RADIO'S LIVEST MAGAZINE

A GERNSBACK PUBLICATION

January
25 Cents

Radio-Craft

FOR THE

SERVICE MAN - DEALER - RADIOTRICIAN

HUGO GERNSBACK Editor

The Radio
TRILLION-TONE ORGAN
See Page 402

Midget Radio Sets
Personal Tone Control
Radio's Latest Devices

Service Men's Department
Testing Equipment and
Methods — Data Sheets

Television — Short Waves
Sound Amplification
Kinks and Experiments

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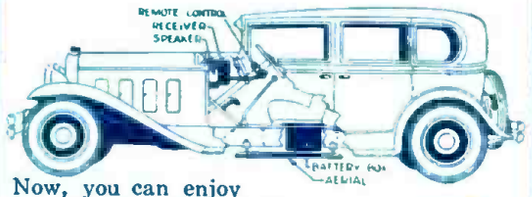

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Radio-Craft

FOR THE SERVICE MAN · DEALER · RADIOTRICIAN

HUGO GERNSBACK, Editor-in-Chief

JOHN F. RIDER,
Editor Service Dept.

C. P. MASON,
Associate Editor

VOLUME II
NUMBER 7

Contents of This Issue

JANUARY
1931

In Forthcoming Issues

TELEVISION AND SHORT-WAVE RECEIVERS FROM THE SERVICE STANDPOINT, by John F. Rider. From the experimenters who made their own apparatus, and learned its peculiarities from the baseboard up, we are coming to the point where the public wants to look and listen in. It will add another problem to those which the Service Man must meet; and this article will deal with the subject in a practical manner.

A LONG-WAVE CONVERTER, by Clyde J. Fitch. Short-wave adapters have introduced a new world to set owners. At the same time, it must be remembered, most of the world's really high-powered stations are above 600 meters. A device which will render them available to the enterprising listener, at little expense, will be described.

A HOME-MADE SLIDE-WIRE BRIDGE, by A. W. Bonser. This device, which applies familiar devices to the measurement of resistance, is very simple; and the labor of calibration and computation has been very much shortened by the provision of a proportional scale. Such equipment, with a few standard resistors—which may be calibrated from one known value—should be on every radio man's workbench.

CHARACTERISTICS OF TUBES. A graphic study of tube properties—especially that important one of mutual conductance—showing different tube types. In addition to this, much practical information on the constants required in tube operation will appear.

And many other practical articles for the Service Man, the Set Builder and the Experimenter.

RADIO-CRAFT is published monthly, on the fifth of the month preceding that of date; its subscription price is $2.50 per year. (In Canada and foreign countries, $3.00 a year to cover additional postage.) Entered at the postoffice at Mt. Morris, Ill., as second-class matter under the act of March 3, 1879. Trademarks and copyrights by permission of Gernsback Publications, Inc., 98 Park Place, New York City.

Published by

TECHNI-CRAFT PUBLISHING CORPORATION

Publication Office: 404 No. Wesley Ave., Mount Morris, Illinois

Editorial and Advertising Offices
96-98 Park Place, New York City

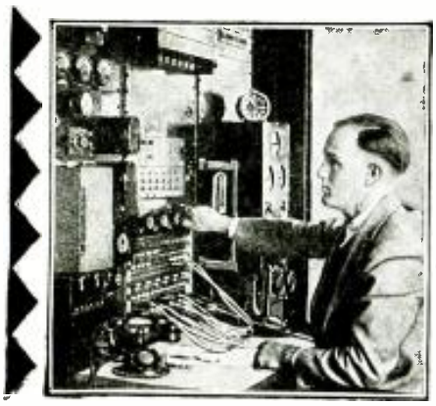
Western Advertising Office
737 North Michigan Avenue, Chicago, Ill.

L. F. McCLURE, Western Advertising Representative

London Agent: Hachette & Cie., 16-17 King William St., Charing Cross, W.C. 2

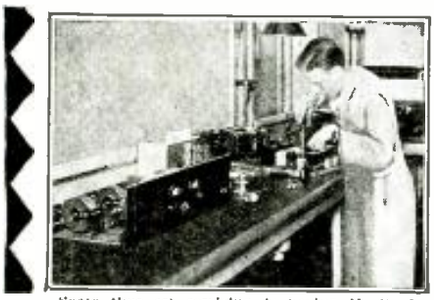
Paris Agent: Hachette & Cie., 111 Rue Reaumur

Australian Agent: McGill's Agency, 179 Elizabeth St., Melbourne

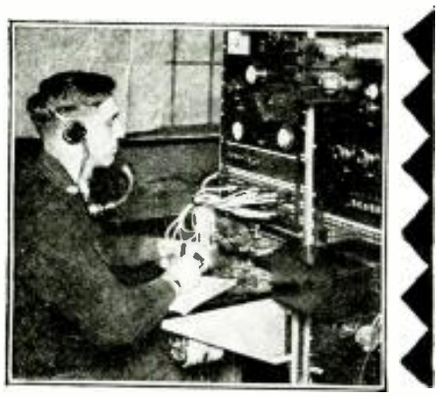


Broadcasting Stations offer fascinating jobs, baying from $1,800 to $5,000 a year.

Operating on board ship gives you world-wide travel without expense and a salary of $85 to $200 a month besides.



Spare time set servicing is paying N. R. I. men $200 to $1,000 a year for their spare time. Earnings begin almost at once after enrolling.



Commercial Land Stations are being opened very rapidly in our leading cities. Trans-Oceanic telephony offers many attractive jobs.

Radio factories employ thousands. Salaries for well trained men range from $1,800 to $5,000 a year.

You're Wanted

Take your pick of these fine Big Pay Radio Jobs

You have seen how the men and young men who got into the automobile, motion picture and other industries when they were started had the first chance at the key jobs—are now the $5,000, $10,000 and $15,000 a year men. Radio offers you the same chance that made men rich in those businesses. Its growth has already made men independent and will make many more wealthy in the future. Its amazing growth can put you ahead too. Don't pass up this opportunity for a good job and future financial independence.

Hundreds of $50 to $100 a week Jobs Opening Every Year

Radio needs more trained men badly. Why slave your life away for $25 to $40 a week in a no-future job when you can get ready in a short time for Radio where the good jobs pay $50, $60, $75 and $100 a week? And many of these jobs can quickly lead to $150 to $200 a week. Hundreds of fine jobs are opening every year for men with the right training—the kind of training I'll give you.

I Am Doubling and Tripling Salaries

Where you find big growth you always find many big opportunities. I am doubling and tripling the salaries of many men every year. After training with me only a short time they are able to make $1,000 to $3,000 a year more than they were getting before. Figure out for yourself what an increase like this would mean to you—the many things that mean so much in happiness and comfort that you could buy with an additional $1,000 to $3,000 a year.

Many Make $10 to $25 a week Extra Almost at Once

The day you start I'll show you how to do ten jobs common in most every neighborhood that you can do in your spare time. I'll show you how to repair and service all makes of sets and do many other jobs all through my course. I'll give you the plans and ideas that are making $200 to $1,000 for my students while they are taking my course. G. W. Page, 107 Raleigh Apts., Nashville, Tenn., writes: "I made $935 in my spare time while taking your course."

You Have Many Jobs to Choose From

Broadcasting stations use engineers, operators, station managers. Radio manufacturers continually need testers, inspectors, foremen, engineers, service men, buyers and managers. Shipping companies use hundreds of operators and give them world-wide travel with practically no expense and a good salary besides. There are hundreds of opportunities for you to have a spare time or full time Radio business of your own. I'll show you how to start one with practically no capital. My book tells you of other opportunities. Be sure to get it at once.

$400 a Month

"I spent fifteen years as traveling salesman and was making good money but could see the opportunities in Radio. Believe me I am not sorry, for I have made more money than ever before. I have made more than $400 each month and it really was your course that brought me to this. I can't say too much for your school."

J. G. Dahlstead,
1484 South 15th St.,
Salt Lake City, Utah.

$800 in Spare Time

"Money could not pay for what I got out of your course. I did not know a single thing about Radio before I enrolled, but I have made $800 in my spare time although my work keeps me away from home from 6.00 A. M. to 7.00 P. M. Every word I ever read about your course I have found true."

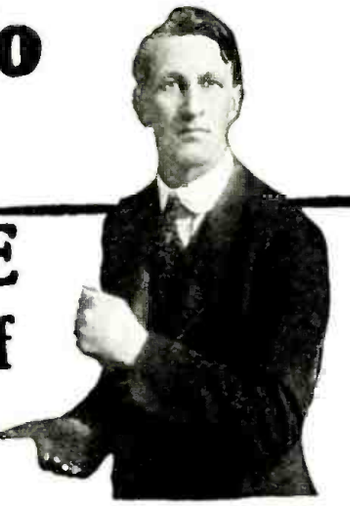
Milton I. Leiby, Jr.,
Topton, Pa.

Seldom Under $100 a week

"My earnings in Radio are many times greater than I ever expected them to be. In November I made $577, December $645, January $465. My earnings seldom fall under $100 a week. I'll say the N. R. I. course is thorough and complete. You give a man more for his money than anybody else."

E. E. Winborne,
1267 W. 48th St., Norfolk, Va.

for a Big Pay Radio Job



I will train you AT HOME
free book gives facts and proof

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Hold your job. There is no need for you to leave home. I will train you quickly and inexpensively during your spare time. You don't have to be a high school graduate. My course is written in a clear, interesting style that most anyone can grasp. I'll give you practical experience under my 50-50 method of training—one-half from lesson books and one-half from practical experiments. When you graduate you won't have to take any kind of a job to get experience—you will be trained and experienced ready to take your place beside men who have been in the field for years.

Television and Talking Movies Included

My course not only gives you a thorough training in Radio—all you need to know to get and hold a good job—but also your choice without extra charge, of any one of these special courses: Television, Aircraft Radio, Broadcasting, Commercial and Ship Radio Stations, Sound Pictures and Public Address Systems, and advanced Radio Servicing and Merchandising. You won't be a "one job" man when you finish my course. You'll know how to handle a job in any one of Radio's 20 different branches of opportunity.

Lifetime Employment Service to All Graduates

When you finish my course you won't be turned loose to shift for yourself. Then is when I will step in and help you find a job through my Employment Department. This Employment Service is free of extra charge both to you and the employer. My Employment Department is getting three times as many calls for graduates this year as last year.

Your Money Back if Not Satisfied

You do not risk a penny when you enroll with me. I will give you an agreement in writing, legal and binding upon the institute, to refund every penny of your money upon completing my course if you are not satisfied with my Lessons and Instruction Service. The resources of the N. R. I., Pioneer and World's Largest Home Study Radio training organization, stand back of this agreement.

Find Out What Radio Offers You—Get My Book at Once

One copy of my valuable book "Rich Rewards in Radio" is free to anyone interested in making more money. It tells you where the good jobs are, what they pay, how you can quickly and easily fit yourself to get one. The coupon below will bring you a copy. Send it at once. Your request does not obligate you in any way. Act NOW.

J. E. SMITH, President
Dept. 1AX
National Radio Institute
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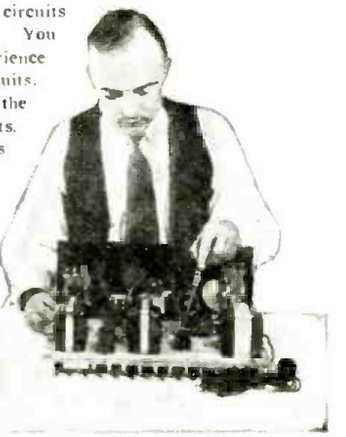
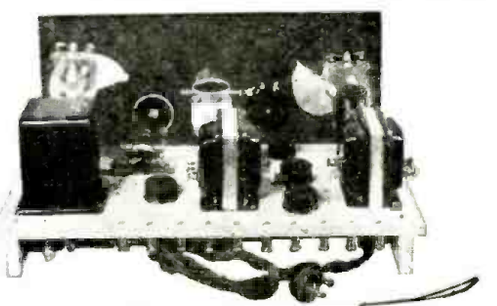
I give You 8 Big Outfits of Radio parts for a home Experimental Laboratory



You can build over 100 circuits with the outfits I give you. You learn from actual experience about A.C. Screen Grid Circuits, push-pull amplification and the other features in modern sets. You work out with your hands the principles, diagrams and circuits you learn from my lesson books. You get as much practical experience under this unequaled method of home training, in a few months, as the average fellow gets in two to four years in the field.



Salary Three Times Larger

"Before I completed your course I went to work for a Radio dealer. Now I am assistant Service Manager of the Sparks-Withington Company. My salary is three times what it was before taking your course. I could not have obtained this position without it. I owe my success to N. R. I. training."

H. A. Wilmoth,
Sparks-Withington Co.,
Jackson, Mich.

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JANUARY
1931
VOL. II—No. 7

Radio-Craft
FOR THE SERVICE MAN-DEALER-RADIOTRICIAN
"Takes the Resistance Out of Radio"

HUGO GERNSBACK
Editor

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

"Midget" Radio Sets

By Hugo Gernsback

ANOTHER minor revolution in the radio industry has occurred, during the past few months, on the appearance of the so-called "midget" or mantel radio sets. We started out with rather small sets during the years 1923 and 1924, when the table model was popular, and before the console had arrived. We are now going back to old times; but going the old style set one better by making one still smaller. Curiously enough, the first table model was of the five-tube variety, while the present mantel sets are mostly of the five-tube variety as well. History, it seems, is repeating itself.

Many people, in the trade and elsewhere, are of the opinion that the popularity of the mantel set is due to present economic conditions; because it seems that, at the present time, the mantel sets are far outselling the more expensive models. One manufacturer alone, within a short season, has sold over 150,000 of these mantel sets; and there are a number of others who are doing as well and even better. This seems to prove the popularity of the midget type. But, so far the economic point is concerned, I do not think that we should stress this too much. Either a family wishes to get a radio set or it doesn't. If they do, the great majority buy on the installment plan, anyway; and, inasmuch as the payments are reasonable, the chances are that the temptation to buy the bigger and more elaborate set, rather than the smaller one, will prevail—always provided that the family wishes a piece of furniture. And herein lies the whole crux of the question.

Modern living conditions are such that space in the average apartment is at a premium. Houses and apartments are becoming smaller all the time; and apartments, particularly, tend to shrink in not only the number of rooms, but the size of the rooms as well. Families who used to live in eight and ten-room apartments now live in four or five rooms; and so on, in proportion. Consequently, room is at a premium and this fact, I believe, is a direct cause of the success of mantel sets, rather than the price.

Furthermore, we seem to be heading towards the average of two and three radio sets per family. There was a time when any family could get along with a single car; but statistics show that today many own two or more cars. The case of radio is similar; there are so many programs in the air, and of such wide variety, that it is impossible to satisfy all tastes with a single set. The old people wish to listen to serious music, lectures, etc., while the younger element prefers lively dance music and what-not; and, as a rule, there is a clash in the average family when the radio is turned on. So, here the mantel set steps in and solves the problem. It is no longer a novelty to find two radio sets in an apartment; I have seen as many as four in a home, although this may be an extreme case. The well-to-do family will wish to have a "furniture-type" receiver in the living room; whereas Junior or the daughter will have sets for themselves in their respective rooms and—with domestic help what it is today—it has been found that a midget set in the maid's or the cook's room will do a lot towards keeping them satisfied.

Make no mistake, the midget sets are here to stay; and the chances are that, during the next few years, they will grow in popularity. I venture to predict that we will have excellent sets even smaller than those which are in such vogue at present. Practically all of the present mantel sets are equipped with dynamic speakers, and have as much power as the large sets. Practically all of the small sets have entirely too much power for city use; and it is my opinion that still smaller sets, using magnetic speakers and fewer tubes, and selling for considerably less than the present mantel sets, will come into use. Such "Tom Thumb" "sub-midget" sets will be desirable; particularly for those owners who do not wish to be annoyed with too much power and who desire a type of receiver that can be used in a small room. It would seem that such sets should be particularly attractive for hotel installations, hospitals and other institutions; since the user would be able to tune in any program he wants, rather than take a choice of one or two—which is now the case with many hotel and hospital installations.

What midget set users require most, today, is a built-in antenna connection that will do away with an outside aerial. One or two such models have already appeared, and it is to be hoped that soon they will be universal. Such sets will become still more popular at the moment when all you are required to do is to plug into the light socket, which will supply also the aerial and ground connections automatically. (It is true that such connections are usually undesirable except in congested centers, where there are many broadcast stations; an outside aerial is, of course, preferable.)

From the service angle, the midget sets are almost ideal; for it is much easier to service them than sets of the large furniture type. The components of the midgets are far more accessible to the Service Man and, consequently, they can be serviced much more quickly and efficiently than other sets.

In my opinion, the chances are that these sets will ultimately outsell all others and that, numerically, they will be far in the lead within the next few years.

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

THE TIME ELEMENT IN SERVICING

By John F. Rider

SINCE the publication of the much-discussed article entitled "The Flying Service Man" in the November issue of RADIO-CRAFT, the writer has been carrying on an experiment to determine just how much time is necessary to satisfactorily repair a defective receiver. Some observations have been made but, unfortunately, the nature of the experiment is such that a final conclusion is impossible.

At the same time, it has been shown that just one type of trouble may be remedied within 15 minutes. This is the defective tube, which is evident by a visual inspection; in other words, that in which the filament or the heater is damaged.

Close observation and timing, of several experienced Service Men, shows that inspection of the modern radio receiver by means of a conventional set analyzer consumes at least 2 minutes per tube; and this means rapid operation with quick decision as to what is good or bad.

Any defect within a receiver, particularly in the underside of the chassis, requires a period of time from at least twenty minutes to an hour. The most advantageous conditions, such as repairing by a man who has specialized upon the model in question and who is familiar with the most vulnerable parts of the receiver, are not conducive to repair within 15 minutes.

After all is said and done, the item of primary importance is the correction of the defect and not the breaking of speed records. One of the major reasons for repeat calls is previous hurried repairing of a defective unit, and acceptance of the subsequent performance of the receiver as normal.

In this connection we can cite a very excellent example. A man was called in to examine a power amplifier afflicted with fitful performance. A checkup showed that one of the voltage divider's terminal connections was very poor, and open-circuited every so often.

The repair was completed and the voltages were normal once more. However, the amplifier was noisy and, furthermore, each time the unit was placed into operation a few arcs were noted, within the rectifier tubes, which disappeared after a few moments. The Service Man noted this condition, yet left with the statement that it was "quite alright." Within thirty minutes of his departure, the rectifier tubes departed this life with a beautiful electrical display from both tubes.

Subsequent inspection showed that the input filter condenser had ruptured, and the consequent load ruined the tubes. Now, the crackling and noise, accompanied by the momentary arcing subsquent to the repair, proved that something was wrong and that a further check was in order. That Service Man should have realized that the location of the open in the voltage divider was such as to open the complete load and, therefore, apply fairly high voltages to the input filter condenser. We should have realized that such a condition is apt to damage that condenser. The initial arcing was evidence of such a defect. Unfortunately, the repair was not permanent and the two tubes must be replaced.

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 as useful guides. Letters, stories, requests and suggestions for this department may be addressed to him in care of RADIO-CRAFT.

Here is an illustration of a case, which proves the point broached by the writer some time ago. Remedying a defect is not in itself sufficient. With the complex structure of a modern radio receiving or amplifying system, an investigation of the complete system is necessary when the original defect was such that it was apt to cause injury to some other part. This is particularly true when the test, subsequent to the repair, shows a condition unusual to normal operation.

It is indeed unfortunate that some defects are not evident by visual inspection. It is also unfortunate that it is quite difficult to differentiate between fault which is productive of noise, and electrical disturbance originating from an external source. Because of these limitations, it becomes imperative to make a thorough test if the slightest irregularity is noted after the original defect is remedied.

Entirely too much stress is placed upon time, and too little stress upon service. If it is necessary to charge for the time spent, do so and make that fact known before the service work is started. All of us appreciate the need for business and realize that customers do not part with their money very readily. Yet, in the long run, in work of this nature, repeat calls are more injurious than a normal charge necessitated by the work at hand.

At the same time, one should not imagine that every defect will cause injury to some other unit in that receiver or amplifier. Time and again, the repaired system will function in normal manner; but the Service Man should prepare for the emergency and stipulate the possibility of more than one defect, and the consequent increase in charges.

In this connection we cannot help but wonder if the radio service business is unlike all other service operations. From the technical angle, the efficient Service Man should be in a position to repair any type of radio receiver. From the monetary angle, specialization appears much more profitable. We realize that such specialization is impossible in certain parts of the country, where Service Men are few and far between, and types of radio receivers are many. But, in large cities, where large numbers of receivers of similar manufacture are available, the specialist finds things more to his advantage.

There can be no denial of the fact that knowledge pertaining to the wiring of systems, the locations of the units which are known to fail most frequently, and sundry other items of this nature, tends to expedite service without undue hurry. Supplementary to this is the realization that one man cannot be familiar with the location of the vulnerable units in all receivers. He cannot be familiar with the possible locations of the various parts so that he can test continuity without much delay. As a matter of fact, a great deal of time is lost determining the functions of the tubes in the respective sockets, when placing the set-analyzer plugs into the tube sockets.

As to specialization, we do not mean continual attendance upon just one make of receiver. With the trend towards a single chassis for a group of models, it is possible to specialize in at least half a dozen manufacturers' receivers.

As to the time lost, prior to the actual service work, we wonder if it is not more sensible to remove the chassis right at the

(*Continued on page* 427)

Leaves from Service Men's Note Books

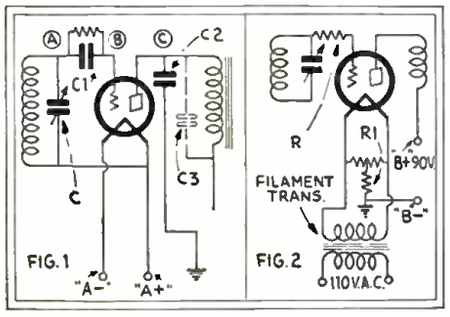
The "Meat" of what our professionals have learned by their own practical experiences of many years

By RADIO-CRAFT READERS

TESTS WITH SIMPLE EQUIPMENT

By Duncan Salmond

THE first thought of the average radio owner is to call the Service Man before he stops to consider whether the noise (or lack of noise) is the fault of the receiver. However, when the Service Man arrives, he will find as a rule, if any trouble is evident, that it is in the accessories; these, therefore, are first to be checked. If, however, the trouble is in the chassis, it is best to take everything to the shop for repairs;



A few quick continuity tests which require only an inexpensive voltmeter; at the right, a point to watch when testing a '26 tube circuit.

for the customer, whether he will admit it or not, dislikes to see the set pulled apart, and usually feels that it never sounds the same again.

Suppose an ordinary six-tube battery set is placed on the shop bench. Hook it up; if a by-pass condenser is shorted, this will be shown at once by the spark as soon as the connection is made. Take an ordinary voltmeter, with a scale of at least a hundred volts; it is not necessary that it be a precision instrument. Put the negative lead of the voltmeter on the "A—" binding post, and touch each plate contact in turn. The detector and two audio readings should be partial (in the latter case because of the drop through the transformer primary) while the readings on the R.F. plates should be full; no reading at all indicates an open plate circuit, or that the by-pass condenser (C2, Fig. 1) is shorted to ground. If, however, this condenser only by-passes the primary winding (C3), we have instead a full reading when it is shorted.

To check grid continuities, a low-range meter is best. It will give a reading on the coil side of the grid condenser (C1 at A, Fig. 1) but none on the socket side because the grid leak has too high a resistance to permit a reading on the meter. If these tests show no lack of continuity, test the audio assembly by touching the grid of the detector tube; a buzz shows that the audio assembly is O. K.

Apply the aerial to the plate of the last R.F. tube, with a local or your oscillator tuned in. If nothing is heard, the plates of the detector tuning condenser are shorted. Test backwards to the aerial. This completes the test: it is assumed that good tubes have been used and that they all light, showing switch and rheostats to be good.

With the all-electric receiver, we test from the ground. However, correct voltage may be read from the plate of a tube to ground when the plate circuit is open. (See Fig. 2.) That is, with a '26 tube, for instance, if the grid-biasing resistor is open, there is no reading between ground and filament; but there is a return to "B—" from the plate through the ground. Shorting the grid to the filament with a piece of wire will give a loud hum and distorted signals, if the trouble is due to an open resistor. (Do not confuse the biasing resistor with the grid-suppressing resistor, which is used in the R.F. stages of many receivers.) The "B" supply is conveniently tested for opens or shorts where the power cable is connected to the chassis.

If a short-circuited tube is found, look for an open primary or grid suppressor resistor; and if one of these is burnt, look for a shorted tube. A tube may test O. K., and yet have weak elements which are shorted readily by a jar or shock. This should be borne in mind when testing. If the first tube is shorted, examine the antenna coupling choke. Opening this may cause oscillation, or hum in electric sets.

WHAT have you found a handy tool in servicing; what points do you find it best to inspect first on a certain receiver model? Other Service Men will profit by your experiences, as you do by theirs; the simplest things are often the most valuable. Tell your story in a few lines to the Service Men's department.

ATWATER KENT DYNAMICS

By Ray Lampson

PERHAPS a lot of expert Service Men have encountered the condition described; but this may help some RADIO-CRAFT readers. First, determine that the trouble is in the speaker; then make a continuity test of the voice coil with a 0-10-volt meter and a 4½-volt battery. The reading should be full; if not, there is most probably a break in the connection between the speaker's binding post and the winding.

The field coil should show a reading of 2 to 2½ volts; a full reading indicates that the winding is shorted to the speaker frame internally.

Take the speaker apart, by unsoldering the connections and taking out the center screw. The whole diaphragm must be taken out; it is then easy to disassemble the speaker and wind tape around the bare spots on the coil.

Then assemble the speaker, but do not tighten the screws that hold the diaphragm until you have centered the latter. Take three brass or tin strips, about ¼-inch wide and 2½ inches long—they must be thin—and place these along the edge of the spider at equal intervals. Push them down between the magnet core and field coil housing; then tighten the center screw, and the screws that hold the rim of the speaker.

A VACUUM-TUBE VOLTMETER FOR SERVICING

By Michael Yanosko

OF all the vacuum-tube voltmeters the writer has seen, none were portable. Most of them were of the laboratory type, requiring high "B" and "C" voltages and consequently blocks of batteries; and most of them were fragile and delicate, and not in the least suitable for work in the field.

With this in mind, a series of experiments was started; to make, if possible, a compact, portable, reasonably accurate and substantial meter. Neither "A," "B" nor large "C" batteries were allowable. The final result is expressed in the diagram (Fig. 3).

The parts required are low in cost; except for the meter, they may be found in almost every Service Man's junk box. In addition to the 0-1-scale milliammeter, there is a '12A vacuum tube and a sub-panel socket; a 25-watt lamp and socket; two fixed condensers of 2- and 1-mf. capacity; a 400-ohm potentiometer, shown as the center-tapped resistor; a grid leak with its mounting; and, if desired, multiplier resistors to be used with a switch, as shown by the dotted lines. The battery is of the 3-volt flashlight type; there are no others to buy.

The condensers serve to keep the frequency error of the voltmeter very small; that is, if the meter is calibrated to zero at 60 cycles, and the frequency is then increased while the other factors are kept

(*Continued on page* 427)

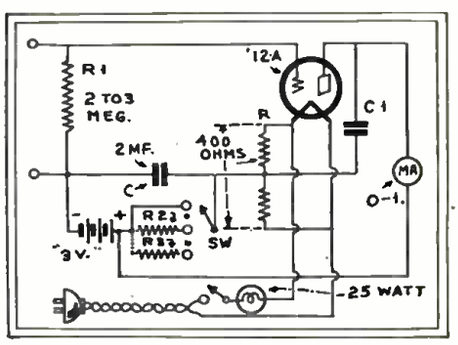


Fig. 3

The simplicity of this really portable unit may be seen; it is a useful companion of the set analyzer. The shunts R2, R3, etc., must be calibrated for the milliammeter used.

Operating Notes for Service Men

As a rule a commercial set, however well built, must have some point weaker than the rest at which trouble may be first experienced. Here are a few suggestions on where to look for trouble in certain commercial models.

By BERTRAM M. FREED

MANY unnecessary calls on the Bosch "48" ("16," "17") series can be avoided if the Service Man, at the time of installation, carefully checks the variometer shield can (Fig. 1) to make sure that it is securely held, and well grounded. Failure to observe this may result in undesired oscillation and noise.

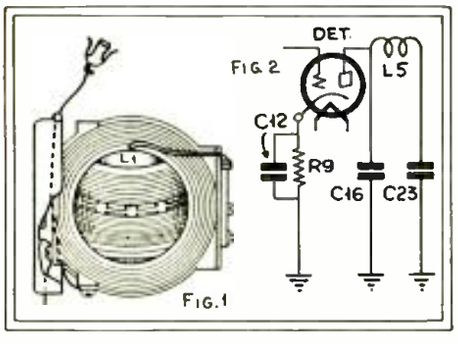
It takes but little additional time to be certain that the wiping ground contact on the variometer is properly bent, and makes a positive contact with the shaft. When removing the shield, care must be taken to avoid throwing the variometer rotor out of phase; which will cause lack of volume and sensitivity.

A common cause of noisy reception, in this series, is found in apparently perfect detector plate by-pass condensers. There are two of these, in parallel; disconnecting them, alternately, will show which is at fault. They are .001-mf. capacity. (Fig. 2).

When pilot lights on the Majestic "90" series take to burning out, substitute a flashlight bulb rated at 3.8 volts. Although in a 2.5-volt circuit, this will throw sufficient light on the dial plate, and will last much longer. If pulling the first A.F. '27 tube out of the socket makes no apparent difference in the volume, it is almost certain that the biasing resistor is open. This is usually a wire-wound, flexible component, connected from the under lug of the "4407-P," by-pass condenser to the metal frame of the first audio transformer.

In Fada A.C. models "10," "16," "15," and "35," the leads from the R.F. coil leads are soldered to lugs, which are fastened to the coil bases. These lugs protrude from the shields, for convenience in making connections; brushing against them, and vibration, cause them to shift, and result in shorts. This results in complaints of low volume and, sometimes, no reception.

Hum in a Zenith "42," which uses three stages of audio—the last a '50—has been found due to the center-tapped resistor across the filament of the second A.F. stage. This resistor, which is wound on an insulating form and riveted to the chassis, sometimes shorts to the chassis through its lugs.



Left, the variometer of the Bosch "48," which must be properly shielded and connected; right, the detector by-passes.

In the same model, after the shield cans have been removed, it is necessary to replace the leads in the small grooves, provided for them in the shields, with care to avoid cutting the insulation when the cans are replaced.

Kolster Models

It is possible that several readers have been experimenting to determine the cause of microphonic conditions in Kolster "K20" sets, which have been marketed in large numbers. A number of Service Men among whom was the writer, considered the problem from various angles—such, for instance, as proper cushioning of the chassis to prevent vibration being transmitted from the speaker. Several makes of '27 tubes were tried, to find out whether any were less affected by vibration.

It became evident that the microphonic condition was due, at least partially, to the fact that the receiver was too near oscillation; and methods of reducing the amplification were tried. The first was to increase the value of the grid suppressors

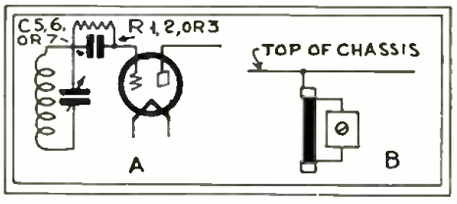


Fig. 3

Kolster "K20" grid suppressors are by-passed by very small condensers, as at A; the position of the parts is shown at B.

in this set (which is shown completely in Radio Service Data Sheet No. 27, which appeared in the October, 1930, issue of RADIO-CRAFT.) However, while this made the set less sensitive to microphonic noises, it also reduced sensitivity.

It was found that by removing either the second or the third of the small by-pass condensers which are across the grid suppressors, the set was thrown farther away from oscillation, without seriously affecting the sensitivity; these condensers are factory-adjusted and sealed with wax, and attached to the grid suppressors in the manner shown in Fig. 3. Placing weighted caps upon the tubes is also a helpful procedure to stop microphonics.

Another complaint, in this model, was of noise which could not be traced except by removing all R.F. tubes, indicating that the fault was in the detector, the audio end, or the pack. In some cases, the voltage divider was found defective; this component is enamel-coated, and cracks or irregular distribution of the enamel are followed by trouble due to moisture, corrosion and changing values. In other cases, more common, the audio transformers are to be blamed. To obtain compactness, both the first- and the second-stage transformers are housed together; and often the entire unit must be replaced. However, impressing a high voltage upon each primary (after disconnecting the leads) sometimes effects a cure of the noise.

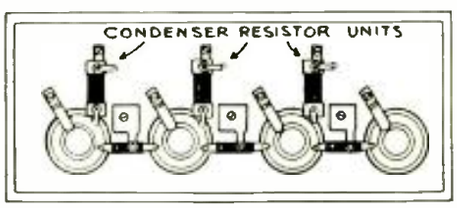


Fig. 4

Position, in the Philco "87" of R.F. plate resistors which include their tubular by-pass condensers.

Colonial Sets

With its novelty, the Colonial "33AC" also recently stumped a number of Service Men; the complaint was in all cases, oscillation on the highest waves. This was finally traced to an open condenser, in the double unit which contains the by-passes from plate and screen-grid of the second '24 R.F. tube. This component is found on the under side of the chassis, near the left front corner; it is metal-clad, and the value of each capacity is 0.2-mf.

Low volume and poor quality on the "32AC" may be due to any of a number of causes; one which may be readily overlooked is open field winding in the dynamic reproducer. Usually, the dynamic used with an A.C. set obtains the necessary field current from a series connection with the power pack, in which it serves also as a filter choke. In this Colonial model, however, the field coil is connected across the entire output of the pack; and tests for continuity must be made with the field leads disconnected from the set. By turning the chassis on its side, and placing a metallic object (such as a screwdriver) near the field, it may be readily determined whether the coil is open or faulty.

When installing a new volume control in this receiver, it is necessary to remove all the hardware from the old unit to replace it on the new. This volume control is of dual type; the two parts being held together by a single long screw and nut. When it is placed in position, be careful that the screw and nut do not short to the chassis anywhere. The screw makes contact with the arm of the outer control, which is the antenna resistor; and will short the aerial to the chassis if it makes contact with the latter.

Another cause of fading in this model may

(*Continued on page* 428)

The Service Man's Open Forum

His Opinions on Conditions and Practices in the Radio Business

CAN THIS BE SARCASM?

Editor, RADIO-CRAFT:

I have just read the article on page 267 of November RADIO-CRAFT, entitled "The Flying Service Man." I hope you were not being sarcastic when you wrote that heading. What I want to know is this, what did he do with the rest of his time? If he had been making calls out in the country where he had to drive ten or twelve miles between calls, it might have done very well; but he says himself that he only drove 43.3 miles in all.

The way some of these young chaps waste the boss' time is nothing short of a crime. Just two instances from Mr. Clerk's log: "10:35 * * burnt-out '80 tube. Replaced it and ran complete test. All O.K." But he did not arrive at the next call until 10:45!

Another: "11:25 * * Visual inspection and complete test showed everything O.K. Inspected aerial; it was 200 feet long, and parallel to car-line feeders. Shifted it to right angles with line, and shortened it to 90 feet, including lead-in. * *" And it was 11:40 *before he reached the next job!* How has a man the nerve to write to a magazine about his work and admit that he fools away his time like that? Is it any wonder that an owner of a service shop does not want to pay more than $75 or 80 per week, when the help lay down on him like that? Some folks have no sense of shame; they will loaf on the boss' time and then brag about it.

R. L. HASTINGS,
Stratton, Maine.

TOO MANY TRAFFIC LIGHTS

Editor, RADIO-CRAFT:

"The Flying Service Man" was very interesting reading. I was very much impressed with Mr. Clerk's account of his methods, but I think you must have made a slight omission, as you showed the times of these 25 calls, by leaving out the dates.

I have been in the game for several years, but Mr. Clerk can have all my marbles and my glass-eyed shooter. I have plenty of trouble getting by traffic signals, and the cops seem to be looking my way most of the time; nevertheless, more power to you, Clerk, but the question before the gang is "how"?

C. A. CONKLIN,
Madrid, Iowa.

WHAT A SKEPTICAL BUNCH!

—Am wondering if you didn't head it that way intentionally to give us an opportunity to wonder if your printer didn't use too many letters in the title. However, don't try to print this; he might be a lot bigger than I am.

GEORGE OLSON,
Carrington, North Dakota.

(You are far enough away from Montreal to be safe, Mr. Olson.—*Editor.*)

—This is the most absurd article I've ever read in a Gernsback publication. If any man tries to tell me that he can make an intelligent test of a Victor "RE45," Majestic "92," etc., in 15 minutes, I dispute his statement. It can't be done—that is, rightly. He must have done his checking with one of those analyzers which tells you that the voltages to the grid, plate and filament are within the 40% limit of being correct; and then all there is left to do is to press the little red button—and the difference in mills tells you that the tube is O.K., *maybe!* Anyway, I like the rest of the magazine.

C. W. LEWIS, JR.,
Service Man, Roger Putnam Co.,
St. Louis, Missouri.

THE "FREE" SERVICE CALL

Editor, RADIO-CRAFT:

I have read the letter of Mr. Louis Minatel, of this city, in the November issue of RADIO-CRAFT; and I think the answer to his inquiry is to be found in "Questions and Answers," in the radio section of the *Indianapolis Star* for Sunday, Oct. 19.

A set owner relates that a man called and offered to test his tubes free of charge. After testing, the owner was informed that he needed a complete new set of tubes; he believes that his radio is working satisfactorily now, and asks if there is any way to check up on this test.

The editor of this radio column gives a very intelligent answer; advising the set owner to have the "Service Man" (probably just a tube salesman) install his new tubes and see whether the results are an improvement. (Ten to one, this so-called "Service Man" won't do it).

Take heart, Mr. Minatel. I have been servicing radios with a $1.50 minimum charge, in your home town, since a time when most of these "50-cent" and "no charge" Service Men did not know grid from plate; and I have plenty of business.

After all, the public is today pretty skeptical of anything that is offered for nothing; and the man who is willing to give away his services evidently doesn't, himself, consider them very valuable. The object is to sell tubes, whether needed or not; and thank heaven, the majority of set owners realize it.

I do not sell tubes unless the customer can note the improvement when they are put in his set; and he is glad to pay $1.50 service fee and know that he won't be loaded up with fifteen or twenty dollars' worth of tubes he does not need. My conscience is clear—and my old customers get me new ones.

RUSSELL R. BYERS,
1036 *Eugene Street, Indianapolis, Ind.*

SERVICE ADVERTISEMENTS

Editor, RADIO-CRAFT:

I have been in the same fix that Mr. Minatel talks about; and I found the only way to discourage such prices is to step on them. I have been in the service business eight year, and found it increasingly harder each year because of this price cutting.

My old customers would call somebody else to do their service work, because they did it cheaper. I am not afraid of fair competition; I lowered my prices to a dollar a call and, for a short time, had pretty good results. The companies advertising in the Detroit newspapers soon cut their prices to 50 cents, and then offered free service. This knocked my business cold; but I refused to advertise free service.

The newspapers kept calling me to solicit my advertisement in their columns daily; but I refused and told them the reason why. It came to the point where the local Better Business Bureau took a hand in the situation, and requested the newspapers to refuse to accept advertisements giving a price or offering free service.

The result? Fewer calls from each ad; but a much better class of trade. I think that, if this system were tried in other cities, there would be fewer starving Service Men, and all would have a fair chance. Hoping this will help others.

SIDNEY CLARK,
5355 *Pacific Avenue, Detroit, Michigan.*

ATTENTION, CLEVELAND B.B.B.

—We here in Cleveland, who try to run an independent service, are out of luck. There are organizations here that have a 50-cent service charge, and give yearly contracts for monthly inspections. We're no longer men of a profession, to have to accept so low a fee for our services. Neither can the independent Service Man get parts discounts, except in rare cases.

Shaker Heights, Ohio.

GOOD BUSINESS METHODS

Editor, RADIO-CRAFT:

I think that Mr. Minatel did not quite get the idea of the meaning of *"Service Charge."*

I think it would be a good thing to publish a few facts about this phase of the game. He quotes an article or ad., that was clipped out of an Indianapolis publication which reads "50c per call—Expert service. Why pay more?" Did it occur to him that, in radio service, the service call price is for the call only? This customary fee does not include any work whatsoever, outside of checking the set and locating the trouble.

Although I charge one dollar for my calls, there are several large service concerns in this city that check radios free of charge. This does not hurt my clientele in the least; because, if a radio man knows his onions, he is bound to get enough to keep him busy if he is a hustler.

The service charge is used more or less as an entrée; as very few people call for radio service that do not need it. As a rule there is very much the matter with sets when you are called for service. (Outside of free dealer service.)

When a call is made, and a major repair is necessary, it will be found that oftentimes the customer will not be able to meet

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VICTOR "MICRO-SYNCHRONOUS" RADIO, MODELS "R-35," "R-39," "RE-57"

These T.R.F. receivers are manufactured by the Victor Division of RCA Victor Co., Inc., Camden, N. J. The schematic circuit shows the multiple-contact switch designed for changing the connections to "radio," "phonograph," "home-recording," or "radio-recording." The parts used in this Victor chassis are itemized below:

Condensers C2, C4, C12, each 5 mmf. (each capacity is formed by a single turn of wire); C5, C6, C7, C9, C13, C14, C15, 0.1-mf.; C10, 10 mmf.; C17, 0.25-mf.; C18, 0.75-mf.; C20, C21, 50 mmf.; C22, 100 mmf.; C24, 0.01-mf.; C25, C29, 1.0 mf.; C26, C27, C28, C30, C34, 2 mf.; C31, 0.2-mf.; C32, .0012-mf.; C33, 4.5 mf.

