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April

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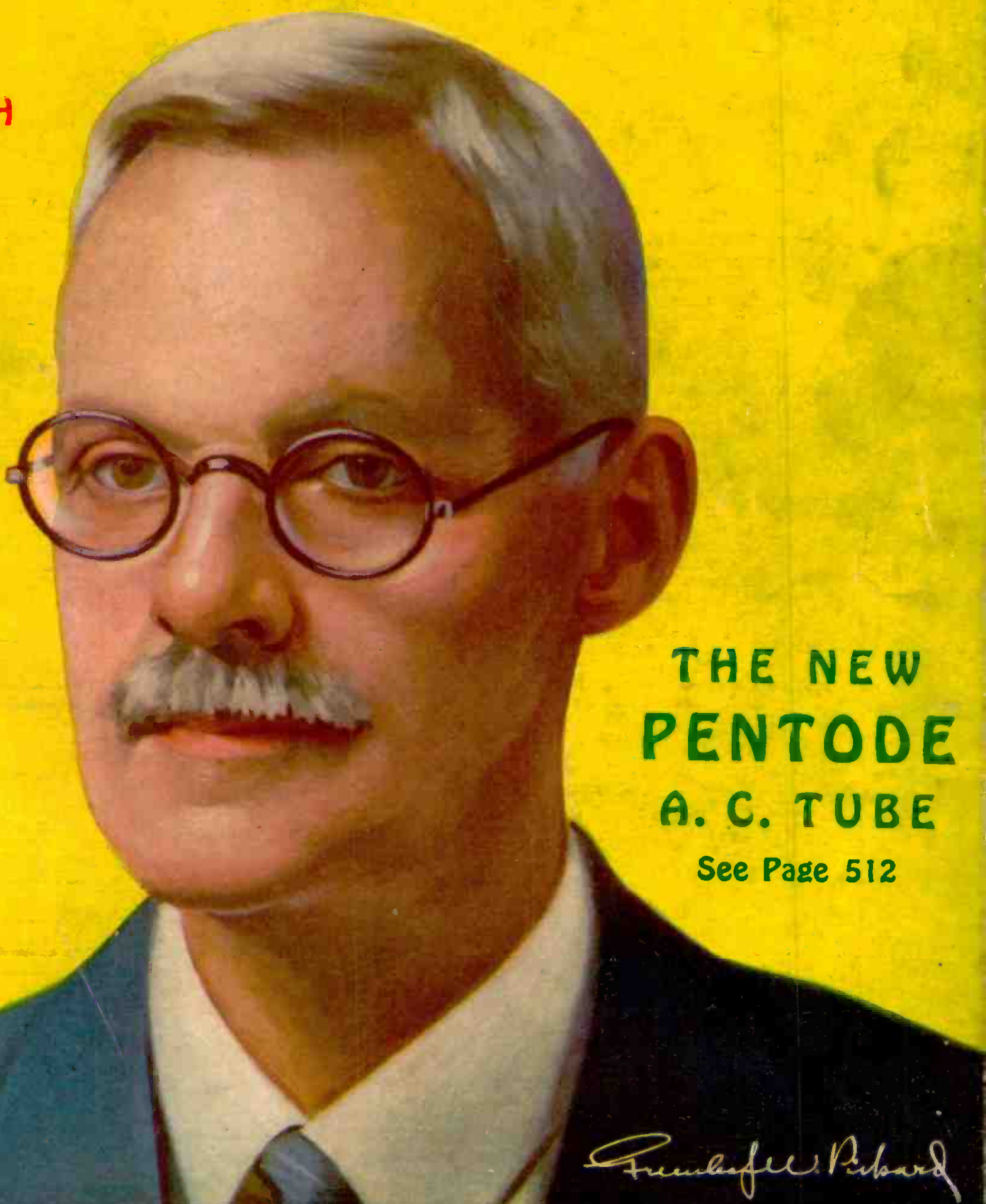
Radio-Craft

for the Professional-Serviceman-Radiotrician

IN THIS ISSUE

HUGO GERNSBACK Editor

Articles by
Dr. A. N. GOLDSMITH
Dr. LEE DeFOREST
L. M. COCKADAY
SYLVAN HARRIS
JOHN F. RIDER
DAVID GRIMES
And Many Others



THE NEW
PENTODE
A. C. TUBE
See Page 512

Men who have made Radio: Greenleaf W. Pickard

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Radio-Craft for the Professional-Serviceman-Radiotrician

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VOLUME I
NUMBER 10

APRIL
1930

Contents of This Issue

In Forthcoming Issues

RADIO-FREQUENCY ELECTROSTATIC TREATMENTS. By Dr. Erwin Schliephake (Jena, Germany). A new medical technique which has given better results in diathermic treatment of deep-seated troubles is described. In this method, the patient becomes one plate of a condenser in a 300- to 40-meter oscillating circuit.

NEW DEVELOPMENTS IN REPRODUCERS. By Laurence M. Cockaday. Continuing his instructive series on the latest methods in radio and its associated fields, Mr. Cockaday takes up the subject of the progress which is being made in loud-speaker design. The subject will be of interest to all.

A VACUUM-TUBE MULTI-METER. By Beryl B. Bryant. The constructional details of an expensive instrument which requires but one milliammeter, and may be utilized to determine amplification-gain ratios and impedance values, as well as to measure currents of a hundred times the meter's rating, and high plate voltages. Invaluable for the Service Man and the experimenter, as shop equipment.

SHORT-WAVE BROADCAST LISTENING. By Arthur J. Green. Mr. Green, organizer of the Short-Wave Club, and one of the most successful fishers for foreign stations, will give practical hints on operating methods for those who would take up this engrossing hobby.

And many other practical and instructive articles.

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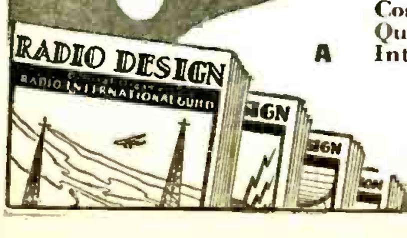

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96-98 Park Place, New York, N. Y.

HUGO GERNSBACK
Editor

Radio Intolerance

By Hugo Gernsback

IT is doubtful whether any other business in the world has so many peculiarities as radio. Ever since the old days of "wireless," there has been a continuous strife within the industry, and to the detriment of all concerned.

Such a thing as pulling together by the radio trade itself is, as a rule, unheard-of. It seems to be the only activity in which everyone who is connected with it wishes to paddle his own canoe; and the theory in radio seems to be "every man for himself—"

When we look into other lines, such as automobiles, building construction, metal trades, and many others, we find that practically all the members of the industry work together for the betterment of their particular field. This is not true in radio—quite the contrary. It is a chaos of conflicting interests; an industry full of intolerance, a trade wherein every individual member delights in knifing the other fellow in the back, as often as he thinks the opportunity presents itself.

Every new improvement that comes along is promptly pooh-poohed and ridiculed by every other man in the business; particularly so when it does not suit his own business ideas. It was so in the old coherer and spark-gap days, and is so today.

It is, of course, true that the radio industry is one of lightning-like changes; and there may be a certain excuse for the strange attitude of the radio manufacturer, or the radio professional. Yet, even here, a real radio industries' association could work wonders, if its members really cooperated.

Three years ago, the radio parts business in this country was one of tremendous proportions. Today, it is practically dead. Only a small minority of the radio parts manufacturers who were in business in 1926 and 1927 are still active today. The reason is that manufacturers got out complete sets so cheap that it no longer pays individuals to "build their own"; particularly in view of the fact that the set manufacturers, who sprung up at that time, in their race for supremacy (?) produced countless half-baked sets that were afterwards sold for less than a fraction of what the material and labor cost. Sets which first retailed at a minimum of $60.00 could later be bought on "Radio Row," in the same year, from $10.00 up. This naturally killed the parts business. A real trade association could have prevented such a condition.

The latest internal squabble illustrates our contention as to radio intolerance.

A prominent eastern tube manufacturer recently announced a new A.C. "Pentode" tube. While tubes of a similar name have been used in England, no tube of the present characteristics has been produced before.

Here we have to do with a real advance of the radio art; one which, no doubt, is going to benefit radio in general during the next few years.

For one thing, it will open up a new experimenters' paradise. The new Pentode will make possible new circuits, new combinations, and probably more convenient automobile and portable radio sets; because fewer tubes need be used to obtain the same results.

But does the radio trade present a solid front to the public, and inform it that here, indeed, is a new development which will be as universally adopted in radio as were balloon tires and four-wheel brakes on automobiles?

Indeed, no! Quite the contrary! The instant that the announcement of the Pentode tube was made, no less important a body than the Radio Manufacturers Association issues a lengthy statement for general publication in the newspapers, denouncing the new tube—in such words as "nothing new or revolutionary," "no improvement in performance with Pentodes," and similar allegations. All of this is calculated to throw cold water on the new enterprise and, in general, mess up the air with static verbiage—which will be forgotten in six months, when every other radio manufacturer will shout Pentodes from the housetops.

To be sure, there is a good "political" reason for all this; because radio set manufacturers have not yet recovered from the 1928 radio debacle, when suddenly one set manufacturer adopted the then almost-unknown screen-grid tube, and raised havoc with every competitor who did not do so at once.

The screen-grid tube scrapped all of the old sets, and today a new set cannot be sold unless it has screen-grid tube equipment. Six or eight months hence—or sooner—history will repeat itself; and this time the essential feature will be the Pentode.

In the meanwhile, it is true that the Pentode will, no doubt, cause chaos in certain directions.

But would it not be infinitely better if the radio trade had a powerful association? So that, if a new radio invention should come along, all its members might benefit thereby; instead of the present "every-man-for-himself" policy which, in the end, benefits no one. Quite the contrary, it steadily eliminates one radio manufacturer after another, till, finally, only half a dozen powerful interests will be left and, when that time comes, the public certainly will not benefit by it.

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

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.

WHAT IS SERVICE

By John F. Rider

"RIGHT or wrong, the customer is right." These seven words sum up the status of service as exemplified by some of the large selling organizations in the country—as a matter of fact, by the majority of large organizations; and we are not limiting our reference to radio stores or to other purveyors of radio sets and accessories.

At first glance, one anticipates a tremendous loss over a period of a year. Yet we find, upon analysis, that the stores operating upon the above-mentioned premise are highly successful; which seems to indicate that the public is not as black as it is painted. Now, this dissertation is intended, not as a discussion of sales policy, but as a means of arriving at a conclusion of fact; which tends to create discussion, whether or not the customer is right or wrong? We are willing to admit at the outset, that in many instances, complaints are premeditated methods of unjustly returning goods unintelligently damaged by the customer. Also that in some cases—a very small percentage of total sales, however—goods are deliberately damaged and returned for credit on the basis that they were damaged when received.

Let us attempt to analyze the radio situation, as applied to complete receivers; because this item constitutes the bulk of sales to individuals who consider radio as a medium of entertainment and are neither radio minded nor technically inclined. It will be best to cite a few examples encountered in daily sales, rather than to assume hypothetical cases.

A resident in the mid-section of Manhattan Island (New York City), living in a D.C. district, purchased a D.C. electric receiver. It was installed by the dealer and operated perfectly. The customer was very well satisfied and so expressed himself to the installation man, at the same time signing a receipt to that effect. Subsequent data bring to light the facts that, within four days after installation, four tubes constituting the output stage burned out, necessitating new tubes. The customer, awed at the outset, purchased four new tubes of identical manufacture. This time the receiver operated normally for five days, and then new tubes were again necessary. Once more he duplicated the burnt-out tubes, without complaint to the dealer who sold the set. And again tubes were necessary in five days, making twelve new tubes in exactly two weeks! The last batch was the "straw that broke the camel's back," and the complaint was registered. Examination showed: first, that the line-voltage was excessive, and had been excessive since the day of the installation. Secondly, that the tubes used in the output stage were not correct for the installation, being of the 0.25-ampere type instead of 0.5-ampere. The receiver owner, knowing nothing about tubes, duplicated the wrong tubes in each case.

Now, here is an example of where the installation man was at fault, producing a condition which makes it very difficult for the receiver owner. Tube replacements are extremely annoying and not very favorably received by radio dealers. Such complaints are numerous, and encountered with A.C. sets as well. The failure of tubes constitutes about sixty per cent. of all the troubles encountered in radio receivers; and about eighty per cent. of this trouble would be eliminated if the operating voltages were checked at the time of installation and adjustments made to secure the correct values.

Good radio service starts when the set is installed, not when it becomes defective.

Every effort must be made to preclude the defective state; to lengthen that period between the original high-caliber performance, and defective performance. We must admit that service will be necessary at some date, but must also incorporate every measure to lengthen the period of satisfactory service.

Checking the operating voltages when a set is delivered is one of the important steps when a radio receiver is installed, regardless of type; yet the practice is not followed. Why, no one can definitely state, unless it is the time-limit method of procedure. An installation of this type places the receiver owner at a definite disadvantage. It is true that there are exceptions to the above rule; but we are not concerned with the instances which do not produce harmful results. We are concerned with the other classification. The structure of the vacuum tube is such that elaborate laboratory equipment is necessary to determine whether a burnt-out filament has been overloaded; such equipment is not available in the average radio store. Furthermore, tube replacement is not general. Why burden a novice with troubles which he should not bear?

Now, we come to another problem; one which, while not discussed to any great length, introduces a matter of interest. If the line-voltage is excessive, increasing the hazard of tube burnout, some means must be provided to reduce the filament voltage to the correct value. This work does not introduce any visible difficulties, yet we find that numerous installations are incorrectly calculated, with very poor results. We refer to the resistance unit, connected between the power-supply plug and the receiver. In order to perform well this unit must dissipate a certain amount of power and this means that certain technical facts must be known: first, the required voltage drop; secondly, the current flow during that period; and thirdly, the wattage rating of the voltage-control unit. Now, we are going to make a surprising statement; that many men who install such units are not aware of these requirements and make haphazard installations. In one case, the line voltage was reduced to 102 volts from a 120-volt line. In another case, the resistance unit overheated and damaged the floor, almost starting a conflagration. In both cases, the customer was inconvenienced, and his complaint was entirely justified.

The selection of such a resistor is not a very technical problem, but it necessitates a knowledge of Ohm's Law and, in some cases, the principles underlying the operation of a power transformer. We realize that the average Service Man does not carry a meter which will indicate A.C. current flow in the primary of the power transformer. Why not approximate the current flow in the primary, by calculating the power load applied to the secondary of the transformer as represented by the various windings, and allow about eighty per cent efficiency in transformation?

Service begins at the time of installation, not after the set is performing poorly.

It is too late to discover excessive line-voltage after a number of tubes "have gone West." Preclude the possibility of premature filament failure by checking and controlling line-voltage at the time of installation. That is the start of service.

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

HASTE CAUSES REGRETS
By G. R. Mann

A SHORT time ago I was called to service a Freshman receiver, which was housed in a console cabinet and employed a magnetic cone speaker. After listening to the set for a short period, I quickly diagnosed the trouble as being in the speaker; because it sounded exactly like a speaker that was out of adjustment, with the armature of the unit striking against the pole pieces. Accordingly, I removed the speaker and increased the distance between armature and pole pieces; but this did not help. Then I took the speaker to the shop, tore it down completely, cleaned out some varnish on the inside of the coils, assembled it and tested it on another set.

That night I took it back, hooked it to the Freshman, and told the owner that I had it all fixed up. Imagine my embarrassment when, upon turning on the set, it sounded exactly as it did before I removed the speaker.

Then, I started testing the set and found a bad power tube ('71A) with very little emission. Replacing this tube cured the trouble.

This taught me always to make a *complete* test of every set and not jump at conclusions. I thought my experience might save someone else a lot of needless work and embarrassment.

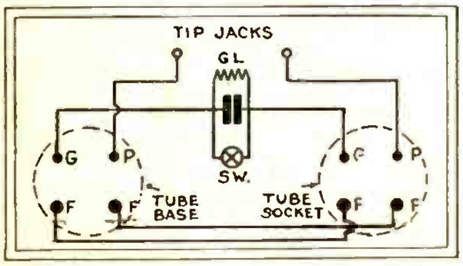


Fig. 1
Mr. Cordaro's handy addition to a test kit is pictured in the next column.

A HANDY STAGE-TEST ADAPTER
By Jos. Cordaro

AN almost universal testing device has been devised by the writer. As diagrammed and pictured in these columns, it consists of a tube socket, a tube base, a grid leak, a grid condenser, and a S.P.S.T. switch.

A lead from the grid prong of the tube base to the grid clip in the tube socket is broken, and a grid leak and condenser are inserted. The plate lead, too, is broken; the ends being brought to tip jacks, or pieces of metal arranged to project slightly from the side of the tube socket.

Headphones or a milliammeter may then be inserted in the plate circuit, of a tube under test, in the convenient manner afforded; the grid circuit of any R.F. tube will function under detector conditions when the midget shorting switch is flipped open.

Fig. A
The circuit of this handy adapter is Fig. 1.

A PHONOGRAPH-DYNAMIC SWITCH
By Cecil F. Hardy

WHEN using a dynamic cone speaker with an electric phonograph (such as the Brunswick "Panatrope") it is desirable to connect the system in such a manner that the switch which controls the phonograph will also control the A.C. input to the dynamic speaker.

This can be accomplished by the following method: disconnect the speaker from the A.C. line, take the turntable off the phonograph, and loosen the screws that hold the motor in place. Take the motor out of the cabinet. The connections from the line and the switch go to a binding-post strip on each side of the motor. Now take the plug off the speaker cord, and connect one wire to the side of the A.C. line that goes directly to the motor. The other wire connects to the motor side of the starting switch.

When the motor is switched on, it will also switch on the dynamic; and when the motor is turned off, the field current is automatically switched off the speaker.

THE process of editing a publication is at time a very pleasant operation, but at other times it is just the contrary—very disagreeable. The difference between the two is nothing more than how the material submitted for publication is prepared.

Speaking from the editor's desk, we request that contributors please submit material typed whenever possible and DOUBLE-SPACED; thus allowing for editorial notations without spoiling the day or week-end for the printer who is obliged to set the type matter.

We realize that typewriters are not always available. We have no objection to LEGIBLE hand-written material; but we also suggest that sufficient separation between lines be available to allow for editorial corrections or comments.

A HUM KILLER
By George W. Brown, Asso. I.R.E.

MANY A.C. sets hum, even though the filter system is quite efficient. I have found that, in sets using push-pull audio stages, a 100,000-ohm resistor R1 connected across the secondary of the input transformer will reduce the hum considerably. In extreme cases, another 100,000-ohm resistor R2 may be connected across the secondary of the first audio transformer. This second resistor may make a very slight change in the volume; but it will certainly kill whatever hum may be left.

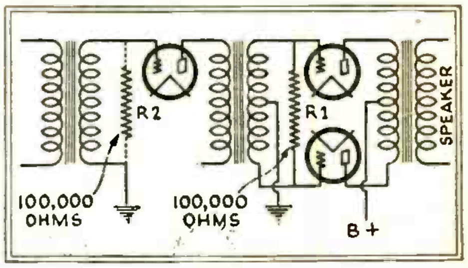


Fig. 2
Mr. Brown finds the use of these resistors a solution of the persistent hum problem.

INTERFERENCE FROM MOTORS
By J. E. Deines

SMALL induction motors of the split-phase type have long been given a clean bill of health by interference men; but some of them do not deserve it. Not long ago we received complaints of noise which was traced to a hatchery; and the only thing found connected was a 14-inch ceiling fan, used to circulate the air in a large incubator.

The noise heard was a severe popping and, when the fan was shut down, it stopped. Since this fan was of the induction type, with a squirrel-cage rotor, it did not seem a likely source of interference.

Upon close inspection it was found that the metal shell (or case, which houses a motor of this kind) collected a static charge and that a thermostat-control cable (lead-covered) was lying on this case, intermittently discharging the shell. Giving this cable plenty of clearance cured the trouble.

Several other cases of this kind have been found on small home refrigerators, where the motor is mounted on fiber supports to prevent mechanical noise. Between motor

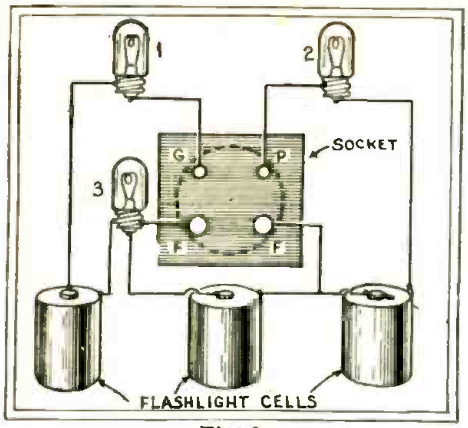


Fig. 3
Mr. Trad's tube tester quickly determines shorts, and prevents disaster to more expensive apparatus.

and compressor a flexible coupling is used and, when this wears, it lets the bolts touch; thus discharging the motor into the compressor which, in most cases, has a ground on it.

Bonding the two with a short piece of wire stops the noise.

(Mr. Deines is employed as "interference man" by the Kansas Power & Light Co. at Topeka, and devotes most of his time to running down strange noises. A special closed-body light truck is used in the work and carries equipment including a "Radiola 26," a smaller four-tube T.R.F. set, and a five tuber; as well as "hotsticks," rubber gloves, a small sledge—which should be effective in correcting some sources of trouble—as well as an assortment of interference filters to be applied on the spot. The work is obviously of commercial importance, since radio cannot be sold where there is interference. We shall be glad to hear further from Mr. Deines, and from other interference shooters.—*Editor.*)

AN EMERGENCY AERIAL CONNECTION

By K. A. MacKarl

HERE is a kink that may prove useful. In connection with my work as a Service Man I have been called a number of times to look at a sick A.C. set, only to find that the aerial had blown down.

When it is inconvenient to make immediate repairs to the aerial system, good operation often has been obtained by putting the ground lead on the aerial post (having removed it from the ground post), leaving the aerial lead-in disconnected.

This is shown in Fig. 4. In some instances this connection has increased selectivity and remained as a permanent installation.

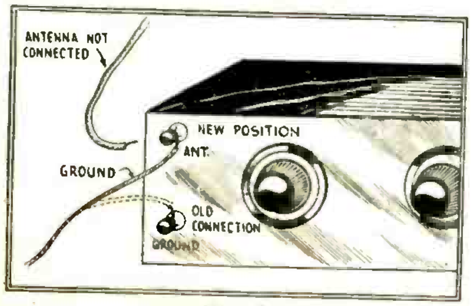


Fig. 4
Not new, perhaps, to most readers; but often a convenient expedient.

TESTING TUBES FOR SHORTS

By Victor Trad

THE tester shown in Fig. 3 is made from three flashlight cells, a tube socket, and three flashlight bulbs, and makes it possible to test tubes quickly for shorts. This precaution will save trouble later.

On inserting a tube in the socket, the continuity of the filament is shown by the lighting of lamp No. 3; if this does not light, the filament is burnt-out. If No. 3 lights, the other two lamps should remain dark if the tube is in perfect shape.

If No. 1 lights, the grid and the filament of the tube are touching; if No. 2 lights, there is a short between the grid and the plate. In either case, the tube should be discarded.

Sometimes, however, such shorts can be remedied by gently tapping the tube in the palm of the hand. This may cause the misplaced elements to separate; if they do, it will be evident on repeating the test, when lamps 1 and 2 will fail to light.

HOW DO YOU TEST A DRY-DISC RECTIFIER?

RADIO-CRAFT especially invites its readers to send in their answers to this question during the coming month, so that we may have, as it were, an open forum on the subject in our July issue. Each month a different subject for discussion will be propounded.

TROUBLES IN DETECTOR CIRCUITS

By Raymond D. Wills

IN the detector circuit, the two most important parts are the grid leak and grid condenser. If either is shorted, the tube at once adapts itself to radio-frequency amplification; so we must be sure that both are O. K.

The fact that a leak is marked "2 meg." does not mean anything, if it has been damaged or subjected to any conditions which alter its value. A grid condenser may be marked ".00025-mf.," but that also means little if it has not been tested for defects.

The detector by-pass condenser assists performance by keeping R.F. impulses out of the primary winding of the first A.F. transformer. One must be certain that this component is not leaky or shorted, when it is worse than no condenser at all.

So, in the "leaky-grid" detector circuit, our troubles are relatively few. If the tube is good, we must look for a defective grid leak, a defective grid condenser, and last—but not least—a shorted by-pass condenser or excessive plate voltage.

The right value of grid leak is determined by trying different resistors until the desired degree of sensitivity is obtained. Some leaks are notoriously for characteristic crackling or frying noises.

The grid-bias detector, however, is different. It is necessary that the ratio of grid bias to plate voltage be exactly correct, in order that the tube may operate at the proper point of its "characteristic" curve. This alone is necessary for good reproduction; and a slight change in grid

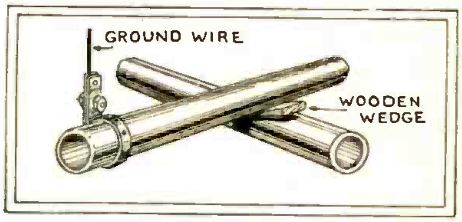


Fig. 5
The vibration of these pipes, changing antenna constants, was easily stopped!

bias completely destroys the condition essential to good performance.

Hence, assuming that the detector tube is good, and that the contacts in the circuit are perfect, we may say that our troubles in a grid-bias detector are commonly confined to the problem of plate and grid voltages.

These, in the A.C.-operated tube, add the grid-bias resistor (where one is used) to our list of possibilities, and its by-pass condenser as well as the plate-circuit by-pass.

WANTED, A PLUMBER

By Paul Moore

IT is always interesting to see how other Service Men get around troubles; I have a very peculiar one to report. I was called to a case one evening, with the warning that all others had failed to fix the set. I found that, every time anyone walked across the room, a noise was set up in the receiver. I tried tests for microphonic tubes and the like, but to no avail. I noticed that a footstep at one point seemed to cause the most interference; and I tapped the floor with a broomstick till I found the sensitive point, when I marked with chalk. I then made a small hole through the floor and dropped a wire through it, then went into the basement. Here I found two crossed pipes, which would vibrate whenever a person walked over the spot. The receiver was grounded to one of these two pipes.

I remedied the trouble quickly by driving a plug of wood between the two pipes, thus holding them solid; then collected my money and went home satisfied.

TUBE REACTIVATION

By George Stoneham

I THINK that the baking process of reactivation will be of interest to many Service Men and dealers not familiar with the method. It is suitable for '26, '71A and tubes of similar nature, as well as the Raytheon "BH." The set-up is shown in Fig. 6.

I used an aluminum cone at A, to hold and concentrate the heat upon the glass and elements of the tube. Copper or iron, of course, would be equally efficient. Two

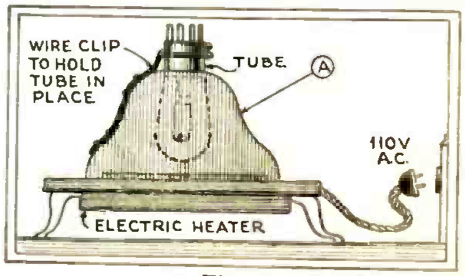


Fig. 6
A method of rejuvenation proposed for tubes which do not yield to the ordinary method.

to five minutes' baking will return the tube to normal emission.

If the temperature is too great, or the tube left in the oven too long, the glass will melt.

(Oxide-coated filaments, like those of the '12A and the other tubes mentioned, are not generally supposed to be rejuvenable, like the thoriated-tungsten filaments of the '01A tubes. The '80 also has a coated filament; but the BH has none, of course, and depends on the ionization of its gas contents. We shall be glad, however, to hear of the results obtained by anyone who tries the experiments with tubes, of the types named, that have passed their usefulness.—*Editor.*)

ELIMINATING EXTERNAL NOISES

By Robert G. Dougherty

ONE day a lady called me from the neighboring town to come and see what was the matter with her radio. She said that it was subject to extensive noise interference.

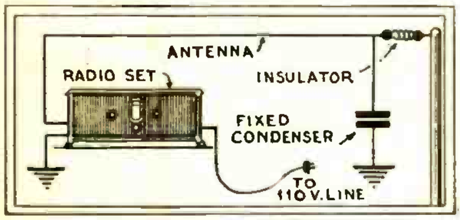


Fig. 7

Another old idea in aerial installation which may solve baffling interference problems.

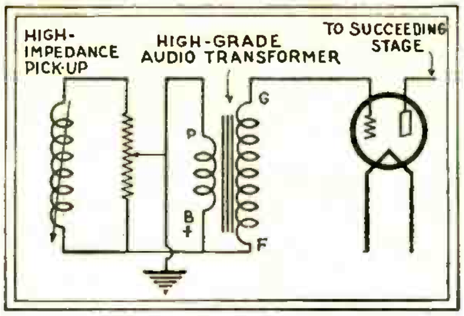


Fig. 8

The method of coupling shown preserves low notes and gives better volume.

On arriving, I found that the set was a new Victor, less than a month old, and that it had always acted in that manner. The people wanted the radio, but would not keep it unless the noise could be eliminated.

I looked for the usual transformers on the light-line, and the favorite old stand-by, oil burners; I tried filters in the light-line, but they did not stop the noise. I tried changing the aerial and ground; that was useless. The set was all right, and I was sure the interference was farther away than a block or two. But what it was, I could not determine.

Then came a happy thought. I grounded the far end of the aerial, and the noise quieted down. I then put a fixed condenser in the ground wire, and the set worked perfectly. The loop thus formed was so large that little directional effect was noticed. In fact, some stations came in better than before. (See Fig. 7.)

MAGNETIC PICK-UP CONNECTIONS

By J. Roth

IF a high-impedance pick-up is connected as shown in the sketch (Fig. 8) better results will be obtained; there will be an improvement in bass reproduction, and also greater volume.

This method is necessary when the first stage of audio is resistance-coupled; otherwise, high-note attenuation will be noticeable.

DEEPENING TONE—SHARPENING TUNE

By M. H. Berry

IN some instances we find individuals who wish augmented bass reproduction. To

(*Continued on page 532*)

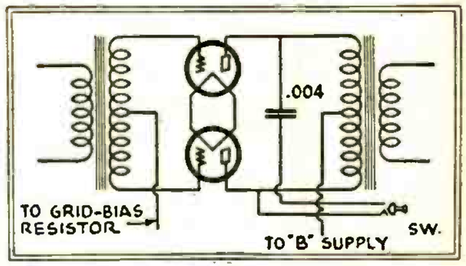


Fig. 9

The use of the condenser shown, with a switch, gives a regulation of the reproducer's tone to suit the car.

A Simple Tester for Gaseous Rectifiers

By BORIS S. NAIMARK

NOT long ago a client of mine called me on the phone and told me of the trouble he was having with his electrified battery receiver. Being more radio-wise than the average owner of a radio receiver, he was able to make himself quite explicit as to the trouble he was having, and, judging by his description of the "ailment," it appeared to me that all his trouble was due to a worn-out Raytheon tube he was using in his Majestic "B" eliminator.

Logically enough, I told my client that, before he dismantled the set and brought it down to the shop for repairs, he should take the Raytheon tube from his eliminator and have it tested in one of the radio stores that happen to abound in his vicinity.

I thought that this was the end of the matter and that, while I may have lost a job, my professional demeanor was instrumental in adding another friend to my already long list. You can imagine my astonishment when, about an hour and a half later, the same gentleman called me again. He had gone from store to store in his neighborhood, and even to several radio stores out of his neighborhood; but it seems that not one of them was equipped to test the Raytheon tube. The dealers were nice enough; practically all of them offered to sell my client a new tube and refund the money upon demand, within a reasonable length of time, if the trouble were not in the tube proper.

The Service Man in the field can easily tell when any rectifier tube is weak. He takes the voltage readings in the various tube sockets and, if the plate voltages are consistently lower than the values specified as normal by the maker of the receiver under test, the trouble, more often than not, lies in the rectifier, whatever its type or make.

In the shop, however, the conditions are somewhat different. It is not logical that a dealer should go to the trouble of testing a rectifier tube by placing it in a receiver and then testing the available plate voltages. Furthermore, the average tube tester found in the store is perfectly satisfactory for testing filament-type rectifiers, but unsuitable for the test of filamentless, gaseous, Raytheon-type rectifiers; since a special circuit is required.

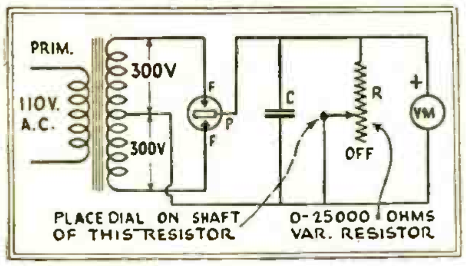


Fig. 1

The simple circuit shown gives a method of testing cold-cathode rectifier tubes; it must be calibrated with a good tube.

It is quite possible to make an inexpensive, simple, efficient, and accurate Raytheon-type tube tester. The circuit arrangement (see Fig. 1) is exceedingly simple and all the parts required (with the exception of the meter, which the reader probably already treasures as a part of his testing equipment) will be found in the proverbial "junk-box."

Take a new and perfect type "BH" Raytheon rectifier (type "B" is practically extinct) and insert it into the socket of the tester. With the shunt resistor in the "Off" position, plug the tester into the electric outlet and note the voltage reading on the meter. This is reading No. 1. Then gradually move the arm of the resistor, and note the various voltage readings corresponding to the various conditions of load imposed upon the rectifier. This is best done by having a calibrated dial on the shaft of the load variable resistor R. Prepare a little chart showing the various resistor dial readings, and the corresponding voltmeter readings. These readings will be "standard," and will serve as a criterion for other gaseous rectifiers to be tested in the future.

Quite naturally, the weaker the tube under test, the lower will be the voltage readings corresponding to the various load conditions. It should be borne in mind that, the lower the value of the resistance across the rectifier, the greater the load and the lower the voltage available.

In conclusion let me say that the above tester may be built into a box and thus make it suitable for panel or counter use. Also, those who have an old Raytheon-type eliminator on hand may use that in conjunction with a variable resistor and a D.C. voltmeter and get substantially the same results. In such a case, both the load resistor and the voltmeter are connected across the "B+ Max" and the "B—" terminals of the eliminator.

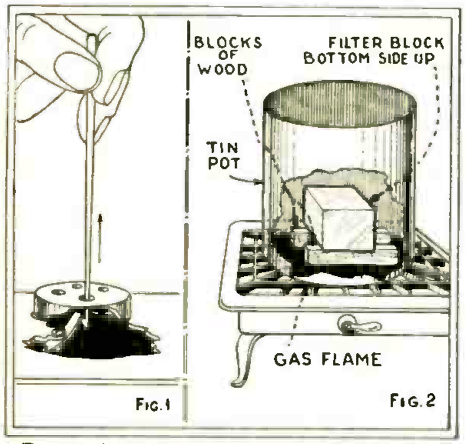
Operating Notes for Service Men

The innumerable little things which are not in the books, a Service Man must learn by experience. Some may learn from the experience of others; and Mr. Freed has had a great deal of it which he relates freely here.

By BERTRAM M. FREED

SERVICE MEN have a simple test, to determine whether noise in a set is internal or external, by disconnecting aerial and ground leads. If the noise ceases when these wires are disconnected, the noise is caused either by a bad antenna system or by atmospheric conditions, etc. If the aerial is in good shape, then the conclusion may be reached that the noise is static or due to a noisy locality. However, this is not always true. Many instances have been found where, though the aerial installation may be seemingly perfect, it is not really so. If another aerial, nearby, is grounded, or crossed with a third aerial, and the lead-ins are near and parallel with each other, noise may be picked up by induction.

A very handy, simple, yet efficient, addition to the kit of a Service Man is a No. 3 crochet needle. Its purpose is that of a



The crochet needle might be used by the Service Man to knit socks in his spare time (laughter) but as a matter of fact, it is a very handy tool for modern tube sockets. The process shown at the right is the only one of salvaging some parts; but care must be taken not to get the sealing compound too hot.

prong straightener. By inserting the needle into a socket, through the holes, each prong in turn may be caught by the nick in the needle and pulled up into place (Fig. 1).

Atwater Kent Models

On occasions of a complaint of choppy and husky reception from the A. K. "Model 55 A.C.," the trouble has been found to lie in the detector biasing resistor between cathode and ground. The symptoms resemble those of a lack of bias in the power stage, and the condition is hard to check with a low-resistance meter and a 4½-volt "C" battery. The value of the resistor in question is approximately 50,000 ohms.

When the A. K. "Model 37 A.C." shows up with "shot" filter condensers, the problem of the best method of repair arises; since these condensers are connected internally to the chokes in the pack (which is composed of two sections; the transformer and the filter block). If a new filter block cannot be obtained, the damaged unit may be inverted upon two blocks of wood in a can and heated (Fig. 2). The sealing compound used as a filler will soon melt and run out. If care is taken, the filter chokes and output choke can be salvaged. After cleaning the block, it is possible to replace the damaged condenser with new, and finally run melted paraffin into the assembly.

If, after all tubes in an A. K. "Model 41 D.C." have been tested, and it has been determined that direct current of proper polarity is being obtained from the house-line outlet, test the R.F. chokes in series with either side of the line. These chokes are wound on small, round strips of composition, and located directly beneath the connection block in the pack. It is easy to repair them by rewinding with No. 22 S.C.C. or enameled wire. (The connections are shown in Fig. 3.)

An open circuit may be found in the voice coil of an A. K. dynamic. In many cases, this is in the leads running from the frame of the speaker to the coil; these are glued to the cone, and held to it by transparent adhesive tape, which covers the soldered connection between the leads of the voice coil and those from the frame. If vibrations of the cone during operation break this soldered joint, an open circuit is produced.

Bosch and Others

The Bosch "28" tuner chassis has six adjusting condensers near the tube sockets, as shown in Fig. 4. Many confuse the neutralizing condensers with those used to trim the tuning condensers. The correct positions are indicated in the sketch.

Sometimes an abnormal hum in this set may be traced to a shorted R.F. bias. There are shunted across the '26 filament circuit two condensers in series, with their center connection grounded. If one of these condensers is shorted, it causes the condition described.

The Bosch, Colonial and Sparton D.C. sets use large filament resistors, which a severe jolt may crack. If so, the winding may be intact; and a large copper ground clamp of ordinary type may be then tightened about the broken section to hold it in place.

The Philco screen-grid and neutrodyne-plus models have a low hum level; if annoying hum is found and all circuits and tubes test O. K., it is a good policy to examine the speaker plug prongs, which may have become corroded and dirty. Clean the prongs with steel wool, and replace the plug in its socket carefully, to correct this condition.

In the Zenith "42," which has three stages of audio with a '50 amplifier, a complaint of fading, oscillation and noisy reception has been traced to the R.F. by-pass condenser which is situated near the combination switch and volume control. The lug

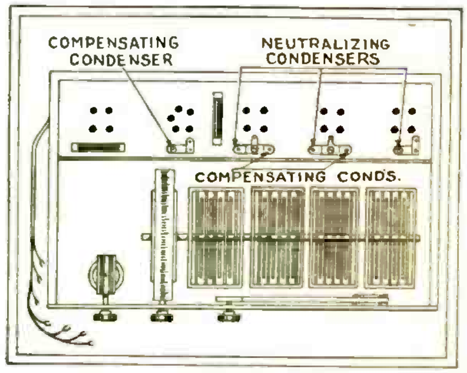


Fig. 4

The positions of the small adjustable condensers in the Bosch "28" are shown here. Some Service Men have had trouble in distinguishing the two groups.

on this condenser was found to be broken internally. Contact was thus made and broken, causing a drop in volume and excessive oscillation. The quickest remedy was to replace the condenser.

In new Majestic sets, where the receiver and pack are a single unit, the mistake of unsoldering the speaker leads from the connection block, under the metal shield of the chassis, has been made. This is unnecessary; for these leads are soldered to a plug which can be pulled from the chassis. Incidentally, in this model, the external line ballast has been replaced recently with a block containing voltage taps, to regulate the A.C. input to the set.

In Radiola and Brunswick superheterodynes, severe motorboating or excessive oscillation (if all tubes are O. K.) indicates a condition which cannot be remedied by adjusting the external oscillator trimmers. The only remedy is to correct the intermediate-frequency transformers. This procedure has been ironed down to a relatively simple matter, and will be explained in a future article.

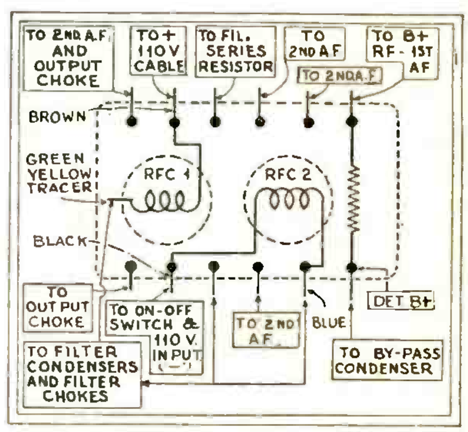


Fig. 3

In an A.K. "41 D.C." it is well to test the chokes RFC 1 and RFC 2, shown above. They are in series with the house line, to prevent interference from being picked up through this connection. These may be readily repaired.

Why Some Radio Manufacturers Fail

By L. H. HOUCK

THE fact that this company services and installs radio sets for about fifteen radio dealers, who do not maintain service departments, has given us the opportunity to get angles of new thought, between the customer and the dealer, that possibly other Service Men have missed.

It is our opinion that, each year, more and more radio set buyers and those who are trading in old sets for new ones are seeking to buy, not only a good radio, but also service. And, as this tendency increases, the manufacturers who will not service their sets and who will not place their technical data in the hands of even those Service Men who may have need for it, are going to be automatically eliminated by those who really control the industry—the buyers.

We hope the continual ego and references to ourselves in this article will be excused; but it is necessary that we relate an incident that actually occurred. We were involved.

We were in need of a part for a standard radio, one well advertised. A telephone call to the distributor's service department was made, and we were told that they had the part in stock. When we said that we would send down for it at once, we were told that they could not sell this part separately but that if we sent the radio set down they would install it. They were promptly told that a part of different manufacture would be substituted for it.

This is co-operation. In effect, this well-advertised set was an orphan. Its father disowned it.

On the contrary, a customer brought in for repair one of the highest-priced radios on the market. A test disclosed that a center-tap resistor was burnt out, together with a few sections of the condenser bank. The service department for this radio furnished us with parts without question, and also gave us some pointers on servicing this model which proved to be very valuable. This radio set is of a make *that did not drop in the latest crash*, and one that was evidently not in overproduction.

REAL CO-OPERATION

One of the biggest surprises we have had in years happened a few days ago, when the local engineer in charge of Sparton service (a very competent man) made a special trip to our office to give us information that we might be able to use in the service of Spartons. He started in with the tubes, that might be switched with the special Cardon tubes used in some models of this make; then went on to an easy and efficient way to balance, an understanding of the band-pass filter used in this set, and an easy and efficient way to make the set more selective. A special tool is required in order to balance, because the equalizing condensers are reached through a hole in the base; this tool was furnished *free of charge*.

It is not hard to figure out what our attitude will be when we are called to service a Sparton. We will think that at last here is a manufacturer who will back us up.

You will note that this set did not drop its prices.

I think there is a very definite connection between the set manufacturers who maintain fair prices and their service to set owners.

