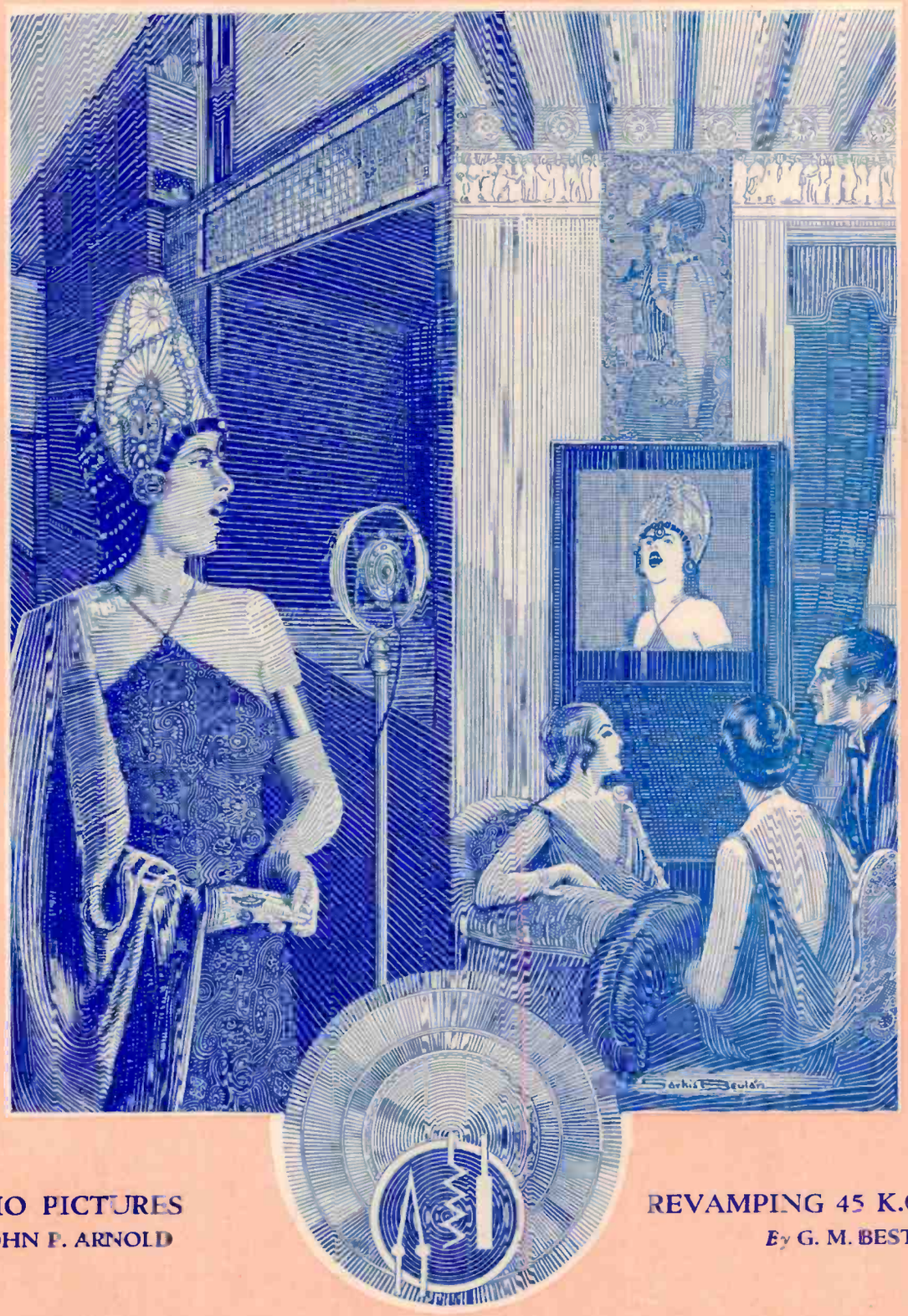
OCTOBER, 1928 25 CENTS

RADIO

(REG. U. S. PATENT OFF.)



