage coupler (A) and aerial coupler (B). The former has the high tube resistance R1, and the latter the high aerial capacity, in the primary circuit.

The signal energy is then transferred to the secondary via the mutual inductance Mo, which can be so adjusted that the amplification is quite large.

Now, suppose we gradually tune to higher and higher frequencies. As the frequency increases, it departs further and further from the resonant frequency of LoCo, and Lo becomes a choke coil in effect. Co acts as a by-pass condenser more and more, as the frequency increases; so that the high impedance of Lo does not obstruct the signal to any considerable amount.

Now the regular primary L1 begins to work, transferring power to the secondary via the mutual inductance M. At very high frequencies, the system acts as if Lo and Co were not present; since Co becomes an effective by-pass. So this is an arrangement which will provide great amplification at low frequencies, because of the resonance effects in the primary, and, likewise, high amplification because of the usual laws pertaining to the simple primary circuit L1. By combining these effects we obtain a curve like that shown in Fig. 6—high at both ends and drooping slightly near the middle. By properly proportioning the various windings, the drop in the middle of the curve can be made small; and the curve will be as nearly linear as can be practically desired.

There are various arrangements of this system, but all work on the same principles. Sometimes the condenser Co is omitted, and the winding Lo is so made that its self-capacity (or distributed capacity) is sufficient to cause the resonance and by-passing effects. The coil Lo may also be located at various points of the secondary, in different designs. There is no rule which can be given. The whole effect is so complicated that the only way in which to design such a system is to do it experimentally; that is, use the cut-and-try method.

Constructing the Transformer

Figs. 7 and 8 show the construction of such an R.F. transformer. The primary loading inductance Lo is a random-wound coil of 400 turns of No. 36 D.S.C. wire on a small bobbin, in a slot 3/16-inch wide, and having an inside diameter of ½-inch. The construction of this bobbin is shown in Fig. 8.

The bobbin is inserted into the top end of the tubing on which the secondary is wound; the latter winding starting just below the bobbin. At the lower end of the secondary—away from the grid end—is wound the normal primary L1, upon a layer of empire cloth; this part of the construction is quite usual. The coil Lo is shunted by a fixed condenser of 40 micromicrofarads (40-mmf.) value.

Before closing the discussion, we must include a few words on the antenna coupling, and see how much voltage step-up we can expect in this tuned circuit. The constants which have been assumed, in making the calculations for the preceding curves, are those shown in the curves of Fig. 9; which are experimental values taken on a regular commercial R.F. transformer. In making the calculations for the antenna circuit the constants shown on the curve were assumed. Two curves are shown; one of these is for a fairly large coupling and a fairly large

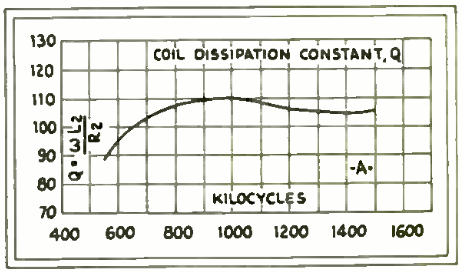
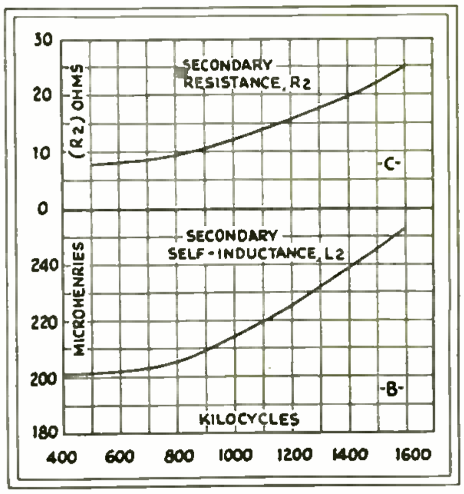


Fig. 11

Above, effect of frequency on a coil: the "dissipation constant," inversely proportional to the resistance is the resultant of the effects shown below and of the frequency itself, which is a straight slope.



antenna; the second is for a smaller antenna and looser coupling. In the lower curve these values have been reduced, in order to see how much the amplification is lowered. As these curves show, we can expect the voltage amplification in the antenna coupling transformer to vary from perhaps unity to as much as 30. This effect also contributes considerably toward making the amplification characteristic of the entire amplifier quite steep with regard to frequency; and it must be compensated for by the special transformer primaries.

Selectivity Found in Number of Circuits

Before closing it will be well to include a few remarks about the selectivity to be expected from such circuits. Fig. 10 shows curves which have been calculated for the two circuits—the interstage circuit and the antenna circuit. It will be seen that there is not a great difference between the selectivities of the two circuits, although the antenna circuit is somewhat less sharp in tuning than the interstage circuit; which we may well expect, considering the resistance of the antenna. In the interstage coupling the primary resistance (the plate resistance of the tube) is so great that the primary has little effect on the tuning of the secondary and on its selectivity.

Although these curves may seem to be quite broad, upon first inspection, it must be remembered that the great selectivity of an amplifier is dependent mainly upon the number of tuned circuits, and not upon the selectivity of each single circuit. By this we mean that only small improvements in over-all selectivity can be made by improving the selectivity of the individual stage; practical, commercial tuned circuits are about as selective as we can make them without adding considerably to the cost. Great improvement in selectivity may be obtained by adding a special tuned circuit to the amplifier; whereas, a slight improvement in the selectivities of the several tuned circuits (as by reducing their losses), will hardly result in any improvement that might be considered appreciable.

Determining Meter Shunts and Multipliers

INVESTMENT in a milliammeter or microammeter may be made to pay greater dividends, in the form of diversified applications, by conversion to a multi-range voltmeter. Likewise, the usual voltmeter can be readily converted to a multi-range voltmeter.

The connections shown in Fig. 1 are intended for the conversion of microammeters and milliammeters into voltmeters. Those shown in Fig. 2 are for the conversion of a 100-volt, high-resistance meter to a multi-range voltmeter, by means of a number of precision wire-wound resistors which serve as voltmeter multipliers. In using resistors of this type as voltmeter multipliers, it is essential to know the internal resistance of the voltmeter, expressed in ohms per volt. Then multiply the full-scale reading of the voltmeter by the number of ohms per volt; insert a similar resistance value in series with the instrument, and the added resistor will double the effective scale reading.

The moving element of voltmeters may be used, in conjunction with a multiplier, to obtain lower ranges than those for which the meter was originally made, with a great saving over the cost of a new meter. The new multiplier or multipliers must be directly connected to the moving-element leads.

The resistance of the multiplier can be computed by the following formula: multiply the ohms per volt by the full-scale deflection; then the product by the desired multiplier ratio; and subtract the resistance of the moving-element. But since the resistance of most moving-elements is low (say 10 ohms to 0.1 ohm) it may be neglected except when the computed multiplier resistance is only fifty (or fewer) times the order of magnitude of the resistance of the moving-element.

The accompanying chart gives the total resistance required to change microammeters and milliammeters into instruments for accurately measuring voltage. Since the resistance of most microammeters and milliammeters is very low, that is, 40 ohms or much less, these values may be used for the multiplying resistors. The error in this assumption is the resistance of the instrument divided by the resistance given in the table; which, in most cases, is very much less than the error in most calibrations. The maximum error, other than the above, is the sum of the error of the moving-element and the

Voltage Range Desired in Volts	100 ua.	200 ua.	300 ua.	500 ua.	1000 ua 1 M A	1.5 M. A	2 M. A.	3 M A.	5 M A.
	Resistance in ohms.								
1	10,000	5,000	3,330	2 000	1,000	667	500	333	200
1.5	15,000	7,500	5,000	3,000	1,500	1,000	750	500	300
2	20,000	10,000	6,670	4,000	2,000	1,330	1,000	667	400
3	30,000	15,000	10,000	6,000	3,000	2,000	1,500	1,000	600
5	50,000	25,000	16,700	10,000	5,000	3,330	2,500	1,670	1,000
7.5	75,000	37,500	25,300	15,000	7,500	5,000	3,750	2,500	1,500
10	100,000	50,000	33,300	20,000	10,000	6,670	5,000	3,330	2,000
15	150,000	75,000	50,000	30,000	15,000	10,000	7,500	5,000	3,000
30	300,000	150,000	100,000	60,000	30 000	20,000	15,000	10,000	6,000
50	500 000	250,000	167 000	100 000	50,000	33,300	25,000	16,700	10,000
100	1 Megohm	500,000	333,000	200,000	100,000	66,700	50,000	33,300	20,000
150	1.5 Megohm	750,000	500,000	300 000	150,000	100 000	75,000	50,000	30,000
300	3 Megohm	1.5 Megohm	1 Megohm	600,000	300,000	200 000	150,000	100,000	{ Two 30,000
500	5 Megohm	2.5 Megohm	{ 1 Meg 667,000	1 Megohm	500,000	333,000	250,000	{ 100,000 66,700	{ 30,000 30,000 40,000
1,000	Two 5 Megohm	5 Megohm	{ 3 Meg 333,000	2 Megohm	1 Megohm	Two 333,000	Two 250,000	Three 111,000	Five 40,000

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If you are one who has not yet recognized the importance of owning a copy of the OFFICIAL RADIO SERVICE MANUAL, turn to page 553 in this issue and learn more about this valuable book.

Future issues of the Supplements will be ready at the following dates:

April 1st June 1st August 1st October 1st error in the resistance value used. A moving element that is accurate to 2 per cent. would never become more accurate, no matter how accurate the multiplier was made. On the other hand, if a high degree of accuracy is wanted and the moving element was designed for that type of work, a very accurate multiplier must be used. If closer accuracies than 1 per cent. are required, resistors must be better than ½ per cent.

Fortunately, wire-wound resistors of an accuracy of 1 per cent. and closer, are now available commercially, as contrasted with the wider tolerances of resistors of the past. Furthermore, these resistors are thoroughly seasoned. These perfected wire-wound resistors now make it possible to convert meters into multi-range instruments with every assurance of accurate readings.

Courtesy of International Resistor Company.

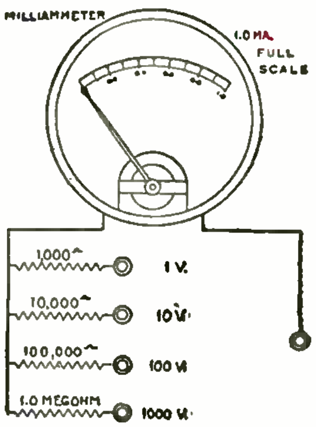


Fig. 1 (left)
The ordinary 0-1 milliammeter, as shown, with the series resistors becomes a multi-scale voltmeter. The resistor values should, theoretically, be lessened by the resistance of the meter's moving element but, except on the 1-volt scale, this would make too trifling a difference to be read.

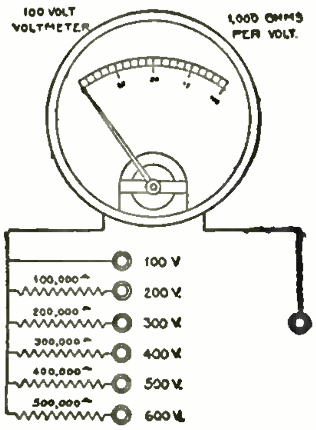


Fig. 2 (right)
The same principle is applied to a standard voltmeter; except that the first series resistor is already provided.

A. C. Beat-Frequency Oscillator

(*Continued from page 656*)

Four Eby sockets, UY-type (38);
Two Eby insulated binding posts (31, 32);
Two Thordarson choke units, type R-196 (21, 27);
One Thordarson autoformer, type R-190 (22);
One Thordarson power-supply transformer, type R-280 (34);
One Thordarson filament transformer, type T-3660 (36);
One Electrad "Royalty" variable grid leak, potentiometer type O (24);
One Electrad "Truvolt" resistor, type C 130 S (33);
Two Flechtheim midget fixed condensers, .00025-mf., type M-C, and two .0001-mf., type M-A, to give two .00035-mf. capacities (2, 11);
Two Flechtheim midget condensers, .0001-mf., type M-A (19, 19A);
Four Amperites, No. 227, with mountings (39, 40, 41, 42);
Four Durham "Powerohm" metallized resistors, with mountings: three 2,000-ohm (4, 14, 25) and one 50,000-ohm (16);
One Electrad power switch (37);
Four Flechtheim bypass condensers: two 0.5-mf., type B-50 (3, 3); and two 1-mf., type B-100 (15, 20);
One Flechtheim midget coupling condenser, .01-mf., type M-K (23);
One Flechtheim filter condenser, 4-mf., type F401 (28);
One Flechtheim condenser block, type F14 (35—used as 2-2-4-mf.);
One aluminum sheet 21 x 14 inches, cut as illustrated (Fig. 3) and bent for chassis;
One roll Corwico "Braidite" solid-core hook-up wire; and
One can Kester rosin-core radio solder.