The resistors in these models have the following values: R1, 50,000 ohms; R2, 130 ohms; R3, 1,000 ohms; R4, 2 megohms; R5, 1.5 megohms; R6, 28,000 ohms; R7, 1.0 megohm, R8, R9, 0.5-megohm, R10, 2,800 ohms; R11, R15, 55 ohms; R12, R13, 8,000 ohms; R14, 70,000 ohms; R16, 730 ohms; R17, 9000 ohms; R18, 60 ohms; R20, 250 ohms; R21, 140 ohms. The two volume-control resistors R1 and R3 are operated by the same knob.

The hand microphone connects to the pin-jacks J. Unit L20 is the record microphone input transformer.

The portion enclosed by the dotted line DL is used only on the combination models. The links are to be closed, on radio models.

The strips in the enclosure DL, marked R, RR, PG, and RV are used to segregate the little rectangles which denote the contacts on the transfer switch. The four positions of these rectangles, and the wires they then connect, are thus clearly indicated.

Following are the voltage readings at the tube sockets of the receiver. Filament potentials: V1, V2, V3, V5, 2.1 volts; V4, 2.0; V6, V7, 2.25; V8, 4.9. Plate potentials: V1, V2, V3, 173 volts; V4, 50; V5, 67; V6, V7, 222. Plate currents: V1, V2, V3, 3.1 ma.; V4, 0.3; V5, 1.5; V8, each plate, 40 ma. Grid potentials: V1, V2, V3, 3.1 volts; V4, 1.5; V5, 0.2; V6, V7, 37. Screen-grid potentials: V1, V2, V3, 89 volts; V4, 3.4.

The power consumption of the "Models R-35" and "R-39" is 120 watts; the "RE-57," 170 watts for the combination.

Microphonic howl in a set of these types may be due to the reproducer's being not properly insulated from the cabinet front; adjust the felt. In home-recording, an open in R20 or R21 may cause a howl.

A good ground connection is essential, and must be used at all times.

If the line voltage is high, a "Type 9-V-10" Amperite may be used to limit the line supply.

Oscillation may be due to an ungrounded, or poorly-grounded chassis; or to shielding for condensers, coils, or tubes, being out of place; too much exposure of the green lead between control grid of a '24 and the coil (the unshielded portion of this wire should be as short as possible). An open circuit in any of the 0.1-mf. by-pass condensers, or poor grounding of one of these condensers (due to loose contact at the rivets), may cause this trouble. Faulty grounding of the shielding of a lead in the radio amplifier may cause the same effect.

Following is the color code of the main cable: 1, 2, light brown; 3, yellow (in most cases); 4, yellow-red tracer, in one cable, and red-yellow tracer, in the other; 5, green-red; 6, blue; 7, red; 8, green-red.

(Note: when replacing a coil, or tube-shield caps, always be sure that the slots are aligned with the green wire before the cap is forced into position. To avoid damage to the wire or coil, never turn the cap after it is once in place.)

Failure of the home-recording section of the receiver may be due to the following causes: poor contacts in microphone pin jack terminals; a loose or broken wire or connection; an open or a short in the microphone; a short in either of the resistors R20, R21, on reactor unit; a shorted or open record-microphone input transformer on motor board; a faulty contact in control switch; an open coil L22, reactor unit; a weak magnet in the electric pick-up.

Faulty record reproduction with noticeable blasting, particularly on bass notes, may be caused by worn records or needles, or by improper centering of the pick-up armature. If such a condition is traced to the pick-up, center the armature in the following manner: remove pick-up from the pick-up arm, and remove the cover. (Note: It is highly important that the magnet be in contact with the pole pieces, or with a small iron or steel "keeper," at all times. Even a momentary break in the magnetic path of the pick-up magnet will produce a noticeable loss of magnetism, which is reflected in decreased efficiency of the pick-up, particularly in home recording.) Place a steel keeper, 1⅝ x ½ x ⅛-in, across the two ends of the magnet, and carefully slide the magnet from the pole pieces onto the keeper. Next, slide the magnet back onto the underside of the pole pieces. Then, loosen both round-head screws in the armature adjusting plate.

Insert a pick-up gauge between the armature and the pole pieces, and retighten the round-head screws in the adjusting plate. After properly centering the armature, replace all parts of the pick-up assembly.

In some models C33 has a capacity of 5.8 mf.; it is not in circuit for electric phonograph or radio reproduction, but serves to increase the power of the motor, during home-recording with either microphone or radio, to avoid increase of speed on playback. It is out of circuit for radio reproduction, to prevent the motor running at high speed and becoming excessively hot as it might if left running after moving the change-over switch from "recording" to "radio."

Following are the oscillator frequencies at which the variable condensers are to be aligned: 550, 710, 1070, 1300, 1500 kc.

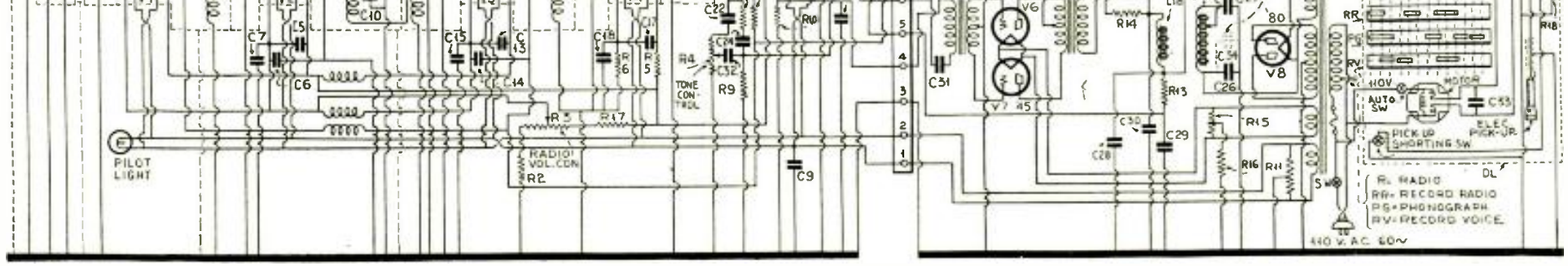
If it becomes necessary to re-center the cone of the dynamic reproducer, a strong 60-cycle hum may be obtained by removing one of the R.F. tubes and running a lead from its cathode to one of the filament terminals of a screen-grid tube's socket.

Should the tuning lever fail to operate freely, or should the vernier roller fail to track when turned, adjust the tension of the lever on its track, by means of the adjusting nut; which will be found on the lever midway between the cam wheel and the dial. A small amount of grease should be placed on both the top and the bottom of the roller track, to assure free movement of the lever.

When replacing or repairing the selector scale, slide the scale to right and left until the indicator is in line with the frequency marking which is correct for a station then being received. Check this at several different points on the scale. If the pilot lamp is mounted off center, the dial readings at certain sections of the scale will be incorrect. Check the location of lamp, which should be exactly in the rear of the center of the dial; while the hair-line station indicator should be vertical at the center and at the extreme ends of the dial.

The tone control is effective on both radio and record reproduction.

To prevent a twisting action the length of the pick-up during recording, the head is splayed. This weight on the sides serves by its inertia to maintain a "level keel."



SILVER-MARSHALL SUPERHETERODYNE, WITH "MODEL 36A" CHASSIS AND "32A" POWER PACK

This late model superheterodyne, a product of Silver-Marshall, Inc., Chicago, Ill., operates on an intermediate frequency of 175 kc. The single stage of signal frequency amplification is preceded by a band-selector. The power consumption is only 100 watts, and it is so sensitive that an antenna longer than 25 feet will seldom be required.

The load for the power pack is the receiver chassis; and the pack must never be operated without the receiver chassis being attached. This is important.

Following is a list of replacement-part values: Condensers C1, C2, C3, C4, 407 mmf.; C5, 750 mmf.; C6, 250 to 600 mmf.; C7, C8, C9, triple 0.1-mf. bank (C7, C8, 200 volts rating; C9, 300 volts); C10, C14, C16, C20, 0.25-mf.; C11, C17, C21, 0.1-mf.; C12, C15, C18, 1.0 mf.; C13, .001-mf.; C19, 4 mf. electrolytic condenser bank.

Resistors R1, R5, 25,000 ohms; R2, 500 ohms; R3, 750 ohms; R4, 2,000 ohms; R6, 300,000 ohms; R7, 400 ohms; R8-R9, 100 to 1000 ohms on one strip, wire-wound; R10, 375 ohms; Rv, 3,000 ohms; R11, 3500 ohms, R12, 4,000 ohms; R13, R15, 10,000 ohms, R14, 20,000 ohms. Resistors R2, R3, R7, and R10 are wire-wound. Note that resistors R12 and R13 are of 2-watt rating; while R11 is rated at 3 watts.

The inductances in this receiver have the following catalog designations: L1, L2, "No. 161" coil; L3, "No. 160" coil; L4, L5, "No. 162" coil; L6, L11, "No. 281" choke; L7, L8, L9, "No. 163" oscillator coil; L10, "No. 339" choke. The speaker field S1' has a resistance of 890 ohms per section. The transformers are listed as follows: T1, "No. 272"; T2, "No. 271A" or special; PT, "No. 346"; IT1, "No. 212"; IT2, IT3, "No. 213."

Average tube-supply values for this receiver are as follows. Filament potentials: V1, V2, V3, V4, V5, V6, 2.27 volts; V7, V8, 2.4. Screen-grid potentials: V2, 85 volts; V3, 80; V4, V5, 110; V6, 162. Grid potentials; V7, 22.5 volts (depending upon meter); V8, 42.5. Cathode potentials: V1, V3, 37.5 volts; V2, V6, 7; V4, 42.5; V5, 45.0. Plate potentials: V1, 82 volts; V2, 162; V3, 76 (depending upon meter); V4, V5, 160; V6, 245; V7, V8, 255. Plate currents: V1, 11 ma.; V2, V4, V5, V6, 4; V3, 3.

One 800-ohm section of the field coil supplies "C" bias for the power tube. Switch Sw2, the "local-distance" control unit, controls both selectivity and amplification at the same time. One power tube is impedance-coupled, and the other transformer-coupled, to the detector tube. The undistorted power ouput of this combination is rated at 4 watts.

It may be found desirable to arrange a line filter, consisting of two 1-mf. condensers in series; the center tap being grounded, and the two ends being connected across the light line, at the receiver. In some localities, it may be necessary to use a shielded lead-in, the antenna length being increased to compensate for the by-pass effect of the shield.

When placing the tubes in the sockets, note that the little metal disc should be placed on top of the '24 tube shield located third from the left, with the grid wire passing through the slot.

Perhaps the most important comment, in connection with this receiver, is the suggestion that extreme care and attention be given to the selection of tubes of satisfactory characteristics for the different positions in the set.

The first detector (V3) may be selected by tuning in a weak station, and tapping the tube in the second-detector (V6) socket; least noise being the desired quality. When a non-microphonic tube is located, it is to be taken out of socket V6 and put in socket V3. The tube for regular use as V6 may be selected by turning the volume control for medium volume (on a local station) and selecting the tube which gives best tone quality.

A noisy volume control may often be repaired by simply turning the control knob rapidly to remove oxidization.

If an exceptional hum develops, check for defective power or rectifier tubes. The power tubes, and each plate of the rectifier tube, should read within 5% of each other. Also, hum may be due to the pilot light V10 becoming grounded.

Granting that good tubes have been selected, a microphonic howl may be due to non-removal of shipping blocks; or to the receiver chassis not being entirely supported by the rubber cushions.

Many radio service stations have a workbench with a metal top. The manufacturers of this set point out that it should be aligned only on a table with a wooden top.

If the set lacks sensitivity and selectivity, even though all tubes check perfect, it is probable that the circuits should be aligned. Start with the I.F. circuit, then check up the R.F. and oscillator circuits.

The I.F. transformer trimmers are accessible through the tops of their shield cans, adjustment for 175-kc. frequency being made with an *insulated* screwdriver.

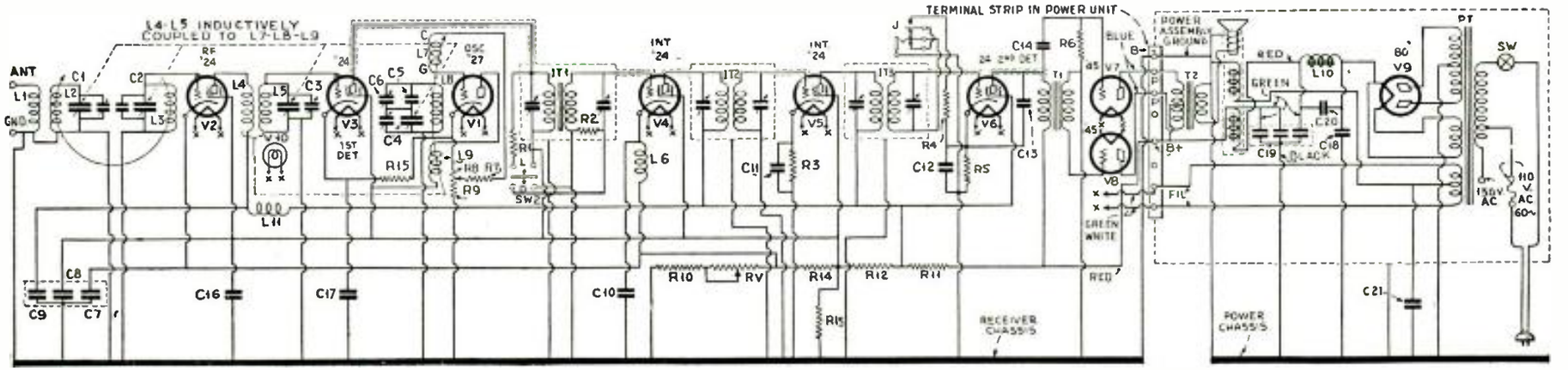
Before proceeding with this alignment process, it will be necessary to provide a temporary pointer, on the dial scale, against which alignment may be made (the chassis being out of its cabinet). Arrange the pointer so that (with the setscrew stop on the drive shaft released and the variable condenser against its own stop in the minimum position) the temporary pointer will line up exactly with the line marked "stop" on the dial. The dial should then be rotated until the 1400-kc. marking is directly opposite the temporary dial pointer. Both of these operations must be performed accurately.

The R.F. circuits are to be balanced at 1400 kc. and the oscillator at 600 kc. To balance the oscillator, it is necessary to locate accurately the point at which 600 kc. is passed by the R.F. amplifier.

To do this, the wire connecting C6 (on the centrally-located micarta strip) to C4, is disconnected from C4. The free end of this wire now should be connected to a separate 350- or 500-mmf. condenser; the other side being grounded to the chassis. The test oscillator should now be re-adjusted to 600 kc., and the receiver dial turned to that reading as well. The external condenser, which has been added to the oscillator, is now rotated until the signal is heard; and the input to the receiver from the oscillator is adjusted to give a convenient value on the output meter connected to the output of the receiver. The dial of the receiver should now be rotated, turning the gang condenser, until the reading in the output meter is a maximum. From this point on, both the setting of the receiver dial and the adjustment of the *four* trimming condensers *on* the gang condenser should remain undisturbed.

The external condenser should now be removed; and the wire between the oscillator section of the gang condenser and the second oscillator trimmer should be replaced and soldered. Now, with a bakelite screwdriver, adjust this oscillator low-frequency trimmer, by means of the adjusting screw in the back of the micarta mounting strip, until the output meter reads maximum. This completes the alignment procedure on the receiver. If, after the chassis is replaced in the cabinet, the dial does not read exactly true, it may be shifted slightly on the shaft.

A new cord may be installed on the drum dial without removing the dial from the set; a 21½-in. length of "SM 3913" Heavy Dial Cord is required. If the drum dial turns stiffly, the gang-condenser bearing may be too tight.



If I Wanted to Make Money in Radio, I'd—

And an authority suggests a few ideas that may be valuable to the dealer and Service Man

By J. B. STRAUGHN*

FIRST, I'd get a fundamental knowledge of radio and, not until I was thoroughly satisfied in my own mind that I was capable, would I go after radio work. I would never be satisfied to be one of those "I-think-I-know-it" radio men—I'd want a real insight into the underlying principles of radio and correct radio practice. With knowledge of this kind, "the sky is the limit." Without it, I'd realize that I wouldn't have a chance to attain real success. Besides taking a recognized radio course, I would subscribe to good magazines which, I know, would help to keep my knowledge up-to-date. The radio field changes so rapidly that what is the last word today may be entirely obsolete three months from now.

Assuming that I have developed my knowledge and my ability, I would make definite plans to get my share of the local business. I would make a thorough survey of my territory, taking into consideration such factors as general business conditions, number of set owners and the average income of my prospects. With this information, I would be able to gauge accurately my prospects and the business I could get. Then I would be ready to go after radio work in earnest.

I'd distribute business cards among the radio stores and those concerns handling radios as a side line. The business cards would carry a simple, "straight-from-the-shoulder" story, and that is all. In interviewing the managers of these concerns I would do all I could to prove to them that I was capable of doing radio service and installation work, and urge them to let me handle their servicing on a piece work or time basis.

I'd go after those stores, in particular, that sell radios on the side, and arrange special prices for installing and servicing their receivers over a period of about three months. I wouldn't worry about how much money I made in this deal; for I would know that, when the time period was up, I would have a customer worth every effort I had made. I would be very careful, in making comments when servicing a radio dealer's receiver, not to say anything derogatory. I would keep in mind that it is just as necessary for the customer to think well of the dealer who sold him a receiver as it is that he think well of me.

Then, houses with antennas visible are inhabited by people who own radios. If there was any way that I could get their names, I would do so and either call on them personally or write to them. If I couldn't get their names, I would drop handbills or business cards into their mail boxes.

I would run an "ad" in my daily or weekly newspaper and I would see that it was placed next to the radio programs, if possible. In this way I could bring to the attention of radio owners that I was a qualified radio-trician in a position to render satisfactory service. A small ad is just as valuable as a large one—one or two inches, one column, with a bold border—and a very simple story is all that is needed. I would change my story from week to week to show that I was alive and that I was giving thought to my prospects, talking to them through my little space in the paper.

I would particularly keep posted on general happenings of importance and the big broadcasts which usually go with them. One or two weeks before a particular event, I would word my ad to read something like this: "Get your radio working 100% before the big fight (the President's speech, or the Army and Navy game, etc.) by telephoning me at No. (my telephone number) etc." Many a wide-awake Service Man has "cleaned up" putting sets in shape for a feature broadcast.

I would put a sign on my porch or fence, advertising that I was a trained Radio-Trician and, to show that I was an electrical man, I would have it illuminated so that it would be visible at night. A sign like this wouldn't cost much and it would be a real beacon for distressed radio owners. I would put signs or display cards in windows of business houses that would give their consent; always bearing in mind that it is necessary to maintain a dignified and conventional front.

But I would always remember that good business cards constitute the best and cheapest advertising possible. These can tell my story simply but completely. It isn't necessary to come right out and ask my friends and acquaintances to let me fix their sets—a word about ability will put them "wise."

Uncle Sam's postal system is always a good business medium. I'd get up a snappy form-letter or circular, have it multigraphed and mail it to set owners whose names and addresses I had. I would give a great deal of attention to the appearance and contents of this circular letter—that is, make it look as if it contained a personal message. As an alternative or "follow-up," I could send out double post cards with perforations between, one side carrying a short advertising message and the detachable portion a stamped, return card, self-addressed to me. On the back of that, I'd have something like this: "Please call and inspect my receiver. I understand that you will render this service without any obligation on my part." After that, I would leave two lines for the name, address and phone number of the set owner. In the advertising portion of my circular card, I would list some of the many things that make for better radio reception, such as having a proper antenna, the addition of a tone control, etc. I would point out the necessity

The external appearance of an attractive radio store in a Detroit, Mich., neighborhood. Observe the window score board. This is the shop of Fred E. DeMerse.

The sanctum of the Community Radio Store shown above; the work-bench is equipped with the latest testing equipment with which a trained radio trician can give the kind of service that brings more business.

* Consultant, Technical Division, National Radio Institute, Washington, D. C.

THE two articles printed here together were received separately, one from an adviser of Service Men, and one from a Service Man. There are many suggestions in each.

What we ask the numerous radio dealers and Service Men among our readers to send in is their profitable experience, in business no less than technical methods. Novel ideas are what count. Such articles will be rewritten, if necessary; illustrations are desirable if clear.

of having the tubes checked regularly. I would stress the importance of a periodic check-up of the entire receiver and mention the convenience of having extra speakers.

On every job, no matter how small or how large, I would see to it that my customers were thoroughly satisfied with my work. My guarantee of satisfaction must be more than a meaningless lot of words. In one or two cases, I might actually lose money on a job because of my guarantee; but that should be charged up to advertising and good-will cost. In building up any business, customer confidence is essential; and this applies to all customers, not just to a select few. It should be apparent to my customer that I have confidence in my own ability. A real guarantee will make him willing to pay as much, if not more, than he would pay the other fellow who does not guarantee his work.

I would not overlook the fact that my customers have opinions of their own and I would never force my opinions on them. I would merely suggest what I believed to be right and, if the still insisted, I would do as they desired in technically possible; even in spite of my better judgment. In other words, I would remember that the customer is always right and I would carry this motto in my mind in big black letters.

I'd be prompt and courteous. I would handle every call on the "dot." If I were rushed, I would frankly tell the customer, and make no engagements which there was the slightest doubt of my being able to fill. Nothing annoys a customer so much as to be kept waiting for a promised service call.

If I had a big job that would take considerable time, I would lend the customer one of my own receivers—it might be a custom-built set or one of those special mantel jobs that are being sold as second receivers for every household. It is a well-known fact that, when a set owner wants his set put in shape, even though it has not been working for months, he wants it "now." He doesn't want to wait. He wants radio reception and that is why I was called. A set left "on loan" usually results in good "word of mouth" advertising.

If I had specialized ability to handle difficult service jobs that required expert knowledge and special equipment, I would equip my laboratory bench with the most up-to-date devices for testing radio receivers and public-address systems, and I would use them. My diagnosis of receiver troubles would be based on facts—not on guess work. I would watch radio magazines for special testing circuits and devices and, if they would fit my needs, adopt them for my own use.

If I were definitely interested in radio servicing only and not in radio sales, I would stick to it 100%; but I wouldn't overlook the fact that the average dealer doesn't sell automotive receivers, doesn't make or sell custom-built receivers, has no inclination to be bothered with short-wave outfits and television equipment, and has no interest in special installations such as receiver chasses in book cases, in staircases or walls. I'd pick up as many of these specialties as might be profitable in my locality and push them to the limit.

Inside leads for new receivers, developed through my service work, could be followed by an arrangement to sell complete radio receivers on a commission basis for the dealers for whom I do extra work. On my own hook, I would sell accessories and build receivers to order as requested, even though they might not be those I specialized in.

I would secure a phonograph pickup and buy or build a power amplifier with two channels; so that I could furnish music for parties, plays and church events. Of course, I'd give considerable thought to the selection of records, including the latest dance records, symphonic numbers and popular music. A small ad in my local paper would book me up, months in advance, for business of this kind which flourishes all the year round.

Lastly, I would never forget that earning money is like making a garden—the ground must be prepared, the seed be planted, the sprouts cared for and the plants protected in order that a rich harvest may be reaped. Promptness, courtesy and ability build up a good reputation; and profitable business naturally flows to the man who can be depended upon for real service.

"BREAKING IN" TO THE SERVICE BUSINESS

By Ralph Mellon

MANY young men, who have taken a correspondence or other technical course in radio, would like to cash in on the knowledge thus gained, and, at the same time, acquire the necessary experience for advancement in the field. It is for those men that this is written; and my advice to them is, "Go into the service business."

Now you are no doubt asking: "Just what opportunities does the radio service business afford?" Well, I'll tell you:

(1) You may start with very little capital; about one hundred dollars should make a nice start.

(2) You may do the work right in your own home, making the overhead small.

(3) The pay is good, about $75 to $100

(*Continued on page 429*)

Small local advertisements backed by the national advertising build up trade for the radio-trician. Display cards, properly distributed, help greatly.

New Radio Applications—Great and Small

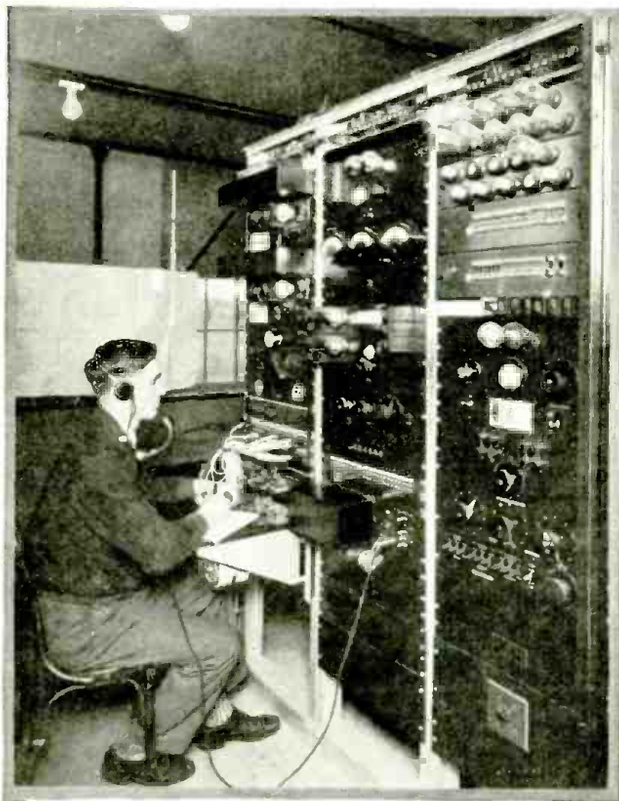
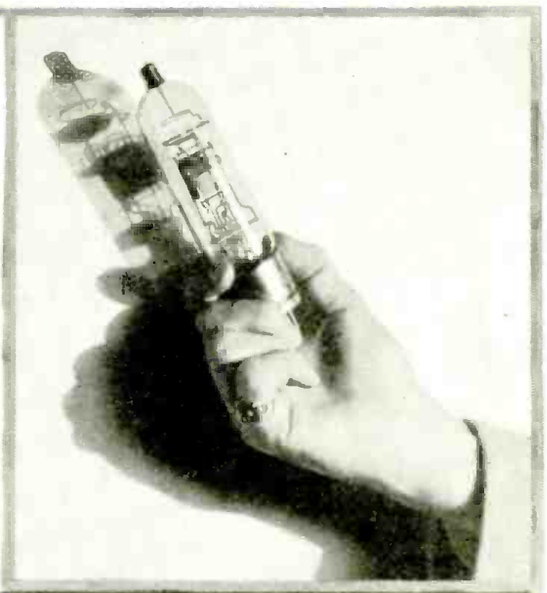


Fig. A (left)
This transmitter-telephone exchange is the "central" used for intercontinental radio telephony. The long-distance wires, which run in to the operator's panel, are connected by him into the transmitter's amplifier.
(Photo Bell Telephone Laboratories)

Fig. B (right)
The tube shown here, intended to amplify inconceivably small currents, is described on the opposite page.
(Photo General Electric Co)



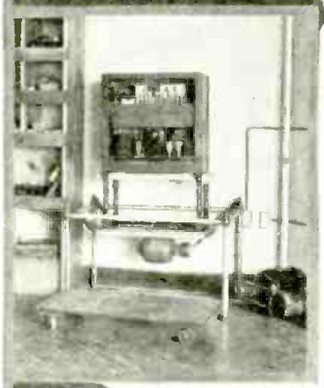


Fig. C (left)
This, dear readers, is a miniature Coney Island for radio sets which like to bump the bumps. The motor makes the table top shimmy, for the purpose of testing the resistance to vibrations of the joints and connections.

Fig. D (right)
This big power plant is not Muscle Shoals, but a part of KDKA's new plant. My, how that child has grown; we remember it as a 500-watter.
(Photos Westinghouse Elec. & Mfg. Co.)

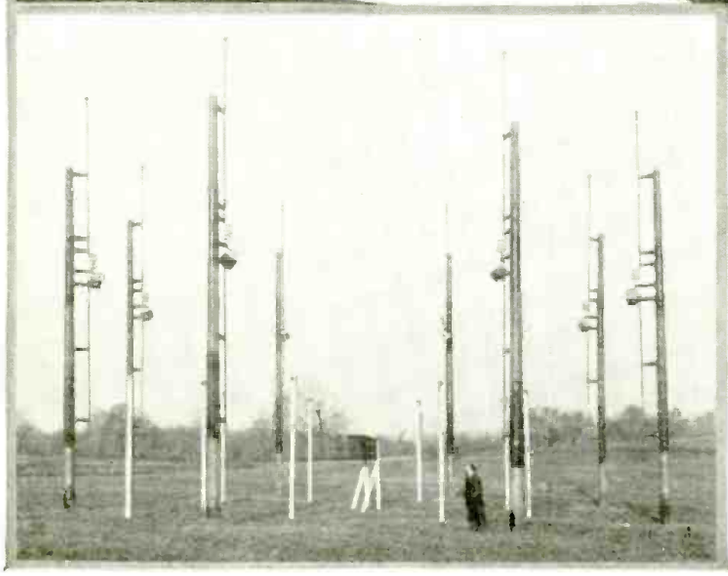
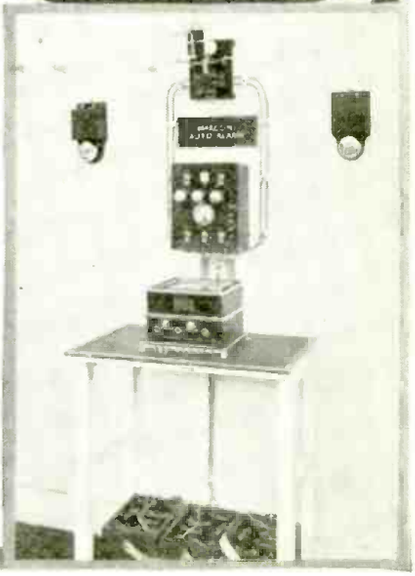


Fig. E (left)
A part of the grounds of KDKA's new Saxonburg station. This is one of the short-wave spray antennas (the long-wave spray antenna, described in last month's RADIO-CRAFT, *is too big to get into one photograph). Each of the poles shown here carries a perpendicular aerial and counterpoise; and the eight work together directionally.*
(Photo Westinghouse Elec. & Mfg. Co.)

Fig. F (right)
The automatic alarm for ships; this will send out, or pick up, a distress signal; it will be described in a forthcoming issue of this magazine.
(Photo The Marconi Company)



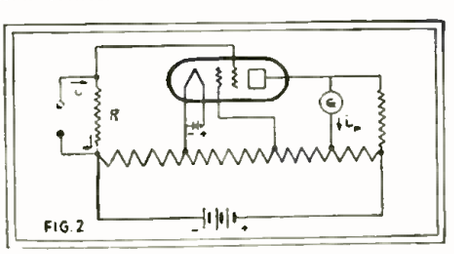
Some of the Ingenious Things Which Radio Laboratories and Engineers Have Produced

RADIO telephone work, as all short-wave fans know, is increasing. Between New York City (or rather its outlying transmitters) and the principal cities of Europe and South America, there are radio lanes devoted to code work, and some to telephone operation; England is linked to Canada, South Africa and Australia; France and Holland to their colonies and Germany to both east and west; while the largest ocean liners carry telephones, too. The result is that conversations meet the ear over a large part of the tuning dial.

In late weeks, too, sounds that resemble no known language have been heard by the listeners. This is the "scrambled" or "inverted" speech, produced by inversion of audio sidebands, which changes the quality of speech completely; since the pitch of the voice creates the "consonants" of speech. The signal is automatically restored, at the receiving end, to its normal frequencies and intelligibility, by reversing the process of "scrambling."

It is possible, from any station in the telephone system of the United States, to talk to the Europeans, South Americans, Australians, or any one else who can be reached by wire from any radio station on the other end. Naturally, of course, a "central" is required at each end of the radio link; and in Fig. A, on the opposite page, we see *him* with his rather complicated switchboard, where radio and wires meet.

The fact that radio appliances have been increasing in power has been often impressed upon us. Fig. D, for instance, shows a generator room with power enough to light a good-sized city; yet all this is merely part of the equipment of one radio transmitter, the new super-power KDKA. It is only ten years since that station started regular transmissions, on the night of the election in 1920; and it had then the unrivalled power of 500 watts. It celebrated its tenth anniversary with a broadcast on 50,000 watts; and the station just erected, with an authorized testing power of 400 kilowatts, is built so that nearly four times that power can be utilized when the occasion comes.



A circuit using the low-grid current tube to produce a measurable output from a very small direct-current input.

Get Your Figuring Pad

On the other hand, it is perhaps not readily realized how radio has been increasing in delicacy. The tube shown in Fig. B, with its internal arrangement outlined in shadow in the background (and explained in Fig. 1) is a new development for the purpose of amplifying direct currents so tiny that the imagination fails to grasp them. It is sensitive to a flow of current amounting to ten one-quintillionths of an ampere, or 63 electrons a second. These figures are not impressive, until we consider that one ampere represents the flow past a given point every second of 6,277,000,000,000,000,000 electrons—plus or minus a few odd trillions, etc. The reader who is good at arithmetic may amuse himself by comparing this number with the grains of sand in the earth, or drops of water in the sea.

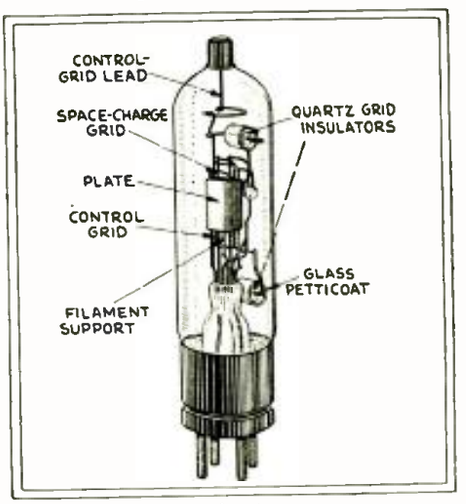


Fig. 1

The elements of the inconceivably sensitive tube are designated here, for comparison with the photographic reproduction in Fig. B, on the opposite page.

Leaving this aside, it may be said that this tube is a hundred times as sensitive as those "pliotrons" previously obtained. In order to accomplish this, it was necessary to eliminate as far as possible tube "noises" or, rather, the variations in current due to irregular atomic and molecular activities between its elements. The vacuum in the tube was rarefied to a trillionth of the normal atmospheric pressure; though even this leaves millions of gaseous atoms in the bulb. However, on the average an electron can travel sixty miles in such a vacuum without striking a particle of gas, according to physicists. In addition to this, a space-charge grid was placed between the control grid and the filament.

The result is, that the effective resistance of this tube between grid and filament mounted to 10,000,000,000 megohms; and the current between this grid and the filament fell to one billionth of a microampere. Against this almost infinite input resistance, the incredibly small variations in input current could be detected. A circuit utilizing this low-grid-current tube, shown in Fig. 2, illustrates its operation. The galvanometer G is calibrated in microamperes; and the resistor R, across the tube's input, should have a value of 400,000 megohms, if the full sensitivity of the tube is to be utilized.

A tube whose characteristics run into such astronomical figures, it need hardly be said, can be applied only to special purposes of delicate measurement, operation from photoelectric devices, etc. Its mutual conductance is but 25 micromhos; yet the measurable plate current variations are a hundred trillion times the control-grid variations shown in Fig. 3. The tube, obviously, is not a voltage amplifier; its "mu" is *one!* Its plate voltage is 6; space-charge grid 4; control-grid, 4 negative. The filament of this tube, which is the General Electric type "FP-54", draws 110 milliamperes at 2.5 volts; the normal plate current is .01-milliampere, and the A.C. plate resistance 40,000 ohms.

Anticipating Service Troubles

It is well known to Service Men that a good many of their calls, and oftentimes long hours of perplexity, are due to the development of slight mechanical defects in manufactured receivers, which causes the breaking of electrical connections or, at least, the introduction of high resistances into circuits. Now, the original model of the receiver was very carefully engineered; but, under conditions of factory production, it is possible for a concealed fault to escape detection under the eyes of more than one inspector, to come out only when the receivers have been transported long distances into the homes of their final owners.

Some years ago at least one enterprising manufacturer was wont to put his wares in packing cases and roll them down a few flights of stairs, to determine how well they would stand shipment. The device illustrated in Fig. C is as effective, but more systematic. It was erected in a proving laboratory, built away from the factory "so that the men working in it will not have the 'factory' point of view." Here the sets, received after rail and truck transportation, are put on the vibrating table shown and jarred to find their weak points, if any; then they are tested and retested, through suitable panels which give exact visual measurements of their outputs as compared with their inputs.

Fig. E, which may be compared with the article on page 342 of last month's RADIO-CRAFT, shows the "spray antenna" principle applied to short waves. The eight vertical antennas (Hertzian aerial and counterpoise type) direct the signals in phase toward

(*Continued on page* 433)

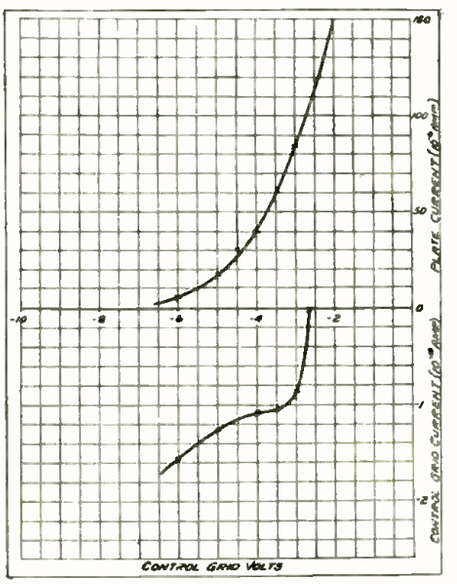
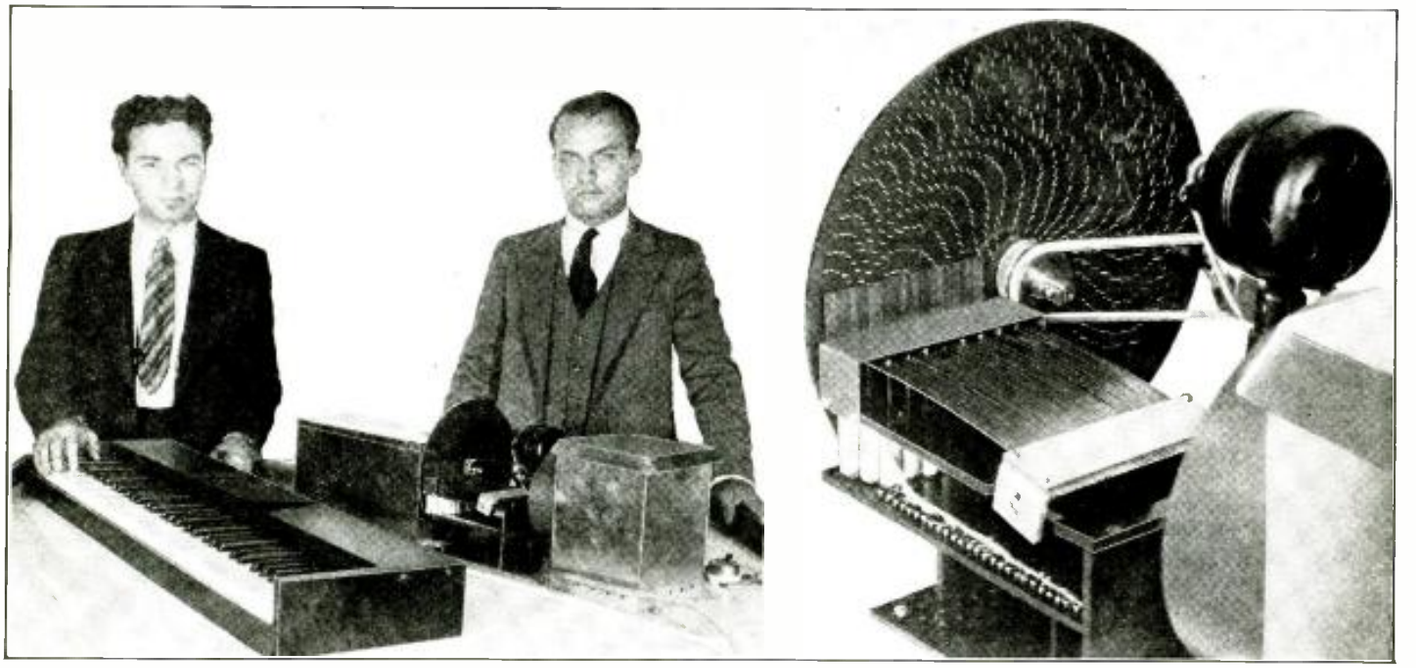


Fig. 3

The plate current (above) and grid current (below) of the "FP-54" low-grid-current tube are here plotted against each other. The two scales are calibrated, one in microamperes, and the other in billionths of a microampere.



Mr. Lesti, left, and Mr. Leo O. Tiedemann, right, with the keyboard and the electrical sound-equipment of the former's versatile invention. The mechanism is shown at the right, with the revolving pitch disc toward the reader; and the electromagnetic shutters beneath.

The Radio Organ of a Trillion Tones

By ARNOLD LESTI

THERE is a fundamental difference between musical instruments and reproducers of sound. The phonograph, radio, and talking pictures are all reproducers, and are distinguished from musical instruments which originate musical values.

Sound is a sensation produced by waves of air beating upon the organs of hearing. These sound waves originate in a vibrating body and in musical instruments the object is to control the manner of vibration of this vibrating body in such a manner as to obtain any desired sound. Ordinary musical instruments are limited in the range of tone quality or "timbre" obtainable from them; they are also limited in the range of pitch and volume of sound delivered. An ideal musical instrument is one which is not limited in these respects.

The musical instrument described herein attempts to approximate this ideal. It is an application of the same principles which are making possible the talking pictures and radio.