I think a careful analysis will show (with that one big exception—and they haven't made their money from selling radio sets) that the many makers who have gone down the bankruptcy route are largely of the kind who have ignored service completely. I think that, if the figures were available, it would be found that those who are the most prosperous are those who are building for the future by trying to give some service.

There is no doubt that there is not one manufacturer to-day who realizes the necessity of furnishing accurate technical data to Service Men. I can understand their unwillingness to put this data in the hands of incompetent men; but who is there to say who is incompetent? Most incompetent radio men eliminate themselves. The competency of most manufacturers' Service Men is certainly to be questioned. They have an opportunity to work on one type of set all the time; they must have the same kind of troubles coming up all the time. Surely they could learn something from that, with the manufacturer's constants and circuits at hand for their guidance, and they should become experts in a short time. Many of them are, but there are a lot who actually do not know the set they work on year after year.

The Service Man handling a large number of different brands, and particularly the so-called independent Service Man, has a vastly harder problem. His is the business of repairing all kinds of sets, all kinds of circuits, all kinds of troubles; and he must be efficient, must have sufficient basic education on which to rest common-sense practice, or he cannot survive. Then, if he does survive without the aid of the different manufacturers, he must be efficient; and the manufacturer should present him with all the facts in his possession—even to the volume marked $1.50 and etched in gold.

It is our policy, and will remain so, to refuse to pay any manufacturer for his data sheets. He has built a complicated machine and sold it to the public for American money. He cannot send men from his factory on every trouble call; this work must be delegated to Service Men all over the country. Would he send a man out from the factory improperly equipped? *Then he either must not want the set repaired, or he would equip Service Men with data sheets on his product.*

Broadcasting and Servicing

By ROY DOUGLASS

MUCH has been written about the present attitude of manufacturers toward Service Men.

It has become almost a sin the way the public has been led around by the R.C.A. and the Radio Commission.

I have been servicing sets for some time and have been in the game since the one-tube days when we could get real radio reception.

If the proposed 7½-kc. separation is put on by the Radio Commission, it will throw practically every set that is in use to-day into the discard; because 90 per cent. of the sets will not separate the stations as they are now classified.

It is true that the chain programs come in good through the cleared channels; but, if you wish to get anything else except chains, you may as well shut off and go to bed.

Nothing is more disgusting than to listen to ten or fifteen minutes' harangue every morning, noon and night about the various stores on Woodward Avenue, or some kind of face powder. Also, 50 per cent. of the broadcasting is phonograph records.

The public should get some kind of action on this matter.

A radio listeners' league in every community will be an absolute necessity, if this kind of nuisance is to be stopped and the quality of broadcasting brought back to what it was two years ago.

Regarding the proposed 7½-kc. separation: What would the attitude of the public be, if the motor car manufacturers all put out a 1931 model car with a different type of engine, that did not burn the present fuel, and the gasoline companies refused to furnish gas for our present cars?

The average manufacturer's dog-in-the-manger policies are very near this line.

Living as I do in a semi-rural community I have to repair numbers of the older battery-type sets that would separate the stations very satisfactorily two years ago; but, at present, one cannot get over from six to nine stations without a heterodyne whistle from each side.

It looks to me as though the manufacturers are having their innings now; but, if the present policies are kept, it will be a big loss to one of the finest institutions in this country.

Nearly every person is very much dissatisfied with the present crowded broadcast situation; and many more sets would be sold if the band were reallocated so the stations could be brought in clear. Blame of non-

(*Continued on page 529*)

KELLOGG 523 AND 526

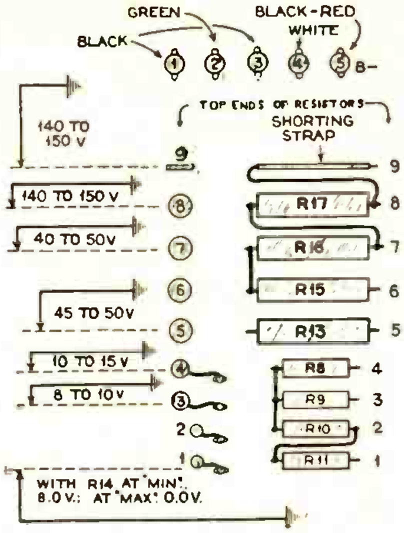
These two models differ only in the power supply to which they are adapted: their R.F. chasses are identical. The "523" is designed for standard 60-cycle alternating current; the "526" for operation on a lower frequency—25 cycles up—and is recommended for even 50-cycle supply. The receiver proper has three stages of '24-type screen-grid amplification, with '27-type detector and first audio; and employs a '27 type tube in a special circuit as an automatic volume control, described later. The push-pull '45-type power stage and power supply is a separate unit, different in the two models. This unit is accompanied by a dynamic reproducer, built into the console; its field-coil resistance is 2000 ohms.

The complete circuits are shown in schematic diagram below: the values of the parts shown are as follows:

Resistors: R1, the manual volume control (operated by lower right-hand knob) 50,000 ohms; R2, R4, R6, each 2 megohms; R3, R5, R7, R15, R18, R19, each 1000 ohms; R8, 10,000 ohms; R9, 2,000 ohms; R10, 100,000 ohms; R11, 50,000 ohms; R12, 500 ohms; R13, 130 ohms; R14, 200 ohms; R16, 1,500 ohms; R17, 3,000 ohms; R21, 30 ohms center-tapped; R22, 750 ohms. Capacities are as follows: C2, C4, C6, each .0005-mf.; C8, .001-mf.; C9, C11, C12, C13, C15, C16, C17, C19, C20, each 0.3-mf.; C10, C14, C18, C23, each 0.5-mf.; C21, C22, C25, C27, (high-voltage), C28, each 2.0-mf.; C26 (high-voltage), 5.0-mf.; C24, .0005-mf.; C29, C30, each .07-mf.; C31, .025-mf. R20 has a value of 3,300 ohms, with a '45 tube; and the "Strap" illustrated replaces a resistor used with '50 amplifiers.

The plate circuit of V3 is coupled through C24 to the grid circuit of V6, the automatic volume-control tube, which automatically governs the amplification of V1 and V2 by changing the grid bias of these tubes; and thus maintains a constant R.F. voltage output. R14, adjusted by the knob at lower left, is the manual control for correct regulation of this tube; at its extreme setting, in a counter-clockwise direction, the magnetic pick-up is connected to the A.F. amplifier binding posts, while the detector is disconnected by Sw1.

V6 is located in the round shield can and may require replacing. To check the operation of this tube, turn the automatic volume control on full and remove the tube. The volume should remain approximately the same. Now replace the tube and (after it has again become sufficiently heated) change the volume control setting to low volume. If the tube should now be removed, the volume will be restored to approximately the same level as with the volume control turned on full. If the volume increases during the first test, the tube is over-controlling and should be changed. (Such a tube will operate exceptionally well as a detector or first audio tube.) If the volume does not increase during the second test, or if the control does not reduce the volume to a whisper, the volume-control tube is under-controlling and should be replaced. Such a tube may be found defective for operation in any other position.



A bottom view of connections at the right of the chassis: showing positions of terminals at top and in the center. The figures at the right edge show the positions of the terminals in the circuit; the voltages at the left, the respective readings between them and ground. "B—" or No. 5 terminal, is below ground potential. The sequence of tubes in the set is from left to right, with V6 between V4 and V5.

R.F. choke Ch1 (located on a single mounting on the lower side of the sub-panel) is catalog No. P55516. Ch2 has a D.C. resistance of about 325 ohms. The primaries of T1 and T2 have resistances of about 800 ohms each.

The voltages shown in the illustration are the operating potentials obtained with a 115-volt supply. Accidental grounding of a high-potential lead, during test, may burn out resistors, damage V9, or blow fuses.

The aligning condensers, mounted on the front of each unit of the gang condenser, are reached by removing the chassis and adjusting through the four round holes in the front of the upper shield. This operation is to be performed while the set is tuned to a weak signal, of a frequency below 1,300 kc. (230 meters); or, since the volume of a station is continually varying, an A.F.-modulated R.F. oscillator may advantageously be used instead. Start the alignment process with the circuit of V1. The maximum capacity of C7 is not the same as for C1, C3 or C5; hence the "apparent" selectivity at high frequencies (low wavelengths, and due to the increased number of dial-scale-divisions per station-carrier position) will not be as great as in the other stages.

To change the drum dial lamp, turn the drum dial so that the opening is on top. The bulb may then be reached with the fingers.

The sensitivity of this set is so great that the antenna binding post will pick up sufficient energy, in certain localities and under certain conditions, to give loud-speaker reproduction of the signal without antenna or ground being connected to the set. If this energy is in the form of interference from radiating electrical equipment or a powerful broadcast station, it may cause disturbance with R1 and R14 adjusted for maximum volume.

Oscillation or squealing, if not due to a station heterodyne, is almost certain to be due to a defective by-pass condenser or faulty tube.

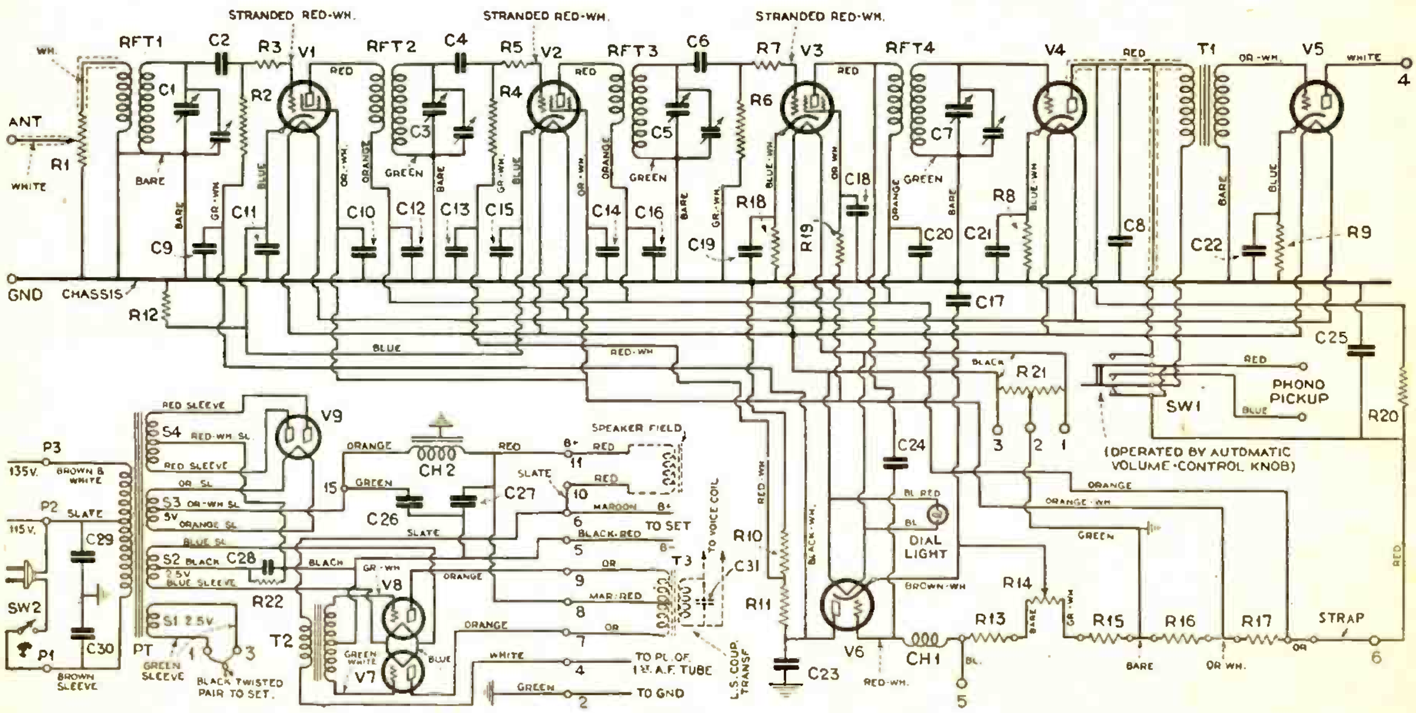
Resistors R11, R10, R9, R8, R13, R15, R16, and R17 are placed in this order and underneath the sub-panel; the last four are of the vitreous type. R12 and R18 use a double mounting, inside the base. R19 is mounted singly inside the base at the rear.

The rating of a replacement fuse is 3 amps.

The chassis is held by four large machine screws through the bottom of the cabinet.

The output transformer T3 is held by four screws and covered by a steel protector, held by two wood screws.

This receiver works best with a good ground connection.



RADIOLA 25 SUPERHETERODYNE

This circuit is one of the variations of the "Second-Harmonic" Radiola Superheterodyne in which the first tube is reflexed for the first stage of intermediate-frequency amplification. The "sequence" of signals in this circuit is as follows: V1 may be considered as both the first stage of R.F. amplification at the broadcast wavelengths, and the first stage of intermediate-frequency amplification at 45 kc.; V2 is the oscillator and first detector; V3 is the second intermediate-frequency amplifier; V4 is the second detector; V5 is first A.F.; and V6 is second A.F. The desired signals are selected by the loop and C1. Since L1A has a high impedance to the broadcast frequencies, the signal, having passed through C5, is amplified by V1 and the output fed to the grid of oscillator V2 through the aperiodic R.F. transformer L3-L4. (The grid circuit of V2 is tuned by L10-C2.) (To prevent circuit oscillation in V1, neutralization has been effected through the use of L1B-C3-C6. C6 is contained inside the catacomb and adjustment of this unit is made at the factory.) The intermediate-frequency component in the plate circuit of V2 is coupled by L2 to L1A and then amplified by V1. The amplified output of V1 at this frequency is coupled by L5-L6 to the second I.F. amplifier V3; and then, after amplification, by L7-L8 to the second detector V4. The A.F. output of this tube is amplified by V5 and V6 in the usual manner.

The units that comprise the "catacomb" are contained within a metal can, represented in the diagram as a dotted outline, and sealed with resin.

L9-L10 are mounted on a bakelite plate under C2. L10 is the upper and L9 is the lower coil (see detail at extreme left); while 5 and 4 are the outside leads, connected as shown in the schematic circuit.

A continuity test of L1A is completed by touching the brass stator-tube of C6; which is accomplished by gently prodding through the small hole, in the top plate, between the sockets for V1 and V2 ("CT," in the diagram).

If one of the two connected phosphor-bronze contact springs in the loop socket breaks, the unused spring (see X in detail at extreme left of diagram) may be used as a replacement. These springs drop into the receptacle and lock into position; they are removed by pushing a small screwdriver into the holes in the side of the bakelite receptacle. If the contact springs on the end of the loop become flattened because of misuse, they may be sprung out again by using a screwdriver placed underneath (this must be done very carefully, else the insulating shell will be split by the excessive pressure).

If the loop is so jarred as to lose its upright position, it may be re-located by loosening the four machine screws that lock the socket-collar in position, moving it around until the loop is again vertical, and then tightening the screws.

Since both sides of the loop are at a different potential from the "A" battery, a "dead" "C" battery may be an indication that one side of the loop circuit has become grounded; the loop may ground if it is carelessly inserted into the receptacle.

V7 is a protective lamp (No. UV-877). It is a double-filament bulb of the "double-contact" bayonet-base type; either or both filaments light or burn out if a short-circuit occurs. In some models of the "25" this lamp and its 1.0-mf. by-pass condenser C13 have been eliminated. If a replacement lamp is not available, temporary operation may be obtained by twisting together its three leads 1 (not numbered), 2 and 3.

Upon removing from the cabinet the chassis and looking at its rear, there will be seen a bakelite connection strip containing 20 connecting lugs; the loop connects to No. 1 at the extreme left, while No. 20 at the extreme right is not connected to anything. Seventeen black wires are seen to leave the catacomb and connect to the lugs shown in the schematic circuit as numbers within circles. By rocking the catacomb on its spring-cradle it will be possible to discern figures, stamped on a bakelite plate underneath the top of the "cat," numbering from 1, at left, to 17 (right) which appear in the diagram as numbers within squares. These stranded leads may short, in a few instances, between two connecting lugs; or between a lug and the case of the "cat." which is grounded to "A+"; or, they may break.

Also at the rear of the "cat." is a connection-panel called a "bus bar" which wires the filaments either in parallel (as shown in the circuit) or in series, when the connection-panel is the special one included in the "A.C. package" required for A.C. operation of this set. Unlighted tubes or noisy operation may be due to loose screws holding and connecting this D.C. bus bar to the specially-provided filament connections of the tube sockets.

Looking at the front of the set, the loop-tuning condenser C1 is at the left; the oscillator-condenser C2 at the right. Noisy or no reception may be due to the rotor pigtail of C1 or C2 touching the stator.

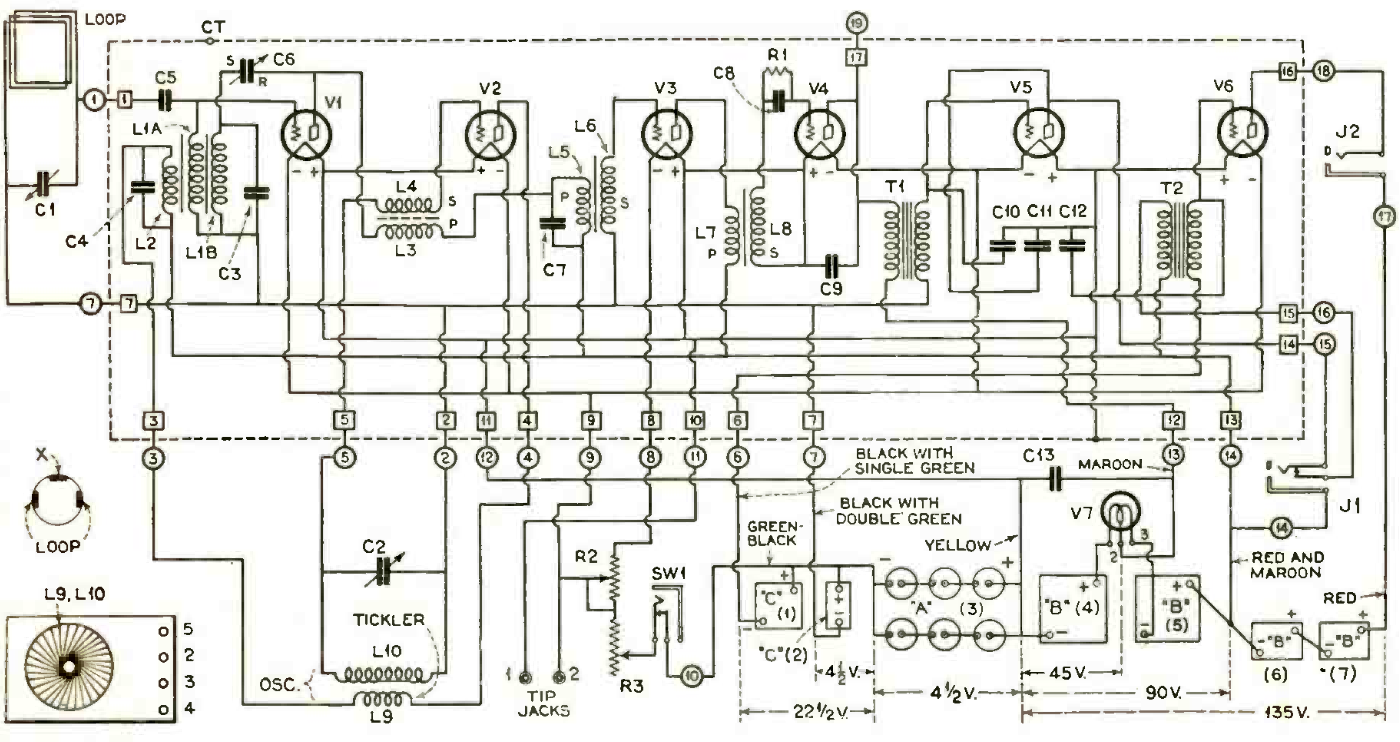
As will be noted from consideration of the diagram, the output of the detector may be connected to an external power amplifier through tap 19; or this tap may be connected to a phonograph pick-up to utilize the A.F. amplifier alone.

Looking at the "cat." from the front, and counting from right to left, tubes 1 to 5 are type '99 tubes marked V1 to V5 in the diagram; V6 (the left and sixth tube). is a type '20. If a single tube is much below par, it is necessary to overload the remaining tubes to bring reception up to standard, and then the tubes deteriorate rapidly; whereas normal life may well be a year and over. The filament potential should never exceed 3.3 volts, and to determine accurately when this voltage has been obtained, a good voltmeter should be connected to the two tip jacks provided on the front vertical panel, just above the filament switch, and shown in the schematic diagram as tip jacks 1 and 2. R3 is the left and master control ("Battery Setting") of these filament potentials; while R2 (right, or "Volume Control") still further reduces the voltage applied to V3.

Batteries of the correct size for the compartments of this set are as follows: C1, Burgess No. 5156BP or Eveready No. 768; C2, Burgess No. 2370 or Eveready No. 771; A3, 6 Burgess No. 6 or Eveready No. 7111 dry cells; B4, 2 45-volt Burgess No. 10308 or Eveready No. 770; B5, 2 22½-volt Burgess No. 2156 (or 2158) or Eveready No. 779.

By plugging into the socket of V5 or V6 a dummy tube base, to the grid-prong of which is soldered a lead wire, it is possible to couple through T1 or T2 the output of V4 or V5 to an external power amplifier of any type, such as push-pull '45s.

The fixed condensers shown in the schematic circuit are, except for C13, within the "cat." non-replaceable, and have values which are not available here.



The Service Man's Open Forum

A SERVICE LEAGUE

WE are organizing a Radio Service League in this territory. Any information you can give us will be highly appreciated. Our purposes are:

(1) Better Radio Service;
(2) Radio Servicing;
(3) Experimental Radio and Theory;
(4) Television;
(5) Short-Wave Work;
(6) "Sound Projection" Engineering;
(7) Amateur Transmitting;
(8) Other Electrical Work;
(9) Standard Prices on Servicing Work;
(10) ....

J. CLARE ELLIOTT,
Claysville, Penn.

(Mr. Elliott's tenth subject, which he omitted, might well be the detection and prevention of local radio interference, which can be dealt with best by an organization. The list of subjects combines the interests of the radio amateur and experimenter with those of the Service Man; among a small group, these distinctly separate fields may be of common interest, as here shown. We shall be especially glad to note the organization of Service Men in various communities for better technical and business practice. *—Editor.*)

SHOOT IF YOU MUST!

MY article, "How a Service Man Does It," in the October issue of RADIO-CRAFT, dealing with repairs to transformers and chokes, seems to have caused much controversy.

By "shooting" (or impressing a voltage higher than the rating under which a choke or transformer operates) the winding, an open circuit may often be closed; the procedure will work in about nine cases out of ten. All this reminds me of a conversation with another Service Man with whom I was checking in the previous day's work:

SERVICE MAN: "This set had an open second audio primary, and I told the customer that we would change the chassis."

CHECKER (*myself*): "Did you try 'shooting' the transformer?"

S. M.: "Did you read that article in RADIO-CRAFT, too? It's a lot of bunk."

C.: "What makes you say that? Did you ever try 'shooting' a winding?"

S. M.: "Sure: once—and it doesn't work."

C.: "You go back today and try it; and report to me tomorrow."

(*Wait between acts*)

S. M.: "It worked, after two tries at it; and I waited an hour to see if it would stay put. But I think we'll have to change the chassis, anyway."

C.: "No, we won't. You see, I wrote the article, and I happen to know that it works."

S. M.: "You—" (speechless.) *Exit.*

I believe that RADIO-CRAFT is doing excellent work. The Data Sheets are very useful to one who is interested in doing the business of repairing sets well; speaking for a number of Service Men, I may say that they would all like to have plenty of data on D.C. operated sets, which many will agree are harder to work than A.C. Your short-wave department should be much larger. Keep up the good work.

BERT M. FREED,
55 Dean St.,
Brooklyn, N. Y.

OPPORTUNITIES

The "Opportunities" column of this month's issue of RADIO-CRAFT will be found on page 543 of this issue. The Service Man who desires to take advantage of this feature may do so without cost, as explained there.

WHAT'S THE USE?

I HAVE just read Mr. Naylor's article, "Don't Blame the Tubes Till You Know," in the February issue. I have just cause to say that Mr. Naylor is right; as I have been in the radio game for about five years, and have had a good many chances to observe the methods used by the various dealers. At present I have in mind one for whom I did some work during the past few months; he was supposed to be the representative for the sets he handles. When I asked him for the diagram for one set, he politely told me that it was not necessary; that I should just go and look the set over and put in a new detector tube, for that was all that was likely to be the matter.

When I got on the job, I tested the tubes and, as they were all O. K., I went at the circuit and found that the trouble was due to a broken-down by-pass condenser and one of the R.F. coils, which was shorted by a piece of wire which was unnecessary in the set. I removed the wire, and the set worked better at once. (I followed out the circuit by means of a diagram I had received from the National Radio Institute, of which I am an active student.)

After the set was taken back, and the customer satisfied, I told the dealer about it. He came back at me with— "Well, if you had put in a new tube for them, they might have been just as well satisfied."

Now talk about your 100% cooperation between the dealer, the Service Man and the customer!

It would be a very good thing for all concerned if the manufacturers would give a little more thought to the subject of having thoroughly qualified men for their distributors.

CARL F. BROSKEY,
Reading, Penn.

HITS THE NAIL ON THE HEAD

I HAVE been a reader of your radio publications for several years, and in December RADIO-CRAFT (Page 249) I note a letter from Mr. Delbert Myers.

Having broken into the Service game several months ago, this particular letter interests me; for it certainly hits the nail on the head.

I encounter the conditions mentioned in the letter, and, were it not for the fact that I have considerable data on hand, THANKS to publications such as yours and others, as well as information gained of the N. R. I., I would have been up against real snags.

So I say, WHY should the manufacturing concerns be so tight with their information? We get the jobs out regardless; but often a little information regarding peculiarities of circuit design, values of constants, etc., would greatly facilitate service.

B. G. CLOTHIER,
Santa Maria, Calif.

STANDARDIZATION WANTED

I HAVE been a reader of RADIO-CRAFT ever since it was put on the market; in fact I was one of the charter subscribers. I am specially interested in the Service Data Sheets which come out monthly.

Why not have binders made to fit these pages and hold about two or three years' run of the Service Sheets, and have the pages perforated at the back; so they could be easily removed for insertion in the binders?

I am sure that every Service Man who buys your magazine would be glad to pay a nominal sum for such a binder; because he would have all of the data at his finger tips at all times, and would have his magazines intact for future reference.

The number of Service Men who read your magazine will run up into the thousands in a few months; so the cost of having these binders made would be reduced to a small figure.

Most Service Men like to carry such data in their test kits on the job; because it would not do them much good on the shelf at home, and that is where it would be if they left it in the magazines.

The most serious service problems today are the set diagrams that do not give even the values of the parts, resistors, fixed condensers, and do not have a continuity test.

The greatest step toward ease of service would be an established system of uniform sizes and values of replacements—resistors, condensers, shunts, etc.

At present each manufacturer has his own pet style and shape of resistor and condenser; which makes it hard for the Service Man to get one to fit without sending to the distributor of that kind of set. Here's hoping the manufacturers get together and standardize these parts soon.

ROY DOUGLASS,
Hastings, Michigan.

(The United States postal laws do not contemplate that magazines shall be used in the manner specified by Mr. Douglass; and prohibit the publishers from printing pages in a manner expressly designed to be removed for reference. Of course, there is no penalty provided by law—as yet—for the reader who cuts out pages and preserves them in any manner he sees fit. This explanation is given because many readers ask us this same question. In other countries, the postal laws are more liberally framed; and recognize the fact that the purpose for which technical publications are printed is to give information of permanent value to their readers.—*Editor.*)

Why and How the Service Man Should Sell

After all, the Service Man is practicing his profession to make money. We will all welcome articles dealing with the financial side of servicing. Mr. Rockhill tells how he developed from a radio fan into a dealer.

By F. C. ROCKHILL

IT has been the writer's experience that the Service Man in small towns does not make nearly as much money out of radio as he could.

About a year ago I decided to go into the radio service game; as I had been called upon by a lot of people to fix up their sets (and most usually without pay) and had discovered that, of the three dealers who sold radios in this town, not one of them had even read a radio magazine of any kind. They could not tell the difference between a radio-frequency transformer and an audio transformer.

I made out a list of all the radio set owners that I knew, and mailed to each one of them a letter stating that I was now servicing radios, and requesting their business. A short time after this, I discovered that many of the owners of the sets I serviced did not like to buy supplies from the local dealers; suspecting that they used a lot of accessories and then sold them for new. So I put in a full line of tubes and accessories, and then went back to my mailing list, which had grown until every man that had a radio in town was listed. I made up a sales letter, telling about my now selling tubes and accessories, and mailed one out to each owner.

The sales were very good and quite a good profit was realized on these alone. Last June the writer heard one of the radio dealers make the remark that he "sold the sets and let Rockhill fix them"; so he himself made the money. This set me to thinking that, if he could sell sets and not give service of any kind, that I ought to be able to sell a good deal more *with service*. A manufacturer at this time was offering a few all-electric sets at a very low price, and four of these sets were bought and offered for sale. This was in July and, at first, there was not a prospect in view; but by the end of the week two of the sets were sold and two more prospects lined up. By the end of the next week, the last two sets were sold, and two more expensive sets with them.

Encouraged by this, I took steps to obtain the agency for one of the best-known lines of receivers; and I will tell something of the methods which I am using to sell them. It must be remembered that this is a small town (in northern New York State) and that my procedure is adapted to a small community. Be that as it may, one must experiment.

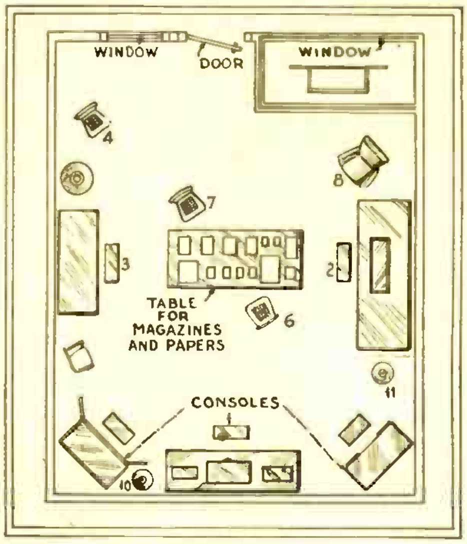


Fig. 1

The layout (not to scale) of Mr. Rockhill's little display room: 1, 2, 3, benches; 4, 5, 6, 7, 8, chairs; 9, 10, 11, floor lamps.

Methods of Selling

The first thing I did was to consider the dealers already engaged in the radio business in this town; and then to decide upon the type of advertising to use in competitition with them. The company which furnishes electricity to the town employs two men selling for them, constantly. A garage in another town also sold here.

To call the attention of prospective customers to my sets, a form letter (reproduced here) was sent out broadcast. Prospects' names came trickling in; and a close study of each name was made, to determine what receiver price class would interest them most. Then a follow-up letter, describing the apparatus that seemed most suitable to their requirements, was sent to each.

A display room on the main street was fitted up (as indicated in the diagram, Fig. 1, which shows the arrangement). Only one receiver of each model is kept on display; the reserve stock being out of sight. Chairs are arranged in a homey manner; no wiring is visible in the room, which is about 12 x 14 feet. When a prospect comes, we try to avoid the appearance of a place of business; in other words, we allow the customer to "sell" himself. This plan has proved very successful, so far.

In addition, outside selling is carried on. Names of other prospects are secured, usually from older customers; and we call upon these in their own homes. An allowance, determined by the sale made and the selling effort required on our own part, is made to customers who assist us to a sale.

The local newspaper carries our advertisement each week, and slides are run during each show at the local theater. At the present time, we are building an amplifier for use in the theater, and we expect to obtain a lot of good advertising through this.

Follow-up cards are used on every sale; and all service calls are noted on these. The price received for the set is listed in one column; the cost, with express charges, and service charges during the period of free service (90 days) are noted in the other. At the end of the ninety days, a balance is struck, and our net profit listed on that page. The rest of the sheet is used whenever accessories for that set are sold; so that we have in compact form a record of all the business given us by the owner of that set.

As we carry on independent service work also, our overhead is computed on the sales made by both departments, and deducted; giving the net profit.

Radio Sets—Power Amplifiers—Accessories

F. C. ROCKHILL

Authorized R. C. A. Radiola Dealer

St. Regis Falls, N. Y.

Radio Sales and Service

October 21, 1929

Dear Sir:

You can buy a Radio set most anywhere now; but you cannot match the values that we offer right here at home. There is also the question of service. If bought from us, we are right here to give you prompt service; no waiting for an outside Service Man who has more ground to cover than he can—so you are left waiting or you must find some one else.

Our sets are made by the largest Radio Company in the world (*Radio Corporation*) and there is a model to suit every one. Prices range from $88.50 to $750.00 and the quality is the best regardless of price.

They are sold on the easy payment plan and terms can be arranged to suit you. Won't you call and look these sets over, or mail the enclosed card and we will call on you?

Sincerely yours,
F. C. Rockhill.

The introductory form letter.

Dear Sir:

I hear that you are interested in a new radio receiver; so I am writing to you to tell you about the Radiolas 44 and 46.

The 44 and 46 use the new Screen-Grid tubes that you hear so much about. Three of these tubes are used in each machine, two as radio frequency amplifiers and the other as a power detector; which gives to this Radio the ability to receive far distant stations with great volume. The amplification in the detector stage is so great that only one stage of audio is needed; this part of the receiver employs another new tube, the 245 power tube which gives a volume and depth of tone that has never been equaled before.

The 44 is a compact table model in a beautiful walnut veneer cabinet and the 46 is a console model with the famous Radiola dynamic speaker built in. Both are single dial with the volume-control knob mounted on the same shaft with the tuning knob; making this Radio one that can be truly operated with one hand.

Call and see these machines as they must be viewed to be appreciated, or mail the enclosed card and one will be brought to your home for a free demonstration. May I hear from you?

Truly yours,
F. C. Rockhill.

A sales letter for certain models.

Dear Sir:

I have just received a new Radiola 33 that I would like to place into your home on demonstration. *Gratis*.

This is an all-electric radio of the latest type and sells complete for only $88.50. This machine is sold with our usual guarantee and is serviced for a period of ninety days free of all charges.

They may be purchased on the easy-payment plan and a liberal allowance will be made for your old radio set. Simply mail the enclosed card or call and you will find me at your service.

May I hear from you?

Very truly yours,
F. C. ROCKHILL

A letter to a low-price prospect.

Making Service Pay

To make a service department pay in connection with the sale of sets was a problem at first; but it has been solved. Some of the methods used are described below.

All accessory sales are credited to the Service Department; as we feel that this is largely responsible for these sales. This, of course, boosts the showing of this department a good deal.

A card-index system is used, in which we list all set owners who are near enough for us to service quickly. A separate list is kept of set owners who live at a greater distance.

On each owner's card, as with sets sold by us, there is recorded the make of receiver, work done and accessories sold. When a call comes in, this card is consulted; and with the information provided by the customer, a rather accurate forecast of the trouble to be expected can be made.

Once each month the file is gone over; and a letter suggesting a visit from the Service Man to check the performance of the set is sent to each owner who has not put in a call for ten weeks. A charge is made for each call, the amount depending on the time required to come and go.

Replacements are charged at the regular list prices, plus the price for labor. The tubes in the set being serviced are tested; and new ones put in to replace those which do not show up as well as they should. This one feature saves many "no charge" calls; and the customer is generally well pleased, since the set performs much better. After servicing the set, the Service Man calls to the owner's attention any accessories which would improve its performance; and this results in quite a few additional sales. In addition, it gives the customer the impression that you are taking a lot of interest in him.

This fall we obtained from the R. C. A. two-color postal cards (in sets of six) calling the attention of the set owner to the fact that new Radiotrons might make the old set work as well as when it was new. These were mailed at intervals of six days; and the results were very satisfactory. The cost of the mailings was small—just that of the cards—and we trace to them the sale of several A.C. dynamic speakers to owners of old A.C. sets who had magnetic speakers, as a result of gaining admittance for the Service Man to the customer's home.

Some Service Hints

Here are a few of the technical problems that we have encountered:

Tube distortion happens often in sets having a '71A power tube; and at first gives the impression that the speaker is loose and rattling. It is due, however, to low filament emission; and a new tube corrects the trouble at once. Watch for '27 tubes that have a blue haze when operating; and for shorted elements in the '45s.

Dear Sir:

I would like to call your attention to the fact that the Radiola 60 for $138.00 is now one of the best buys in the radio market today; so I am taking the liberty of writing you regarding this set.

This set uses nine of the new A.C. tubes in the famous superheterodyne circuit, which makes it one of the most powerful, selective and sensitive of sets. It also makes use of a power detector, and has only one stage of audio amplification; which results in a true and lifelike tone.

It may be purchased on the easy-payment plan and a liberal allowance will be allowed you on your old set. Simply mail the enclosed card or call, and you will find that I am glad to serve you.

May I hear from you?

Very truly yours,
F. C. ROCKHILL.

Short and to the point.

Sometime the "Radiola 33" does not seem to be as sensitive as it should be. Test the tubes, and put the best '26 in the second socket from the right (facing the receiver). The compensating condenser should be adjusted just below the oscillation point. This unit is located at the back of the chassis, and may be reached through a small hole in the back of the cabinet—the last to the left, facing the rear of the chassis.

In the Atwater Kents, watch for shorted by-pass condensers and for an open voice coil in the dynamic. The plate voltages will generally read low if condensers are shorted. At times, too, the voice coil in the speaker will ground to the speaker frame; so, if everything else seems O. K., test for shorts between the speaker terminals and its frame.

From Service Man to Radio Engineer

By DR. ALFRED N. GOLDSMITH

Vice-President and General Engineer, Radio Corporation of America

BEFORE entering the radio field, a young man should ask himself these questions: Have I a keen ear, a quick eye, and some skill at manipulation? Do I quickly grasp scientific facts about machinery and electrical devices? Am I willing to study nights? Am I prepared to spend several years working my way up from the bottom in a radio factory, a broadcast station, or a transoceanic or a marine station? And will I be at home in an engineering profession?

If he can answer all of these questions sincerely and positively in the affirmative, he may consider radio as a profession.

There are two ways to get into the radio field. One of them is to study electrical engineering, and finally concentrating on radio engineering. He can then enter a radio company in an assistant engineering capacity and work his way up.

The other method largely involves *self-tuition*.

It is a harder way and a longer way, and requires real grit and unusual aptitude. The prospective radio engineer must study at home the best available books on elementary and advanced physics, algebra, some trigonometry, some good books on direct- and alternating-current machinery, and a succession of radio engineering text books, starting with the more elementary and ending up with the most advanced books which he can find. At the same time, or shortly thereafter, he will do well first to assemble a number of radio sets himself at his home, and then to get a job in the assembly of radio sets, or in the testing or servicing of sets with a reliable and up-to-date radio concern. By sticking to this job, and keeping his eyes and ears open, there is no reason why he should not within a few years secure a fairly responsible position as an engineer in the radio field.

He should also keep in touch with other engineers and attend meetings of engineering societies, at the same time reading the best journals which he can secure. It is only in this way that he can keep up-to-date in the radio art.

Radio engineering is a splendid profession for a moderate number of ambitious young Americans, but it has no place for the man who is waiting for life to hand him its rewards on a gold platter. He will have to learn his job and stick to it.

FOR THE AMBITIOUS

THIS interesting article, outlining the opportunities for the intelligent and ambitious young man who desires to graduate from the status of a Radio Service Man into that of a Radio Engineer—truly deserving the name—was written nearly four years ago by Dr. Alfred N. Goldsmith, the well-known authority on radio, who has been since that time elected president of the Institute of Radio Engineers, to Mr. Boris S. Naimark, of New York City.

RADIO-CRAFT asked of Dr. Goldsmith if he had anything to add to this message for Service Men of 1930; and he replied: "I do not think it would be desirable to enlarge on it; its brevity is, I believe, one of its virtues." Its inspirational value is another; there are many of the readers of this magazine who will, we are confident, profit by it, and act accordingly.

The Possibilities of the Pentode

A conservative appraisal of the latest radio tube, from the man who gave radio its growth by making the first one.

By DR. LEE DE FOREST

BACK in the early days of 1908-9, when I wanted to get more power out of the audion, which up to that time had contained only a single grid and a single plate, (or "wing," as it was then called), I asked McCandless, who was making audions for me, to put in a duplicate set of a grid and a plate, on the opposite side of the filament. This was done, and the two additional leads were brought out at the top of the tube, independent and insulated from each other.

With this combination I was able to try out a great number of novel hook-ups; for I had then two independent plates and two independent grids, with a common filament.

For standard use as a detector or an audio amplifier, I always connected the two plates in parallel, and the same with the two grids.

Later on, McCandless connected the two plates together inside the bulb, as also the two grids; bringing out only two leads instead of four. This arrangement gave me the close equivalent of the box or cylindrical types of plate and grid; although my first actual cylindrical grid and plate electrodes were constructed in the spring of 1913.

Early Experiments

But I did a lot of experimenting with these "tetrode" and "pentode" types of audion (in which the four leads from the two grids and the two plates came out separately) during the years from 1912 to 1916.

One of the most interesting circuits, of all I found, was the "double-oscillator" type; where one plate and the *opposite* grid were connected together through an R.F. coil with a variable condenser in shunt thereto, and a grid-stopping condenser to keep the plate voltage off the grid. When both plate-grid pairs were thus linked, through distinct but coupled R.F. coils, an exceedingly intense oscillator, of very short wavelengths, was obtained.

Some of the very interesting circuits, combinations of radio and audio frequencies, then obtained are outlined in my U. S. Patent No. 1,311,264, filed September 4, 1915. There is shown schematically the screen-grid tube construction, as well as some early forms of "push-pull" arrangements. Incidentally, the arrangements there shown of the "oscillator grid" with another grid for audio modulation will, I am convinced, be found very useful in the future, for small-power, light-weight radiophone transmitters for very short-wave work.

But all that I have above stated, while interesting as showing the early history of what has recently been developed into the modern pentode tube, is of little direct bearing on the matter I am now asked to discuss—the possibilities of the latter.

DR. LEE DE FOREST

President of the Institute of Radio Engineers, and Inventor of the Audion Vacuum Tube

Although the intensive development of the audion tube, in quantity production, brought about by the insistent demands of war, stopped work on the multi-electrode tube, radio engineers have recently returned to this rich field of research. Last year, in this country, the tetrode, or screen-grid tube, was finally put on a firm engineering basis of accurate quantity production. Many were the headaches endured, and many the fortunes lost, in prematurely bringing out screen-grid sets before the tube itself was on a secure basis.

Advantages of the Pentode

And, more recently, radio engineers have returned to the pentode. Those who have followed this path of research view the possibilities of the pentode with enthusiasm; and rightly so, as I well know. And I am convinced that the "split-plate" will permit of great developments which have, thus far, been generally unthought of in connection with the five-element tube. Undoubtedly this will be one of the many new features of the pentode of tomorrow, especially for transmitting purposes.

Now that the radio market has tightened up, manufacturers are casting about for fertile fields. The farm population of this country (which, contrary to general opinion, uses the radio more than any other class of our heterogeneous population) has been as yet largely neglected. Battery receivers have been made for farm consumption; but for the most part they have not approached the quality of the A.C. sets. The nine million American homes still unwired present a tremendous market. It is entirely possible that the pentode will soon be found in battery sets manufactured for rural consumption.