Operating Notes for Service Men

(*Continued from page 649*)

these service tools. The first step is the adjustment of the antenna and oscillator circuits. These nuts are located as follows:

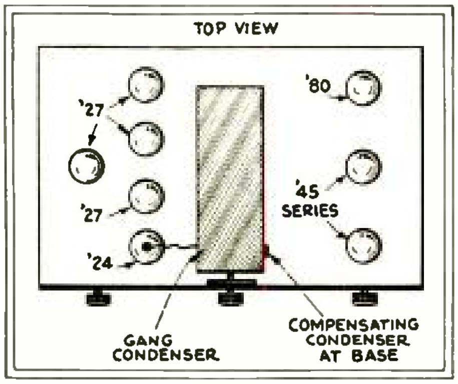


Fig. 5
Position of trimmer on Emerson chassis.

the oscillator tracking condenser is beneath the first screen-grid tube, and can be reached through the small aperture. The antenna compensator is situated at the right of the antenna and ground binding posts. Under the chassis, there are two adjusting nuts; the one nearest the drum-dial cable is the oscillator trimmer; the other is the second antenna adjustment (Fig. 3). The tracking condenser should be adjusted for maximum response at about 600 kc. The oscillator trimmer should be turned for maximum response at a frequency of 1500 kc. while the dial is set on that marking. It is necessary to use a station of that frequency and, if it does not come in at that marking on the scale, the scale must be moved to the correct position. Try the scale at a station of about 700 kc. to ascertain whether it is correct. The first antenna knob should be aligned for maximum response at about 1200 to 1000 kc. It is advisable to repeat this procedure, to insure perfect adjustment. If the I.F. adjustments have not been tampered with, it is best to leave them. However should it become necessary, continue in this manner. There are four adjustment nuts; these tune and are located in the rear right of the chassis from left to right (Fig. 4): first detector plate, I.F. grid, I.F. plate, second detector grid; and should be adjusted at 175 kc. in that order. If an oscillator is not available, choose a powerful broadcaster, whose signal is constant, and adjust the four nuts in the order given for maximum response. When the I.F. adjustments are made, it is best to adjust the oscillator and antenna circuit. The second antenna adjustment is made at 1200 kc. with the volume control turned down; so that a difference can be noted.

The Emerson set now on the market uses one screen-grid stage, but the '45 amplifier filaments are in series. Opposite the second '45 tube is a condenser compensator, which trims the detector gang condenser. It usually makes a great difference when this is adjusted. (Fig. 5).

Lack of sensitivity and a hum is sometimes caused by an open variometer in the Bosch "28" and "29 AC" models. This unit has a coiled spring, which is used for connection to one side of the rotor. If the spring loosens and breaks from the terminal, it need only be resoldered.

The Brunswick "15" and "22 AC" ("unicontrol") chasses use a condenser-type volume control (See Data Sheet No. 38, March RADIO-CRAFT); if this component becomes noisy after a short time in operation, it cannot be cleaned like a wire-wound resistor or carbon-type control. With the chassis bottom side up and the bottom plate off, rotate the volume control. You will notice a wide, grey-covered lead moving with the action; it is soldered to one of the stators of the variable gang. Pull lightly on this lead, first in one direction, then the other. This procedure has cleared up every case of noisy control where it has been tried, and gives no further trouble.

The "LLB" type Symington dynamic speaker used in the Zenith "10, 11, 12" (new series) is not adjusted in the usual manner. It has no spider, and the voice coil is not adjusted by loosening the mounting nuts. The large bolt in the rear must be loosened. The stand should be removed out of the way; this will permit the field pot to be pulled out. The center armature bar should be turned and pulled out. Here three screws will be noticed; these should be loosened to enable the Service Man to center the voice coil. This can be done, in the usual manner, by inserting strips between the frame and the voice coil. The bar should be replaced, and the pot put back by tightening the bolt provided for the purpose.

Notes on Band-Pass Tuning

(*Continued from page 658*)

screen-grid, and —3 on the control-grid. The operation of the tubes in this fashion will minimize the effects of grid-circuit damping and will allow of greater selectivity in the preceding grid circuit. Unless the constructor's poverty dictates otherwise, the use of at least four tuned circuits ahead of the untuned stages is recommended.

For best results, the variable antenna resistor and the screen-grid voltage control should be coupled together, on the same shaft. With the high-inductance antenna specified by the writer, provision should be made for shunting a .0001-mf. condenser across the antenna and ground connections, where very short aerials are used.

Some correspondents are surprised at the use of a 200-turn antenna coil. Let these sceptics be reassured; this is not a typographical error and 200 turns is correct. The constants for the circuit are as follows: C, .00035-mf. (four-gang condenser); Ce, .05-mf.; C1, 0.1-mf.; C2, .0001-mf.; these are mica condensers. M is composed of 12 turns of double-strand (not twisted) No. 22 D.C.C. wire on a 1-inch tube. There is no spacing between turns.

L1, L2, L3, and R1 are as specified in the preceding article (page 561, March, 1931, RADIO-CRAFT); L4 and L5 are the same as L2 and L3, except that their axes are parallel and are spaced 3½ inches apart, and the two coils are placed together inside a large shield.

The writer is preparing data on a thoroughly modern receiver, with all the gadgets of the 1932 season, for which he hopes to find early publication.

Are You Treble-or Bass-Minded?

By A. G. HELLER*

ALL musical ears do not agree as to what constitutes realistic tone quality. In fact, three radio sets may give three totally different renditions of the identical program; and each of the three set owners insist that his particular set has the natural tone quality sought. Of course the three sets and the three owners cannot all be correct so far as the *natural tone quality* is concerned; which simply goes to prove that there are variable factors involved.

First of all, human ears vary greatly. Not so long ago a scientist concluded a five-year study of human ears during which he discovered a wide discrepancy in frequency response. Women, it appears, are more susceptible to the higher frequencies and, therefore, like their radio rendition either muted or reduced in volume. Men, being less susceptible to the higher frequencies, like their radio rendition crisp, sharp, almost penetrating, and certainly loud.

It has been found through test that, where the tone is muted or mellowed, by eliminating more or less of the higher fre-

* *Chief Engineer, Insuline Corporation of America.*

quencies, women also like the rendition louder so as to approach natural volume; but, where the tone is not muted, they like the rendition subdued in volume if not in tone.

Secondly, room acoustics have much to do with tone quality. Take a powerful radio set, such as we have enjoyed during the past two years, and place it in a sparsely furnished room; particularly one with hard floors and lacking carpets as well as upholstered furniture and drapes. Immediately the rendition is sharp, penetrating, disagreeable.

Take the same set and place it in a richly furnished room. The tone is entirely changed, and the music is pleasingly mellow. The fundamental tone of the reproducer has not been changed, of course, but the higher frequencies have been absorbed to a greater degree than in the sparsely furnished room, so that they cannot persist and cause disagreeable acoustics.

The tone control is an absolute necessity, I believe, in old as well as new sets. No set is really capable of performing to the best advantage without this feature; which is even more important than the volume control, since it is the degree of penetration, rather than the actual force of the sound waves, which determines the desired result.

Aside from musical tastes and room acoustics, radio programs themselves require different tone treatments. The speaking voice absolutely requires the higher frequencies, for ready understandability; and brass instruments require higher frequencies for natural rendition. String music, on the other hand, should have less of the higher frequencies, for pleasing rendition. Hence in the matter of programs as well as in other directions, tone control is essential. Fortunately, the tone control feature may now be added to any radio set, without tools or technical knowledge, and at a very low cost.

Certain tone controls are designed to cover a rather wide range of frequencies and assure the proper "muting" of even the old horn-type speakers, with their notorious high-pitched rendition. In many instances where the horn type is on the verge of being retired from active service, it may be salvaged and brought back into the good graces of the family circle once more by a suitable tone control.

Cold-Cathode Vacuum Tubes

(*Continued from page 659*)

remarkable when you consider that neither inventor was aware of the other's work. I am convinced that the practical possibilities of this multi-stage cell are enormous, not only for the radio receiver, but in allied fields where electronic amplification is employed. You can imagine how small and efficient such a radio receiver would be, with practically nothing to get out of order."

The fundamental principle is shown in Fig. 2; here, it will be observed, the input is made to the anode (corresponding to the plate of an ordinary vacuum tube) and the grid. The photoelectric substance forms the cathode, and must therefore be maintained at a negative potential. The grid modulates the flow of electrons, just as in an ordinary vacuum tube.

The flow of electrons from the photoelectric substance which forms the cathode is obtained by subjecting the latter to a source of steady illumination, preferably high-frequency or ultra-violet light.

In addition, Mr. Thomas worked out the idea of a multiple cold-cathode tube, in which a single light shall operate a number of distinct cathodes each with its anode (plate) and auxiliary electrodes, in a single envelope. The external connections to such a tube would include it into a number of stages—as radio-frequency amplifiers and detector, say. Mr. Thomas' patent claims contemplate an annular, or ring-like, bulb, with several sets of tube elements grouped around the central opening; into which a lamp bulb for purposes of excitation could be introduced.

Another variation upon the same idea appears in his patent application; two designs from which are reproduced in Fig. 3. Here A shows a cross-section of the bulb, in which the central illumination is produced by a glow-lamp with distinct electrodes; while on each side of it are the three elements of a vacuum tube. At B we have a top view of the bulb, showing the respective positions of five sets of elements, and the exciting lamp in the center.

The theory is scientifically sound. Several practical problems are presented, however; among them that of increasing the limited amount of current (measured in microamperes rather than milliamperes) emitted by photoelectric cells of the present ordinary design. Another is that of obtaining economically a source of light which shall be absolutely steady. Any variation in the light is represented at once in the photoelectric cell, which has practically no "time lag"; this very property, so indispensable in television, is troublesome here. For instance, while daylight will operate a photoelectric cell, every passing cloud would cut down the effectiveness of amplification. Then, too, the methods of producing light at the present time are much less efficient, from the standpoint of loss of energy, than those of producing heat. Nevertheless, much in the way of discovery along these lines may be looked for in the next few years.

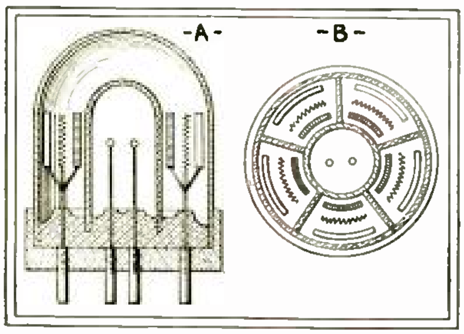


Fig. 3

Here the elements of five ordinary tubes are built into one envelope, with an interior glow-lamp to excite the five cathodes.

New Types of Receiving Tubes

(Continued from page 663)

ing. The hum level, in these indirectly heated tubes, has been reduced to one-fiftieth of the value in earlier models.

The quick-heating quality has been produced by notching the insulator which surrounds the twin or hairpin filament. The method is illustrated in Fig. 1; there are twelve notches in the insulator tubing, so that, while the filament is exposed between the "fins" it is firmly supported by them at thirteen points and cannot alter its position. The bulk of the insulator is thereby greatly reduced.

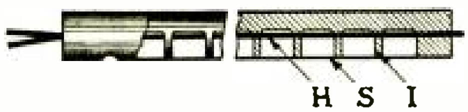


Fig. 1
Elements of De Forest quick-heater tube in section: H, heater, I, the notched insulator; S, oxide-covered nickel cathode.

Variable Mu Tube

In the preceding issue of RADIO-CRAFT, the principle of the variable-mu tube was described; the RCA Radiotron Co. has brought out a tube operating on this principle, to be known as the "RCA 235." It is intended not to replace the 224 in receivers now in use, but for use in circuits especially designed for the purpose.

As explained before, the purpose of these tubes is to overcome cross-modulation and distortion, due to the application of high negative grid biases which are required to control volume in the presence of powerful interfering signals.

The mutual conductance of the 235, operating under a bias of 1.5 volts, is 1100, its plate resistance some 200,000 ohms, and the plate current is 9 milliamps, or about twice that of the '24. But, when the grid bias is raised to 40 volts, the mutual conductance of the tube is nominally 10 micromhos, or just one one-hundred-and-tenth that obtained under ordinary conditions. This enormous range permits a multi-stage receiver to function under the most diverse conditions.