Musical sounds exhibit "periodicity" when analyzed, and this characteristic distinguishes them from noises. Regardless of how complicated a sound-wave form may be, if the pressure is a periodic function of the time it will be musical. Tone quality is determined by the form of the wave, and the pitch by the frequency of its occurrence. In ordinary musical instruments, the pitch is usually easily regulated; but timbre or tone quality can be controlled only to a very limited degree for a given instrument.

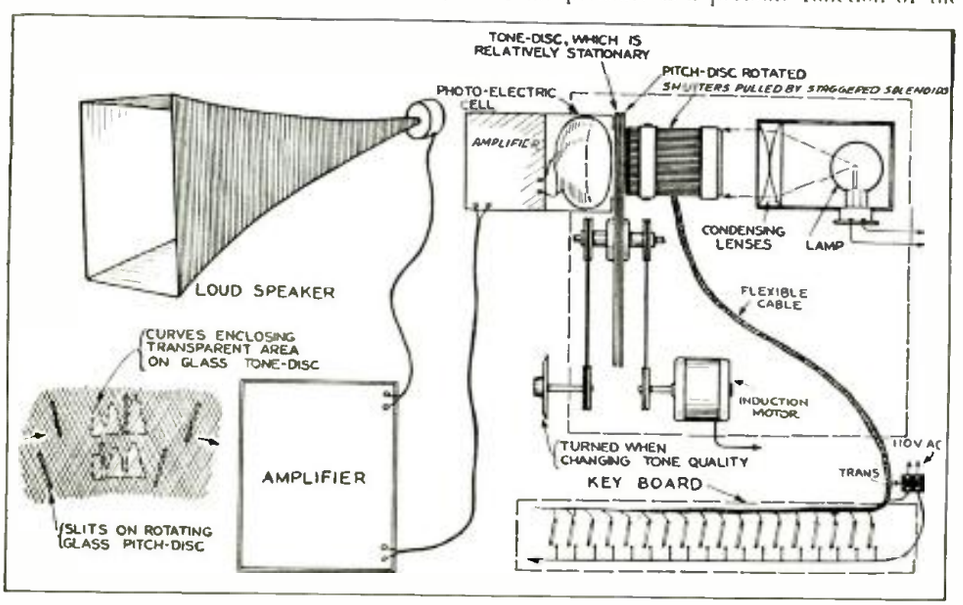
The new musical instrument illustrated here may be made to give tones similar to those of a horn, clarinet, violin, oboe, the human voice, etc.; or even any arbitrary sounds which no known musical instrument can deliver. It utilizes a keyboard, similar to those of pianos, while the quality of tone may be changed by turning a dial.

Representations of sound vibrations are impressed photographically on a glass disc. Only one complete waveform, or period of vibrations, for each note is depicted; since it suffices to characterize a tone. This disc is called the "tone-disc."

Another glass disc contains photographic impressions of a large number of slits, arranged in concentric order. The ratio (of frequencies of vibration) of successive half-tones, in the "even-tempered" scale, is as the twelfth root of two is to one, or about 106 to 100. The number and arrangement of the slits is worked out to comply with this fact. This "pitch-disc," rotating continuously, intercepts the light that shines through it and sweeps it across the predetermined sound-quality representations on the "tone-disc."

The light then falls into a photo-electric cell, which translates the light values into corresponding electrical values. An amplifier raises the level of the small currents to any value desired and, finally, a loud speaker translates the amplified electrical vibrations into sound.

The keyboard controls electromagnetic shutters, which open any passage so that light can strike the desired sections of the



The essentials of the apparatus are shown schematically above; the fundamental principle is the same as that used in sound-on-film movies. The "sound track," however, in this case, is produced by the two discs, which pass light from the lamp into the photo-cell to create any possible succession of audio frequencies.

discs. Any number of notes may be operated at the same time.

The action of the instrument may be compared to that of the talking pictures. Instead of a stationary light, and moving photographic transparencies, there is employed here an arrangement of moving slits and stationary transparencies. In this manner it is possible to obtain a whole tone from the representation of one single wave, making it possible to have a great number of tones recorded in a small space. By shifting from one set of curves to another, it is possible to obtain variations of timbre.

The sound representations, or "curves," are placed in the disc arbitrarily, and need not necessarily correspond to known musical instruments; these latter tones may be included, however. With this instrument, hitherto unknown tones may be produced. Ideal waveforms, which no known musical instrument can deliver, may be placed on the tone-disc and, thus, new musical sounds may be literally created.

The accompanying illustration shows more clearly the method by which modulation of the light-stream is obtained: the waveforms visible on the tone disc, above, correspond to pure and complex notes. At A, for instance, there is a sine-wave, which may be used to give a pure note over two octaves; according as one or another of the identical forms is uncovered by the electrical shutters, which select the inner (corresponding to lower notes) or outer wave-shapes. The solid, almost rectangular area at B, when scanned by the slits of the piten disc, gives a clear tone like that of a clarinet. These forms, worked out by mathematical calculations, are very like those which are recorded in moving-picture sound tracks. It is impossible for the photoelectric cell, amplifier and speaker to appreciate all the harmonics which may be included in an "ideal" sound curve; but within the limitations of their characteristics, they do so; and sufficiently for all musical purposes.

It will be observed that, because the waveforms are of equal width, those at the outer edge of the tone disc are scanned with greater rapidity, and therefore give a higher pitch. This would have a frequency in proportion to the distance of the scanned waveform from the center of the disc, if the transparent lines on the pitch disc were radial; but, as will be seen from the lower part of the illustration, they are modified, in such a manner that the ratios of their speeds of scanning are proportional to the twenty-six notes of the keyboard. One waveform at a time is scanned, in this model; but a very slight rotation of the disc brings up a new quality of notes.

This new musical instrument can be constructed as a substitute for expensive organs, at an insignificant fraction of their cost; or it may be assembled in the portable form for orchestras. It may be manufactured at a very low cost; for use in the average home in connection with present radio sets.

In this way, a musical instrument, far superior to a piano and considerably lower in cost, may be used with the audio-frequency channel of a radio set; so that the present investments in radio receivers may be used to greater advantage. This statement also applies to theatres which are already equipped with sound installations.

The writer has been perfecting this development over a period of some four years; and has protected it by patent applications. In its reduction to practical form, he has been assisted by Mr. Tiedemann, illustrated here with him in the pictures of the apparatus, who has among other things constructed the shutter system.

European Instruments

(The apparatus here explained by Mr. Lesti goes a step beyond the previous development of the possibilities of a radio musical instrument. The idea of using vacuum-tube oscillating circuits, electrically tuned, to deliver pure sine-wave tones directly into the amplifier of a radio transmitter, was developed by the editor of RADIO-CRAFT four years ago, with the assistance of C. J. Fitch, into an instrument, the Pianorad, by which brief "radio music" selections were broadcast over station WRNY. The instrument, while interesting as a novelty, lacked the range and the color of a regular organ, or even piano.

The idea of an universal-range electrical instrument of music has persisted in Europe; and a Viennese architect, named Spielmann, not long ago, constructed a "photoelectric piano." In this, as in Mr. Lesti's invention, photoelectric cells and amplifier were used. The description indicates, however, that only pure notes were generated; the system comprises an axis to which are fixed twelve discs, perforated with holes, the numbers of which increase in geometrical progression. On one side of each disc were eight lamps; on the other, eight photoelectric cells. The whole seems to have formed a photoelectric equivalent of the "siren" which is familiar in acoustics. Each disc could give the same note in eight octaves: depending on the hole selected, as it

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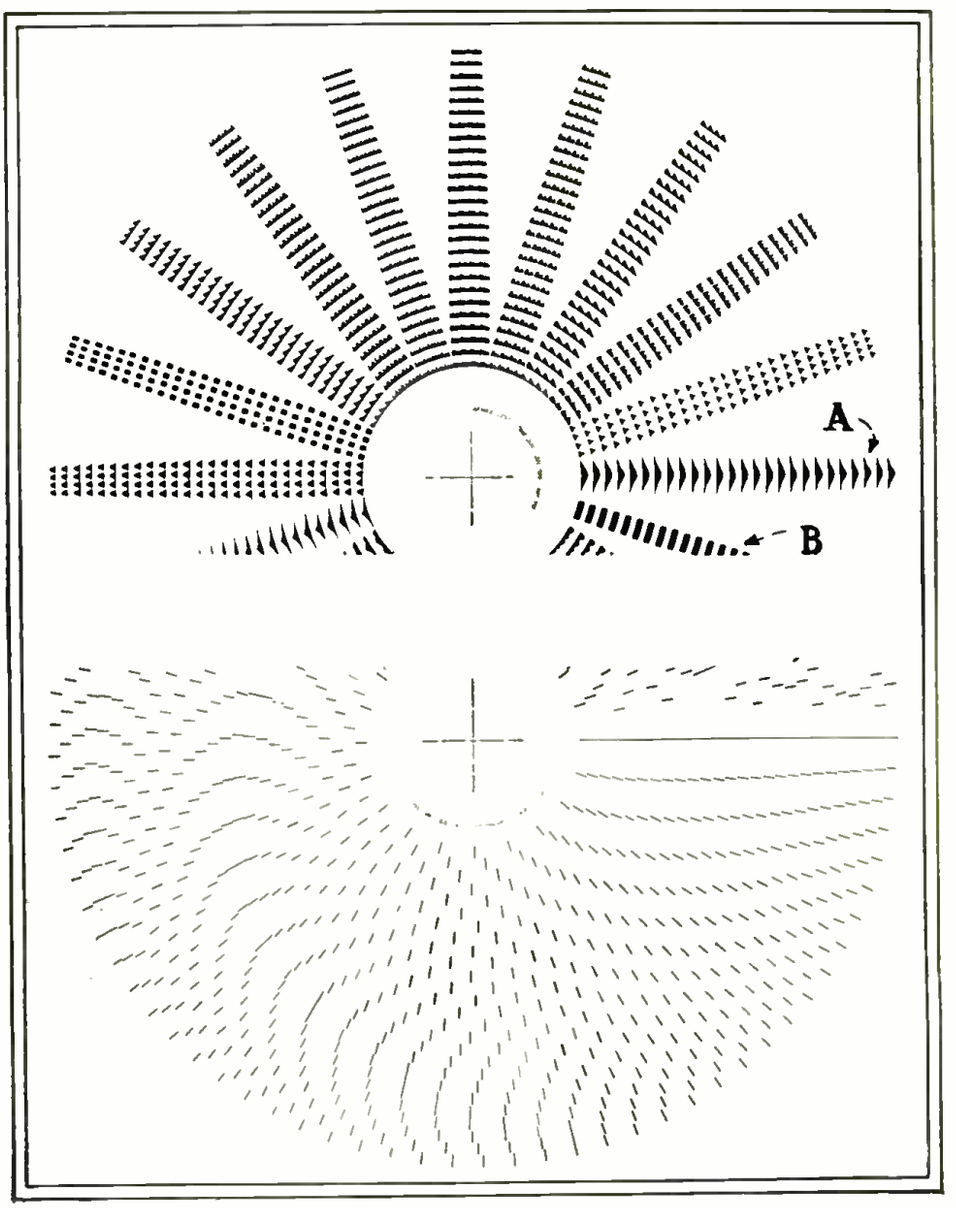


The light and dark areas of the two discs reproduced here have been reversed; so that the reader may better appreciate the proportions of the sound-wave forms on the "tone disc" (above). It will be seen that those along any radius are identical, and represent notes varying from the simplest (at A and B) to the most complicated. There are 26 in each row, corresponding to the keys of the instrument; and, while the wave form is the same in each case, the rapidity with which it is scanned by the corresponding slots of the "pitch disc" (below) gives higher or lower frequencies. All these have been designed by elaborate mathematical calculations.

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.

"GEN-WIN" TONE-CONTROL ADAPTER

IT is a relatively simple matter for the Service Man to build a tone control into most of the older radio sets. But incorporating this modern "necessity" into a receiver, whose chassis is of later design, may be not always convenient. In service work, one of the most important requisites is *speed;* and this precludes consideration of any structural change involving more than a modicum of time.

For this reason alone, the "tone-control adapter" recommends itself to every Service Man who is wide-awake to the various possibilities for increasing the revenue obtainable from each of his service calls. It is but the work of a minute to attach a tone-control unit of the adapter type, and often will produce astonishing results in the way of more satisfactory reproduction.

The unit of Fig. A, a product of the General Winding Company, is representative of the type of control used by most manufacturers of receivers: *viz.,* a fixed condenser and a variable resistor connected in series. One lead of the instrument is an end of the resistor; and the other, a condenser lead. The resistor has a range from zero to 1½-meg.; while the condenser has a capacity of .0075-mf.

Through the use of perforated bakelite discs, this device is conveniently attached to any radio set; the procedure is to remove the power tubes, place the discs over the UX sockets, and replace the tubes. Thus the grid prongs of the power tubes, in passing through the grid holes in the discs, are automatically connected, by two leads, in shunt with the tone control.

Of course, a little variation in the connection is necessary when only one power tube is used in the set. In such a case, only one disc is used to connect to the tube's grid; the other is clipped off, and the wire lead electrically grounded to the chassis or filament circuit.

Then, the adapter is placed wherever most convenient; a 4-foot length of twisted, flexible wire being provided for the purpose. A neat, brown-finish metal case, about 4 in. in diameter and 4 in. high, encloses the components; its exterior appearance is completed by a white celluloid plate, with the scale of positions—"Brilliant," "Bright," "Mellow," and "Deep"—underneath the control knob.

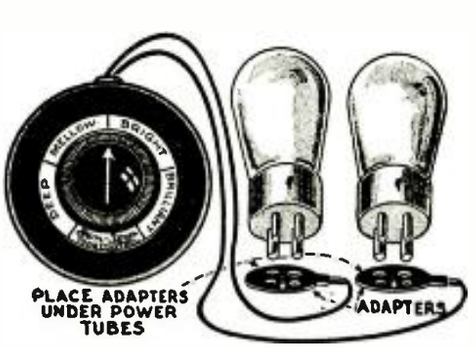


Fig. A

The tone-control adapter shown is applicable to any set; the two discs simply slip over the prongs of the push-pull tubes. With but one power tube, one disc is cut off and the lead grounded.

UNIQUE SET ANALYZER INCORPORATES TWENTY-FIVE TESTING INSTRUMENTS IN ONE

By H. G. Cisin, M.E.

Fig. B

A light, but complete set analyzer which gives all readings with a single meter.

SERVICE MEN all realize the necessity for simplicity in radio testing equipment, although as a rule, this is a point very often overlooked by the manufacturers of such devices. The exception to the rule however, is the Supreme "Set Analyzer, Model 90," which is one of the simplest and most efficient instruments of its kind, ever built. This unit is pictured in Fig. A.

Through the means explained below, it has been found possible to employ a single meter to measure both A.C. and D.C. Another handy feature is the use of a small knob located directly below the meter, which turns a scale selector switch. To facilitate meter reading, the instrument is graduated in two scales, 0-9 and 0-3; this minimizes the chance of making an error while reading the scale. In order to change the scale, the selector knob is rotated to the scale desired. There are six ranges on the selector—900, 300, 90, 30, 9, and 3. The scale selector switch controls both voltage and current ranges.

All voltage readings, both A.C. and D.C., are available in the following ranges: 0-3, 0-9, 0-30, 0-90, 0-300, 0-900. A.C. voltages are measured at 1000 ohms per volt. All current readings, both A.C. and D.C., are in milliamperes in ranges as follows: 0-3, 0-9, 0-30, 0-90, 0-300. All voltage and current ranges are available through the insulated pin jacks on the face of the instrument panel.

For external use, twenty-two distinct ranges can be obtained. In getting these, only three external connections are utilized; these are made through the three pin jacks located at the lower left of the instrument panel, and marked "Ext. Connections."

The toggle switch at the right of the scale selector, marked "UX" on one side and "Heater" on the other, is left in the "UX" position when analyzing from sockets which do not utilize cathode-emitter tubes. For all cathode-emitter tubes, including "top heater" tubes, the switch is closed to the "Heater" position, which separates the cathode connection from the heater, and prevents the possibility of short-circuiting the cathode bias. Under the UX socket at the upper right is a pin jack, for making a connection to the control grid of either a pentode or a screen-grid tube; the jack under the UY socket is used for connecting to the space-charge grid of the pentode. The fact, that facilities are provided for making pentode analyses, is evidence of the advanced design of this set analyzer.

Although operation of the "Model 90" has been simplified to the highest degree, accomplishment of this simplicity has been a matter of overcoming many technical obstacles to this design. Reference to the schematic circuit of this unit, Fig. 1, will indicate this.

The idea of using a D.C. meter movement with a suitable rectifier for measuring A.C. has been accomplished in a simple manner, and without the usual bulky rectifier equipment, through the use of a very small and efficient copper-oxide rectifier developed by the engineers of the General Electric Company; the circuit of this dry-disc rectifier

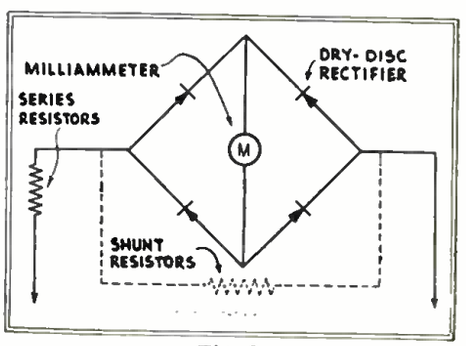


Fig. 2

The bridge adjustment shown utilizes the D.C. meter for reading A.C. voltages, which are rectified in their passage through the rectifier discs, which pass current only one way.

is shown in Fig. 2. Correction of the reading to indicate the usual R.M.S. value of A.C. potentials is taken care of automatically on the scale. The turn of a toggle switch automatically throws the rectifier in or out of circuit.

No reversing switch is necessary with the "Model 90," since the meter reads independently of the applied voltage's polarity; however, the two pin jacks, marked "Pos." and "Neg." "Polarity," which may be noted on either side of the scale selector, can be

(*Continued on page* 425)

Making Your "Mike" for Home Recording

By MICHAEL BLAN*

AN inexpensive hand-microphone, for home-recording and novelty experiments, may be easily made from a few pieces of cigar-box wood, a diaphragm, a strip of sheet metal, a small piece of "suiting," a telephone mouthpiece, and a "microphone button." A push button, too will be useful.

The general principles of home-recording have been covered in considerable detail in the preceding issue of RADIO-CRAFT; it will be recalled that a microphone is a very necessary part of the equipment. And, since not every set owner is in a position to make the purchase of an expensive unit, the constructional details of one which is very easy for the experimenter to build are shown in the accompanying illustrations.

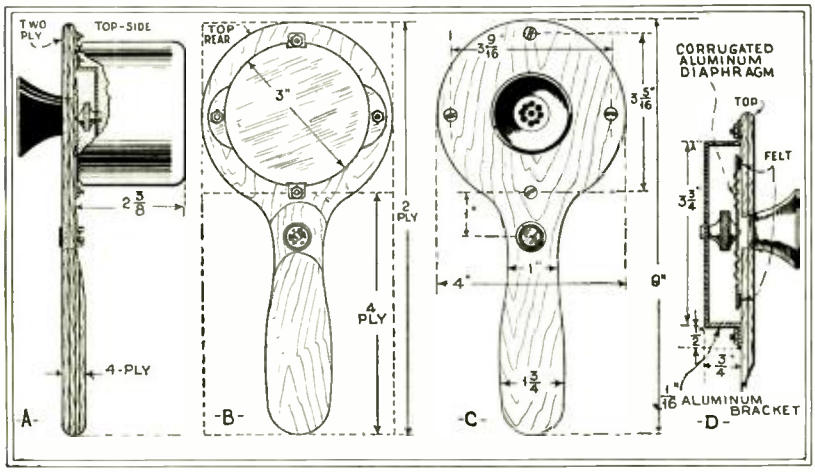


Fig. 1

The various stages of making the "mike" are shown clearly in this illustration.

Before starting the construction of this "hand-mike," dig through the "miscellaneous" box for the following items:

One pearl push-button;
One "Skinderviken" microphone button;
One Fada (or equivalent) shield can;
One telephone mouthpiece;
One diaphragm (see below);
One piece of metal strip, ½ x 5¼ x 1/16-in.;
Six small pieces of cloth (see below);
Four pieces of cigar-box wood, 4 x 9 x 1/16-in.
Four nickeled machine-screws, ½-in. long and 6-32 thread; four nickeled 6-32 hex. nuts, and two 6-32 battery nuts.

Now that all the parts have been collected (What's that? Where can you get a diaphragm? Well, just wait a few minutes and you will find out just where you may be able to locate one.) let's make the wooden frame. After all, the exact dimensions of this will vary with the particular size of diaphragm and shield can available in each instance. The dimensions given are for the specified equipment, which was used for the instrument illustrated here.

Use about two pieces of the cigar-box wood for most of the frame, (as shown in Fig. 1A) and build up a handle of four thicknesses. Glue, and means of clamping the pieces, will be required, of course. The general appearance of the wood, before being cut to shape, is indicated in the dotted outline of Fig. 1B; while the dimensions of the completed frame are given in Fig. 1C.

It will be necessary to bore a hole, ⅞-in. in diameter, to receive the mouthpiece. Two holes will be needed for the strip-mounting screws, and two more for the shield-can mounting screws. The original dimensions

(*Continued on page* 440)

*President, Blan the Radio Man, Inc.

Watching the Wheels Go 'Round

By LEO BRAMS

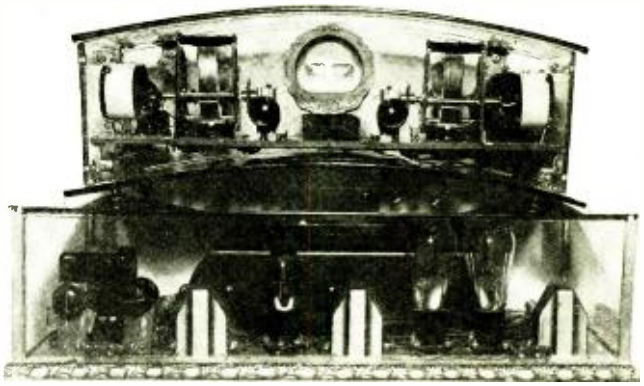
FOR several years the writer has made a specialty of designing and constructing odd and unique arrangements of radio apparatus. One which attracted considerable attention, and favorable comment on the placement of the parts, is pictured in these columns.

The receiver chassis was an adaptation of units taken from a Karas "Equamatic" kit, housed in the upper glass cabinet which has a curved top and bottom; the curved bottom plate is of black glass. A wooden beading finishes off the base of the lower glass cabinet.

The power pack, also put in a glass cabinet, was a standard Samson "210" job that presents nothing new in circuit arrangement. The glass sections of the lower cabinet were held in place by nickeled strips; but these were not conveniently adaptable to the curved sections of the upper cabinet, which required the use of little nickeled angles. (The author paid quite a bit to have all the necessary holes drilled by a competent glass-working house.)

The beauty of an arrangement such as this is difficult to picture; while its novelty as a display is always a pleasing and effective way of attracting attention to a window trim. This manner of presenting a favored circuit design is sure to be a profitable one. Thus, little details of arrangement and connection may be pointed out to the custom set builder's radio prospects.

Radio sets built by the writer, along such novel constructional lines as these, have won many awards at radio shows. And this tip should be equally as profitable to other radio men.



The mysteries of the radio sets are exposed in this glass-cased receiver, built by a constructor of considerable ingenuity. A well-known standard circuit was utilized: but the glass and nickeled fittings were cut to order, so that the expense was not low. Still, this novelty attracted much comment wherever exhibited.

The Midget Receivers--Inside and Out

The demand for a small, but efficient radio receiver, modern throughout, but occupying small space as, for instance, on a mantelpiece, has led to the production of many interesting designs. Eight of the latest are shown.

FEW things are more inharmonious than a big console radio receiver in a small room; regardless of how tastefully or artistically the set has been decorated or camouflaged. But, until the advent of the "midget," or "mantelpiece," style in radio sets, it was difficult to find a substitute for the big set in the little room.

These little radio receivers, with big possibilities, are the acme of ease in servicing. The average dimensions are exemplified in these of the Pilot midget illustrated below; which measures 17 inches in length, 8½ in. in depth, and 17½ in. high, overall.

It is but the work of a moment to remove the chassis of a midget set, to reach for the "works" for testing, or replacement of parts. In fact, it is no trick at all to pick up the entire machine and take it to the service station for the more extensive repairs which may be occasionally necessary.

While all radio sets are designed and manufactured with the theoretical premise that they will not need to be serviced, for faults in the receiver, nevertheless it is not unusual for any of the faults of the big brothers to arise as well in the smaller member of the radio set family. However, with the lesser number of tubes, and lowered requirements from the power-pack, there is an increase in the "factor of safety," and, according to the law of averages, there should be less chance for defects to develop, in consequence of the lesser number of parts involved.

In the November, 1930, issue of RADIO-CRAFT, the Crosley, "Model 54 — New Buddy," the Jackson-Bell "Model 62," and the Simplex, "Model H," were described and illustrated. Here eight other new "midget" receivers are shown, with full data.

The Pilot "Midget"

This receiver, a product of the Pilot Radio and Tube Corp., is one of the best-sounding small radio sets it has been the writer's pleasure to hear. Its diminutive size is achieved by clever arrangement of standard components, and by restricting the circuit requirements to five tubes. Its undistorted power output is quite sufficient for good reception in a room of rather large size. High quality reproduction, throughout the entire audio range, has been obtained by exceptionally careful design of the entire audio system, with due regard for the small dimensions of the baffle afforded by a midget cabinet. It is not enough merely to state that the bass notes are reproduced very well; for it is a fact that the low notes are reproduced without recourse to barrel-resonance, which causes a fictitious low-note response.

A point of particular importance is the design of the receiver, from the standpoint

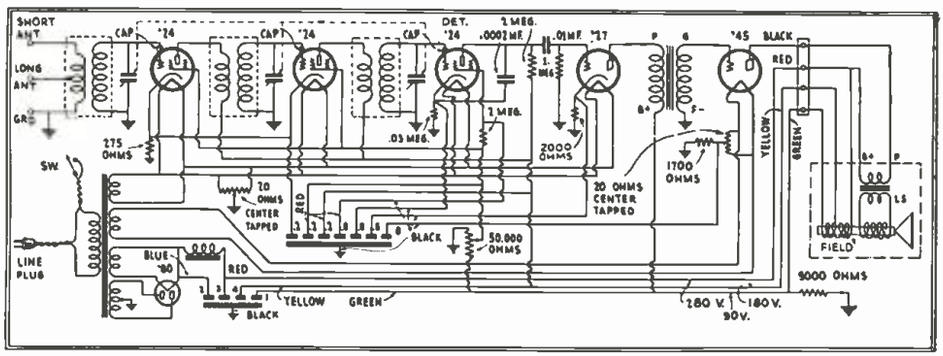


Fig. 1

The circuit of the efficient new Pilot "Midget Set."

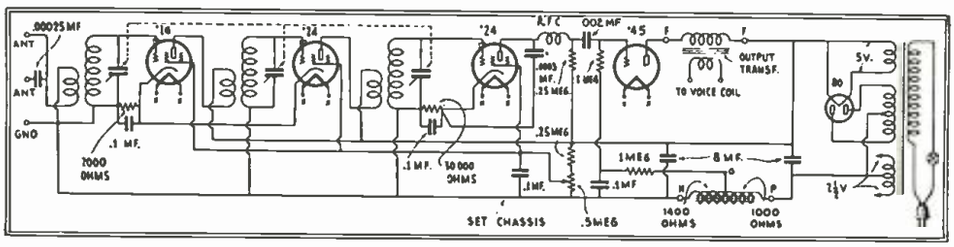


Fig. 2

Schematic circuit of the Melorad "Cathedral Tone" midget receiver.

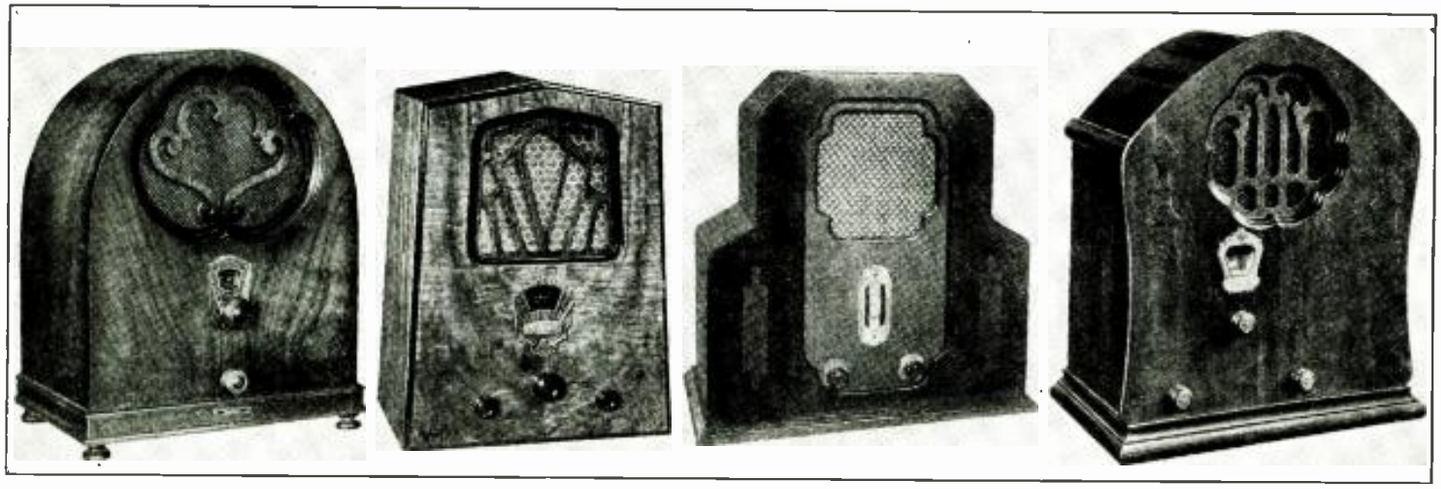


Fig. A

From left to right, the following midget receivers are illustrated above: The "Radiette Model 14"; Pierce-Airo, "DeWald Model AC-524"; "Pilot Midget Set"; T.C.A., "Clarion, Jr. Model 60."

Fig. B

From left to right, following are the mantel or midget radio sets shown in this illustration: "Master, Model 424"; "Jesse French, Jr., Model G"; "Remler Cameo, Model 14"; "Melorad, Cathedral Tone."

of service. The chassis is easily removable, and continues to play when removed from the cabinet. Fig. 1 gives circuit details.

Melorad "Cathedral Tone"

A simple circuit, comprising two stages of tuned R.F., using type '24 tubes, feeding into a type '24 detector, which is in turn resistance-capacity coupled to the type '45 power tube, is used in the Melorad "Cathedral Tone" receiver, sponsored by Federated Purchaser. The diagram of connections is reproduced in Fig. 2.

Master Radio Receiver

Another manufacturer of midget radio sets incorporates tone control in a direct-coupled audio amplifier; so that the detector feeds directly into the power amplifier without the introduction of a coupling condenser or transformer. The circuit of this set, the "Model 424" receiver made by the Master Radio Mfg. Co., Ltd., Los Angeles, Calif., is shown in Fig. 4.

The technical details are as follows: R (volume control), 6,050 ohms; R1, 500; R2, R8, 50,000; R3, 425; R4 (hum control) 200;

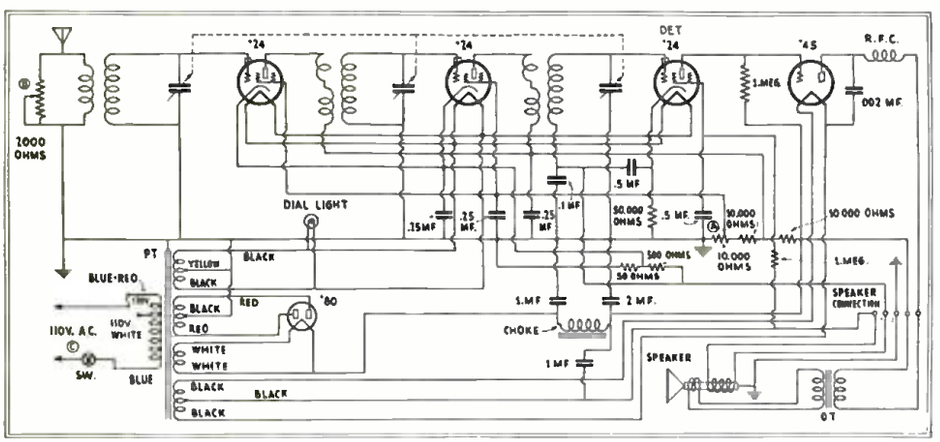


Fig. 3

Circuit of the "Model G, Jesse French, Jr.," direct coupled set.

The field coil of the dynamic reproducer is the only choke in the filter system, and serves to smooth the voltage obtainable from the power unit.

Jesse French, Jr.

One of the first radio sets to introduce direct coupling in the audio amplifier system is the Junior "Model G" receiver, sold by the Jesse French & Son Piano Co., and illustrated in Fig. 3.

Three screen-grid tubes are used, the last being the detector. The detector output is sufficient to drive the type '45 power tube, with considerable grid-bias swing. By the use of direct coupling, it has been possible to conserve part of the space which would be taken by an input transformer. Still, an output transformer (OT) is required, to couple the dynamic reproducer to the power tube's output circuit. Units A, B, C are controlled by a single knob

R5, 1584; R6, 1,800; R7, 2515; R9, 100,000; R10, R11, 500,000 (tone selector). The voltage divider comprises R3, R5, R6, R7.

The condensers have the following values: C, 350 mmf.; (C1, trimmer condenser); C2, C4, 0.1-mf.; C3, .002-mf.; C5, 0.5-mf.; C6, C7, 1.0 mf. (600 V.); C8, C9, 2 mf. (1,000 V.); Condensers C4, C5, C6, C7, C8, C9 are in filter bank. In some cases it is necessary to use .004-mf. for C3, to overcome feedback from the R.F. stages.

Coil L consists of 300 turns of wire on a bobbin, and secondary L2 of 133 turns. The remaining three R.F. transformers have 45-turn primaries and 120-turn secondaries.

In some of the sets of this model, the "tone selector" is not connected as shown in Fig. 4 but, instead, to the plate of the '45. The fixed .002-mf. condenser remains connected to the plate of the '45; but the tone selector capacity in parallel with it is increased to ¼-mf., and the variable resistor, with one side grounded, then has a maximum value of 15,000 ohms. The grid of the '45 now must be by-passed to ground by a fixed condenser of 50 mmf. Accurate replacement parts must be used in servicing this set.

Clarion, Jr. Midget

This set manufactured by the Transformer Corp. of America, is also in the "5-tube" class, but the circuit arrangement results in somewhat different performance from that of the average small-space radio sets. Two stages of screen-grid amplification (See Fig. 5) are followed by a screen-grid detector, the cathode circuit of which is provided with a switch for cutting into circuit a phonograph pick-up. The output of the

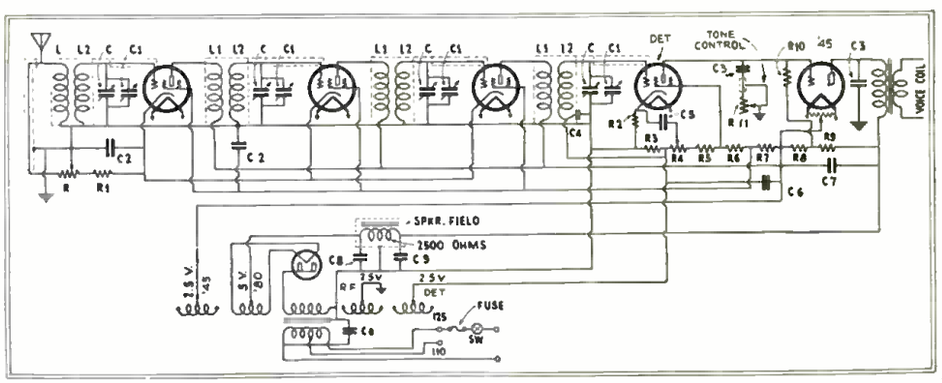


Fig. 4

The Master "Model 424" midget set has direct audio coupling, screen-grid tubes, hum balancer, and tone control. All midget circuits shown have ganged condensers.

detector is transformer-coupled to the power stage, two type-'45 tubes in push-pull; while their output is transformer-coupled to a dynamic reproducer. Tone control is provided in the grid circuit of these two tubes, and controlled by an off-on switch.

Pierce-Airo "DeWald"

A midget product of Pierce-Airo, Inc., is the "DeWald Model AC-524" receiver shown in Fig. 6. This circuit is practically identical with that of the "Melorad" described above; however, in the former receiver, volume control is obtained by varying the screen-grid voltage, while the "DeWald" varies the signal input to the first R.F. transformer.

"Radiette Model 14F"

Although the "Radiette Model 14 F" midget receiver, manufactured by Keller-Fuller Mfg. Co., Ltd., provides screen-grid R.F. tubes, like most of the midget sets, the circuit (Fig. 7) contains several interesting features.

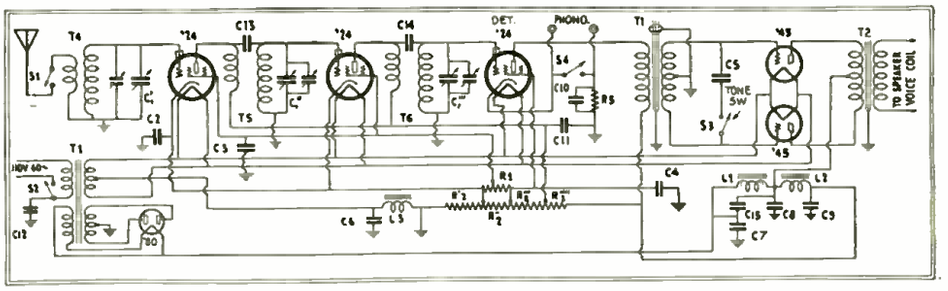


Fig. 5

(Above) Diagram of the phonograph-adapter, "Clarion, Jr., Model 60," receiver.

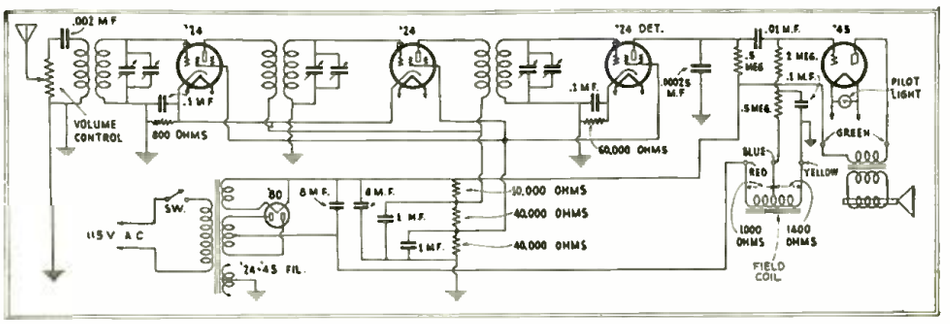
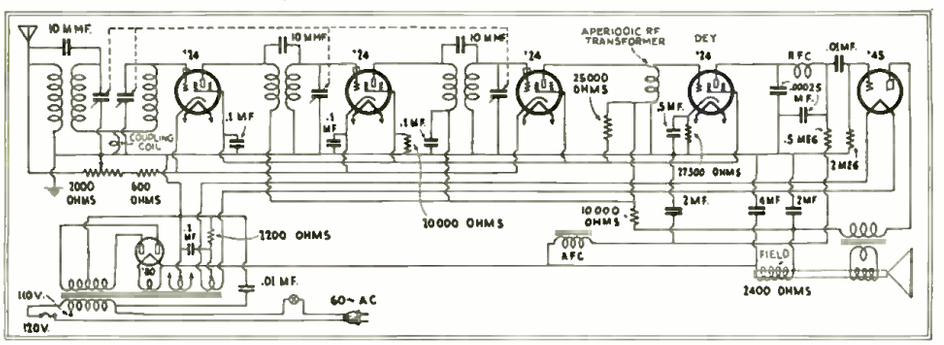


Fig. 6

(Above) The Pierce-Airo "DeWald" circuit.



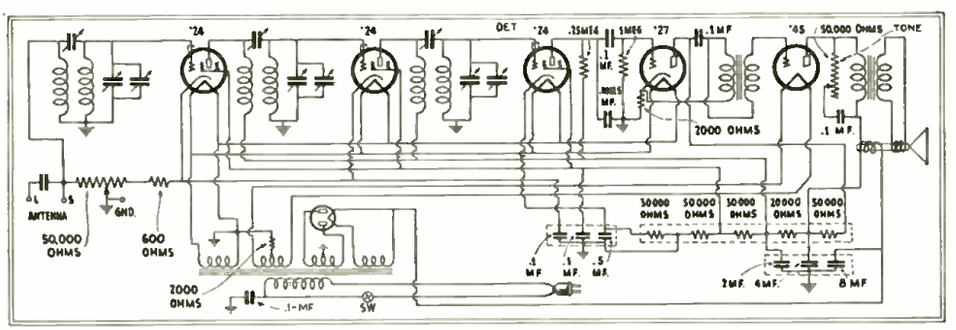


Fig. 7

(Below) The band-selector, "Radiette, Model 14F" receiver diagram.

For instance, the first screen-grid tube is preceded by a band-selector; there is a little coil furnishing inductively the required coupling between the two tuned circuits of this unit. The detector is coupled to the preceding tube, an R.F. amplifier, through an aperiodic R.F. transformer, untuned by a variable condenser; and its output is resistance-capacity coupled to the power tube. The volume control varies the control-grid bias. The small 10-mmf. condensers in the R.F. circuit are included to improve the response at the high-frequency end of the tuning scale.

Remler "Cameo"

A compact midget set, incorporating the transformer-coupled audio amplification, and tone control, is the Remler "Cameo Model 14" receiver offered by Remler Division, Gray & Danielson Mfg. Co., and shown in diagram form in Fig. 8.