Let us hope that amateur radio, now dormant, will again come to the fore. Amateur transmitters with a single tube should be most popular; and this tube will, in all probability, be the pentode, with its many possibilities for those ingenious and tireless workers.

In England, where radio receivers are taxed according to the number of tubes they use, the pentode is a great economy; such a situation is non-existent in this country. However, (though I hope to the contrary) if the crass advertising which our broadcast sponsors are foisting upon the public continues, that public might decide that it is worth while to pay a small fee or tax, which will be allotted by the government to the broadcast stations, in return for unadulterated entertainment. Such a move is already on foot; if it materializes, the chances are that such a tax will be based on the number of tubes. And if so, the pentode will then come into its own in our country.

Problems of the Pentode

The cost of pentodes will always be higher than that of the simpler types. Only those tube engineers who have themselves encountered and overcome the thousand-and-one difficulties, which faced them in putting into practise accurate quantity manufacture of the screen-grid tube, can begin to appreciate what it will cost to do the same for the three-grid type. The addition of this third grid will introduce a series of difficulties, in assemblage, gauging, inspection, testing, entirely disproportionate to the number of elements added.

It is certain that the life of the filament or cathode will be no longer than for the '27 or '24 types, which cost much less. And when a pentode burns out out goes the entire tube. So an unfortunate mal-adjustment of the tube will be disproportionately more costly.

It is not my intent here to go into a detailed description of the modern pentode, or the various methods of using it. Suffice it to say here that, by the use of the third grid, positively charged to act as a "space-charge" grid, all the advantages of employing the extra grid in the '24 type as a space-charge grid are retained; while the tube may still be used as a screen-grid type with its excessively small control-grid-plate capacity, its high mu, etc.

But do not for one moment assume that there is not a basket-full of trouble ahead of the set manufacturer before he gets a really reliable, foolproof, pentode set on the unstable sea of market popularity. And this is assuming (a long assumption) that the tube manufacturers will soon be able to turn out large quantities of reliable, standardized, interchangeable pentodes with a long life and practically non-microphonic.

Most of the development work on pentodes has been carried out in Europe. Just

(*Continued on page 513*)

Developments in Beam Radio

How the sharply directional characteristics of the Short Waves are used to link together continents by telephone and with international broadcast programs, as well as to develop safety in aviation

By LAURENCE M. COCKADAY

Fig. A
An experimental short-wave receiving station of the General Electric Co. at Schenectady, N. Y.

FIVE years ago this month, experiments with high-frequency transmissions were first being begun. During this tempestuous half-decade, many transitions have taken place. Today, these rapidly-vibrating radio signals are being focused like invisible wires to destinations half-way around the globe, concentrating a given amount of power, not into all directions, but stretching out in a narrow beam pointing to the desired receiving station and warding off reception at undesired points. In a similar manner they are providing eyes for aircraft pilots blinded by bad weather, as if to point a finger to the spot of safe landing.

When the science of radio communication was very young, the transmission of a signal in a given direction was thought to be preposterous. Engineers often dreamed of the day when it would be possible to direct a signal to a given point; but almost all discarded the problem as a hopeless task. It was considered to be one of the many phenomena of radio transmission, that an antenna should radiate a signal of equal intensity in all directions.

Not until the practicability of short-wave transmission was well beyond the experimental stage, was it discovered that the size and shape of the radiator employed has an important bearing on the good or bad reception of a signal at a given distance and direction from the transmitter. During these early days of real development it was found that signals emitted from a horizontal antenna had greater signal strength and consistency in the direction to which it pointed; with perhaps a more pronounced directional effect favoring the lead-in end of the aerial. Similarly, it was discovered that a vertical antenna showed practically no directional favoritism.

Fig. E
A short-wave receiver especially designed for installation in an airplane.
(Radio Corporation of America)

Fig. B
The transmitter of the ground apparatus at Mineola, N. Y., used to direct Lieut. Doolittle's "blind" flight from and to Mitchel Field. Its signals were viewed in an indicator like that of Fig. D.

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Wave Polarization

The findings led engineers and experimenters to believe that it would therefore be possible to confine a radio signal within a small arc, and direct it to a desired locality without much difficulty. Marconi was one of the first to discover this phenomenon, and design a reflector system of radiating signals which could be directed, and would virtually confine almost all of the normal radiated power to a given direction; thus building up the radiating qualities of a given-powered transmitter and greatly increasing the normal range. Also, by restricting the signal to a small sector, reception would be virtually cut off in all other directions, and thus secrecy, one of the greatest problems of transmission, would be partly obtained.

Marconi discovered, as did others, that placing a meshed "screen" of wire behind a high-frequency radiator would tend to shield transmission behind the mesh, and polarize the waves in the opposite direction. During the course of his experiments, it was found that the size of the reflector, its position and design bore a direct relation to the wavelength of the transmitter. Thousands of different types of antennas and reflectors were experimented with. Some took the shape of a series of a dozen or more vertical antennas arranged to form a parabolic reflector, some being connected directly to the transmitting set, and others merely hanging, to absorb the signals radiating in the undesired direction. An attempt was even made to build a huge radiating system on a revolving platform which could be rotated in any direction to "shoot" the radio signals to any desired destination.

No small amount of work on beam experimentation has been done by Dr. E. F. W. Alexanderson, of the General Electric Company, at Schenectady. When Marconi was first experimenting with his beam theory, Alexanderson was busy in his laboratory experimenting with polarized propagation of short-wave signals. He tried several hundred different types of directional antennas, varying from fifty feet to two miles in length, and ranging in height from one foot to four hundred feet; and discovered that a radiating system which emitted a purely horizontal signal had unusual characteristics.

For several months during 1926 he carried on experiments with a receiving station on Long Island, a hundred miles away, transmitting first purely horizontally-polarized waves, then vertically polarized signals. While this phenomenon had been previously known at the time of his experiments, and he was credited with "rediscovering" horizontal polarization, it was the first time the principle had been applied to cast a signal in a given direction.

Fig. D

The visual-reed indicator used by aviators to receive beacon signals; the diversion of the white reeds to either side shows a departure from the course.

As a result of these experiments, Alexanderson developed a number of different types of reflectors and directional types of antennas, and many of these are in use today by American short-wave telegraph stations carrying on communication with all points of the globe.

The "Beam" Systems

The beam or directional antenna has virtually revolutionized the international communication systems of the world, and made possible, not only telegraphy, but telephoning over distances previously impossible. Through the system of directional transmission developed by Marconi, Great Britain now maintains one of the most extensive beam radio systems of the world, which reaches out like long fingers to each of the country's dominions, islands and possessions, and forms a spider-web-like communication network which facilitates constant communication from all of these remote lands to London.

Other foreign countries have also done considerable experiments on world-wide high-frequency communication. Holland has been an ardent experimenter along this line. Ever since its possibilities in the early days of wireless telephony, short-wave distribution has been a subject of serious study and experimentation among Dutch scientists; and the Dutch Government has also shown wisdom in encouraging such study and research. While long-wave broadcasting does not flourish in Holland, because of political influences, in the domain of short waves, Holland has in several matters beaten the world. Some of the success is due to the experiments of a great electrical firm at Eindhoven which employs, besides twenty thousand workers, eminent electricians, engineers and inventors, whose work is known to millions of the public, but whose names are known to only scientific circles.

It was as recently as 1927 that a surprise was accorded the directors of the radiophone transmitters at Eindhoven by the reception of a telegram from the East Indies, that a concert had been picked up at Bandoeng, Java, 7,000 miles away. A little later a successful world broadcast was made through this transmitter, the transmission being a concert of Mengelberg and his Amsterdam Concert Orchestra. Holland has perhaps the most modern short-wave broadcasting apparatus in the world, and the signals of the station, PCJ, are consistently received in the United States by amateurs, and frequently rebroadcast by American stations.

The "Skip Distance"

"Skip-distance" phenomena which cause radio signals, transmitted on a given wavelength to a known destination, to be reliable during only a certain few hours of the day, may soon be reduced to a negligible problem as the result of present beam experiments. My own experiments with short-wave phenomena almost definitely prove that the so-called "skip distance" effect is caused by the radiation from an antenna, at an obtuse angle, of signals which therefore strike a layer of ionized atmosphere, (commonly referred to as the Heaviside Layer) and are reflected back to earth. (The action is similar to that which is produced when a narrow beam of light is flashed on a mirror, the light being reflected away from the mirror at an angle equal to that of the direct beam.)

Experiments are now under way for building a beam antenna which will radiate a signal at the desired angle to strike the Heaviside layer, and rebound to earth right at the receiving station. These researches are experimental; as there are many facts to be discovered before the idea is developed to practicability. The ionized layer of atmosphere is constantly varying in height;

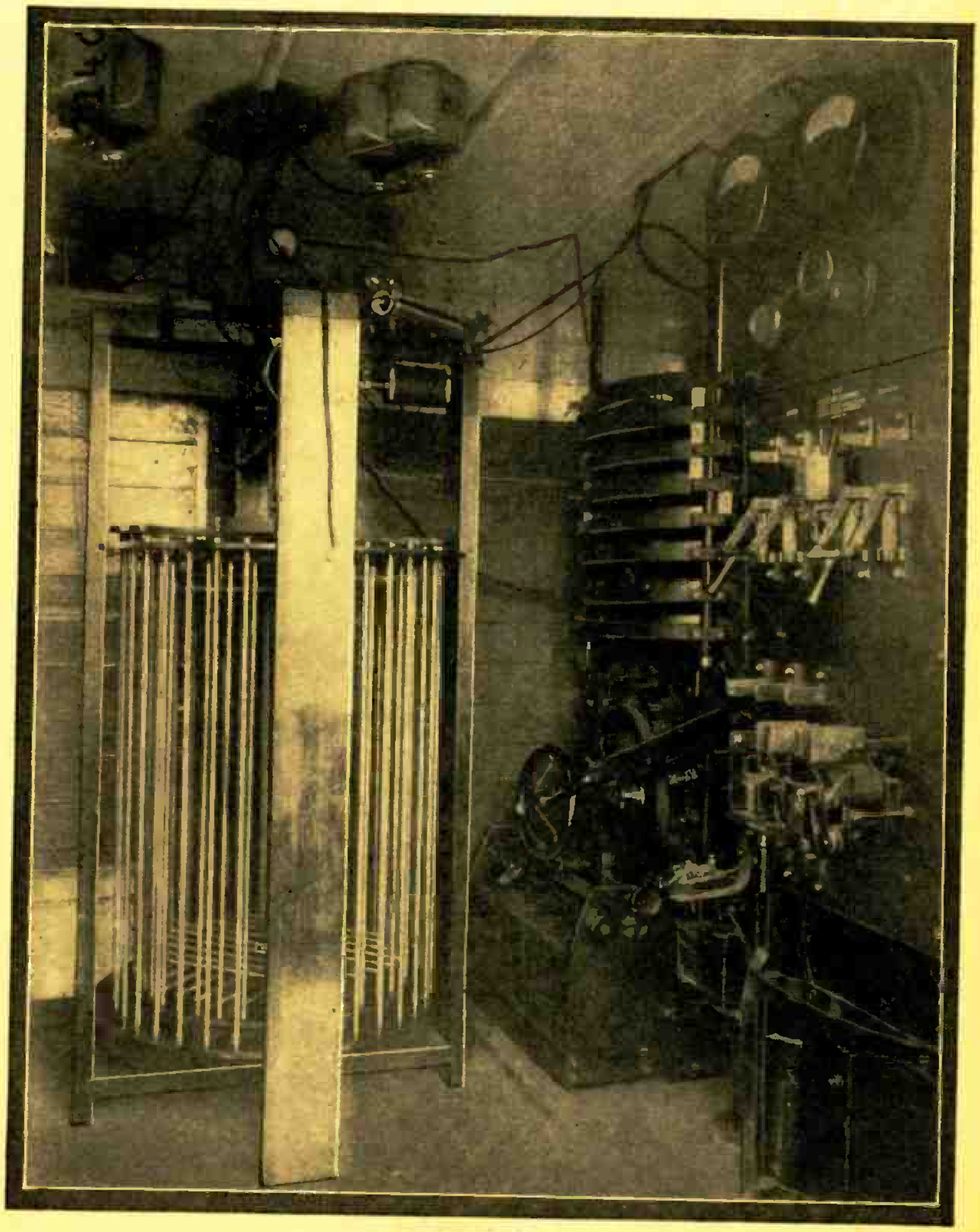


Fig. C

The interior of a radio beacon station, showing the transmitting apparatus, which is connected to huge loop antennas outside. (From an official photograph by the U. S. Army Air Corps.)

which, of course, would change the angle of reflection. Also, these strata above the earth's atmosphere frequently have a tendency to absorb a signal, carrying it for an undeterminable distance before it returns to earth. While the idea has some merit, a considerable amount of research will be required before it is fully developed and understood.

Perhaps one of the most recent developments in high-frequency beam transmission has been the transatlantic radio-telephone circuit installed by the American Telephone and Telegraph Company, in co-operation with the British Post Office. One of the most modern beam stations in the world was erected by the company at Laurenceville, N. J., last June. The station represents the latest innovations in the design and practice of short-wave beam telephone equipment. It is located atop a high hill, about one mile from Laurenceville and three miles south of Princeton. The towers, which are visible for miles around the surrounding country, number twenty-four in all, and support a beam or broadside antenna of the latest type. (A portion of this, and other beam antennas, were illustrated in my article in the preceding issue of RADIO-CRAFT.)

Transmitting equipment is housed in two separate buildings about a half mile apart, each of which contains two transmitting sets. Both transmitters in the west building are used on the European circuit of the system.

MR. COCKADAY, well known to all our readers as a radio authority and publicist, will contribute to each issue of RADIO-CRAFT an article reviewing the latest developments in applied radio, during the coming year. We know that they will be among the most valued features of this magazine.—*Editor*.

Plan of the System

Because of the inherent characteristics of the beam antenna, the aerial masts are erected in an "L" formation, one leg of which is used for the London circuits, and the other for South America. The antennas for the three short-wave systems to Europe are in a direct line and are supported by nineteen steel towers at 250-foot intervals. This series of nineteen towers stands in line as nearly at right angles to the direction of New Southgate, England (the location of the London receiving station) as surveying permits. The wires forming each part of the three antennas are not strung on top of the towers, however, but, like a coarse-meshed screen or curtain, hang in a vertical plane between the towers; the lower edge of the screen or curtain coming within several feet of the ground.

The design of the antennas is calculated to give a marked directional effect to the outgoing signals. Because of the arrangement of interconnecting wires in the form of a coarse-meshed screen, the dimensions of which bear a definite relation to the wavelength of the impulses sent out, the signals are strongest in a direction at right angles to the plane of the curtain. The impulses sent out from the various vertical segments of each antenna cross one another and, therefore, neutralize one another.

In an antenna consisting of a single curtain, strong signals would also be sent out in the opposite direction from England. To divert these to useful purposes, a "reflector" curtain, similar in design to the "exciter" or transmitting curtain, is hung at a certain definite interval behind it. This reflector curtain of wires, in no way electrically connected to the front curtain, plays the role of a mirror; the energy reaching it from the exciter curtain is reflected in the direction of England, and thus signals moving that way are reinforced.

Each of the transmitters can operate on three wavelengths, approximately 16, 22 and 33 meters. The three are desirable in order to give the best efficiency of transmission; since one wavelength seems to work better at different times of the day than the other. Specially-designed crystal oscillators, contained in metal shield cans and maintained at a constant temperature, make possible the operation of the station within a half meter.

Radio in Aviation

Beam transmission in a slightly different form, but embodying the same principles, has literally given aircraft pilots automatic eyes, enabling them to fly through the severest of bad weather with the safety of clear vision. The marriage of aviation and radio has been accomplished virtually through the development of these short-wave beam systems of guiding and navigating aircraft. The past year has seen the installation of radio apparatus on practically every important air route in the United States, and the installation of adequate apparatus on every commercial piece of aircraft in the country.

The Federal Radio Commission has contributed no small amount to this successful marriage by the designation of sixty-four short-wave or high-frequency channels for the exclusive use of aviation. The aeronautical division of the Department of Commerce has installed and put in operation twelve stations, situated along the major transcontinental air routes, for transmission of weather reports and similar information. Practically every air-mail plane in the country is radio-equipped.

Perhaps the greatest contribution of short waves to this development is the perfection of the radio directive beacon, or the "visual-reed" indicator. (See Fig. D). This system involves the transmission of a characteristic signal from each of two transmitting stations along the air route.

The pilot determines his course by watching the reed indicator, which is installed on the instrument board of his plane. Should he veer to one side or the other, the variation in the beat caused by the interference of the signals would cause the reed to swing in that direction, and vice versa. This enables the flyer to take a direct course to the airport, regardless of the weather conditions.

Perhaps the most practical demonstration of the visual-reed indicator was the experiment successfully completed in October, 1929, by Lieutenant James H. Doolittle, who took-off at Mitchel Field, Long Island, and flew for a distance of fifteen miles in a blind cockpit. The tests were the culmination of a series of experiments conducted under the direction of the Daniel Guggenheim Fund for Aeronautics.

When Doolittle took-off, he was inclosed in a hooded cockpit of a small biplane. He flew directly into the wind, for a course of about five miles, following the direction of the radio beacon. On the instrument board, the visual-reed indicator told him how nearly he was following the course. As he veered to one side, one of the reeds vibrated more profusely than the other; and he shaped his course until both were vibrating in synchronism. At a point five miles from the take-off, he turned about and returned to the field.

As he drew closer, the reeds oscillated

(*Continued on page 530*)

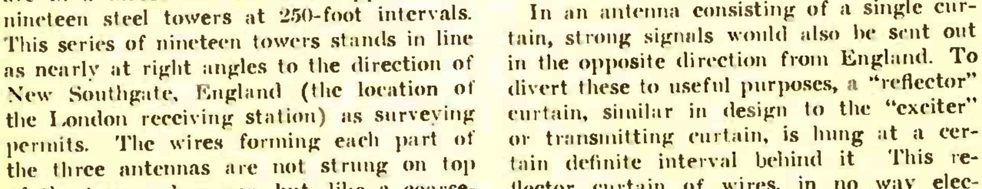


Fig. 1

The schematic circuit of the essential features of the airplane radio beacon. The automatic signals, sent out by the two transmitting loops at right angles to each other, blend perfectly only on the angle of 45° to each loop. Outside this course, the aviator receives a signal showing that he is straying from his route.

Men Who Have Made Radio-G. W. Pickard

THE SEVENTH OF A SERIES

TO cajole that coy dame, Science, into making herself useful in the world, there are needed not only keen reasoners and brilliant inventors, but the possessors of that genius which has been defined as an infinite capacity for taking pains. The subject of this brief biographical sketch is a man who has exemplified all three of these indispensable characters, in his life work of developing radio from a mysterious feat of advanced engineering to a household necessity, for even the humblest house. Even today, there are millions throughout the world who still rely for their share, in the benefits of radio, upon the simple crystal whose magical properties he discovered.

Greenleaf Whittier Pickard, a grandnephew of the poet for whom he was named, was born at Portland, Maine, February 14, 1877. Educated at Harvard and M. I. T., he turned his attention as a young man to radio. Under the auspices of the Smithsonian Institution, he experimented in "wireless" at the Blue Hill Observatory, near Boston, in 1898; and later worked with the A. T. & T. Co. on the problems of telephony. Theoretically, the experiments were successful; but the means of obtaining a suitable carrier wave and a suitable amplifier were to be provided only years later.

At that time the detector presented the most trying problem to radio men. The fundamental defects of the coherer were obvious to all; and Pickard devoted his attention to this subject most fruitfully. He found in 1902 that a contact between a steel point and a carbon block added highly to the sensitivity of a receiver. Pursuing his experiments with all manner of substances, he determined the extraordinary sensitivity of the crystal; and thereby made possible radio reception with simple and inexpensive apparatus. During the next four years, no less than 31,250 combinations of minerals and metals were tried by him, to determine which effected the most satisfactory results. To this day, as we have said, the simple crystal set affords immeasurable pleasure to thousands of listeners in this country; as well as to millions abroad, where the costly multi-tube set is still beyond the reach of the masses. The crystal detector has merits which still commend it to many radio experimenters as a part of pretentious circuits.

In the early days, as now, static was recognized as the deadliest enemy of radio reception, and Pickard constituted himself its most persistent foe. In 1902, he began research work on the loop antenna as a means not only of obtaining strong signals from the desired station, but also of eliminating atmospheric "strays." His studies led to the development of the radio compass which he demonstrated before the representatives of the United States Navy in 1907.

His continued work in the study of the

(*Continued on page 529*)

Attention: Radio Service Men

RADIO-CRAFT is compiling an international list of names of qualified service men throughout the United States and Canada, as well as in foreign countries.

This list, which RADIO-CRAFT is trying to make the most complete one in the world, will be a connecting link between the radio manufacturer and the radio service man.

RADIO-CRAFT is continuously being solicited by radio manufacturers for the names of competent service men; and it is for this purpose only that this list is being compiled. There is no charge for this service to either radio service men or radio manufacturers.

We are hereby asking every reader of RADIO-CRAFT who is a professional service man to fill out the blank printed on this page or (if he prefers not to cut the page of this magazine) to put the same information on his letterhead or that of his firm, and send it in to RADIO-CRAFT. The data thus obtained will be arranged in systematic form and will constitute an official list of radio service men, throughout the United States and foreign countries, available to radio manufacturers. This list makes possible increased cooperation for the benefit of the industry and all concerned in the betterment of the radio trade.

NATIONAL LIST OF SERVICE MEN,
c/o RADIO-CRAFT, 98 Park Place, New York, N. Y.

Please enter the undersigned in the files of your National List of Radio Service Men. My qualifications are as set forth below:

Name (please print) ....
Address .... (City) .... (State) ....
Firm Name and Address ....
(If in business for self, please so state)
Age .... Years' Experience in Radio Construction? ....
Years in Professional Servicing? ....
Have You Agency for Commercial Sets? .... (What Makes?)
....
What Tubes Do You Recommend? ....
Custom Builder .... (What Specialties?) ....
Study Courses Taken in Radio Work from Following Institutions
....
Specialized in Servicing Following Makes ....
....
What Testing Equipment Do You Own? ....
What Other Trades or Professions? ....
Educational and Other Qualifications? ....
Comments ....

(APRIL) (Signed) ....

Short Wave Craft

Five Meters or Bust!

By CLYDE A. RANDON

SEVERAL years' experience of the wavelengths below twenty meters has resulted in a wealth of practical information which is of unusual interest; because these frequencies are practically unexplored and are fertile ground for experimenters and amateurs interested in extraordinary effects. Ordinary apparatus can be used for work at five meters and, with the description of a receiver and transmitter which are easily constructed at small cost, in this article, anyone interested can successfully operate here.

The ordinary experimenter, when attempting operation for the first time at the extremely short wavelength of five meters, usually makes several mistakes. In the first place, the existing transmitter and receiver in the station are dismantled, partly at least, and entirely new outfits are hooked up. Needless to state, they do not operate at once, and the experimenter is at a loss to explain why.

The reason is not difficult to see. An automobile designed to have a maximum speed of sixty miles an hour simply will not go eighty; and the ordinary tubes and equipment designed for low frequencies simply will not operate successfully at higher frequencies. The conditions are so very different that special precautions must be taken. One should go about the work, at extremely high frequencies, in a systematic manner and gradually working from known to unknown conditions—and that's sufficient excuse for the following instructions.

Not Too Fast

Take it easy. Your present transmitter and receiver probably operate at forty meters; but the procedure applies equally well to a twenty- or even an eighty-meter transmitter. First, gradually reduce the number of turns in the inductor (the popular Hartley circuit shown in Fig. 1 will be used for an example). Each time, reset the filament clip properly and readjust the set for proper oscillation, testing for this with the station wavemeter. If none is available for use at the very high frequencies, shunt a 5-plate condenser (or some other convenient size) across a small coil in series with a flashlight-lamp, as in the usual "ham" wavemeter. Each time, light the flashlight-bulb by coupling it to the transmitter.

If at any time the set will not oscillate, retrace your steps carefully, making one change at a time, until oscillation is again produced. In the vicinity of fifteen meters, it will probably be discovered that changing the R.F. choke in the transmitter to a couple of small coils Ch1, Ch2 (described later) connected in series, as shown in Fig. 2, will again restore oscillation. When oscillation is again produced, the number of turns can be reduced still further, while allowing the set to operate properly.

It will be at last found that the tuning condenser across the oscillating circuit can be removed, because the distributed capacity of the coil is sufficient for oscillation.

No filament clip is necessary. In fact, operation is often extremely erratic when a filament clip is used; and oscillation can be produced, under these conditions, only by inserting in the filament-clip lead a small condenser or choke coil. But operation is better without any filament clip at all, as shown in Fig. 2.

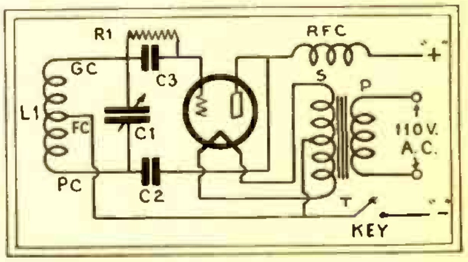


Fig. 1
The original Hartley circuit as used at, say, twenty meters before starting to overhaul it for five-meter work.

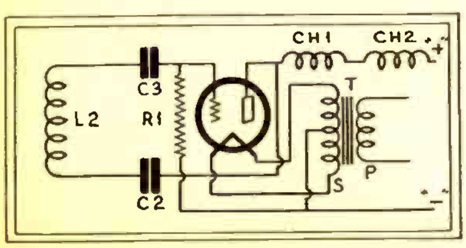


Fig. 2
Now the circuit of Fig. 1 has been cut down to about half the former wavelength, with only a couple of turns in L2.

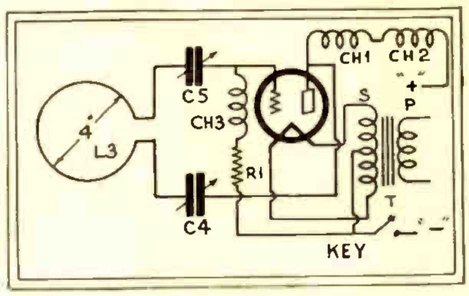


Fig. 3
Our final five meter-circuit, with midgets at C4 and C5, and a single four-inch loop L3 for an inductance.

Short, Short Waves

At this point (about ten meters), it will be found that reducing the number of turns (which are now two or three, and small in diameter) will not give strong oscillation. The next step is to shorten the length of the plate and grid leads. This will result in a surprising decrease in wavelength, with the same size inductor. At this point, it will be necessary to remove the plate and grid-blocking condensers (which have a value in the order of 100 mmf. in the usual forty-meter transmitter) and replace these with small midget variable condensers of about 32 mmf. (seven plates, or so), C4 and C5 in Fig. 3. The grid leak should be connected to the filament, and a small 30-turn basket-weave coil Ch3 (about one inch in diameter) placed in series, to confine the R.F. currents to their proper paths. It will be found that the wavelength is controlled easily, by varying the capacity of the blocking condensers. The coil is now replaced by a single four-inch loop of copper tubing L3, and the transmitter will be operating at approximately five meters; but one can never be sure unless the wavelength is accurately measured, as described later. The final circuit is shown in Fig. 3.

Since the operator has gradually reduced the wavelength, much has been learned as to the practical differences between a forty- and a five-meter set. The latter is slightly harder to adjust, since any small changes also affect the frequency; but the experimenter will find real enjoyment in trying various tests at these extreme frequencies.

Measuring Short Waves

The wavelength of the transmitter must be known accurately, if one is to operate "on the air;" it is easily measured with Lecher wires. These are simply two parallel wires spaced about two inches apart, left "open" at one end and "shorted" at the other, as shown in Fig. 4A.

For five-meter measurements, the wires should be about twenty-five feet long and spaced about two inches apart; although this separation is not critical. Since the waves are measured along the wires, it is necessary to have them of sufficient length; twenty-five feet is approximately correct. Details of the "bridge" or shorting handle are shown in Fig. 4B; the two triangular cuts in the bridge fit over the wires, and the brass piece slides along them while measurements are being taken.

The wires are supported by strong cords fastened to them, and must be well-insulated

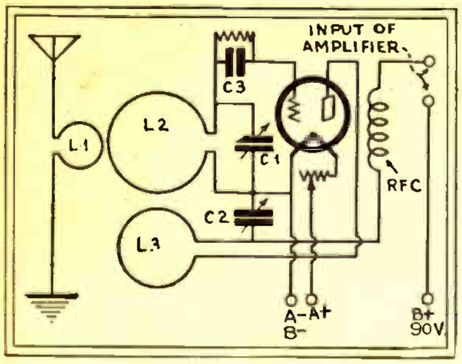


Fig. 6
The circuit of a five-meter receiver used by the author. The capacity and inductance of its leads must be as small as possible.

from surrounding objects, if good results are to be obtained.

The set-up for measuring the length of the waves impressed on the wires is shown in Fig. 5.

The oscillator is coupled loosely to the shorted end of the wires, and the bridge is moved along the wires, to short them at the other end. In certain positions, the plate milliammeter in the transmitter will show an abrupt change. When one of these positions is discovered, a mark should be made on the wires. The bridge is then moved along them until another such position is located. The distance between any two such positions is just half a wavelength. This distance should be accurately measured, preferably with a meter-stick (obtainable at any store dealing in drawing supplies). Suppose that the distance between two such positions is found to be 2.65 meters. The actual wavelength of the oscillator is then obtained by multiplying this value by two. The transmitter is thus operating on a wavelength of 5.30 meters.

(If a meter-stick is not available, inches multiplied by .0254 will give the meters.—*Editor.*)

Calibration

The wavelength of the oscillator may now be reduced, and other wavelengths determined. These values may be marked on the oscillator scale; but it is preferable to transfer them to a small wavemeter constructed of a 4-inch loop of copper tubing and a 32-mmf. (7-plate) midget variable condenser. Thus, one can always refer back to the wavemeter, in case some alteration is made in the transmitter which changes its dial settings.

To calibrate the wavemeter, simply measure the wavelength as described above; then, before changing anything, couple the wavemeter's coil to the oscillator and vary its condenser until the plate current in the oscillator shows an abrupt change. The wavemeter is then tuned to the oscillator's wavelength.

Since the wavemeter, the oscillator and wires are all tuned to the same wavelength, and this wavelength is known, from the

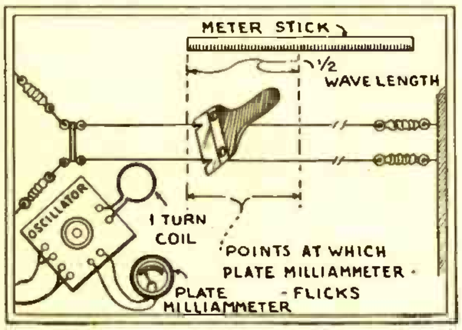


Fig. 5
Use of the Lecher wires enables us to measure the wavelength of a transmitter, with a very good degree of accuracy

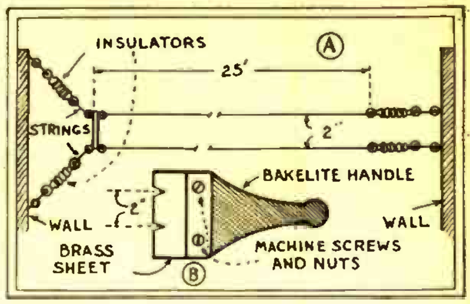


Fig. 4
On the Lecher wires, shown at A, "standing waves" may be set up. The bridge B determines the dimensions of the oscillating circuit.

Lecher-wire measurements, this value may be marked on the wavemeter scale. Other points are obtained by changing the wavelength of the oscillator, measuring the new distance on the wires, and marking a new point on the wavemeter's scale, as before.

With a calibrated oscillator in operation in the five-meter band, it is extremely simple to build a receiver (Fig. 6) and adjust it to receive on the transmitter's wavelength. There are, however, certain important factors which must be taken into consideration when a receiver for these extreme frequencies is constructed.

The inductance and capacity in the tuned circuit of a five-meter receiver are necessarily quite small; so that it is very essential to use the shortest possible leads. It is desirable, also, to use a tube of low internal capacity, so that a comparatively large value of inductance can be used externally; thus obtaining better sensitivity. Since the circuit constants are extremely small, the type of tube used and other factors of construction will have much to do with the size of coil required. In one receiver used by the writer, two turns an inch in diameter served

(*Continued on page 534*)

Short-Wave Reception With Super-Regeneration

By R. WM. TANNER, W8AD

VERY little, if anything, has been written on the subject of super-regenerative reception on the short-wave bands. This method is very desirable below about 150 meters; for the gain increases with a decrease in wavelength.

It is possible to employ a very low variation-frequency (approximately 10,000 cycles) and still obtain a great amount of amplification; for a super-regenerative detector gives a signal strength greater than is obtained with a screen-grid R.F. stage ahead of a straight detector. With proper tuning of the long-wave circuit and a correct adjustment of the grid leak, the quality of short-wave broadcast reproduction is excellent, with almost entire absence of the "mush" so prominent in the 200-600-meter super-regenerators of a few years back.

The only disadvantage is lack of selectivity. However, this desirable characteristic may be increased to a degree as high as (if not higher than) that obtained with the plain regenerative circuit; by mounting the short-wave components and tube in a shielded box and loose-coupling the antenna to the secondary.

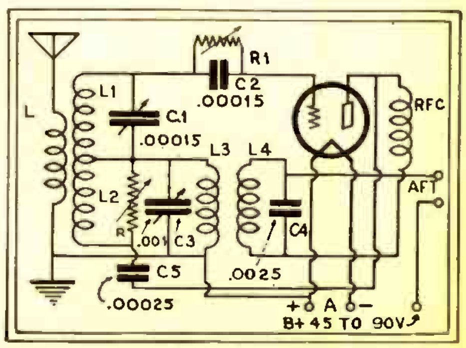
A single-tube circuit is shown in the accompanying diagram. An '01A tube may be used successfully; but a '12A seems to give decidedly better results. The coils L1 and L2 are Silver-Marshall type-131 T, U and V; having a range of 17 to 110 meters when tuned by a variable condenser (C) with a maximum capacity of .00014-mf. The lower end (near the slot) of the grid coil and the finish of the slot winding are connected and made common to the filament.

Adjustments

The primary or antenna coil L is wound with 5 turns of No. 14 or 16 cotton-covered wire to a diameter of about 2½ inches, and tied with string in three or four places to insure rigidity. This is connected to the "A" and "G" binding posts and placed directly over the coil-mounting socket. Because of the stiffness of the wire, it is easily held in place.

If a large antenna is employed, selectivity may not be good, and some points on the dial may be found where the tube will not oscillate with the 5-turn coupling coil. The number should then be cut down until the selectivity is satisfactory and the regeneration smooth over the entire range.

A higher degree of regeneration is required with this circuit; so the number of turns in the slot windings may not be sufficient when certain tubes are employed. If the set fails to function on the high end of the scale with any of the coils, it probably



The circuit of Mr. Tanner's short-wave super-regenerator. Values and coil data are given in the accompanying text. A screen-grid stage may be added between L1 and the antenna.

means that the tickler is too small and more turns will have to be added. Regeneration is controlled by means of a 50,000-ohm variable resistor (R) across the tickler.

The long-wave coils L3 and L4 may be 1250- and 1500-turn honeycombs respectively. An .001-mf. XL "Variodenser" (C3) is used to tune L3, and a .0025-mf. fixed condenser (C4) to tune L4. The coupling between the two coils should be variable over a comparatively wide range.

Some types of 45- or 30-kilocycle iron-core intermediate-frequency (superheterodyne) transformers may be used in place of honeycombs. The secondary will then be used as the primary, and vice versa; that is, the "G" terminal would go to "B+"; "F" to the plate; "P" to the center tap of L1-L2, and "B+" to the filament. It has been found that the Acme 30-kc. transformer functions perfectly; however, these are hard to procure as they are no longer manufactured.

In the beginning of the writer's experimental work with short-wave super-regenerators, a great amount of trouble was experienced from a loud continuous roar which drowned out the signals almost completely. No adjustments of the long-wave coils or coupling seemed to help in the least. This roar was finally eliminated by employing a grid leak of lower value. As the leak R1 is rather critical, a Standard Clarostat was installed and proved very effective.

Operation

In operation, the coupling between L3 and L4 is reduced and the Variodenser C3 varied until the tube oscillates at the variation frequency or until a faint high-pitched hum is heard. (These adjustments are made with all of the resistor R in circuit). If the loud roar is heard, adjust the grid leak (and possibly the "B" voltage) until this is eliminated. Now tune in some phone or I.C.W. signal, and reduce the regeneration just below the point of oscillation. Then vary the grid leak for greatest strength of signal without the roar. Stations should now pound in like the proverbial "ton of brick."

It might be well, before attempting to adjust the long-wave coils, to try each of the plug-in coils and ascertain if it gives smooth oscillation over the entire tuning scale. If "dead spots" are found, loosen the antenna coupling and, if this does not help, the R.F. choke is at fault and another should be installed. If the short-wave circuits are not operating properly the set will be an absolute failure, so far as the additional super-regenerative gain is concerned. After this part of the outfit is in good working order then, and only then, should the variation-frequency coils be adjusted.

An improvement in the selectivity, and the sensitivity as well, can be obtained by employing an aerial with a length not over 25 feet (preferably an inside one) and connecting a variometer of the old type in the antenna lead. Looser coupling between the coupling coil and the secondary will then be necessary or "dead spots" in the tuning may develop.

If the constructor is ambitious and has plenty of money, a stage of screen-grid R.F. amplification, either tuned or untuned, ahead of the detector will result in still greater sensitivity and selectivity.

The Short-Wave Fan's Use For Old Supers

By AARON L. SLAUGHTER

MANY a radio enthusiast has an old superheterodyne, or can purchase one in good condition, for a small sum. If so, he may convert it readily into an efficient short-wave receiver.

Having obtained the super, proceed to remove the antenna and oscillator coils, and the two large variable condensers.

Next, procure two small variable condensers, one 5- or 7-plate, and one 11- or 13-plate; one for a tuning control and the other for the control of oscillation.

The inductance and capacity of a particular antenna will have considerable effect on the coil values necessary. Consequently, any standard set of short-wave coils may be used for experiment. Although complete instructions for making such coils have appeared in past issues of RADIO-CRAFT, accurate manufactured coils, obtainable in a set that will cover the entire frequency-range, are recommended.

In fact, it is most convenient to obtain a set of coils which are calibrated to work with a particular tuning condenser. For accurate results, it is necessary that a specific size and type of condenser be used with a coil of given design.

The secondary and tickler coils should be wound in the same direction; the correct manner of connecting them is shown in the small sketch (b).

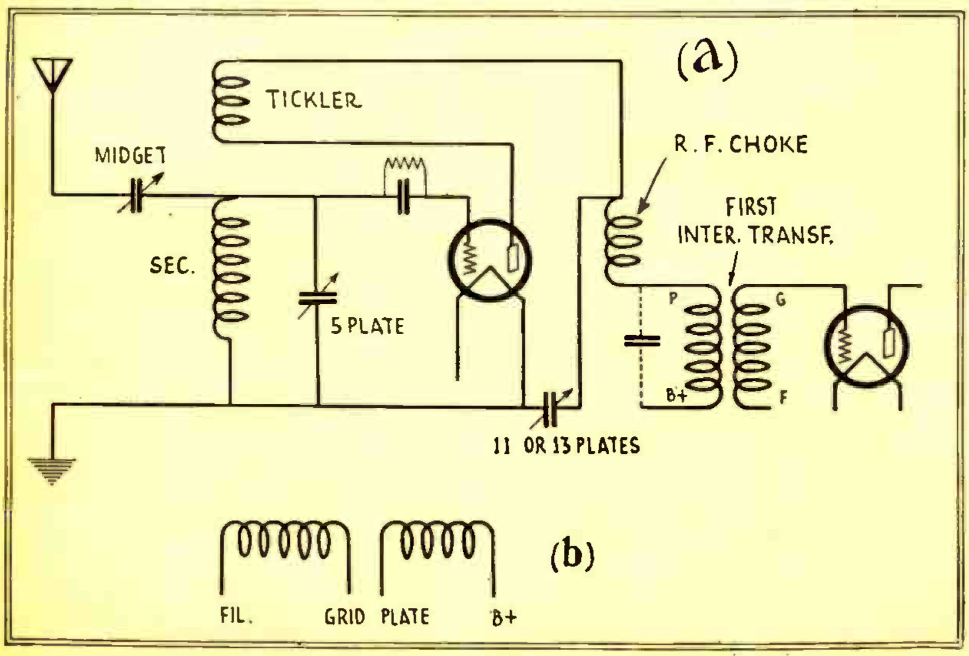
It may be desirable to connect a fixed condenser of .001-mf., or even .00025-mf. capacity, in shunt across the primary of the first intermediate-frequency transformer, as shown in dotted lines. However, this capacity is incorporated within some of these transformers.

Any type of antenna may be used. A "midget" variable condenser should be connected in the aerial lead. This bears a very important relation to the successful operation of almost every type of short-wave receiver; particularly, the "super" adaptation described here.

It is recommended that the aerial condenser, two-winding short-wave coil, detector tube, grid leak and condenser, the 5- and 11-plate variable condensers, and the R.F. choke, be carefully shielded from the remainder of the equipment. This is desirable also as a means of preventing pick-up of undesirable signals.

If best results are expected, it is necessary to use an R.F. choke coil of a type designed specially for use in short-wave receivers. Otherwise, there will be "holes"—lack of normal volume—in the reception at certain points along the tuning range where the choke does not work at full efficiency.

As the operation of this type of receiver is quite different from that of the more standard types of short-wave set, it will be necessary for the operator to exercise a little patience until he has become accustomed to handling it. With its high amplification, it should give very satisfactory results in a good location.



It is now possible to purchase an old battery-type superheterodyne for much less than the cost of the components; and the experienced constructor can readily adapt it to short-wave reception as shown at A. The connections of the plug-in secondary and tickler should be made as indicated at B.

Short-Wave Adapter Design and Operation

A discussion of the problem of utilizing standard broadcast receivers to bring in international broadcasts and other short-wave programs directly; and of the importance of the detector tube characteristics

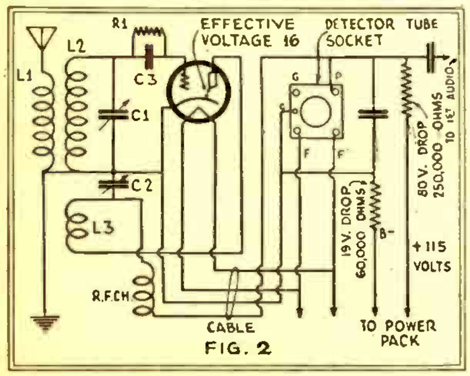
By J. M. PETERSON
President, J-M-P Mfg. Co., Inc.

SHORT-WAVE broadcasting, while only of an experimental nature as yet, lends plenty of thrills to those who want to get away from the sameness of programs receivable on a regular broadcast receiver. As to the possibility of the reception of foreign programs, there is only one chance to do this with a highly efficient broadcast receiver, as against a thousand with a good short-wave adapter connected to practically any broadcast receiver.