The 235, like the '24, has a cathode heated indirectly by a filament drawing 1.75 amperes at 2.5 volts; the plate voltage recommended is 180, and the screen-grid voltage 75. The screen current should not exceed a third that drawn by the plate. The internal capacities are, approximately, .01-mmf. between grid and plate; 5 mmf. across the input and 10 mmf. across the output.

Two-Volt Tube Characteristics

The values given above, as with any new tube type, are subject to slight alterations, when the experimental models are replaced by those produced for the market. For instance, in the July, 1930, issue of this magazine, the tentative values for the two-volt tube types were announced. They have been slightly modified in some particulars; and the present standard (average) values for the Radiotron tubes are as follows:

Type '30 (general purpose): mutual conductance 715 micromhos; amplification factor, 9.3; plate resistance, 13,000 ohms; plate current, 1.8 ma.; base, small UX (like the '20).

Type '32 (screen-grid) mutual conductance, 550 micromhos; amplification factor (theoretical) 580; plate resistance, 1,150,000 ohms (original rating, 800,000); plate current, 1.4 ma.; screen voltage, 67.5 maximum; screen current, not over one third of plate current; grid-plate capacity, not over .02-mmf. Base, large UX (like '22).

Type 31 (power tube); mutual conductance, 760 micromhos; amplification factor, 3.8; plate resistance, 4,950 ohms; undistorted power output, 150 milliwatts; plate current, 6.8 milliamps. No output protective device, therefore, is needed, and the reproducer may be connected directly in the plate circuit. The filament current is 130 milliamperes, at 2 volts. Base, small UX type.

A Mercury-Vapor Rectifier

The use of rectifying tubes which, instead of a high vacuum, contain mercury vapor, is general in apparatus where high power and high voltages are required. There has just been announced the development of a small mercury-vapor tube for the power packs of receiving sets; it is similar to the '80 in design, but will pass more current with less power loss. The type is designated as "PR 280M" by its makers, the Perryman Electric Co.

This tube is designed with additional insulation for its plate leads, extending beyond the "press" (assembly of internal parts). Its power limit is found, practically, in the amount of heat which can be dissipated from the bulb. During the live cycle of the tube, the potential drop through it is about 17 volts; as compared with, say, 43 in the standard high-vacuum '80. The mercury-vapor tube, it is estimated, will carry 316 milliamperes at 500 volts, or (allowing for power loss) 152 watts, compared with 50 for the '80 type. This increase of the

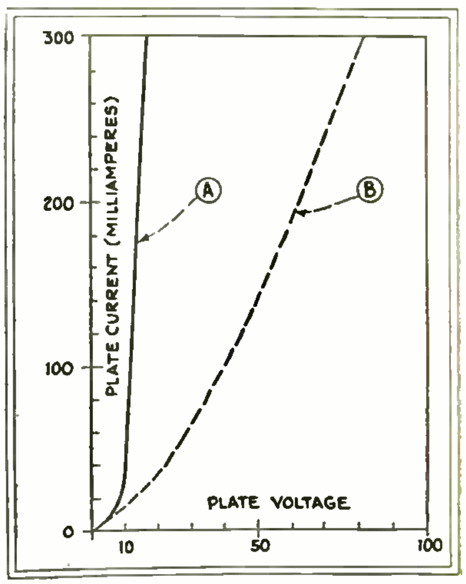


Fig. 2
Operating curve of Perryman mercury vapor rectifier (A), showing advantage over high-vacuum '80 (B).

available power will permit a more efficient application of higher voltages to receiving tubes; but new design of the power unit, to utilize the added current supply, will be desirable if maximum efficiency is to be secured. Incidentally, the factor of safety of the rectifier tube, in modern sets with push-pull power tubes, should be considerably increased.

"Unitary" Tube Assembly

One of the major problems connected with the manufacture and use of tubes is that of obtaining uniformity in characteristics. The proper proportioning of the elements, and especially their spacing, determines whether or not the mutual conductance of a tube, and consequently its amplification, will be according to its listed "average" rating; it also determines the inter-element capacities, which are important especially in the functioning of radio-frequency and detector circuits.

Since modern tubes are made in great quantities, to sell at low prices, any method which will increase their uniformity is a benefit, not merely to the manufacturer, but to the user; and this must interest the Service Man who is concerned with keeping a set in proper adjustment.

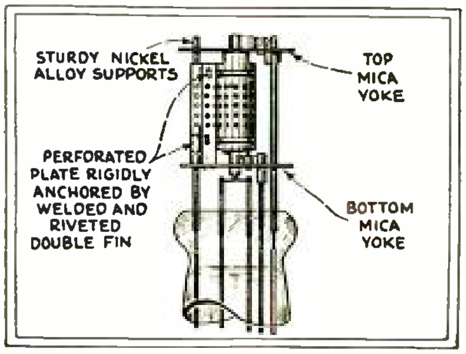


Fig. 3

The Arcturus "unitary" tube construction, producing a rigid, uniform assembly which makes characteristics permanent.

The Arcturus Radio Tube Co., has developed a new type of construction, known as "unitary structure," for the purpose of insuring precision alignment of the electrodes. The elements—as in the type '27 tube, a section of which is shown in the illustration—are fixed rigidly in an assembly held at each end by mica yokes, perpendicular to each electrode. The plate is a rigid cylinder of nickel, perforated to permit dissipation of heat, and ribbed to increase its mechanical strength. The cathode is held by a collar, and the grid by a clip, which reinforce the unit, as well as furnish electrical connections; the grid clip prevents any turning of the grid support in the holes through the yokes. In the assembly, each electrode is separately welded to the stem wires which support it; the whole is held for this purpose in a jig, which permits no deviation. The resulting uniformity obviates the need for matching tubes.

A new minimum-hum '24 tube is announced by the same manufacturer; it is quick-heating (7 seconds) and has a special patented high-resistance filament insulator which prevents escape of electrons, from the heater to the cathode, to introduce noise or hum.

ON Page 682 you will find an interesting announcement on the Supplements to to OFFICIAL RADIO SERVICE MANUAL. It takes but a few minutes to read full particulars about this message.

Radiola 28 with 2-Volt Tubes

(*Continued from page 671*)

filament circuit; the writer led it to one side of the left rheostat, marked "filament control" and governing all the tubes except the first I.F. (V4).

Neutralizing the R.F. Stage

Replace the unit in the container, as far as it will go; place the container with the unit again in boiling water, until the unit slips into place. Take the assembly from the water and allow it to cool; which will take about an hour. Then place the catacomb on its supports and resolder the nineteen wire whiskers in place.

You are now ready to give the receiver a trial; reconnect the battery-terminal strip; and connect the batteries. Check the voltages at the tube sockets to see that they are O. K., if not, go over your connections until you locate the trouble. When everything is O. K., plug in the tubes, loud speaker, and loop aerial.

Turn on the filament switch and rheostats; that on the left all the way, and the other about three-fourths of the way. An accurate filament voltmeter must be connected to the tipjacks provided. The more constant the filament voltage, between 1.8 and 2 volts, the longer the tubes will last. Tune for signals in the usual way, keeping the rheostats on as far as possible.

The neutralizing condenser NC, connected between terminals 7 and 8, must now be adjusted. It is located at the left end of the chassis near the bottom, and is nothing more than two copper strips separated by a thin strip of mica. A screw, located at about the center of the plates, provides the adjustment; this will be covered with wax, which must be removed carefully with a knife blade.

Now tune in a strong signal, at about 1300 kc.; remove the first I.F. tube (No. 3) and insulate one of the filament prongs with a short piece of straw obtained from a soda fountain. Place the tube back in its socket, and see that it does not light. Adjust the screw of the neutralizing condenser NC for minimum signal; (it must be turned to the left from its original position.) After adjusting for minimum signal, remove the straw from the filament prong; the receiver is now neutralized. Reseal the screw with beeswax.

With 5-Volt Power Tube

If a type '71A is used, a six-volt filament source such as a storage battery is required. A fixed 10-ohm resistor should be used in the negative filament lead to drop the filament voltage from 6 to 2, for the two-volt tubes. A 4-ohm fixed resistor reduces to 5 the filament voltage for the '71A; it is connected as follows: refer to Fig. 3, which shows the connections of the catacomb unit at the left end, as viewed from the rear. Unsolder wire "X" at point "1B," and connect the 4-ohm resistor between wire "X2" and negative of battery. Figure 4 shows these two connections as they were made to battery. (In lieu of resistors R2 and R3, for 6-volt "A supply" a "No. 112" Amperite serves at "X1"; for 2.5-volt "A supply" a No. 3A Amperite, is suitable for nine 2-volt tubes).

Connect 27 volts negative to cable marked "22.5 C—." It will be found that a '71A tube just fits in socket No. 8, although it is a tight squeeze.

To use two '31's connected in parallel, insert a "Type RA" Tubadapta into tube socket No. 8, and place two '31's in the sockets provided on the adapter; it will be unnecessary to disturb any of the set's wiring. The writer used DeForest type 430 and 431 tubes for his experiments; however, other standard tubes can be used if desired.

An Eveready air-cell battery was tried for the filament circuit and was found entirely satisfactory. The filament drain on this battery never should be allowed to exceed 0.75-ampere. (Therefore, it is recommended that there be connected in the "A" circuit a meter with a range of 0-1.0 amp. This low-resistance instrument connected in series with the "A" supply will not appreciably add to the drain, as a low-resistance voltmeter might do. This meter should indicate not more than the total consumption of the receiver, or, about 700 ma.—*Tech. Editor.*)

Never use dry cells unless a voltmeter is permanently connected to the "A" circuit tip jacks to check the voltage.

External Power Amplifier

Many people operate the Radiola "28" in conjunction with the Radiola "104" power speaker. In the original installation, filament current for the type '99 tubes, and their plate supply, was furnished by the power pack of the speaker. (See pages 247 and 254 of the OFFICIAL RADIO SERVICE MANUAL.) But when the new two-volt tubes are used, the filament cannot be operated from the Radiola 104. However, an Eveready air-cell battery may be used, the filament connections to the speaker being disconnected; and only the "B" current for the tubes is then drawn from the amplifier.

Those who wish to use this receiver with an external power amplifier will not have to worry about replacing the output tube of the "28," inasmuch as this stage will not be used. (The external power amplifier plugs into the first audio jack.) Be *sure*, however, to adjust the filament voltage to the correct value.

The writer will endeavor to prepare for a forthcoming issue of RADIO-CRAFT a condensed description of the manner in which the Radiola "812" (semi-portable) and "25" may be improved, if the readers manifest sufficient interest in this subject. Inquiries regarding this conversion system may be addressed to the writer, provided there is enclosed a stamped return envelope. (Before closing this article it is desired to sound a note of caution: while this story by Mr. Sprayberry follows sound practice, and is the outcome of practical experiments in his laboratory, the results obtained by other constructors will depend upon individual ability to follow instructions and master slightly differing conditions. The most important point to remember is that "it can be done."—*Tech. Editor.*)

The "L-32" Ultradyne

(*Continued from page 667*)

They fit tightly a bakelite tube having a diameter of 1¼ inches. The finished coils are about 5/16-inch wide; and are wound to about the same thickness.

With the specified parts, calibrated coils are available for L1, L2 and L3. Rough approximations of their construction are as follows: broadcast band, L1, 6 turns; L2, 120 turns; L3, 74 turns. The 160-meter band, L1, 40 turns; L2, 60 turns; L3, 45 turns. The 80-meter band, L1, 20 turns; L2, 25 turns; L3, 32 turns. The 40-meter band, L1, 15 turns; L2, 15 turns; L3, 21 turns. The 20-meter band, L1, 10 turns; L2, 10 turns; L3, 14 turns. Tube bases of the UY-type may be used for forms; small wire being used for the larger windings. The spacing between turns and windings, and the sizes of wire are experimental.

In closing, it must be mentioned that owners of early models of the "L-32" have been able during the early part of the evening to tune in distant stations while the New York (local) broadcast stations were operating. For instance, station WLW in Cincinnati may be tuned in, to the total exclusion of the powerful Newark station, WOR. And stations throughout the world have been copied on short waves.

Additional information, and data regarding circuit or construction blueprints, will gladly be given by the writer; who may be addressed in care of RADIO-CRAFT.