(Continued on page 440)

Fig. 8

(Left) The tone-control, "Remler Cameo, Model 14," midget receiver circuit diagram.

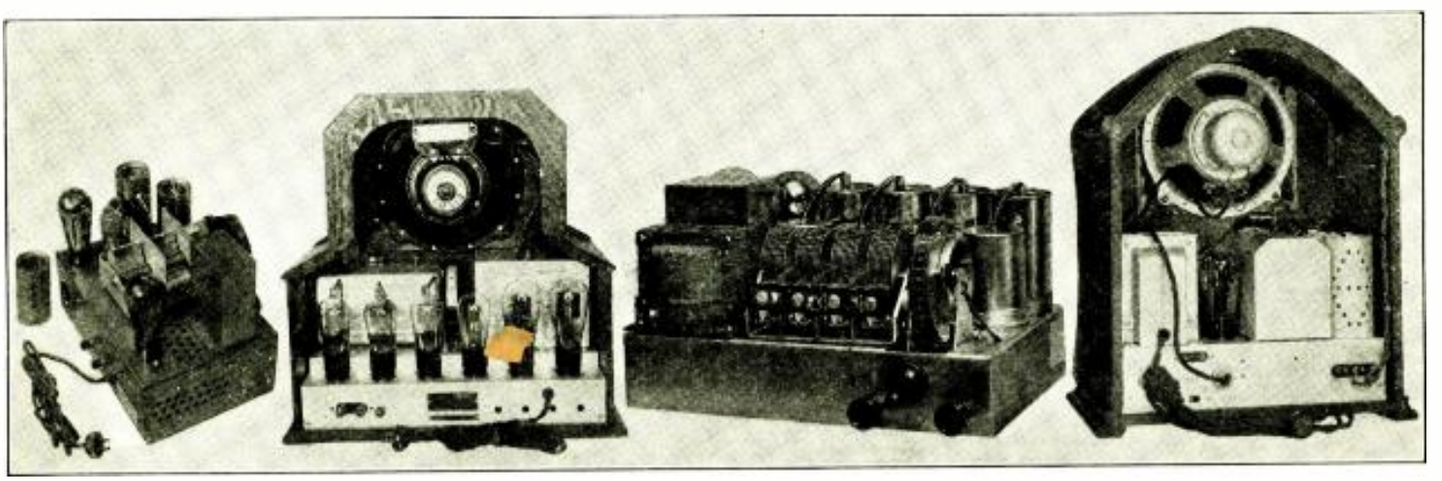


Fig. C

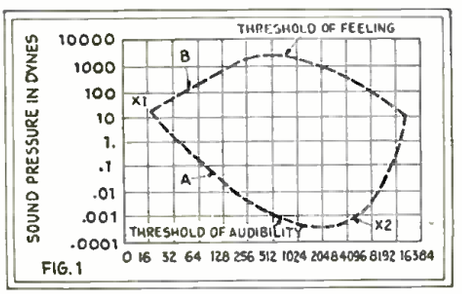
The astonishingly compact, but effective, assembly of "midget sets" is illustrated in these pictures of the following commercial receivers: (left to right) "Jesse French, Jr. Model G"; "Pilot Midget"; "Master, Model 424"; "Clarion, Jr., Model 60."

Tone-Control Design for Your Radio Set

And an Opinion on True and False Values in Sound Reproduction

By C. H. W. NASON

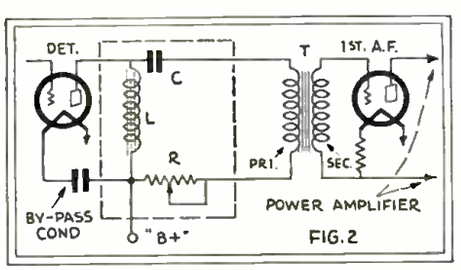
IT has not been uncommon practice in radio, at least until a short time ago, to meet deficiencies in some particular unit by a compensating effect in another; lack of low-frequency response in an audio amplifier by the use of dynamic reproducers having a pronounced resonance in the low-frequency register.



The upper curve gives the highest values of sound which can be borne; the lower, the lowest which can be heard. Middle tones are easiest heard; but there are great differences in individual hearing, at both ends of the scale.

With the improvement in low-frequency response which followed, some manufacturers retained the resonated speakers—and a pronounced "boom-boom" was the result. To some ears the effect is pleasing, but to others it is anathema. Although some manufacturers still pursue this course, others have maintained the logical idea: that radio apparatus should achieve a rendition which is as faithful to the original as technically possible. But this year brought "tone control," and the idea of the "most pleasing effect" returned. Now, tone control may be achieved in some forty odd ways and, to misquote Kipling, "all but one of them are wrong."

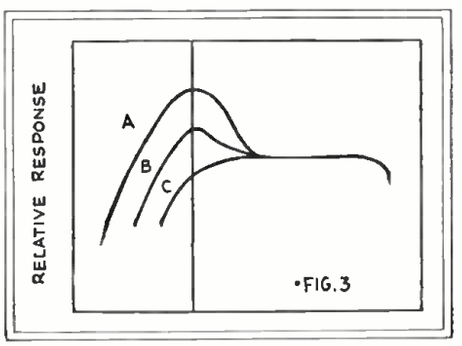
A mellow effect may be produced by employing a block of fixed condensers in the audio-frequency circuit, thus cutting off the higher frequencies in a varying degree. Since these very "highs" are conspicuous by their absence in nearly all receivers, this method of attack is fatal to quality, although it produces an effect quite pleasing to some ears. I do not know of one trained musician who would condescend to listen to such a receiver while the control was in the "mellow" position.



Since the transformer T has a natural resonance, inserting a parallel unit (as shown in dotted lines) permits this to be overcome, and quality given its most natural character. The author prefers this.

In these systems, the control knob has some three or four positions graduated from "brilliant" to "mellow." Considering that the "brilliant" position is already lacking in the high frequencies, which are necessary to the proper reproduction of the sibilants in speech and the overtones of orchestral instruments, it is hard to find an excuse for still further ruining the delineation.

The frequencies known to human hearing range from 15 cycles to 17,000 cycles. Restriction of this range, from the given figures to between 30 and 10,000 cycles, will have no noticeable effect upon the reproduction. In order to effect savings in the width of band occupied, and to remove ground noise (which is mostly high-frequency in character), the restriction may be carried still further down to 7,000 cycles, where direct comparison, with the original, is necessary to judge the difference. Requirements of the Federal Radio Commission necessitate the further restriction of the higher broadcast frequencies to an upper limit of 5,000 cycles.



Resonance of the transformer exaggerates the response of low notes, as at A. As resistance is cut in (at R Fig. 2) tones become more natural, between curves B and C.

It is self-evident that the chain, from microphone to loud speaker, should be so perfect as to amount to a clear channel from one to the other. There is, however, one condition where "tone control" is necessary to the correct reproduction of the original: if the output of the reproducer is to be adjusted to some volume level other than that of the original, a re-proportioning as to *frequency response* will be necessary.

Don't Believe Your Ears

Fig. 1 is a well-known diagram of the response of the human ear at various frequencies. (This graph is taken from "Speech and Hearing," by Dr. Harvey Fletcher, of the Bell Laboratories, who is one of the great authorities on sound.) For our purpose, we will refer to the lower curve (A) which indicates the *absolute* mechanical power of a sound wave necessary to produce a *perceptible effect* upon the human ear. The upper curve (B) shows the power which can be exerted before a *sensation of pain* is experienced. These curves represent the average of conditions found in a great number of persons, upon whom the tests were carried out. We are particularly interested in the range between 16 and 5,000 cycles; and you will note that the air pressure required to produce an audible effect at the upper end X2 is a minute fraction of that required at the lower end, X1. (It is less than one ten-thousandth, in fact; the scale of this curve is logarithmic.)

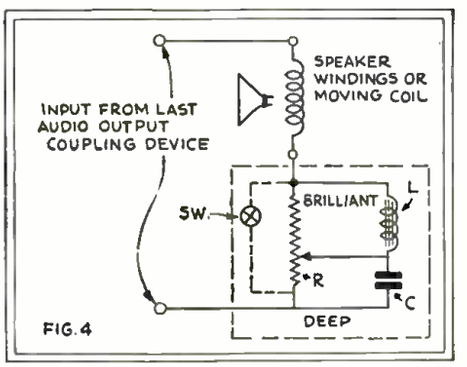
If a transmission system, of any nature, is employed to convey the efforts of a singer from one point to another; and the gain through the circuit is so adjusted that the mechanical work done by the reproducer is the same as that done by the singer at all frequencies, then natural reproduction will be attained. The apparent effect at each frequency is proportionate—not to the absolute level of the sound—but to the level above the threshold of audibility at that frequency. If the singer's voice were to include all frequencies over the entire range at an average pressure of one dyne, then all components of the original would be audible.

If, however, we desire to reproduce the program at an average level of .01-dyne, a reference to the curve will show that the frequencies from 190 cycles on down will be below the threshold of audibility, and will not be heard. In order to achieve a natural rendition it is necessary to raise the response at the low end, and thus reproduce the original in apparently true proportion above the threshold of audibility.

Conversely, if we found it desirable to reproduce the original at a higher level than normal, it would be necessary to reduce the response at the low-frequency end.

It is not enough to retain all frequencies in their correct proportions; it is essential to achieve a relationship between them such that they effect the human ear in a corresponding manner, if the illusion of life is to be retained.

(*Continued on page* 441)



The unit described above, applied externally to a speaker circuit, is easily made, and gives customers what they want. It is thus more desirable for the man whose interests in radio are financial, not artistic.

Tone Controls in Commercial Radio Sets

And methods, old and new, of applying this convenience to other models

By R. D. WASHBURNE

THE subject of tone control recently has been brought to the attention of the public through the efforts of the engineering and sales departments of many radio concerns. A review of the methods in use may suggest to the set constructor and to the Service Man the most convenient manner in which control of the audio output quality may be arranged in particular cases.

First, let us state that *tone control* means changing the relative strength of various audible frequencies; while various other frequencies remain unchanged. This is disproportionate reduction of signal strength, as compared to *volume control,* or (nearly) proportionate reduction of signal strength. By tone control, the "timbre" or distinctive quality of an audio sound may be modified to such an extent as to mislead the listener entirely as to the true origin of the sound. For instance, to use obvious examples, a violin may be made to sound like a cello; or, a soprano voice may be made to sound like an alto, and a baritone like a bass. In each of these examples the effect is obtained by removing or reducing the proportion of high notes, or "highs." A reverse effect is obtained when the low notes, or the "lows," are removed or reduced, while the highs remain normal.

Why Tone Control?

One of the first questions that arises, when tone control is mentioned, is whether tone control is needed. Those radio salesmen who are only moderately glib find it a bit embarrassing to present a reasonable alibi when the customer inquires: "The radio set you advertised last year was stated to have 'perfect tone.' The one you offer this year is said to have "life-like reproduction,' combined with 'color modulation.' If the reproduction is 'life-like,' why is there any need of changing the quality?" And review of the statements by representatives of the foremost radio companies reveals a number of not necessarily obvious, yet vitally important, reasons for control of the "perfect tone."

A musical selection played in a large hall will not sound the same when reproduced in a much smaller place—for instance, a room at home. The "acoustics," or the conditions (the amount of drapes, the type of furniture, the amount of hard surface such as glass windows, the distances of the nearest and furthest walls) which affect sound in the hall and in the room at home, differ widely. To a certain extent, a better balance between these widely differing and uncontrollable mechanical conditions may be obtained through electrical means—the "tone control" unit. (A novel way of obtaining the echo effect of a large hall sometimes may be found, when a particular program is being broadcast from both long- and short-wave stations, by using one reproducer to take the combined output of a long- and a short-wave receiver tuned to the program.)

Then again, transmissions vary widely in quality, between those of the high-power, expensive stations, and those of low power and cost. In fact, it is possible at times to improve upon the received signals of even the best stations. There are numerous reasons, of which we will mention one or two: (a) although a "frequency run" has been made along remote-control wires and through to the output of the transmitter, it occasionally happens that a particular part of the circuit will develop a slight distortion which may go uncorrected for the balance of the program. Modification of the received signal will materially improve the reception.

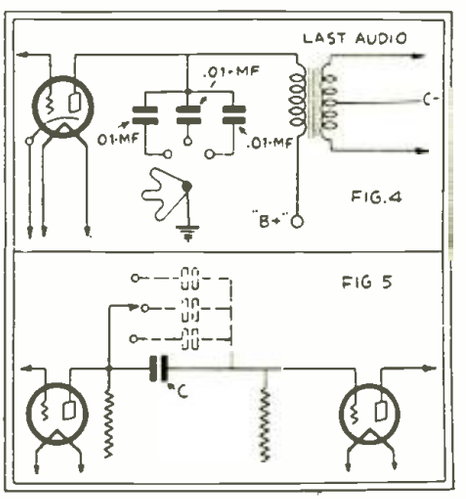
Or (b), a performer may for a moment forget his or her coaching in "microphone technique," with harrowing results; but recourse to a tone modulator renews the desire to listen.

Another factor normally beyond the control of the listener is the variation in audio quality, due to different degrees of power to the receiver input. A local station of high power comes through with a quality differing from that of the "DX" station. Modern receiver design, to a great extent, has overcome this obstacle; the older sets are greatly improved, however, by the use of a tone control in such instances.

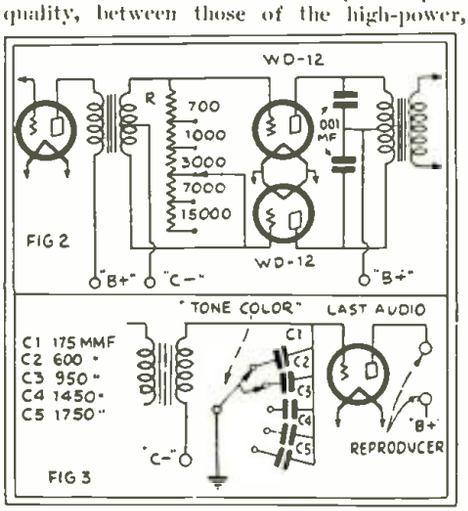
Have you ever noticed how the "boom-boom" of bass instruments varies with each station, the hour of the day, and the particular program? In many instances a little more, or a little less, boom-boom is the listener's personal preference. A tone-control on the receiver is the means of effecting this.

Local "static" interference is in many instances, particularly in congested districts, a rational reason for tone control. The latter makes it possible to enjoy, with but slightly less "brilliancy" of reproduction, a program which otherwise would be marred by crackles and scratching sounds.

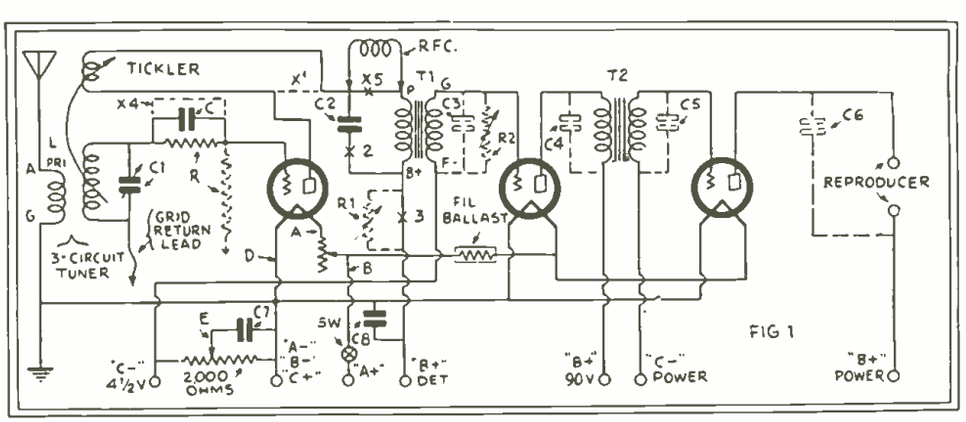
It may be well to point out here that the



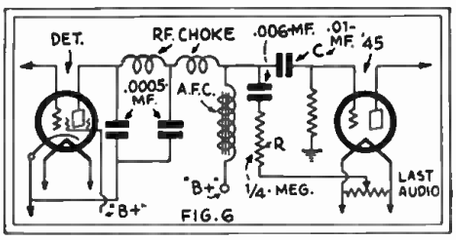
Above: the principle of the tone control used in many Philco models. Below: controlling the "low-frequency pass" of the coupling condenser in audio circuits using resistors or chokes in the plate and grid circuits.



Above: tone and volume control are first cousins, as this old 1922 circuit shows. Below: nine capacity changes, through single and shunt connections of the fan-switch, are possible in this "tone color" circuit of the "Synchrophase."



A standard 3-circuit tuner: the striking appearance of this circuit is due to the numerous marks of reference, which indicate some of the many ways in which the quality of reproduction, of any standard radio set, may be modified. Shunt capacities, shunt and series resistors, and variations in grid connections and voltages are represented.



A slight modification of existing receiver components gives "tone control," as by making variable the resistor R, above.

tone control should be designed to be operative both with the radio and with the phonograph pick-up; in the latter usage, it permits needle-scratch to be controlled as the operator deems necessary. In home-recording, too, tone control is a "life-saver."

Few people realize that famous broadcasters often have a strident, sharp tone of voice (a tone that their friends do not hear in conversation and do not realize they possess); that they reserve for use on the air, knowing full well that the *reproduced* voice will have a richness and mellowness that is sure to charm the listener. On the other hand, the broadcaster untutored in the ways of the "mike" will talk in his normally heavy voice, only to have the listeners remark that his voice sounded "as though he were talking in a barrel." Here again, a slight modification of the audio amplification characteristic will help.

Still another point to observe is that concert music must have a tone different from that which is to accompany a dance where the throbbing tempo of the drums must be heard above the shuffle of dancing feet. A motion of the tone control toward "deep" modifies the tone to suit the special conditions.

Strange as it may seem to some people, there are thousands and thousands of listeners who seldom hear notes above a certain frequency, individually-determined, considerably below the average limits of audio reception. It is, therefore, obvious that a control which can boost the high notes to a volume level out of normal proportion will be to them a real boon. In the same breath, it may be mentioned that this auditory discrimination is sometimes found at the low end of the audio scale, instead.

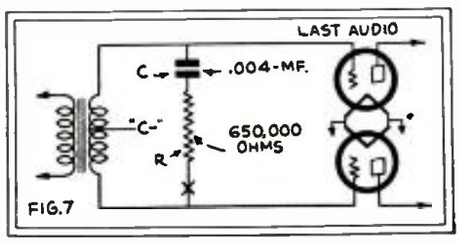
This unusual characteristic in some people recalls the story of one Service Man who repeatedly reported that he had cleared the trouble of "a high-pitched whistle" reported by the customer; only to have the customer call back in a short time and say the set was tooting as merrily as ever. The Service Man simply had not heard the whistle that was so clear to others. (The solution of that problem was to send a different Service Man on future similar complaints.)

Most radio sets reproduce programs with a fidelity which varies somewhat with the setting of the volume control; to be more specific, we may point to the loss of bass notes at low volumes. A control which brings back a certain proportion of the lowest notes will be a redeeming feature for many sets, particularly the older ones.

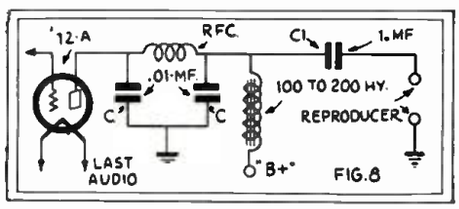
Examples of Tone Control

To show the numerous ways in which the tone reproduction of a radio set may be changed, Fig. 1 is presented. For the sake of argument, a three-circuit tuner has been selected to bear the brunt of the reference; of course, this circuit may be considered as only the detector circuit of an average radio receiver, by imagining a shunt across the tickler coil at X1, and the output of an R.F. amplifier connected to the "A" and "G" posts of the primary of L.

A form of tone control is obtained by slightly detuning the receiver. The use of a feed-back or regeneration coil (tickler) is shown in Fig. 1; because regeneration too is a form of tone control. Still another form of control, which might be considered inherent in the receiver, is the result of the grid-return connection of the detector. For instance, the grid return lead may be connected to any of the points lettered *A, B, D,* or *E;* the correct plate potential for each of these grid connections is secured through proper tapping of the "B" supply, or by the adjustment of a variable resistor R1 connected at X3. Another point of control, by a change in value or connections,



A switch at X cuts an existing high-frequency by-pass system in or out of circuit.



Adjusting the capacity of C1 varies the bass output—the highs remaining unchanged.

is at the grid condenser C and the grid leak R; the latter is either shunted across C, or connected to the point of grid return as shown dotted; or both grid leak and condenser may be dispensed with, as shown by the dotted shunt X4.

Other factors perhaps more conveniently accessible are an R.F. choke, as shown at X5, and a by-pass condenser C2. Varying the capacity of C2 will result in considerable tone control. This may be done in "step" fashion by means of several condensers and a fan switch; or more gradual control may be obtained by the use of a variable resistor in series with this by-pass condenser, as shown at X2.

The idea of using a shunt condenser as a tone control may be applied at a number of positions in the audio circuit. For instance, it may be shunted across a transformer primary, as shown at C2, C4; or it may be a shunt across the secondary, as indicated at C3, C5. Another favorite point is in shunt with the reproducer, or the primary of the output transformer, as shown at C6. The proper capacities will vary with each position and with the design of the equipment; average values utilized in the adaptations of various manufacturers are indicated in the illustrations. In all of the condenser positions illustrated in Fig. 1, the timbre of reproduction is controlled by taking the high notes out of the program, to a greater or less degree.

A type of control favored by the writer is a resistor in shunt with the secondary of the first A.F. transformer, as indicated at R2. (It may instead be connected across the secondary of T2, if desired.) In this position the effect of a volume control is secured; but at the same time the low notes are not reduced as rapidly as the highs, and a pleasing effect is secured because the reproduction does not become "tinney," or "thin," through lack of bass. One of the first sets to apply this connection was the old "Radiola Grand," a detail circuit of which is shown in Fig. 2.

Fan-Switch Circuits

A fan-switch and fixed condensers are the components of the "tone color" control of the Grebe "Synchrophase 7," as shown in Fig. 3. A lesser number of condensers are used in a fan-switch circuit in the Philco "Model 77" and "Model 96," as illustrated in Fig. 4.

The fan-switch idea may be applied to any radio set, where the jumpy "step" control of the tone is no objection. For instance, the capacity of the coupling condenser (in a resistance-capacity coupled audio amplifier) may be varied; resulting in disproportionate transfer of the audio frequencies, and thus tone control, as shown in Fig. 5. This control method could be applied to coupling condenser C in the "Radiola 47," shown in Fig. 6; although it might be more convenient to use a higher maximum value at R, and make this adjustable.

In the Brunswick "S-14" and "S-21" receiver, there is a tone-modifying connection shown in Fig. 7; by placing an off-on switch at X this may be cut in or out. The tone may be changed also by placing a two-way switch to select either of two capacities for C.

Before leaving the idea of the fan switch, it might be well to point out that non-linear graduation of audio frequency output may be obtained by changing the value of the reproducer coupling condenser, as shown for example at C1 in Fig. 8. This illustrates the output of the Delco automotive radio receiver, in which where tone control makes it convenient to match the reproduction to the small-space and noise-level conditions inside a closed car.

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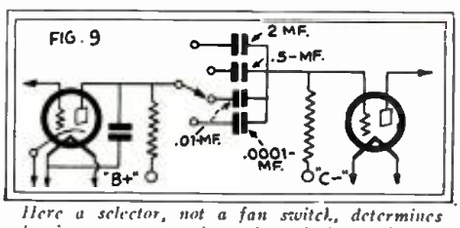
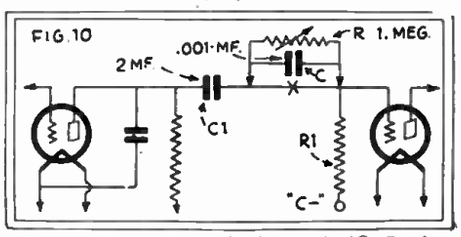


Here a selector, not a fan switch, determines by jumps the capacity value of the audio amplifier coupling condenser.



The author suggests this little unit (C, R) for gradual variation of the effective capacity of the audio coupling condenser.

The Installation of Dynamic Reproducers

Some helpful pointers on the conditions for good sound amplification, in auditorium and outdoor systems

By H. G. CISIN, M.E.

SELECTING the best amplifier and the most suitable type of reproducer for a particular installation is not everything.

Installation engineers occasionally fail to make permanent and secure electrical connections and mechanical mounting. Very often, loose mounting screws may cause a rattling noise difficult to locate.

Where the dynamic reproducer is used indoors, the materials of the walls, ceiling, etc., have a distinct bearing on the results obtained. The size and shape of the room, the curvature of the ceiling, the type of seats employed, the use of draperies and carpets—all these considerations affect the acoustical properties of an interior. Experience has demonstrated that reverberation increases very rapidly, the larger the room. The use of upholstered seats will increase the amount of effective absorbent surface and hence help to reduce the reverberation. In a large motion-picture theatre, reproduction is likely to be carried on at such a high level of volume that more absorbent material will be necessary to prevent undue overlapping of words or syllables. Where reverberation is present in the recording, this also is added to the reverberation present in the theatre.

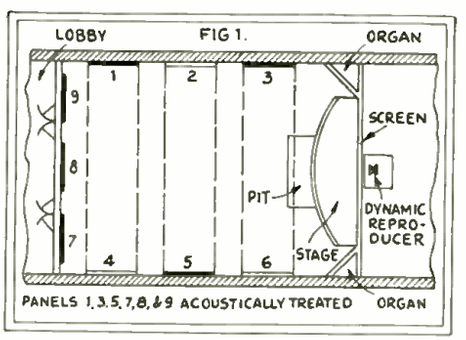
The shape and curvature of the interior are also responsible for many bad cases of echoes. It is then necessary to provide acoustical treatment, using draperies, special felt or asbestos. One satisfactory method of acoustical treatment is illustrated in Fig. 1.

Eliminating Echoes

It is generally conceded that for best results, absorbent treatment should not be applied in the immediate vicinity of the source of sound. Sound reflected from the stage walls, near the speaker, serves the useful purpose of reinforcing the direct sound of the voice, without *necessarily* adding to the reverberant sound which causes the acoustical difficulty. For this reason, it is not advisable to use acoustical treatment on the stage walls, either at the rear of the stage or on the sides.

In reducing reverberation, it has also been found that absorbent treatment under balconies is not as efficient as the same amount of material applied on ceilings or walls *above* the balcony. This leaves the wall and ceiling surfaces of the main room as the best places for the application of the acoustical treatment.

In general, if there is no balcony, the material (felt or asbestos) should be applied upon available areas of rear wall, higher than the head level of the audience; if there is a balcony, on available areas of the rear wall higher than the head level of the balcony audience. Treatment should be applied on the side walls and ceiling first at the rear (opposite the screen) and then forward as far as needed to get the total amount of treatment required.



The numbered heavy lines represent absorbent panels on a theatre's walls; shown more clearly in Fig. 3.

Various methods of applying the acoustical treatment suggest themselves. The nature of the space where material is to be applied must be considered. Different types of interiors require different methods of application. Usually the wall or ceiling is of wood, tile, brick, concrete, sheet steel, plaster or composition.

On all walls that permit tacking or nailing, it is recommended that materials such as felt be mounted direct to the available space. This is illustrated in Fig. 2. Furring strips can be used to hold it in place. In order to make an installation of this sort more decorative, the felt may be placed in panels, using an attractive molding around the margin as a frame. Decorative "theatrical gauze" is often used, mounted in a frame as shown in Fig. 3.

On walls which do not permit the use of nails or tacks, a good waterproof cement may be used. Be sure that the adhesive has moisture and heat-resisting qualities, and that it will adhere readily to the burlap back. Cement and paste of a kind used successfully on many installations can be obtained from most linoleum stores. The base of the space, where application is to be made, should be sanded so that the adhesive will have a chance to adhere direct to the raw material rather than to painted or otherwise covered surfaces. (If the waterproof cement is applied directly to a painted or varnished surface, the counter action tends to dissolve the paint and varnish, and the whole sheet of sound absorbing material might fall.)

Another method of application is to remove the plaster and apply the felt directly to the laths with flat-head nails. Where the room has tile walls, furring strips will have to be anchored to the wall with toggle bolts.

Fig. B

The installation of dynamics with directional horns at Fairfax Airport, Kansas City, Mo.

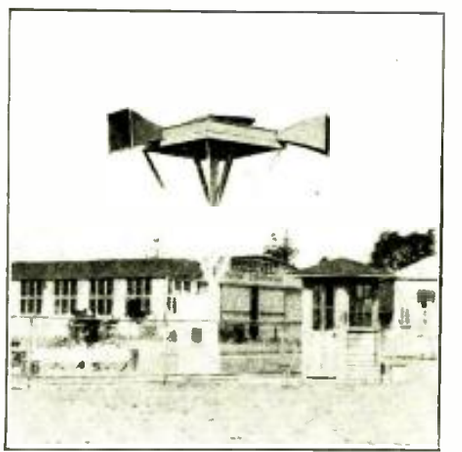
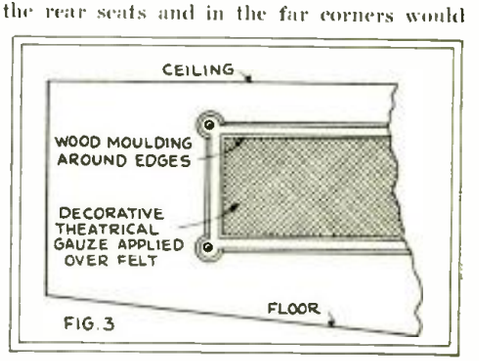


Fig. A

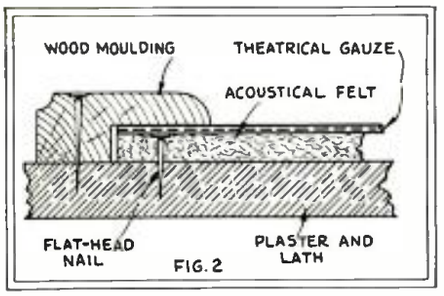
Dynamic installation at Roosevelt Field, Mineola, Long Island.

Distribution of Sound

In the ideal theatre or auditorium, the design should be such that the listeners in the rear seats and in the far corners would



The panels thus treated are not only part of a theatre's decorations, but absorbents of sound; thereby preventing reverberations, or "echoes" from the walls, from spoiling quality.



The method of applying the felt and gauze panels of Figs 1 and 3. These absorb sound instead of echoing it.

receive as much sound energy as those closer to the source of sound and the judicious use of reflecting surfaces and proper design will closely approximate such a condition.

According to John S. Parkinson, acoustical expert, much of this uneven distribution of sound results from the use of directional horns. For purely theoretical reasons, he favors the use of cone-type dynamic speakers with non-directional baffles for theatre work; but, for the larger houses it is obvious that the best practical combination is the cone-type dynamic, with a horn of large orifice and wide angle in the horizontal plane. (Fig. C.) This combination is used extensively in theatre work, being placed below the solid screens or in back of the sound screens.

When the source emits sounds in a comparatively narrow beam and in a single direction, it becomes increasingly difficult to provide adequate coverage.

Mr. Parkinson gives a most excellent analogy to illustrate this point. The ordinary garden hose is usually equipped with a nozzle, which will enable the user to direct the stream either in a single narrow jet or in a wide spray. Obviously, if the garden is large it is not possible to water all of it at once except by using a wide well-dispersed spray (as in the case illustrated by Fig. 4). In a similar fashion, in the theatre there is danger that certain areas will not receive their proper share of the direct "stream," or that certain reflectors will predominate in such a way as to produce phase distortion or even echoes. This analogy holds in the case of the dynamic unit having a small metal diaphragm combined with an exponential horn.

In many cases, it will be found absolutely necessary to obtain directional effect through the use of horns; this especially applies to outdoor installations. The cone-type dynamic reproducer can be combined with a directional horn to give results superior to any other method known.

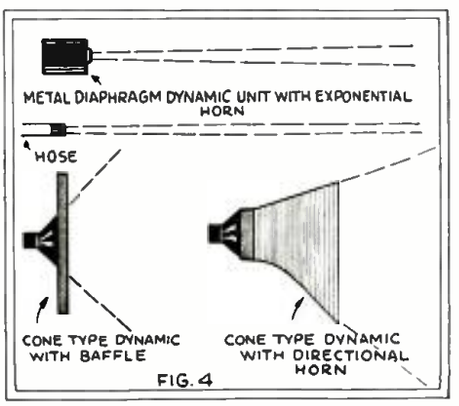
Matching Outputs and Reproducers

The matter of correct matching of impedances is naturally of the utmost importance and, if this is ignored, distortion and under-volume are almost certain to be experienced. For example, the dynamic speaker is generally equipped with a coupling transformer, designed to match the voice-coil system of the speaker to the output of an amplifier using tubes '45 or '50. Where the output tubes of the amplifier are used in special combinations (such as two '10's, four '10's, four '50's, etc.) careful attention must be given to the selection of the correct matching transformer, so that the impedance of the moving-coil system of the speaker will be adjusted to the resultant impedance of the output tube system. Likewise, where a number of loud speakers in multiple are coupled to the output of an audio amplifier, special provision must be made for correct matching. "Impedance adjusting transformers," having tapped primaries and secondaries, are available.

Incidentally, the pickup also should be carefully matched to the input impedance of the amplifier. Very often, loss of high or low notes are unjustly blamed on a perfect loud speaker; whereas the fault actually lies in improper matching between the pick-up and the amplifier.

A volume control of poor design or quality may obliterate a substantial percentage of the overtones necessary to the brilliant and lifelike reproduction of sound.

A common defect, in talking-picture work, is that caused by excessive loudness, due to setting the fader far too high. Excessive loudness is uncomfortable to the listener and increases the tendency to reverberation. Monitor for moderate volume, and use "9" or "10" sparingly.



The smaller the flare of the horn, the more concentrated the sound. That of the horn above may be carried some distance through a flexible hose with little loss. With the others, the sound spreads at once.

Where two speakers are used with the same amplifier, they should be connected so that the diaphragms of both are moving in the same direction simultaneously. Otherwise, nodal points will be formed by the conflicting sound waves; with unpleasant reactions on the ears of the listeners at various points in the auditorium. This is a point often overlooked. (How often has this condition been checked in home radio installations?)

TABLE I
ABSORPTION PERCENTAGES

Table Giving Approximate Proportions of Sound or Noise Absorbed by Common Building Materials.

Open window	100
Brick wall 18 inches thick	3.2
Bricks set in cement	2.5
Carpet unlined	15
Carpets lined	20
Carpets heavy with lining	25
Cement or concrete	1.5
Cork tile	3
Curtains, chenille	23
Curtains in heavy folds	25 to 75
Glass	2.7
Linoleum	3
Marble	1
Oil paintings, including frames	28
Plaster on wood lath	3.4
Plaster on wire	3.3
Plaster on tile	2.5
Rubber tile	3
Sheet metal	1.5
Stage opening	25 to 40
Steel walls and ceilings	1
Terrazzo	1
Wood Trim	3
Wood floor	3 to 6

(Strictly speaking, the above "absorption coefficients" will vary somewhat with the *frequency* of the sound. The values in the above table are for a frequency of 512 sound vibrations per second.)

The proportion of any sound which is not absorbed is, of course, reflected.

Radio Book Review

NEW EMPIRES, by Karl A. Bickel. 112 pages, cloth 5 x 7½ inches. Published by the J. B. Lippincott Co., Philadelphia. $1.50.

The author of this work as active head of a great news-gathering agency—the United Press—has been enabled to gather facts and opinions from, not the United States alone, but the world over. The last 26 pages of the book are occupied by a survey of broadcasting conditions throughout foreign countries; and these facts are probably unobtainable from any other work of reference. They are preceded by a list of the broadcast stations of the United States owned by or affiliated with newspapers—also useful for many purposes.

The main body of the book, as the author explains, is an amplification of an address delivered to teachers of journalism, a few months ago. The "new empires" are those of international business, the newspapers and the radio; and the book is written throughout with the newspaper viewpoint foremost. It will be interesting, not to the journalist alone, but to all who are desirous of interpreting history as it transpires. Whether, how-

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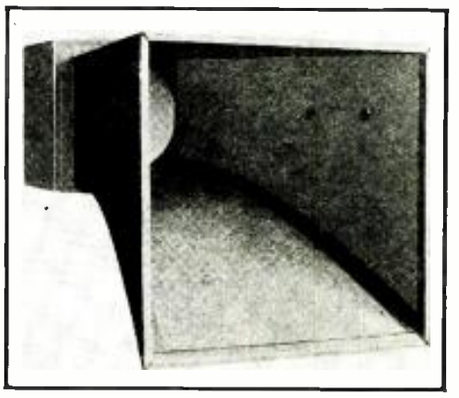


Fig. C

The large horn shown at the right is intended expressly to distribute sound over a considerable audience. It may be seen that it is more useful for some purposes than the flat baffle (as shown in Fig. 4); while the latter covers a larger angle. Because of the size of the floating cone, this exponential curve is much shorter than that of a horn connected to a small diaphragm. It is intended for use with a dynamic unit taking up to 15 watts from its amplifiers.

Illustrations courtesy Wright-De Coster, Inc.

The Progress of Television Technique

Scientists and engineers, throughout the world, are working to perfect radio vision. Their success is recorded here, month by month.

THE MIHALY SYSTEM

By Dr. Albert Neuburger (Berlin)

THE difficulty of obtaining freedom from the flickering which is familiar to all who have seen television images, has been completely overcome by D. von Mihaly. In his latest apparatus, the images are perfectly motionless in the "window," and they do not show the customary shifting dark lines, which are due to the holes in the scanning disc. The image is evenly illuminated and clear.

Part of this is due to the increased speed of the scanning disc. This, which has thirty holes, revolves so fast that an area 12 x 16 inches is covered at the rate of 15,000 scanning points a second; and this figure may be increased to 18,000 points. (*The former corresponds to a speed of 750 revolutions per minute, and the latter to 900, which is standard with American 48-hole scanning. German television, however, is permitted the use of the broadcast band, as explained in October* RADIO-CRAFT; *and this limits the modulating frequency.*)

Furthermore, the holes in the scanning disc have been given the special shape shown in Fig. 1A. The sides of the hole slant toward each other at a very acute angle; while the top and bottom are concentric arcs.

From Fig. 1B, it will be seen that equality of illumination cannot be obtained with circular holes; in 1C, it will be seen that square holes, while an improvement, still cause lines; but the shape of opening just described, with its slanting sides, gives exactly even illumination and freedom from lines, as illustrated at 1D.

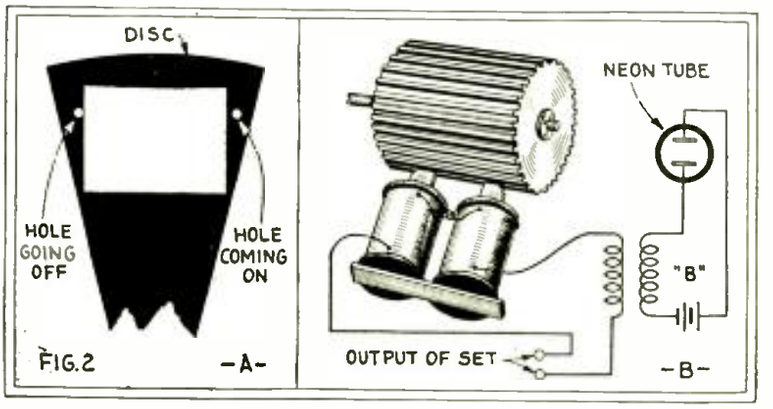


FIG. 2

The fundamental principle of synchronization by a signal, transmitted with the television image, is based upon the creation of a signal by the scanning disc itself. This done by making the mask narrow enough so that a complete darkening of the scanning hole is caused after every line. This causes a frequency component which is applied to a "phonic wheel" as at B.

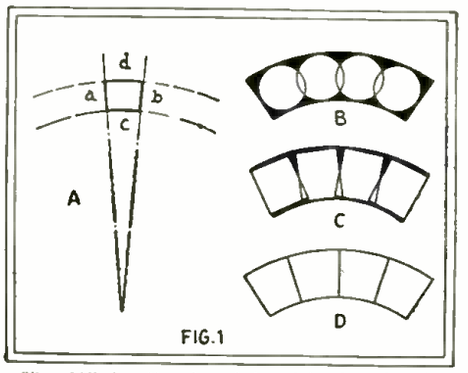


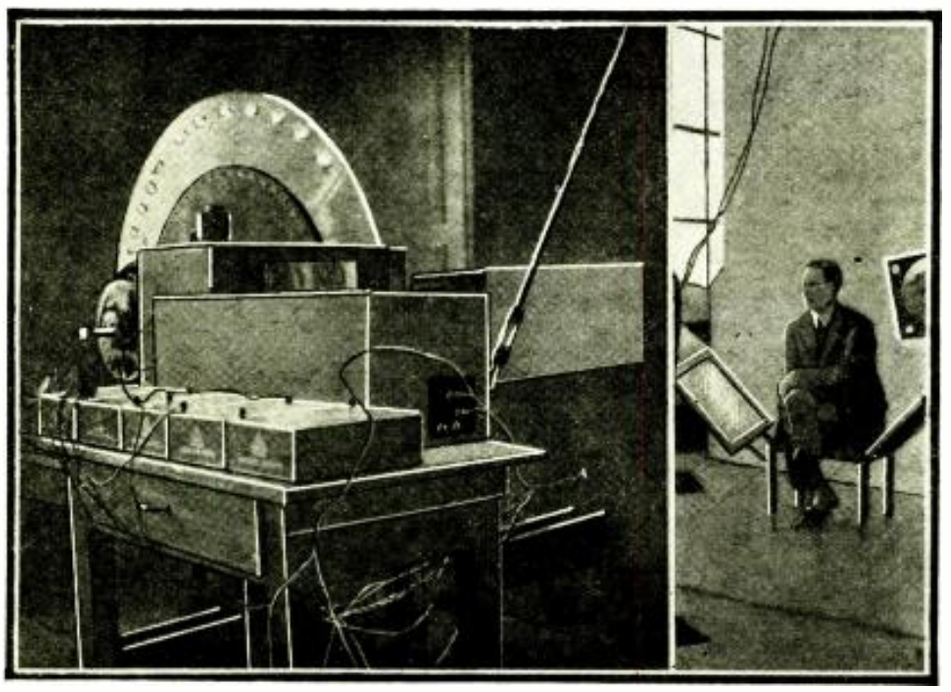
FIG. 1

The Mihaly disc has holes (A) bounded by arcs and radii. This overcomes the nervousness of light received through circular (B) or square (C) holes; and gives perfect illumination, as at D.