The sharpness of tuning on short waves, together with their lack of patience, leads many people to believe that short-wave reception is something you hear talked of but never a reality. The writer produced and placed on the market, four years ago, the first short-wave adapter to be commercialized in this country; and from that time he has been continually active in making short-wave adapters practical. There has been a continuous increase in the interest shown by all classes of people and, no doubt, within the near future the short wave will become as popular as the regular broadcast wavelengths, especially in static seasons.

The simpler diagram (Fig. 1) is that of the circuit used by the writer in the first short-wave adapter and, to this date, practically no improvements have been made upon this circuit. A short-wave adapter, however, using this arrangement, would hardly be practical on most of the sets manufactured during 1929 or at the present time.

For instance, the adapter in Fig. 1 is designed with a plug to be inserted in the detector socket of a broadcast receiver. This means that the detector tube in the socket of the adapter will get its plate voltage from this socket. This is all very well, so long as the "B" voltage is supplied by "B" batteries or an eliminator which can be adjusted. The best voltage for battery tubes is around 45 volts; while on A.C. tubes it may be between 35 and 60.



With the new receivers, operating from the house-line, a great number of undesirable conditions may be encountered; because of the absence of any standard of circuit design in commercial A.C. receivers.

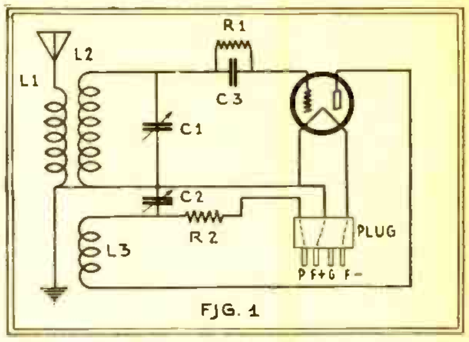
But, when an adapter of this kind is connected to receivers using plate rectification, we may find all the way from 100 to 300 volts—which is entirely too high. As there is no way to change this, the adapter cannot operate correctly.

On the other hand, many of the new receivers use resistance coupling and this resistance is so high that the plate voltage is very low. On top of this, most A.C. detectors use cathode bias, which subtracts from the total voltage supplied to a short-wave adapter. An illustration of this is given in Fig. 2, where a regular short-wave adapter is attached to a detector tube which has resistance coupling and cathode bias. The voltage effective on the plate of the tube in the adapter is only 16 volts, which is not enough.

Another thing: assume that the adapter attached to a receiver, indicated in Fig. 2, did have the ideal voltages, it would still be handicapped in delivering speaker volume; because resistance coupling does not have a great deal of amplification. The power tubes in these sets have an amplification factor of three, which further reduces the effectiveness as compared with older sets which used tubes with an amplification of eight. Some sets use only one audio stage; which, of course, completely eliminates this arrangement, so far as speaker reception is concerned.

As stated before, practically no improvement has been made upon the original circuit; but the arrangement and method of adapting it to eliminate these difficulties has been worked out so well that a good short-wave adapter, attached to present-day receivers, operates as smoothly and delivers volume on short waves comparable with the receiver itself operating alone on the broadcast band.

There is positively no reason, mechanical, electrical or theoretical, why a short-wave adapter will not give the same efficiency as a short-wave receiver. The receiving circuit used in the adapter can be just as elaborate (low-loss, high-gain, or any other of the current style phrases) as that employed in a specially designed short-wave receiver. Therefore, the only difference between the two is the audio channel; and this is not to be sneezed at in recent receivers, so far as tone quality is concerned. The audio channel of a short-wave receiver cannot even hope to be any better. It is very plain, therefore, that a good short-wave adapter, attached to a broadcast receiver, can be just as highly efficient and effective as a special short-wave receiver. The adapter has the advantage that it costs less; for it does not have to have an audio channel or



The early model of the short-wave adapter, used with battery-operated sets, was simple and practically fool-proof. Its operating voltages, taken from the receiver, gave no trouble.

power supply, as these are supplied by the receiver to which it is attached.

There have been a number of short-wave adapters on the market, from time to time, and it would seem that the manufacturers of these were always afraid to tell the actual consumer what was required to get the best results. For instance, when an adapter is to be used with A.C. sets using a 5-prong detector, the instructions invariably state that the 5-prong detector is to be used in the adapter regardless of its make.

As a matter of fact, a 5-prong tube for the reception below 50 meters must have a certain physical structure; which narrows the selection of this tube to very few makes. This requirement is that the plate element be of *sheet metal.*

On looking over the 5-prong tubes available, it will be noted that most, if not all, of these use a *screen mesh* for the plate element. From the present tubes, of all makes available, using screen-mesh plate elements, the writer has been unable to find one out of a hundred that would operate smoothly on wavelengths around 20 to 30 meters. Tubes with sheet-metal plate elements oscillate easily and smoothly on any wavelength. The five-prong tubes having the sheet-metal plate element, which the writer has used, are easily procurable and are not special. So, if you are trying to operate a short-wave adapter that only squawks at you, look to see that the tube used has a sheet-metal plate and this difficulty will at least be eliminated.

Just why this physical makeup is favorable to short waves is hard to say; in fact, it is doubtful if any tube manufacturers have a theory. Also, just why most tube manufacturers insist on using a screen-mesh plate element in the '27 type, when all other types have used the sheet-metal plate (and still do), is hard to even guess at. Perhaps some of these manufacturers will come forward in defense of the screen-mesh plate element?

(*Continued on page 531*)

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.**
8.57 35,000—**W2XCU**, Ampere, 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.
13.97 21,460—**W2XAL**, New York.
14.06 21,320—**DIV**, Nauen, Germany.
14.50 20,680—**LSH**, Monte Grande, Argentina, after 10:30 p. m. Telephony with Europe.
—**FMB**, Tamatave, Madagascar.
—**PMB**, Bandoeng, Java.
14.62 20,500—**W9XF**, Chicago, Ill. (WENR).
14.84 20,200—**DGW**, Nauen, Germany, 2 to 9 p.m. Telephony to Buenos Aires.
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.
15.10 19,850—**WMI**, Deal, N. J.
15.40 19,460—**FZU**, Tamatave, Madagascar.
15.50 19,350—....Nancy, France, 4 to 5 p.m.
—**FW3**, Paris, France. From 10 a.m. Telephony to Monte Grande (Buenos Aires).
—**VK2ME**, Sydney, Australia.
15.60 19,220—**WNC**, Deal, N. J.
15.85 18,920—**XDA**, Mexico City, Mex. 12:30 to 2:30 p.m.
15.91 18,850—**PLE**, Bandoeng, Java. Broadcasts Wed. 8:40 to 10:40 a.m. Telephony with Kootwijk (Amsterdam).
16.10 18,620—**GBJ**, Bodmin, England. Telephony with Montreal.
16.11 18,610—**GBU**, Rugby, England.
16.30 18,400—**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.
16.50 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"). Works with Holland.
16.82 17,830—**PCV**, Kootwijk, Holland. 3 to 9 a.m.
16.88 17,770—**PHI**, Huizen, Holland. Beam station to Dutch colonies. Broadcasts Mon., Wed., Thurs., Fri. 8 to 11 a.m. N. V. Philips Radio, Amsterdam.
16.90 17,750—**HSIPJ**, Bangkok, Siam. 7-9:30 a.m., 1-3 p.m. Sundays.
17.20 17,410—**AGC**, Nauen, Germany.
17.34 17,300—**W2XK**, Schenectady, N. Y. Tues., Thurs., Sat. 12 to 5 p.m. General Electric Co.
—**W2XCU**, Ampere, N. J.
—**W9XL**, Anoka, Minn., and other experimental stations.
18.40 16,300—**PCL**, Kootwijk, Holland. Works with Bandoeng from 7 a.m. Netherland State Telegraphs.
—**WLO**, Lawrence, N. J.
18.56 16,150—**GBX**, Rugby, England.
18.75 15,990—....Saigon, Indo-China.
18.80 15,950—**PLG**, Bandoeng, Java. Afternoons.
19.56 15,340—**W2XAD**, Schenectady, N. Y. Broadcasts Sun. 2:30 to 5:40 p.m., Tues., Thurs. and Sat. noon to 5 p.m., Fri. 2 to 3 p.m.; besides relaying WGY's evening program on Mon., Wed., Fri. and Sat. evenings. General Electric Company.
19.60 15,300—....Lyngby, Denmark. Experimental.
19.63 15,280—**W2XE**, Jamaica, N. Y.
19.66 15,250—**W2XAL**, New York, N. Y.
19.70 15,220—**W8XF** (KDKA) Pittsburgh, Pa. 4:30 p.m. on; Saturday from 6. Sundays, entire program.
19.99 15,000—**CM6XJ**, Central Tuinucu, Cuba.
—**LSJ**, Monte Grande, Argentina.
20.00 14,990—**TFZSH**, Iceland.
20.80 14,420—**VPD**, Suva, Fiji Islands.
20.90 14,340—**G2NM**, Caterham, England.
20.97-21.26 14,300-14,100—**Amateur Telephony.**
22.20 13,500—....Vienna, Austria.
22.38 13,400—**WND**, Deal Beach, N. J. Transatlantic telephony.
22.69 13,050—**W2XAA**, Houlton, Me. Transatlantic telephony.
22.75 13,180—**WFA**, Byrd Expedition, Antarctica.
—**WFAT**, S. S. "Eleanor Bolling," Byrd Expedition.
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. Relays KGO from 8 p.m., Mon., Thu., Sat., to 2:45 a.m. Tues., 3 a.m. Fri., 4 a.m. Sunday. General Electric Co.
—**W2XCU**, Ampere, N. J.
—**W9XL**, Anoka, Minn., and other experimental relay broadcasters.
24.41 12,280—**GBU**, Rugby, England.
24.50 12,240—**FW4**, 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.
—**GBX**, Rugby, England.
24.63 12,180—**Airplane.**
24.68 12,150—**GBS**, Rugby, England. Transatlantic phone to Deal, N. J. (New York).
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.
25.10 11,945—**KKQ**, Bolinas, Calif.
25.10 11,940—....Zeesen, Germany. Tests of new Superpower broadcasters.
25.34 11,840—**W2XE**, Jamaica, New York (WABC).

Meters Kilo-cycles

25.40 11,800—**W8XK** (KDKA) Pittsburgh, Pa. 4:30 p.m. on; Saturdays from 6 on; Sundays entire program.
—**W9XF**, Chicago (WENR).
—**W2XAL**, New York (WRNY).
25.53 11,750—**G5SW**, Chelmsford, England. 7:30-8:30 a.m. and 2-7 p.m. except Saturdays and Sundays. Also 7-9 p.m. Mondays and Wednesdays. Tests with W2XO 12-1 a.m. Mondays and Thursdays.
25.68 11,670—**KIO**, Kahuku, Hawaii.
26.00 11,530—**CGA**, Drummondville, Canada.
26.10 11,490—**GBK**, Rugby, England.
26.22 11,430—**DHC**, Nauen, Germany (Berlin) Weekdays after 5, Sun. after 9 p.m.
—**DHF**, Nauen, Germany.
26.70 11,230—**WSBN**, SS. "Leviathan" and A. T. & T. telephone connection.
27.00 11,100—**EATH**, Vienna, Austria. Mon. and Thurs., 5:30 to 7 p.m.
27.75 10,800—**PLN**, Bandoeng, Java.
27.88 10,760—**PLR**, Bandoeng, Java. Works with Holland and France weekdays from 7 a.m.; sometimes after 9:30.
28.00 10,710—**VAS**, Glace Bay, N. S., Canada 5 a.m. to 2 p.m. Canadian Marconi Co.
28.50 10,510—**RDRL**, Leningrad, U.S.S.R. (Russia)
—**VK2BL**, Sydney, Australia.
28.80 10,410—**VK2ME**, Sydney, Australia. Irregular. On Wed. after 6 a.m. Amalgamated Wireless of Australia, Pennant Hills, N. S. W.
—**KES**, Bolinas, Calif.

(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.)

29.50 10,160—**ARI**, Hongkong, China. 8 a.m.
29.98 10,000—**CM2LA**, Havana, Cuba.
30.00 9,995—....Posen, Poland.
30.15 9,910—**GBU**, Rugby, England.
30.20 9,930—**W2XU**, Long Island City, New York.
30.64 9,790—**GBW**, Rugby, England.
30.75 9,750—....Agen, France. Tues. and Fri., 5 to 6:15 p.m.
30.90 9,700—**NRH**, Heredia, Costa Rica. 10:00 to 11:00 p.m. Amando Cespedes Marin, Apartado 40.
31.00 9,680—**7LO**, Nairobi, Kenya, Africa. Noon to 3 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, Holland. Wed. 8-10 p.m.; Thurs. 2-4, 7-11 p.m.; Fri. 2-4 p.m., 8 p.m. to 2 a.m. Sat. N. V. Philips Radio, Eindhoven, Holland.
—**W3XAU**, Byberry, Pa., relays WCAU daily.
31.28 9,580—**VK2FC**, Sydney, Australia. Irregularly after 4 a.m. N. S. W. Broadcasting Co.
—**VPD**, Suva, Fiji Islands.
31.35 9,570—**W1XAZ**, Springfield, Mass. (WBZ).
31.38 9,550—....Zeesen, 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.
31.48 9,530—**W2XAF**, Schenectady, New York. Mon., Tues., Thurs. and Sat. nights, relays WGY from 6 p.m. General Electric Co.
—**W9XA**, Denver, Colorado. Relays KOA.
—....Helsingfors, Finland.
31.56 9,500—**VK3LO**, Melbourne, Australia, Irregular. Broadcasting Co. of Australia.
—**OZ7RL**, Copenhagen, Denmark. Around 7 p.m.
31.60 9,490—....Lyngby, Denmark. Noon to 3 p.m.
31.66 9,480—....Paris, France, 4 p.m. weekdays.
31.80 9,430—....Posen, Poland. Tuesdays and Saturdays, 1:50-4:30 p.m., Sat. 1:25-7 p.m.
—**XDA**, Mexico City, Mex.
32.00 9,375—**EH9OC**, Berne, Switzerland. Mon., Tues., Sat. 3 to 4 p.m.
—**OZ7MK**, Copenhagen, Denmark. Irregular after 7 p.m.
32.06 9,350—**CM2MK**, Havana, Cuba.
32.13 9,330—**CGA**, Drummondville, Canada.
32.40 9,250—**GBK**, Rugby, England.
32.50 9,230—**FL**, Paris, France (Eiffel Tower) Time signals 3:56 a.m. and 3:56 p.m.
—**VK2BL**, Sydney, Australia.
32.59 9,200—**GBS**, Rugby, England. Transatlantic phone.
33.26 9,010—**GBS**, Rugby, England.
33.70 8,900—....Posen, Poland. Tests Mon. and Thurs. 6 to 7 p.m.
33.81 8,872—**NPO**, Cavite (Manila) Philippine Islands. Time signals 9:55-10 p.m.
33.96 8,830—**WFAT**, S. S. "Eleanor Bolling," Byrd Expedition.
34.03 8,810—**WFA**, Byrd Expedition, Antarctica.

Meters Kilo-cycles

34.50 8,690—**W2XAC**, Schenectady, New York.
34.68 8,650—**W2XCU**, Ampere, N. J.;—**W9XL**, Chicago.
34.74 8,630—**WOO**, Deal, N. J.
35.00 8,570—**HKCJ**, Manizales, Colombia.
35.03 8,560—**KVUA**, S. S. "Lake Ormoc," Ford Motor Co.
35.48 8,450—**WSBN**, SS. "Leviathan."
36.00 8,330—**3KAA**, Leningrad, Russia. 2-6 a.m., Mon., Tues., Thurs., Fri.
37.02 8,100—**EATH**, Vienna, Austria. Mon. and Thurs. 5:30 to 7 p.m.
—**HS4P**, Bangkok, Siam. Tues. and Fri: 8-11 a.m., 2-4 p.m. Tuesdays.
37.36 8,030—**NAA**, Arlington, Va. Time signals 8:55-9 a.m., 9:55-10 p.m.
37.43 8,015—**Airplanes.**
37.80 7,930—**DOA**, Doeberitz, Germany. 1 to 3 p.m. Reichspostzentralamt, Berlin.
38.00 7,890—**VPD**, Suva, Fiji Islands.
38.30 7,830—**PCV**, Kootwijk, Holland, after 9 a.m.
38.56 7,775—**F8BZ**, Montelimar, France.
38.80 7,770—**PCL**, Kootwijk, Holland. 9 a.m. to 7 p.m.
39.98 7,500—**TFZSH**, Reykjavik, Iceland.
—**EK4ZZZ**, Danzig (Free State).
40.20 7,460—**YR**, Lyons, France. Daily except Sun., 11:30 a.m. to 12:30 p.m.
41.00 7,310—....Paris, France ("Radio Vitus") Tests.
41.46 7,230—**DOA**, Doeberitz, Germany.
41.50 7,220—....Zurich, Switzerland. Sat. 3 to 5 p.m.
41.70 7,190—**VK6AG**, Perth, West Australia. Between 6:30 and 11a.m.
42.12 7,120—**OZ7RL**, Copenhagen, Denmark. Irregular. Around 7 p.m.
42.27 7,030—**PMZ**, All-American Lyric Expedition, Borneo.
43.00 6,870—**EAR 110**, Madrid, Spain. Tues. and Sat., 5:30 to 7 p.m., Fri. 7 to 8 p.m.
43.50 6,900—**IMA**, Rome, Italy, Sun., noon to 2:30 p.m.
43.57 6,880—**D4AFF**, Coethen, Germany.
43.86 6,835—**VRY**, Georgetown, British Guiana. Wed. and Sun., 7:15 to 10:15.
44.00 6,820—**XC 51**, San Lazaro, Mexico. 3 a.m. and 3 p.m.
45.00 6,600—....Berlin, Germany.
45.20 6,635—**WSBN**, SS. "Leviathan."
45.56 6,580—**WFA**, Byrd Expedition, Antarctica.
—**WFAT**, S. S. "Eleanor Bolling."
46.05 6,515—**WOO**, Deal, N. J.
46.70 6,425—**W2XCU**, Ampere, N. J.;—**W9XL**, Anoka, Minn.; and others.
47.00 6,380—**CT3AG**, Funchal, Madeira Island. Sat. after 10 p.m.
—**VE9AT**, Drummondville, Canada.
47.35 6,335—**W1OXZ**. Airplane Television.
48.74 6,155—**W9XAL**, Chicago, Ill. (WMAC) and Airplanes.
48.80 6,140—**KIXR**, Manila, P. I. 3-4:30, 5-9 or 10 a.m. 2-3 a.m. Sundays.
48.96 6,120—....Motala, Sweden, "Rundradio." 6:30-7 a.m., 11-4:30 p.m. Holidays, 5 a.m.-5 p.m.
—**ARI**, Hongkong, China
49.02 6,120—**W2XE**, New York City. Relays WABC. Atlantic Broadcasting Co.
49.15 6,100—**W3XL**, Bound Brook, N. J. (WJZ, New York). 12 midnight on.
49.20 6,040—**W2XAL**, New York.
49.31 6,080—**W2XCX**, Newark, N. J. Relays WOR.
—**W9XAA**, Chicago, Ill. (WCFL).
49.40 6,070—**UOR2**, Vienna, Austria. 5-7 a.m., 5-7 p.m.
49.50 6,060—**W8XAL**, Cincinnati, Ohio. Relays WLW.
—**W9XU**, Council Bluffs, Iowa. Relays KOIL.
—**W3XAU**, Byberry, Pa., relays WCAU.
—**HKT**, Bogota, Colombia. 8 to 11 p.m., ex. Sun. and Mon.
49.67 6,040—**W9XAO**, Chicago, Ill. (WMAQ).
49.80 6,020—**W9XF**, Chicago, Ill.
—**W2XBR**, New York, N. Y. (WRNY).
49.97 6,000—**ZL3ZC**, Christchurch, New Zealand. 11 p.m.-midnight.
—**EAJ25**, Barcelona, Spain. Sat. 3 to 4 p.m.
—**RFN**, Moscow, Russia. Tues., Thurs., Sat. 8 to 9 a.m.
—**SAJ**, Karlsborg, Sweden.
—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.
—**HRD**, Teguelgalpa, Honduras. 9:15 p.m.-midnight, Mon., Wed., Fridays.
52.00 5,770—**AFL**, Bergedorf, Germany.
52.42 5,720—**VE9CL**, Winnipeg, Canada. Jas. Richardson & Sons.
52.72-54.44 5,690-5,510—**Aircraft.**
54.51 5,500—**W2XBH**, Brooklyn, New York City (WBBC, WCGH).
56.70 5,300—**AGJ**, Nauen, Germany. Occasionally after 7 p.m.
58.00 5,172—....Prague, Czechoslovakia.
60.90 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.
62.50 4,800—**W8XK**, Pittsburgh, Pa. Relays KDKA after 6 p.m. Works with 5SW 5 to 7 p.m. Tues. and Thurs. Westinghouse Electric Co.
62.56 4,795—**W9XAM**, Elgin, Ill.
—**W9XL**, Chicago, Ill.
62.69 4,785—**Aircraft.**
65.22 to 66.67 meters—4,500 to 4,600 kc. **Television.**
—**W6XC**, Los Angeles, Calif.
67.65 4,430—**DOA**, Doeberitz, 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.
—**RA97**, Khabarovsk, Siberia. 5:30-7 a.m.
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.
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.**

(Continued on page 543)

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.

THE PILOT "P. E. 6" BROADCAST RECEIVER

By Robert Hertzberg

FROM their disappointing experiences with ordinary tuned R.F. circuits, in which they have attempted to use screen-grid tubes without considering their unusual characteristics, many radio set constructors have drawn the conclusion that selectivity from 550 to 1500 kilocycles in a screen-grid receiver is obtainable only with the aid of band-pass tuners. This is not altogether true; although the band-pass tuner fills a specific need in certain circuits. A screen-grid set can be made selective enough for present-day conditions if the antenna transformer or "coupler" is properly designed and if an aerial of the correct dimensions is used.

Fig. A

The "P. E. 6" receiver in the neat metal cabinet, which is furnished with it as optional equipment.

Effective Coil Design

With very loose coupling between the antenna circuit and the input circuit of the first screen-grid amplifier, and with a very short aerial, a screen-grid receiver of very simple and inexpensive design can be made to separate the local stations quite cleanly, and even leave in between enough room for a DX station or two to slip through. The tremendous amplification afforded by the tubes compensates for the small pick-up system, and the set can and will deliver signals of great strength.

As the size of the antenna is increased, the signals naturally increase in number and volume; but the selectivity likewise drops. In eight different places, in and around New York, the set here described operated on an indoor aerial, consisting of ten feet of No. 24 magnet wire (taken from an old short-wave coil), bringing in all the local stations with full volume, yet with two-degree selectivity. It also brought in, with fair volume, the more powerful stations in Chicago, Cincinnati, Pittsburgh and Hartford. The signal obtained from a 95-foot outside aerial was sufficient to overload the R.F. tubes and made them act as detectors. (The effectiveness of indoor aerial arrangements is greatly dependent upon local conditions.—*Editor.*)

So successful were the experiments conducted with a screen-grid receiver embodying the foregoing ideas that a kit set has been developed. It contains all the necessary parts in fully prepared form, and can be assembled by constructors who would be absolutely stumped by the more complicated outfits.

Option of Kits

Known generally as the "P. E. 6," the new set is marketed in three forms. The components of the six-tube circuit are the same in all three kits; but in the first, the "K-122," a plain front panel, without cabinet or power pack, is supplied. This "chassis" model may be installed in any standard 7 x 18-inch cabinet or console. The second kit, "K-123," has the same sub-panel, but is supplied with a decorative steel cabinet, finished in walnut. The front of this cabinet is drilled for the tuning dial, the power switch and the volume control, the sub-panel being mounted directly against it. This kit, likewise, is not furnished with a power pack, for any standard pack of 171A capacity may be used. The third kit, the "K-124," is quite complete consisting of the "K-123" plus a "K-111" power pack. This unit fits nicely inside the cabinet just behind the sub-panel, a suitable mounting bracket being supplied. (Detailed assembly directions are included in each kit.)

A study of the diagram of the "P. E. 6" shows that two stages of tuned R.F. amplification are used, with screen-grid tubes V1, V2. These are followed by a non-regenerative detector V3, one stage of straight transformer-coupled audio V4, and one stage of push-pull audio, using '71A tubes, V5, V6. A pair of '71A's will handle far more volume than the ordinary home can comfortably accommodate, and they require only a power pack which is small and trouble-free compared to that needed for the popular '45. If the builder feels that he simply must keep up with the Joneses by making his set heard all the way down the street, he can easily put in '45s without changing anything more than the grid-biasing resistor. The present 1200-ohm unit should merely be replaced by a 750-ohm one, and, of course, a power pack of suitable capacity installed. (For example, the type "K-112" will deliver the desired voltages.)

The antenna coupler L1, the interstage R.F. transformer L2 and the detector transformer L3 take the form of shielded plug-in coils which fit standard UY tube sockets. The primary of the antenna coupler L1 consists of only ten turns (with 127 on the secondary) and those ten are tapped at the seventh; so that either seven or ten turns may be used, depending on the size of the aerial. A short aerial allows the use of the full winding; a longer one requires the smaller section. Two "Ant." binding posts are provided; so that the individual owner can suit the coupling to meet his own local

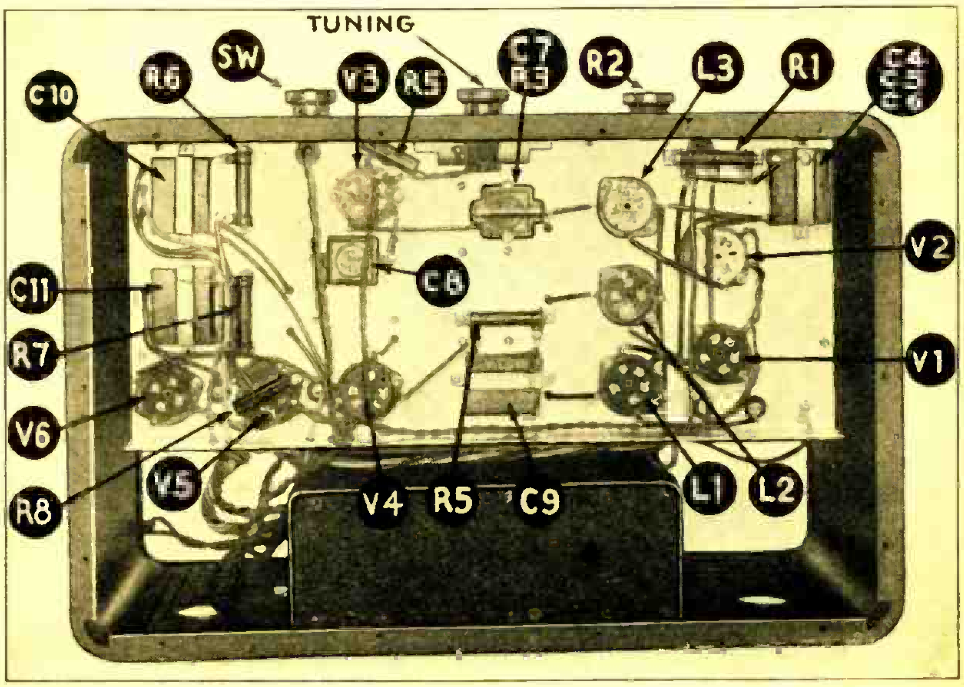


Fig. B

A view from below of the placement of parts in the "P. E. 6": the aluminum sub-panel covers only a portion of the area. The components shown may be identified by comparison with the schematic (Fig. 1) and the detailed list of parts.

conditions. In and around the big cities an outside aerial is altogether unnecessary; for ten, fifteen or twenty feet of wire tacked around the edge of the floor will deliver violent signals.

Successful Ganging

The interstage coils L2, L3 have large primaries (50 turns) wound directly over the secondaries. The cathode, screen-grid and plate circuits of the screen-grid tubes are adequately by-passed by a single three-section non-inductive condenser C4-C5-C6.

The volume is controlled by a 50,000-ohm potentiometer R2, which regulates the screen voltage. This is the simplest method of volume control in a screen-grid set, and is a very smooth and effective one.

The R.F. circuits are tuned by a triple condenser, C1-C2-C3, which is mounted in the center of the sub-panel. The very loose antenna coupling obviates the annoying detuning effects common to other single-control receivers, and permits sharp matching of circuits over the full 200-550 meter wave-length range. This is one of the incidental factors contributing to the overall selectivity. With ordinary degrees of antenna coupling, the detuning effects are so bad that the individual tuning circuits must be damped considerably; the result is that, even if their resonant peaks don't exactly coincide all over the scale, at least they overlap enough to let through an insistent signal.

The detector and audio portions of the "P. E. 6" are quite orthodox, except for the presence in the audio system of what is best termed a "tone equalizer." This comprises merely a condenser C10 and resistor R6 connected in series, and shunted across the primary of the push-pull transformer T2. Through by-passing some of the higher frequencies, which all audio transformers amplify a bit too well, it gives the effect of accentuating the lower ones, which they pass with difficulty. The resulting "tone quality" is quite good.

The adjustment of the receiver, after the assembly and wiring, resolves itself into a few minutes of playing with the little compensating condensers on the side of the main triple condenser. These compensators are not shown in the diagram. When they are properly trimmed, the set is ready to work. Everything else is fixed.

Technical Data

The value of 0.6-mf., indicated for C9 and C11, is obtained by connecting in parallel the three 0.2-mf. condensers that make the standard No. 806 condenser bank.

The dial-light is not shown in the schematic circuit; where it connects is optional with the constructor. If a 2.5-volt lamp is used, it may be connected across the filament supply for V3, V4. If the No. 1282 dial (which constitutes part of the standard kit) is used, considerable leeway is permitted in the choice of dial-lights; due to the fact that the lamp socket of this dial is entirely insulated. For this reason it is recommended that the dial-light be of 6-volt rating and connected across the filament supply to V5, V6.

The mechanical arrangement of the parts allows rapid assembly and easy wiring. The sub-panel is a piece of formed aluminum, accurately drilled with all mounting and wire holes. There is practically no wiring on the upper side of the sub-panel, all the connections being made on the conveniently accessible underside, as may be seen in Fig. B. The bottom of the cabinet supplied with the "K-123" and "K-124" kits is removable and allows ready access to the parts for examination, trouble shooting, etc.

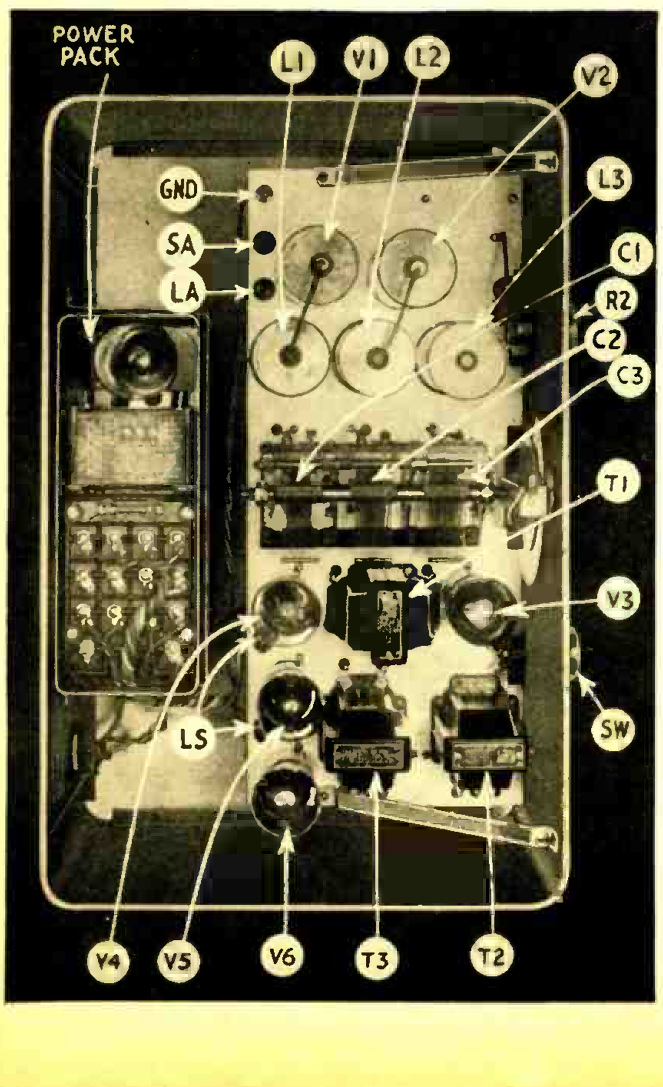


Fig. C

A view of the "P. E. 6" assembled in its cabinet, showing the space allotted for the compact power pack. The receiver connections from the shielded coils to the screen-grid tubes, etc., are very direct. The placement throughout is logical.

The wiring is exceedingly simple, and will present no difficulties to anyone who can handle a soldering iron. As the metal chassis forms the ground and the "B—" side of the circuit, many connections are made by running the mounting screws right through the soldering-lugs or other terminals on the instruments, and thus much wiring is saved.

Details of Power Pack

The No. "K-111" power pack includes a "No. 398" power transformer PT, with five secondary windings delivering the following current and voltage: S1, 5 volt, 2 amps.; S2, 550 volts, center-tapped (275 volts on each side), 60 ma.; S3, 2.5 volts, 7 amps.; S4, 5 volts, 1 amp.; S5, 1½ volts, 4 amps. (not used for this receiver).

The condenser bank, "No. 396," contains C12 (2 mf., 400 volts D.C. rating); C13 and C14 (3 mf., each, 300 volts D.C.); and C15, C16 and C17 (1 mf. each, 300 volts D.C.)

The voltage divider is a "No. 960" resistor with the following values: R9, 4,000 ohms; R10, 3,600 ohms; R11, 2,250 ohms; R12, 2,800 ohms. Sufficient voltage and current for operation of type '45 tubes may be obtained at the "B plus 220 V." tap by connecting a variable resistor between Ch2 and the resistor net-work at the point marked "X," varying its value until the desired results are obtained.

A "No. 395 Jumbo" model, or double-choke Ch1, Ch2, is used in this receiver.

List of Parts for Receiver

One triple-gang condenser, .00035-mf., "No. 1703" (C1, C2, C3);
One vernier dial, illuminated, "No. 1282";
One "Volumgrad" variable resistor, 50,000 ohms, "No. 940" (R2);
One set of plug-in coils, 200 to 550 meters "No. 235" ("235A," antenna coil; "235B," R.F. coil; "235C" detector coil) (L1, L2, L3);
Two screen-grid tube shields, "No. 222S";
One A.F. transformer, 3½ to 1 ratio, "No. 391" (T1);
One push-pull input A.F. transformer, "No. 399" (T2);
One push-pull output A.F. coupler, "No. 401" (T3);
One fixed condenser, .00025-mf. "No. 51" (C7);
One fixed condenser, .002-mf., "No. 64" (C8);
Three by-pass condensers, each with three sections of 0.2-mf., "No. 806" (C4, C5, C6);
Two by-pass condensers, 0.6-mf., "No. 806" (C9, C11);
One by-pass condenser, 0.1-mf., "No. 808" (C10);
One fixed resistor, 1,200 ohms, "No. 956" (R7);
One fixed resistor, 2,000 ohms, "No. 958" (R5);
One fixed resistor, 900 ohms and tapped at 450 ohms (shunt-connected for 225 ohms) "No. 959" (R1);
One fixed resistor, 6,000 ohms, "No. 968" (R6);
One resistor, center-tapped, 20 ohms, "No. 354" (R4);
One resistor, center-tapped, 50 ohms, "No. 356" (R8);
One grid leak, 2 megs., "No. 756" (R3);

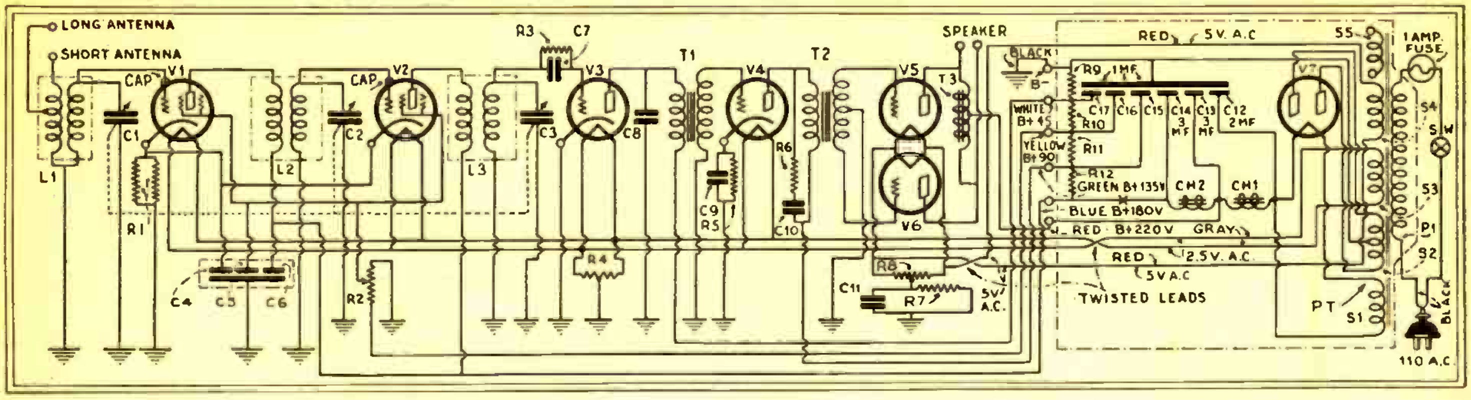


Fig. 1
The circuit diagram of the Pilot "P. E. 6" broadcast receiver, at the left; the dotted square at the right encloses the "K-111" power pack, designed for push-pull '71-A operation. Circuit values and constants are given in the text and list of parts.

Four UX-type sockets, "No. 216" (for V5, V6, L2, L3);
Five UY-type sockets, "No. 217" (for V1, V2, V3, V4, L1);
Five binding posts, lettered "Ant.", "Short Ant.", "Gnd.", "L. S.", and "L. S.";
One knob switch, "No. 44" (Sw);
One package of hardware (condenser mounting brackets, wire, spaghetti, screws, nuts, washers, lugs, and nine binding post insulators);
One metal front panel, 7 x 18 inches (included only in "K-122" kit), "No. 787"; or
One metal cabinet (supplied with "K-123" and "K-124" kits), "No. 2501";
One power pack (supplied only with K-124 kit), "No. K-111";
One aluminum sub-panel, 7½ x 17¼ inches, "No. 788";

THE FREED NEUTRALIZING KIT

It is the practice of the average Service Man to carry a set of tools for neutralizing the various makes of radio sets with which he comes in contact. A few of these tools are available in hardware stores; but most of them are special and obtainable only from the makers of the various receivers. Often the Service Man is called to service a set for which he does not have the required neutralizing tool; and it isn't possible to ask the customer to wait until one arrives from the factory. The result is a miscellaneous collection of manufactured and home-constructed tools that may, or may not, be correct for most sets.

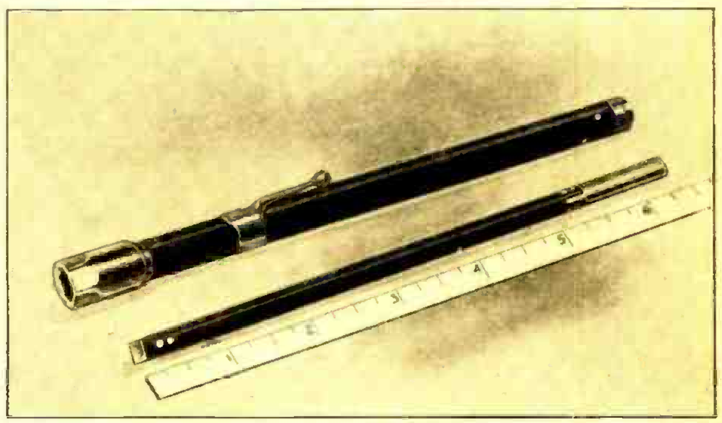
To meet this demand for a tool which is convenient to carry and use, and almost universal in its application, the Servicemen's Supply Co., Brooklyn Heights, N. Y., is now making the "Universal Neutralizing Kit No. 10," as designed by Bertram M. Freed and pictured below.

It consists of two neutralizing "sticks" which nest. The larger one has about the same diameter as a fountain pen, and may be clipped into the pocket.

The larger "stick" carries on its insulating tube two neutralizing wrenches; the smaller one has a neutralizing screwdriver at one end and, at the other, a magnet for picking up and placing small iron screws.

This combination is so designed as to be effective for neutralizing and balancing almost every commercial radio receiver.

The pocket neutralizing kit shown at the right is made according to the specifications of that well-known writer on servicing, Bertram M. Freed, to fit the adjusting nuts of practically all sets. The small rod nests into the larger, which is carried in the vest pocket like a pen; their size is shown by the rule beside them.



Review of Recent Radio Literature

Publishers and Manufacturers are invited to send their latest radio books, pamphlets, leaflets and technical data to the office of RADIO-CRAFT *for review*

B. B. C. YEAR BOOK for 1930, size 7½ x 5 inches, 461 pages, price two shillings (50c).

This latest edition of the well-known British Broadcasting Company's *Year Book*, as usual, contains a profuse array of all sorts of radio information. Space does not allow listing all the contents; but we might say that it includes all the latest radio information of the year. Then there is a general section, containing all sorts of broadcasting material. Of great interest to our readers is the technical section, which contains a tremendous amount of information on transmission and reception, short-wave material, measuring instruments, technical broadcasting information, and special articles.

In addition to that, there is a large amount of technical data, formulas, etc., and a technical dictionary pertaining to radio terminology.

A valuable book in all respects. (H. G.)

LE SUPERHETERODYNE, by De Bellescize, published by Etienne Chiron, Paris, France. 6½" x 9¾", paper covers, diagrams, folding plates, 112 pages.

This small book, written by a well-known French engineer, deals primarily with the fundamental principle and evolution of the "super" circuit, and the patent situation which has arisen with regard to it. The popularity which this circuit has enjoyed, and still enjoys, in this country has produced many works on the subject; one of the best, to the reviewer's mind, being that of the late R. E. Lacault. In this volume, M. de Bellescize discusses the definitions and mathematics of the superheterodyne in about thirty pages; the remainder of the book is devoted to the enumeration of the principal fundamental (French) patents, which are reproduced in facsimile.

(S. G.)

HAMMARLUND "HI Q-30" MANUAL, published by Hammarlund Mfg. Co., New York City. 6" x 9", 48 pp., rotogravure insert, paper covers. Price 25 cents.

This booklet is primarily devoted to the subject of custom building around the receiver circuit whose name it bears. Its first part takes up this theme and the advantage of the custom-built set, with its careful adjustments and its flexibility to the requirements and tastes of the set owner. The second part deals with the subject of band-pass tuning, which is increasing in interest with the demand for higher amplification with better selectivity and fidelity of reproduction. Apparatus and servicing are discussed in the latter pages, while the insert deals with tastefully designed and handsomely illustrated cabinets and consoles, now available for the customer who demands that a fine receiver be housed in a piece of furniture that will be worthy of it.

THE ART AND SCIENCE OF THE GRAMOPHONE, by Harry A. Gaydon. Published by Dunlop & Co., Ltd., London, England. 4¾" x 7¼", 222 pages. Diagrams. Price 4/2 ($1.00).