List of Kit Parts

One *Ultradyne* antenna coil, L1, L2;
One *Ultradyne* oscillator coil, L3;
One *Amerchoke* "Type 3842," L4;
One *Amerchoke* "Type 709," L5;
One *National* "Type S. E. 50" variable condenser, C1;
One *National* "Type E. C. 250" variable condenser, C2;
One *National* variable condenser, special design, C3-C4;
Three *Aerovox* condenser units, 0-.1-.1-.1-mf., C5, C6, C7;
One *Aerovox* special condenser unit, 0-1, 0-1-1-1 mf., C8;
Four *Polymet* fixed condensers; one .0005-mf., C9; one .05-mf., C10; one 0.25-mf, C11; one .01-mf., C12;
One *Aerovox* "Hi-Farad" dry electrolytic condenser bank, 0-4-4-4-4 mf., C14-15-16-17;
One *Pilot* fixed condenser, 1 mf., C18;
Three *Ultraformers* "Type L-32," T1, T2, T3;
One *Amertran* "Type 151" audio transformer, T4;
One *Amertran* "Type PF 245A" power transformer, T6;
Two *Lynch* resistors "Type LF4," 0.5-Megohm, R1, R17;
One *Durham* resistor, 750 ohms, R2;
Nine *Lynch* resistors "Type LF4," 0.5-megohm (two needed) R1, R17; 15,000 ohms (two needed), R3, R12; 50,000 ohms (four needed), R4, R7, R10, R14; 0.25-megohm (1 needed), R16;
Six *Lynch* resistors "Type LR4," 1,000 ohms, R5, R6, R8, R9, R11, R13;

(*Continued on page 690*)

One *Clarostat* "Type M-3-TSP" volume-control potentiometer, 3,000 ohms, R17;
One *Durham* resistor, heavy-duty type, 1,500 ohms, R17;
One *Pilot* voltage divider for '45 power pack, R19, R20, R21, R22;
Three *Durham* center-tapped resistors, 20-ohm type, R23, R24, R25;
One *Durham* resistor, 790 ohms, R26;
One *Ultradyne* chassis, drilled;
One *National* illuminated dial, 270-degree, "Type H";
Four *National* tube shields;
One *Alcoa* aluminum box-shield;
Nine *Eby* "UY" sockets;
Three *Eby* "UX" sockets;
One UY-plug for reproducer;
Two *National* knobs, for ¼-in. shaft;
Two *National* screen-grid clips;
One "antenna-ground" connection-strip;
One ¼-inch rod;
Fifty feet of hook-up wire;
Two feet of resin-core solder;
Screws, nuts, lugs, washers, etc.;
One instruction book;
One set of Arcturus tubes, as follows: five No. 124; one No. 127; two No. 145; one No. 180.

Service Man's Forum

(*Continued from page* 651)

(with the single exception of our friend Mr. Clerk, of Canada). However, I would like to offer a few suggestions:

In presenting articles describing new devices, such as the dynatron oscillator in the February issue, have the writer specify the proper parts. As it is, the would-be builder has to spend a lot of time writing to different manufacturers. Then, too, in the article mentioned, the choke is a pair of headphones. Who wants to use a perfectly good pair of Baldwins there? Why not specify a particular value of audio choke and the make? And who makes a transformer that exactly meets the specifications?

Then, why not run a series of articles on short-wave converters, using standard parts, instead of the usual roll-your-own? How well I remember my first (*and last*) attempt to build a short-wave coil.

W. C. STRAUGHN,
540 *Marigold Avenue,*
Rocky Mount, N. C.

(We are glad to have this letter from Mr. Straughn, like any other bearing upon editorial policy, as a guide in our endeavor to supply the greatest number of readers with what they want. Most articles list parts and maker's numbers; although many constructors use parts out of a well-stored junkbox, which it would be difficult to duplicate today. The experimenter must be prepared to substitute. As for short-wave coils, no doubt it is more satisfactory and perhaps less expensive, when the value of time is considered, to buy the manufactured article; but no article has ever been published specifying a manufactured set of coils, without arousing the desire of innumerable readers to know the number of turns and the size of wire. There is no doubt that there are thousands who wish to "roll their own," even if it costs them a little more to do so.—*Editor.*)

"S. W. S." Super

(*Continued from page* 669)

thereafter tuning should be done with the main tuning control and the vernier to its left. Variations in volume should be taken care of by means of the volume control. The set should now be ready to use.

While tuning, if you hear a broadcast station, don't pass over it because it is loud; get the call letters, if only to calibrate the receiver. The reason for this statement is the fact that most people, while tuning this receiver, go past any station that happens to be loud, thinking it only a powerful local. It takes quite a while to get used to the fact that (as in most cases when we have tried the receiver) *the distant stations may be as loud, if not louder than the local!*

The author will at all times be interested in hearing how constructors of this receiver make out with it; since he is certain that, if the receiver does not come up to its mark, there has been something wrong in either the parts or construction. There will seldom be anything wrong in the tuning, because it is so simple. If there are any questions or further information the reader would like to ask he may feel free to write to the author, in care of RADIO-CRAFT.

List of Parts

Two *Hammarlund* "Type ML-7" 140-mf. variable condensers (C1, C3);
One *Tobe Deutschmann* .00015-mf. fixed condenser (C2—to be mounted directly on cap of screen-grid tube);
One *Pilot* "Type J-23" .0001-mf., variable condenser, (C4);
One *Dubilier* .00015-mf. fixed condenser, (C5);
Four *Polymet* "siamese" 0.25-mf., by-pass condensers (C6, C7, C9, C10, C13, C14, C19, C20);
Three *Hammarlund* "Type EC-80" 80-mmf. equalizing condensers (C8, C11, C15);
Two *Sangamo* .01-mf. fixed condensers, (C12, C16);
One *Polymet* .0002-mf. fixed condenser (C17);
Two *Polymet* .002-mf. fixed condensers, (C18, C24);
One *Dubilier* 1,000-volt 1-mf. fixed condenser (C21);
Two *Polymet* electrolytic 8-mf. fixed condensers (C22, C23);
One *Polymet* 0.5-mf. fixed condenser, (C25);
One *Durham* 25,000-ohm fixed resistor (R1);
Two *Durham* 2-meg. resistors (R2, R7);
Three *Lynch* 10,000-ohm fixed resistors (R3, R4, R10);
Two *Durham* 500-ohm fixed resistors (R5, R6);
One *Clarostat* 500,000-ohm potentiometer (R8);
One *Clarostat* 50,000-ohm potentiometer (R9);
One *Durham* 5,000-ohm fixed resistor (R11);
One *Lynch* 10,000-ohm heavy duty limiting resistor (R12);
Two *Durham* 20-ohm center-tapped resistors (R13, R15);
One *Cresradio* 780-ohm 25-watt resistor (R14);

(*Continued on page* 692)

One *Electrad* 20,000-ohm tapped voltage divider (R16);
One *Durham* 2000-ohm resistor (R17);
Four *W.E.E.Co.* 115-millihenry R.F. chokes (RFC1, RFC2, RFC3, RFC4);
Five *General Radio* plug-in jacks and plugs (J1, J2, J3, J4, J5; these must be insulated from the metal front panel.—*Technical Editor*);
One *National* "Type VHCC" drum dial;
One *Arrow-H.&H.* toggle switch, Sw.;
One Metal front panel;
Three *W.E.E.Co.* "Types LL, LM, and LH" shielded plug-in inductances, one each (L1: see text);
Three *W.E.E.Co.* "Types IF1, IF2, IF3" shielded I.F. transformers (one each L2, L3, L4; see text);
One *Amertran* first stage "DeLuxe" A.F. transformer (T1);
One *Amertran* "Type 151" input push-pull A.F. transformer (T2);
One *Amertran* "Type 443" (for dynamic reproducer), or "Type 442" (magnetic reproducer), output push-pull A.F. transformer (T3);
Two *Thordarson* 30-henry, 75-ma. filter chokes (Ch. 1, Ch. 2);
One *W.E.E.Co.* "Type PT 116" power transformer (PT);
Nine *Cinch* tube sockets, three UX and six UY.

Radio-Craft Kinks

(*Continued from page 673*)

in the metal sheet that he uses for a chassis base. Obtaining neat holes was a problem to me until I had made up the outfit illustrated. The method is as follows:

Two pieces of flat iron (about 30 inches long, 1/4-inch thick, and two or three inches wide) are obtained and clamped together, one above the other; so that, after drilling, the holes in both pieces will correspond to size and location. Now, drill a 3/8-inch hole, about 1 inch from each end of the iron strips; and also, near the center of the strips, drill holes of the sizes that will later be required in the chassis base. Next, remove the clamp that holds them together, and bolt them together. Use two 3/8-inch bolts for this, and place a 3/32-inch washer at each end, between the iron strips.

This completes the construction of the jig, but you will need punches, to fit the various holes in it; they are made of round steel and should fit neatly into the holes.

To use the device, slid the sheet of metal to be punched between the iron strips; place the proper punch in the hole in the top strip, and strike with a heavy hammer.

I had my punches and jig made at a machine shop, at a cost of $1.50; and the outfit has certainly paid for itself over and over.

A Home-Made Super

(*Continued from page 672*)

that this receiver, properly constructed, will reproduce faithfully, and that tone control, merely lessening the high or low notes, makes the quality inferior.

It should not be necessary to go into the details of construction, as they have been pretty well covered in preceding issues. It is essential to have no pickup other than through the antenna. Shielded hookup wire was used throughout, with its braiding grounded.

The biasing resistor R2, for the detector stage, is 50 ohms, wire-wound; R3 is 15 ohms. The same values are used for the intermediate amplifier V3, in R5 and R6. Other filament controls are the appropriate Amperites (630 and 631 types). The small lamp in the common "B—" return will protect the tubes, in the case of a short-circuit.

Two dry cells, giving 3 volts, may be used to light the filaments of these tubes, which draw a total of 0.49-ampere. In that case, remove the filament resistors; insert a 6-ohm rheostat at X in the "A+" lead, after fixing a stop so that two ohms must always remain in the circuit. The grid returns from V1 and V3 are then brought to the negative terminal of a 3-volt "C" battery, and those from V2 and V5 to the negative of a 4½-volt battery. (If a 2-volt air-cell battery is to be used, the precautions described on pages 594 and 595 of the April issue of RADIO-CRAFT should be observed.—*Editor.*)

List of Parts Used

Two *Pilot* .00035-mf. variable condensers, No. 1617 (C1, C2) and flexible coupling;
One *Pilot* .0005-mf. variable condenser, No. 1623; and drum dials; one 6-volt pilot lamp and socket, for fuse;
Three Pilot R.F. transformers No. 176, altered as per text (L1, L2, L6);
Two I.F. transformers (L4, L5—see below);
Ten *Pilot sub-panel* UX sockets, for coils and tubes;
Three X-L Variodensers, G-5 (C4, C5, C6);
Five *Pilot* 80-millihenry R.F. chokes, No. 130;
Two 3,000-ohm variable resistors (R1, R8);
Four wire-wound filament resistors: two 50-ohm, (R2, R5); two 15-ohm (R3, R6);
Five *Amperites* four 630 (R4, R9, R10, R12); one 631 (R11);
Eleven fixed condensers: four 0.5-mf.; four 0.1-mf.; two 001-mf. (C7, C9); one .00025-mf. (C8);
Three *Pilot* tube shields; one No. 46 snap switch; two No. 37 brackets.
One panel 7 x 18 inches, and baseboard 7 x 17, and hardware.

(The oscillator and intermediate-frequency coils were described and illustrated on page 544 of the March issue of RADIO-CRAFT. The former, with a .0005-mf. tuning capacity, has 50 turns of No. 28 enamelled wire for the grid winding and 30 turns for the plate winding; all on a Pilot plug-in form for a UX socket. The I.F. coils had 200 turns of No. 36 S.S.C. wire on a 1-inch core for each winding except the tickler of L5 (which was but 100 turns); these windings are to be tuned by the Variodensers until they match. The construction of this receiver should not be attempted by a constructor without some superheterodyne experience and the ability to match his I.F. transformers; as in this point lies the trouble experienced by most of the unsuccessful experimenters from whom we have heard.—*Editor.*)

Demonstration Receiver

(*Continued from page 675*)

to the "British-made valves" are the following American types, for the positions given: V1A, V1B, type '24; V2A, V2B, V3A, V3B, type '27; V4A, V4B, type '50; V5A, V5B, type UV-211. However, these are only very rough approximations of American equivalents to the English tubes, as reference to the characteristic data for each stage will readily show.