Mihaly Synchronizing Method

The "window" used to frame the image on the scanning disc is narrower than the distance between successive holes. For this reason, there is always at the end of each line an instant when no light can pass into the photo-cell at the transmitter (Fig. 2A), and the cell therefore gives out no current. To emphasize this effect, a rotating collector, which shorts the cell at this instant, is employed.

The result is that, at the receiver, a black line is formed after every passage of a hole across the window; that is to say, 375 times a second. This frequency of 375 a second acts upon a "phonic wheel," or cylinder, which is made of an insulating drum covered with thirty strips of soft iron, one for each hole in the disc. Opposite the wheel is an electromagnet, through which the synchronizing current impulses are directed. The wheel, therefore, turns in synchronism with the scanning disc at the transmitter; as its strips (corresponding electrically to the teeth of a gear) are attracted and released 375 times a second. This disc is mounted on the shaft of the receiver's scanning disc, which is thereby driven in synchronism with the transmitter (Fig. 2B).

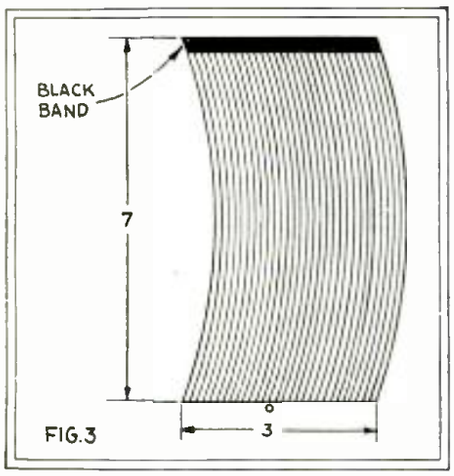


The set-up of the Mihaly televisor for scanning subjects by natural daylight. Mirrors help to illuminate the subject properly; and a powerful lens concentrates the image upon the large scanning disc, which is placed in a dark room.

BRITISH SYNCHRONIZING SYSTEM

IN the transmission of images, and their reception, by the Baird system, now in use in England, a somewhat similar principle is employed. In following this description, it must be remembered that, on the Baird televisors, the image is framed at the side of the disc, and scanned from bottom to top; it is narrow and high (Fig. 3).

The Baird method, it is explained, differs in the use of the synchronizing impulse to actuate, not a phonic wheel (which is a true synchronous motor) but a speed controller which regulates the actual driving motor. This controller is a "cogwheel," built up of thin laminations of mild steel in later models, and cut with thirty equally-spaced teeth, one for each hole in the disc. This cogwheel is connected in series with the



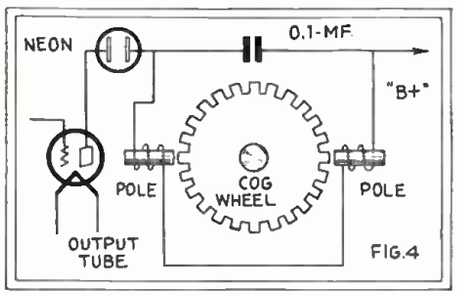
In the Baird system, which scans the image vertically, a part of the line is cut off at the upper end; this serves to create a synchronizing signal.

output of the television amplifier and the neon tube, as shown in Fig. 4.

On each side is mounted an electromagnet, so connected that poles of opposite polarity are always presented to the cogwheel. The surface of each magnet pole is exactly equal in size to the outer face of each cog, and the clearance is very small—about 1/500-inch. The cogwheel, which is keyed to the driving shaft of the scanning disc, is so set that, whenever a hole on the scanning disc is just half covered by the frame of the window (that is, half of it is in the black band of Fig. 3) two opposite teeth of the cogwheel are exactly facing the magnet poles.

When the scanning hole is completely within the shadow, and no current is emitted by the photoelectric cell, the accelerating force exerted on the wheel by the magnet poles has reached its maximum; and their pull will tend to retard it, while the next hole is passing into the illuminated area of the scanner. If the disc is running in exact synchronism with the received impulses, these opposite pulls will balance. The result is that the speed of the driving shaft is subject to correction every time the image is scanned. Under working conditions, it is stated, very good synchronism is maintained.

However, we may speculate what the effect of a horizontal black or white element in the image might be; presumably similar to that of a vertical white element in American scanning, as described by Mr. Nason in the preceding issue of RADIO-CRAFT.



Here we have the synchronizing regulator at the receiver, which is placed in series with the glow lamp, and responds to the strongest component of the signal.

USE OF THE TELEVISION SIGNAL IN MEASURING THE EFFECTIVE HEIGHT OF THE KENNELLY-HEAVISIDE LAYER

By C. H. W. Nason

THE mechanics of wave transmission are rather obscure to the average radio enthusiast. Although almost all of us have at one time or another heard of the "Heaviside layer" as one of the causes of fading and as the fundamental cause of "skip distance" in short-wave transmission, there has been little of a popular nature said in connection with these phenomena. In pursuing the elusive television signal certain facts have become apparent which, the writer believes, will lead to a simpler understanding of fading, and of other things contributing to the engineer's difficulties.

Very often, in receiving an image from a not too distant transmitter, double or "ghost" images evidence themselves. Fig. 6 shows an image of a simple geometric figure as it would appear on the television scanning disc. The image proper is dark. Superposed on this is another image, displaced by one-half the width of the field of vision.

Now, radio waves travel at a substantially constant velocity, and a wave traveling from point to point along the earth's surface naturally takes a shorter time to traverse the distance than a wave which has been directed upward and then reflected back from a medium impervious to the wave. This medium which reflected our wave (as shown in Fig. 7) is known variously as the Heaviside layer or (more properly, the Kennelly-Heaviside layer) and is

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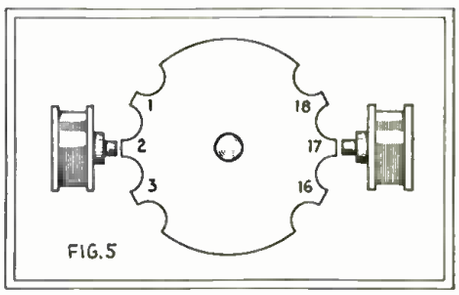
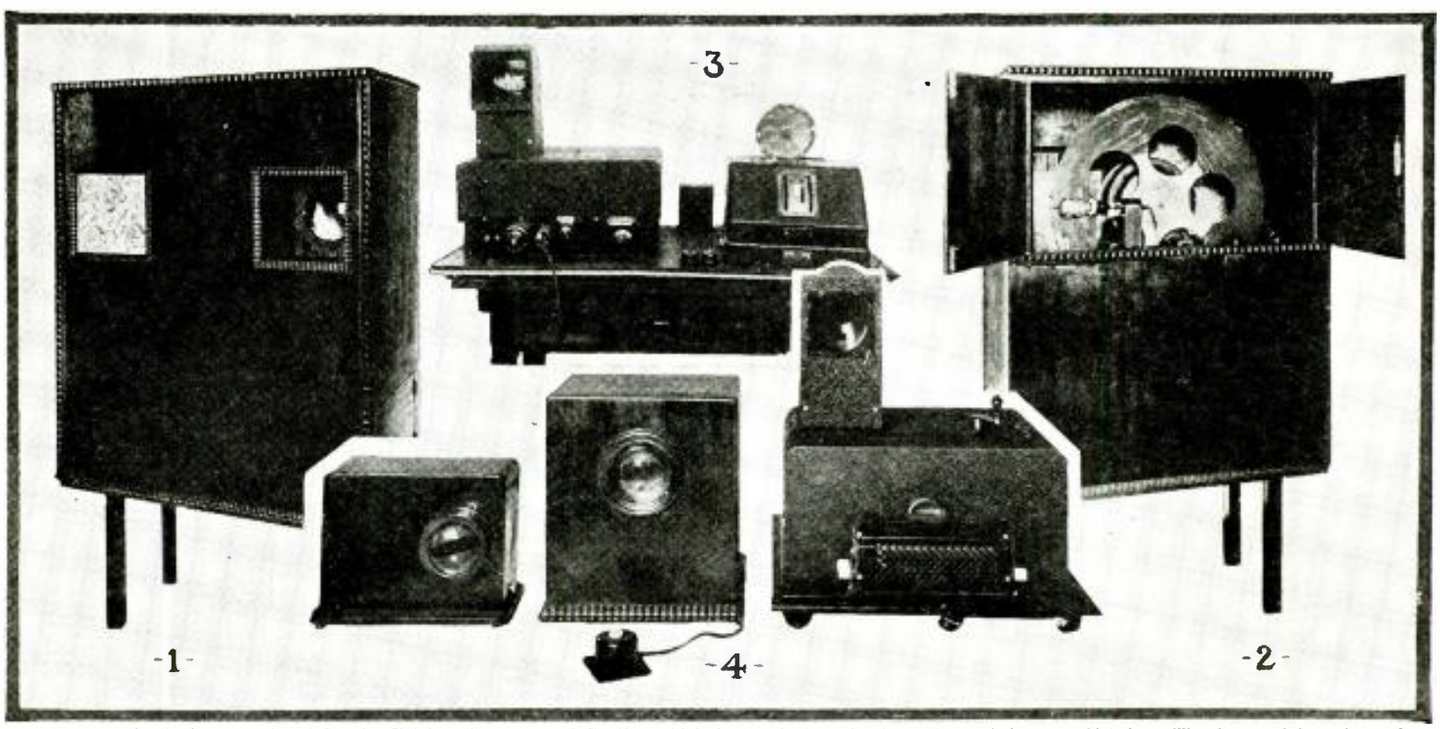


A close-up of the Baird speed controller, shown in circuit in Fig. 4. The adjustment is very close. (*From Wireless Magazine.*)



A group of televisors produced by the Telehor Company, of Berlin, which is developing the inventions of D. von Mihaly. The large sight-and-sound receiver shown at 1 is viewed from the rear at 2; it has a large disc, reproducing the image at the side in the window. At 3, a layout including a modern German broadcast receiver, with a televisor at its left; here the image is reflected upward into a "window." In the foreground at 4 are small televisors, one in the center with a speed control.

RADIO CRAFT KINKS

CONSTRUCTION OF A RESISTANCE METER

By Malvern H. Berry

ALMOST every radio and electrical experimenter has need of an efficient and reliable resistance meter. With this he can design his own resistors, choke coils, and many other things. The instrument mentioned in this article was constructed from a potentiometer, a galvanometer, two binding posts, one dial, and a small box. (Fig. 2.)

Assemble and wire in accordance with the diagrams; Fig. 1 is the schematic circuit.

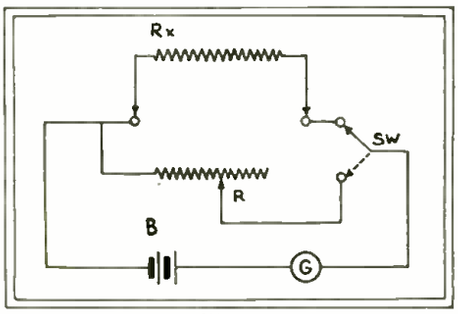


Fig. 1

A good wire-wound potentiometer, a galvanometer, some calibrated resistance standards, and a few odds and ends, complete this handy instrument.

The potentiometer R should be one of about 1000 ohms. The galvanometer G may be replaced by a high-range milliammeter and the results will be the same. The battery B is just a two-cell flashlight battery, which can be purchased from the ten-cent store.

After everything is assembled comes the calibration of the potentiometer R. This can be done with a Wheatstone bridge. (If the constructor does not have a Wheatstone bridge, one may be had for the asking at your local high school. In the event that the constructor is not familiar with the Wheatstone bridge, the physics instructor at the high school would be glad to explain it.) If you can use the bridge, proceed as follows: attach to the potentiometer a dial, (vernier preferred) and adjust the potentiometer for a reading of 5 on the dial.

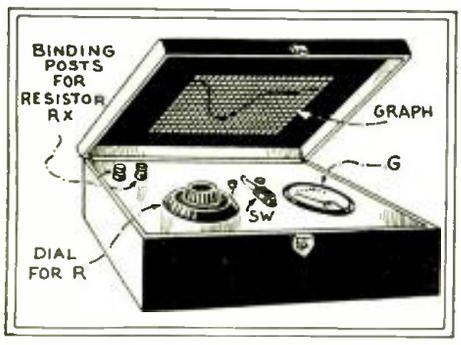


Fig. 2

Mr. Berry's layout; the graph in the lid is the reference calibration.

With this fractional part of the potentiometer in the circuit, connect it to the Wheatstone bridge and find what the resistance of that part is. Get a piece of "graph" squared paper and graph the resistance in ohms, for every five marks or degrees on the dial, *across the paper;* and graph the reading or degrees on the dial *up and down.* Where the two intersect on the graph page, place a dot. After the resistances have been calibrated from zero to the full value of the dial for every five degrees, draw a line through all of the dots. This will be your calibrated curve for the resistance meter.

To operate the meter, place an unknown resistance Rx across at the binding posts, and note the reading of the galvanometer G when the unknown resistance is placed in the circuit. Switch on to the calibrated potentiometer R and adjust until the galvanometer reads the same as before. The value is then the same in both resistances. Take the reading of the dial in degrees and look that reading up on the graph, and the value of the unknown resistance can be read direct from there.

By ganging several variable resistors of assorted ranges at R, and tapping them to a selector switch, the resistance range may thus be greatly increased.

A CONVENIENT HYDROMETER RACK

By Willis W. Futer

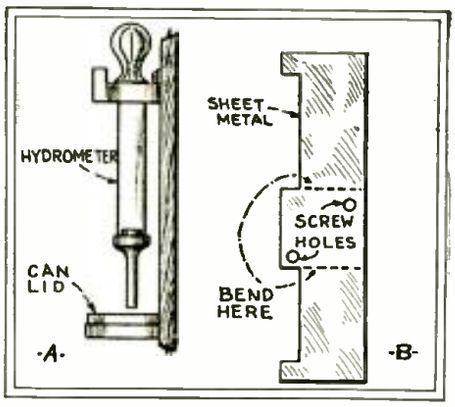


Fig. 3

The hydrometer holder A—made from the strip B—is fitted with a wax-covered drip pan, which is acid-proof.

FINDING that the hydrometer had a habit of getting into the tool box, against coils and condensers, and into other undesirable places—thus putting sulphuric acid where it wasn't wanted—the writer rigged up a simple rack that nicely solved the problem.

As the illustration shows, a sheet of metal, of the shape shown at B, is bent into arm shape to hold the rubber cap, as at A.

An acid drip-pan, made from a can cover, is fastened below the nozzle.

Both pieces of metal are to be dipped into paraffin (which may be obtained by melting a candle) to prevent the acid from eating through the metal wherever it may touch.

IMPROVING AUDIO QUALITY

By George H. Ohmer

SOME experimenters claim that, when the secondary of an A.F. transformer is used as an audio impedance, it is better to use one having a burnt-out primary. Their contention is that the inductance of the unused primary winding will set up stray,

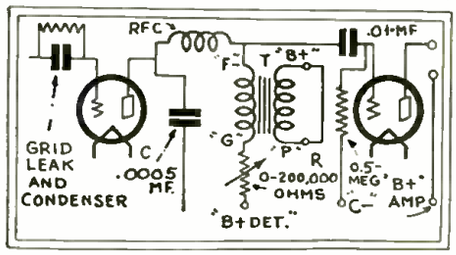


Fig. 4

As a comment on audio quality, the author suggests shorting the unused primary, when using the secondary as an audio coupling choke.

out of phase, currents which will cause distortion.

The author built an audio amplifier of the impedance-capacity coupled type, using the secondary of an A.F. transformer of 6-to-1 ratio whose primary was still perfect. On loud volume the signals were distorted.

Shunting the unused primary with a .001-mf. condenser reduced the distortion slightly; and a .005-mf. capacity greatly reduced the distortion. Shorting the primary connections ("B+" and "P") was best.

However, still further improvement was effected by the use of an R.F. choke, the condenser C, and a variable resistor R with a value of 0 to 200,000 ohms.

THE "HOWLER" AS A SERVICE OSCILLATOR

By B. Fox

THE old idea of putting a microphone transmitter against a receiver may now be put to more practical use than annoying the party at the other end of the wire, as illustrated in Fig. 5.

Transformers T1 and T2 are any handy

(*Continued on page* 442)

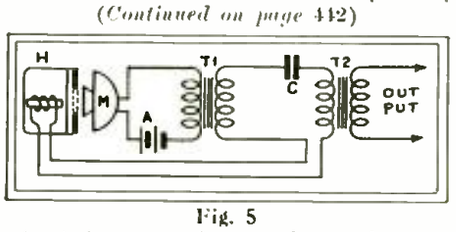


Fig. 5

A telephone transmitter, receiver, and transformer, are the essentials of this "audio howler," designed for use in radio adjustment.

SHORT WAVE CRAFT

An A. C. Short-Wave Receiver with the Automatic Tuner

By H. E. HURLEY, W6CKS

THE receiver to be described is an example of what may be accomplished by the experimenter or set builder who is not technically trained and must depend on the magazines for his "dope." The author claims no credit for any part of the circuit shown. Every portion was lifted, wholly, or in part, from some circuit described in a radio magazine or from a manufacturer's pamphlet. Much credit is due to W8AYO.

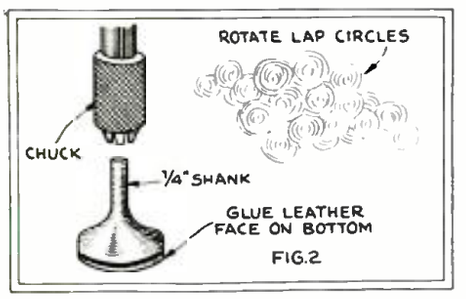
The receiver's range is from about 18 to 100 meters; no "coils" are used and frequency is varied by setting, to a given mark, one dial. All important "ham" bands are covered and automatically well spaced over the secondary tuning dial. Most of the short-wave commercial phone and broadcast stations are covered, as well as numerous airplane, ham and transatlantic phone stations.

The operating power is all A.C. Even "C" batteries are eliminated, and it is as near "humless," with good tubes, as an A.C. set can be. This means that little or no hum is to be heard, except a slight residual hum at very low wavelengths. In explanation of this, even a "D.C." short-wave receiver, if operated near A.C. leads at 20 meters, will pick up some A.C. hum. This receiver has no more hum at 20 meters than the direct-current receiver in the same location.

The radio-frequency input is untuned. Authorities differ as to the value of tuned or untuned radio frequency in short-wave reception. The writer's experience is that about everything heard on a commercially-built tuned R.F. set is to be heard on this receiver; so the '24 screen-grid R.F. stage is left untuned. The detector also is screen-grid, and is exceptionally sensitive at all frequencies. (See Fig. 1.) The '24 is non-microphonic, and one may jar or slam the set without trace of "racket" in the phones. The set goes into oscillation, at 18 meters, as smoothly as at 100 meters. Absolutely no "dead spots" are encountered at any frequency.

The audio end is "dual." A switching arrangement is used to change over from "peaked" audio for C. W. code reception to "quality" audio for phone and broadcast work. The value of this feature is apparent the first time listening on the crowded "Ham" bands is attempted.

The second stage is also controlled by a switch; no plugging in or out of phone jack being necessary. In the receiver pictured, extra jacks are provided to accommodate visitors who desire to "put on the cans." As "ham" work is the usual duty of this receiver, no provision was made for a speaker; however, such a hook-up has been used with very satisfactory results (Fig. 1A.)



This kink may be applied to give that frosted metallic finish to an aluminum front panel; the overlapping circles produce an attractive effect.

Dimensions of the chassis are: panel 7 x 14 inches; sub-panel 13 x 8 x 1¾ inches, with a section 1½ inches wide cut out back of the panel; ⅛-inch aluminum stock is used for the panel and 1/16-inch for the sub-panel. (Lighter stock may be used.) The front of the panel is given a "frosted" finish by placing a 1-inch block in the drill chuck (Fig. 2) then rotating on the panel, after it has been lightly covered with fine valve-grinding compound. Lap the circles and, when the entire panel has been worked, wash off (do not wipe off) the remainder of the compound.

All wiring is beneath the sub-panel. The biasing batteries are soldered in place, as they should last for a long time. The individual 1½-volt cells were obtained from the smallest 4½-volt "C" battery; though small flash-light cells could be used. All parts, except the automatic tuning unit, are standard and may be purchased from any good supply house; the tuner must be ordered direct from the factory. It was fully described in RADIO-CRAFT for May, 1930, beginning on page 572.

(*Continued on page* 431)

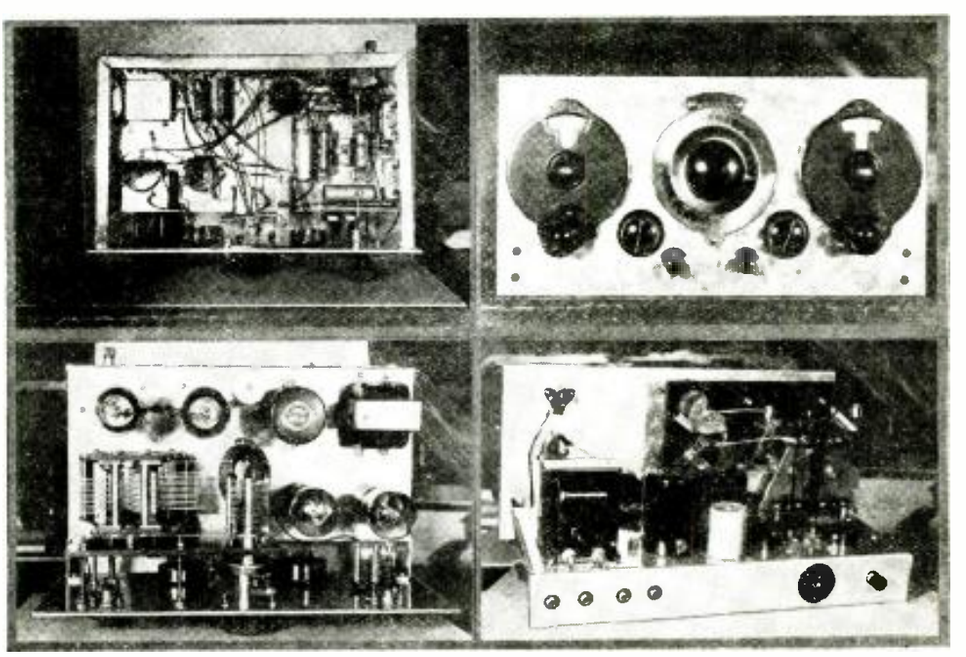


Fig. A

Four views of the receiver built by Mr. Hurley, that at the upper right illustrates the panel arrangement described in the text. The placement of parts is very completely shown. The automatic tuner visible at the left of the panel (from above) comprises the condensers C1 and C2, the variometer L1 and tickler L2. The regeneration control is located where the volume control is in an ordinary receiver.

The Hows and Whys of the Push-Pull Circuit

(PART II)

The push-pull circuit, it is generally known, gives more power than tubes in parallel; and it gives better quality. The reasons will be explained in a series of articles of which this is the second.

By EDGAR MESSING

THE first installment of this article, in the December issue of RADIO-CRAFT, was devoted to a consideration of whether, and how, resistance in the plate circuit of a tube could cause false reproduction. The next step is to investigate the tube's behavior when the load contains inductance, or capacity, as well as resistance.

Fig. 6 shows what happens to the curve with an audio transformer T as the load. Curve A represents the relation between grid voltage and plate current at a given plate voltage. Curve B shows the same relation but at a lower plate voltage; and curve C shows the characteristic under higher plate voltage. The three curves are shown because the passage of plate current through the load (the primary of T) causes a potential drop across it, and thereby lessens the voltage at the plate. Actually, as we pointed out previously, the tube operates *between* curves B and C which represent, respectively, the minimum and maximum voltages at the plate of the tube.

Point *a* on A will be that around which we operate. On the positive side of the incoming wave, shown as a variation of the grid voltage Eg, the grid's becoming more positive, or rather less negative, tends to increase the plate current. But the load circuit contains inductance as well as resistance; and the effect of inductance, as we all know, is to discourage any change in the current through it. In other words, we say that the current through an inductance "lags" behind the voltage causing that current. What happens, then, is that the plate current cannot follow the grid voltage variations *instantly* but, marching up to the point *b*, lags the input voltage, as shown by *a-b*.

We have said that the plate current lags the input voltage. More truly, the input voltage on the grid causes a variation of the plate current, which is more conveniently interpreted as the result of a voltage

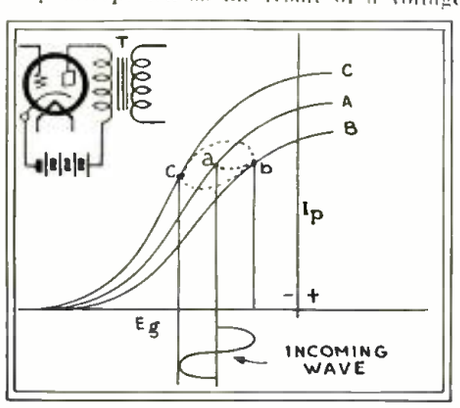


Fig. 6

We have previously seen the curves of resistance coupling; here are those of a tube with an inductive load in the plate circuit.

which we consider to be generated between the plate and cathode. The plate current, of course, is lagging this generated voltage.

If we plot all the points for various grid potentials, we obtain a loop as our dynamic or operating characteristic, as shown dotted in the graph. Now, obviously, operating along a loop means that the plate current does not exactly follow the grid-voltage variations. Fig. 7 makes this more clear. Note here that, if we change the grid voltage by one unit (say, from *x* to *y*), the plate current may change less than a unit (or from *p* to *w* only). But, on the contrary, at some other point of the curve, a change of one unit of grid voltage (as from *r* to *s*) may

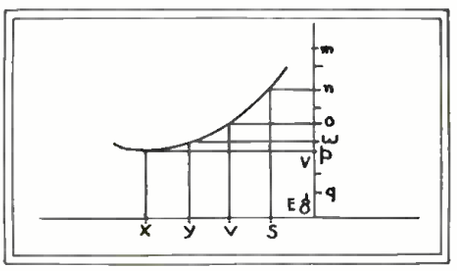


Fig. 7

Wherever a tube is operated on a "curved characteristic," the output current (vertical) does not exactly reproduce the input voltage (horizontal).

mean a change of two units of plate current (*o* to *n*). If we had operated along a straight line instead of a loop, any change in grid voltage, anywhere on the line, would always produce an equal change of plate current. The effect of an impedance load, then is to cause distortion. And now we know that a tube, operating under the usual conditions, will produce distortion, and that this distortion will be considerable if the output impedance is small. But—and this is what we have been getting around to through several paragraphs—the use of a push-pull circuit will eliminate this distortion; and therefore we may resort to it, even when a low-impedance output is necessary.

Just how this is accomplished, we will be able to see with the help of Fig. 8. Curve *A*, above (which represents the shape of the plate current of tube V1 of Fig. 1) may be resolved into curves *C* and *D*, where *C* is the fundamental which exactly represents the wave impressed on tube V1, and *D* is the component representing the distortion caused by the tube. Wave *D*, we note, has twice the frequency of *C* and is therefore its second harmonic.

(We are justified in resolving the curve into components because it has been proven mathematically, many, many times, that a curve may be regarded as the sum of any number of curves; and we may see that *C* and *D* added together produce *A*.)

Now, *B* is the curve of the plate current

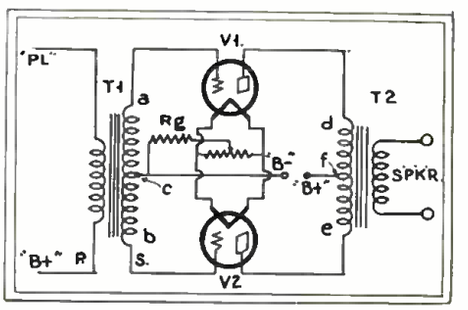


Fig. 1

The standard push-pull output stage.

of tube V2, which (as explained in Part I) has impressed upon it voltage which differs in *phase* from that on the grid of V1, and shows a corresponding difference in plate current. We proceed to break up *B* similarly into its fundamental *C'* and second harmonic *D'*.

Now we note that curves *C* and *C'* are directly opposite: *i.e.*, one is positive and the other is negative or, as an engineer would say, they are 180 degrees out of phase. Curves *D* and *D'*, however, are exactly in phase. If *C* and *C'* are directly opposed, this means that, when *C* is flowing from *d* to *f* through one half of the output transformer (T2 in Fig. 1) *C'* is flowing from *f* to *e*. (If we consider, as we may for this purpose, the alternating component in the

(*Continued on page* 438)

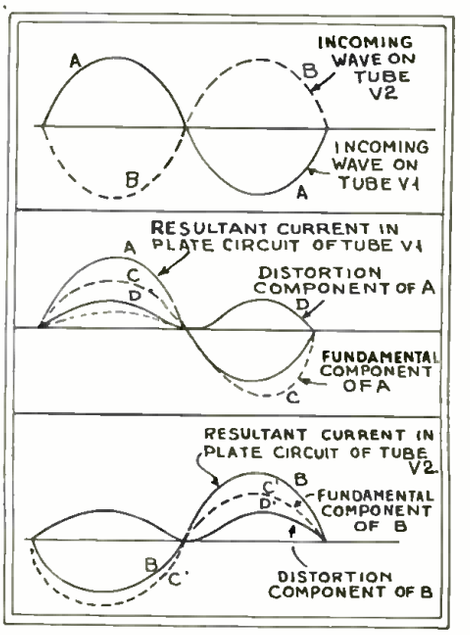


Fig. 8

The two tubes create the two waves A-B; each, as a result of the distortion explained in Fig. 7, has a distortion component added to the fundamental which represents the signal. By the push-pull circuit, the distortion is canceled out.

Constructing An All-Wave Superheterodyne

With Data for R.F., Oscillator, and Intermediate Coils, for the "Roll-Your-Own" Constructor

By R. WILLIAM TANNER, W8AD

A GREAT many broadcast listeners, interested in the short waves, are using for such reception an S.W. adapter which plugs into the detector socket of the regular broadcast receiver. The sensitivity of such an arrangement leaves much to be desired.

The writer recently worked out the circuit, shown in Fig. 1, which allows efficient reception on all waves, from approximately 17 to 600 meters, with a single receiver. A total of seven tubes are needed; an '01A first detector, an '01A oscillator, two '22 screen-grid I.F. stages, an '01A second detector, a '12A first audio amplifier and a '71A power amplifier. Although a screen-grid R.F. stage ahead of the first detector is very desirable from the standpoint of gain and selectivity, as well as for the elimination of interference with neighboring listeners, it is not an absolute necessity and is not shown in the diagram.

Even without an R.F. stage there is remarkable sensitivity, due to the use of regeneration in the first detector and a high-gain intermediate-frequency amplifier of the variometer-tuned type. The selectivity is on a par with that of any other receiver and is sufficient for even the most exacting operator. The use of high-grade audio transformers, plate rectification in the second detector, and inductance-tuned I.F. transformers results in a very fine quality of reproduction. (*Note*—the quality of some short-wave broadcasting is none too good; therefore do not blame the receiver if distortion is present below 200 meters).

The Frequency-Changer

This part of the super is of somewhat different design from that usually employed; in that the oscillator is of the tuned-plate type and a variable resistor is connected in parallel with the first-detector tickler to control regeneration.

It will be noticed, by referring to Fig. 1, that for tuning the first-detector input and the oscillator-plate coil, double condensers are employed in parallel. These are Pilot two-gang .00035-mf. units, with removable shafts and modified straight-line-frequency plates. In both condensers the back sections are cut down to three rotor plates, resulting in a capacity of approximately .00015-mf.; the front sections have each one plate removed. A bridge of No. 14 bare copper wire is made to fit between the two stator terminals on each condenser. When receiving in the 200-600-meter band, both sections are thus connected in parallel; the effective capacity being slightly over .00035-mf. On the other hand, when the short waves are desired, the wire bridges are removed; leaving only the back sections in circuit. In this manner efficient tuning is obtained throughout the entire range.

THE writer of this article, well known in the short-wave field, here describes a set which is well adapted for use over the broadcast range as well as for short-wave work, and which will give high amplification.

We shall be glad to hear from the constructors of supers of such a range whether similar in design to Mr. Tanner's, or showing differences.

The radio-frequency choke (RFC) used in the plate circuit of the oscillator may be one of the many on the market designed for waves below 600 meters. That (RFC1) in the first-detector circuit may not be needed; as the primary of the first intermediate-frequency transformer acts as a R.F. choke. However, if "holes" where regeneration is absent are found in tuning the first detector, the inductance of the transformer primary may not be correct; if so, try connecting in a coil consisting of 100 turns of No. 36 enamel wire on a ½-inch wooden dowel, which has been previously "boiled" in paraffine.

The fixed condensers C1, C2 and C3 are, respectively, the grid, plate blocking and bypass condensers, and have capacities of .00015-mf., .00025-mf. and .002-mf. R is a grid leak, 6- to 8-megohm; the higher value giving the greater sensitivity. R1, the regeneration control, may be almost any variable instrument with a maximum of 10,000 to 50,000 ohms resistance. The two filaments are controlled by a fixed 2-ohm resistor R3, which is connected in the positive lead so that the negative side could be grounded.

If the completed receiver is to be mounted in a metal cabinet (it should be for best results) the metal shaft of the oscillator tuning condenser must be replaced with one of bakelite, and the frame insulated from the panel.

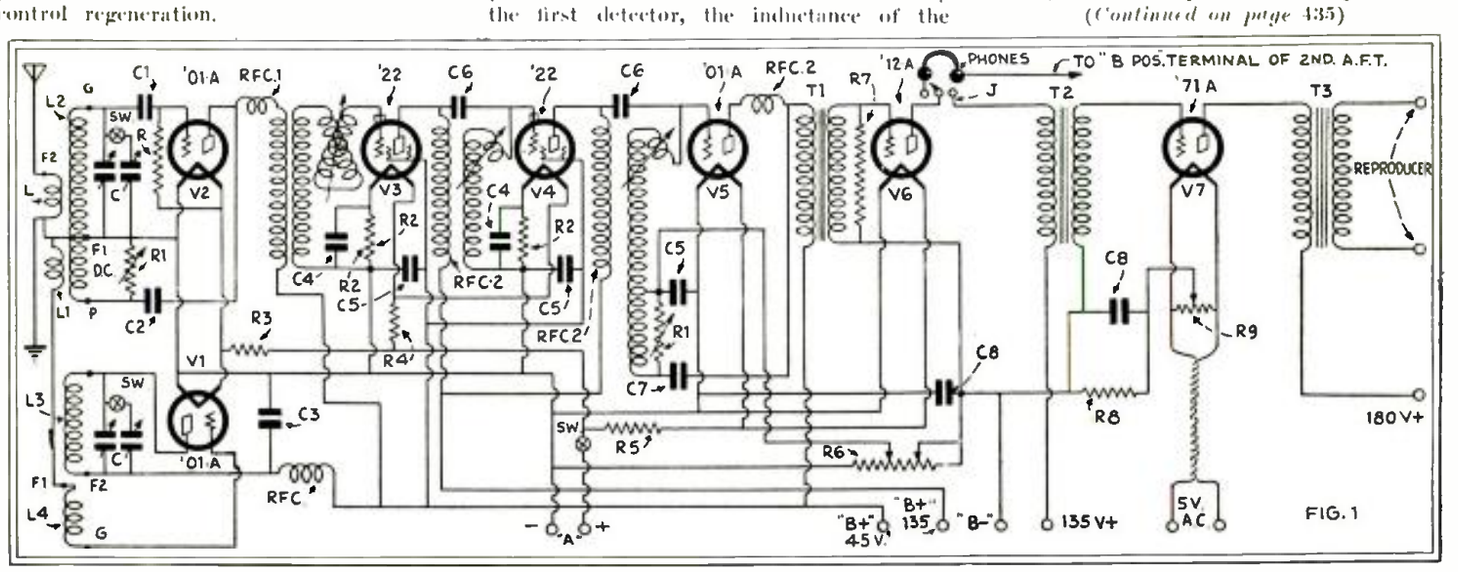
Even though the entire set is housed in a metal cabinet, the oscillator stage and component parts should in addition be enclosed within a copper or aluminum shield, to prevent stray coupling to the first detector circuit.

Intermediate-Frequency Amplifier

This unit is the heart of the super, and upon it depends whether the receiver will be *really* sensitive and selective, or be like a great many home-constructed supers—neither very sensitive nor very selective.

As the vacuum tube is a *voltage*-operated device, the I.F. transformers should be so designed and constructed that the highest possible voltage is impressed upon the grids. It is a well-known fact that capacity in shunt lowers the effective voltage and, if too high, also sharpens the tuning to such

(*Continued on page* 435)



The circuit of Mr. Tanner's receiver; only the plug-in coils and condensers of the first detector and oscillator must be changed and switched over, for different reception ranges. The remainder of the circuit is set to balance the intermediate stages most effectively; it will be noticed that these circuits are tuned by variometers, rather than condensers, to give stronger signals.

SPECIAL NOTICE TO CORRESPONDENTS: ***Ask as many questions as you like, but please observe these rules:***

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.

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.*

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

NORTHERN ELECTRIC "R-50" RECEIVER

(102) Mr. R. Stark, Port Arthur, Ont., Can.

(Q.1) If available, please show the schematic circuit, and any additional material you may have available, on the "Model R-50" receiver. This was a product of the Northern Electric Company of Canada but, since as the receiver is now obsolete, it is difficult to obtain any data regarding its circuit. This set uses three of the little type "215A" peanut tubes (known also as "N" tubes) for R.F. amplification and detection; the two audio tubes are type "DX235." The last two (A.F.) filaments are wired in parallel, but the detector and the two R.F. tube filaments are connected in series; a 6-volt "A" supply being used. The tubes for the R.F. windings are 3 in. in diameter and 3 in. long, wound with No. 22 enameled wire. The tuning condensers C1, C2 and C3 have a capacity of approximately .0005-mf., each.

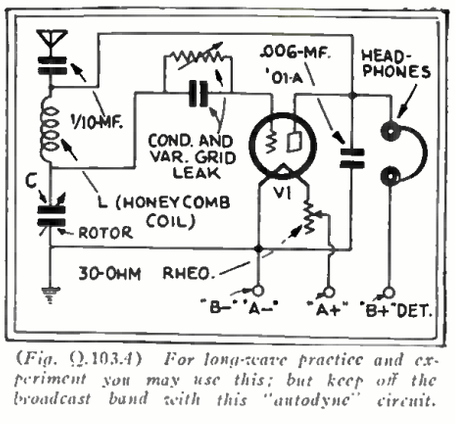
Please state where the coils are tapped, and the values of the remaining units.

(A.1.) R.F. Coil L1 has a total of 63 turns, tapped 10th and 15th turns; L2 and L3, 67 turns, tapped at the center for the plate connection, and half-way between the center and one end, connecting either to C4 or C5, for the "B+" lead. Condensers C4 and C5 are the usual small neutralizing condensers, having a maximum capacity of about 35 to 50 mmf. Resistor R4 may have a resistance of about 30 ohms. Although not shown in the diagram, the "B+90" lead to the audio tubes is by-passed by a 1-mf. condenser; this value may be used also as the "B" by-pass condenser C10 across the "B45" and "A—" posts. Coils L1, L2 and L3 *must* be in non-inductive relation.

(By an odd coincidence, a letter from Mr. W. Harvey Wright, Marion, Ind., has come to the attention of this desk, in which substantially the same circuit is recommended to RADIO-CRAFT readers for experimental consideration. However, his directions call for 60 turns of wire on the R.F. coils—though the total number of turns will depend upon the capacity of the tuning condensers—tapped at 20 and 40 turns. The antenna coil, it is suggested, is to be tapped at the 6th and 10th turns; but this will vary with the selectivity desired. Mr. Wright is using type '01A tubes, up to the output stage, which has push-pull '71A's.)

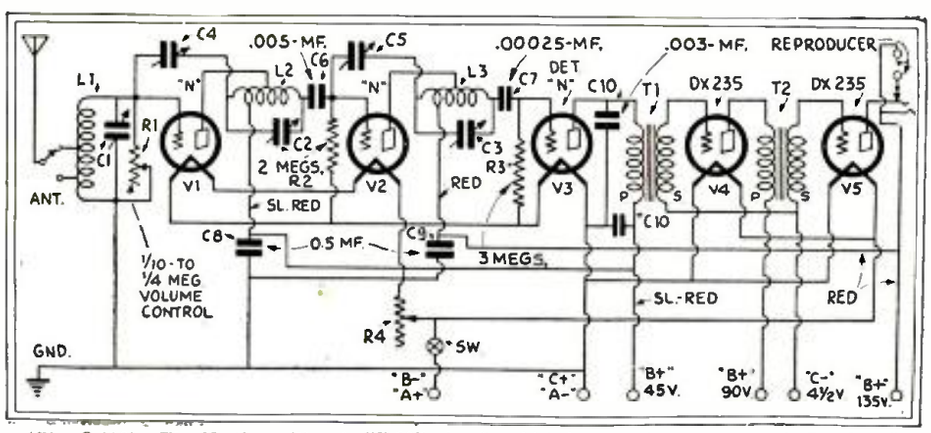
(Q.2) How can this set be prevented from motorboating?