Plain though its format is, this book is a very interesting and practical discussion of the principles of acoustics and their application to recording and reproducing sounds. Such a chapter as that devoted to the subject of the very numerous styles of phonographic needles show the thoroughness with which the author has gone into his subject. The style is easy and the author, unlike most transatlantic engineers, has carefully avoided mathematical treatment. While the first part of the book was written some years ago, considerable

(*Continued on page 541*)

The A. C. Screen-Grid Pentode

The five-electrode tube which introduces revolutionary possibilities into radio circuit design, with data as to its characteristics, and suggestions as to circuits adapted for its employment

THE progress of tube development, which has been rapid during the past three years, made another spurt recently with the appearance of a new American "pentode," or "five-element" tube; which was demonstrated in this city to radio engineers late in January, and will, it was then stated, be available on the market about the time of the appearance of this issue of RADIO-CRAFT.

This tube (unlike the British pentode, which has been used as a power tube only, for the past two years) is designed especially as a radio-frequency amplifier, to work into a tuned-plate impedance; and is adapted also for audio-frequency amplification in suitable circuits. Its amplification factor, as may be seen from the technical data given below, is enormously high; rising to as much as 750, compared with the 420 of the '24 type, which it is intended to replace; while its mutual conductance may be as high as 2,500, compared with 1,050 for the '24. This operating characteristic is gained by operating with 250 volts on the plate, and 135 (positive) on the screen-grid; while the space-charge grid (the new element) carries 20 volts, positive.

It is well known that the older screen-grid tubes give two circuit options. One is that of using the fourth or screen-grid element as a capacity shield around the plate (from which fact the tube was often called a "shield-grid" type), while the inner grid serves the purpose of impressing the signal input on the tube. In the other connection, the inner grid is used with a positive charge to accelerate the flow of electrons from the filament and break up the negative "space charge" which surrounded it. This "space-charge" hook-up is preferred for audio amplification.

In the new pentode (styled the "P-1" by its manufacturer, the CeCo Mfg. Co.) both these advantages are obtainable. We find in the tube the following:

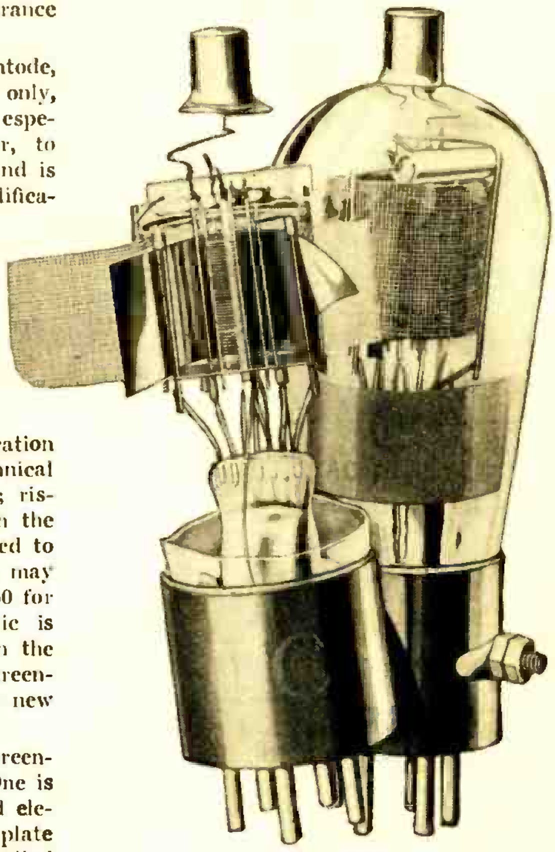


Fig. A

At the right, the new pentode, showing its external appearance. The connection to the additional, or "space-charge," grid is made through the binding post on the tube base. At the left, a pentode broken open to show its elements; the plate and screen-grid are spread out; the inner electrodes in their usual position.

Fig. 2

Plate-current curves of the "P-1" pentode, showing the effect of different values of negative bias, applied to the middle or "control-grid," at different plate potentials.

The Five Electrodes

(1) A heater filament, similar to that of the '24 type, drawing 1.75 amperes at 2.5 volts. This is electrically isolated from the electrodes or elements of the tube, and connected to the "F" prongs of a UY-type tube base.

(2) An electron-emitter or cathode, heated by the filament as in the '24 and '27 tubes, and connected to the "C" prong of the tube.

(3) A "space-charge grid" surrounding the cathode. This is connected, not to the socket, but to a terminal at the side of the tube base. To this a source of low, positive potential is connected.

(4) A control-grid which, as in the '22 and '24 types, is connected to a metal cap at the top of the bulb. This, by means of a clip and lead, is connected to the signal input.

(5) A screen-grid which, as in previous tube types, is connected to the "G" prong of the tube base. Upon this is impressed a high positive voltage, somewhat lower than that of the plate. It serves the purpose of eliminating the capacitive effect between plate and control-grid.

(6) A plate, which is similar to that of the '24, and connected to the "P" prong of the tube.

The tube itself, a view of whose elements is given herewith, fits the standard UY tube socket; it is 1 13/16 inches in diameter, and 5¼ inches high.

A Pentode Circuit

The circuit diagram (Fig. 1) given here shows two pentodes used for R.F. amplification, following a band-pass filter; a third R.F. stage might follow, or the two stages feed into a standard detector.

The constants of the coils and tuning condensers are not given; this would depend upon the design of the receiver. (Articles dealing with band selectors have appeared, and will appear, in RADIO-CRAFT from time to time.) The cathode resistors R1, producing the control-grid bias, should be 150 to 160 ohms; the screen-grid resistors R2, 5,000 ohms; and the potentiometer R3, regulating the voltage on these elements and thereby serving as a volume control, 25,000 ohms. The by-pass condensers C1 (for space-charge grid), C2 (for screen-grid), C3 (for plate), and C4 (for cathode) may be of the customary 1-mf. value each; it will be noted that the common side of the unit shown is the cathode, or neutral point of the tube, and not the ground. The R.F. chokes L1 are also of standard value. With the high degree of amplification obtained by the pentode, the filter system shown is most essential.

Characteristics

In Fig. 2, we illustrate the effect of the various control-grid voltages upon the plate current. The screen-grid voltage used is 180 and the space-charge voltage 10. Irrespective of the control-grid bias, it will be seen, the plate-current curve rises abruptly with the plate voltage until the latter reaches about 180, and then flattens out.

The curve of the space-charge grid bias, which is not reproduced here, is practically a straight line, from 7 volts up, under standard operating conditions. While the increase of this positive grid voltage results in a higher mutual conductance reading, it produces at the same time also a higher plate current as well as a much higher grid current and it is therefore desirable to limit this voltage in the interests of longer tube life.

A comparison of the P-1 with the '24 type indicates a comparative R.F. gain 23 per cent. higher for the pentode in each stage. This would amount to 51 per cent. more gain for two stages. With such amplification, it is obvious that precaution against grid overloading must be taken, especially in the detector. The characteristics of the tube, with a plate voltage of 250, and a control-grid voltage of 1.5 (negative) are as follows:

Space-Charge (volts +)	10	20	10	20
Screen-Grid (volts +)	180	180	135	135
Amplification Factor	575	540	740	750
Plate Resistance (thousands of ohms)	285	180	380	300
Mutual Conductance (micromhos)	2000	3000	1930	2500
	Milliamperes			
Plate Current	4.1	6.0	1.7	2.6
Screen-Grid Current	0.8	0.9	0.5	0.2
Space-Charge Current	3.0	10.0	5.0	12.0

The D.C. Pentodes

In view of the non-technical publicity given the demonstration of the pentode, the Radio Manufacturers Association has issued a statement, conceding that "a given result is possible with less tubes, using pentodes," but arguing that "it is unlikely that the cost of a complete radio receiver would be any less. The pentode is used more widely in England, because of the greater popularity of battery-operated portable sets and because patent licenses are based on the number of tubes in the receiver. Reduction of tubes has therefore been more important in England, just as low-powered automobiles are more popular there on account of the license taxes being based upon horsepower."

The British pentode, as we have stated above, is a different type of tube, being a high-amplification power tube designed to work out of a low-voltage detector; just as we have here power detectors to work into a power tube without an intervening first audio stage. The Marconi "PT240," a typical pentode with two-volt filament (British and Continental tubes are standard at 2, 4 and 6 volts for storage battery operation) has a maximum plate voltage of 150, and a rated amplification factor of 100 with an impedance of 50,000 ohms (measured at 100 volts each on plate and screen-grid). It is used to give power output from a battery-operated set; while simpler tubes supplied with power from the house-current are not under such requirements of economy. It is possible however, that the power pentode will soon be introduced here.

EXPERIMENTERS will be rejoiced to know that, for the first time in many months, "something new in radio" has been developed.

The new tube, the Pentode, described in these columns, is revolutionary enough to be called new. It is true that in England, Pentodes have been used for some time; but they are of a different construction and used for an entirely different purpose (namely for audio-frequency output stages) never for radio-frequency.

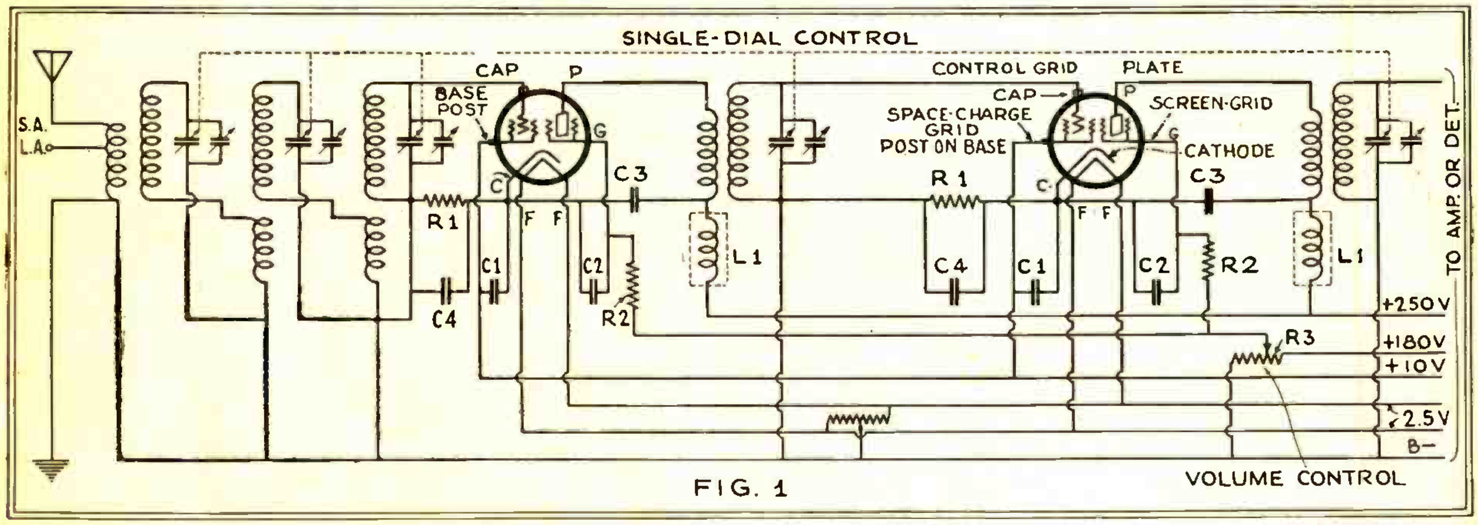
Of importance is the fact that this new tube marks, probably, as great a revolution in radio as did the screen-grid a few years ago. Entirely new combinations and new radio circuits will be developed; and since the sensitivity of this tube is vastly greater than that of the screen-grid, fewer tubes will be required to accomplish the desired purpose.

We believe that the possibilities of the Pentode are greater than those of any previously-known amplifying tube.

The radio professional and Service Man will, of course, welcome the opportunity to familiarize himself with this new development, which will prove of considerable importance in commercial practice during the next few years.

As an interesting sidelight, it should be noted that (just as it did so many times before when a new and important radio item came along) the short-sighted radio trade at once "pooh-poohs" the Pentode, and begins to oppose it. Naturally, a new and important tube will scrap older developments; and such progress is never liked in certain quarters.

Such an important body as the Radio Manufacturers Association has taken great pains to send out warnings to the trade that the Pentode is not new and will not prove of value. We do not share this view; time will tell who is right.



A band-pass filter circuit, suggested by the makers of the pentode, for development of the tube's highest efficiency; the filter design is a special engineering problem, so constants are not given. As pentode circuits are developed for use, they will appear in later issues of RADIO-CRAFT.

The Possibilities of the Pentode

(*Continued from page 499*)

as in Germany we saw developed to an actual "quantity-production" stage (although mostly by hand labor) the exceedingly intricate and ingeniously constructed *mehrfach-rohr*, of Dr. Sigmund Loewe, containing three, four, and sometimes five complete and distinct three-element units mounted upon a single stem, and all within a single evacuated bulb.

Such developments abroad were economically necessary; because of government taxes, and the fact that few indeed can afford the prices, for radio sets, which in our country are considered exceedingly cheap. We have not experienced the need for such economy here. But the advent of pentodes on a quantity basis will unquestionably speed the production of the cheaper sets, intended for the more modest radio fan.

Opportunities for the Experimenter

Revolutionary claims for the pentode will doubtless be made. Our past experience with the screen-grid should render us cautious in accepting such assertions; at least so far as the general public use of the tube is concerned. Unquestionably, many new and ingenious hook-ups will be found advantageous; just as the case has proven so richly during the past few months, with the simpler screen-grid tube.

For, when it comes to the experimenter, the possibilities handed to him with a pair of well-built pentodes—and all the condensers, transformers, chokes, potentiometers, meters, and batteries which he can desire—are beyond all computation. There lie, I promise you, alluring paths, devious and quite without end!

What Is Detector Overload?

The idea of unlimited amplification in a radio receiver appeals to many. A distinguished radio engineer points out here the limitations of the detector, and the certainty of distortion when a radio-frequency signal is amplified too highly.

By SYLVAN HARRIS

WE hear quite a lot nowadays about the matter of overloading tubes; we want to know what is the undistorted power output of amplifier tubes; we want to know what the bias on the tubes happens to be, so that we may know how great a signal we can impress with safety on their input and so on.

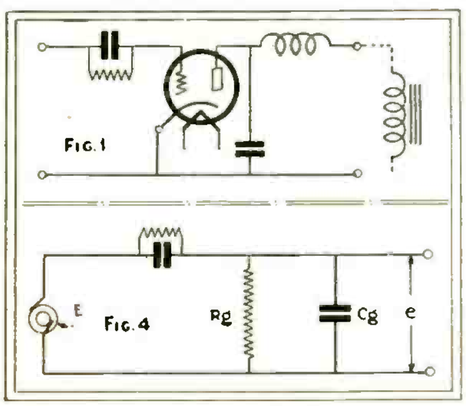
We also hear quite a lot about overloading detectors as well as amplifiers—but here we strike a snag; because the detector is infinitely more complicated than the amplifier—not in its structure, but in its operation. It is surprising how few investigators have taken the trouble to look more seriously into the detector and its operational characteristics—yet how many can speak glibly and copiously about detector overload, the voltage output of the various detector circuits, the frequency-characteristic, and what not.

At any rate, regardless of how much we think we know about detectors, there is still plenty to be learned about them. It was for this reason—that plenty of vague information was available, not definite or quantitative data—that the writer some time ago undertook to study the variation of the tube "parameters" under the stress of signals of various strength. What happens to the plate current of a tube when the signal comes on; how does the grid bias of the tube vary with signal strength? How does the detecting efficiency of the tube vary with the strength of the signal? How? Why? When? Where?

Normal Detector Action

The results of this study are contained, in part, in a paper published in the *Proceedings of the I.R.E.*, for October, 1929. They will be here interpreted in a more elementary fashion for the benefit of the younger students of radio.

In the past a great deal of work has been



The simple detector circuit of the '27 type, standard in A.C. sets, is shown above as Fig. 1. We may analyze its input further into the form of Fig. 4, below, in which the grid-to-filament resistance is Rg and the tube capacity is Cg. The voltage actually impressed upon the tube, therefore, is e rather than E.

MR. HARRIS, well known as a radio editor and as a designer of commercial receivers, here presents the fruit of some technical researches, designed for the guidance of engineers, in a form which will appeal more to the Service Man and the experimenter who are trying to demonstrate the combination of sensitivity with quality.

done by investigators of the theory of detection; but, unfortunately, nearly all of this work was confined to the study of the effects of *small signals*, of the order of fifty millivolts or less, applied to the input. The signal was assumed to be so small that it produced no appreciable effect on the plate resistance, the plate current, the grid voltage, or the other tube constants.

Actually, however, and especially in the case of the more modern radio receivers, the signal voltage applied to the input of the detector is rarely less than 200 or 300 millivolts; so much is generally required to furnish what we might call "good room volume" out of the loud speaker. Let us consider first the grid-leak detector. Of course this is somewhat out of date to-day, when we are using the "C" bias detector; but it is important that we know how the former type of detector acts, as well as the other.

We won't go into the theory of its operation. You can read all about that in any of the many text-books available. Besides, it has been printed time and again in radio magazines. At any rate, we know that, when a signal is applied to the input of the tube, there is a *decrease* of plate current. How much does this plate current decrease?

Fig. 1 shows the circuit of the detector. A constant signal of fifty millivolts (.05-volt) at radio frequency, was applied across the input of the tube, and kept constant. The grid-leak resistance was varied, and the current flowing in the grid circuit was measured. The curve obtained by this is marked ig in Fig. 2. This shows that, as the grid-leak resistance was decreased, the grid current increased; at first slowly, then more rapidly until, when the grid leak value was smaller than about half a megohm, the grid current increased to quite large values—as large as fifty or a hundred microamperes.

Grid Leak Not Critical

The bias on the grid is equal to the grid-leak resistance, multiplied by the current through it. So, performing this multiplication for various points on the ig curve, we obtained the curve marked Ec. This is interesting because it shows the grid bias of the tube to be practically constant, and independent of the grid-leak resistance; for the curve Ec is quite flat. In fact, there is no serious change in Ec until the grid-leak resistance is well under half a megohm. This, of course, does not interest us; because we would have a poor detector if we were to use such a low grid leak.

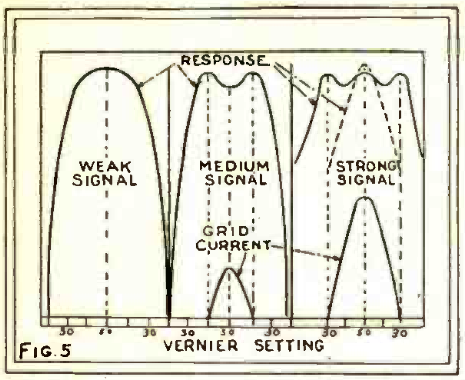
These curves apply to the UY-227 tube. The tube used was an "average" tube; so we may say that the usual operating grid bias of the UY-227 tube used with grid leak and condenser, and for small signals, is about 0.9-volt.

The other curve in Fig. 2, marked Dip, represents the *rate of change of plate current;* that is, the amount the plate current decreases when we apply the fifty-millivolt signal. This is of interest because it is a measure of the response of the detector to a signal of constant modulation. Notice also that this curve, Dip, is quite flat. This indicates that little is to be gained by using large grid-leak resistances. When we use grid leaks lower than about one megohm, we notice quite a drop in the response; but we see that there is very little, if anything, gained by going above two megohms.

Now all this is well enough for the small signal; but how about the large signal? Suppose we let the grid leak remain at 2 megohms and the grid condenser at .00025-mf., and gradually increase the signal, making the same measurements as before. We obtain the curves shown in Fig. 3. There is no use discussing the curves above about 500 millivolts (0.5-volt); because then the effects only become more marked.

Effect of Strong Signals

In Fig. 3 we see again the curves of grid current (ig) and grid bias (Ec); but now we notice that the grid bias *increases* with the signal strength. For very small signals it is about 0.9-volt; whereas, for a signal



Varying the tuning of a weak signal with the "vernier," we find true selectivity; but a medium signal is actually weaker on the point of exact resonance, because a grid current flows. The strongest signal causes bad distortion in a "C"-bias amplifier.

of about 500 millivolts (half a volt), we see it is about 1.7 volts.

Now we all know that increasing the bias of a tube increases its plate resistance. So the plate resistance of the tube was measured for various values of grid bias, and plotted as Rp in Fig. 3 according to the signal strengths corresponding to the variout grid-bias voltages. Immediately we know the effect on the quality; at least as regards the output circuit of the detector. An increase in Rp means a decrease in the response of low audio frequencies; in other words, the greater the signal the poorer the low-frequency response, at least as concerns the output of the detector. Let us see what happens at the input.

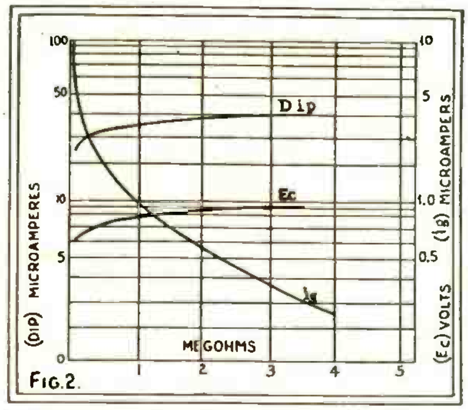
Since the grid circuit has current flowing in it we know that its input impedance is not infinite. The input circuit of the grid-leak detector may be represented as in Fig. 4. The resistance Rg represents the *dynamic* input resistance of the tube, through which the grid current flows; and the condenser Cg represents the capacity of the tube. The other resistance and capacity are the grid leak and grid condenser. The generator E is supposed to be the audio-frequency (or modulation) component of the signal. If we were to analyze this circuit, and consider the value of the voltage E, which is applied to the grid and cathode, to be amplified in the tube, we would find—even though we kept the generator voltage constant and merely varied the frequency—that our signal would suffer a loss at the higher frequencies. In other words, the high modulation-frequencies would be attenuated by the operation of the grid condenser and grid leak and by the input impedance of the tube.

So, in the input of the tube, we have a loss of high frequencies, even for very small signals. But there is another effect, which is that, because of the increase of the dynamic input resistance of the tube with an increase of signal strength, the *detection factor*, shown in Fig. 3, decreases quite rapidly. (The detection factor is a measure of the efficiency of *rectification* of the tube.) So you see that our loss of high frequencies at the input of the tube becomes more serious as the signal strength becomes greater. Now let us sum up:

Broad Tuning Effects

With small signals, there is some attenuation of the higher audio frequencies. As the signal becomes greater, we have a greater loss in the high frequencies at the input of the tube, and an increasing loss in the low frequencies at the output of the tube. At the same time we have a decrease in the efficiency of the tube as a detector.

Let us see what happens as we tune to a very strong station. At first, as we turn the dial around and approach the station, the signal comes in weakly with fairly good quality. As we approach closer to the station the signal becomes louder and louder, but we notice a change in the quality. First we notice the weakening of the low frequencies as compared with the high frequencies. Then, when we get quite close to the exact tuning point on the dial, the higher frequencies drop out, and our signal actually becomes weaker. This is because the detection factor has decreased more rapidly than the signal has increased. Then, as we pass over the exact tuning point, we find that our response increases, and the high frequencies come back again. Going still



On a small signal, the change of grid-leak value directly affects the grid current ig; but there is little change in the effective grid bias Ec or in the rate of change of plate current, Dip.

further around the dial, our signal becomes weak again and our low frequencies return.

You will notice that there were two "humps" or points on the dial at which the signal was loudest; this is due to overloading the detector. We have no precise rule when a detector of this type becomes overloaded, except to say that we must never let the signal on the detector get so strong that the detection factor has decreased faster than the signal increased and thus brought into view the "double hump." This double-hump affair not only gives us poor quality, but it also makes the tuning seem very broad.

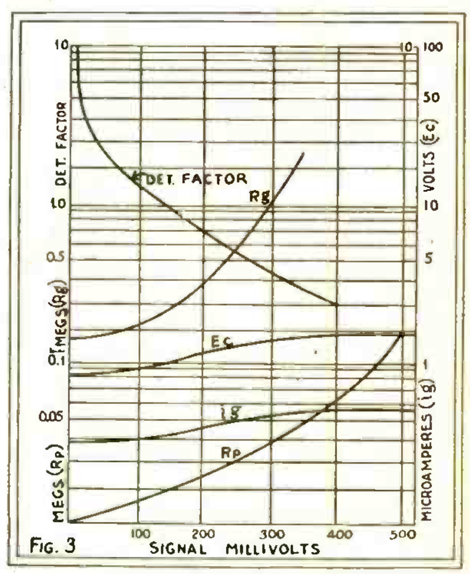
These humps are quite similar to those shown in Fig. 5, which were taken on a "C"-bias detector, of the UY-227 type, but in a different way. A modulated signal was picked up by a receiver which incorporated a "C"-bias detector. The audio voltage across the loud-speaker terminals was measured. (Instead of plotting the actual voltage applied to the input of the detector, it was simpler to plot the setting of the vernier condenser in the tuned circuit. The exact point of resonance in each case was at 50 on the dial.) There are three cases shown—a curve for a fairly weak signal, one for a signal of medium strength and one for a signal of great strength. Thus we see in the curves, respectively, one peak, two peaks, and three peaks.

Comparing the middle curve with that on the right, we see that the stronger signal made the two peaks of the medium signal move farther apart and also introduced another one, between the other two. The peak in the middle was caused by making the signal so enormously strong that it caused an actual increase of response, in spite of the serious overloading of the tube. In other words, it fairly "swamped" the set.

Signal vs. Grid Bias

The "C"-bias detector is supposed to operate without any flow of grid current in the input circuit. You will notice in these curves that, when there is more than one peak, grid current flows (as shown below) and this grid current starts precisely at the points where the peaks occur. So the simple rule is, never let the signal applied to a "C"-bias detector be greater than the bias on the tube. To prove this, in the case of the extremely strong signal, the grid-bias voltage was increased, and the broken curve was obtained; which shows that the peaks have disappeared. In other words, by stopping the flow of grid current, the overload on the tube was removed and the tube was rendered capable of handling a greater signal.

Now, to consider the effect of the signal strength on the quality. In the case of the grid-leak detector we had a decrease of plate current and an increase of plate resistance; in the case of the "C"-bias detector we have an increase of plate current and an apparent decrease of plate resistance. So the answer is that, the stronger the signal (up to, but *not beyond* the overload point, at which grid current flows) the better is the reproduction of the low frequencies. When we allow the signal to be so strong that grid current flows, we "knock the quality all to pieces;" because of the great number of harmonics introduced into the signal. Furthermore, as you can see by the curves of Fig. 5, the apparent broadness of tuning becomes quite bad.



As the signal strength rises to high values, so do grid bias Ec and grid current ig; but especially the input (Rg) and plate (Rp) resistances. The result is that the detector's efficiency falls off badly, as shown in the highest curve. (In this graph, which like the others is taken from the Proceedings of the I.R.E. *for October, the vertical scales are "logarithmic.")*

Modern Sound Projection

(PART III)

The third and last of a series of articles on synchronized sound and pictures, from the standpoint of a practical projectionist. The mechanism used and its operation are fully described.

By RICHARD CARMAN

AT the present moment there is still much controversy as to which is superior; sound on film, or sound on disc. There are many arguments, both pro and con, that may be brought forward on either side. Consequently, the industry is still divided on the point; with the result that practically every modern sound-picture booth is equipped for both.

Sound on Film

We will discuss first the sound on film. Perhaps one of its greatest advantages lies in the fact that the sound is recorded on a tiny band about one-eighth inch wide at the side of the film and therefore must run exactly in synchronism with the picture.

Sound on film also presents a greater possibility of high- and low-frequency recording, especially where the new type of wide film is employed; as the speed of the wide film is relatively faster in proportion to its size. The greater the recording surface exposed per second, the wider is the possible band of frequencies.

The life of the film, however, is greatly shortened in comparison with that used with sound on disc; because of the fact that the film becomes scratched, oil-spattered and spotted in not too many trips through the projector. This results in the distortion of the resultant sound; naturally, every scratch or oil spot or bit of dust will vary the light thrown into the photoelectric cell, just as the photographed sound-variation bands do. So, long before the actual picture has been ruined by wear and tear in the projector, the sound track has become totally unfit for further service and the film has to be discarded.

Sound-on-Film Amplifier

Sound on film also presents a problem that is not present in the disc system. The tiny electric current which is produced by the photoelectric cell is so small that it must be amplified, say two hundred times, to bring it up to the value of the current delivered by the electrical magnetic pick-up, used on the disc; the current delivered from the film or disc must be of the same value when it reaches the fader.

This amplifier must be constructed with the greatest of care, and fed with the purest direct current. It is fitted just below and in front of the projector head (see Fig. A) and therefore the greatest of care must be exercised to eliminate any possibility of microphonic noises, audio feed-backs or strays of any kind. Pure current is required; because the slightest variation would be magnified many times in the sound reproducers back of the screen, with an obvious result.

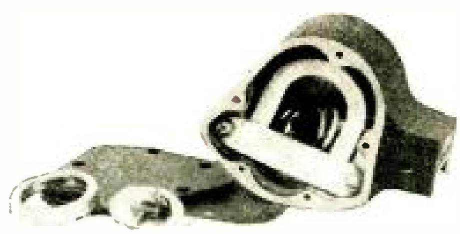


Fig. E
The parts of the disc reproducer; compare Fig. 3.

Sound Optical Trains

Fig. 1 shows the "heart" of the sound on film; the component parts so placed are called an optical train. At the extreme

Fig. D
A W. E. Type "4-A" disc reproducer. The needle receptacle has been removed from the armature.

left is shown the exciter lamp, a bulb containing a straight "line" filament, which is operated usually on a voltage of from six to twelve, and draws a current of three to eight amperes.

This filament lights to an exceptional brilliancy; and a photographic image of this lighted filament is focused on the moving film by the lens assembly just to the right of the exciter lamp. This assembly, in the Western Electric equipment, consists of two small high-powered condenser lenses, followed by an aperture or slit 3/16-inch long and from .0012- to .0015-inch wide. Beyond these are placed two of the finest type "objective" lenses, which complete the assembly. At the extreme right is a line representing the film, moving past the "sound aperture." This moving film, passing at a constant rate of speed, varies the light in a degree corresponding exactly to the photographic sound variations which are recorded on the film. This varying light now falls into the photoelectric cell, which correspondingly varies the current passing into the small amplifier beside it, and thus the current to the fader and the main amplifiers. The photoelectric cell is a "light-sensitive" device (see Fig. 2) comprising

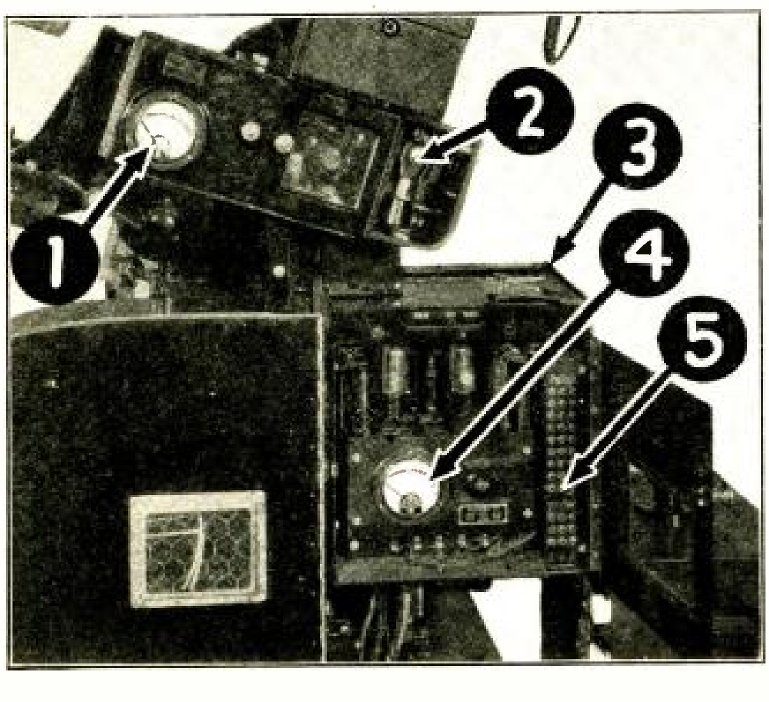


Fig. A
At the left, a film pick-up head and film sound amplifier. The parts are: 1, current meter, for the exciter lamp, which is mounted on the lamp's housing; 2, the photoelectric cell, the construction of which is diagrammed in Fig. 2; 3, the housing of the film sound amplifier; 4, filament current meter for amplifier; 5, "attenuator panel," used to equalize current from the film pick-ups of both machines.
At the right, the arrangement of the essential parts of the film driving mechanism in its relation to the film sound pick-up, shown in Fig. 1.
All illustrations by courtesy of Bell Telephone Laboratories.

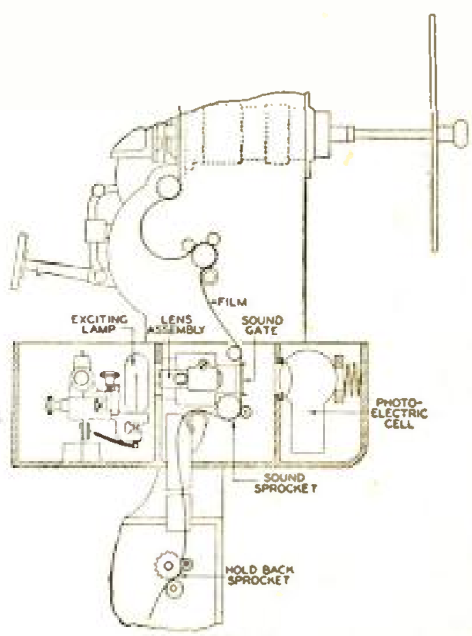


Fig. 4

a glass bulb from which run two leads or connections; one, connected to a ring-shaped electrode in the center of the bulb, called the anode, is always connected to the positive side of the circuit. The other lead makes contact with the inner surface of the bulb which has been silver-plated, to form an electrical connection with the light-sensitive material which is coated over the silver. This light-sensitive surface, called the cathode or negative electrode, is always connected to the negative side of the circuit. A small portion of the bulb, on one side, is left clear to serve as an opening or "window" through which the light enters the cell.

The light-sensitive material is made of a special compound of potassium. Besides this, the bulb contains a small amount of "noble" gas, such as argon. When the light-sensitive surface is not illuminated, this gas is an effective non-conductor and no current will pass in the circuit through the cell. The instant that light enters the cell, however, these conditions change instantly; and electrons then flow from the sensitive surface to the anode, attracted by the positive voltage on the latter. The flow of electrons, in itself, constitutes a very minute electric current; but by the action of the electrons on the gas in the tube the flow of current is considerably increased. The gas becomes "ionized" (that is it breaks down electrically) and is then a fairly good conductor instead of an insulator. A current therefore flows in the circuit.

The light entering the photoelectric cell increases the current flowing through it, in direct proportion to the amount and variations of the light itself.

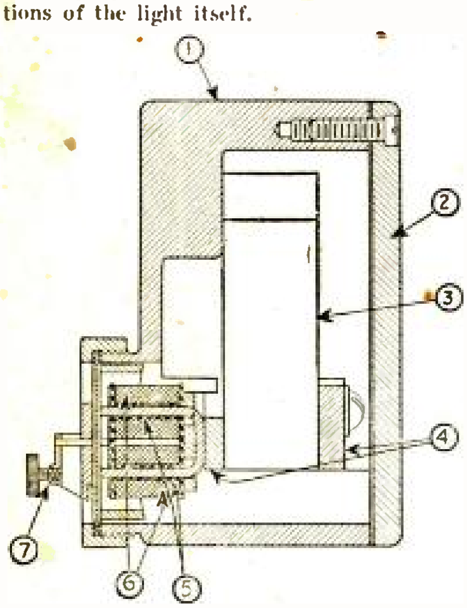


Fig. 3

Sound on Disc

The principal advantage of sound on disc is that, so long as the print of film holds together, it may still be used; while the quality of the sound will remain perfect, because, as often as necessary, the record may be replaced with a new one. The separate record, nevertheless, entails much trouble that we do not have to contend with in sound on film. In case of a break or damage to the film, the exact amount of film must be replaced, either by the picture, or by black or opaque film; so that the exact number of squares or pictures shall remain unchanged from the original length and the film continue to match the record and retain its synchronism. This method also entails all the necessary handling of the discs, both in projection and in shipment. Records will also "single-track" and jump grooves, in case of defects in the record or, sometimes, in case of extreme or harsh sound. This necessitates a high degree of skill and efficiency on the part of the projectionist to restore synchronism—a fact which is seldom, if ever, appreciated by the public.

Of course we must realize that synchronization of sound with motion pictures is actually in its infancy and, therefore, we should not condemn any one system of recording or reproduction until time and actual experience has proven conclusively the superiority of one over the others.

The Electro-Magnetic Disc Pick-Up

The equipment necessary for sound on disc, so far as the pick-up is concerned, is very simple in comparison with the film method. The only equipment between the electromagnetic pick-up and the fader is the selector switch. The electromagnetic pick-up (see Fig. 3) consists fundamentally of a permanent magnet the ends of which are placed against two field-pieces, around which are wound field coils. The coils are placed in series, and the remaining leads furnish the output of the reproducer. A steel armature is so placed between these field-pieces, so that when the needle, to which it is connected by a needle receptacle, is vibrated by the record groove variations it will vary the voltage in the tiny field coils. This arrangement may be varied in design and construction, the parts hermetically sealed and damped with oil, and other refinements of various kinds may be introduced; but the electrical pick-up is basically the same as in any radio-phonograph.

THE "talkies" and their kindred developments, all originating from the application of radio engineering methods to the moving-picture and the phonograph industries, present a wonderful opening to the radio technician. The ambitious radio Service Man and experimenter should not fail to read every one of this series of articles on Sound Projection which began in the February issue of RADIO-CRAFT
—Editor.

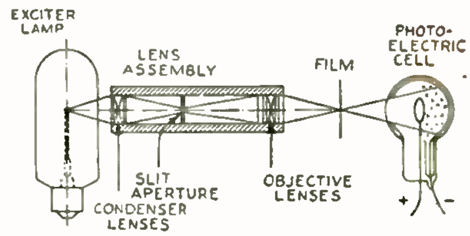


Fig. 1
The optical train of the film sound pick-up; compare also Fig. 1 on page 520.

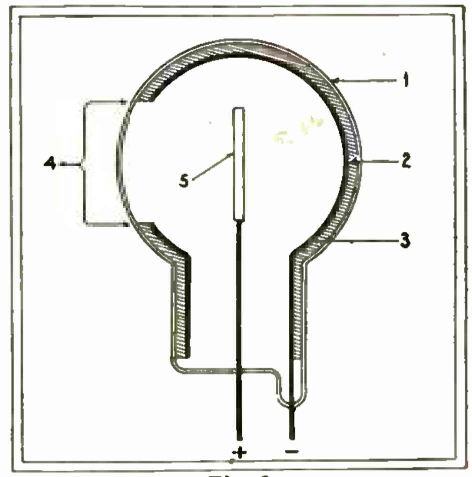
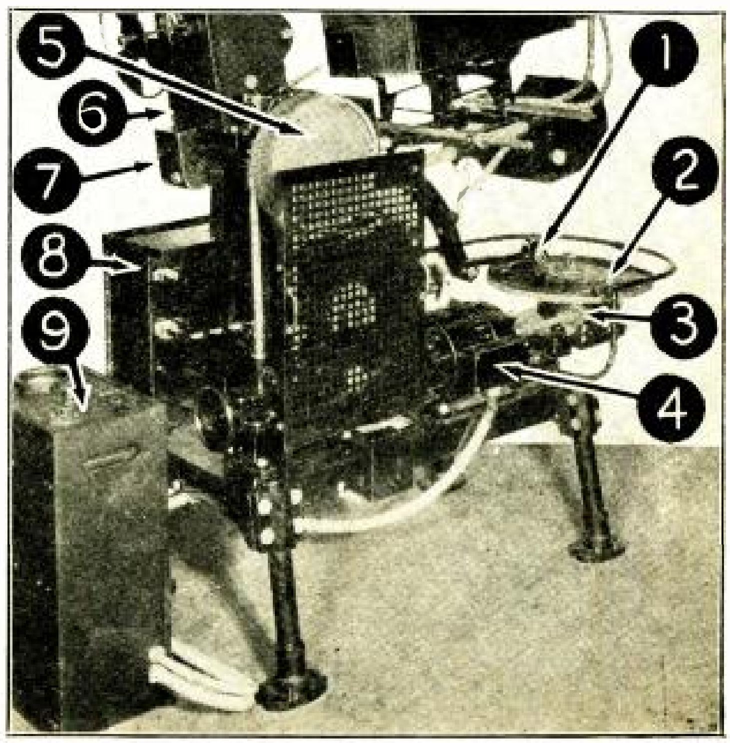


Fig. 2
The photoelectric cell or "electric eye": 1, bulb; 2, silver; 3, potassium; 4, window; 5, anode ring.

The Mechanical Filter

The purpose of the mechanical filter is to overcome any fluctuations or irregularities

Fig. C
At the right, the Western Electric "Universal" base, equipped for both film and disc. The figures indicate: 1, electromagnetic pick-up (see Figs. D and E); 2, disc on its turntable; 3, mechanical filter (see Fig. B); 4, speed-control motor; 5, film-sprocket mechanical filter; 6, projector head; 7, photoelectric cell compartment; 8, photoelectric cell amplifier; 9, motor-control box and tuned circuit described in Part 2 of this series.
At the left, mechanism of the disc pick-up; 1, sealed housing containing "damping" oil; 2, cover; 3, permanent magnet; 4, magnet-retaining bars; 5, field-pieces of magnets; 6, field coils; 7, needle receptacle, attached to armature.



in the motion of the disc turntable or the film-drive sound-sprocket. A separate filter is used for each purpose; but both are built upon the same principle. No matter how much care has been exercised in the design and manufacture of the machinery, there is a certain amount of fluttering or irregular motion, due to the meshing of the gears, etc. The mechanical filter is designed to overcome this and deliver an absolutely even flow of motion, taking up all the shocks, fluttering and irregularities. Fig. B is a picture of a Western Electric mechanical filter for the disc. At one side is the housing, containing the driving shaft which connects the motor with the worm gear, part of which is shown engaging the circular gear. On the latter are mounted six springs at three different points. The other ends of these springs are connected to the turntable drive shaft by means of the triangular part mounted in the center of these springs. The turntable is mounted directly on this shaft and the only connection to the driving unit is through these springs. The difference between this filter and the film-sprocket filter is that the triangular part is connected, not to the turntable shaft, but to a heavy flywheel firmly fixed to the driving-film sound-sprocket.

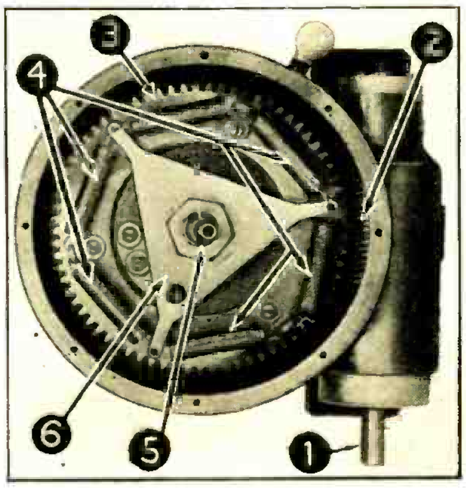


Fig. B

Disc-type mechanical filter: 1, motor drive shaft; 2, worm gear; 3, ring gear; 4, springs; 5, turntable drive shaft; 6, triangular connecting link.