As a matter of record, the type numbers, and characteristics, of the English tubes which the set was designed to use, and other data on this radio set, are given below:

V1A, V1B, type AC/SG; V2A, V2B, type 164V; V3A, V3B, type AC/P; V4A, V4B, type LS5; V5A, V5B, type UV845. The plate impedances are as follows: V1A, V1B, 600,000 ohms; V2A, V2B, 6,650 ohms; V3A, V3B, 2,650 ohms; V4A, V4B, 6,000 ohms; V5A, V5B, 2,100 ohms. Amplification factors: V1A, V1B, 1,200 (standard American tubes have a mu. of only 400); V2A, V2B, 16; V3A, V3B, 10; V4A, V4B, 6; V5A, V5B, 5. Mutual conductances: V1A, V1B, 2,000 micromhos; V2A, V2B, 2,400; V3A, V3B, 3,750; V4A, V4B, 830; V5A, V5B, 2,300. The approximate stage gains are given as follows: V3, 8; V4, 4; V5, 5. The approximate grid swings required to overload the output are given as follows: V2 3.5 R.F. peak volts (1.6 ma. rectified current for 100% modulation); V3, + 5 volts; V4, + 37 volts; V4, 150 volts. Grid bias, V2, zero; V3, 12 volts; V4, 70 volts; V5, 150 volts. Plate potential, V2, 150 volts; V3, 200 volts; V4, 500 volts; V5, 1,000 volts. Plate current, V2, 20 ma.; V3, 20 ma.; V4, 20 ma.; V5, 75 ma.

To forestall any requests from set builders for further data on this receiver, it is here definitely stated that no further data on its construction and no blueprints are available, and we cannot suggest the changes necessary for its modification to suit American tubes. This receiver was designed by engineers who had a well-equipped laboratory, and worked out the values for all its many components with precision testing equipment. Its imitation, even with low power, is not to be commended to the set builder who has only ordinary shop equipment; and it is presented here, not for emulation, but as a matter of curious interest.

HUGE RADIO PRODUCTION

RADIO manufacturers in 1929 produced just under $440,000,000 worth of equipment, if we lump phonographs with radio, as the census bureau does. But the value of radio material produced (and these are factory costs) increased about 70 per cent over the figures of 1927, when the preceding census of manufactures was taken. That of phonographs alone, on the contrary, was more than cut in half; though combination radio-phonograph instruments tripled.

The Radio Craftsmen

(*Continued from page 676*)

when the set happened to be tuned to the wavelength of WTAM, Cleveland. How is this?

GEORGE LEWERS,
Brewster, Ohio.

(This occurrence indicates that something about the receiver is free to vibrate, like the driving unit of the loud speaker. Usually the laminations of the core of the audio transformer are found to be sufficiently loose. In a power transformer, such a condition causes hum; in an audio transformer carrying considerable signal current, the audio frequencies are transmitted mechanically to the chassis.

Oftentimes the newspapers report that radio programs are heard without the intervention of a radio receiver; but seldom, if ever, are sufficient details supplied to explain the process of detection.—*Editor.*)

A TONE CONTROL

Editor, RADIO-CRAFT:

Just a word of appreciation to let you know how much I like your magazine. The excellent articles on tone controls made a hit with me. I especially like the articles showing various stunts and kinks that your readers send in and, for this reason, like it better than any other radio magazine.

I have tried several of the tone control hook-ups shown in the January and February numbers, including the one shown in Fig. 33, which lowered the pitch, all right, but seemed to have but little effect in raising it. The amplifier I have is very good on the low notes, so I wanted to pitch it up a bit for speech. I finally hit upon the following stunt—a .006-mf. condenser shunted with a 100,000-ohm variable resistor, placed in series in one of the speaker leads. Of course this tends to cut down volume when more resistance is turned in but, for strong signals, it works nicely and makes speech often times more intelligible by taking any "fuzziness" out of same.

The pitch of this layout can be run up fully as high as old-style phonograph records and on up to the "rotten." I am wondering if some folks are not going to be disappointed with some of these tone controls on the market, which only go down on the bass in place of both ways. It takes but little condenser action across the line on my set to become objectionable although, of course, if the transformers were higher-pitched I suppose they would stand more.

JAMES S. ROWELL,
Sioux City, Iowa.

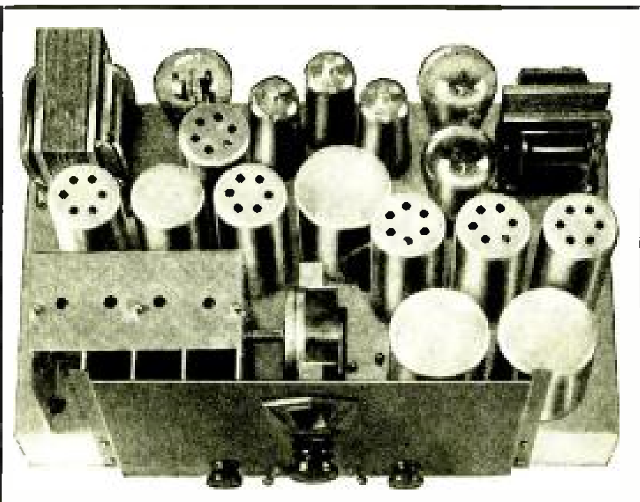
STRANGE LOCAL INTERFERENCE

Editor, RADIO-CRAFT:

As I am going away from Detroit for a few months, I thought it would be a good thing to write you and ask you to be kind enough to solve my radio trouble.

I built a three-tube single-circuit regenerative set, *about eleven years ago*, which seems to give results on long distance equal, if not superior, to many sets selling for several hundred dollars.

This set, which was so carefully constructed by the writer, is free from body capacity and, moreover, does not squeal. (Of course,



it will squeal a little bit, like every other set, when picking up a long-distance station but this little bit of squealing will only last one second—that's all.)

This set will pick up as many as thirty stations outside of Detroit, weather permitting, and Mexico City will be brought to Detroit with clearness and volume. The Spanish will be heard a block down street.

Now, to come to my trouble; in the daytime, while turning on locals, it is very much like an auction room. Everybody from everywhere seems to talk and sing at the same time. I tried a wavetrap, but that would not do any good. What do you advise? Shortening my aerial, which is about 120 feet, including the lead-in? Or another variocoupler with fewer turns on the primary? I have always thought that perhaps the primary of my variocoupler did not have enough wire, from the moment the change to the higher wavelength was made by the Radio Commission. Will the 180° degree variocoupler, covering a wavelength range of 175 to 650 meters, furnish a remedy?

I forgot to mention that all those faraway stations are picked up only after locals are off the air—that is, after 12 o'clock p.m. I would like very much to clear up these locals, without spoiling my long-distance reception, which is wonderful.

PAUL SOIDE,
4600 *Goodwin Avenue,*
Detroit, Michigan.

(We are sure that Mr. Soide's neighbors will take an interest in his problems, if they are at all inclined to radio distance work, and will be glad to do what they can to enable him to take his departure with his receiver in good DX condition. Will any of our Detroit readers help him out?—*Editor.*)

AN ALL-WAVE SET

Editor, RADIO-CRAFT:

I observe the diagram of my short-wave set in the December issue (page 353). With a coil of 50 turns of No. 22 wire on the secondary, and 20 turns of No. 28 on the tickler, stations can be logged between 220 and 520 meters. By shunting the tuning condenser with a 15-plate midget; and the set is as selective as the best. Thus, with three coils, I cover the entire scale of wavebands with perfect oscillation control and good speaker volume. The circuit is sensitive, easy to adjust and operate, and uses very little current.

M. J. ALTAMIRANO,
La Union, El Salvador, C. A.

The Radio Sextant

(*Continued from page 665*)

mental difficulties, he is now refining the design of his instrument, to make it more convenient for use, as well as more versatile. The inclusion of an "azimuth ring" will make it possible also to measure bearings—that is, angles along the horizon—and thus correct compass errors.

The inventor has also devoted considerable time to the problem of visibility through fog, along the course of a ship or aircraft, and hopes to have other interesting announcements to make later.

SPECIAL FREQUENCY TRANSMISSIONS

IN addition to transmitting, once a month, a program of code signals on several standard frequencies, for the use of radio workers calibrating and checking their wavemeters, the Bureau of Standards has undertaken a program of special weekly transmissions on 60 meters (5,000 kilocycles), on which they invite reports from listeners who are in a position to make measurements. It is desired to know how strongly the signals are received at various points at definite hours, the ratio of fading to full strength, and the length of the periods of fading, between successive crests of full signal intensity.

During November, the Bureau supervised tests of the field strength of a 150-watt transmitter, working on this frequency, over the distance between Washington and Chicago. A field intensity of about 100 microvolts per meter was maintained, in daylight, up to about 400 miles from Washington; at Chicago, 10 microvolts per meter at peak was measured. In the evening, the field strength was cut to half and, at 8 p.m., it was sometimes too low to measure, between 75 and 150 miles from Washington. Fading varied the signal strength in a ratio of about 3 to 1.

The 5,000-kc. transmissions will be given on the following Tuesdays, from 1:30 to 3:30 and from 8:00 to 10:00 p.m., Eastern Standard Time: March 10, 24, 31; April 7, 14, 28; May 5, 12, 26; June 2, 9, 16, and 30.

The signal consists of a series of very long dashes, prefaced for five minutes by the station's general call ("CQ de WWV") and an announcement of the frequency, in code. The call and frequency announcement will be repeated every ten minutes. The transmitter is crystal-controlled, and the accuracy of these transmissions is even greater than that of preceding standard-frequency broadcasts. It is planned to increase the power later.

The regular monthly transmissions will be continued on the following schedule during the spring months. Times are Eastern Standard; figures opposite each represent the kilocycles of the frequency transmitted:

Hour and Minutes E.S.T.	March 20	(Frequencies) April 20	May 20	June 22
10:00	550	1,600	4,000	550
10:12	600	1,800	4,440	600
10:24	700	2,000	4,800	700
10:36	800	2,400	5,200	800
10:48	1,000	2,800	5,800	1,000
11:00	1,200	3,200	6,400	1,200
11:12	1,400	3,600	7,000	1,400
11:24	1,500	4,000	7,600	1,500

The first two minutes of each period are devoted to the announcement of the station and of the frequency transmitted; four minutes more to a series of long dashes, with the letters WWV intervening; there are then further announcements, and an interval of four minutes while the transmitter is being adjusted for the next frequency. Information on the proper method of utilizing these signals is contained in the Bureau's Letter Circular No. 280, which may be obtained on application to The Bureau of Standards, Washington, D. C.

Hotel Directory of the Radio Trade

The hotels on this and opposite page are patronized by the Radio Trade. Make them your headquarters.

Review of Recent Radio Books

CONQUEROR OF SPACE—The Life of Lee de Forest. By Georgette Carneal. $5\frac{1}{2}$ x $8\frac{1}{4}$ inches, 296 pages. Published by Horace Liveright, New York. Price $3.00.

During the past few years, the type of biography which is devoted to picturesque expression of personality has reached its greatest vogue; almost replacing the novel as a means of "psychological escape." This biography of Dr. de Forest, one of the most colorful, as well as most important figures in the development of modern scientific and engineering methods, is not in the least dry. It is intensely human, and it describes a strenuous career. Whether or not the ambitious youth who read it will decide that it is better to be a moderately successful business man than a great inventor, is another story. But after all, inventors and discoverers, the poets of science, are born, not made; and it is to be doubted that the hero of this book would exchange his life's experience with all its ups and downs, and his international reputation, for that of a much more prosaic, though lucrative career.

The story is written for the public, not for technicians; though it contains the story of the development of "wireless," radio and the talking movies. It closes with the note, which the "Father of Radio" has prophetically sounded, that radio must find worthier ends than that to which broadcasting is today so often put, and in the confidence that radio will do so, in the field of international relations.

It is to be hoped that some typographical errors may be eliminated in subsequent editions.

PHOTOCELLS AND THEIR APPLICATION; by V. K. Zworykin and E. D. Wilson: xi, 209 pages, cloth, $5\frac{1}{4}$ x $7\frac{1}{2}$ inches, 98 illustrations, tables, and formulas. Published by John Wiley & Son, Inc., New York. Price $2.50.

Any person who is at all interested in one of the numerous fields connected with photo-electricity will find in this book a remarkably complete source of information, both historical and technical. The authors have spent much time in correlating the scientific discoveries that resulted in the present photoelectric cell, with its varied applications, and in detailing the facts concerning the various types of photo devices.

The first two chapters alone, covering the historical background and the general theories of radiant energy and photo-emissive effects, are sufficient to make the book a valuable asset to most experimenters' libraries. In the first, a chronological description of the discovery of photo-emission and the steps that followed in its development, are given. Numerous references to scientific periodicals are included, for the use of readers desiring more detailed accounts of any of the steps.