(A.2) If batteries are used for the "B" supply, it is probable they are too low and should be replaced. If an eliminator is supplying plate current, it is not large enough for the job, and lacks filtering capacity. Increasing the values of the output by-pass condensers should enable the circuit to operate without motorboating. Especially, try increasing the "B+" detector by-pass capacity to 2, or even 4 mf.; in the diagram, this is condenser C10, connected to post P. Try another ground connection; and try other grid leaks for R2 or R3.

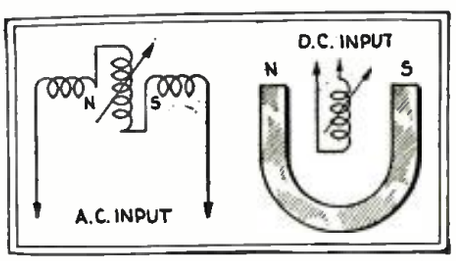


(Fig. Q.103A) For long-wave practice and experiment you may use this; but keep off the broadcast band with this "autodyne" circuit.

(Q.3) How is a phonograph pick-up to be connected into circuit; and would it be possible to use a screen-grid tube in place of one of the "N" tubes?



(Fig. Q.102) The Northern Electric "R-50" circuit, which is very similar to the W. E. "Betts" and the "Everyman Four." This circuit is excellently adapted to use screen-grid instead of "N" tubes; the neutralizing condensers C4 and C5 would be then eliminated. We shall be glad to hear from experimenters who have tried this.



(Fig. Q.103B) Left, the series "reversing field" of an A.C. meter; right, the fixed field of a D.C. meter.

(A.3) A phonograph pick-up may be connected to the grid and filament posts of the detector tube V3, and switch may be used to control this connection.

This circuit is a "neutrodyne," and consequently redesigning would be necessary in order to adapt it to screen-grid tubes. Also, the increase of amplification would necessitate re-location of the components, to prevent feed-back effects. At any rate, condensers C4 and C5 would not be needed; and the new dry-cell type screen-grid tubes ('32s) should be used if the filaments are to remain series-connected.

LONG-WAVE RECEIVER

(103) Mr. T. T. Curling, Ft. Wayne, Ind.

(Q.1) How may a simple one-tube receiver be made, for picking up long-wave code station transmissions to obtain code practice?

(A.1) The schematic circuit of an easily-built set, the DeForest "Ultra-Audion," is shown in Fig. Q.103A. Although a tuning condenser C of .0005-mf. capacity may be used, it is recommended that this part have a capacity of about .001-mf.; which value may be obtained by ganging two .0005-mf. units. The larger capacity will make it easier to tune in a greater number of stations with a lesser number of coils. Any type of tube may be used at V1. Honeycomb coils may be purchased, or home-made coils scramble-wound, with No. 30 enameled S.C.C. wire, on a form an inch wide and about two inches in diameter, to the following number of turns: (25, 80-350 meters; 35, 175-550) 50, 200-750 meters; 75, 330-1030; 100, 450-1460; 150, 660-2200; 200, 1300-4000; 250, 1550-4800; 300, 2050-6300; 500, 3,000-8,500; 600, 4,000-12,000; 750, 5,000-15,000; 1,000, 6,200-19,000; 1,250, 7,000-21,000; 1,500, 8,200-25,000, meters. The two smallest coils are listed merely for completeness; the ranges are roughly those covered with a .001-mf. condenser. Some form of mounting must be arranged so that the coils may be conveniently interchanged. The coils should be rigidly supported; so that the turns cannot move, even slightly, when the coils are interchanged.

(Q.2) How does an A.C. meter work? Why does it indicate, steadily, on A.C.; when the needle of an ordinary D.C. meter on this supply will flutter?

(A.2) The D.C. meter when measuring D.C. may be represented as shown at the right in Fig. Q-103—B; where a moving coil, carrying the current to be measured, produces a field which reacts

(Continued on page 443)

Short-Wave Stations of the World

All Schedules Eastern Standard Time: Add 5 Hours for Greenwich Mean Time.

Meters	Kilo-cycles	
4.97-5.35	60,000-56,000	**Amateur Telephony and Television.**
5.83	51,400	**W2XBC**, New Brunswick, N. J.
7.32	41,000	**W8XI**, East Pittsburgh, Penna.
8.57	35,000	**W2XCU**, Ampere, N. J.
8.67	34,600	**W2XBC**, New Brunswick, N. J.
9.68	31,000	**W8XI**, Pittsburgh, Pa.
9.96	30,105	....Golfo Aranci, Sardinia. Telephone to Rome.
10.51	29,190	**PK3I3**, Sourabaya, Java. Wed. and Sat., 5:50-7:50 a.m.
11.55	25,960	**G5SW**, Chelmsford, England Experimental.
11.67	25,700	**W2XBC**, New Brunswick, N. J.
12.48	24,000	**W6AQ**, San Mateo, Calif. (Several experimental stations are authorized to operate on non-exclusive waves of a series, both above this and down to 4 meters.)
13.04	23,000	**W2XAW**, Schenectady, N. Y.
13.92	21,540	**W8XK**, Pittsburgh, Pa.
13.97	21,460	**W2XAL**, New York.
14.01	21,400	**WLO**, Lawrence, N. J., transatlantic phone.
14.06	21,320	**DIV**, Nauen, Germany.
14.15	21,130	**LSN**, Monte Grande, Argentina. —**W2XAO**, New Brunswick, N. J.
14.50	20,680	**LSN**, Monte Grande, Argentina, after 10:30 p. m. Telephony with Europe. —**FMB**, Tamatave, Madagascar. —**PMB**, Bandoeng, Java. —**FSR**, Paris-Saigon phone.
14.62	20,500	**W9XF**, Chicago, Ill. (WENR).
14.89	20,140	**DGW**, Nauen, Germany. Tests 10 a.m.-3 p.m.
15.03	19,950	**LSG**, Monte Grande, Argentina. From 9 a.m. to 1 p.m. Telephony to Paris and Nauen (Berlin). —**DIH**, Nauen, Germany.
15.07	19,900	....Monte Grande, Argentina. 8-10 a.m.
15.10	19,850	**WMI, Deal, N. J.** —**SPU**, Rio de Janeiro, Brazil.
15.12	19,830	**FTD**, St. Assise, France.
15.40	19,460	**FZU**, Tamatave, Madagascar.
15.45	19,400	**FRO**, **FRE**, St. Assise, France.
15.50	19,350	....Nancy, France, 4 to 5 p.m. —**VK2ME**, Sydney, Australia.
15.55	19,300	**FTM**, St. Assise, France. 10 a.m. to noon.
15.60	19,220	**WNC, Deal, N. J.**
15.94	18,820	**PLE**, Bandoeng, Java. 5.40-6:10 a.m. and from 2:40 a.m. Tues. and Fri.; 8:10-10:40 a.m. Tues. Also telephony. —....Saigon, Indio-China.
16.10	18,620	**GBJ**, Bodmin, England. Telephony with Montreal.
16.11	18,610	**GBU**, Rugby, England.
16.30	18,100	**PCK**, Kootwijk, Holland. Daily from 1 to 6:30 a.m.
16.35	18,350	**WND**, Deal Beach, N. J. Transatlantic telephony.
16.38	18,310	**GBS**, Rugby, England. Telephony with New York. General Postoffice, London. —**FZS**, Saigon, Indo-China, 1 to 3 p.m. Sundays.
16.41	18,210	**FRO**, **FRE**, Ste. Assise, France.
16.50	18,170	**CGA**, Drummondville, Quebec, Canada Telephony to England. Canadian Marconi Co.
16.54	18,130	**GBW**, Rugby, England.
16.57	18,120	**GBK**, Rugby, England.
16.61	18,050	**KQJ**, Bolinas, Calif.
16.70	17,950	**FZU**, Tamatave, Madagascar.
16.80	17,850	**PLF**, Bandoeng, Java ("Radio Malabar"). —**W2XAO**, New Brunswick, N. J.
16.82	17,830	**PCV**, Kootwijk, Holland. 3 to 9 a.m.
16.87	17,780	**W8XK**, Pittsburgh, Pa.
16.90	17,750	**HSIPJ**, Bangkok, Siam. 7-9:30 a.m., 1-3 p.m. Sundays.
17.10	17,550	**G2IV**, S.S. "Majestic." —**G2GN**, "Olympic."
17.34	17,300	**W2XK**, Schenectady, N. Y. Tues., Thurs., Sat. 12 to 5 p.m. General Electric Co. —**W8XL**, Dayton, Ohio. —**W6XN**, Oakland, Calif. —**W6AJ**, Oakland, Calif. —**W7XA**, Portland, Ore. —**W7XC**, Seattle, Wash. —**W2XCU, Ampere, N. J.** —**W9XL**, Anoka, Minn., and other experimental stations.
17.52	17,110	**WOO**, Deal, N. J. Transatlantic phone. —**W2XDO**, Ocean Gate, N. J. A. T. & T. Co.
18.10	16,560	**G2AA**, ship phone.
18.37	16,320	**VLK**, Sydney, Australia. Phone to England.
18.40	16,300	**PCL**, Kootwijk, Holland. Works with Bandoeng from 7 a.m. Netherland State Telegraphs. —**WLO**, Lawrence, N. J.
18.50	16,200	**FRE**, Saigon, Indo-China.
18.56	16,150	**GBX**, Rugby, England.
18.80	15,950	**PLG**, Bandoeng, Java. Afternoons.
19.50	15,375	**F8BZ**. French phone to G2GN. 1-3 p.m. relaying WGY.
19.56	15,310	**W2XAD**, Schenectady, N. Y. Broadcasts
19.60	15,300	**OXY**, Lyngby, Denmark. Experimental
19.63	15,280	**W2XE**, Jamaica, N. Y.
19.66	15,250	**W2XAL**, New York, N. Y.
19.72	15,210	**W8XK** (KDKA) Pittsburgh, Pa. Tues., Thu., Sat., Sun., 8 a.m. to noon.
19.83	15,120	....Vatican City (Rome).
19.99	15,000	**CM6XJ**, Central Tuinucu, Cuba. —**LSJ**, Monte Grande, Argentina.
20.00	14,990	**VK6AG**, Perth, Australia.
20.50	14,620	**WMI**, Deal, N. J. —**XDA**, Mexico City, 2:30-3 p.m.
20.70	14,480	**W8XK**, East Pittsburgh, Pa. —**GBW**, Rugby, England. —**WNC**, Deal, N. J.
20.80	14,420	**VPD**, Suva, Fiji Islands.
20.90	14,340	**G2NM**, Sonning-on-Thames, England. Sundays 1:30-3 p.m.
20.97-21.26	14,300-14,100	**Amateur Telephony.**
21.00	14,280	....Radio-Maroc," Rabat, Morocco.
21.50	13,940	....Bucharest, Roumania. 2-5 p.m. Wed., Sat.
21.59	13,890	....Mombasa, East Africa.
22.20	13,500	....Vienna, Austria.
22.38	13,400	**WND**, Deal Beach, N. J. Transatlantic telephony.
22.50	13,325	**G2IV**, S.S. "Majestic." —**G2GN**, S.S. "Olympic."
23.00	13,043	**OBE**, La Punta, Peru. Time Signals 2 p.m. —....Radio-Maroc," Rabat, Morocco, 8-9 a.m. Tues., Thurs., Sat.
23.35	12,850	**W2XO**, Schenectady, N. Y. Antipodal program 9 p.m. Mon. to 3 a.m. Tues.; noon to 5 p.m. on Tues., Thurs. and Sat. General Electric Co. —**W6XN**, Oakland, Calif. —**W2XCU, Ampere, N. J.** **W2XDO**, Ocean Gate, N. J. —**W9XL**, Anoka, Minn., and other experimental relay broadcasters.
23.70	12,650	**CJA**, Drummondville, Canada.
24.41	12,280	**GBU**, Rugby, England.
24.66	12,250	**FTN**, Ste. Assise (Paris) France. Works Buenos Aires, Indo-China and Java. On 9 a.m. to 1 p.m., and other hours. —**KIXR**, Manila, P. I. —**GBS**, Rugby, England.
24.63	12,280	**Airplane.**
24.68	12,150	**GBS**, Rugby, England. Transatlantic phone to Deal, N. J. (New York). —**FQO**, **FQE**, Ste. Assise, France.
24.89	12,045	**NAA**, Arlington, Va. Time signals, 8:55-9 a.m., 9:55-10 p.m.
24.98	12,000	**FZG**, Saigon, Indo-China. Time Signals, 2-2:05 p.m. —....Oporto, Portugal.
25.10	11,945	**KKQ**, Bolinas, Calif.
25.24	11,880	**W8XK** (KDKA) Pittsburgh, Pa. Tues., Thu., Sat., Sun., noon to 5 p.m., and Sat. night Arctic programs. Television Mon. and Fri. 2:30 p.m., 60 lines, 1200 r.p.m. —**W9XF**, Chicago (WENR). —**W2XAL**, New York (WRNY).
25.34	11,840	**W2XE**, Jamaica, New York (WABC).
25.36	11,820	**KIXR**, Manila, P. I., 5-6 p.m., 11:15 a.m.-12:15 p.m., 2-4 a.m., and (except Monday) 5-10 a.m. —....Calcutta, India.
25.40	11,810	**I3RO**, Prato Smeraldo (Rome), Italy.

(NOTE: This list is compiled from many sources, all of which are not in agreement, and which show greater or less discrepancies; in view of the fact that most schedules and many wavelengths are still in an experimental stage; that daylight time introduces confusion and that wavelengths are calculated differently in many schedules. In addition to this, one experimental station may operate on any of several wavelengths which are assigned to a group of stations in common. We shall be glad to receive later and more accurate information from broadcasters and other transmitting organizations, and from listeners who have authentic information as to calls, exact wavelengths and schedules. We cannot undertake to answer readers who inquire as to the identity of unknown stations heard, as that is a matter of guesswork; in addition to this, the harmonics of many local long-wave stations can be heard in a short-wave receiver.—EDITOR.)

25.42	11,800	**UOR2**, Vienna, Austria. Tues., 9-11 a.m.; Wed., 5-7 p.m.; Thurs., 5-7 a.m.
25.53	11,750	**G5SW**, Chelmsford, England. 7:30-8:30 a.m. and 2-7 p.m. except Saturdays and Sundays.
25.60	11,690	**CJRX**, Winnipeg, Canada.
25.68	11,670	**KIO**, Kahuku, Hawaii.
26.00	11,530	**CGA**, Drummondville, Canada.
26.10	11,490	**GBK**, Rugby, England.
26.20	11,440	**KIXR**, Manila, P. I., 11:15-12:15 p. m., 2-4 a.m., 5-10 a.m.
26.22	11,435	**DHC**, Nauen, Germany.
26.60	11,280	**IBDK**, Brussels, Belgium.
26.70	11,230	**WSBN**, SS, "Leviathan" and A. T. & T. telephone connection. —**IBDK**, S.S. "Elettra," Marconi's yacht.
27.30	10,980	**ZLW**, Wellington, N. Z. Tests 3-8 a.m.
27.75	10,800	**GBX**, Rugby, England.
28.00	10,710	**CTIBO**, Lisbon, Portugal. —....Casablanca, Morocco.
28.20	10,630	**PLR**, Bandoeng, Java. Works with Holland and France weekdays from 7 a.m.; sometimes after 9:30.
28.11	10,510	**WLO**, Lawrence, N. J.
28.50	10,510	**RDRL**, Leningrad, U.S.S.R. (Russia) —**VK2ME**, Sydney, Australia. 1-7 a.m.
28.80	10,110	**PCK**, Kootwijk, Holland
28.86	10,390	**GBX**, Rugby, England.
28.97	10,350	**LSX**, Buenos Aires, Argentina Testing, 8-10 p.m. Transradio Internacional, San Martin 329, Buenos Aires.
29.00	10,310	.....Paris, France. 1:30-3 p.m. daily; 9 a.m. Sundays.
29.50	10,160	**HS2PJ**, Bangkok, Siam. Sun., Tues., Fri., 8-11 p.m.
29.98	10,000	**CM2LA**, Havana, Cuba. ....Belgrade, Jugoslavia. Monday 3-4 p.m.
30.15	9,910	**GBU**, Rugby, England.
30.20	9,930	**W2XU**, Long Island City, New York. —....Posen, Poland.
30.30	9,890	**LSN**, Buenos Aires, phone to Europe.
30.50	9,830	**NRH**, Heredia, Costa Rica. 5-6 and 10-11 p.m. Amanda Cespedes Marin, Apartado 40.
30.64	9,790	**GBW**, Rugby, England.
30.75	9,750	.....Agen, France. Tues and Fri., 3 to 4:15 p.m. —**WNC**, Deal, N. J.
31.10	9,640	**7LO**, Nairobi, Kenya, Africa. 11:00 a.m. to 2 p.m. Relays G5SW. Chelmsford, frequently from 2 to 3 p.m. —....Monte Grande, Argentina, works Nauen irregularly after 10::30 p.m.
31.23	9,600	**LGN**, Bergen, Norway.
31.26	9,590	**PCJ**, Hilversum (Eindhoven) Holland Wed. 5-9 p.m.; Thu. 7-9, 11-12 p.m.; Fri. 7-9 p.m., 1-4 a.m. Sat. 1-7 a.m., N. V. Philips Radio. —**KIXR**, Manila, P. I.
31.28	9,580	**W3XAU**, Byberry, Pa., relays WCAU daily. —**VPD**, Suva, Fiji Islands.
31.35	9,570	**W1XAZ**, Springfield, Mass. (WBZ).
31.36	9,560	.....Konigswusterhausen, Germany. 10 to 11 a.m., 11:30 a.m. to 2:30 p.m., and 3 to 7:30 or 8:30 p.m. Relays Berlin. —**NAA**, Arlington, Va. —**KIXR**, Manila, P. I. —**ZL2XX**, Wellington, New Zealand.
31.48	9,530	**W2XAF**, Schenectady, New York. Mon., Tues., Thurs. and Sat. nights, relays WGY 5:30-11 p.m., daily. General Electric Co. —**W9XA**, Denver, Colorado. Relays KOA. —....Helsingfors, Finland.
31.56	9,500	**OZ7RL**, Copenhagen, Denmark. Around 7 p.m. —**VK3ME**, Melbourne, Australia.
31.60	9,490	**OXY**, Lyngby, Denmark. 1 p.m.
31.70	9,460	.....Radio Club of Buenos Aires, Argentina.
31.80	9,430	.....Posen, Poland. Tues. 1:45-4:45 p.m.; Thu. 1:30-8 p.m.
32.00	9,375	**EH9OC**, Berne, Switzerland. 3-5:30 p.m. —**OZ7MK, Copenhagen, Denmark. Irregular** after 7 p.m. —**3UZ**, Melbourne, Australia.
32.06	9,350	**CM2MK**, Havana, Cuba.
32.13	9,330	**CGA**, Drummondville, Canada.
32.40	9,250	**GBK**, Bodmin, England.
32.50	9,230	**FL**, Paris, France (Eiffel Tower) Time signals 4:56 a.m. and 4:56 p.m. —**VK2BL**, Sydney, Australia.
32.59	9,200	**GBS**, Rugby, England. Transatlantic phone.
32.80	9,110	**SUS**, Cairo, Egypt.
33.26	9,010	**GBS**, Rugby, England.
33.81	8,872	**NPO**, Cavite (Manila) Philippine Islands. Time signals 9:55-10 p.m.
34.00	8,820	**VK2UZ**, Sydney, Australia.
34.50	8,690	**W2XAC**, Schenectady, New York. —**HKF**, Bogota, Colombia.
34.68	8,650	**W2XCU, Ampere, N. J.**;—**W9XL, Chicago.** —**W3XE**, Baltimore, Md. 12:15-1:15 p.m., 10:15-11:15 p.m. —**W2XAV**, Long Island City, N. Y. —**W8XAG**, Dayton, Ohio. —**W6XN**, Oakland. —**W4XG**, Miami, Fla. —And other experimental stations.
34.74	8,630	**WOO, Deal, N. J.** —**W2XDO**, Ocean Gate, N. J.
35.00	8,570	**RBI5**, Khabarovsk, Siberia. 5-7:30 a.m.
35.02	8,560	**G2GN**, SS, "Olympic." —**G2IV**, SS, "Majestic."
35.54	8,440	**G2AA**, shore-to-ship phone.
35.48	8,450	**WSBN**, SS, "Leviathan."
36.00	8,330	**3KAA**, Leningrad, Russia. 2-6 a.m., Mon., Tues., Thurs., Fri.
36.74	8,160	.....Mombasa, East Africa.
37.02	8,100	**EATH**, Vienna, Austria. Mon. and Thurs. 5:30 to 7 p.m. —**JIAA**, Tokyo, Japan. Tests 5-8 a.m. —**HS4PJ**, Bangkok, Siam. Sunday 8-10 a.m.
37.36	8,030	**NAA**, Arlington, Va. Time signals 8:55-9 a.m., 9:55-10 p.m.
37.43	8,015	**Airplanes.**
37.65	7,980	**VK2ME**, Sydney, Australia.
37.80	7,930	**DOA**, Doeberitz, Germany. 1 to 3 p.m. Reichspostzentralamt, Berlin.
38.00	7,890	**VPD**, Suva, Fiji Islands.
38.30	7,830	**PDV**, Kootwijk, Holland. after 9 a.m.
38.60	7,770	**FTF**, Ste. Assise, France. —**PCK**, Kootwijk, Holland. 9 a.m. to 7 p.m.
39.15	7,660	**FTL**, Ste. Assise.
39.40	7,600	.....Riobamba, Ecuador.
39.70	7,550	.....SS. "Bremen." —**HKF**, Bogota, Columbia, 5-7 p.m., 11 p.m.-1 a.m.
40.00	7,500	....."Radio-Touraine," France.
40.20	7,460	**YR**, Lyons, France. Daily except Sun., 10:30 to 1:30 a.m.
40.50	7,410	....Eberswalde, Germany. Mo., Thu. 1-2 p.m.
41.00	7,310	.....Paris, France ("Radio Vitus") Tests. —.....Moscow, USSR. 7-7:45 a.m.
41.46	7,230	**DOA**, Doeberitz, Germany.
41.50	7,220	**HB9D**, Zurich, Switzerland. 1st and 3rd Sundays at 7 a.m., 2 p.m.
41.70	7,190	**VK6AG**, Perth, West Australia. Between 7:30 and 10 a.m. —**EAR58**, Canary Islands (Spain). Testing 5:30 p.m.
42.12	7,120	**OZ7RL, Copenhagen, Denmark. Irregular.** Around 7 p.m.
42.50	7,060	.....Liakov Islands (north of Siberia).
42.70	7,020	**EAR125**, Madrid, Spain. 6-7 p.m.
42.80	7,000	**F8KR**, Constantin, Algeria.
43.00	6,980	**EAR 110**, Madrid, Spain. Tues. and Sat., 5:30 to 7 p.m., Fri. 7 to 8 p.m. —**CT1AA**, Samos, Portugal. Friday, 4-5 p.m.
43.50	6,900	**IMA**, Rome, Italy, Sun., noon to 2:30 p.m.
43.60	6,875	**F8MC**, Casablanca, Morocco. Sun., Tues., Wed., Sat. —**D4AFF**, Coethen, Germany. Sundays 1-6 a.m.; Tuesdays, Fridays, noon-2 p.m.; Thursdays 4-6 p.m.
44.40	6,750	**WND, Deal, N. J.**
44.60	6,720	**VRY**, Georgetown, British Guiana. Wed and Sun., 7:15 to 10:15.
45.00	6,600	.....Berlin, Germany.
45.20	6,635	**WSBN, SS, "Leviathan."**
46.05	6,515	**WOO, Deal, N. J.** —**W4XG**, Miami, Fla.
46.70	6,425	**W2XCU**, Ampere, N. J.;—**W9XL**, Anoka, Minn.; and others.
47.00	6,380	**CT3AG**, Funchal, Madeira Island. Sat. 5-7 p.m. —**HCIBR**, Quito, Ecuador, 8-11 p.m.
47.35	6,335	**W10XZ. Airplane Television.** —**VE9AP**, Drummondville, Canada. —....Casablanca, Morocco.
48.00	6,250	....Radio-Maroc," Rabat, Morocco
48.30	6,205	**HKC**, Bogota, Colombia. 9:45-11:30 p.m.
48.82	6,170	**HRB**, Tegucigalpa, Honduras. 2-12 p.m., Mon., Wed., Fri., Sat. Int. S. W. Club program. Sat. 11:30-12 p.m.
48.74	6,157	**W9XAL, Chicago, Ill. (WMAC) and Airplanes.** **VE9CL**, Winnipeg, Canada.
48.83	6,146	**KIXR**, Manila, P. I. 3-4:30, 5-9 or 10 a.m., 2-3 a.m. Sundays. —**W8XK**, East Pittsburgh, Pa. Tu., Thu., Sat., Sun., 5 p.m. to midnight.

(Continued on page 440)

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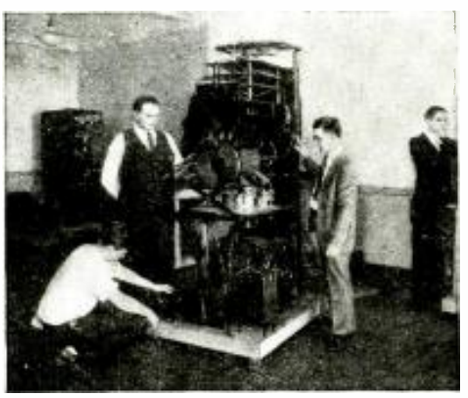

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You can tell a leader by how many followers he has. Pilot Super-Wasp's success is proved by its many imitators. Remember, Pilot Super-Wasp covers from 14 to 500 meters, giving you practically all the regular broadcasting channels as well as short waves. And don't overlook the fact that Pilot products are known *personally* to more users throughout the world than any others and that every single Pilot product is made in the largest factory in the world owned and operated by a radio manufacturer.

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IN KIT FORM

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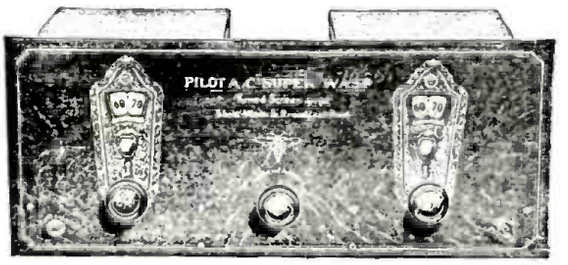
Kit K-110: The battery-operated Super-Wasp. Batteries and Tubes extra.



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PILOT SUPER-WASP RADIO

FOR LONG AND SHORT
WAVE RADIO RECEPTION

New Radio Devices for Shop and Home

(*Continued from page* 404)

used for determining the polarity of even very small voltages.

For continuity tests, three pin jacks are provided at the lower right of the panel; one pair for high, and one for low resistances. The battery is protected beneath a metal plate.

One of the most interesting and important parts of the "Model 90" is the universal analyzer plug, which is approximately the size of a '99 tube; making it very convenient for tests on "midget" or "mantelpiece" receivers, where very compact tube arrangements are encountered. By an ingenious snap-catch arrangement, the adapters used in analyzing become virtually a part of the plug itself, and will not pull loose on removal from a tight socket. All connections are brought into the set analyzer through the same seven-wire cable.

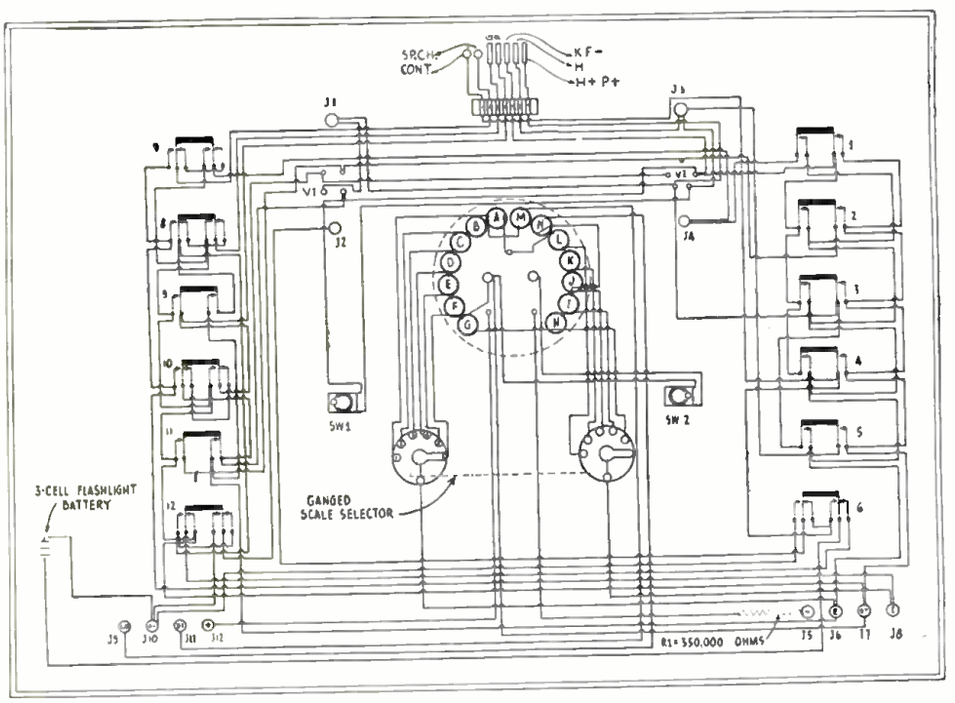


Fig. 1

Supreme "Model 90" circuit. Ohmic values: (multipliers) A, 1000; B, 6000; C, 21,000; D, 60,000; E, 210,000; F, 600,000; M, 1500; N, 40.5 (shunts) G, 11.1; H, 259; I, 74; J, 259; K, 740; L, 2220.

In addition to measuring screen-grid current and pentode current, the "Model 90" tests helium (non-filament) rectifier tubes, and measures not only resistances and capacities, but the reactances of choke coils from 2 to 100 henries. It may be used as an output meter on any type of radio receiver, being adaptable for output impedances ranging from 1000 to 35,000 ohms. "Model 90" weighs only six pounds and is only 4¼ in. x 9¼ in. x 11¼ in. in size. It is enclosed in a beautifully finished carrying case, available either in pecan or natural walnut finish, or covered with high-grade leather-grained material. Slip hinges are provided for easy removal of the cover.

A testimony to the simplicity, flexibility and efficiency of this instrument for the Service Man is found in the fact that it has been adopted by the R.C.A. Institutes for the use of its students who are taking courses in radio servicing.

A NEW ARTIFICIAL CRYSTAL

By Dr. F. Noack (Berlin)

A DETECTOR of unusual sensitivity, as crystals go, has been found by a German scientist, Dr. Erich Habann, in cuprous iodide (*a salt of copper—CuI in chemical parlance*) which is pressed into a metal cup to form a solid substance. For a "cat-whisker," a metal needle is forced into contact with the iodide; and aluminum, zinc or lead has been found better for this purpose than, say, copper. The explanation is that a pure electric current is composed only of electrons; but, where the materials of a substance are able to move, electrolytically, there are also positive ions in motion. When, therefore, a copper wire was placed in contact with the iodide, the detecting action was very sensitive; however, this fell off, and it was evident that ions were accumulating between the metallic copper and the iodide. This effect did not result with lead, aluminum and zinc; but it did with molybdenum, tungsten and platinum. The difference is due, undoubtedly, to the atomic constitution of these metals as it affects their electric nature. (Reported in *Zeitschrift fur technische Physik.*)

A CHECKER FOR ALL TUBES

NOT only the better known standard makes of tubes, but the newest models, are provided for in the shop testing instrument shown in the illustration; the "Model D" Van Horne-Flewelling tube checker. It has been designed to take care of pentodes, as well as the single-screen-grid types, and the '80 double-plate or the "866" mercury rectifier; and it has heater leads for Kellogg and other special tubes. The instrument is attached by screws to counter or wall,

Fig. C

The Van-Horne-Flewelling tube checker for shop use.

as found most convenient, and operated by standard 60-cycle current, 110 or 115 volts.

Readings, for the different tube types, are taken first without and then with the "Grid Test" button depressed; the standard differences in plate current readings which may be expected (as engraved on the panel for reference) are:

Tube	Dif. Ma.	Tube	Dif. Ma.	Tube	Dif. Ma.
'99	1.0	D'12	3.0	'10	7.0
'22	1.1-2.1	'40	3.0	'12	8.0
'20	2.0	Kardon	4.0	'26	8.0
'45	2.0	'01A	5.0	'27	9.0
'71	2.5	'00A	3.0	'50	7.0

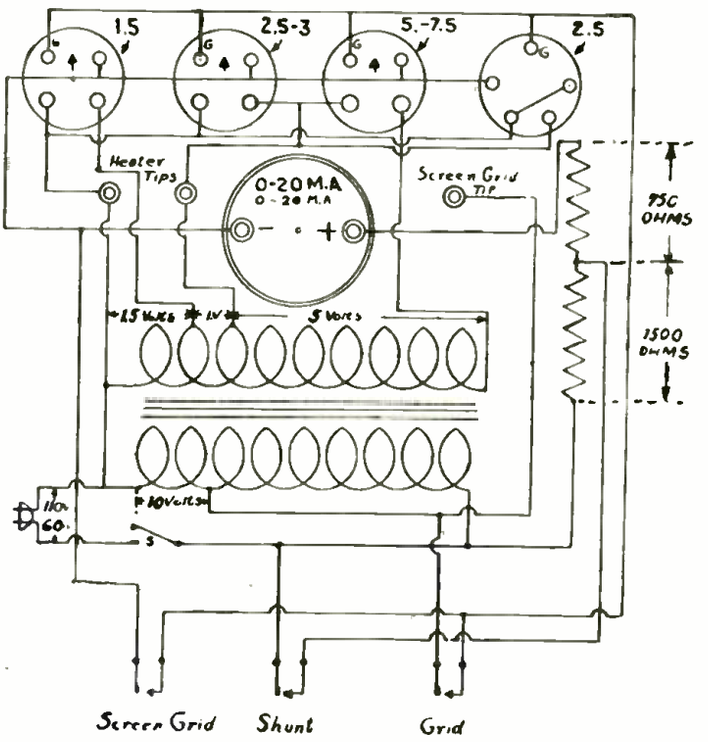
A normal tube, say the manufacturers, may be allowed 15% variation from the standard reading; any tube exceeding this tolerance should be considered inferior. The sockets, reading from left to right, are for '26 and 1.1-volt tubes; 3-volt battery and the UX-'45 A.C. tubes; 5- to 7.5-volt UX tubes; and 2.5-volt (heater-cathode) UY tubes, respectively; the connections will be seen in the diagram. On the '71 and the '45, as well as the rectifiers, readings are taken without pressing the shunt button used for the others. The '80 tubes are rated at 11 and 15 ma.; the second plate is tested by pressing the screen-grid-test button.

Fig. 3

The fundamental circuit of the tube checker; external connections also permit readings of 0-20 milliamperes, 0-20 and 0-400 volts on the meter scale. In case of a short-circuit between tube elements, the fact is indicated without damage to the checker.

The front panel is of bakelite, as well as the case, and the contacts are cadmium-plated.

The checker, designed by E. T. Flewelling, is made by the Van Horne Tube Co., of Franklin, Ohio.



Time Element in Servicing

(*Continued from page* 392)

start. Of course, if the trouble is caused by a bad tube, which can be detected by simple replacement, removal of the chassis is not necessary; but, if the trouble is such that "pulling" the chassis will be necessary, it might just as well be "pulled" at the start. In this respect, we believe it more advantageous to remove a chassis than to fumble with set analyzer plugs when the sockets are located in the innermost depths of the console cabinet.

Of what value is it to make a complete test of receiver voltages by means of a set analyzer or other device with the chassis in place, and a subsequent test after the chassis has been removed? In view of the possible troubles which might exist—yet not become evident during a test of receiver voltages—we feel prone to suggest such a removal of the chassis, if the trouble is other than tubes. In connection with this procedure, which is a change from the usual routine, the modern set analyzer should contain a system whereby one can test the tubes without contact with the receiver. If it does not, a simple arrangement operating from the power mains should be an additional part of the test equipment.

This subject of the chassis is an interesting point, and we would appreciate comments from readers. Bear in mind the supplementary tube-testing equipment previously cited.

Service Men's Notebooks

(*Continued from page* 393)

constant, the readings may be made with the same accuracy as at the lower frequency. Since very low potentials are encountered, the condensers need not be of high rating.

The potentiometer R is set at its center point, which is the zero potential of the filament circuit. The lamp, as will be seen, serves merely to cut down the supply of house current to the amount drawn by the tube; and it serves also as a ballast to keep the current flow smooth. A '12A type was selected for the tube, because of its efficiency at low filament voltages; it has a practically linear curve at this temperature, and, with its high thermal lag, it is best for this purpose. Select a good tube for the meter.

The meter should be of a good make; the main considerations are a long scale, easily read, and reliability. The instrument used by the writer is calibrated in microamperes —fifty divisions of 20 each. This makes it easier to read and tends to encourage greater accuracy. It is not advisable to make a new scale at home; if you must have one, let an experienced draftsman make it. It is not indispensable, but convenient.

The meter is calibrated by putting known A.C. voltages on the grid. During and after calibration, no part may be changed; this applies to the grid leak (2 or 3 megohms) across the input.

With this instrument, radio sets may be neutralized, and tuned circuits synchronized in the manner explained in all service manuals and data sheets; sensitivity at different frequencies may be measured, etc.

Operating Notes

(*Continued from page 384*)

be the red carbon resistor in the first R.F. stage; shorting this out of circuit will often increase the volume of reception but, at the same time, decrease the selectivity of the receiver. If this resistor is open, replacement is the surest and safest method.

In the "32 DC" model, shorting the red resistor in the third R.F. stage may produce a marked increase of selectivity. Also, connecting a 0.5-mf. condenser from one side of the line to one of the R.F. line chokes will greatly improve clarity and volume.

Be careful of the metal-braid shielding which encases the aerial and grid leads of the first R.F. stages; a short to the shield here will cut off reception.

Philco

Some time ago, fading in a Philco "65" was brought to the attention of the writer; the symptoms were alternate normal reception and fading, as often as every two minutes. Countless tubes were tried in the set; receiver and pack were thoroughly checked for continuity and voltages, and, after much work, it was found that the fading was accompanied by a lessened detector plate voltage, while other readings showed no marked decrease. The first A.F. transformer was being carefully watched when it was noted that pressure, put accidentally on the detector by-pass condenser, caused a similar decrease in voltage and the resultant fading. This condenser, a Dubilier .001-mf., is one of the type riveted together, and vibration had caused it to loosen. The remedy was replacement; and this accidental discovery led to clearing up several similar complaints.

In the Philco "87" neutrodyne, there are used some small tubular components, which seem to be condensers of a common type but, in reality, are both resistors and condensers (Fig. 4). The resistance is in an R.F. plate circuit; the condenser is its by-pass. If the resistor is open, there will be no plate voltage on that particular stage; but the Service Man who takes the unit for a mere condenser will be misled. If the condenser is shorted, there is a decrease of plate voltage at the power tube, and none at the R.F. plate; if it is open, oscillation in the circuit will occur.

Freshman Sets and Packs

A few years ago, there was a very large sale of early Freshman electric models, which obtained general distribution; very little information for servicing them, however, was ever issued by the makers.

For this reason, power packs intended for different models were often mistakenly interchanged, and leads were therefore hooked up incorrectly. A recent case, which came to the writer's attention, was of this nature. Four '26 tubes were burned out, first, and then the power transformer; because the leads were wrong. To help reduce the number of accidents like this, the following codes are given:

Freshman "Equaphase," with "Model G-60-S" pack, has the following arrangement of its numbered terminals: 1, 2, A.C. 1½ volts; 3, 4, A.C. 2½ volts; 5, 6, A.C. 5 volts; 10, "B—"; 7, D.C. 45 volts; 8, D.C. 145 volts; 9, D.C. 225 volts.

Freshman "Masterpiece," with 15-volt

model pack: 1, 2, A.C. 5 volts; 3, 4, A.C. 15 volts; 5, D.C. 165 volts; 6, D.C. 90 volts; 7, D.C. 30 volts; 8, D.C. 9 volts positive on detector; 9, common negative grid return.

Freshman "Masterpiece" E.R.A.C. model, and pack: 2, 6, A.C. 5 volts; 1, 8, A.C. 2½ volts; 3, 4, A.C. 1½ volts; 9, "B—"; 5, D.C. 135 volts; 7, D.C. 50 volts.

The color code on this last combination is: 1, black; 2 yellow; 3, blue-white; 4, blue; 5, red; 6, orange-blue; 7, brown; 8, black-green; 9, green.

Breaking Into Servicing

(*Continued from page* 399)

per week after you have worked up a fairly large clientele.

(4) The experience you get is first-hand, every job presenting a problem, and it is your business to solve the riddle.

(5) You are practically master of your own time, giving you opportunity for study or research to improve your technical knowledge.

(6) Finally, it will give you a thorough business training that will be most useful to you as time goes on.

There are many ways of getting started in the radio service business. You probably have ideas of your own along this line; but the methods I am about to relate have given very satisfactory results in a town with a population of 20,000.

First of all: when entering any business, you've got to let people know you are doing the work, and that they can depend upon you to do it. Of course you can "broadcast" this news around among your friends and relatives, and get some work; but this is not usually sufficient to work up a large clientele. You must advertise.

At this stage of your business career, your advertising must be as effective as it is possible for you to make it. Usually, experiment at this stage means waste of money. I have found a two weeks' advertising campaign, as follows, to be best.

Take one street each day for a week; walk the full length of the street, up one side and back the other, copying the numbers from the houses having aerials. Each evening you can look up the names of the persons living in those houses from the city or telephone directory. At the end of the week you will have a large mailing list, 100% of whom are radio users.