In Figure C is shown the Western Electric universal base, upon which is mounted everything necessary for one machine to project sound pictures. This machine, when assembled, may be moved as one complete unit; thus doing away with the alignment of various parts, so common with many installations and with the earlier models of Western Electric sound apparatus.

The positions of the mechanical filters for film and disc is easily discerned; turntable, reproducer unit and arm, and mechanical filter are mounted in a suspension arrangement of rubber which absorbs any mechanical vibration of the machine. The shaft which connects the motor to the mechanical filter is in two sections coupled by a rubber hose as an additional buffer.

The Methods of Sound Picture Recording

By JOSEPH RILEY

THE electrical recording of sound requires a method of transforming sound vibrations into electric currents; then the transmission, control and amplification of these currents, and finally, a method of changing the electrical energy into mechanical energy, so that a permanent record may be impressed on the recording medium—either by modulated light on a sensitized film, or by the movement of a cutting stylus in soft wax.

In a recording studio, the essential apparatus consists of the microphone pick-ups on the stage, a mixer and volume control, amplifiers, recording machines, and a synchronous motor system for synchronizing the recorders with the cameras.

The stage on which recording is done is constructed purposely to exclude external noises by covering the walls and ceiling with sound-absorbing materials.

As in the broadcast studio, particular care must be taken in placing the microphones, to record successfully the speech or music occurring on the set. However, it often happens that the problem of locating the microphones is complicated by the construction of the set, and by the necessity of keeping them out of view of the camera. In such a case the "mike" then may be hung from the ceiling (as in Fig. B) or suspended from the end of a long boom (as in Fig. A). The microphones used are generally of the condenser transmitting type: this is, briefly, a condenser in which one of the plates is a very thin, stretched sheet of duralumin, which may be set in motion by the vibration of the sound waves. The capacity of the microphone is thus varied, and a modulation is caused in the electrical circuit to which the microphone is connected.

Camera booths are constructed of sound-proof materials to eliminate camera and motor noises, but have a clear glass window in front for the camera to "shoot" through. In Fig. B a sound-proof camera booth is shown in an actual studio scene.

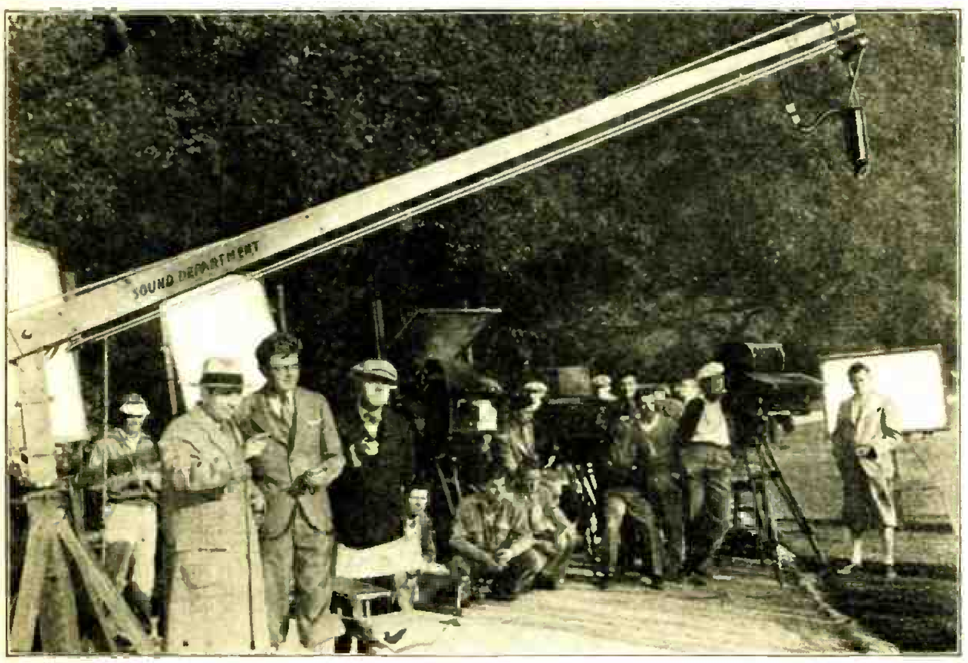


Fig. A

A sound-picture staff on the lot; the microphone hangs below the amplifier at the end of the boom. The cameras used are larger and more complicated than the hand-operated type used for silent pictures.
Courtesy United Artists.

The Man Who Hears

The person responsible for the balance, quality and volume of the recording is called the "monitor man." His duty, is first, to place the microphones properly after determining the acoustic conditions of the set; and he must be, therefore, very familiar with the action being photographed. He then sits in a bay window in the "monitor room" with a clear view of the stage and, by means of special horns only, since his room is insulated from the stage by sound-proof walls, hears all sounds picked up from the stage.

The centralized control for the whole system is the "mixer table." Here controls are located for fading microphones in and out, maintaining volume balance between several microphones, and regulating total volume; also for operating communicating systems, signal lights and relay-control switches. The monitor man in his room has a visual volume indicator, to help him keep the sound volume range within the limits of the recording system. The amplifier room contains the system amplifiers, monitor amplifiers and power-control panels.

If the picture is to be released with the sound recorded on film, the common practise is to operate two film recording machines for the permanent film record, and one wax recorder for "playback" purposes. The use of the wax playback has proved advantageous to the director and actors for immediate judging of the dramatic effort and the quality of the recorded scene, without the necessity of waiting for the film or wax record to be completed. The recording rooms usually contain two film and two disk recording machines, which are all driven in synchronism with the camera motors on the set.

Fig. C

A "frame" of sound motion-picture film, enlarged. The sound track at the left, between the sprocket holes and the picture, represents the sound frequencies recorded in synchronism with the action, though not necessarily on the identical piece of film, because of the distance separating the optical camera from the sound recording device. This may be compared with the film on page 457 of the March issue of RADIO-CRAFT. *Both record sound fluctuation by light and dark areas, but in different types of patterns.*

Courtesy R. C. A. Photophone, Inc.

Record on Film

Perfect synchronism between the action and the accompanying sound is inherent, since the picture and sound record are made in fixed relation on the same piece of film. Standard film is used, but a small portion of the width of the film one-tenth of an inch wide is used for the sound track (Fig. C, and see also page 457 of RADIO-CRAFT for March.) The sound vibrations are recorded in this track as alternate light and dark lines of varying density. In the projector, these lines serve as a means for the reproduction of the original sound, accurately synchronized with the action.

The vibrations of the air which constitute sound are picked up by the diaphragm of the microphone. The vibrations of this diaphragm in turn give rise to feeble electrical oscillations, corresponding in frequency and strength to the pitch and intensity of the original sound. These weak oscillations are then amplified enormously by four or five stages of vacuum-tube amplification. The amplifier must have very faithful characteristics; so that the output shall be an undistorted copy of the input, except that it is much greater in volume. This pick-up amplification is similar to that of the speech input system of a broadcast station, or of a public-address system.

The output of the amplifier is applied to a special vacuum glow tube called an "Aeo" light. This tube glows with bluish-white light of its normal brightness when a uniform direct current of ten milliamperes is passed through it. When the sound-modulated output from the amplifier is also applied to the tube, the glow is alternately increased and partially extinguished; it follows the modulating current in frequency, for it varies in intensity with that of the current. The action of this tube is somewhat similar to that of the neon lamp used in television work. The light from the "Aeo" lamp then shines through a slit and optical system (as in Fig. 1) which brings it to focus on the film, as a fine line running crosswise of the sound track. According to the modulation applied to the "Aeo" light, there is produced in the developed film a series of alternate light and dark lines whose spacing and contrast depend on the frequency and intensity of the modulated current applied to the "Aeo" light. A low note corresponds to a slow frequency of sound vibration, and results in a wider spacing of lines on the film. A high note, corresponding to rapid frequency of sound vibrations, results in a close spacing of the lines. Relatively pure notes, such as those from a whistle, give uniform alternate light and dark lines; while the complex sounds of speech and orchestra are recorded in quite complicated patterns.

A camera similar to those for making silent pictures is used in the sound-on-film method. However certain modifications are made to adapt it to recording sound and picture simultaneously. It is provided with a holder for the slit and "Aeo" light, at a point where the film moves uniformly, and with a motor drive (Fig. 2); since it is not possible to crank smoothly enough for sound recording, especially at the speed of ninety feet of film per minute. On the other hand, the camera must be quiet, so that noise from its operation shall not be picked up in the microphones and recorded along with the desired sound.

Sound on Wax

If the picture is to be released with the sound recorded on discs, the electrical impulses, after coming from the amplifiers, are fed into the recording mechanism. The wax recording machine used in the Western Electric system consists essentially of the following parts: a motor drive; a reduction gear, with a belt drive connected to the lead screw which moves a recorder radially across the surface of the wax disk; and a second reduction gear driving a turntable on which the wax is placed.

Recording is done with an electrical recorder receiving its power from the system amplifiers. The electrical energy drives a cutting stylus, made of sapphire or ruby, which must be sharp to insure a clean cut; since any roughness in the walls of the groove introduces extraneous noises into the reproduced sound. In "lateral" recording, which the Western Electric system uses, the vibrations are produced along a radius of the disc record; so that the stylus cuts a spiral groove of constant depth, about 0.0025-inch, but of varying width.

The lateral method of recording is used

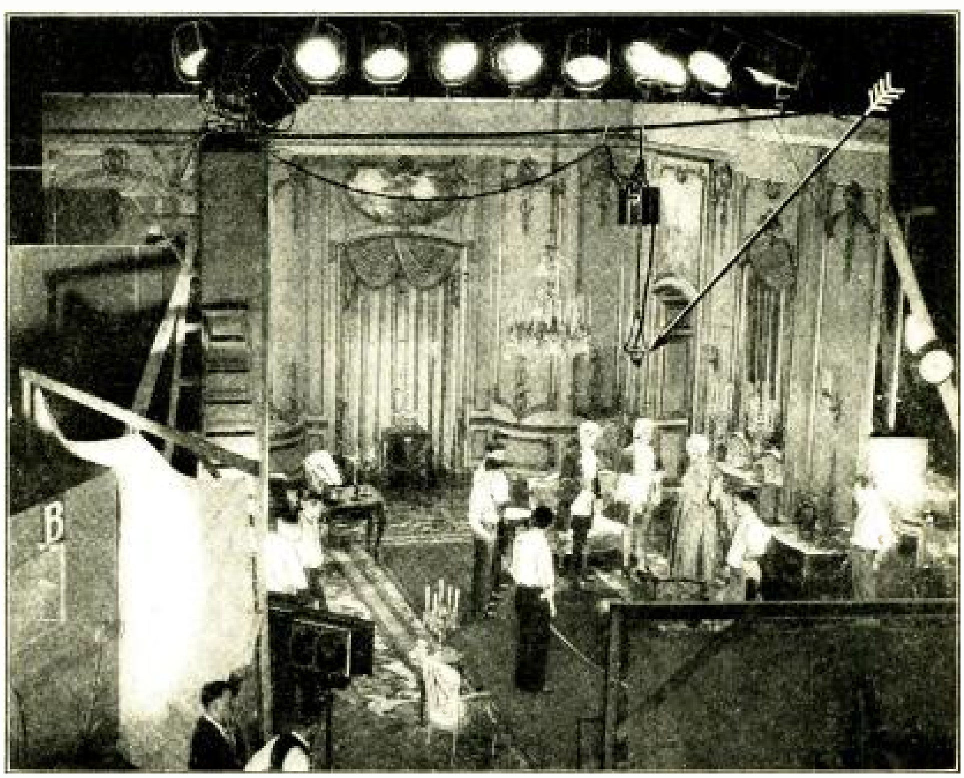


Fig. B

Recording a talking picture at R. C. A. Photophone's Gramercy studio, New York City. The arrow points to the microphone. The optical camera is behind the screen at the lower right; the white line on the floor marks the area of the picture. The sound is recorded in the sound-proof box at the lower left.

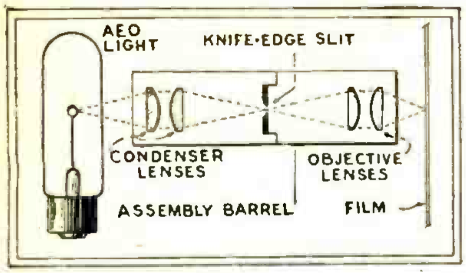


Fig. 1

The system of recording sound on film may be compared with that for reproducing it from the film, shown on page 517. The AEO light flickers according to the audio modulation of its current.

almost exclusively in sound picture work. The original wax is a disc of metallic soap, from thirteen to seventeen inches in diameter and about one inch in thickness. This disc is first given a high polish, before being mounted horizontally on a turntable which is driven at a uniform speed of approximately thirty revolutions per minute (or less than one-half the speed of the ordinary phonograph). At the same time, the disc is being synchronized with the film being run through the cameras. On the ordinary phonograph, the reproducer travels in playing from the outer edge towards the center of the record; but, in sound recording, the stylus is made to travel outward from the center of the disk at such a rate that it cuts a spiral having the pitch of about one hundred turns per inch.

As mentioned before, as soon as the wax has been cut, it is desirable to play it at once, in order to detect any flaws by the play-back. This special reproducer is extremely light, so that it produces no appreciable wear on the comparatively soft wax record. Then if the wax is pronounced satisfactory, it is dusted with a fine conducting powder and electroplated, thereby creating a *negative* copy of the wax, called the

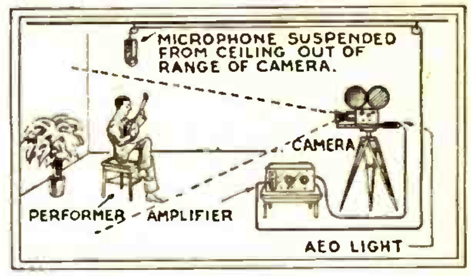


Fig. 2

The set-up for a "talkie" studio; the microphone connects through the amplifier with the apparatus of Fig. 1, which is in the base of the camera, and operates on the unexposed side of the synchronous film.

"master" record. By successive electroplating steps, duplicates of the "master" are obtained. These are known as "stampers," from which large quantities of playing records may be pressed. By taking the proper precautions during these processes, the acoustical fidelity is preserved.

Installing "Talkies" In a Small Town

By ROBERT HAVILAND

WHEN the local house installed talkies, I did quite a bit of the electrical and mechanical work. Numerous special problems arose, and it was usually necessary to consult an expert. If the Service Man has a knowledge of some of the problems, he is in a position to make more money.

Sound on film is hardly practicable for small houses, because of its price and the technical and mechanical difficulties. However, there are several medium-price ($1,000 to $2,000) outfits on the market.

There are two types of disc machines: the first drives the projector, the second is driven by the projector. The Vitaphone is usually chosen to represent the first, and some smaller outfit, such as the Mellophone, is taken for the second type. The first sells for about $10,000 complete, and the second for about $1,000. There is some difference in tone, and much in amplifier capacity.

The disc is a 16-inch record, turning at *about* 33 1/3 R.P.M.; the record tracks from the center to the edge. The film runs through the machine at the rate of 90 feet per minute. The main drive shaft turns at 90 R.P.M.

The auditorium of the house here is 65 x 22 x 11 feet; according to the rule below, no acoustical treatment was necessary. However, the back wall was covered with acoustical "Westfelt." It was found that the sound was improved, with an audience below the average, and that noise from the projection room was reduced.

(The rule for determination of acoustical treatment, given through the courtesy of the Western Felt Works, is:

Find the total "effective audience" by a formula which adds to the average number of persons in the hall on an ordinary night, one for each ten square feet of tapestry, seventeen feet of carpet, three empty upholstered chairs or 14 empty plain chairs. This is to give the equivalent *sound absorption* of the contents of the theatre. The acoustic felt absorbs as much sound as one person, with 22 square feet of ¼-inch material, or 12 square feet of ½-inch. The "effective audience," thus found, is subtracted from the quotient of the number of cubic feet, in the auditorium, divided by 150. The remainder is then multiplied by 12, to get the number of square feet of ½-inch material needed to equalize the acoustic conditions.)

A Samson "PAM 17" was used for the amplification; the house is small, so that this model was found to give ample volume. Bigger houses require a larger amplifier; any manufacturer will supply data. It is necessary to add input, output, and impedance-matching transformers, switches and faders to any self-contained amplifier. A volume indicator is very helpful at all times.

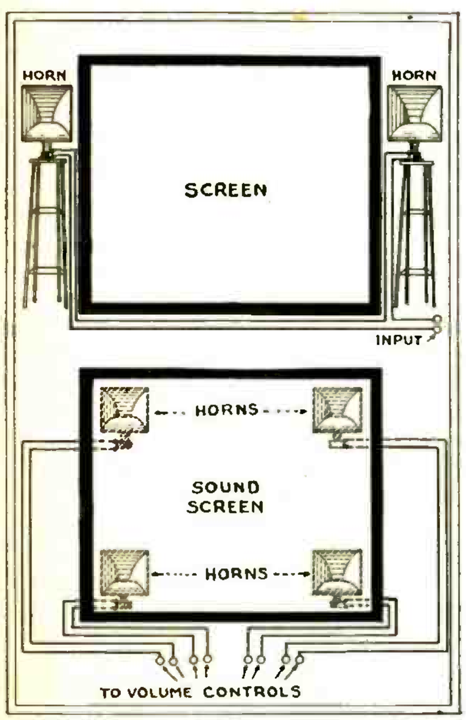


Fig. 2

Two arrangements of the reproducers in a theater; two horns may be separated by the screen, but it is better to put four behind a porous ("sound") screen.

The turntables were located under the lamphouses of each machine; a larger motor or weighted turntable will reduce the "flutter." Twisted leads were run from the pick-ups to the fader, and from the fader to the amplifier. (*Illustrations of apparatus, fully explaining all terms, are contained in the articles on Modern Sound Projection, which began in the February issue of* RADIO-CRAFT.—Editor.) It may not be necessary to shield these, but this reduces pick-up of A.C. hum from the supply line to the projector; LBX, with a flexible, braided cover, is excellent.

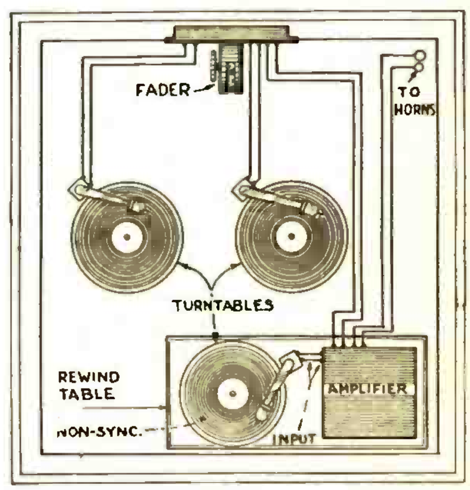


Fig. 1

Arrangement for the sound-on-disc apparatus of the booth as wired by Mr. Haviland. It may be seen that compactness was necessary.

Low-priced faders cut off the frequencies necessary for best reproduction. Amplifiers fall off in amplification on the high and the low frequencies; if the output impedance

(*Continued on page 535*)

The Cooperative Radio Laboratory

More data on Mr. Grimes' "Filter Feed-Back" circuit, which is designed as an automatic regulator of regeneration in a radio-frequency amplifier, to produce a practically level amplification curve throughout the band

By DAVID GRIMES

AMPLIFICATION versus selectivity is the latest problem with which this Laboratory discussion is concerned. There is apparent renewed interest in good distant radio reception, in addition to good tone quality on the immediate locals. For a while, real selectivity—right through the nearby stations—seemed to be on the wane; due, no doubt, to a greater interest on the part of experimenters in the electrification of their old battery sets. Most of these electrified circuits have been confined to straightforward radio-frequency arrangements, in order to simplify the process as much as possible. Now the next logical step is to improve on these hook-ups, to obtain some real DX performance again.

And this is possible, more than ever before, because the new A.C. tubes, especially the '24 type, are much better for radio-frequency work than any combination of the old battery tubes. Of course, certain circuit precautions are necessary and these are most interesting to us in this present Laboratory series. It was brought out, in the last article, that as we increase the amplification we increase also the effective broadness of tuning in a receiver, so long as the same number of tuning condensers is employed. Such a practice tends to bring our locals even nearer to us; and we all know the effect on selectivity when this is done.

Furthermore, many of the trick circuits to obtain equal selectivity and equal amplification with the old battery tubes have not as yet been applied to A.C. tubes; at least, not so that the experimenter can proceed with some assurance of success. It now remains for us to engage in this type of circuit development; and suggestions will be in order from those of you who have already delved into this art.

Problems of Feed-Back

In the first place, one of the most successful equal-amplification, equal-selectivity circuit arrangements which it ever fell to my lot to devise was an automatic regeneration stunt used in one of the last battery-operated Inverse Duplex circuits. This was conceived through a fortunate combination of connections—largely the result of luck. Some of you will recall that the audio amplification in the Inverse Duplex was fed back through the radio stages, and that the R.F. tubes also acted as audio amplifiers. Well, all that was needed to give radio feed-back was to allow some of the radio currents to filter back through the audio channel—and behold! (The circuit details of this Inverse Duplex are not given here; for space does not permit and they are really aside from the issue.)

But this automatic feed-back has been constantly in my mind and, recently, I had occasion to work it out with the new A.C. screen-grid tubes. The preliminary results were most encouraging and the experimenters will be able, no doubt, to further improve the performance with a little effort. Anyway, the long-wave amplification was considerably boosted, yet with an increase in selectivity while the short-wave amplification (around 200-250 meters) was not impaired and the circuit's selectivity was also increased over the standard connection.

It would be well at this point for you to review the article in last month's issue. There you will find a full discussion of "equal-amplification, equal-selectivity" circuits. (Of course, there really isn't any such thing.) Most of the circuits are mere approximations. And this is nothing against them for even the poorest approximations are better than the standard straight radio-frequency circuits, which are notoriously bad on amplification at the high wavelengths around 500-550 meters. The approximation which I wish to propose consists of a simple electrical filter feed-back connection, which is applied to an otherwise simple straight R.F. circuit. The arrangement is extremely inexpensive and simple to construct. Perhaps you can apply it to your present set with but few changes.

Effect of Tubes Used

Fig. 1 shows a standard straight radio-frequency circuit employing two stages of screen-grid R.F. amplification. For my particular purpose, a screen-grid detector was also employed, and the associated circuits herein described will involve this type of detection. But don't let this discourage you; for the principle of automatic feed-back filter circuits is fundamental, and it can be applied to any system of radio-frequency amplification and any type of detection. If you can but master the theory, you can apply it to your present set. It is in this respect that the idea lends itself to extensive experiment. Your results will be awaited with interest, and several of the most successful circuits will be published in this section. So go to it, with at least improved reception as your reward.

The radio-frequency amplification curve of the above circuit is given in Fig. 2; it

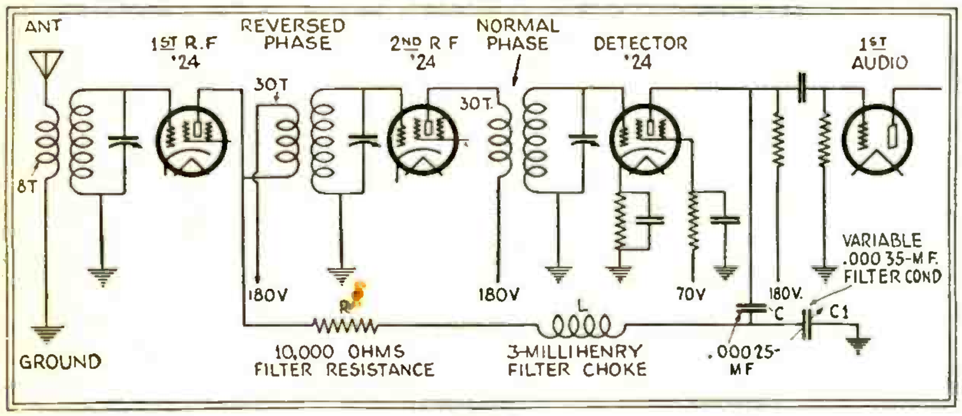


Fig. 3

The constants of the "Filter Feed-Back" system, applied to the screen-grid amplifier and detector unit of Fig. 1. Its efficiency curve is Fig. 4.

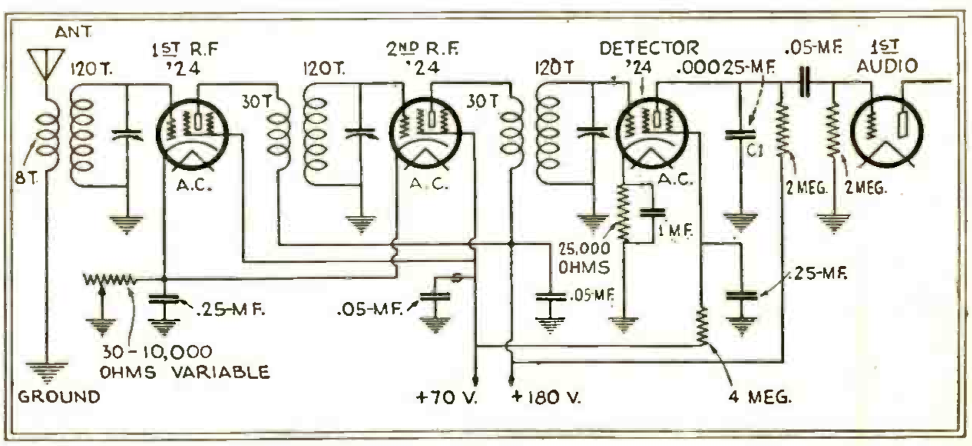


Fig. 1

An amplifier with '24 tubes in all stages, of great efficiency up to about 400 meters, as shown in Fig. 2, and much better than '27-type amplification.

is peculiar (as will be seen by comparison with the curves given last month) but the R.F. gain is practically uniform from 200 to 400 meters. This is most unusual; but it is no doubt due to the presence of the screen-grid, which prevents any tendency toward oscillation within the tube itself at the lower wavelengths. Fig. 2A shows this same condition when an unshielded amplifier tube, such as the '27, is used. There is a tendency for the curve to rise rapidly at 200 meters. This is only one of the circuit differences called for in the use of the new tubes. It is obvious that a different filter feed-back circuit would be needed, in Fig. 2, from that of Fig. 2A. This leaves ample

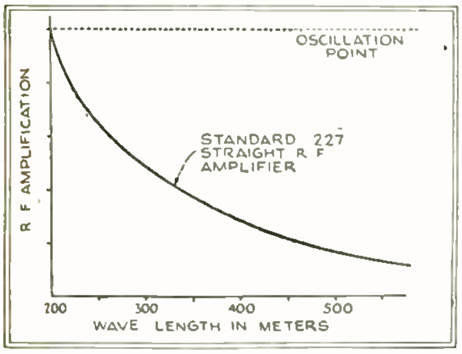


Fig. 2A

The ordinary R.F. amplifier reaches oscillation at the bottom of the band, and loses efficiency all the way up.

room for original experiments on this circuit, by those who wish to apply it to their present sets.

Now to proceed to the business at hand. All forms of grid-suppressing resistances should first be removed from the circuit. These all cause losses, of one form or another, which tend to raise havoc with the selectivity; particularly on the short waves between two and three hundred meters. Out with them! Oscillation? Oh yes, you will probably experience oscillation; but this must be cured in an entirely different manner than by the insertion of "lossers." The next step is to remove turns on the primary windings in the plate circuits of the several radio-frequency tubes. The same number should be taken off each primary, if possible; and be careful not to remove too many. Try taking off one or two at a time, and proceed until the set just barely oscillates at 200 meters and not above this point.

I know that this will reduce your amplification still more at the long waves, but proceed anyway; as we are to regain much of this sacrifice through the feed-back action and some selectivity we will have in addition! The dotted lines in Figs. 2 and 2A represent the point of oscillation, above which the amplification cannot be raised without experiencing trouble. You see, by juggling the primary turns as described above, we can just reach this point at the low wavelengths—no more, no less. It is at this point that we have maximum amplification and maximum selectivity.

The New Circuit

Now for the filter feed-back! It is best to take this feed-back off in the plate of the detector tube. It could be taken from the plate of the last radio tube in the amplification chain; but some difficulty is encountered here in tuning out near-by locals. (This will be explained next month.) Fig. 3 will give you some idea of the method by which this is accomplished. It will be noted that a small .00035-mf. condenser C1 (preferably variable for experimental purposes) has been inserted in series, on the ground side, with the regular .00025-mf. plate block-

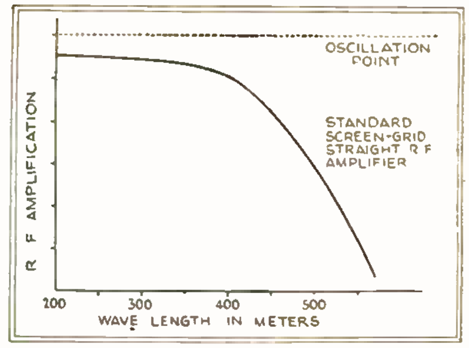


Fig. 2

The screen-grid tube is a better R.F. amplifier than earlier types; but it weakens too on long waves.

ing condenser C. It is across this inserted condenser that the feed-back is taken, on through to the beginning of the R.F. system or at any other convenient point desired.

In addition to the potential condenser (as the extra condenser is called because it furnishes the feed-back R.F. voltage) there is the low-wave choke L and a series resistor R, of rather high value. These three units combine to give feed-back on the long waves, above 400 meters, and to entirely prevent such action below this point. The theory is rather simple. Where the amplification is uniform and good, there is no need for any boosting effect. It is only between the 400- and 550-meter ranges that some compensation is required. Well, the initial feed-back condenser C1 creates more feed-back voltage on the long waves; as it tends to completely by-pass to ground the short-wave R.F. currents in the plate circuit of the detector. And conversely, the feed-back voltage becomes appreciable on the lower frequencies, longer waves above 400 meters.

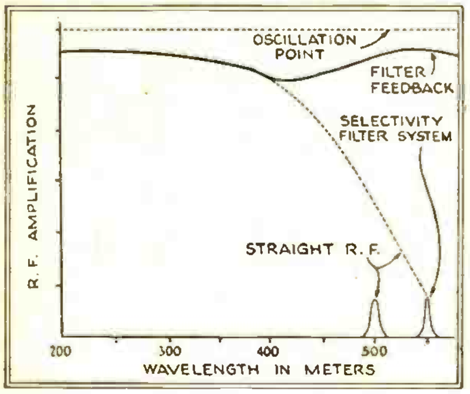


Fig. 4

The Filter "Feed-Back" supports the curve of falling efficiency (compare with Fig. 2 opposite) while at the same time it holds the selectivity peak sharp.

The differential action is still further augmented by the choke coil L, which discriminates against the short-wave feed-back still further, if any short-wave voltage attempts to find its way back through this circuit. The long waves pass through such a choke with comparative ease.

The full explanation of the purpose of the resistor R involves some rather delicate questions of phase relationships, which are not so easily disposed of. The fact remains that such a resistance is desirable, and the exact value of it was determined solely by experiment. It is sufficient to say that the feed-back through this path aids operation at low frequencies, and that the slight amount that does get back on the higher frequencies actually opposes the R.F. gain and, furthermore, permits the positive feed-back action to take place more gradually.

Connections of Windings

It is further necessary to discuss the question of phase in this feed-back consideration. Those of you who have had experience, in the old regenerative days, realize that a tickler coil has a detrimental effect where it is connected in the reverse direction. The same action is possible in this filter circuit; except that each of the primaries of the succeeding R.F. coils really constitutes a tickler. This makes it extremely necessary to obtain the correct connections on the coils. Fortunately there is some "rhyme and reason" to the procedure; the phase connections should be "normal" on all the coils except that to which the feed-back circuit is connected; this should be connected in the reverse fashion. Fig. 4 shows the effect of the feed-back filter circuit on the amplification and selectivity of the standard R.F. curve shown in Fig. 2.

Although the entire subject of "normal" and "reversed" R.F. phases has been previously discussed, it is so important in this particular circuit that I am sure that those who are familiar with it will permit this small repetition. Fig. 5 gives some idea of the connections. It is first assumed that the primary and secondary coils are wound in the same direction of rotation. This is generally the case; for the same type of winding machine is used in both cases. If this is the case, the plate of the preceding tube is always connected to the end of the primary which corresponds to the grid end of the secondary when a normal phase connection is desired; the reverse is true when a "reverse phase" is desired. Both of these connections are shown in Fig. 5.

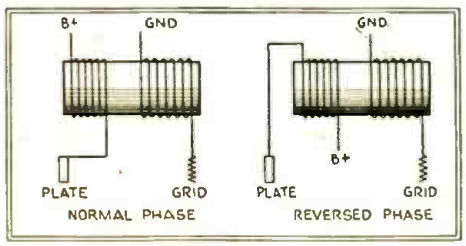


Fig. 5

The coupler to which the filter is attached must have "reversed" coil connections, to insure proper action.

As a last resort and as a check on the previous information, it is a simple matter to verify the aiding or opposing feed-back action by merely reversing the primary winding to which the feed-back circuit is connected. The proper reverse phase should aid the long-wave signals; while the improper "normal" phase will materially reduce the already weak signals. Fig. 3 is intended to make this phase reversal in the actual circuit clear.

Experimental results obtained by our readers with this arrangement will be welcomed. Several new commercial sets for the coming year have incorporated some such stunt; perhaps you can find a combination that will beat them. Another clue is now given to aid you in the work; it will greatly simplify matters if you provide some regeneration control (radio-frequency gain control), because you may then employ a filter design that is less critical. Slight oscillations, which would require almost endless experiment to iron out in the filter, may be suppressed without serious detriment by the R.F. volume control. A variable "C" bias, on the grid returns of the R.F. tubes, is a very good way to accomplish this result.

And another thing which we almost forgot to mention! The R.F. filter-choke coil design, fortunately, is rather easy to arrive at by experiment. Of course, for those who have R.F. or even audio inductance bridges, the problem is still simpler. For instance, I may tell you that the filter choke should be about three millihenries, measured at 1,000 cycles.

The inductance of the ordinary secondary coil in a R.F. transformer is about 0.25-millihenry; so the value of the filter coil L is about twelve times as great. This can be roughly approximated by winding about 600 turns of No. 34 gauge S.S.C. enameled wire on a ¼-inch spool, in a rather careless fashion.

A Couple of Hints for the Amateur

By WESLEY W. BROGAN (W3ARM AND W3AGU)

THOSE of the "ham" fraternity who have entered into the matrimonial stage of life, and have been blessed by the appearance of the "second op.", or "Sparks, Jr.", will—no doubt—have lying about the kitchen several rubber nipples for baby's bottle.

When these have served their usefulness in their ordinary service, just take them into the radio shack and introduce them to a couple of Mueller "Universal" Test Clips, No. 48B, or an equivalent clip.

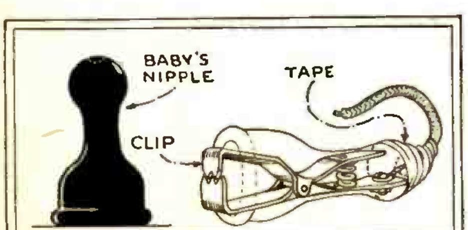


Fig. 1

The "ham" who is a proud parent will find a use for discarded nipples, as shown. An "Old Bach" must use his own discretion.

The next step is to cut a small hole in the tip of the nipple and place it over the test clip; after first fastening to the clip any wire leads necessary. This results in a neat and economical insulated-clip. (Fig. 1.)

The writer has a 2-amp. tungar charger and, since this charging rate is too rapid to permit the use of an automatic relay (except the more expensive "full-automatic" type), a simple switching arrangement was devised so that full control of charging, and current supply to the set, could be obtained. The circuit appears in these columns. (Fig. 2.)

In this diagram is shown a four-pole, double-throw switch. The process of charging may be stopped at any time by putting the switch in the neutral position.

Instead of the four-pole, double-throw switch, two D.P.D.T. switches, fastened together with a tie-bar, may be used.

In one extreme position of the switch, the "A" battery and "B" eliminator are connected to the set; in the other, the "A" battery is changed from the set over to the charger, and the "B" unit line connection is broken and the line circuit closed through the "A" charger.

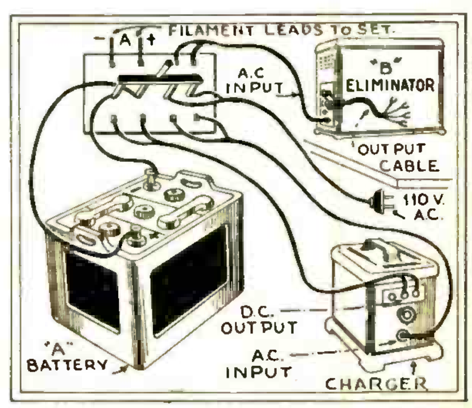


Fig. 2

The expense of an automatic relay may be saved by the use of this simple and convenient method of connection with a high-rate charger.

The Radio Craftsman's Own Page

This page is reserved for the readers of RADIO-CRAFT; we shall be glad to hear what they are doing in the construction line—especially when it contains the element of novelty

WE'RE GETTING BETTER

Editor, RADIO-CRAFT:

I want to congratulate you on the best magazine published. I did not think much of the first one; but now you are putting out a real radio fan's book. Keep the good work going and for the love of Pete keep the fiction stories out of RADIO-CRAFT. The Service Man's data sheets are great; I would like to see one on the Fada, especially the "R-60." I am keeping a file of RADIO-CRAFT, and don't want to miss an issue.

B. F. CRAWFORD,
1316 North St., Flint, Mich.

(We welcome letters from our readers. even though it is possible to print but a few; and we therefore reserve this page for those which contain information and experiences of practical benefit to other readers. We acknowledge here, however, many bouquets and a brickbat or two which we cannot find space to publish.—*Editor.*)

WHAT'S THE MATTER WITH KANSAS?

Editor, RADIO-CRAFT:

Will you please tell me which is the best ground for a radio set, a hot-water pipe or a cold-water pipe?

Is it too far from Central Kansas to Europe to pick up some of their stations with a short-wave receiver? I have not seen a letter from Kansas on the Craftsman's page.

RAYMOND MCCOMB,
Stafford, Kansas.

(We can only say that the value of a pipe as a ground depends upon what the other end of it is attached to. Usually a cold-water pipe makes the lowest-resistance ground; but that can only be found out by testing it.

Kansas is not too far from Europe to pick up stations; even Australia is not. The distance in miles is not so important as the "skip distance" zone and the location of the receiving station. We shall be glad to hear from any readers in Kansas who have had good results; and so, no doubt, will Mr. McComb.—*Editor.*)

A GROUND ANTENNA

Editor, RADIO-CRAFT:

It gives me great pleasure to pronounce your magazine "wonderful;" I watch the stands for it every month.

I have a Pilot "Wasp" which is a go-getter: I have no outside aerial, but in the basement, I have three 4½-foot rods (⅜-inch metal) driven three feet into the ground. Along them I have thirty feet of wire running straight, then thirty feet more, L-shaped, with an eight-foot lead-up. While the snow (about five inches—we don't have much as a rule, and this is the heaviest fall since 1918) lay on the ground, I buried an old aerial wire in it and connected it to the "Wasp." The reception from it was surprisingly good that afternoon and night.

C. H. BINGHAM,
Sanford & Day Iron Works,
Knoxville, Tennessee.

SHORT-WAVE DOPE

Editor, RADIO-CRAFT:

I recently received a letter from the British East African Broadcasting Company, Ltd., with verification of reception of their station 7LO, Nairobi, Kenya. It is operating on 31.1 meters, 500 watts, from 11 a. m. to 2:00 p. m., E. S. T., daily and Sundays. I have also verification from VK2ME, G5SW, PHI, XRH. My set is a Junk Box with two stages of audio.

M. P. NEMITZ,
Box 286, Hampton, Iowa.

Editor, RADIO-CRAFT:

The following information has been received from the radio laboratory of the Dutch government's telegraph and telephone service. A new transmitter, PCV, with a power of 80 kw. has recently been finished. Its tests should be heard in the United States daily except Sunday from 3 to 9 p. m. E. S. T. on 16.82 meters for it has not yet been equipped with the directional aerial for transmission to the Dutch East Indies. After 9 p. m. it works on 38.3 meters. PCK on 16.3 and 38.8 meters may also be heard. Telephone communication is maintained between Kootwijk, Holland, and the independent, though associated, stations at Bandoeng, Java, over 7,000 miles.

R. H. ADDISON,
29 Armandine St.,
Boston 24, Mass.

Editor, RADIO-CRAFT:

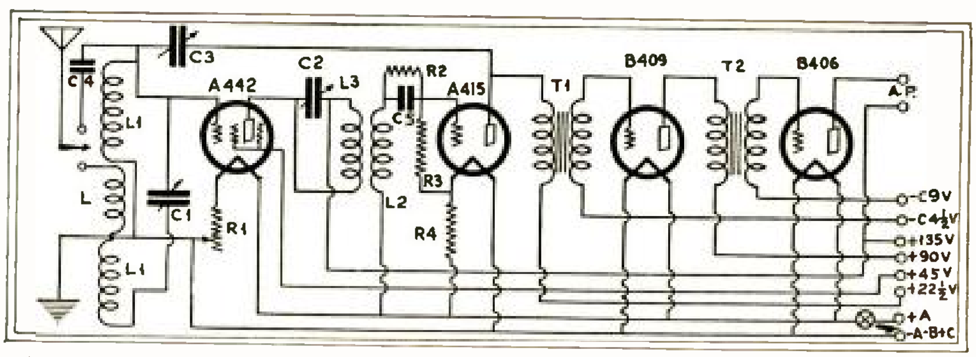
Please give the Short-Wave Club credit for the following:

G2GN on the S.S. *Olympic* uses French and English on 18, 24, and 35 meters. The French station F8BZ heard by Mr. Schroeder is the *Olympic's* French phone connection on 19.5, 22 and 38.5 meters. The U. S. end is now W2XG.

The Lyngby station on 19.6 is OXY; the 14.5 Monte Grande station is LSH. CJRX is now VE9CL and on 52 meters or close.

Leningrad, Russia, 3KAA, is on 36 meters from 4 to 6 a. m. Mondays, Tuesdays, Thursdays and Fridays.

ARTHUR J. GREEN,
700 Alpha St.,
Klondyke, Ohio.



The tuned-grid, tuned-plate broadcast receiver of Señor Molero. While the coil constants which he used are given below, the tubes employed are of a European type; and the experimenter in the United States may have to change their constants, as well as those of the filament circuit.

AN UNUSUAL RECEIVER

Editor, RADIO-CRAFT:

My regards to an old radio pioneer. I enclose the details of receiver which I have constructed to obtain selectivity with quality, by means of the band-selection coupling illustrated.

The coil L1 is wound in two halves of 34 turns each of 0.4-mm. (*approximately 26 gauge*) D.C.C. wire on a 2-inch tube, 3½ inches long. Between these, which are separated ⅞-inch, L is wound with 7 turns of the same wire, spaced to occupy 1/3-inch. This coil is mounted on brackets, and carries on another bracket the antenna coupling condenser C4.