Other chapters cover the mechanical construction of different types of photo-cells (including the central-anode and the central-cathode types) and the effect of using different inert gases in the envelopes; the best cells for visible-light rays and for infra-red or ultra-violet rays; the comparative efficiency of the various types of cells; a description of the construction and the use of other photo-electric devices (such as the selenium or photo-resistive cell and the photo-voltaic cell); the practical application of photo-electricity to the talking movie industry, to television and other commercial uses; and a myriad of other subjects connected with the design and application of photo-electric equipment.

The book is written in a clear style that will please even a literary epicure, and considering the amount of useful information squeezed between the covers, it is remarkably compact.

Possibly the only criticism that could be offered would be that too little space is devoted to the present commercially-available photo-electric cells and devices. As there is a notable lack of readily-available information, regarding the characteristics and recommended uses of the present cells, a book on this subject would be improved by the addition of such commercial data. However, this is a debatable viewpoint and certainly, this book should have a place on every experimenter's bookshelf.

(C. W. P.)

SHORT WAVES, by Charles R. Leutz and Robert B. Gable: 384 pages, 6 x 9 inches, cloth, profusely illustrated. Published by C. R. Leutz, Altoona, Pa. Price $3.00

The first impulse, before opening this book, is to comment that it is a weighty one: the quality of paper used, for the purpose of obtaining the clearest photographic reproductions, is unusual. The work itself will be read with interest by any radio fan; it is not what is commonly called technical, although it goes thoroughly into all the manifestations of short waves, and gives the circuits of many pieces of apparatus which it illustrates. It is the first work of its kind to collect, from many sources, all the short-wave aspects of radio and to bring them together for ready consultation. The history of short-wave theory and technique, the phenomena of short-wave propagation, commercial work, ship, shore, and aircraft equipment, short-wave antennas, broadcast reception on short waves, medical work with high frequencies, and amateur short-wave operation are covered: a liberal chapter is devoted to television.

"It is surprising" say the authors, speaking of the survey which they conducted before the preparation of the book, "that many of the leading radio engineers, while intensely interested in short-wave research, had not conducted any original investigations. In other words, the present developments attained have been the result of work by a relatively small number of organizations and individuals." Among the latter, it may be observed, are the authors of *Short Waves*. Mr. Leutz has been a pioneer in the development of short-wave receivers, since the days when short-wave listening was a hobby of the very few; and Mr. Gable has been a worker for many years in long-distance reception study, as well as in broadcast work.

The work has covered its rapidly changing field right up to the date of publication. It is not only interesting to read, but will be valuable for future reference; as much material has been collected here which is not elsewhere conveniently available.

THE RADIO AMATEUR'S HANDBOOK. A Manual of Amateur Short-Wave Radiotelegraphic Communication. vii, 216 pp., 6½ x 8½ inches, illustrated; paper covers. Published by the American Radio Relay League, Hartford, Conn. Price $1.00, postpaid.

This, the seventh edition of this well-known work, brings its circulation to well over the hundred thousand mark. For more than four years it has been the guide of the great "ham" family; and the latest issue will replace those which have been worn out in daily and nightly service.

While the contents, dealing with amateur transmission, reception and traffic problems, can not be summarized briefly to show the additions to previous matter, the book has been increased to the extent of seventeen pages in the thorough revision which brings it up to the close of 1930. The appearance is highly improved by the use of more legible type; and the *Handbook* in every way is worthy of its publishers. Even the short-wave broadcast fan who is not interested in amateur transmission, or even code reception, will find its pages interesting and valuable; no transmitting amateur needs to be told more than that this is the latest and up-to-date edition of this convenient manual.

RADIO SERVICE MAN'S HANDYBOOK, with Addenda Data Sheets; 160 pp. and supplemental graphs, 9x12 inches, loose-leaf flexible cover. Illustrated. Published by Gernsback Publications, Inc., New York City. Price $2.00.

"It is not so much to know the law, as to know where to find it," said a great lawyer. For the radio Service Man, thanks to the many guides in his work which are becoming available, it is now more of a problem to keep under his hand the information which he requires daily. Many Service Men have expended much time and ingenuity in making home-made filing systems, to which, however, published data are not always readily adaptable.

This *Handybook*, "Volume One," contains a wealth of material on the peculiarities of commercial radio apparatus, on test methods and test equipment, service kinks and hints, etc., all indexed for ready reference. In addition, the looseleaf character of the book permits the Service Man to make his own notes, or to cut out and paste up servicing articles from any source, indexing them in the spaces left in the proper classifications. Graph paper of good quality is provided, and especially suited to making records of tests of the performance of receivers, speakers, etc. Other standard loose-leaf sheets may be inserted where desired.

To judge from the frequent suggestions received by RADIO-CRAFT, as to Service Men's filing methods, this book should be exactly what the systematic and studious worker requires daily.

PRACTICAL RADIO REPAIRING HINTS, by John F. Rider: xxi, 262 pages, 6 x 9 inches, cloth. Published by Radio Treatise Co., New York. Price $2.00.

This work is so solidly filled with condensed service information that it is difficult to give an adequate idea of its contents in a few paragraphs; the twelve solid pages of index would do so more readily. The book has over 200 illustrations, largely in the form of circuit diagrams, twenty-two pages of handy-reference tables, in addition to those scattered through the book. The work itself, however, is not mathematical in its contents, which are, as the title states, devoted almost entirely to practical consideration of the problems encountered in modern servicing, the methods of finding out most expeditiously where trouble lies, and the procedure required for the correction of these faults. The work belongs in a handy place beside the workbench of any Service Man; it is hard to imagine one either so new or so experienced that he cannot find valuable material in its pages.

THIS THING CALLED BROADCASTING. By Alfred N. Goldsmith and Austin C. Lescarboura. 5¾ x 8¾ inches, xi, 362 pp., 21 halftone illustrations. Published by Henry Holt & Co., New York. Price $3.50.

The co-authors of this work are entitled to speak with authority on the development of broadcasting. They "do not claim to have prepared a reference work on the technical progress of radio," though none are better fitted for the task; they distinctly disavow the intention of allotting the Apple of Discord to the true originator, of radio as the public understands it. This work is, however, the history of the development of radio from its first invasion of the field of telephony (and we miss the story which Mr. Lescarboura has told some radio gatherings, about the first "fan response" in radio history; however, it is probable that studio censorship would not pass it) until the present day, when television is about to join broadcast reception in every home.

The work will effect the preservation of the early history of radio's entrance into the life of a nation; which future generations trying to resurrect our times will find invaluable, for its memories of the "pre-recording" age. It is filled with personal recollections, descriptions of events and incidents over a period of many years, told in a very pleasant fashion; and much other material which everyone interested in radio or in broadcasting as a business, or as a means of advertisement should have at hand. Its value as a work of reference would have much been enhanced by an index, which, undoubtedly, will be later supplied.

In describing the rise and fall of the radio parts industry the authors declare that "millions of dollars were expended in this direction which might better have been invested in sound industrial progress." This is a viewpoint, boldly stated, which must nevertheless be read in the light of the background of the book and the affiliations of its authors.

It is true that, for most people, the enjoyment of a radio program, or of any music, is a financially unprofitable luxury. A radio set does not earn money, as does a savings-bank account; yet there are times, as economists may point out, when the expenditure of millions of dollars by the public is preferable to "conditions basically sound."

Home set building lacked, perhaps, some of the "efficiency" of mass production; but the former was the ladder by which radio manufacture climbed to its present eminence and to which, in classical manner, the industry has turned its back.

And while, as the authors say "the practice blew up; the public was through; the dealer was through"—there is no doubt that many thousands still cherish the set-building hobby, and spend money upon it; and that a new generation of set-building amateurs is succeeding the old.

One thing further: "The radio set manufacturer is under a certain obligation to see that the radio buyer obtains satisfactory radio entertainment, so far as the normal performance of the receiver is concerned. Thus the owner is assured that he will not be buying a possible radio orphan when he buys a reliable make of receiver. And so we have the modern radio set, built ingeniously, sold efficiently, and *serviced conscientiously*." The two words, closing this quotation are, as the majority of our readers will agree, the appropriate climax of a chapter on "Radio Sets by the Million."

WIRELESS CHART OF THE WORLD. 33 x 45 inches, in colors. Published by the Scandinavian Shipping Gazette, Copenhagen, Denmark; Kelvin & Wilfred O. White, Boston and New York. Price $3.50.

While this big map is intended for maritime purposes, and not broadcast notations, it would furnish the amateur and the DX fan with a splendid wall decoration. All coast radio stations, compass and beacon stations are shown on this "Mercator's projection"; which is invaluable for ship's operators, and especially attractive for the short-wave worker.

VOLUME CONTROL IN AIRCRAFT SETS

AUTOMATIC volume control has recently been developed for use on receiving apparatus for the visual type aviation beacon, which relieves the pilot of volume control manipulation. This device has been in continuous use on the experimental plane of the Bureau of Aeronautics for several months and has demonstrated its convenience and efficiency in several ways.

In the course of a flight on an air route provided with radio range-beacon facilities, the shortening of the distance between the airplane and the beacon station causes the signal intensity to increase five-thousand fold. This variation is likely to prove troublesome, particularly when following the radio course within the last ten to fifteen miles of the beacon station, where the signal strength is changing most rapidly. Since the range-beacon is to aid in directing the plane to its landing place, the new invention is especially valuable in the last few minutes of flight.

SHORT WAVES *with a Converter!*

The Model PR-3FS Short-Wave Converter that is, in fact, an all-wave converter, as it enables also the reception of broadcast frequencies. The range is 25 to 600 meters, so you are sure to cover the television band, too.

WITH high-gain radio frequency amplifiers characterizing experimenters' broadcast receivers today, and audio amplification remarkably faithful, it is convenient, economical and easy to tune in short waves and television with a converter. In that way you use your entire broadcast receiver just as it is, and besides the television band, tune in other short waves. The range is 25 to 600 meters, when the broadcast set is worked at a high frequency, around 1,500 kc.

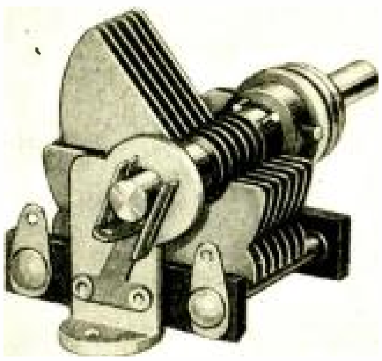
The converter illustrated is model PR-3FS and has a filament transformer built in. There are only four external connections to make, and one of these is to a positive B voltage, 50 to 180 volts, taken from the receiver. If you have a screen grid set you may take this voltage from the screen of a radio frequency tube, by looping the bared end of the B plus lead and slipping the screen prong of the tube through the loop before reinserting the tube in the set.

The converter uses three 227 tubes and plug-in coils of the tube base type. There is an AC switch built in, but there is only one tuning dial (at right). The condenser is the new Hammarlund Junior Midline of .0002 mfd. capacity.

This short-wave converter has proved highly satisfactory, developing great sensitivity and enabling the penetration of great distances. There are no body capacity, no squealing, no squawking and no tricky tuning.

By all means provide yourself with the complete parts for this dandy converter, as specified by Herman Bernard, the designer.

▽ ▽



The new Hammarlund Junior Midline Short-Wave Condenser, capacity .0002 mfd. The rotor plates turn in a diameter of only 2 inches, while the total frame depth is only 1 5/8 inches. So this is an extremely compact condenser, made by one of the foremost condenser manufacturers in the world. It is our Model No. PR-H-20, made specially for us.

THE newest condenser to come from the laboratories of the Hammarlund Manufacturing Co. is the Junior Midline, made especially for us, and designed for highest grade short-wave performance. The capacity is .0002 mfd. and the midline tuning characteristic prevails. Single hole panel mount, in a 3/8-inch hole (with option of sub-panel mounting by built-in brackets): end stop provision at both extremes; rigid plate assembly and the fine workmanship of Hammarlund mark this compact condenser. The overall depth of the frame is 1 5/8 inches, while the rotor plates turn in a diameter of only two inches. This condenser, our Model PR-H-20, is a superb product, in line with the modern vogue of compact parts.

▽ ▽

PRECISION short-wave plug-in coils, three coils to a kit, not counting as a coil the movable tickler. Used with .0002 mfd. for tuning, this kit of coils affords coverage of from 15 to 160 meters. These coils are wound on 97% air dielectric and are precision, de luxe products. A receptacle base, on which the adjustable tickler is mounted, is supplied with each coil kit. This kit is our Model No. PR-AK-1 and represents the pinnacle of short-wave plug-in coil achievement. It is for short-wave receiver circuits.