The next week you may send a typewritten post-card, similar to that reproduced below, to your mailing list. None of these cards will fall into the hands of anyone not having a radio set. Everyone receiving one will, sometime at least, be interested in its message. Therefore these cards should produce very good results.

IS YOUR RADIO WEAK, SICK?

Don't throw it away. I'll put it back on "its feet" with more pep than it ever had. That's my guarantee. I am trained and experienced on all types and models of Radio sets. Call me NOW!

(Name and Address)

After you have obtained some results from the above method, a newspaper advertisement should be run. One in the classified section of your newspaper, giving a state-

ment of the work you do and including a suggestion that the set owner call you the next time his radio goes bad, should give good results with low cost.

Apply your own ideas to your advertising, with the idea of making it original. It is all right to copy or take ideas from other ads, once in a while; but you will probably find that an original piece of "copy," with some "punch" behind it, will give much better results.

Now, a few words about conducting your business. Charge a reasonable rate, but don't work for nothing; don't charge less than $1.00 per hour, and not more than $2.50 per hour. The rate must depend upon your overhead expenses, living expenses in your particular town, and the rate of other radio men in the same town. Do not try to get work by price-cutting, unless you are in business for the fun of it. People are willing to pay good money, as a rule, for good service.

If you can give them better and more efficient service than the other fellow, your time is worth more than his. Just remember this: that, if you give the people the kind of service they want, and give it to them consistently, you can't keep the money away.

Trillion-Tone Organ

(*Continued from page* 403)

had a lamp and a cell opposite each circle of holes. In this instrument, as with an organ, any note could be prolonged.

A subsequent development, less like that detailed in Mr. Lesti's article, is the "Magneton," produced by an Austrian piano factory. In this instrument, musical notes are produced electrically by coils revolving, at varying rates, in magnetic fields. Neither of these developments, it would seem, has the versatility of Mr. Lesti's invention, which renders it possible to introduce tones of any complexity and color, which an amplifier can transmit and a speaker reproduce, into his musical output.—*Editor.*)

Heaviside Layer

(*Continued from page* 415)

taken to be a heavily *ionized* stratum in the earth's outer "stratosphere." If the portion traveling along the earth is taken as the main component of the signal, we may consider that a wave traveling from the transmitter upward to the reflecting layer and back to the receiving antenna will travel a greater distance than the first or "ground wave" and will arrive at the receiving antenna slightly late. Just how late this retarded arrival is, can be determined by the relative displacement of the second image noted in our first figure.

This observation recalls the phenomenon of fading and we arrive at the conclusion that the second component may arrive either in phase or out of phase with the main signal. In this event the two component will be sometimes additive, and sometimes subtractive, with the net result that the signal varies in its average intensity, and gives rise to unpleasant effects where audible reception is to be carried out.

In England Professor Appleton has noted

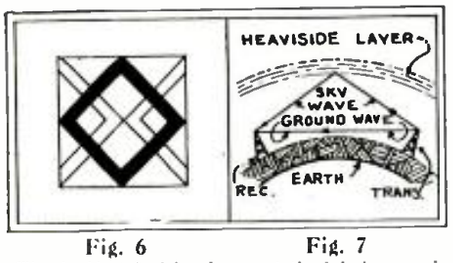


Fig. 6 Fig. 7

The double television image at the left is caused by the two paths of the signal, at the left.

that, at times, the variation in arrival time between the two components from a station from sixty to eighty miles distant amounts to 1/3000 of a second. In the case taken for an example in Fig. 6, we will assume a 48-line picture repeated 15 times per second, and the time required for any one aperture to traverse the field of view will be 1/720 of a second. The displacement indicated is half the width of the image or, in units of time, 1/1440 of a second.

Hence, since we know the speed with which the waves travel (it is approximately 186,000 miles per second) and the time elapsed between the arrival of the first component and the arrival of the second, we may arrive at a figure representing the difference in the distances traveled, or about 130 miles. With this knowledge, together with an accurate knowledge of the actual mileage between the two stations, we may calculate the probable height of the reflecting layer.

This, however, is continually shifting; but some interesting data may be gathered regarding seasonal variations in radio.

An A. C. Short-Wave Receiver

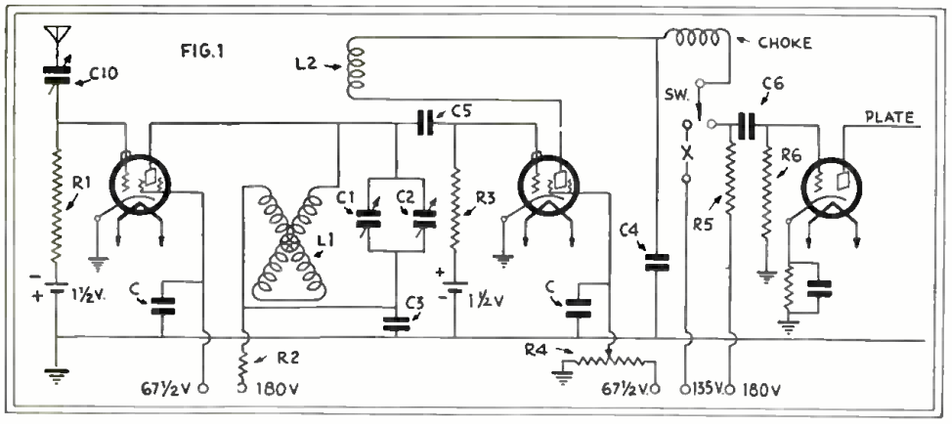
(*Continued from page* 417)

The front panel layout is designed for ease of operation. From left to right are shown (Fig. A): the tuning dial; the regeneration-control knob with the stage switch just below it; the band-selector dial, in the center, which governs the wavelength range to be covered by the left-hand dial. Below, to the right, is the "peak-quality" switch; above it, the volume-control knob; and, last, another dial which is provided largely for experimental purposes. The last may be used, with a midget variable condenser, to control regeneration, or to experiment with a tuned R.F. stage; or, if so desired, it may be omitted.

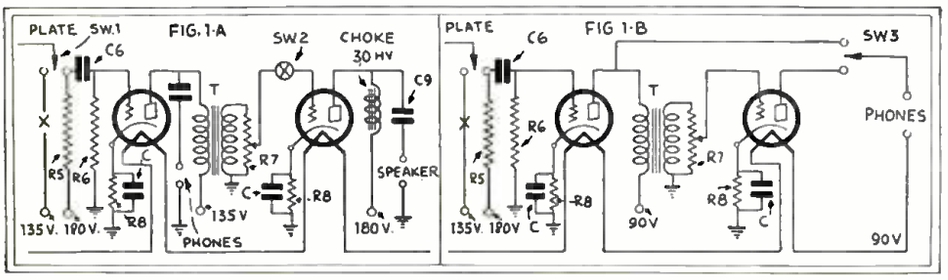
Power is supplied, in this case, by a 10-volt stepdown transformer, for the series filaments, and a "B" eliminator. Any good combination power supply may be used; and the filaments may be wired in parallel, though heavier wire must be used to carry the heavier amperage at 2½ volts. The leads are run through a plug; no pick-up is noticed from running the A.C. and D.C. leads together, and the A.C. leads are not twisted.

Every A.C. short-wave set seems to have individual characteristics. A receiver, built by an electrical engineer, which duplicated this receiver in every respect, required several minor changes before entirely satisfactory operation was obtained.

Choice of tubes is important, though all makes seem to have good and bad speci-



The circuit of Mr. Hurley's short-wave tuner. Besides the phones at X, either of the two audio connections below may be used. The author is a patient in a government hospital, where phones enable his friends to listen to code messages quietly.



At the left, we have an adaptation of the audio end for loud-speaker work; the operator uses phones on the detector. At the right, the arrangement preferred by the author under his special circumstances and for "ham" work; multiple phone connections were provided in the output.

mens. If convenient, take your receiver to your dealer and try several tubes in each socket; though the detector is most important and the '27s are least troublesome.

As for information on the circuit, each and every portion is covered by an article in one or another of the last few issues of RADIO-CRAFT, SHORT WAVE CRAFT, or *QST*. Good luck!

List of Parts

One *Aero* "automatic tuner" variometer-condenser unit (L1-L2, C1-C2.)
Two *National* "Type C" dials, for tuning;
One *National* "Type N" dial, for waveband selection;
One *National* No. 10 impedance (R1);
One *Pilot* 450-ohm resistor, (R2);
One 5-meg. grid leak (R3);
One *Frost* 100,000-ohm variable resistor (R4);
One 250,000-ohm fixed resistor (R5);
One 2-meg. grid leak (R6);
One *Frost* 200,000-ohm variable resistor (R7);
One 30-henry choke (OC);
One A.F. transformer (T);
Seven fixed condensers: C, 0.1- to 0.5-mf.; C3, C6, .006-mf.; C4, .0005-mf.; C5, .0001-mf.; C7, 0.5-mf.;
One *National* "Velvet" "B" eliminator.
Three switches: two S.P.D.T. (Sw1, Sw3); one S.P.S.T. (Sw2); and jacks for phones or speaker, as desired.

Service Man's Forum

(*Continued from page* 395)

the price of the job. Consequently, without a service charge of some kind, considerable time would be lost.

In view of the fact that there are very, very many attic mechanics who profess to know radio, a charge too steep oftentimes loses business for a bona fide radio engineer who would otherwise get the work.

There are several ways through which business may be forthcoming. One of the best is to use the best parts, and do a good job that pleases the customer, which will give the best advertising possible. There is no better advertising than by word of mouth.

A follow-up card asking for a recommendation to friends will always bring at least one more job even in these hard times. I enclose a specimen of one which I use, and which brings results. Of course, it is an impossibility to please all the people all the time *but*, if the job is right, you can rest assured that the customer will sing it from the housetops if the price is right.

To anyone venturing into this field it might be in order to say; *don't jump at conclusions!* Of course, there are many symptoms that will be recognized by the experienced Service Man, by merely listening to the set; but even then it is a good policy to be sure of the fault before breaking the news to the prospective customer.

There are also defects which may be seen with the naked eye (such as tubes failing to light or the plates of an '80 glowing a cherry red or a power tube giving off a purplish glow) but, nevertheless, a check with a *good* set analyzer will always make the Service Man feel more secure in his diagnosis.

When a major repair is to be made, the

most logical thing to do is to take the set to the shop, where you will not be molested by the curious and where there is a good place to work. If an auto Service Man was called for service and started to dismantle the car in the street, he would not get very far; and the same applies to the radio Service Man, only under different conditions.

One other good thing to remember is: never laugh at what might be a foolish question; because, if the person asking it knew as much about radio as you do, he would not have called you.

Never be untruthful, for you might not get the job and, when another Service Man calls, the customer will think that neither one knows exactly what is wrong. This makes it hard for all Service Men in general.

Below are some of the questions asked me:

How much will it cost to fix it?
Can I get the police department (short waves) with it when it comes back?
My neighbor gets Cuba; why can't I?
What makes it stop? It never did that before?
Why can't I get short waves with eight tubes when the man next door gets them with three?
And so far into the night.

F. G. Poli,
1905 *Spruce St., Detroit, Mich.*

(Mr. Poli's card is a simple government posteard, typewritten. It reads:

Dear Sir:

If our radio service has been satisfactory, a recommendation to your friends will be *greatly appreciated.*

THANK YOU
F. G. Poli,
Radio Engineer.
—Glendale 1008—)

New Applications

(*Continued from page* 401)

each other. The effect of the numerous reflections is to concentrate the strength of the wave in the form of a circular cone directed outward and upward toward the Heaviside layer, and, it is hoped, to give a better distribution of field strength at great distances.

The sixth illustration, Fig. F, is a device intended to serve at sea, the purpose of a fire-alarm telegraph service on land. It may be put in operation to send out a signal of distress; a series of twelve dashes, each four seconds long, and spaced one second; these are transmitted on the calling wave of 600 meters. This signal will not only be recognized by an operator; but, if another ship sends out such a signal within the receiving range of this instrument, it will operate a relay which sets the gong ringing and summons the radio operator. In this manner it maintains an automatic watch —the most important part of its work, since the regular "SOS" can be, and in fact, must be sent manually after this alarm.

The same principle has been applied to apparatus to send code automatically—as in a clandestine portable transmitter seized by the French authorities; but none of these mechanical devices eliminate the need for a trained radio operator.

Announcing ~ RADIO

Service Man's HANDYBOOK

WITH ADDENDA DATA SHEETS

THIS new book contains a tremendous amount of the most important data of every kind — several hundred illustrations, wiring diagrams, charts, on every conceivable subject pertaining to radio sets, tubes, etc. The book is live "meat" from start to finish, and contains only *practical information* on which every radio man can cash in immediately.

Just to give you a few subjects contained in the book, we mention the following:

Prescriptions of a radio doctor
Modernizing old receivers
Servicing obsolete sets
Operating notes for Service Men
Service Men's data
Servicing automobile radio installations
Curing man-made static
Causes and cure of radio interference
Notes on repairing "B" power units
Constructional data on laboratory equipment
A portable radio testing laboratory
Servicing with the set analyzer
What and how the Service Man should sell
Helping the Service Man to make money
How to become a Service Man
Servicing broadcast receivers
All about vacuum tubes, and vacuum-tube data
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Dozens of radio service data sheets
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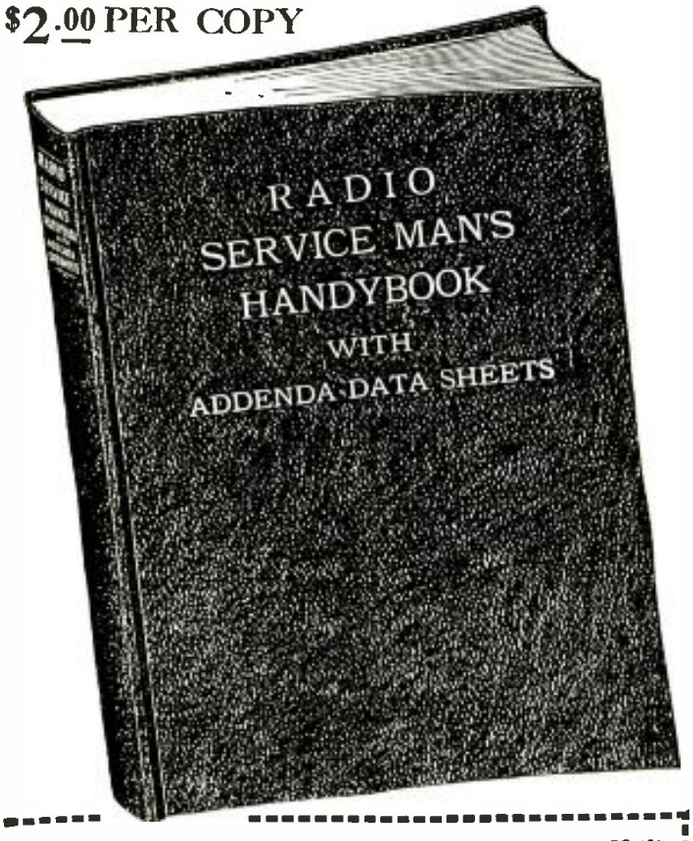

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96-98 Park Place. New York City. N. Y.

Gentlemen:

As per your special offer. I enclose herewith remittance of $2.00 (Canada and foreign $2.25) which pays the entire amount on your new book entitled RADIO SERVICE MAN'S HANDYBOOK with Addenda Data Sheets, in loose-leaf form, as described in RADIO-CRAFT.

Name .....

Street .....

City and State .....

The Foremost Radio Service Authorities Have Contributed to This Book

C. W. PALMER	GEO. C. MILLER	H. WEILER
LEON L. ADELMAN	JULIUS G. ACEVES	J. E. DEINES
SYLVAN HARRIS	C. W. TECK	F. R. BRISTOW
BERTRAM M. FREED	PAUL L. WELKER	and many others

A NEW DEPARTURE

EVERY Service Man, every radio man, every radio experimenter and every radio professional makes his own notes, draws his own circuits and writes down his own observations and his own data. For these reasons, the RADIO SERVICE MAN'S HANDYBOOK has been made in loose-leaf form. *There are supplied with this book 48 special ledger paper pages, square ruled on both sides so that you can take a leaf and place it wherever you wish, and write on it your own data.* If you wish, you can also cut out data from other publications and paste it on the sheet—placing it in its proper position in the loose-leaf book.

The total number of pages is 200 and the book contains such a wealth of radio material as you have never seen before between two covers. *Nothing like it has ever been produced.* The book is of the large size, 9 x 12 inches, and is in the same loose-leaf form as the OFFICIAL RADIO SERVICE MANUAL. It has a semi-flexible cover with gold stamping.

MAIL COUPON TODAY

An All-Wave Superheterodyne

(*Continued from page* 419)

an extent that side bands are clipped and distortion results. For this reason, inductance-tuned transformers were designed for use in this receiver. However, unless the high-frequency resistance is kept low, the effective voltage will be no greater than that obtained from capacity-tuned types.

To eliminate harmonics and bring about practically "one-spot" tuning, an intermediate frequency between 250 and 300 kilocycles was chosen. This will require a secondary inductance of comparatively high value, and some form of concentrated winding will have to be employed. Multi-layer continuous-bank coils are about the easiest to wind; the distributed capacity is quite low for the large number of turns required.

Each of the transformers is somewhat different in construction. The winding forms are bakelite tubes, 2 inches in diameter by 2⅜ inches long. The rotors also are of bakelite, 1 inch long by 1 3/16 inches in diameter; old tube bases are ideal for this purpose.

The first transformer consists of a primary, secondary and rotor. The secondary is wound first, starting ⅜-inch from the edge of the form. A total of 460 turns of No. 28 D.C.C. wire is bank-wound in two 5-layer sections, 230 turns per section; each being approximately 1 inch long and separated ⅜-inch to allow room for the rotor shaft.

Design of Transformer

It is assumed here that anyone interested in building this receiver is experienced enough to be able to bank-wind coils. It might be well, however, to state at this time that the use of plenty of collodion will prevent the turns from falling; this liquid dries almost instantly, and may be procured at any drug store for the nominal sum of 10 to 20c per ounce. In case bank windings are too difficult for the constructor, they can be obtained, wound to order, from many companies. Failing in this, plain layer windings may be used to good advantage with, perhaps, a slight increase in distributed capacity.

The rotor is wound next; the small bakelite tube should first be drilled with two holes for the shaft. These must be in the exact center, and directly opposite to assure true turning of the finished coil. Threaded 8/32 brass rod, 3 inches long, is employed for a shaft.

As only a small variation in inductance is necessary or desirable, the rotors need not have a large number of turns; a total of 102 turns in two sections, (51 per section) 5 layers high, will be sufficient. Because of the small space available, No. 30 S.C.C. wire will be needed. Enough space should be left between the sections to allow small washers to be slipped on the shaft, to fit it snugly within the large form. Short lengths of 3/16-inch brass tubing are recommended in place of the washers.

The primary is wound in a "hank," in the same direction as the secondary to a diameter of about 1⅞-inch, with 185 turns of No. 30 enamel or cotton-covered wire. The completed coil is then placed inside the secondary near the filament end, using collodion as an adhesive. The start of this winding goes to the "B+" and the finish to the plate. (The primary should be tied with string in three or four places, before placing).

After all the windings are completed, the rotor may be installed. Two holes are drilled in the outside form, between the secondary sections, and must be directly in line with those in the rotor. The shaft is inserted in one of the holes; then a few small washers—or a short length of brass tubing—are placed over the shaft, which is then pushed into one of the rotor holes. Two 8/32 nuts are screwed on the shaft, which is passed finally through the other rotor hole, another short brass tubing and the outside hole. If the brass pieces have been cut correctly, the rotor should turn freely but fit snugly. A binding-post top may be put on one end of the shaft, if desired for ease of adjustment, and the nuts inside the rotor may then be tightened. Other methods of mounting the rotor which would, possibly, be superior to this one may be worked out by the constructor.

Four connecting terminals are needed for the coil leads. Two are placed at each end of the form, through holes drilled 3/16-inch from the edge. The mounting brackets will be left entirely to the constructor to devise for himself.

One lead of the rotor is soldered to the top lead of the secondary. The other rotor lead goes to the grid of the first I.F. tube.

Special Tickler Optional

The second transformer has only one winding, and a rotor, both exactly like those just described. The third transformer has an additional winding for a tickler; this is not absolutely necessary, but does give greater sensitivity—a worth-while feature if extreme "DX" is desired. Some broadcast listeners, also, are interested in the reception of commercial or amateur code stations; a tickler is needed in this case to provide beats with the incoming signal.

The tickler may consist of 100 turns of No. 30 wire, wound in a manner similar to the primary of the first transformer, and placed within the form at the filament end of the secondary. The leads are then con-

TABLE OF TURNS ON R.F. COILS
(See text for sizes of wire)

Top of Band (Meters)	1st Det. Pri. L	Coupler Sec. L2	Tick.		Osc. Grid L4	Inductance Plate L3
20	2	7	6	1	6	7
40	3	13	7	1	7	12
80	5	24	9	4	9	23
160	7	47	12	8	11	45
600	12	95	33	12	20	90

nected, with the start of the winding going to the plate through condenser C7 and the finish to the filament. The regeneration control is like that in the first detector circuit, and is connected directly across the tickler.

Energy is fed from the plate circuit of one tube to the grid of the next through a coupling condenser (C6) having a capacity of .00025-mf. Although a fixed-capacity type may be employed, a variable is to be preferred; as then practically any degree of selectivity may be obtained, the lower values sharpening the tuning and vice versa. A Muter or XL "Variodenser," with a maximum of .0005-mf. is very fine for this service.

The radio-frequency chokes (RFC2) in the "B+" leads to the screen-grid tubes prevent the feeding back of energy into the "B" supply. The Silver-Marshall long-wave type is recommended. The choke following the second-detector is of the same size, and eliminates howling by keeping the I.F. currents out of the audio amplifier.

The grids of the I.F. tubes are biased by taking the voltage drop across a fixed 10-ohm resistor (R2) in the negative side of each filament; a 0.1-mf. condenser (C4) by-passes the R.F. energy around each resistor. The screen-grids are by-passed by 0.5-mf. condensers (C5). The filaments of these tubes have an additional fixed 5-ohm resistor (R4) in the positive leg, to drop the voltage to 3.3.

The second detector is of the plate-rectification type, the grid bias being obtained from a 1000-ohm resistor (R6) in the negative lead (of the "B" supply) through which passes the plate current of all tubes except the last audio. Two sliders are provided, one for the detector and one for the first audio stage. The detector bias will generally be in the vicinity of 4 volts; however, at this value, loud signals may overload the detector, in which case the bias should be increased to 6 or 7 volts.

Best results will be obtained if the I.F. stages are individually shielded. The last transformer and second detector may be left in the open without impairing reception in the least.

Coil Data

The plug-in antenna and oscillator couplers are wound on standard (midget) plain coil forms; five of each are employed for the 20-, 40-, 80-, 160 meter and broadcast bands. A "color scheme" is used for the windings, making it easier to select the proper coils for any band; the advantage of this will be realized when the completed receiver is placed in operation. Data for the windings are given in the table.

In the antenna couplers the primaries L are all wound of No. 18 single-cotton-covered wire to a diameter of ¾-inch; these are placed inside of the forms near the bottom and are self-supporting. Both the secondaries and the ticklers for the 20-, 40-, and 80-meter coils are wound directly on the forms, with the secondary turns spaced slightly to reduce distributed capacity to a minimum. The ticklers are close-wound, of No. 30 enamel wire.

On the two larger coils the secondaries are wound on the forms and the ticklers in the slots; in each case the finish of the tickler and the lower lead of the secondary

are connected together and made common to the filament.

The oscillator-coupling windings L1 are wound directly over the filament ends of the secondaries, with No. 30 enamel wire.

The oscillator plug-in inductances L3-L4 have only two windings, those for the plate being wound on the form; the grid coils are wound in the slots. Because some tubes give greater output than others, the given numbers of turns for the oscillator-coupling and the oscillator-grid coils are only experimental values, and others should be tried until best operation is secured.

The diagram (Fig. 1) shows the order in which the leads from the different coils are connected to the contact pins on the forms.

In the 20-meter coils, the antenna secondary L2 and the oscillator plate coil L3 are wound with No. 18 white S.C.C. wire; in the 40-meter pair, with No. 18 black-enamelled; in the 80-meter pair, with No. 20 green-silk covered; for the 160-meter band, the increased number of turns makes No. 28 white S.C.C. sufficiently distinctive; and No. 30 brown-enamelled will be found suitable for the largest coils.

Audio Amplifier

This is of the conventional two-stage transformer-coupled type with a '71A, operated from A.C. for loud-speaker reception in the last stage. Any good make of high-grade transformers may be employed. A fixed resistor of the grid-leak type is connected across the secondary of the first transformer to eliminate any chance of howling; this (R7) should have a value of 0.5 to 1 megohm. A switch is provided in the plate circuit of the '12A, enabling the operator thus to use a set of headphones.

The filament of the '12A is controlled from the same 2-ohm resistor (R5) as the second detector, while the grid bias for this tube is taken also from R6. The filament of the '71A is lighted by alternating current, which may be obtained from a separate filament transformer or from a 5-volt winding on the "B" eliminator transformer. The 40-volt "C" bias required for this tube is obtained from a 2000-ohm fixed resistor (R8) connected from "B—" to the center tap on the 30-ohm resistor R9.

No provision has been made for controlling the volume. All methods have their disadvantages, and each experimenter has his own preference; therefore this is left to the individual.

Conclusion

After the set has been completely assembled and wired, it may be tested and the amplifier lined up. This is an easy matter: first make all external connections and plug in the coils for the band desired; set the two regeneration resistors R1 at zero, or until they act as a short circuit; light the filaments, and adjust the biasing voltages to the correct values as shown on a high-resistance voltmeter. Tune in some rather weak station, and vary the I.F. transformer rotors until the signal is the loudest. Once set, these should not be touched again. Increasing the first-detector regeneration control should greatly increase the volume and selectivity.

An improvement well worth while comprises merely one of the old-type variometers connected in series with the antenna

lead; in this case, the antenna should not be longer than about 20 feet. This is particularly desirable for tuning above 100 meters, the additional gain in selectivity and sensitivity being decidedly worth while.

List of Parts

Two 2-gang .00035-mf. tuning condensers (C), cut down as described;
Eleven fixed condensers, as follows: one .00015-mf., C1; one .00025-mf., C2; one .002-mf., C3; two 0.1-mf., C4; three 0.5-mf., C5., two 1-mf., C8; one .0005-mf., C7;
Two .0005-mf. semi-variable condensers, C6;
Ten Silver-Marshall type-130P plug-in coil-forms, and two sockets for same;
Three bakelite tube forms, rotors and shafts for I.F. transformers, as specified in text;
One Silver-Marshall short-wave choke coil, RFC;
Three Silver-Marshall long-wave choke coils, RFC2;
One home-made choke coil (if needed; see text) RFC1;
One grid leak, 8-megohm, R;
Two 50,000-ohm variable resistors, R1;
Five filament resistors; two 10-ohm, R2; one 2-ohm, R3; one 5-ohm, R4; one 2-ohm, R5;
One Carter 1000-ohm resistor type P-10 with two sliders, R6;
One high resistor, half to one-megohm, R7;
One 2000-ohm fixed resistor, R8;
One 30-ohm center-tapped resistor, R9;
One jack for phones, J;
Three A.F. transformers, T1, T2, T3; power transformer for '71A tube, if winding is not already available;
Panel and sub-panel, to suit layout of tuner and power unit preferred; 7 UX tube sockets; 3 CX-301A tubes; two CX-222; one each 312A and 371A; inductance and hook-up wire; binding posts or cable plug; and other miscellaneous hardware.

Whys of Push-Pull

(*Continued from page* 418)

plate current of a tube as a true alternating current flowing back and forth through the tube—the two A.C. components are flowing in opposite directions at the same time. That in V1 is moving from plate to cathode while that in V2 is moving from cathode to plate.)

But D and D' are not out of phase; they are exactly in phase and flowing in the same direction in each tube. Therefore, the current of D is flowing from *d* to *f* at the same time, and with the same intensity, that that of D' is flowing from *e* to *f*.

The result is that, while the currents C and C', moving in the same direction through the transformer windings, strengthen each other, the currents D and D', moving in opposite directions with equal intensity, "buck" and cancel each other. And, again considering our tubes as the path of the alternating current, we may view the path of the combined output signal voltages as from the plate of V1 to its cathode, through the filament wiring to the cathode of V2, and then through the transformer *e-f-d* back to the cathode of V1; and then in reverse.

This may be better understood by means of Fig. 9, wherein *a* represents the voltage generated in tube V1, and *b* that generated

in tube V2; these are represented as batteries for the sake of convenience and clarity; but, more accurately, they are A.C. generators. The letters *a*, *b*, *c*, *d*, *e* and *f* refer to the corresponding parts of Fig. 1, in which the primary of the output transformer T2 is regarded as a center-tapped resistance.

The full arrows show the direction the current produced by V1 tends to take and the dotted ones show the direction of the current produced by V2. If *f* is the true center-tap, and the two voltages *a* and *b* are alike, the currents in arm *f-c* are 180 degrees out of phase, or exactly opposed to each other; and the result is that there is no signal current in the arm through Rg, while the current through *d-e* is the sum of that produced by *a* and *b*.

Now let us see what happens to *D* and *D'* the distortion waves; these, we see from Fig. 8, are exactly in phase and we may use Fig. 10 to represent the condition. The full arrows and the dotted arrows show the respective currents as before. Now the situation is a little more interesting; *a'* sends current through *d-f* and *Rg*, while *b'* is sending current through *e-f* and *Rg*. The result is that Rg has both currents flowing through it in the *same* direction; while the

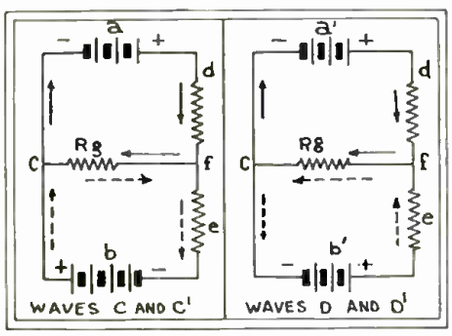


Fig. 9 Fig. 10

In push-pull, the two tubes strengthen the signal (left) but cancel out the "harmonics" or tube distortion factors (right).

output transformer has a current going through half of its primary in one direction, and an equal current going through the other half in the opposite direction.

We know: (1) That a voltage is induced in a winding whenever a flux (magnetic field) is varying through the winding; (2) that the flux is directly proportional to the current producing it; (3) that the flux is in phase with the current producing it; and (4) that the value of the voltage produced by the flux bears a fixed relation to the flux.

Applying these laws to our circuit for waves *D* and *D'* (Fig. 8) we may consider that two fluxes are set up in the transformer by the two currents through the primary. These two fluxes, being in phase with their currents, are 180 degrees out of phase with each other, because the currents producing them are directly opposed through the primary. Each flux produces a voltage in the secondary but, since the fluxes are out of phase, the voltages are also exactly out of phase and "buck" each other. The result is that there is zero voltage at the terminals of the transformer's secondary; which means that the distortion currents D and D' have had no effect and will not appear in the speaker.

This statement will also be true for the fourth, sixth and other even-numbered distortion harmonics; because, in each case, we will have the condition of Fig. 10—that there are equal polarities across the transformer. The result, as we have just found, is zero.

Currents C and C', however, which represent the true signal input have passed through the transformer in such a way that the voltages each has produced in the secondary add; while their currents through the biasing resistor *Rg* have eliminated each other.

This last point—about the bucking currents through the biasing resistor Rg—is one of the most important characteristics of the push-pull circuit. A study of this eccentricity reveals some highly interesting speculations; some of which we hope to include in the next installment.

The Midget Receivers

(*Continued from page* 408)

Volume is controlled in this set by varying the control-grid bias of the first two R.F. tubes. The type '24 detector is resistance-capacity-coupled to the type '27 first audio; the grid of the latter tube being returned to ground through a grid leak, as usual. The output of the first audio is resistance-capacity-coupled to the type '45 power audio; but the grid of the power tube is returned to the first A.F. cathode through an audio choke. This choke is tapped for the coupling condenser connection, and, thus, a "parallel plate feed" circuit is obtained. The tone control shunts the primary winding of the output transformer.

In forthcoming issues of RADIO-CRAFT, other midget sets and circuits, not received in time for this article, will be shown.

Making Your "Mike" for Home Recording

(*Continued from page* 405)

are given; but the positions and sizes will vary in each construction. A hole for the push-button completes this part of the work.

Now, about that diaphragm; if you can't find an old Baldwin headphone, with its corrugated diaphragm, it will be necessary to use that from an ordinary headphone. In the latter case, it will be found that a hole must be drilled in the center, for the threaded shaft of the microphone button. This drilling must be done *very* carefully, in order to prevent bending the thin metal.

Next, the bracket for the microphone button is to be bent into shape. Although the button will work when fastened only to the diaphragm, because of its "inertia," such a mounting necessitates a rigid-edge diaphragm; and this type of construction is not used in making this unit. Instead, six little pieces of light-weight cloth (such as your tailor can give you from his many "samples" of medium-weight woolens), are to be fastened to the wooden frame, with a touch of glue, at six points equally spaced around the edge of the diaphragm.

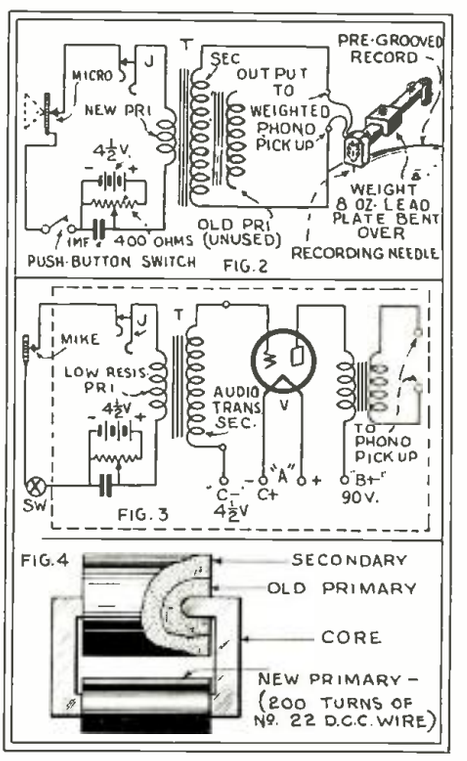
Now, tightly bolt the microphone button to the center of the diaphragm, (using extreme caution to prevent cracking the delicate piece of mica in the button) and fasten the other end of the button to the metal bracket; after which the bracket is to be mounted on the wooden frame. Then carefully raise or lower the button, until the diaphragm is just resting against the pieces of 1/16-in. cloth; and tighten the button against the bracket (Fig. 1D).

Finally, screw the mouthpiece into the wooden frame and fasten the aluminum shield can in place, by means of the two battery nuts, after having brought out two leads; which are to be connected as shown in the schematic circuit (Fig. 2).

The proper handling of microphones has been described in the article, "A Public-Address Adapter Unit," by Howard Smith, in the October, 1930, issue of RADIO-CRAFT. In this story, the interest centered in a "double-button" microphone; but the same principles apply to the single-button type we are now describing. The similarity between the circuits will be seen by comparing the circuit diagrams. As stated in the article named, a suitable "microphone transformer" is a very necessary part of the equipment, in order to obtain good matching between the impedances of the microphone and that of the unit into which it couples.

The experimenter is strongly urged to buy, or at least borrow for the occasion, a milliammeter having a range up to about 25 or 50 ma. This is to be plugged into the circuit at J, to determine the amount of current passing through the hand microphone. This value should seldom be allowed to exceed 8 to 10 ma.

There are a few cautions to be learned



Above, a circuit suitable for the home microphone with a reversed "pickup"; center, the connections used with audio amplification; below, an A.F. transformer converted into a microphone transformer.

before attempting the use of the circuit shown in Fig. 2 for home-recording. In the first place, a "sensitive" or easily-impressed record-blank is needed; in the second, a good "recording needle" is essential. Also, it will be necessary to operate the microphone at its maximum sensitivity. It will be necessary, too, to weight the recorder (a "pick-up" connected backward), as the illustration shows.

If it is impossible to obtain maximum sensitivity from the particular microphone used, it may be necessary to amplify the output; a circuit for this purpose is shown in Fig. 3. Of course, a second stage of audio amplification may be used, if necessary; but whether it is needed must be determined by experiment.

Although the construction of a really good microphone transformer is a work of some skill, the experimenter may want to try his hand at making one. This unit (T in the circuit diagrams) may be made from an ordinary audio transformer, as shown in Fig. 4; note that it is necessary only to wind a low-resistance primary for the "mike," using rather heavy wire. This primary takes the place of the old, high-resistance primary, which is left unconnected.

If a suitable radio set is available, it may be called into service, connecting the home-made microphone in the manner described in last month's article.

Tone-Control Design for Your Set

(*Continued from page* 409)

A True-Tone Circuit

Just how to do this in a simple manner is a problem. The introduction of more capacity across the transformer windings short-circuits the high frequencies which are already lacking to an alarming degree. It is a well-known fact that the coupling of audio-frequency transformers may be improved at the low frequencies by resonating the primaries of the transformers to some particular frequency at the lower end of the audible range.

The effect upon the response curve, however, is shown in Fig. 3. Here "C" is the normal response characteristic of the transformer and "A" and "B" illustrate the effect of employing such a circuit as that of Fig. 2; where the capacity C, connecting the high end of the choke and the transformer primary, is of such value as to resonate with the transformer primary at some low frequency (40 cycles for example; resonating the primary at sixty cycles would increase the hum to an undesirable extent). The feed choke L, through which the plate current flows, is an "Amertran 103" choke or a similar device of high inductance. The condenser C should have a capacitance of about 0.25-mf., which is an average value based upon an inductance of fifty henries for the primary of the transformer T. (The by-pass condenser does not enter into the calculations, but should be 0.5-mf. or more.)

You will note that, in Fig. 3, the "resonance hump" in the response characteristic is lower in curve "B" than in "A"; the introduction of resistance into the resonant circuit decreases the voltage effective across the inductance at the resonant frequency. Here we find a method of controlling the low-frequency response. A fifty-thousand ohm variable resistance R is inserted in the return lead from the low end of the transformer primary. This value will give a variation in response, over the range indicated by the curves "A", "B" and "C"; which now indicate the response at the lower frequencies over the control range. Now, the louder the reproduction desired (above the original level), the greater the resistance in the circuit for accurate reproduction.

Here we have a tone control which may be adapted to existing receivers; either by remodelling the set, or by using an adapter.

Such an audio system is based upon the actual physiological conditions involved in listening to a reproduction; and not upon the desire for the most pleasing effect regardless of fidelity.

Tone Control for the Trade

For the Service Man, the most desirable unit must be one which will enable him to secure the same results obtained in recent commercial receivers, without altering the wiring of an old receiver to a major degree. Such a device may be employed, by making slight changes in the values of the components, in any receiver, whether equipped with a magnetic or a dynamic reproducer. This device is to be inserted in series with the windings of a magnetic speaker, or with the moving coil of the dynamic. (Fig. 4).

In the case of the magnetic reproducer the values would be as follows: L, 1 henry; C, .05-mf.; R, 50,000-ohm potentiometer. For use in series with a 15-ohm moving coil the constants would be: L, 2 millihenries; C, 4-mf.; R, 200 ohms.

The effect of this device will be to attenuate the lower or the upper register, as desired, in a manner similar to that employed in the finer broadcast receivers of today. The connections given in Fig. 4 are self-explanatory. It might be well to provide a switch SW to short-circuit the resistance, and cut the tone control out of the circuit, when desired.

When a magnetic reproducer is used, a coil having approximately the desired value for L may consist of about 300 turns of No. 32 insulated wire, bunch-wound on any convenient core. For use with a dynamic reproducer's voice coil, this inductance may consist of no more than 50 to 75 turns of No. 16 to 18 insulated wire.

The two systems explained represent the two extremes—the search for maximum fidelity on one hand, and the search for the most pleasing tone on the other. The writer would suggest that the first method be used in the experimental reader's own receiver—where he can afford to buck the trend of the day in order to obtain maximum personal satisfaction. The second method is fine for use in adding tone control to an obsolescent receiver; for the effect is startling in its action.

(See also, "How Tests of Audio Quality are Made," page 632, in the June, 1930, issue of RADIO-CRAFT.—*Editor.*)

Turn to page 430 of this issue and read the special offer to those who are actively engaged in radio.

Radio-Craft Kinks

(*Continued from page* 416)

telephone or high-ratio audio transformers; while condenser C (ordinarily about .01-mf.) may be varied for different tones. The telephone receiver is designated as H; the microphone, M; the voltage supply for the microphone, A (which will vary with each mike—although its average value is 3 to 4½ volts).

If no microphone is available, one may be conveniently made by mounting on the diaphragm of the receiver a "microphone button," obtainable for about a dollar. The assembly is to be taped together and placed in a box, padded with felt or cotton to prevent the audio howl being heard in the room.

A TEMPORARY FUSE

By J. B. McGirt

THE writer ran across this "kink" when the new Crosley screen-grid models first came out. The sets were equipped with a 1-amp. fuse and frequently, when the radio was first put in use, the fuse would blow; whereas the fuse would hold if the heater-type tubes could be brought up to operating temperature. To keep from blowing so many fuses, I resorted to a tinfoil fuse.

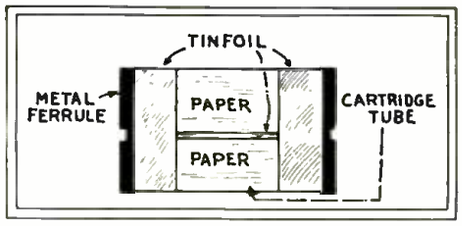


Fig. 6

A way to renew an old fuse.

Take a piece of tinfoil on paper (such as you find around chewing gum and cigarettes) and cut it to a size that will just about go around the old fuse tube. Next, cut away a portion of the paper and tinfoil; and your fuse then should look like the one illustrated.