L2 is wound with 88 turns of the same wire on a similar tube; over it, in the same direction, and separated from it by a double layer of insulating paper, is L3, of 68 turns. The grid lead from L2 to the leak and condenser is taken from the same end of the coil as the plate lead of L3, which is connected to the rotor of the tuning condenser C2.

The tuning condensers C1, C2, are .0005-mf.; they are equipped with vernier dials; C3 is a three-plate condenser of the neutralizing type; C4 a .00025-mf. fixed condenser. The grid condenser is .0002-mf., the grid leaks R2, R3, are Carborundum, 5 and 7 megohms. R1 is a 30-ohm rheostat; R4 a 2-ohm filament ballast. The audio transformers are low-ratio and of good quality. The metal sub-panel may be of any non-magnetic, low resistance metal; and a shield of the same material covers it entirely. A filament switch, sockets, a 7-lead cable and plug, and binding posts or jacks for antenna and speaker connections are obvious. The shielded receiver is 9 x 12 x 7¼ inches. Antenna connections are provided for a long or short aerial. The peculiar arrangement of the grid leaks promotes high sensitivity for distant reception.

FELIX F. MOLERO,
Chief of the Meteorological Observatory,
Puerto Madryn, Chubut, Argentina.

(Señor Molero's circuit will be of interest to many experimenters. The tubes used, however, are of types not available in the United States; the screen-grid tube works on four volts, like the others with which it is in parallel. Some changes will therefore be found necessary by a constructor in the States. The use, also, of an R.F. choke and by-pass condenser in the detector plate lead commends itself.—*Editor.*)

HARMONICS ANNOYING

Editor, RADIO-CRAFT:

Mr. Schroeder speaks of interference with foreign stations by harmonics of long-wave stations; of course the stations you want are most interfered with. Between 49 and 52 meters there are at least five harmonics; KWKH and WHT are steady on this band. There are several foreigners near, but not much chance of getting them. VRY is badly interfered with by code and sometimes by harmonics from both amateurs and broadcast stations. This is getting serious and something should be done.

I should like to identify a French station on 16.5 meters heard mostly on Sundays after 1 p. m., E. S. T.

I have joined the Short-Wave Club; it is surely worth the dollar a year. I have visited Mr. Green several times and heard his receiving station, and I am convinced that there is no short-wave fan in the country more qualified to give information concerning these stations.

J. R. MCALLISTER,
Struthers, Ohio.

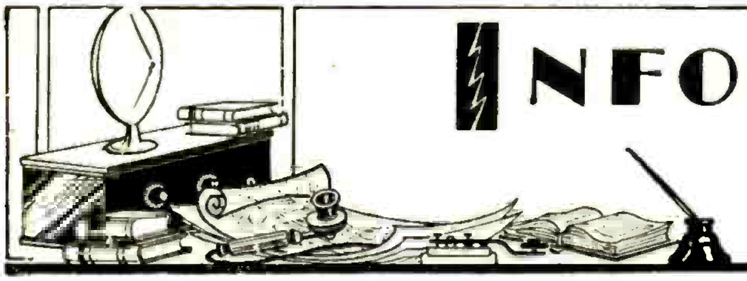
(We have had several inquiries as to whether broadcast transmissions heard by short-wave listeners are harmonics. If they are not found in the short-wave list, see whether the frequency on which they are heard is an exact multiple of their regular broadcast assignment. If so, a harmonic may be suspected. While several stations are authorized to use each of several waves for relay broadcasting, a short-wave transmission outside the lawful band is almost surely a harmonic. These are strongest on odd multiples of the fundamental.—*Editor.*)

CORRESPONDENTS WANTED

Editor, RADIO-CRAFT:

I would like to exchange notes with other readers and can give a helping hand to some in need of

(*Continued on page 543*)



INFORMATION BUREAU

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.*

Inquiries can be answered by mail only when accompanied by 25 cents (stamps) for each separate question. *We cannot furnish blueprints or give comparisons of the merit of commercial products.*

The reader asking the greatest number of interesting questions, though they may not be all answered in the same issue, will find his name at the head of this department.

Highest for the current month: CARROLL TAAFE with five interesting questions.

TRUE SELECTIVITY—METERS—MAJESTIC "90"

(50) Mr. Carroll Taaffe, Winter Haven, Fla.

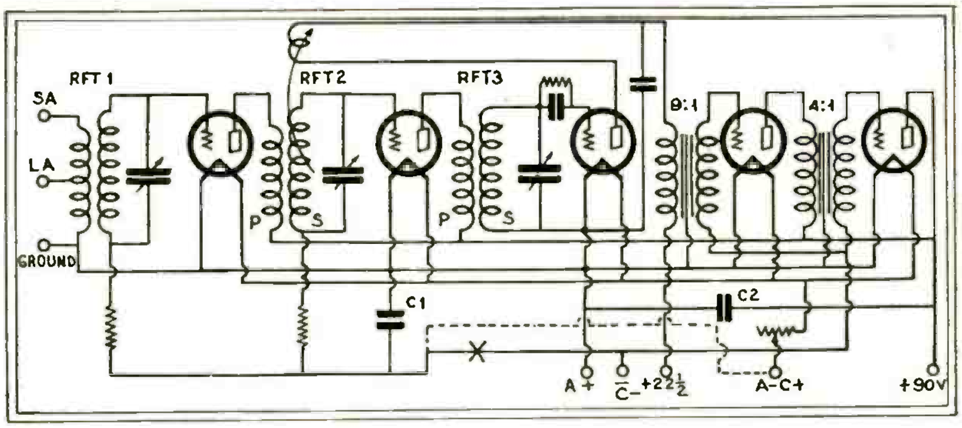
(Q.) Why does a variable condenser, having a maximum capacity smaller than that for which the associated tuning coil is designed, reduce the selectivity of stations on the broadcast band?

(A.) The phenomenon to which you refer has been misinterpreted. It is the "apparent" or observed selectivity and not the actual or electrical selectivity that has been reduced. That is, station interference is not increased; but there has been an increase in the allotment of space to each station on the tuning dial, because of the limiting of its upper range.

A very similar result is obtained when the variable condenser is tuned by a dial having a built-in "vernier" attachment. There is no difference in the selectivity, whether the dial is adjusted directly or by the vernier attachment; although it is somewhat more *convenient*, in the latter instance, to tune exactly to the desired station. This simple comparison illustrates the point very nicely; for "apparent" selectivity is obtained without changing either the inductance or capacity.

(Q.) What is, approximately, the internal resistance of a Jewell 0-1-ma. meter?

(A.) The internal resistance of the average milliammeter of this make and rating is 28 ohms. However, this value may vary five percent, plus or minus. Each instrument is a hand-made unit, and this causes slight variations which do not noticeably effect the scale readings. The exact constants of all meters are individually recorded and may be obtained by writing to the makers, if special laboratory work should necessitate the data.



(Q51) The Crosley "5-38" tuned radio-frequency receiver, battery model, at one time a very popular receiver, obtained exceptional sensitivity by the use of controlled regeneration. Feed-back was obtained through RFT2, instead of RFT3, as with most regenerative circuits. Dotted lines indicate the grid returns of early-production models of the set wherein a "C" battery was not used.

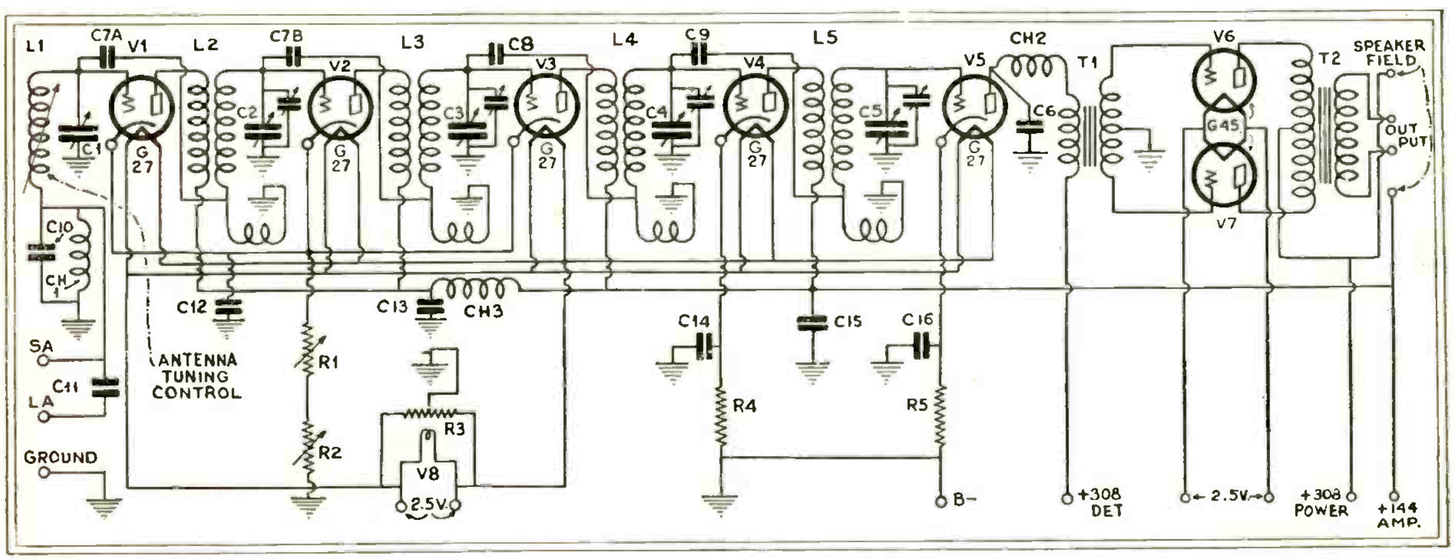
(Q.) Using a 0-1 milliammeter with resistors of the proper value in series as a voltmeter, will the accuracy of the meter be as good or better than one of the high-grade standard voltmeters?

(A.) A voltmeter can be no better than its different parts and, if any part of the assembly, exclusive of the resistor, is of inferior design, the resulting instrument will be inferior to just that extent. The usual good voltmeter, shorn of its series resistor, is simply a milliammeter with a range of 0-10 ma.; precise voltmeters, designed to read voltages in high-resistance circuits, and known as "high-resistance voltmeters," usually consume only about 1 milliamp.

(Q.) If available, please show the schematic circuit of the Majestic "Model 90" chassis. Constants of the parts and the operating voltages are also desired. How is the volume controlled?

(A.) The schematic circuit of this receiver is shown in these columns.

The constants are as follows: V1, V2, V3, V4, V5, type '27 tubes; V6, V7, '45s; V8, 3-volt pilot



(Q50) Schematic circuit of the Majestic "Model 90" receiver chassis (its power pack was shown on page 428 of our last issue); without a diagram the Service Man would find it difficult to check one of the Majestic "90s." Several circuit innovations are to be noted; such as the variometer tuning of L1, and the use of four tuned, neutralized R. F. stages.

lamp; R1, 75,000 ohms, variable (volume control); R2, adjustable resistor, 500 to 2500 ohms; R3, non-inductive, center-tapped, 1.6 ohms total; R4, 1800 ohms (blue); R5, 35,000 ohms (green); C6, .004-mf.; C10, .001-mf.; C11, .0001-mf.; C12, C13, C14, C15, 0.5-mf.; C16, 1.0-mf. Ch1, Ch2 and Ch3 are R.F. chokes.

Volume is controlled by varying the grid bias of V1, V2, V3.

The voltage readings for this set should be as follows: filaments of V1, V2, V3, V4, V5, 2.35; of V6, V7, 2.45; plates of V1, V2, V3, V4, 130; of V5, 270; of V6, V7, 250; grid biases of V1, V2, V3, 8 volts; V4, 9 volts; V5, 30; V6 and V7, 50. The plate current of V1, V2, V3 is 5.5 milliamperes; V4, 5 ma.; V5, 1 ma.; V6, V7, 32 ma. These readings are exact only when the receiver is tuned to 550 kc., the volume control is set at maximum, and the line potential is 115 volts A.C.

R2 is secured to, and rotated by, the gang condenser shaft. It varies the grid bias of V1, V2 and V3 from 9 to 32 volts. This serves automatically to maintain even amplification throughout the tuning range. (This equalizer should have a resistance of 500 ohms at 550 kc., 1,500 ohms at 1,000 kc., and 2,500 ohms at 1,500 kc.)

The Type "91'6" power pack for this receiver was shown in the schematic form on page 428 of the March, 1930, issue of RADIO-CRAFT.

CROSLEY "5-38"

(51) Mr. Edward V. Secor, Babylon, N. Y.

(Q.) I would like to know if you could publish a wiring diagram of the "Crosley 5-38" receiver. This is a battery set and the one that is in for repair has half of the wires missing.

(A.) The schematic circuit desired is given here. Note that sets of this model bearing serial numbers below 8.00011 are wired as indicated by the dotted lines (that is, without a "C" bias on the R.F. tubes). It is seen that the "Crescendon" feature of this receiver is the regeneration obtained by placing a detector plate coil in variable inductive relation to the secondary S of RFT2.

"A" BATTERY ELIMINATION

(52) Mr. Joseph McEvoy, Brooklyn, N. Y.

(Q.) I have a Philco trickle charger and a Kuprox replacement unit, "Type A-110." Can I connect this combination in such a way as to make an "A" eliminator?

(A.) As this unit is designed to pass not more than 0.8 amps., it cannot be used in an "A" unit requiring more than this amount of current. In addition to this, filtering would be required.

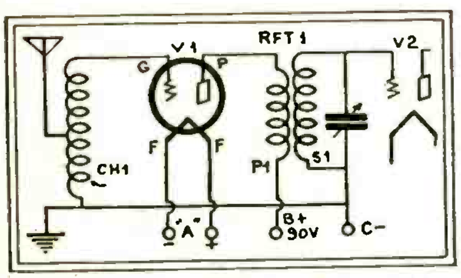
REWIRING FOR SCREEN-GRID TUBE

(53) Mr. H. Hayward, Ontario, Can.

(Q.) I have a six-tube neutrodyne receiver, the first stage of which is untuned. This set tunes very broadly. Will results be improved if the circuit is re-wired to include a screen-grid tube?

(A.) It is impossible to give more than a general answer to this question, without further information about the exact circuit of the original wiring.

An ordinary commercial circuit appears in these columns as A and, modified, as B. In the latter circuit are shown three recommended fixed by-



(Q53A) The first R.F. stage before rewiring for a screen-grid tube, as shown in the third column.

pass condensers C3, C4, C5, each having a capacity of about ¼-mf.

Fixed condenser C1 is recommended as a means of reducing the broadness of tuning which results when the screen-grid tube is used. This condenser may be of an adjustable type, if desired, with a maximum capacity of about .00025-mf.

A choke-coil input is unusual in neutralized circuits. Unless a regular R.F. transformer and tuning condenser are substituted for CH1, it will not be possible to obtain maximum amplification throughout the tuning band from the screen-grid tube V1, shown in B. Unless the number of turns in primary P2 is also increased two or

A Reference List of the Schematic Circuits of COMMERCIAL RECEIVERS Which Have Appeared in Past Issues of RADIO-CRAFT

Copies of any of these back numbers are still available at 25 cents each, postpaid

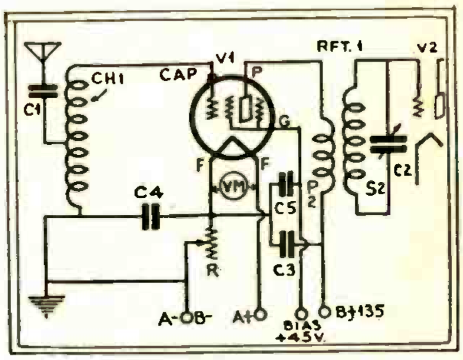
three times, and wound closely over the filament end of S2, it will not be possible to obtain very satisfactory results from the use of a screen-grid tube.

It is doubtful whether shielding will be needed. R is a 30-ohm rheostat; it should be adjusted while a voltmeter VM is shunted across the filament, to indicate when a voltage not exceeding 3.3 has been obtained.

(Q.) Can an electric set be used on 25- or 60-cycle supply, optionally? If not why not?

(A.) A radio set designed to be used with 60-cycle supply cannot, except by special design, be used with 25-cycle current supply.

The 25-cycle supply changes polarity very slowly, as compared to 60-cycle supply and the lower impedance at this frequency permits a much greater



(Q53B) The circuit of Fig. 53.A modified for screen-grid operation. The job of "modernizing" is one for an experienced radio man.

current flow in power transformer windings, which causes them to heat to a high degree. In fact, the primary would probably burn out.

It is easier to filter properly 60-cycle current than 25-cycle current. For the latter, it will be necessary to double or triple the capacity values of the units in the filter condenser bank; and perhaps to increase the inductance of the choke coils.

A power transformer designed for 25-cycle supply must need to be substituted for the 60-cycle transformer. If a current-regulating line ballast is used, this must be changed for one having the correct value.

OBSOLETE SETS—TELEVISORS

(54) Mr. W. S. Patterson, Pecos, Tex.

(Q.) I have an old-model 3-tube Tuska set which is tuned with a vario-coupler and a variable condenser, and an old-model Magnavox 2-stage power amplifier and speaker. Will you kindly give a good circuit whereby I can combine and rewire these sets, to obtain a modern 5-tube A.C. operated set at the least possible expense?

(A.) It is not possible to make a "modern" radio set and yet retain the instruments you mention.

The A.F. transformers in the audio units have a very considerable "peak," which results in considerable amplification of one band of audio notes to the exclusion of others. The vario-coupler cannot very easily be matched to standard R.F. transformers. In a three-dial set, two of the dial readings would match, while the third dial, (controlling the variable condenser in shunt with the vario-coupler) would not "track" with the other two.

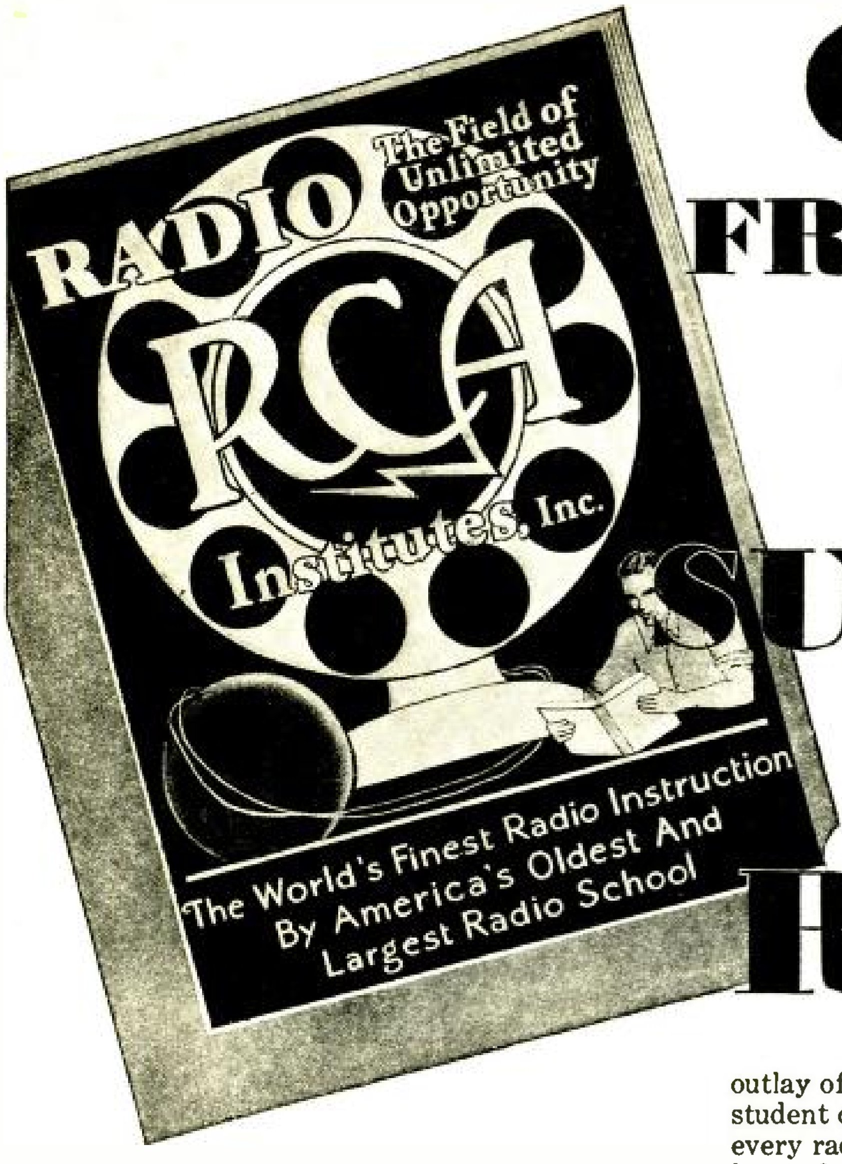
The most satisfactory plan will be to follow one of the numerous circuits that have appeared in past issues of RADIO-CRAFT. Constructional details for easily-made coils have been given; and the exact constants, placement of parts, and wiring procedure have been clearly explained.

(Q.) My father has a recent Stewart-Warner screen-grid model which is shown wired for television. Kindly state what extra parts are needed to enable the operator to "see," and where they may be obtained?

(A.) As explained in Data Sheet No. 12, which appeared in the February issue of RADIO-CRAFT, the provision for television was in accord with the then projected transmissions on the broadcast wavelengths. However, the only picture transmission at the present time occurs on the lower wavelengths (as indicated in the "List of Short-Wave Stations" which appears in each issue of this magazine) and to receive these a "short-wave adapter," or a "short-wave receiver" is required.

The elements of a television reproducer comprise (in addition to a suitable radio-frequency tuning unit, detector and audio-frequency ampli-

(Continued on page 542)



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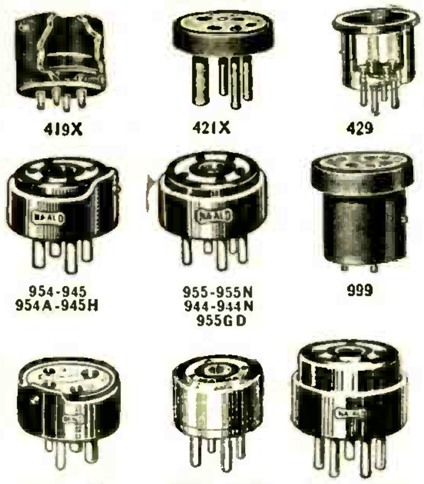

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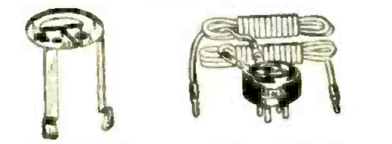
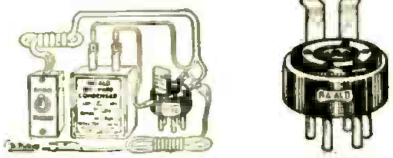
954-945 954A-945H 955-955N 944-944N 955GD 999

968 - 967 954D - 945D 955E - 944E

GROUP D

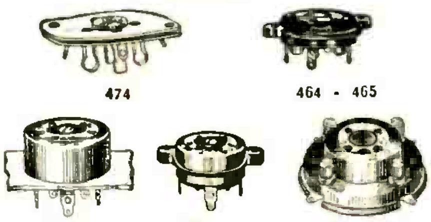


949 - 949P 949G - 949PN 951 - 943 - 950



948A 955KTS

GROUP I



474 464 - 465

423 - 422 425 - 424 426 - 427

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959—To connect input transformer of power amplifier to P of 5-prong tube and direct to B supply. Breaks plate, lead to P hole and extra lead to connect to plus B 1.50

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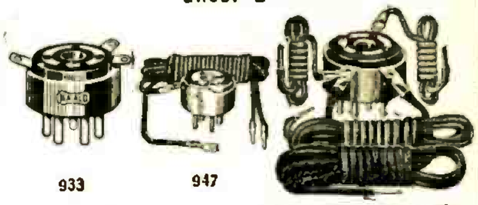
914—1-Prong Metal Cap Plug (No Harness) ...... .25
914H—Ditto with 40" Harness 1.25
915—5-Prong Metal Cap Plug (No Harness) ..... .25
915H—5-Prong Ditto with 40" Harness 1.25
944FF—UX Adapter—Connects Ammeter to Fil. Prongs 1.25
944GP—Test Adapter 4-prong, making detector of any stage, breaks grid circuit for grid leak and condenser, also breaks plate with phone tip terminals for headphones.
944GPL—Adapter for measuring voltage impressed on both plates of No. 280 Tubes 1.50
944GT—UX Adapter—Breaks G with Tip Jacks. Other connections through 1.25
944N—UX Neutralizing Adapter—One F Dead 1.00
944X—(Coming) 4" long UX Extension Adapter.
955GD—Adapter for Testing 224 Screen Grid Tubes—G post dead 1.00
955GP—UY Test Adapter, making detector of any stage, breaks grid circuit for grid leak and condenser, also breaks plate with phone tip terminals for headphones.
955GT—UY Adapter breaks G with Tip Jacks—Other Connections through 1.25
955HH—UY Adapter—Connects Ammeter to H prongs 1.25
955N—UY Neutralizing Adapter—One H Dead .. 1.00
955X—(Coming) 4" long UY Extension Adapter.
982—Victor Adapter—Recommended in Service Manual 5.00
984—4-prong all Bakelite Plug (No Harness) ..... .50

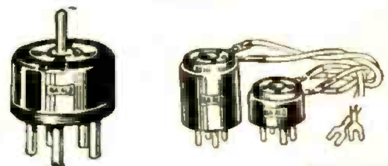
Send Stamps for new Descriptive Catalog and list of a large variety of parts at special prices

GROUP E



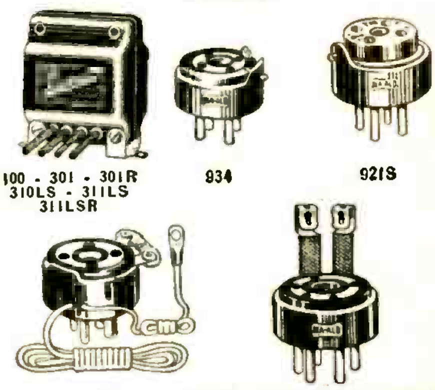
933 947 953A - 952A 952 - 953

GROUP F



957 942 - 932

GROUP G

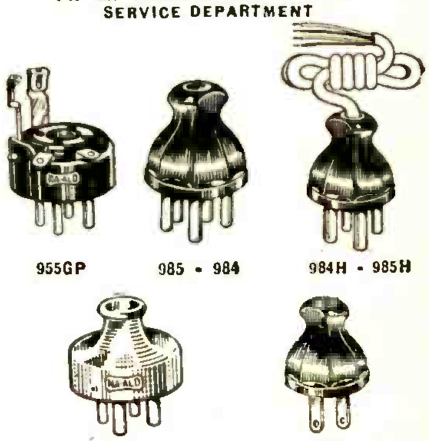


300 - 301 - 301R 310LS - 311LS 311LSR 934 921S

923 955PT - 955GT 944PT - 944GT

GROUP H

For the RADIOTRICIAN and the SERVICE DEPARTMENT



955GP 985 - 984 984H - 985H

914 701

GROUP A—ADAPTERS PUTTING ANY TUBE INTO ANY SOCKET

419X—UX199 Tube in UV201A Socket .... .35
421X—UX Tube in WD11 Socket .... .75
429—UV199 Tube in UX or UV201A Socket ...... .75
944—UX to UX Raises Tube ⅝" 1.00
944-E—UX to UX Raises Tube ⅞" 1.00
945—UX Tube in UY Socket 1.00
945D—UX Tube in UY Socket (small diameter) .. 1.00
954—UY Tube to UX Socket 1.00
954D—UY Tube to UX Socket (small diameter) .. 1.00
955—UY to UY Raises Tube ⅝" 1.00
955E—UY to UY Raises Tube ⅞" 1.00
967—UV201A Tube in UX Socket 1.00
968—WD11 Tube in UX or UV201A Socket 1.25
999—UX Tube in UV199 Socket 1.00

GROUPS B AND C—CONNECTORALDS FOR ADDING POWER TUBES TO ANY SET AND FOR CONVERTING BATTERY SETS TO A.C.

Please write for price sheets.

GROUP D—ELECTRIC PICKUP ADAPTERS

949—Connects Pickup to Grid Circuit of UX or UY Tubes .... .50
949P—Connects Pickup to Plate Circuit of UX or UY Tubes .... .60
949G—Like 949, omit lead to fil .... .60
949PN—Like 949P, omit lead to fil .... .60
948—Connects Pickup to Plate Circuit of UY Tubes 1.50
948A—Ditto—Includes Radio Phono Switch and By-Pass Condensers 4.00
950—Connects Pickup to Grid Circuit of UX Tubes. 1.50
951—Connects Pickup to Plate Circuit of UX Tubes 1.50
955KTS—Connects Pickup to Kathode Circuit of Screen Grid Sets 1.25

GROUP E—ADAPTERS FOR CONNECTING POWER AMPLIFIERS TO ANY SET

933—For attaching A.C. Sets to Power Amplifiers, plate break clips on P hole, P prong, K, no leads 1.25

984H—4-prong all Bakelite Plug with Harness 1.50
985—5-prong all Bakelite Plug (No Harness) .... .50
985H—5-prong all Bakelite Plug with Harness ... 1.50

GROUP I—SOCKETS

400—De Luxe Socket with neck and slot for Bayonet .... .75
422—Small Space UX Socket for below panel soldering .... .35
423—Small Space UY Socket for below panel soldering .... .35
424—UX Socket with 2 mounting holes for above or below panel mounting, below panel soldering .50
425—UY Socket with 2 mounting holes for above or below panel mounting, below panel soldering .50
426—UX Socket with contacts for above panel soldering .... .50
427—UY Socket with contacts for above panel soldering .... .50
428—UX Small Space Socket especially for Rectifier Tubes, for above panel soldering .... .25
464—UX Sport Model A.C. Socket .... .50
465—UY Sport Model A.C. Socket .... .50
474—UX Laminated A.C. Socket .... .25
475—UY Laminated A.C. Socket .... .25
481XS—NA-ALD 4-prong Non-Microphonic Socket with mounting base .... .65
482S—NA-ALD 4-prong Non-Microphonic Socket for direct panel mounting .... .35

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Broadcasting and Servicing

(*Continued from page 493*)

selectivity is laid to many sets that are as near perfect as money and brains can make them, but they cannot do the impossible.

Less promiscuous broadcasting and better programs and more station separation seems to be the only salvation.

Regarding the manufacturers' policies toward service, I will say that the Stewart Warner Corp. is very good about furnishing information and help in servicing its receivers, and will send manuals, diagrams, etc., to any Service Man who writes for them and will state model numbers.

The Federal Radio Corporation is very hard to get any kind of service information out of; I have a Federal "Model E.10" battery type that is not working properly and wanted a wiring diagram of same and a battery hookup.

They sent a battery hookup of a "Model E.10;" but it was not the one that went with this model, for there were more wires in the cable and the color code was different.

I had to go ahead and fish out the hookup for myself; and the set does not work very well, because I have not the diagrams to work from.

I do not know of any solution to this problem, except for the executive staff and Service Department heads to keep hammering articles into the public through their magazines until someone wakes up to the needs of the Service Man.

Greenleaf W. Pickard

(*Continued from page 503*)

propagation of radio waves, natural and artificial, though less known to the public than his earlier discoveries, has been most important in the progress of both practice and theory of radio.

In 1917, he was able to place at the disposal of the government an improved antenna system, which made possible consistent reception of radio communications from Europe in a trying time, when other means failed.

Among the most interesting of his discoveries in later years have been those of the singular distortion of radio waves, particularly of short wavelength, while passing through the atmosphere, and of the definite influence of the activity of the sun upon radio reception. At present known to radio engineers and amateurs (to whom he has always been an active ally) they are less familiar to the rank and file of radio fans than his earlier work; but it is hard to appraise too high the importance which they will bear in a few years, when the fields of radio usefulness are extended to an extent whose limits it will be unsafe to prophesy.

Dr. Pickard's services to radio have been recognized by those best qualified to judge, in his election to the presidency of the Institute of Radio Engineers, and by the award to him in 1926 of that organization's medal of honor. The roll of scientific societies of which he is a member is long and formidable; it may only be added here that he has been chosen in recent years a research associate of the Carnegie Institution, in cooperation with which he is pursuing his studies. He is the holder of over a hundred patents, American and foreign, on electrical and radio inventions.

New Developments in Beam Radio

(*Continued from page 502*)

with greater magnitude; and, at a point directly over the field, they stopped vibrating for an instant. He snapped a sensitive stopwatch in order to calculate his distance; flew to a point about two miles beyond the field, reversed, and leveled off for a perfect landing. A beacon marker indicated when he was over the edge of the field.

The new beacon, developed especially for the tests, is a one-kilowatt transmitter, sending out a directive signal in two directions. Instructions of changes in wind direction were transmitted over a short-wave radiophone.

While installation of radio equipment on aircraft has been mainly for receiving, a number of transport concerns have developed and installed transmitting apparatus for this purpose. Notable among these is the Pan-American Airways, Inc., who have inaugurated passenger service from Miami, Fla., to all of the major West Indian cities. All of this company's planes are equipped with specially-designed short-wave telegraph and telephone transmitters.

The demand for Service Men and repair forces for this type of radio-aviation equipment is an increasing one, and wide-awake radio men who have kept abreast of progress are finding opportunities in this service.

Special land stations have been erected at points along the air routes, and maintain constant communication with all planes from the time they take off until they make a successful landing. Because of the impracticability of erecting radio-beacon stations on water, engineers have developed a direction-finding system which enables the flyers to maintain an accurate course. Two land stations maintain constant contact with the plane while it is en route. Its position is constantly recorded, and checked between the two stations; and, as the pilot veers from one side of his course to another, he is notified by the land station of his exact position, and ordered to change his route if it is found he has deviated. By this method the planes are enabled to maintain a straight course over the sea.

Apparatus on these planes is of 100-watt rating, operating on wavelengths between 109 and 133 meters. These sets are adaptable to either telephone or telegraph.

BRITISH TELEVISION BROADCASTS

TELEVISION transmissions on the Baird system have recently been made from the new Brookman's Park broadcast station in London, England. This "London No. 2" station, which operates on 261.3 meters, 30 kilowatts, sends out the image signals from 7 to 7:30 p. m., Mondays and Thursdays. It is said that they have been successfully picked up in Germany.

Short-Wave Adapters

(*Continued from page 507*)

A word about radio-frequency amplification on short waves: the only truly effective way, as yet, is the super-heterodyne method. The use of a screen-grid tube, untuned at the input, gives a very small gain, perhaps two at its best. A stage of tuned screen-grid, on wavelengths around 20 to 30 meters, might show a gain of five or six if everything is right. While the use of tuned R.F. is not to be discouraged, its use complicates apparatus already too complicated (for some people) enough to offset its present advantages. Screen-grid tubes, with their theoretical amplification, will give all the sensitivity that will ever be usable for radio reception; but at the present time this theoretical amplification has never been anywhere near attained practically. If it were, a set using only one screen-grid R.F. tube should at least equal other sets using three R.F. stages; whereas, as a matter of fact, the ordinary layman cannot tell the difference between sets using three screen-grid R.F. and one with three ordinary R.F. tubes.

What applies to regular receivers, applies also to short-wave adapters, and the writer has correspondence from ordinary laymen who state that even more consistent results are obtainable with an adapter using detector only, than with one using screen-grid R.F.

On the other hand, what is needed most on short waves is high-gain audio frequency; for any signal which cannot be properly received and amplified from a detector without R.F. amplification, is swinging badly or submerged below the noise level. Standard audio amplification, using three stages, results in a gain of five to ten per stage; which means that the weakest signal can be brought up to speaker volume, without the unnecessary amplification of unwanted noises that are usually brought into the detector by R.F. amplification. And, again, adding one stage of audio will give a positive gain of from five to ten without complication; whereas one stage of R.F. with its complication in tuning, extra coils, etc., can give only from two to six—and that is questionable.

ALL IN THE DAY'S WORK

We have heard of the engineer who "held her nozzle against the bank, till the last soul was ashore"; of the youthful Hollander who kept out the North Sea with his finger till help arrived; and many other heroic worthies. Among the number may fairly be listed a radio man, who closed through himself the circuit which was linking two nations in a peace broadcast.

While the welcoming speech of King George V to the international delegates at London was being rebroadcast, a splice in a temporary lead in the control room of the Columbia Broadcasting Company at New York was snapped, cutting off the 220-volt A.C. supply from the speech amplifier. The chief control operator, Harold Vivian, seized the two ends, receiving the shock, and held the wires together for several minutes so that the program could go out uninterruptedly. His fingers were burned by the first contact; but the broadcast carried on.

Leaves from Service Men's Notebooks

(*Continued from page* 491)

satisfy this wish the author suggests the following. The illustration (Fig. 9) shows how a .004 mf. condenser is placed across the plates of the output tubes in series with a switch, in an Atwater Kent model.

This gives the listener a choice of tone. Many service men will find this arrangement a method of appeasing a dissatisfied customer.

The tuning on a Majestic receiver can be sharpened somewhat, by adjusting the last radio-frequency neutralizing condenser until the set is slightly out of balance. Be sure and tune to a very weak station, and adjust until there is a slight hissing sound when the station is passed on the tuning dial.

IMPROVING OLD SETS

By Paul McDooald

HERE is a suggestion to those servicing old-model sets, whose tone quality is not of the best. The system described is very seldom used by Service Men, yet it has many features to recommend it. It is the so-called Clough, or resonated-primary, method.

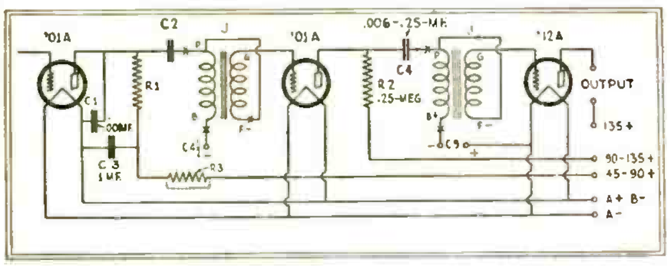
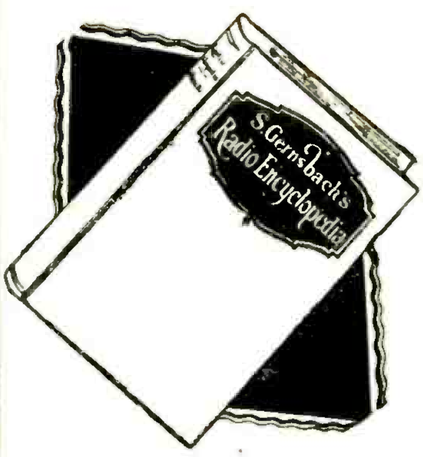


Fig. 10
The change shown is recommended with older sets using transformer coupling, which are readily and inexpensively converted to a more modern system. The plate current, it will be seen, is eliminated from the transformer windings.

The only additional parts needed are two 0.25-megohm resistors, rated at 3 watts (R1, R2) and two small fixed condensers (C2, C4) of a value somewhere between .006- and 0.25-mf. The method of procedure is as follows:

Break connections between the plate of the detector and the plate post of the A.F.

If you are a service man, professional or radiotrician, you should receive RADIO-CRAFT *each month. Turn to page* 540 *of this issue and read the special offer to those who are actively engaged in radio.*



transformer. Connect one end of a resistor (R1) to the plate of the tube, and the other end to the proper "B+" tap of the battery or power unit. Connect a condenser (C2) between the tube plate and the "P" post of the transformer. Put a jumper (J) between the "P" post and the "F—" post of the transformer, breaking the connection between the latter and the negative filament circuit. The "B+" post of the transformer is then led to "C—4½;" while the "G" post remains connected to the grid of the following tube.

The procedure is then repeated with the first audio tube and second audio transformer. In a receiver using an '01A in the last stage, a '12A should be substituted, with higher "B" and "C" voltages, as shown in Fig. 10.

To those who are not familiar with this system, it may be well to say that it is not resistance coupling, and does not cut down the gain but instead increases it, without introducing distortion.*

If this method is used with a set employing a "B" power supply, it may be necessary to use a filter in the detector plate lead. This consists of a 25,000-ohm resistor R3 and a 1-mf. condenser C3. The resistor is placed in series with the quarter-megohm resistor R1, previously mentioned; and the connection between them is by-passed to "B—" through the condenser.

It may be necessary to increase the detector voltage, particularly in a regenerative circuit, from 22½ to 45 or 90 (or even 135) volts. This is necessary because of the voltage drop through the high resistance.

After these changes, the amplifier will equal, if not surpass, many of the more modern designs, whose low-note reproduction is highly praised. Another feature attractive to those with a bit of the heather in their ancestral make-up—"'tis verra economical"—and permits one to retain his kilts with dignity.

* Those who question this statement are referred to that valuable work, John F. Rider's "Mathematics of Radio."—P. M.D.)

PLANE—TO SHORE—TO SHIP

On December 22 last, telephone conversation between the airplane "flying laboratory" of the Bell Telephone Laboratories, above New York City, and the S.S. *Leviathan* at sea, seven hundred miles out, was demonstrated to the press. The intermediary radio station was the Whippany experimental transmitter and receiver of the Bell system, which relayed the plane's signals to WOO, Deal Beach; which then handled them just as it does regular commercial calls. The conversations lasted half an hour, and were very clear.

WHAT TO DO WITH OLD PARTS

Veteran experimenters among our readers will be pleased to know that the Smithsonian Institution, at Washington, has started to make a collection of antique and obsolete radio parts for its radio museum. It is stated in the news dispatches, however, that the search for real relics will be prosecuted especially in England.

Editor, SLOGAN CONTEST,
RADIO-CRAFT,
96-98 Park Place, New York City.

SEE PAGE 522
4-30

Gentlemen:

I have written below my entry in your $100.00 Prize Slogan Contest.

....

Name ....

Occupation .... *Age* ....

Street Address ....

City .... *State* ....

Five Meters or Bust!

(Continued from page 505)

as a secondary, the tickler being of the same size; a '99 tube was employed.

A small choke (RFC) consisting of about 30 turns, an inch in diameter, will be suitable in a receiver at these frequencies. The tuning condenser C1 is a small midget variable, cut down to two plates; and a 50-mmf. midget serves as a throttle control C2. One should be sure not to use too large a tuning condenser; for the range covered will be excessive and the dial cramped. A grid condenser of about 20 mmf. will serve for C3, and a grid leak of about 5 megohms will do. The audio amplifier is, of course, the usual arrangement employing, preferably (if only one stage is included), a high-ratio audio transformer.

In the usual short-wave receiver, coupling the antenna closely to the secondary circuit will prevent proper oscillation of the detector; so the coupling used should be very loose. It is possible to secure good results simply by running an inch or so of the antenna wire near the tuning condenser for L1. If a coupling coil is employed, it should be very small in diameter and the coupling should, in any case, be very loose.

RADIO MARKET STILL HUGE

NOTWITHSTANDING the unfavorable business conditions at the end of 1929, it is estimated that the total retail sales of radio receivers and other equipment and their accessories during that year came to more than eight hundred million dollars, or a gain over 1928 of more than a hundred million dollars. Nearly five hundred million dollars of this great sum went directly into receivers; yet the survey conducted by *Radio Retailing*, on which these estimates are based, indicates that out of nearly twenty million homes wired for electricity, only about seven million have modern electric sets; and that "the number of homes to which alternating current sets may still be sold is 13,500,000." In other words, the radio market is still less than forty per cent. saturated.