▽ ▽

EXTRA-SPECIAL FREE OFFERS OF SUBSCRIPTION PREMIUMS!

RADIO WORLD, now in its *ninth* year, is the first and only national radio weekly, and publishes the latest, up-to-the-second news of circuits, both of kit types and of 1931 commercial receivers, as well as news of happenings in the broadcasting field. Lists of broadcast and short-wave stations, including television stations, are published regularly. You get your information weekly—which means quickly—and you get it accurately, so be sure to become or remain a subscriber for RADIO WORLD. We are able to offer now premiums especially attractive to short-wave experimenters, and ask you to make your choice from the parts offered on this page. When ordering, please use coupon.

The regular subscription rates are: $6 for one year, 52 issues, one each week; $3 for 6 months, (26 weeks); $1.50 for three months, (13 weeks); $1 for 8 weeks; 15c per single copy.

RADIO WORLD,
145 West 45th St., New York, N. Y.

Enclosed please find:

☐ $12.00 for two years' subscription (104 issues) for RADIO WORLD at the regular rate. Please send as a premium all parts to build the Short-Wave Converter, including filament transformer and 5½x7-inch cabinet, but not including tubes. This is your Model PR-3FS.

☐ $6.00 for one year's subscription (52 issues) for RADIO WORLD. Please send the Short-Wave Coil Kit as a premium, your model PR-AK-1, consisting of three plug-in coils and base receptacle.

☐ $3.00 for six months' subscription (26 issues). Please send the Hammarlund Condenser, PR-H-20.

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(S)

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SANGAMO QUALITY AUDIO TRANSFORMERS

A type for every purpose.

Never sold at these prices before.

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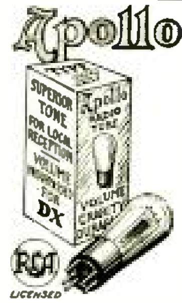
3561	BX	Push-pull Input	6.50	
3563	11X	Push-pull Output for 250 or 271 power output tubes to match the impedance of moving coil of dynamic speaker	6.50	$2.25
3565	E	Output choke to match impedance of the various type power tubes	5.00	Each



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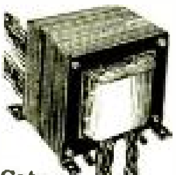
10c EACH — Lots of 100 $10.00

NO LESS THAN 50 TUBES SOLD

GUARANTEE:—All tubes packed in original manufacturer's cartons. Tubes guaranteed to light and play. FREE replacements within 5 days.

FILTER CONDENSER BLOCKS FOR ALL STANDARD SETS



STANDARD REPLACEMENT POWER TRANSFORMERS

Cat. No.	Set Model	Price
2550	Amrad Bel Canto Series 81	$3.85
2642	Atwater Kent (D) 37	2.50
2559	Bremer-Tully (R) BT 6-40	1.85
2567	Colonial (R) 32 AC	3.90
2617	Crosley (R) 30, 31, 33, 34, 40 421, 42, 82, 804	3.75
2608	Dongan 2½, 5, 15 & Hi	2.75
2575	Earl (O) 21, 22	2.25
2522	Earl 21, 22, 55, 56	3.95
2657	Eveready-Bosch (O) 28	3.50
2617	Fada (R) 25	3.75
2580	Franklin 210-250-281	3.85
2662	Freed-Eisemann (O) NR 70	5.75
2626	Freshman Q	3.85
2557	G. T. C. 1½, 2½, 5 & Hi	2.75
2575	Kolster (R) K20, K21, 6K	2.25
2655	Kolster K24 (210-250)	4.75
2656	Kolster K20, 22,	
2630	Loftin-White 600, 2½. 2½, 5	4.25
2654	Loftin & White (D), 245 Power Amplifier	3.85
2572	Midget sets using 224, 227, 245 & 280 Tubes	2.85
2615	Peerless Kylectron	2.25
2565	Peerless (O) 20, 22, 60 cy.	3.50
2600	Philco all sets	3.90
2551	R C A 17, 18, 33, 51	3.95
2573	R C A 44, 46	4.25
2566	R C A 60, 62	5.95
2603	Sonora A-31, B-31	4.50
2618	Sonora with 600 V. C.T. 2—7½V. 1—2½V., and 1—15V. with 85V. primary for voltage regulator tube	3.75
2608	Sonora (O) 4-R, 2-RP, 25, 3R	2.75
2602	Sparton (O) Using 3V heaters	4.50
2559	Steinite (R) 261, 262	1.85
2662	Stromberg-Carlson (D) 641, 642	4.75
2617	Temple (R) 8-60, 8-80, 8-90	3.75
2602	Thordarson T-3487 for Sparton 600, 5, 5, 3 V	4.50
2558	Victor using 245's	2.75
2664	Zenith 33, 34, 35, 35A	2.95
2527	Zenlth 9, 11, 12	5.00

R.C.A. VICTOR UNCASED CONDENSER

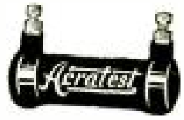
100 VOLTS D.C. WORKING VOLTAGE

This genuine R.C.A. Victor uncased condenser is composed of the highest grade materials. They are compact and moisture proof, impregnated in special heat resisting compound.

100% REPLACEMENT GUARANTEED

Cat. No.	Size	Each	
2927	½ Mfd.	25c	$2.50 doz.
2928	1 Mfd.	35c	3.60 doz.
2929	2 Mfd.	50c	5.50 doz.
2930	4 Mfd.	85c	9.00 doz.

VOLTAGE DIVIDERS, FIXED RESISTANCES AND GRID SUPPRESSORS



FOR ALL STANDARD SETS AND POWER AMPLIFIERS

Receiver, Model and Desc.	Cat. No.	Price
Brandes, B-11—4,650 ohms (tapped at 2,500, 500, 50 and a separate 1,600 sec	3922	$0.60
Crosley—5,000 ohm voltage divider	3965	.75
Earl, 31, 32—5,000 ohm voltage divider	3907	.35
Freed-Eisemann, 78, 79, 95—5,000 ohm voltage divider	3907	.35
Freshman, all N models—18,000 ohm voltage divider	3963	.75
Freshman, G10—6,560 ohms tapped at 1,100, 1,500, 1,460, 1,500, 1,000	3918	.75
General Motors, 16005—Part 14547, 9,372 ohms tapped at 800, 59, 1,863, 2,000, 4,500	3169	.80
Kolster, 6K—7,120 ohms tapped at 3,000, 220, 60, 840	4014	.65
Kolster, K-24—7,835 ohms tapped at 3,400, 3,800, 55, 80, 40, 360	3965	.75
Peerless, Courier model 22—225,000 ohm voltage divider	3870	.75
Philco, 3865—B resistor 4900 tapped at 1,400, 1,500, 2,000	3987	.80
R C A, 18, 33, 51—3,940 ohm voltage divider	3872	.30
Sparton, 110—7,000, tapped at 2,000	3976	.80
Stewart-Warner—8,000 ohms tapped at 3,500, 3,500, 2,800	3873	.40
Silver-Marshall, 655 — 11,350 ohm volt, divider	3164	1.00
Victor, R-32, R-42, RE-45 and RE-75 — voltage dividers	3170	.90
Stromberg-Carlson, 10 and 11 — Parts P19559 and P19557	3171	.80
Temple, 8-60, 8-80, 8-90—6,850 ohm voltage divider	3951	.30

UTILITY CONDENSERS IN METAL CANS

3150	1 Mfd.	450V.	.50
3152	2 Mfd.	450V.	.75
2925	1 Mfd.	1000V.	.75
2926	2 Mfd.	1000V.	1.45

10½ MFD., 600

For replacement in All Victor Sets

Total capacity 10¾ Mfds., 600 working voltage. Housed in metal can. Size: 5¾ in. long, 5 in. high and 4 in. wide.

Cat. No. 2709

Our Price $1.75

Set Model Item	Part No.	Cat. No.	Price
Atwater Kent 37 Filter Block		5001	3.75
Brandes B-15, B-16 Filter Block		5004	5.00
Columbia-Kolster, C-6 Filter Block 5005			2.00
Eveready and Bosch 1928-29 Filter Block		2988	3.95
Earl A2 Filter Block		5006	4.00
Fada D Filter Block		5008	3.75
Freed-Eisemann NR57 Filter Block		5010	3.75
Freshman H-5 Filter Block		5012	7.00
Freshman M12 (171 tube) Filter Block		5013	5.00
Freshman N11 (250 tube) Filter Block		5014	6.00
Kolster K-22, K-20, K-40, K-42. Filter Block		2805	2.50
Columbia-Kolster 920, K-43 Filter Block	WS3626A	2963	2.95
Kolster 6-H and K-5 Filter Block	2316	2815	2.75
Kolster 6J, 6K Filter Block		5022	3.50
Kolster K20, 22, 25, 48A, 48B Condenser Block	2624	2805	2.50
Majestic 171 Sets Filter Block		5026	3.95
Majestic 250 Sets Filter Block		5027	3.95
Majestic 245 Sets Filter Block		5028	3.95
Majestic Master B, Super B Filter Block		5029	2.95
Majestic Special Master B Filter Block		5030	3.25
Majestic A Eliminator		5031	3.75
Peerless All Courier Sets Filter Block		2855	1.50
R C A 18, 33, 51 Filter Block	8333	2710	1.50
R C A 41 Filter Block		5033	4.25
R C A 17 Filter Block	8289	2714	4.95
R C A 44, 46 Filter Block		2711	4.50
R C A 60 Filter Block	8346	2726	4.95
R C A 62 Filter Block		2659	5.95
Sonora Using 250 tubes, Filter Block		2914	1.85
Sparton 69, 79, 89, Filter Block		4049	4.75
Steinite 45 Filter Block		5037	5.00
Steinite 40 Filter Block		5028	6.00
Temple 8-60, 8-80, 8-90 Filter Block		2754	.95
Zenith ZE11, 12, 14, 18 Filter Cond.	PL1145	2800	3.25
Zenith ZE18 Filter Cond. 35Px, 35APX, and 37A		2701	3.25
Zenith ZE17 Filter Cond.	333X, 353X	2700	3.25

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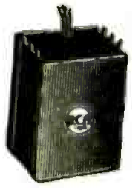
HERE'S a NEW plan, which saves you money. *Stop shopping—the lowest prices are right on this page.* Yes, lower than in our own catalog. Why? Because no house can get out a new catalog every month, but by advertising in this magazine we can bring you the latest and lowest prices *up to the time this ad is printed.* We watch our competitors and *do not allow anyone to undersell* us. We meet ANY price on NEW merchandise. *Order direct from this page and save money. 100% satisfaction on every transaction.*

Dry Electrolytic Condensers

Mount in any position! Guaranteed never to blow out! Remarkably compact and very inexpensive, permitting generous use of filtering systems. The greater the mfd. capacity employed, the less A.C. hum remains. 500 volt peak rating. Ideal for all 171A - 245 power packs—use two of each capacity desired for 250 power packs (1,000 volt peak thereby assured).

No.	Mfd.	Diameter	Length	YOUR PRICE
1801	1	¾ in.	2⅛ in.	$0.27
1802	2	1 in.	2⅛ in.	.44
1804	4	1¼ in.	2⅝ in.	.83
1808	8	1⅜ in.	4¼ in.	1.20
1816	16	3 in.	4¼ in.	2.10
1824	24	3 in.	4¼ in.	2.70
1832	32	3 in.	4¼ in.	3.30

R.C.A. Double Filter Chokes



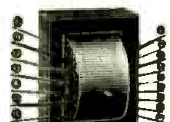
This heavy-duty, extremely strong, double filter choke can be used for all types of filter circuits, experimental work, power amplifiers, receivers, eliminators, power packs, converted sets, etc. Known as R. C. A. replacement part for all Radiola models, particularly Nos. 33, 17 and 18. Each choke D.C. resistance, 500 ohms. Connected in parallel, these double filter chokes have a rating of 15 Henries at 160 Mills; connected in series, 60 Henries at 80 Mills. Fully shielded in heavy metal case with special insulating compound. Size 5¼ x 3¾ x 2⅞. Shipping weight 6 lbs.

List Price, $10.05.