Ordinarily, the least amount of tinfoil that can be left is about right; although it can be made to fuse at higher current levels by making the conducting strip wider.

Tone Controls

(*Continued from page* 411)

Instead of the *fan* switch, a *selector* switch may be used in, for instance, the coupling-condenser-variation idea, as shown in Fig. 9; different values of capacity are required, since they do not add up as when a fan switch shunts the capacities.

Another suggestion of the writer, for cases when it is desired to obtain a *gradual* change of the coupling-condenser value, in effect, is shown in Fig. 10. The advantage of this combination is that, although the volume is reduced, there is greater reduction of the low notes than of the high; an effect opposite to that obtained when condensers are used to by-pass the high frequencies around transformer windings. To insert the units R and C, the connection between R1 and C1 is broken at X.

(*To be continued in February* RADIO-CRAFT.)

Information Bureau

(*Continued from page 420*)

against the stationary field of the permanent magnet. This reaction is physical, and the coil, being freely suspended, moves in proportion to the amount of current through it. However, alternating current, flowing through this winding, at the rate of, say, 60 cycles, changes polarity so rapidly and is attracted and repelled so fast, that the coil cannot follow it. If there were some means of changing the field of the permanent magnet, at the same rate as the change in the moving coil, there would be continuous repulsion; and the needle would indicate truly.

This action may be obtained by discarding the permanent magnet and substituting two coils (N, S, shown at the left). These are connected in series with the moving coil, so that alternating current through these coils changes polarity at the same rate as the current through the single moving coil. This produces continuous repulsion, and indication on the A.C. meter scale.

57 ELEMENTS IN VACUUM TUBES

(104) Mr. Warren Haley, Mountainside, N. J.

(Q.) Mention has recently been made that there are 57 elements that enter into the construction of vacuum tubes. Is there any record of the names of these elements?

(A.) While the statement as to the number of elements is essentially true, the actual count varies from time to time, as the designs are modified; while the elements are, in the main, representative of most vacuum tubes. A late list of these elements is given below, by courtesy of the R.C.A.-Radiotron Co.

Hydrogen	Aluminum	Tungsten
Sodium	Yttrium	Chlorine
Potassium	14 Rare Earths*	Helium
Caesium	Carbon	Neon
Copper	Silicon	Argon
Silver	Titanium	Iron
Calcium	Tin	Cobalt
Strontium	Lead	Nickel
Barium	Phosphorus	Iridium
Magnesium	Tantalum	Platinum
Zinc	Oxygen	Thorium
Mercury	Chromium	Nitrogen
Boron	Molybdenum	

* (The "rare earths" include the metallic elements cerium, lanthanum, praseodymium, neodymium, illinium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutecium which occur together and are hard to separate. They are used for coating filaments.—*Editor.*)

The different elements and materials are used as follows in differents parts of the tubes:

GLASS

Silica	Borax
Sodium carbonate	Zinc oxide
Calcium oxide	Cobalt oxide
Sodium nitrate	Potassium carbonate
Lead oxide	

BASES

Bakelite	Copper
Porcelain	Nickel
Glass	Tin
Wood fiber	Marble flour
Zinc	Ethyl alcohol

FILAMENTS

Tungsten	Silicon
Thorium nitrate	Barium carbonate
Carbon	Strontium carbonate
Nickel	Calcium
Cobalt	Barium nitrate
Iron	Strontium
Titanium	

GRIDS

Nickel	Copper
Monel	Chromium
Molybdenum	

PLATES

Nickel	Iron
Monel	Tantalum
Molybdenum	

LEADS

Iron	Zinc
Nickel	Borax
Copper	

SUPPORTS

Glass	Nickel
Mica	Molybdenum
Lava	Monel
Isolantite	

(Continued on page 446)

RADIO'S GREATEST BARGAINS

THIS month we are offering a great variety of battery sets at such ridiculously low prices that they cannot fail to astonish you.

These sets are so-called store demonstration models and are not sold as brand new. However, all sets have been carefully tested and put into good shape and we guarantee them to be in good working order.

All other merchandise listed on this page is brand new and is shipped in original factory sealed cartons and carries the same guarantee of absolute satisfaction.

Act immediately as the supply is limited and we reserve the right to return remittances as soon as items are sold out.

In many instances, our sale prices are lower than the actual manufacturer's cost. For terms, see bottom boxes.

Radiola 25 Superheterodyne

The "25" is a loop-operated set requiring 6 "X-199" tubes. No outside aerial is needed. The receiver has "10-kc selectivity. Tuning of this receiver is accomplished through large "thumb-operated" tuning drums, so designed that stations may be "logged" directly on the drums. The small center knob controls a multiple-contact switch which changes the circuit to include one or two stages of A.F. A two-tone mahogany veneer cabinet of original pattern houses the chassis and batteries. Its overall dimensions are 28x19x12 inches high. Shipping weight, 55 lbs.

List Price $265.00.
YOUR SPECIAL PRICE **$10.95**

Stromberg-Carlson 523

This fine set uses 4 201A and 1 200A tubes. The cabinet is one of the finest ever made for radio sets. A slanting, beautifully grained wooden panel carries the tuning escutcheons. The panel controls include a "Long-Short Antenna" switch; 3-ohm and 20-ohm rheostats; "On-Off" snap switch; audio output jack; and a Weston 0-7 voltmeter. The jack on the panel is for phonograph pickup. A neutrodyne circuit is used. 26 long x 11 deep x 13 inches high. Shipping weight 75 lbs.

List Price $160.00.
YOUR SPECIAL PRICE **$24.95**

Freed-Eisemann NR-5 (Neutrodyne)

A solid walnut cabinet with a piano finish is the housing. Jacks for 1st and 2nd A.F., and Detector output are provided. Hard rubber insulated variable condensers (15-plate) are used. There are two glass-insulated "neutrodons"; 3 "full vision" molded tuning dials; 2 molded rheostat knobs; 2 A.F. transformers and 3 tuning condensers. Overall dimensions are 28 x 9 x 9 inches. The panel is black bakelite, engraved and highly polished. Shipping weight 30 lbs.

List Price $145.00.
YOUR SPECIAL PRICE **$7.95**

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.
YOUR SPECIAL PRICE..... **$7.50**

A.C. Phonograph Motor

SYNCHRONOUS—revolves EXACTLY 80 turns per minute despite any voltage variations. Most compact make—only 1¼ in. thick—mounts in any limited space. For 110 volt, 60 cycle, A.C. Complete with turntable. Shipping wgt. 10 lbs. List Price $15.00.
YOUR SPECIAL PRICE..... **$4.45**

Pacent "Phonovox" Pick-up

One of the best and most powerful electric phonograph pick-ups made. Balanced tone arm, unusually sensitive.
Shipping weight 7 lbs.
YOUR PRICE..... **$4.85**

Radiola 28 Superheterodyne

Is a "Second Harmonic" superheterodyne. However, the circuit of the "28" includes 7 type X199 tubes and 1 type X120 tube. The Radiola 28 includes 3 S.L.F. condensers, 2 1-mf. safety-lamp by-pass condensers; center-tapped loop (necessitated by the stage of neutralized R.F.); 1 off-on switch; 2 filament rheostats; 1 4-coil R.F. inductance; 2 jacks; and the special 8-socket "catacomb" containing the I.F., R.F. and A.F. transformers. Coast to coast reception is a rather usual accomplishment! Uses 2 drum dials—space for station logging thereon. Many easy ways of electrifying this receiver. Revolving loop—greatly assists tuning. Access to battery compartment obtained by raising receiver on hinge. A pressed steel frame supports the chassis equipment. The mahogany cabinet has the general appearance of a secretary.

List Price $295.00.
YOUR SPECIAL PRICE **$24.98**

Atwater Kent 30 Compact

One of the best sets Atwater Kent produced. It is a six-tube set. Three stages of R.F. amplification, detector, two stages of A.F. amplification. **And, single dial control.** Even as an ordinary battery set it will sell on sight, as the glossy, molded bakelite "full vision" dial, volume controls, and highly gilded metal parts present an attractive appearance. There is a vernier wheel at the lower edge of the dial, for fine tuning. The variable condensers are 16-plate size. The two A.F. transformers are shielded. These transformers may be used as replacements as they will fit into almost every set. The sockets are demountable. Overall dimensions are 20x6½ x6½ inches high. Shipping weight 20 lbs. A 6-wire color-coded cable 6 ft. long is included. 5 type 201A tubes and 1 type 112A or 171A are recommended for this receiver.

List Price $80.00.
YOUR SPECIAL PRICE **$14.95**

Ware Type T. Neutrodyne

This is the most economical in operation of all radio sets. The circuit is that of a REFLEXED NEUTRODYNE incorporating 3 UV-199 tubes. The mahogany cabinet is 11 in. long and 13 in. deep. This design provides room for the "A" supply of 3 dry cells, 2 "B" and 1 "C" battery. There are 2 15-plate variable condensers, 2 neutrodyne-type R.F. transformers, 2 A.F. transformers, rheostat, 2 jacks, R.F. choke, 2 tuning dials, shock-absorbing mounting for the 3 tubes. Shipping weight 16 lbs.

List Price $65.00.
YOUR SPECIAL PRICE **$5.95**

245 A.C. Power Transformer

For five 224 (or five 227), two 245, one 280 A.C. tubes, OR ANY COMBINATIONS OF 2½-VOLT TUBES. All secondary windings CENTER TAPPED. 600-VOLT HIGH VOLTAGE SECONDARY. 75 WATT CAPACITY. Size 5¼x1¾x3½ inches. For 110 volt, 60 cycle, A.C. Shipping weight 12 lbs.

List Price $15.00
YOUR SPECIAL PRICE..... **$3.40**

2½ Volt A.C. Fil. Transformer

Two windings, both center tapped. One "lights" six 227 or six 224 2½-volt tubes, and the other lights two 245 tubes. Total: 14 amps. For 110 volt, 60 cycle, A.C. Size 1¾x2⅝x 3¼ inches. Shipping weight 6 lbs.

List Price $10.00.
YOUR SPECIAL PRICE..... **$2.75**

Radiola Superhet. AR-812

One of the most famous radio sets in America. This set placed on a table, the battery switch turned to "on," and music will be heard,—without an outdoor antenna; it works with a loop aerial built inside the cabinet. The set is super-sensitive and, in certain localities, it is possible, on the east coast, to hear west coast stations. The cabinet holds all the batteries for the six "dry-cell" tubes required. Some experimenters tune in short wave stations and use the AR-812 as the INTERMEDIATE FREQUENCY AMPLIFIER. In that way the tremendous amplification obtainable from this receiver is used to the fullest extent. A push-pull switch (center) turns the set on and off; another, (lower left) cuts in either one or two stages of A.F. amplification. Although the cabinet is 35 inches long, 11½ deep and 11½ high, the panel of the receiver is only 19 inches long and 9 inches high. The difference lies in the two end compartments for "A" and "B" batteries. Six type UV199 tubes are required for this receiver. Dry-cell power tubes, the type "20, may be used in this set if a Naald or similar adapter is used. Shipping weight 45 lbs.

List Price is $220.00.
YOUR SPECIAL PRICE **$10.95**

Atwater Kent Model 35

One of the most compact receivers ever offered to the public. 3 stages R.F. 3 variable condensers are used. Overall dimensions are: 17½x8x5½ inches. The chassis is housed in a brown crackle-finish pressed metal cabinet. This is a "one-dial control" receiver. Incorporated in this set is a 6-wire cable, each wire of which is rubber insulated and "color coded." This shielded receiver has very high "gain" and may be used with antennas of any length, without in the least affecting the tuning. The variable condensers are of the "single bearing rotor" type. This set takes the following tubes: 5 type-201A and one type-112A or 171A tubes. Shipping weight 16 lbs. List Price $65.00.
YOUR SPECIAL PRICE **$14.95**

Freshman "Masterpiece" B

It is finished in grained walnut to match the veneer of the cabinet. Tapered pressed-metal knobs through a 9-to-1 ratio gear control the tuning condensers, the dial setting being observed through windows. Volume, as well as regeneration and oscillation, is adjusted by the two "levers," which are rheostat-arm control. An off on switch completes the panel layout. Set uses 5 201A tubes. Two type "30" A.F. transformers are used, ratio of about 3 to 1. Three 19-plate variable condensers are riveted to the frame. Zig zag-wound coils constitute tuning inductances. A power tube may be used in the last stage of A.F. amplification, if desired. Shipping weight 30 lbs.

List Price $75.00.
YOUR SPECIAL PRICE **$6.95**

Earl Power Transformer

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 (or 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-tabbed. May be used in any number of combinations. Suitable resistors, a couple of 1-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.
YOUR SPECIAL PRICE..... **$1.75**

The Radiola 20

Two stages of tuned frequency amplification, a regenerative detector, and two stages of A.F. amplification, using 4 type X-199 tubes and a X-120 for the last audio stage, is the arrangement of this receiver. The A.F. transformers used in this set are perfectly designed for the required performance. Heavy, soft iron encases the windings, and the frequency characteristic is exceptionally good. Cabinet is mahogany. Overall dimensions are: 19x16x11 inches high. Shipping weight 35 lbs. List Price $102.50.
YOUR SPECIAL PRICE **$12.50**

Atwater Kent 20 Compact

Five 201A tubes are used in this very sensitive and selective tuned radio frequency set. Dimensions: 20x6½x 6½ inches high. A six-wire cable, "color coded," 6 ft. long, is included. Cabinet is finished in walnut. The panel is metal, finished in flat brown. Variable condensers having 16 plates are used. The variable condensers are independent of the receiver chassis. 3 brown molded "full vision" dials are used. A 3-point switch on the panel selects taps on the first R.F. coil, for "local" or "distance" reception. Non-oscillating. Easily re-wired for A.C. operation. Shipping weight 20 lbs. List Price $60.00.
YOUR SPECIAL PRICE **$10.95**

Freshman "Masterpiece" A

It is of the tuned Radio Frequency type. Requires 4 201A, 1 171A tube. Has 2 A.F. transformers, and 3 variable condensers. Overall dimensions are: 20½ x 12 x 9¼ inches; mahogany bakelite panel. The cabinet is finished in mahogany. 3 19-plate variable condensers used. The dial settings are read through recessed windows. 2 jacks mounted on panel. Shipping weight 25 lbs. List Price $80.00.
YOUR SPECIAL PRICE **$7.00**

Allen Hough ROTROLA

This remarkable new instrument enables you to play phonograph records through your radio loud speaker. Plugs into any radio set, whether same uses batteries or A.C. Connected to your radio in a jiffy. Equipped with fine electric motor operating only on A.C., 60 cycles, 110 volts. New Webster pick-up; volume control; special constant speed electric motor. Beautiful portable cabinet. Full bronze trimmings. In factory sealed case. Shipping weight 18 lbs. List Price $45.00.
YOUR SPECIAL PRICE..... **$13.50**

Replacement Power-Pack Condenser Blocks

Exact duplicate, physical size, placement of connection terminals, and electrical specifications of original blocks.

For Majestic 171 type receivers ... **$5.75**

For Majestic 250 type receivers.....	**$5.75**
For Majestic 215 type receivers.....	**5.75**
For Atwater Kent 37.....	**5.75**
For Freshman M-12	**5.75**
For Majestic "B" Eliminator.....	**2.90**
For Majestic Master "B" Eliminator.	**2.90**
For Majestic Special Master "B" Eliminator	**3.80**
For Majestic "A" Eliminator.....	**4.40**

WE ARE A WHOLESALE HOUSE AND CANNOT ACCEPT ORDERS FOR LESS THAN $3.00.

If C. O. D. shipment is desired, please remit 20% remittance, which must accompany all orders; balance on delivery.

If the full cash amount accompanies the order, you may deduct 2% discount. Send money order—check—U. S. stamps (any denominations).

Radio Trading Co.
25 West Broadway
New York, N. Y.

Should you wish goods shipped by parcel post, be sure to include sufficient extra remittance for same. Any excess will be refunded.

We have no catalog — order from this page; you will find special offers from time to time in this magazine. Prompt shipments will be made.

Short-Wave Notes

An unprecedented occurrence followed the recent revolution in Argentina, when Gen. José F. Uriburn, the new provisional president, addressed not merely his own countrymen, but the world at large, to announce the new policies. The address, broadcast from the Argentine transmitters on the longer waves, was also transmitted to the United States over a Buenos Aires-New York telephone link, and there rebroadcast by the N. B. C.; so that it was heard simultaneously throughout both continents. On the occasion, a week before, when Gen. Uriburn took the oath of office, more than three hundred thousand persons, gathered before the presidential palace, heard clearly the ceremonies through the public-address system which had been erected for the occasion, according to *Revista Telegrafica*.

To connect the Hawaiian Islands together by telephone, authority has been given by the Radio Commission to the Mutual Telephone Company to use waves from 13 down to 5 meters. This would appear to be the first application commercially of waves so short.

The tank service of the British army now utilizes a standard transmitter, designed, for work between 7 and 8 meters, by the Marconi Co. As the tank forms a very substantial "shield can," it is necessary to provide an external antenna which is in the form of a 12-foot copper plated rod. The immediate range of such transmissions is necessarily short. The power for the tubes is derived through a rotary transformer from a 12-volt storage battery; 600 volts is applied to the plates.

While commonly, short waves are freer from "static" than the longer ones, it was recently reported to the French Academy of Sciences that the aurora borealis had, one night last September, made it necessary to change from 30 meters to 17,000 to maintain the New York-Paris radio service; and similar troubles were experienced in communication between Paris and Japan and South America.

Telephony across the Tasman Sea, between Australia and New Zealand (about fifteen hundred miles) is in view; and the tests of station ZLW, Wellington, N. Z., with VK2ME, Sydney, have been heard in this country. Through the latter, New Zealand would be able to connect with the European and American telephones.

Station LSX, Buenos Aires, which has been testing with 20 kilowatts on 28.98 meters (10,350 kilocycles) and has been heard in this country—it was the means used to transmit Gen. Uriburn's speech, above mentioned—is to be used later for commercial telephony. Reports on tests are solicited by the operator, the Transradio Internacional, San Martin 329, Buenos Aires, Rep. Argentina.

For a long time, "Paris Experimental" has been listed in French and other radio publications as a powerful short-wave transmitter and, since it was not licensed, was a "mystery" station. It now appears from *L'Antenne* that, while it had originally 25 watts, the fervent imagination of its youthful operators caused them to send out announcements, duly published, of transmissions on 6 kilowatts—and some listeners with good imaginations seem to have heard it clearly. The practical jokers are now in the hands of the police and, while the well-known sense of humor of the French will probably mitigate their punishment, it is to be hoped that future falsifiers of the station list will be discouraged.

Book Review

(*Continued from page* 413)

ever—unlike the senates of Rome and Carthage, or the English and the Dutch East India Companies—the business organizations of the future will be able to settle their trade rivalries without calling on the naval and military arms for support, as the author predicts, is a matter unsuitable for consideration in the pages of a journal of radio.

Throughout the body of the book, radio is considered especially for its influence as a colleague, or as a competitor, of the newspapers; and it is treated as a disseminator of news, of advertising and of propaganda, in turn. The author declares that it is essential that the various broadcast stations of this country, unlike those of other nations, shall remain in diversified ownership; and that "The newspapers of America should never make the supreme mistake of standing idly by and permitting broadcasting to become a bureaucratic creature."

(Continued from page 443)

GETTERS

Magnesium	Caesium
Calcium	Phosphorus
Strontium	Carbon
Barium	Tantalum
Sodium	Mischmetal
Potassium	

GASES

Hydrogen	Argon
Helium	Nitrogen
Neon	Oxygen

RADIO EMPLOYMENT WANTED

The writers of the following notices may be addressed in care of RADIO CRAFT by the respective Opportunity numbers:

(Opportunity 94) Service Man, three years' experience including jobbing house, desires connection about the first of the year. S.O.E. resident graduate. Age 21. Single. (Minneapolis).

(Opportunity 95) Service Man, now in business for self, four years experience all makes, Capitol R.E. Inst. student, N. R. I. graduate, licensed commercial operator, seeks position as foreman, Service Man or broadcast operator preferably in west. but will go anywhere. Age 30. Married. (Iowa.)

CORRESPONDENTS WANTED

I would like to correspond with anyone about my age (19) who has built the battery model "Super-Wasp."

ALBERT J. SANTORO.
203 Tillary St., Brooklyn, N. Y.

Short-Wave Stations—When to Listen

(Continued from page 421)

Meters	Kilocycles	
48.99	6,120	....Motala, Sweden, "Rundradio." 6:30-7 a.m., 11-4:30 p.m. Holidays, 5 a.m.-5 p.m.
		—NAA, Arlington, Va.
		—....Chi-Hoa (Saigon), Indo-China. 6:30-7:30 a.m.
		—W2XE, New York City. Relays WABC. Atlantic Broadcasting Co.
		—FL, Eiffel Tower, Paris, 5:30-5:15 a.m., 5:45-12:30, 4:15-4:45 p.m.
		—....Toulouse, France. Sunday 2:30-4 p.m.
		—MTH, Rio de Janeiro, Brazil. 5-7 p.m.
		—EAR25, Barcelona, Spain. 3-4 p.m.
49.15	6,100	—W3XAL, Bound Brook, N. J. (WJZ, New York). 5-6:30 p.m., 11 p.m.-1 a.m.
49.17	6,095	—VE9GW, Bowmanville, Ontario, Canada. Daily, 1:45-5 a.m., noon to 7 p.m. Sundays, 5 a.m. to 7 p.m. Gooderham & Wets, Ltd.
49.26	6,090	—....Copenhagen, Denmark.
49.31	6,080	—W2XCX, Newark, N. J. Relays WOR.
		—W9XAA, Chicago, Ill. (WCFL). 6-7 a.m., 7-8 p.m., 9:30-10:15, 11-12 p.m. Int. S.-W. Club programs. Sat. from 10 p.m. to 6 a.m. Sunday
		—W6XAL, Westminster, Calif.
		—HS2PJ, Bangkok, Siam. 6-6:30 a.m.
49.40	6,070	—UOR2, Vienna, Austria. 5-7 a.m., 5-7 p.m. Tues. and Sat., 9-10 a.m. Thu.
49.46	6,065	—SAJ, Motala, Sweden. 6:30-7 a.m., 11 a.m.-4:30 p.m.
49.50	6,060	—W8XAL, Cincinnati, Ohio. Relays WLW. 6:30-11 a.m., 1:30-3 p.m., 6 p.m.-1 a.m., daily.
		—W9XU, Council Bluffs, Iowa. Relays KOIL.
		—W3XAU, Byberry, Pa., relays WCAU.
49.67	6,040	—W9XAQ, Chicago, Ill. (WMAQ).
		—W2XAL, New York.
		—PK3AN, Sourabaya, Java. 8-9 a.m.
49.80	6,020	—W9XF, Chicago, Ill.
		—W2XBR, New York, N. Y. (WRNY).
49.97	6,000	—ZL3ZC, Christchurch, New Zealand. 10 p.m.-midnight, Tuesdays, Thursdays and Fridays.
		—HRB, Tegucigalpa, Honduras. 9:15 p.m.-midnight, Mo., Wed., Fri. From 11 p.m. to midnight Sat., Int. S. W. Club programs.
		—EAR25, Barcelona, Spain. Sat. 3 to 4 p.m.
		—RFN, Moscow, Russia. Tues., Thurs., Sat. 8 to 9 a.m.
		—Eiffel Tower, Paris, France Testing 6:30 to 6:45 a.m., 1:15 to 1:30, 5:15 to 5:45 p.m., around this wave.
50.23	5,970	....Vatican City (Rome).
51.40	5,833	—HK7, Barranquilla, Colombia. 8:30 to 10:30 p.m., exc. Sun.
52.00	5,770	—AFL, Bergedorf, Germany.
52.50	5,710	—VE9CL, Winnipeg, Canada.
52.72-54.44	5,690-5,510	—Aircraft.
52.80	5,680	—OCTU, Tunis, No. Africa.
54.02	5,550	—W8XJ, Columbus, Ohio.
54.51	5,500	—W2XBH, Brooklyn, New York City (WBBC, WCGU).
56.70	5,300	—AGJ, Nauen, Germany. Occasionally after 7 p.m.
58.00	5,170	—OKIMPT, Prague, Czechoslovakia. 1 to 3:30 p.m., Tues. and Fri.
		—PMB, Sourabaya, Java.
59.96	5,000	....Bratislava, Czechoslovakia.
60.98	4,920	—LL, Paris, France.
61.22	to 62.50	meters—4,800 to 4,900 kc. Television.
		—W8XK, Pittsburgh, Pa.;—W1XAY, Lexington, Mass.; W2XBU, Beacon, N. Y.;
		—WENR, Chicago, Ill.
62.56	4,795	—W9XAM, Elgin, Ill.
		—W3XZ, Washington, D. C.
		—WSXDD, portable. Bell Telephone Laboratories, New York.
		—W9XL, Chicago, Ill.
62.69	4,785	—Aircraft.
		—And other experimental stations.
62.70	4,785	—VZA, Drummondville, Canada.
62.80	4,770	—ZL2XX, Wellington, New Zealand.
63.13	4,750	—WOO, Deal, N. J.
		—WXDO, Ocean Gate, N. J.
65.22	to 66.67	meters—4,500 to 4,600 kc. Television.
		—W6XC, Los Angeles, Calif.
67.65	4,430	—OOA, Docberitz, Germany. 6 to 7 p.m. 2 to 3 p.m., Mon., Wed., Fri.
70.00	4,280	—OHK2, Vienna, Austria. Sun., first 15 minutes of hour from 1 to 7 p.m.
70.20	4,273	—RB15, Khabarovsk, Siberia. 5-7:30 a.m.
		—G2GL, SS. "Homeric."
72.70	4,120	—G2GN, SS. "Olympic."
		—G2IV, SS. "Majestic."
71.77-72.98	4,180-4,100	—Aircraft.
72.87	4,116	—WOO, Deal, N. J.
74.72	4,105	—NAA, Arlington, Va. Time signals 8:55-9 a.m., 9:55-10 p.m.
80.00	3,750	—F8KR, Constantine, Tunis, Africa. Mon. and Fri.
		—....Turin, Italy.
82.90	3,620	—OOA, Doberitz, Germany. (Television.)
84.24	3,560	—OZ7RL, Copenhagen, Denmark. Tuesday and Fri. after 6 p.m.
84.46-85.66	3,550-3,500	—Amateur Telephony.
86.50-86.00	3,490-3,460	—Aircraft.
92.50	3,256	—W9XL, Chicago, Ill.
		—W6XBA, S.S. Metha Nelson, Fox Film Corp.
		—W2XDD, portable.
		—And other experimental stations.
91.76	3,166	—WCK, Detroit, Mich. (Police Dept.)
95.48-97.71	3,142-3,070	—Aircraft.
96.03	3,124	—WOO, Deal, N. J.
97.15	3,088	—W10XZ, Airplane Television.
97.53	3,076	—W9XL, Chicago, Ill.
98.95	3,030	—....Motala, Sweden. 11:30 a.m.-noon, 4-10 p.m.
101.7	to 105.3	meters—2,850 to 2,950 kc. Television.
		—W3XK, Wheaton, Md., 8 to 9 p.m. except Sunday;—W2XR, New York, N. Y.;—W9XR, Chicago, Ill.
104.4	2,870	—....Milan, Italy. After 2 p.m.
105.3	to 109.1	meters—2,750 to 2,850 kc. Television.
		—W2XBA, Newark, N. J., Tues. and Fri. 12 to 1 a.m.;—W8XAV, Pittsburgh, Pa.;—W1XB, Somerville, Mass.;—W7XAO, Portland, Ore.;—W9XAP, Chicago, Ill.;—W2XAP, Jersey City, N. J.
		—W2XCR, Jersey City, N. J. 8-10 p.m., Mo., Wed., Fri., 3-5 p.m.
		—W2XBO, Long Island City, N. Y.
122.3	2,452	—W7XAU, Portland, Oregon, Police Dept.
110.2	2,722	—Aircraft.
124.2	2,416	—W7XP, Seattle, Wash., Police and Fire Depts.
125.1	2,398	—W9XL, Chicago, Ill.;—W2XCU, Auburn, N. J. —And other experimental stations.
128.0-129.0		—Aircraft.
129.0	2,325	—W10XZ, Airplane Television.
130.0	2,306	—DDDX, SS "Bremen" and "Europa" testing.
135.0	2,220	—....Stockholm, Sweden.
		—....Oslo, Norway.
136.1	to 142.9	meters—2,100 to 2,200 kc. Television.
		—W2XBS, New York, N. Y., 1,200 R.P.M., 60 lines deep, 72 wide.
		—W1XAV, Boston, Mass.
		—W2XCW, Schenectady, N. Y.
		—W3XAD, Camden, N. J.
		—W3XAK, Bound Brook, N. J. (Portable.)
		—W2XR, Long Island City, New York. 4-6:30, 7:30-10 p.m., daily.
		—W8XAV, Pittsburgh, Pa., 1,200 R.P.M., 60 holes, 1:30-2:30 p.m., Mon., Wed., Fri.
142.9	to 150	meters—2,000 to 2,100 kc. Television.
		—W1XAE, Springfield, Mass.
		—W1XY, Lawrence, Mass.
		—W2XBO, Long Island City, N. Y.
		—W3XK, Wheaton, Maryland. 8-10 p.m.; Mo., Wed., Fri. 3-5 p.m.
		—W2XBU, No. Beacon, N. Y. (1-2 p.m.)
		—W2XCD, Passaic, N. J. 8-10 p.m., exc. Sat. and Sun.
		—W8XAV, Pittsburgh, Pa.
		—W9XAA, Chicago, Ill.
		—W9XAC, Chicago, Ill.
		—W9XG, West Lafayette, Ind.
		—W10XU, Wheaton, Md. (Airplane.)
150	2,000	—RA72, Smolensk, USSR.
149.9-174.8	2,000-1,715	—Amateur Telephony and Television.
174.0	1,723	—ZL2XS, Wellington, New Zealand.
175.2	1,712	—WKDU, Cincinnati, Ohio. (Police Dept.)
		—WMP, Framingham, Mass. 11 a.m., 1 and 5 p.m. daily. Music and police reports.
		—WRBH, Cleveland, O., (Police Dept.)
		—KGJX—Pasadena, Calif., (Police Dept.)
		—....St. Quentin, France.
		—F8FY, Cannes, France. 5 p.m. Wed.; 4 a.m. Sunday.
176.5	1,700	—....Orly, France.
178.1	1,681	—WDKX, New York, N. Y. (Police Dept.)
180.4	1,662	—....Michigan State Police.
186.6	1,608	—W9XAL, Chicago, Ill. (WMAC) and Aircraft Television.
		—W2XY, Newark, N. J.
187.0	1,604	—W2XCU, Wired Radio, Ampere, N. J.
		—W2XCD, DeForest Radio Co., Passaic, N. J. 8-10 p.m.
		—W9XX, Cartersville, Mo.
		—W5XN, Dallas, Texas.
		—W2XDD, portable.
		—....Orrskoldvik, Sweden.
		—And other experimental stations.
187.9	1,596	—WRBC, New York, N. Y. (Fire Dept.)
		—WKOT, Detroit, Mich. (Fire Dept.)
		—W7XP, Seattle, Wash. (Police and Fire Depts.)
192.3	1,560	—....Scheveningen, Holland.
196	1,530	—....Karlskrona, Sweden.

(Standard Television scanning, 48 lines, 900 R.P.M.)

WE WILL NOT BE UNDERSOLD!

NATIONALLY ADVERTISED GOODS — IN ORIGINAL CONTAINERS — FULLY GUARANTEED

WE ARE HEADQUARTERS FOR REPLACEMENT PARTS FOR ALL STANDARD SETS

We can replace any A. C. Power Transformer, Condenser Block, Resistor, etc., WITH AN EXACT DUPLICATE! In our catalog, we list them all, at ROCK-BOTTOM PRICES! Mention set and model number, and we will ship you proper item. C. O. D. your wholesale cost.

Thordarson Power Transf.

All types listed below furnish all plate and filament voltages for any A. C. set.

MODEL 171 PUSH-PULL
For 4-226, 1 or 2-227, 1 or 2-171A, 1-280. **$2.55**

MODEL 245 PUSH-PULL
For 3 or 4-227 or 245, 2-227, 2-245, 1-280 **$3.40**

MODEL 250 PUSH-PULL
For 5 or 6-227 or 224, 2-250, 2-281 **$5.55**

2½ Volt Fil. Transf.

Two windings, both center tapped.
Total Cap. 16 Amperes **$3.75**

Power Trans. for R.C.A.

For Radiolas 17, 18, 33, 51; for 4-226, 1-227, 2-171A, 1-280 **$4.95**
For Radiolas 44, 46, 47; for 3-224, 1 (or 2)-245, 1-280 (and 2-227) **$4.85**
For Radiolas 60, 62, 66. For 6 or 7-227 (or 224), 1 or 2-171A, 1-280 **$4.65**
For Radiolas 64, 67. For 8-227 (or 224), 2-250, 2-281 **$14.75**

Hundreds of other models and types in stock!

Dubilier-Majestic Cond. Blocks

For MAJESTIC "SUPER and MASTER B" Eliminators. **$2.75**
For MAJESTIC "SPECIAL MASTER B" **$3.85**
For MAJESTIC 171 SETS **$5.45**
For MAJESTIC 245 SETS **$5.45**
For MAJESTIC 250 SETS **$5.45**
For Freed Eiseman Sets **$1.95**

All of the above can be used with any similar set or power pack. Guaranteed ONE YEAR! We can supply a block FOR ANY MAKE ELIMINATOR, OR POWER PACK—SHIP US YOUR DEFECTIVE BLOCK, for proper replacement thereof.

Tone Control

Modernizes any battery or AC set in two minutes. Emphasis can be placed on bass or treble notes, to suit your tastes. Installed outside of set.

$2.05

(*Panel Mount Type* $1.50)

Atwater-Kent 37-38 Block

Contains three chokes (one being a speaker choke) and four surge-proof filter condenser sections. Steeped in special pitch. GUARANTEED ONE YEAR! Can be used in any power pack. **$3.95**

AK 40, 41, 42, 44, 46

Contains above unit plus the necessary A-C POWER TRANSFORMER. Housed in one metal Box. Can be used with any set using 4-226, 2-227, 2-171A, 1-280 **$9.00**

Dry Electrolytic Condensers

Mount in any position. Self-healing. Will never blow-out. 300 volt peak voltage — use two in series for 1,000 volt rating duty. Very compact—most perfect filters made!

No. Anodes	Total Cap.	Price
1	1 mfd.	$ .28
1	2 mfd.	.45
1	4 mfd.	.85
1	8 mfd.	1.25
2	16 mfd.	2.13
3	24 mfd.	2.75
4	32 mfd.	3.38

Peerless 16 inch 110 volt A.C. Dynamic Speaker

Note that a 280 tube is used instead of sometimes troublesome metallic disc rectifiers. Produces super auditorium volume, with uncanny perfection of realism of reproduction. Contains push-pull output transformer. Can be used with any set. **$19.75**

Surge-Proof "Hang-Up" Filter Condenser Units

600 volt rating. Dipped in black pitch, with long flexible leads protruding. For repairing defective condenser block sections, or ideal for new power packs.

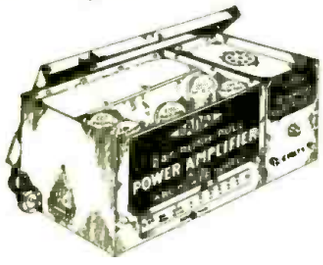
.5 mfd. **25¢**
1 mfd. **30¢**
2 mfd. **40¢**
4 mfd. **60¢**

100% *Replacement Guarantee*

SEND FOR OUR FREE CATALOG

Write for Our Offer of a Free "Official Radio Service Manual"

Convert Any Battery Set for A.C. Operation, Using Super-Powerful 245 or 250 Push-Pull Amplifier.



Simply connect detector plate lead of any battery set to input terminal. Keep using present 4 or 6 volt tubes in present tuner. No re-wiring of battery set—no changing of sockets or coils. Whole change-over takes a few minutes. Battery set audio amplifier stages, or tubes, not used. The Radax amplifier produces auditorium volume. Self contained ABC current supply in amplifier—also furnishes plate current (45, 67, 90, 135, 180) for tubes in tuner (as well as 2½ v. or 1½ and 2½ v. for A.C. tubes, if used). Amplifier requires 2-227, 2-245, 1-280 tubes. A separate 227 is used for phono. pickup. Furnishes field current for dynamic speaker.

As illustrated, less tubes **$27.85**
Same, but uses 2-250, 2-281, 2-227 **38.50**

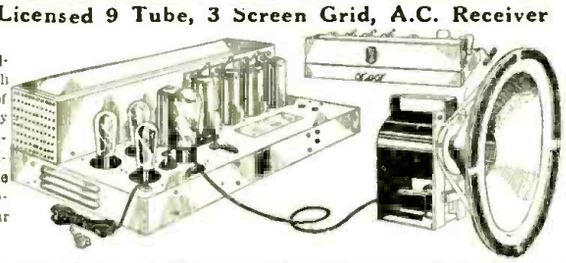
UNITS AVAILABLE SEPARATELY

*245 Amp. Unit, and A.C. "ABC" Power Supply **18.75**
*250 Amp. Unit, and A.C. "ABC" Power Supply **28.55**
4-6 Volt "A" Unit (2½ amps.) Bone-Dry. **11.95**

*Choice of AC fil. supply for tuner—see above copy.

R.C.A. Licensed 9 Tube, 3 Screen Grid, A.C. Receiver

Due to binding contract with manufacturer of this nationally advertised receiver, we cannot mention name—it would upset their regular market.



Uses THREE SCREEN GRID TUBES! LINEAL POWER DETECTION! PUSH PULL 245 AMPLIFIER! PHONOGRAPH ATTACHMENT! RECEPTACLE FOR SHORT-WAVE SUPERHETERODYNE ATTACHMENTS! TUBE VOLTAGE REGULATOR! TOTALLY SHIELDED! IMMENSE POWER PACK! TONE CONTROL! Requires 3-224, 2-227, 2-245, 1-280 and CLAROSTAT VOLTAGE REGULATOR. Operates with a 15 foot aerial—even picks up 2,000 miles on same.

Designed for any 110 volt D. C. dynamic speaker. (We can furnish the type illustrated for $6.95 additional!) FULLY GUARANTEED. **$29.50**

(We can furnish this receiver, semi-assembled, ready for wiring, for $22.50.)

Kolster K-6 Speaker

So realistic in reproduction it almost rivals a good dynamic, even though it is actually a magnetic speaker! Will operate PERFECTLY with any receiver, using 171-245 or even 250 tubes. Never blasts—nor distorts! 12½ inches high.

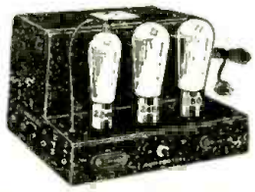
Very attractive cabinet.
Reg. $35.00 **$4.90**

Readrite 245-A Set and Tube Tester

Tests 224 and 245 tubes and sets. 3 double reading meters: 0-10-140 volts A. C. and D. C.; 0-60-300 plate and grid volts; 0-20-100 plate milliammeter. Housed in attractive metal case, holding all adapters, plugs, cables, 300,000 ohm in use!

4"x8½"x3¼" **$11.76**

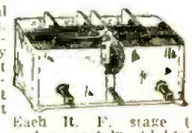
Loftin-White Direct Coupled Amplifier



Affords more than sufficient volume, sufficient for most dance halls, schools, small auditoriums, etc. The very finest of parts only are used—made by the most renowned and reliable mfgrs. A splendid phonograph amplifier! Can be used with Loftin-White tuner or any other tuner. Requires: one 224—one 245—one 280 tubes. 6¾" deep, 8½" high, 9" long. Very easily connected. Self-contained ABC supply. Also furnishes all ABC voltages to any 2½ volt A.C. tuner. **$16.50**

250 MODEL
Uses 1-250, 1-281, 1-224 **$27.45**

Improved 3 Screen Grid Loftin-White Tuner



Uses 3-224, and 1-227 AC Tubes. Razor-edge selectivity — sensitivity sufficient to permit 2500 miles reception on a 15-foot antenna, and right "through locals." Each R. F. stage (3 of them!) carefully and separately shielded. Single dial control. Attractive metal box with cover. Requires external AC ABC current supply **$24.95**

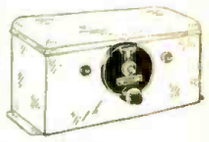
Battery model, 3-222, 1-201A **$22.85**

171A-245-250 ABC Power Packs

Furnish 45-67-90-135-180 volts plate current besides maximum plate voltage and suitable AC filament voltage in each instance.

For 4-226, 1-227, 2-171A 1-280 **$7.50**
For 4-227 or 224, 2-227, 2-245, 1-180 **$10.75**
For 4-227 or 224, 2-227, 2-250, 2-281 **$18.90**

Radax "Round the World" Short Wave Receiver



Tunes 10 to 200 meters. Fully shielded. Uses 1-222 Screen Grid, and 2-201A tubes. Completely wired and assembled. Tremendous value at **$16.55**

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Tests all types of tubes, including screen-grid, overhead heater types and the new 2-volt tubes. Tests both plates of 80 type full-wave rectifier tubes.

All Tubes tested independent of radio.

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Provides means for aligning of condensers by thermo-coupler meter.

Neutralizing of tubes actually used in set—only accurate method.

Tests gain of audio amplifiers.

Locates unbalanced power transformer secondaries.

Reads either positive or negative cathode bias.

Provides D-C continuity tests without batteries.

Indicates resistances without use of batteries in four ranges, .1 to 25 ohms, 10 to 200 ohms, 150 to 30,000 ohms (calibration curve furnished) 5,000 ohms to 5 megohms.

High-resistance continuity for checking voltage, dividers, insulation leakages, bypass and filter condenser leakages, bias resistors, grid leaks, etc.

Low resistance continuity for checking rosin joints, shorted variable condensers (without disconnecting R. F. Coil), Center tapped filament resistors, etc.

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