A contrast in prices, showing how increased demand has reduced costs, and how the demand for larger, more powerful apparatus then increased them, is contained in the calculation that $177,500,000 was spent for tubes by set owners last year; as against $110,250,000 in 1928 and $6,000,000 in 1922. Yet the average tube in 1927 sold for $1.63 as against $2.20 in 1929—though the average 1922 tube cost the purchaser $6.00.

RADIO "CEILING" FLUCTUATES

HEAVISIDE-LAYER "wobbulation" is claimed by "B. A. R.," writing in an English publication, as follows: "Recent investigations have shown that the surface limits of the Heaviside layer fluctuate rapidly from minute to minute, particularly during the daylight hours. On one occasion the layer was found to rise at the rate of six miles per minute, and to fall at the rate of twenty miles per minute, over a period of approximately a quarter of an hour. One possible explanation for this behavior is the existence of mysterious electric fields, which impact on the outer atmosphere from interstellar space, and swing the free electrons up and down in bulk."

"Talkies" in a Small Town

(*Continued from page 520*)

of the fader does not match the input impedance of the amplifier, these frequencies will be even more reduced. A constant-impedance fader decreases the resistance from pick-up to amplifier as it is turned on; but it does not change the resistance across the pick-up or amplifier terminals.

To switch in the "non sync," a D.P.D.T. switch is used; two non-sync turntables may be used with a fader between. Fig. 1 shows the general layout, omitting the projectors.

The output of the amplifier is fed through a Samson "012" transformer into another pair of twisted leads. (In large houses, a rack-and-panel installation is best.) This pair of leads is connected through the output panel by parallel leads to each speaker. Each lead should have its own volume control of the constant-impedance type, of course.

The speakers used are two Temple "Air-Chrome," a large one for low notes and a smaller one for the high frequencies. Dynamics could be used, but I never could understand the fuss over dynamics. If you use horns, take a tip from W. E.; they use a small horn for the high notes, and two larger horns for the low notes. It seems that the small horns have a high cut-off frequency, while the larger ones suppress the high notes because of their very long air column.

The two speakers are placed on either side of the screen (as shown in Fig. 2), giving good illusion. If four speakers are used, a "sound screen" is necessary. The speakers are adjusted for volume and angle until the reproduction is best; the volume should be as low as possible. Installation is largely a trial-and-error method.

GROUNDING THE BOOTH

By R. E. Norris

SOME time ago the local theatre man decided to install an amplifier and disc apparatus to furnish music for his theatre; and I, as the local Service Man, was naturally called into consultation. Mr. Theatre Man was easily convinced that his equipment should be bought with the idea of utilizing it later for talkies.

With record amplification, we had no trouble; but, when he bought the "talkie" equipment, our difficulties started.

First, the arc lights had to be changed to Mazdas; then, we found that we could get no volume out of the pick-ups through the fader attached to the metal-lined walls of our booth, though we used standard porcelain insulators and plenty of separation between wires. We were in touch with various parts manufacturers who, in all fairness it must be said, tried to help us as much as they could. We also talked to several experts in nearby cities without results. Finally, as a last resort, the idea occurred to us to ground the lining of the booth—and the job was done! Not only did our volume from the machine fader come up, but our speaker controls, local and remote, then behaved as they should.

Another trouble we encountered was poor reproduction of music from the discs, which we traced to slipping drive belts and now new motors are being installed. This trouble was located by a ——— Co. man who was making an installation in a nearby town.

It is quite probable that an expert would have corrected our troubles in short order; but, as experts are few and expensive, we feel that we have gained some valuable knowledge in hunting out these "bugs" ourselves.

TAKING STATIC'S PICTURE

THE visual broadcasting system is to be put to a novel use at the Slough (England) radio research station for the purpose of recording "atmospherics or static." By arrangement with the British Broadcasting Co., special transmissions will be made from the Daventry broadcast station, after the normal experimental periods; and these will be picked up at recording stations in various parts of Europe. The transmissions will not take the form of pictures; instead there will be transmitted a series of straight lines, both horizontal and vertical, forming a grid or network. When an atmospheric occurs, deformations of the straight lines will take place to an extent depending upon the intensity of the interference.

It is hoped by this means to make records giving the most valuable data for research into the intensity, duration, and origin of individual atmospherics. Since the drums of all receiving apparatus, wherever situated, are synchronized, it will be possible by comparing the results obtained in different places to determine the range at which an individual atmospheric can cause interference and the intensity of this interference in different localities.

ELABORATE SHORT-WAVE PROGRAMS

THE most elaborate program of international relay broadcasting till then attempted was presented on Christmas day last, when programs from Holland, Germany and England, transmitted respectively by the short-wave transmitters of Eindhoven, Koenigswusterhausen and Chelmsford, were reproduced by the National Broadcasting Co's. chains. In reciprocity, special English and Dutch programs were sent out on Christmas morning by these stations and their allied short-wave transmitters, to be picked up on the other side of the Atlantic; and on the following morning a special German program. Many short-wave listeners picked up the transmissions direct, from both sides of the water. For the reception which was to be reproduced, the Riverhead station of the Radio Corporation was used, with its elaborate multiple antenna, similar to those illustrated in the short-wave department of last month's RADIO-CRAFT.

OUR LAW-ABIDING COUSINS

IT has often been commented, as lately in the discussion around the pentode, that the British set owner tries to limit the number of his tubes, because of the patent royalty per socket which he must pay on even his home-made set. More than this: we note in an English radio paper that a push-pull transformer manufacturer provides the set builder gratis with "a license plate to fix to your amplifier in order to show that you have conformed with the law."

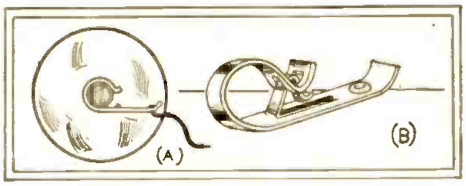
As the hams would say, "hi."

Radio-Craft Kinks

LIGHTNING ARRESTER, SCREEN-GRID CLIP, AND SWITCH-POINT CONTACT

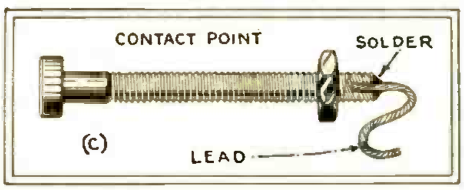
By Fred Erdos

THREE "kinks" used by the writer may be of interest to the readers of RADIO-CRAFT. The first one, shown as Fig. A, is the adaptation of a Fahnestock clip to fit the control-grid cap connection on the top of a screen-grid tube. At B we have the clip before the little middle spring has been broken off and the larger, outer ones, bent to fit.



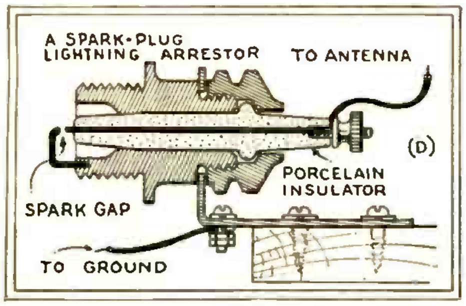
A clip for the control-grid cap of a screen-grid tube is quickly and effectively made as shown.

The second (Fig. C) is a switch-point with its end drilled to receive soldering-flux, globule of solder, and then the wire. As these contacts are usually made of brass, they are easy to drill. An iron nut should be run over the contact-point before soldering begins; thus forming a convenient way of tapping, or removing any solder that might get into the threads of the contact-point.



The method shown makes an excellent contact to a switch point, and Mr. Erdos deems it worth the trouble.

A new automobile spark-plug makes a very satisfactory lighting arrester, when mounted in any convenient manner, as Fig. D illustrates. An old spark-plug cannot be used, because of the leakage caused by the carbon which has been burned into the insulating material during operation in the cylinder.



A kink to be commended for its ingenuity rather than its practical desirability.

(Note: The idea is ingenious, but a home-made lightning arrester is not to be recommended for home use, because of insurance requirements. An arrester approved by the underwriters is to be preferred.—*Editor.*)

AN EASILY-MADE TUBE SOCKET

By J. A. Donathan

IT is often desirable to know how commercial apparatus can be conveniently duplicated with gadgets taken from the "miscellaneous" box. A tube socket, for example, which grips a tube positively may be made by mounting four Fahnestock clips on a sheet of bakelite in the manner illustrated (Fig. 1).

This plate (of course, it may be any convenient material having first-grade insulation value) may be the sub-panel of a radio set, or it may be a strip only about 2½ inches square; while the connectors may be placed either above or below the insulating plate. The plate is to be drilled to accommodate the type of tubes to be used, the holes being made only a little larger than the prongs of the tubes.

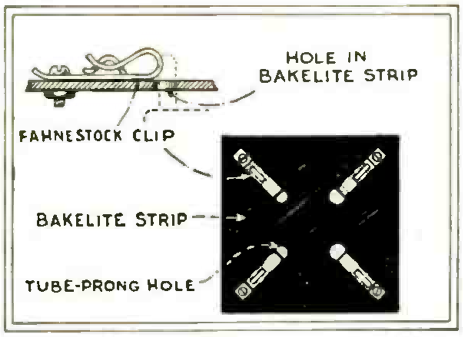


Fig. 1

A home-made socket, when one is needed quickly for the work bench, may be produced in the manner shown.

LOCATING THE FILAMENT METER

By S. Hetherington

OFTENTIMES it is inconvenient to take filament-voltage readings, of the tubes in a set, because of the compactness of the parts arrangement. Another objection: solder on the prongs of tubes, or deformation of the tubes or sockets, may cause the tube to stick; and to remove it from the socket may result in a sudden jerk that causes the filaments to break or the elements to short.

The writer wished to be able to take voltage readings of the potentials supplied to the filaments of several tubes in a receiver, without having the voltmeter as conspicuous as when it is mounted in a test-unit, or on the front panel of the receiver.

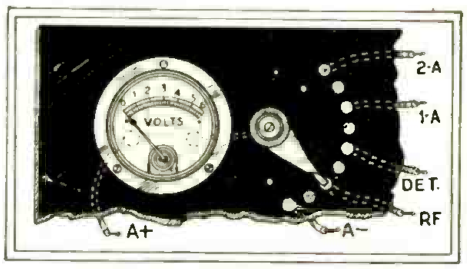


Fig. 2

The particular experimenter, who wants to know the operating condition of each tube at the socket, may follow this idea.

How the desired result was obtained is shown in Fig. 2, which illustrates a meter and a selector-switch, mounted on the *sub-panel* of the receiver.

Two stops and nine contacts (four being "dead" spacers) will be required to read the filament voltages of first R.F., detector, first A.F., second A.F., and the voltage of the "A" supply.

INCREASING "WASP'S" EFFICIENCY

By W. H. Nilsson

SINCE last August the writer has been using the simple switching circuit illustrated in Fig. 3 for changing from a long aerial to a short one to obtain better results with a Pilot "Wasp" short-wave receiver,

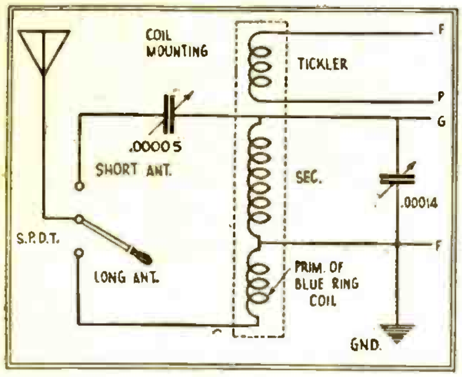


Fig. 3

With a set covering several wavebands, this switch makes it more convenient to change the aerial coupling.

the long aerial being used only with the "blue ring" coil.

This arrangement has the merit of convenience. It may be used with the "Super-Wasp" also.

A "SPARK-COIL" RELAY

By J. H. Mills

WHEN, last fall, the writer needed a relay to control only a "B" eliminator, the thought occurred to use an automobile spark-coil primary winding. The sketch shows how this coil was wired.

The writer followed the process of removing the coil top and then the secondary coil; leaving only the core and the heavy-wire primary. This primary was then carefully

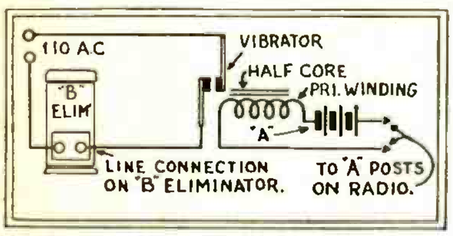


Fig. 4

Another use for the ubiquitous spark coil.

removed and the core cut in half with a hack-saw. The primary was rewound on one of these core halves, and taped to prevent unwinding. (Its resistance is sufficiently low not to reduce too greatly the "A" supply to the set.)

The "vibrator" parts were then removed and remounted; so that the contacts would complete a circuit (connecting the light-line to the "B" eliminator) when battery current was put through the rewound spark-coil primary.

LINEN-DIAPHRAGM SPEAKER DESIGN

AFTER many attempts to obtain good reproduction from a square "airplane-cloth reproducer," "J. L.," writing in a recent issue of *Amateur Wireless*, advises builders to use a circular form, following his most satisfactory mechanical-acoustic design, to obtain even pull on the cloth at all points along the edge. He cut 15- and 20-inch circles out of the centers of laminated boards, 24 inches square; glued the linen tightly to the boards, over all, and then drew it in to the unit in the usual manner.

A subscriber of RADIO-CRAFT Magazine who recently visited our offices suggests that an *odd* ratio be maintained between the

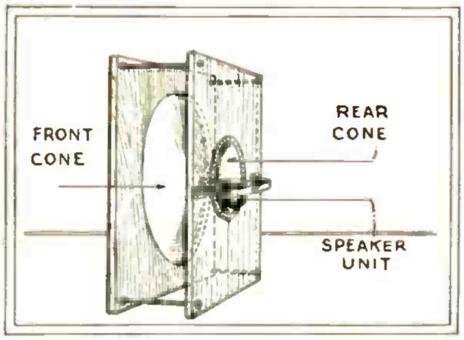


Fig. 5

Round holes in a linen-diaphragm speaker give more even tension; odd ratios in their diameter help to suppress harmonic resonances

sizes of the large and small diaphragms of airplane-cloth reproducers. For example, instead of using a small cloth, eight inches square, with a standard 24-inch major diaphragm, a dimension for the minor square of 7, 9, 11 or 13 inches is recommended. The purpose is to avoid undesirable resonance points.

COST OF ELECTRIC OPERATION

"ARE electric sets cheaper to operate than battery sets?" is a question which George Lewis, of the Arcturus Radio Tube Co., says should be answered by the inquiring individual, himself, after application of the simple test outlined below.

First, stating that electric receivers are necessarily the most economical type of sets, because they have eliminated the charge-discharge inefficiencies of the battery sets, he then points out: "It is easy to check the current consumed by an all-electric set, and compare it with the current consumption of the average electric lamps, by noting how fast the metal disc on the watt-hour meter revolves. For instance, with all current in the house turned off, the disc will not move unless there is current leakage. If, with one 75-watt lamp turned on, the disc revolves five times in one minute, while with only the radio receiver turned on, it revolves fifteen times in one minute, it is obvious that the set consumes three times as much power as the 75-watt lamp, or 225 watts. Multiply this by the number of hours a month the set is in operation, divide by one thousand and multiply by the cost to you of electricity per kilowatt hour (refer to your monthly bill for this information)—and you will know what it costs for current to operate your radio for one month. *This will invariably be less than the cost of charging batteries and buying new 'B' batteries.*"

A HOOK-UP USING LOTS OF COPPERS

"Boy, 7, wedged in chimney, saved by PUSH-PULL cops" is the headline of a story in the *New York Daily News*. Here is a combination which should have a good deal of amplification; but the expense of maintenance is high for the average set owner.

—Contributed by M. Rosenthal.

"The A.C. Set in the D.C. Apartment"

WE are sure that some of our readers, who reside in the regions served with 100-volt direct current, will lend a sympathetic ear to the woes of a poet who sang thus in the columns of the *New York Sun* of December 11 last.

I bought me a set
  Quite expensive, but, gee!
I found to my grief
  That my flat was D.C.

It looked very swell,
  Oh, it looked very hot;
It stood by the wall,
  But it might as well not.

To get it to work
  Was an intricate job;
It took engineers
  And a technical mob.

They promised to come
  Each forenoon at 10,
But what is a promise
  To radio men?

(The curtain now drops
  At this point, old dear,
To mark and denote
  The lapse of one year.)

At last the men came,
  They said I must get
A transformer* that
  Cost more than the set.

I shopped all around,
  Walked block after block,
But nobody had
  The darned thing in stock.

At last in despair
  I gave a weird shout;
A window I raised—
  And threw the set out!

* * * * *

The moral is this:
  You'll never know glee
If you find too late
  Your current's D C.

*Or maybe it's a generator or something.

Radio Literature

(*Continued from page* 511)

additions to cover the new methods of electrical reproduction have been made in the current edition. "Stereophonic" sound effects are considered in one chapter, together with the problems of orchestral disposal. The author ventures to predict that the disc will soon be obsolete, and that "a cheap transparent ribbon having a photographed record, but without pictures, will be perfected and used exclusively for the reproduction of sound; or some form of magnetic record on a steel wire may be the final solution." Advice on care of motors is given: and it is interesting to note that our author discusses the use of water motors for operation, but gravely decides that "the disadvantages far outweigh the advantages." The book should be of help to anyone who uses and cares for a phonograph, as well as to many experimenters on radio reproduction, etc.

It is interesting, in passing, to note the advertisements of graphophones and equipment bound with the book, and the patriotic appeal embodied in them, beginning with the first: "Columbia—British to the Core!"

(C. P. M.)

THEY GO TOGETHER, UNFORTUNATELY

"A short-wave adapter" explains the *Minneapolis Star*, "capable of Eliminating Static and DISTANCE in any radio set has been successfully built by E. T. Flewelling, Internationally-known radio expert." Several of our indignant readers want the Information Bureau to explain why those that they build work the same way.

—*Contributed by O. Ingmar Olson.*

Radio-Craft's Information Bureau

(*Continued from page 526*)

fier) a neon tube or glow-lamp, which is connected in the output of the power tube, and a scanning mechanism, such as a disc or drum, with its driving motor and speed control. The subject is discussed quite thoroughly by Mr. D. E. Replogle in the February and March issues of RADIO-CRAFT, with reference to the Jenkins system. The disc method is somewhat simpler, employing a drilled metal disc mounted directly on the shaft of a motor traveling at 900 R. P. M., but entails certain disadvantages.

COIL SPACING

(55) Mr. Gilman Wilson, New York City.

(Q.) "I wish to thank you for publishing Mr. Beck's article, in January RADIO-CRAFT, on making a machine for winding coils on celluloid. I have been looking for just such information for a long while; and have tried several ways, but without the desired success.

"I started making the machine and, when I went to buy the No. 38 steel spacing wire, I was handed a wire 0.112-inch in diameter, at a wire merchant's in Park Row. The clerk there said that is the way their wire is numbered. Naturally, I did not take it. In thinking it over, it came to me that I should have asked for Browne & Sharpe 38 gauge wire. Will you be kind enough to tell me if the desired wire is B. & S. gauge, or give me the diameter in decimals?"

(A.) In reply to this inquiry, Mr. Teck answers as follows: "The object in recommending steel wire as a spacer is to take advantage of its strength. To use any other metal—copper, for instance—is not easy. It would be less difficult if No. 36 B. & S. copper wire (.005-inch) were used; I have done this with success and used No. 33 copper wire (.007-inch) with no hitch at all.

"It should be understood that this matter of spacing is simply one of choice. The difference in the spacing with No. 38 wire (.004-inch) and that with No. 33 has only a slight bearing on the capacity of the coil: and between No. 33 and No. 30 (.01-inch) there is no noticeable difference whatever.

"The spacing used determines the length of the coil; and the finer spacing makes it more compact. Here again the difference is not so noticeable and may be overlooked. Wide spacings, however, have much to commend them in the distinctness with which the individual turns stand out.

"No. 38 enamelled steel wire (.006-inch) or soft iron wire should not be difficult to get. No. 36 enamelled steel has many uses, and should be easily obtained. No doubt your wire merchants carry this gauge."

GROUNDING AERIALS—SET REBUILDING

(56) Mr. P. F. Barrett, Shenandoah, Pa.

(Q.) Does each radio set in operation take its share of the energy broadcast by a radio station and dissipate it; thereby making the signal weaker for the next receiving station? If this were the case, perhaps it would be desirable if every one left his set ungrounded (removed the lead-in from the antenna post on the set) when not using it.

(A.) This question has been answered, partially at least, on page 393 of the February issue of RADIO-CRAFT. The dissipation of energy picked up by receiving sets is not important in comparison with other losses in the field of a transmitter, as a matter of fact.

It is inadvisable to disconnect an aerial and leave the lead-in ungrounded, as suggested. It was once customary to use a switch to cut out the receiver, and short the aerial to ground, when not using it. In Europe today, some broadcast stations make a rule of advising the listener to ground his aerial, just before they sign off. However, the use of a good lightning arrester serves the same purpose. This acts as an automatic switch and by-passes charges of static from the receiving set.

(Q.) I have an old Garod 4-tube reflex set, which I changed to a 5-tube straight neutrodyne. This set has a 7-turn primary and 65-turn secondary. The secondary of each R.F.T. is tuned by 15-plate variable condensers with a maximum capacity of about .00035-mf. At the maximum-capacity setting of the variable condensers, code is received; at the minimum, the wavelength adjustment is about 250 meters. I would like to know if it is possible to alter this receiver to tune in 200-meter stations?

(A.) Reducing the number of turns in the secondary winding will enable the receiver to respond to 200-meter stations. Exactly the same number of turns should be removed from the grid end of each secondary, at each successive trial.

Removing turns may, however, destroy the inductive relation of the R.F. transformers, and cause the circuit to spill into uncontrollable oscillation. Changing slightly the angles of the coils may overcome this.

THE AIRLINE "A" AND FADING—OPERATING COSTS

(57) Mr. W. R. Hampton, Kansas City, Kan.

(Q.) What is the remedy for fading signals under the conditions described below?

Two Freed-Eisemann receivers were operated from Airline "A" units, which incorporate "dry" rectifiers. One set was an 8-tube receiver operated from a 2½-amp. "A" unit, and the other was a 7-tube set used with a 2-amp. unit of the Kuprox dry-disc type.

(A.) The trouble mentioned can be traced, usually, to a defective "A" rectifier unit, defective "A" filter condensers, or poor contact elsewhere in the "A" circuit. Defective units must be replaced.

Of course, this is working on the assumption that the trouble is in the "A" circuit; there are numerous other possibilities, exterior to the "A" circuit.

While all tubes are "on," test the output voltage of the "A" unit with a low-scale voltmeter. If the voltage is not steady, the source of the fading has been located.

(Q.) What is the cost of current per month for operating a 75-watt radio set?

(A.) Find the total wattage required to operate the set for an average month, and find the relation this figure bears to 1,000 watts—the usual basis on which the current is priced.

For example: the receiver is operated on an average of four hours every day, requiring a total current of approximately 9,000 watt-hours per month. This is nine times 1,000 watt hours. In some localities the charge is "ten cents per kilowatt-hour (1,000 watt-hours)" and this would make the cost of operation 90 cents per month.

RADIO'S UPS AND DOWNS

THE Arctic and the Antarctic exchanged greetings recently, when the Soviet radio station in Franz Josef Land, several hundred miles above the Arctic Circle, worked Commander Byrd at Little America. The two transmitters are, respectively, the farthest north and the farthest south in the world. Communication was maintained on 41 meters. While the Antarctic was enjoying "midsummer," and the Arctic had bid the sun good bye months before, there was undoubtedly little to choose between the two stations for December climate.

RANGE OF SHORT WAVES

THE average effective range of signals, from a powerful transmitter, on the various high frequencies has been thus estimated by the advisers of the Radio Commission, in determining allotments of channels for short-wave work. The figures given below are only averages; for reception has frequently been obtained at the maximum separation possible between two stations on the surface of the earth—about 12,500 miles airline.

Wavelength (Meters)	Miles (Day)	Miles (Night)
13.0-21.2	7000	Not useful
24.4-25.6	4000	Over 5000
27.3-31.6	2500	Over 5000
31.6-35.1	1500	Over 5000
41.2-45.0	1000	Over 5000
48.8-50.0	600	Over 5000
54.5-75.0	450	2500
75.0-85.7	300	1000
109.0-133.0	150	500
150.0-200.0	100	250

Radio-Craft's Opportunity Column

TO make this magazine of additional benefit to Service Men, RADIO-CRAFT has instituted a new feature, of which advantage may be taken, free of charge, by any Service Man who has enrolled himself in the NATIONAL LIST OF RADIO SERVICE MEN (by filling out in full the blank which is printed in every issue of this magazine). We will print short notices of the same nature as those which follow; and will forward to the writer of any of them the replies which may be addressed to him (by the number given) in care of RADIO-CRAFT.

We must reserve the right to condense all letters into their most essential details; and we urge all our correspondents who use this service to be as concise, though thorough, as they would be in the composition of a paid advertisement which would cost them several dollars.

Service Men seeking employment should give, at the beginning, the important details which an employer will first ask; and anyone offering employment to a Service Man should be equally specific.

It is desirable that references be given in all letters seeking employment, etc.—not for publication, but in order that RADIO-CRAFT may verify the statements made, if requested to do so, by parties interested in replying to the advertisement.

Please give all information for publication on a sheet of paper separate from the questionnaire, which is filed by us. Age, years' experience, domestic affairs, etc.; and do not forget to put your name and address on each sheet. We have several requests lacking these important details, which we cannot publish as yet. A period of at least one month must elapse between receipt of letters and publication; as the forms of RADIO-CRAFT close several weeks ahead.

We cannot publish under this heading any advertising of a commercial nature—for the sale of goods, or instruction, etc.; or for an employment agency. We cannot publish offers of general servicing for the public, or general representation of a manufacturer in a district. For the former, local advertising mediums are available, and as to the latter, a manufacturer requesting such information will be given it directly from the files of the NATIONAL LIST OF RADIO SERVICE MEN. Announcements seeking or offering regular employment, however, will be accepted under the conditions stated above.

The writers of any of these requests may be addressed as Opportunity No. .... (number given below), in care of RADIO-CRAFT, 98 Park Place, New York City.

(Opportunity 23) Naval Electrician, eight years' radio experience, to be discharged late in year, wishes to take up sound picture work, or servicing. Age 22. Married. (California.)

(Opportunity 24) Service Man experienced on all-around general work. One time owner of shop, and long connected with radio and wireless. Wishes to make permanent connection. Age 36. Married. Protestant. (New York City.)

(Opportunity 25) Service Man, graduate Wentworth Institute, Boston; School of Engineering, Milwaukee; R. C. A. Institutes operating course; wishes to locate with reputable concern or manufacturer. Age 22. Single. (Wisconsin.)

(Opportunity 26) Radiotrician, experienced, desires permanent connection. Excellent references. Opportunity for advancement more important than starting salary. (Iowa.)

(Opportunity 27) Radio Dealer would like to make contact with manufacturers who wish to introduce their products in Belgium. (Brussels, Belgium.)

(Opportunity 28) Electrical Engineer, familiar with Sound Effects, as also all branches of radio; licensed projectionist. Denver and Kansas City. For years in charge of electrical development for large oil company. Qualified by education and experience to undertake any problem in design, installation or operation of sound-synchronized movies; desires position of supervisory or consulting character, preferably traveling. Splendid references; at present employed; available on reasonable notice. Age 31. Single. (Colorado.)

(Opportunity 29) Service Man, electrician, twelve years' experience, batteries, ignition, motors and generators. Has own radio testing equipment. Will go anywhere. Belgian. Married. (Oklahoma.)

(Opportunity 30) Electrician, plant superintendent large station, wishes to change over to radio work exclusively. (Kentucky.)

(Opportunity 31) Service Man, several years' experience, desires place with manufacturer of a good set, to study the line thoroughly and have opportunity for advancement. Salary to begin less important. Age 37. Married. (Ontario.)

Craftsmen's Letters

(*Continued from page 524*)

advice, on how to get the most out of their present sets.

CHESTER L. PRICE,
110 Heartt Ave., Cohoes, N. Y.

I have never been able to get good results with short-wave sets. Will appreciate anyone's answer.

FRANK LENTO,
829 East 220th St., New York, N. Y.

I have been working with radio for three years and would like to correspond with fans of my age (15) or older.

TOM KENNEDY,
3521 W. 28th Ave.,
Vancouver, B. C., Canada.

Others who would appreciate correspondence from fans are Edward M. Neil, Box 306, North Berwick, Maine; Kenneth J. Pilz, 924 Hubbard St., Green Bay, Wis.; Irving Olson, 879 Raymond St., Akron, Ohio; and D. S. Hatzer, 45 Flax St., Delaware, Ohio.

RADIO'S SECOND CENTENARY

"Two CENTURIES of Radio Experience is back of Jalisco Radio Service"—From advertisement in the *Minneapolis Sunday Journal* of September 22, 1929. Let's see; Ben Franklin was a lively youth of twenty in 1729. Perhaps we have his whereabouts located.

—*Contributed by Charles Rehl.*

Short-Wave Stations of the World

(*Continued from page 508*)

Meters	Kilo-cycles	
92.50	3,256	—**W9XL**, Chicago, Ill.
94.76	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**, Silver Springs, Md., 8 to 9 p.m. except Sunday; **WPY**, Allwood, N. J.—**W2XR**, New York, N. Y.—**W3XL**, Bound Brook, N. J.
104.1	2,870	—**6WF**, Perth, Australia.
105.3 to 109.1 meters	2,750 to 2,850 kc.	**Televisian.** —**W2XBA**, Newark, N. J., Tues. and Fri. 12 to 1 a.m.;—**W2XCL**, Brooklyn, N. Y.; —**W8XAU**, Pittsburgh, Pa.; —**W1XB**, Somerville, Mass.;—**W7XAO**, Portland, Ore.; —**W9XAP**, Chicago, Ill. —**W2XCR**, Jersey City, N. J. 8:15 and 9 p.m.
109.1 to 113.1 meters	2,650 to 2,750 kc.	**Television**—**W9XR**, Chicago, Ill.
110.2	2,722	—**Aircraft.**
124.2	2,416	—Seattle, Wash., Police and Fire Depts.
125.1	2,398	—**W9XL**, Chicago, Ill.;—**W2XCU**, Ampere, N. J.
128.0-129.0		—**Aircraft.**
129.0	2,325	—**W10XZ**, **Airplane Television.**
136.4 to 142.9 meters	2,10 to 2,200 kc.	**Television.** **W8XAU**, Pittsburgh, Pa.;—**W1XB**, Somerville, Mass.;—**W2XCW**, Schenectady, N. Y.;—**W1XAU**, Boston, Mass.
142.9 to 150 meters	2,000 to 2,100 kc.	**Television.** —**W2XCL**, Brooklyn, N. Y., Mon., Wed., Fri., 9 to 10 p.m.;—**W9XAA**, Chicago, Ill.;—**W2XBS**, New York, N. Y., frame 60 lines deep, 72 wides, 1,200 R.M.P.;—**W1XAE**, Springfield, Mass.;—**W8XAU**, Pittsburgh, Pa.; **W6XAM**, Los Angeles; —**W2XBU**, Beacon, N. Y.;—**W3XAK**, Bound Brook, N. J.;—**W3XK**, Washington, D. C. Daily except Sun., 8 to 9 p.m.;—**WPY**, Allwood, N. J.;—**W10XU**, Airplane.
149.9-174.8	2,000-1,715	—**Amateur Telephony.**
175.2	1,712	—**WKDU**, Cincinnati, Ohio. (Police Dept.) —**WRBH**, Cleveland, O., (Police Dept.)
178.1	1,684	—**WDKX**, New York, N. Y. (Police Dept.)
186.6	1,608	—**W9XAL**, Chicago, Ill. (WMAC) and **Aircraft Television.**
187.0	1,604	—**W2XCU**, Wired Radio, Ampere, N. J. —**W2XCD**, DeForest Radio Co., Passaic, N. J. 8-10 p.m.
187.9	1,596	—**WKDT**, Detroit, Mich. (Fire Dept.)

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

Radio's Greatest Bargains!

THESE are the greatest radio set bargains that have ever been offered. The radio sets listed here are standard sets made by the greatest and best known radio set companies in America.

All of these sets are battery sets (with the exception of the Freshman All-Electric A.C. Set); but this is only one reason why they are sold at such ridiculously low prices.

The other reason is that these sets are mostly demonstration and display models from New York's largest radio and department stores.

We have been able to make connections with a number of houses in New York City, and we secured these fine sets at remarkable prices. Due to these circumstances, we are enabled to sell them to you at only a fraction of their original cost.

IMPORTANT!—SET BUILDERS, CONSTRUCTORS AND EXPERIMENTERS TURN THESE SETS INTO BIG MONEY!

There are still many families and many houses not equipped with radio today. At the prices at which we are selling them, it will pay you to install these sets and sell them at an excellent profit.

A number of our customers have made as much as $20.00 and $30.00 on each one of these sets by installing them, incidentally making a profit on tubes, loud speakers, etc.

Remember, we do not sell you these sets as brand new. They all have been used somewhat, but they are all in excellent condition, and, by going over the cabinets with some furniture polish, or otherwise renovating them, they will make a first-class appearance and, in most instances, you will not be able to tell the set apart from a new one. This is your great opportunity to make a few extra dollars, and we trust that you will not let this opportunity go by.

We promise reasonably prompt shipments. We have a large supply of these sets on hand, and, in most cases, can ship within 24 to 48 hours.

ALL SETS ARE TESTED BY OUR EXPERTS AND WE GUARANTEE THEM TO WORK SATISFACTORILY.

STROMBERG-CARLSON 523 RECEIVER

ONLY $ 24.95

This model of the famous "Treasure Chests" was one of the first to introduce the idea of electrification. Four 201A tubes and one 200A were recommended; all operating voltages to be supplied from an external power unit operating from the light socket, such as the No. 403 Audio Power Unit. (Of course, regular batteries may be used.) A beautifully-grained slanting wood panel carries the well-known phosphor bronze tuning and control escutcheons. The panel controls include a "Long-Short Antenna" switch, and a Weston 0-7 voltmeter. Jack on panel is for phonograph pick-up. Neutrodyne circuit is used. Weight is 40 lbs. Cabinet is 26 in. long x 14 in. deep x 13 in. high. Its appearance is unusually attractive. Makes a fine appearance in any home. The chassis of this set is the same as the one used to complete the No. 524 Console that listed for $230.00. Circuit will accommodate either a 112A or a 171A without any changes in wiring. List price is $160.00.

RADIOLA 20

ONLY $ 12.50

Two stages of tuned radio frequency amplification, a regenerative detector, and two stages of A.F. amplification, using 4 type 199 tubes and a 120 for the last audio stage, is the arrangement of this receiver. A marvel for sensitivity. Made by Radio Corporation of America. Like the big superheterodynes of the same make, drum dials are used. Three variable condensers are used and these are ganged, and adjusted by the left-hand or "station selector" dial. The two R.F. stages are NEUTRALIZED. Two jacks are provided; a choice of one A.F. or two is obtainable. Two small black knobs on the lower right are controls which vary the filament circuit resistance, and two similar knobs at lower left are controls for 3-plate balancing condensers. Cabinet is mahogany. The tube sockets are moulded in a single strip of bakelite. This strip is supported on sponge rubber. A terminal strip is provided, to which is fastened one end of a 7-wire battery cable 5 ft. long. The clever constructor can adapt this chassis to short-wave operation by mounting sockets for plug-in coils, and by doing a bit of engineering with the variable condensers. Overall dimensions are: 19 x 16 x 11 inches high. It weighs 29 pounds. List price is $102.50.

FRESHMAN "MASTERPIECE" TYPE E

ONLY $ 11.95

This is a single-dial receiver (what everyone wants) and, like the A.K. 35, it uses a phosphor bronze "belt" to couple the three 19-plate brass variable condensers. Six tubes are required for this set. Easy to turn over at a big profit. Its overall dimensions are: 20 x 10 x 10 inches high, and the slanting panel measures 7 x 18 x 1/32 inch. It is of brown crackle-finish metal. Weight of set is 21 pounds. The escutcheon in the middle of the panel has an opening through which the dial setting may be seen; a semi-circular rheostat for volume control is adjusted by the small knob to be seen below the tuning knob. At the extreme left is a little 13-plate condenser connected from grid to filament of the first R.F. tube, for obtaining distant station programs. The first R.F. is untuned, while the second and third are tuned; circuit oscillation being prevented by the use of grid suppressors. This set is designed to be used with five type 201A's and a type 112 tube. The cabinet is of two-tone mahogany veneer, with a nickeled, full-length piano hinge. List price is $89.50.

Send for FREE RADIO SET CATALOG— A Postal Card Brings It

FRESHMAN ALL-ELECTRIC RADIO FOR 110-VOLT A.C. OPERATION

ONLY $ 31.95

This is a brand new and unused set. It comes in the original factory case. The latest and best of the famous Freshman all-electric radio sets. It is a 1929 model. This set uses 1 type 227 tube, 4 226s, a 250 and a rectifier of the 281 type. The power pack is contained in a small shielded case at the rear of the chassis and within the cabinet; thus, it is an entirely self-contained electric receiver. All equipment is housed in a gold and crystalline olive finished metal cabinet 19 in. long x 10 in. high x 12 in. deep; set weighs approximately 35 lbs. The Freshman Electric Radio supplies the demand for a simple, neat-appearing, illuminated single-dial control, entirely self-contained, shielded, all-electric radio set. List price is $90.00.

ATWATER KENT MODEL 35

ONLY $ 14.95

One of the most compact receivers ever offered to the public. It is of the tuned radio frequency type. The first stage of R.F. is untuned and acts as a "blocking" tube. Circuit oscillation is prevented by the use of grid suppressors, of which two are provided. There is a total of three stages of R.F. amplification and two of A.F. Three variable condensers are used. Overall dimensions are: 17½ x 8 x 5½ inches. The chassis is housed in a brown crackle-finish pressed metal cabinet. This is a "one-dial control" receiver. A "full vision" moulded bakelite dial controls the variable condenser gang; another moulded control varies the filament heat. It weighs 12 pounds. Incorporated in this set is a 6-wire cable, each wire of which is rubber insulated and "color coded." A power tube may be used in the last stage. Phosphor bronze "belting" couples the two side condensers to the central one, upon the shaft of which the tuning dial is fastened. This shielded receiver has very high "gain" and may be used with antennas of any length. 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. List price is $65.00.

FRESHMAN 3-DIAL "MASTERPIECE"

ONLY $ 5.00

This is distinctly a Custom Built set. Where it was thought that a change of parts would improve the performance of the receiver, the change has been made. Although, in the main, the circuit is that of the famous "Masterpiece." There are three standard R.F. coils, and three standard Freshman variable condensers (19 plates) made with brass plates. The panel is mahogany hard-rubber, 7 x 18 x 3/16-inch thick; the baseboard is the same size and material. A Cutler-Hammer push-pull snap switch is used. Ample volume control is obtained with the two panel-mounted rheostats. One is 25 and the other is 10 ohms. Two phone jacks are provided for loud speaker connection to first audio or second audio output. Seven battery connection binding posts are mounted on the rear of the baseboard. The dials are black, moulded. This set takes five type 201A tubes. Total weight is 12 pounds. The overall dimensions are: 20¼ x 9 x 9-inches high. The cabinet is finished in mahogany, to match the panel. The set lists for $60.00.

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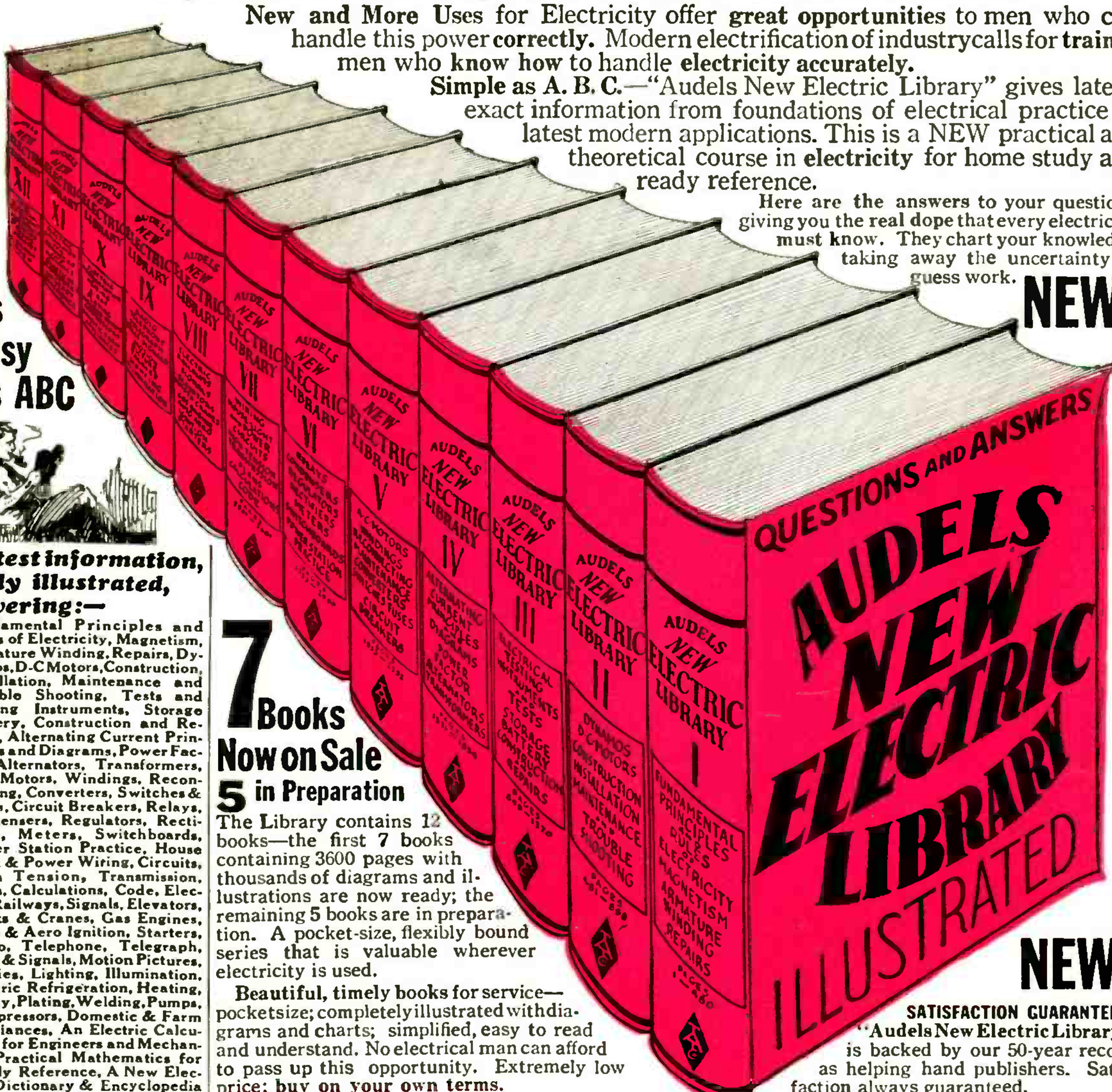

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