No. 8336—YOUR SPECIAL PRICE.. **90c**

Earl Power Transformer

70 WATTS



Make money revamping the old battery set. This power transformer used in Earl Model 22 receiver supplies "A," "B" and "C" potentials for: two '27's (for screen - grid '24's), three '26's, two '71A's and one '80 rectifier; total current output of high-voltage winding at maximum output (about 200 volts) is 80 ma. High-voltage secondary, filament winding for '27's, and for '71A's are center-tapped. May be used in any number of combinations. Suitable resistors, a couple of 4-mf. filter condensers, two 30-henry chokes and by-pass condensers complete fine power pack. Size 3¾ x 3 x 2¾ inches. 16 long leads and full wiring directions. Shipping weight 5 lbs. List Price $7.50.

No. 1410—YOUR SPECIAL PRICE **$1.73**

Utah Dynamic A.C. Power Speaker—Model 33A

110-volt, 60-cycle A.C. light socket supply for field excitation with Westinghouse dry rectifier. 9 in. high, 9½ in. wide, 7½ in. deep. Speaker comes packed in wooden crate. Weight 19 lbs. It is one of the most powerful as well as best reproducers in the market. 9-inch cone. List Price $50.00.

No. 1506—YOUR SPECIAL PRICE **$7.45**

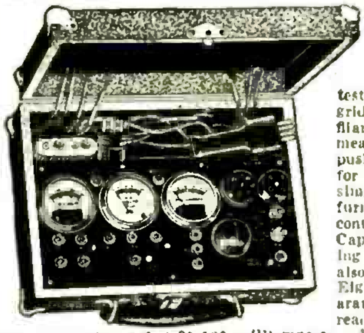
Adjustable Voltage Divider

Designed for extra heavy duty. It can be used in any radio power operated set, "B" eliminators, power packs, amplifiers, etc. Especially useful in all radio set replacement work, used in converting battery sets into power sets. The correct voltage is obtained by loosening screws of sliders and by moving the latter into the correct position. Voltage cannot vary due to the peculiar construction of the resistor and contact sliders. Shipping weight ½ lb. List $1.50.

No. 2275—Divider, 10,000 Ohms, 3 slides.......... **75c**

No. 2276—Divider, 25,000 Ohms, 4 slides.......... **75c**

New READRITE Analyzer.



This three-meter analyzer has selector switch for checking all parts of tube circuits by connecting to the set sockets. Selection for testing voltages of plate, grid, cathode and screen-grid done quickly and accurately. Plate current, filament volts, line and power supply volts are measured. Grid swing test for tubes used. Just push one button for screen-grid and other button for other tubes. Makes testing of all type tubes simple and thorough. 4½-volt grid battery is furnished. Battery is used for grid test and continuity testing of transformers, chokes, etc. Capacity and resistance charts furnished showing use of instruments for testing condensers, also measuring resistances up to 100,000 ohms. Eight scale readings of meters may be used separately with the jack terminals provided. Scale readings are 0-60-300-600 D.C. volts, 0-10-140, 700 A.C. volts and 0-20-120 milliamperes. A.C. and D.C. filament voltages are accurately measured on the one meter. Strong case with leatherette covering. Attractive. Compact. Complete. Fills every need for the expert serviceman or the beginner for radio set analyzing. Size 10¾x3½x8 inches. Shipping weight 15 lbs. List Price $25.00.

No. 700—READRITE ANALYZER. YOUR PRICE.......................... **$14.70**

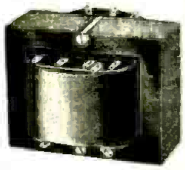
Kolster Power Transformer

85 WATTS

Will supply sufficient current and voltage for push-pull '10's, in conjunction with type '81 half-wave rectifiers. The 2.25-volt secondary output is just below the rated maximum for type '24 and '27 tubes; tubes will last much longer than when heated from a higher-voltage transformer. Four secondaries are rated as follows: Secondary S1, 7.5 V., 1.25 A.; S2, center-tapped, 7.5 V., 1.25 A.; S3, 1.5 V., 4.25 A.; S4, 2.25 V., 1.65 A.; S5, 725 V., 90 Ma. Primary is tapped for low line voltage. For 110-120 volts, 50-60 cycles. 4½ x 4½ x 4½ inches. Shipping weight, 12 lbs. List Price, $19.50

No. 4336—YOUR PRICE........ **$5.75**

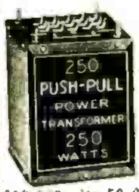
Peerless ABC Power Transformer—80 Watts



As used in "Courier Model 65" chassis. Plate, control-grid, screen - grid, filament voltages for three '24's, two '27's two '45's, and '80 rectifier (electrostatic reproducer biasing potential rectifier). Has approximately the following output ratings: 2.5 V., 10 A.; 700 V., center-tapped, 350 V. and 120 Ma. on each side; 5 V., 2 A.; 3 V., 60 Ma. Primary tapped for low or high line voltage. The correct replacement for big sets. For 110-120 volts, 50 or 60 cycles. Dimensions 4x4x3½ in. Weight 6 lbs. List $12.00.

No. 1403—YOUR PRICE......... **$2.65**

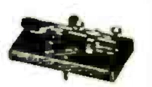
"250" A.C. Power Transformer



This power transformer supplies currents for five 15 - volt Arcturus tubes drawing 5 Ma. and ½ amp. on filaments; one 2.5 V. tube; two '50's, and two '81's. Two 227 or 224 (if suitable resistance is used) and 750 volts. Full wave "B" and "C." Entirely shielded in metal. 4⅞x4⅞x6⅛ inches high. Weight 15 lbs. For 110-120 volts, 50-60 cycles. List $20.

No. 1412—YOUR PRICE........ **$3.75**

Professional Telegraph Key



Used for telegraphy, radio, home practice, house-to-house communication, as a keying means in test circuits, etc. Mounted on heavy micanite base 3¼x5x½ in. thick. Has 2 switches to telegraph on two circuits, independently or together. **A wonderful chance to get a commercial telegraph key with sturdy ¼-in. silver contacts!** Handles a lot of power. Shipping weight 2 lbs. List price $3.50.

No. 1625—YOUR PRICE.......... **70c**

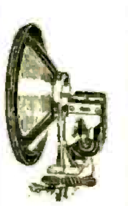
NEW! NEW!! Superheterodyne S-W Converter

Positively greatest converter ever built. It brings in European stations daily, clear as a bell.

At last a short-wave converter that converts any broadcast set into a superheterodyne short-wave receiver. Employs three 227 tubes and covers from 20 to 115 meters. No plug-in coils! Coil switch is used to cover all wavelengths. Single dial control, no body capacity, no squeals. This converter has built-in filament transformer to heat the three 227's. All you need to obtain from your receiver is a positive B voltage anywhere from 45 to 180 volts. Voltage is not critical; no molestation of the receiver. So simple a child can operate it. Size 7x10x5 inches. Shipping weight 8 lbs.

No. 1614—Super Converter. List Price $25. Your Price (less tubes) **$15.95**

Kolster Speaker Chassis



May be connected directly in the plate circuit of type '12A tubes; or to higher-power tubes through an output device. In push-pull circuits, speaker may be connected from plate to plate. "9-inch cone" type. Paper-rattle is prevented by a flannel damper; bass notes are well reproduced due to the "free-edge" effect. Its small dimensions make it eligible for use in home-constructed midget sets. Comes with 6 ft. cord. Dimensions: 10 x 5½ x 9½ inches. Shipping weight 6½ lbs. List Price, $18.00.

No. 1500—YOUR PRICE........ **$2.80**

6 MONTHS GUARANTEED NEONTRON TUBES

Sold on a 6 MONTHS FREE REPLACEMENT GUARANTEE BASIS, PROVIDING TUBE LIGHTS! All tubes are carefully meter-tested before shipment, and carefully packed. Do not confuse these HIGH QUALITY tubes with any other "low priced" tubes—our low prices are possible because we do a VOLUME business!

Choice of	Choice of	Choice of	Choice of
226	112A	245	222
227	200-A-199UX	280	210
171A	199UV-120	171	250
201A	224		281
63c each	69c each	79c each	$1.58 each

Genuine Magnavox Microphone

Do Your Own Home Phonograph Recording

Made by the world-famous Magnavox Co. While originally made to strap on the head, it is easy to screw a handle onto one of the side brackets. The side brackets are covered with soft rubber and place the microphone at the best speaking distance from the mouth. Comes with 6 feet of cord. **The biggest mike bargain in America!** Complete with straps and buckle to fit around head. Brand new, in original factory packing. Shipping weight 1 lb.

List Price, $10.75.

No. 1610—YOUR SPECIAL PRICE **$1.55**

A.C. Short Wave Converter

The thrill of tuning in short waves is yours, because you can connect this short-wave converter to your broadcast receiver, no matter what type receiver you have. Tunes from 10 to 200 meters, using only two plug-in coils. Coils, already wound, are supplied with outfit. Converter has built-in filament transformer to heat three 227's. All you need obtain from your receiver is a positive "B" voltage, anything from 45 to 180 volts. Voltage not critical. No molestation of the receiver. No tricky regeneration control, only a single, smooth-operating dial to manipulate. No squeals, no grunting, no body capacity. All parts for 3-tube short-wave converter, including cabinet, with filament transformer, complete instructions and pictorial diagram. Shipping weight 8 lbs.

List Price $20.00.

No. 1617—YOUR PRICE, less tubes **$9.45**

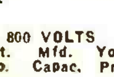
FREE

We have just issued our new "RADIO SERVICE TREATISE." It's red hot all the way through. 52 new hookups and circuit diagrams. 110 illustrations.

Partial contents: Modernizing old radio sets. How to convert battery to power sets. Selection of tubes. The detector tube. The power tube. Changes in grid or "C" bias circuits. Push pull amplifiers. Replacing audio transformers. Phono. attachments. How to choose power transformers. Voltage dividers. Wattage of power transformers. Selecting and installing replacement parts in radio sets. Filter condensers. Repairing "B" eliminators. ALL BRAND NEW DOPE—NOT A REPRINT. Chuck full of REAL radio information all the way through. Even the catalog section has dozens of hookups—never found anywhere before.

WRITE TODAY. Enclose 2 cents for postage. Treatise sent by return mail.

High-Voltage Condenser Units



We guarantee these condensers unconditionally. They are ideal for general replacement purposes and can be installed in any new power-pack. All condensers are furnished with 8-inch lengths of tinned "push-back" wire.

600 VOLTS			800 VOLTS		
Cat. No.	Mfd. Capac.	Your Price	Cat. No.	Mfd. Capac.	Your Price
1702	½	$0.25	1706	1	$0.40
1703	1	.30	1707	2	.70
1704	2	.40	1708	4	1.05
1705	4	.60			

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15 TO 650 METERS — NO COILS TO CHANGE

The New

PILOT

UNIVERSAL SUPER WASP RECEIVER

Pilot's wonderful wave band changing switch, incorporated in the new Universal Super-Wasp, revolutionizes the short wave art. No longer need numerous coils be changed to cover the various wave bands. No longer need dial settings change each time the same distant stations are tuned in. You can log permanently all the stations you can get throughout the world, you can tune from the short waves to the high ship waves without removing your hand from the single control knob.

Universal Features Revolutionizing the Short Wave Art

Complete coverage all wave bands from 15 to 650 meters *without coil changing*. Complete A.C. operated *chassis in cabinet*. (*Also available in battery model*)
All *Metal* Chassis.
Highly sensitive and selective circuit.
Screen Grid T R F amplifier *plus* Screen Grid *Detector*.
227 First Audio Stage.
Two 245's in push-pull output stage.
Stations can be logged *permanently on dial*.
Regeneration control does not alter tuning.
Provision for *Phonograph Pick-up*.
Earphone Jack on *Front Panel*.
Illuminated Dials.
Handsome Walnut Cabinet.
Most advanced construction yet used for short wave work.

In kit form for easy home assembly; no drilling or cutting, all parts fully prepared.

> NOTICE TO "HAMS": Pilot will continue building the original Super-Wasp in kit form for licensed amateurs and others who want to spread the tuning on their pet wave bands and add their own audio features. A. C. and battery models.

What You Can Get on the UNIVERSAL Super-Wasp

On the short waves are hundreds of relay broadcasting, experimental and amateur stations transmitting voice and music; actually thousands of amateur and commercial stations sending code; numerous trans-oceanic and ship-to-shore telephone stations; dozens of television transmitters; and police radiophone stations in many cities.

On the broadcast ranges, the Universal Super-Wasp covers the full maximum and minimum limits, bringing in broadcasts never heard on the average broadcast receiver.

Above broadcast ranges, the Universal brings in ship and shore stations on 600 meters.

What other receiver offers you as much radio with as little effort?

Ask your dealer for a demonstration!

Pilot Universal Super Wasp $79.50 A. C. Model (K-136) in Kit Form

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