RADIO PICTURES
By JOHN P. ARNOLD

REVAMPING 45 K.C. SUPER
By G. M. BEST

A MAGAZINE OF NATIONAL CIRCULATION — COVERING THE ENTIRE FIELD

MAGNAVOX "Dynamic" SPEAKERS

The Cordova

110 volt, 60 cycle AC. Combining rectifier and power amplifier. Takes place of last audio stage in set. Handsome walnut cabinet. *List $175.*

The Beverly

Gracefully proportioned cabinet finished in light mahogany.

For A-Battery Operation $55
For AC Operation $70

Units only; DC $35; AC $50.

"FIRST SPEAKER FIRST DYNAMIC"

DYNAMIC

Only a dynamic speaker can give you studio realism . . . the rich, full, undistorted beauty of music . . . with power volume.

Credit Magnavox for this advance in radio. Magnavox created and sponsored the Dynamic. Half a million owners now enjoy Magnavox speakers. Leading set manufacturers use them as built-in equipment. Let these facts guide you.

THE MAGNAVOX COMPANY

Oakland, California Chicago, Illinois

283

FADA Radio

THE FADA 10 RECEIVER *and* THE FADA 4 SPEAKER

Using The Indirect Heater Tube

They do more than receive—they deliver—*and how!*

These are the leaders of the big radio parade. In a purchaser's home they deliver the four radio essentials—*tone quality, distance, selectivity* and *reliability*. These are the points the consuming public is looking for in a radio set of today. Fada radios deliver permanent radio satisfaction to their owners and—

DELIVER PROFITS TO FADA DEALERS

It is the combination of dollar for dollar value with the utmost in radio results which gives Fada dealers radio profits and Fada owners the utmost lasting satisfaction.

F. A. D. ANDREA, Inc.

Jackson Avenue, Orchard and Queens Streets
LONG ISLAND CITY, N. Y.

CHICAGO SAN FRANCISCO

Prices Slightly Less East of the Rockies

THE FADA 4 CONE SPEAKER

Mantel Clock Type

A seven-inch completely encased cone, balanced armature with extra large chrome steel magnet with improved bobbin winding and simplified direct drive.

Price $32.50

THE FADA 10

Operated from A.C. light socket (90 to 130 volts, 25 or 60 cycle) single dial, illuminated station finder, adjustment for long or short antenna, rejector, phonograph attachment jack, with improved circuit and volume control, self-contained in a beautiful metal velvetex cabinet in two tones of gold and brown.

Price $115

RADIO

Established 1917

Published Monthly by the Pacific Radio Publishing Co.

ARTHUR H. HALLORAN, *Editor* — H. W. DICKOW, *Business Manager*

GERALD M. BEST, *Technical Editor* — A. I. RIVETT, *Draughtsman*

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VOL. X — OCTOBER, 1928 — NO. 10

CONTENTS

FORECAST FOR NOVEMBER ISSUE

G. M. Best exposes some interesting facts about so-called underground antennas in "When Is An Antenna Not An Antenna?" L. W. Hatry discusses the grid condenser and leak in modern dress. John P. Arnold has a wealth of information regarding progress in transmission and reception of radio pictures. R. Wm. Tanner describes the construction of a short-wave superheterodyne. Clinton Osborne gives details regarding the construction and use of a vacuum-tube tester which tells more about a tube than any device yet described. Glenn L. Browning presents the results of his study of r.f. choke coils. Arthur Hobart works out a great simplification in the formulas for reactance. G. F. Lampkin tells how to charge a battery with a synchronous rectifier. A. Binneweg, Jr., describes the practical construction of equipment for the 1929 amateur station.

Follow the Lead of the Leading Manufacturers Pay More—Get More with DUBILIER SOCKET POWER CONDENSERS

Type PL-666 and PL-667 are standard equipment on high voltage AmerTran, Samson, Thordarson and other power packs specifying UX 281 or CX 381 type rectifier tubes. Type PL-666—2 mfd. 1000 volts—$6.50: Type PL-667—4 mfd—1000 volts—Price $11.00.

After exhaustive tests, the engineers of the leading manufacturers, have standardized on Dubilier Condensers. They pay more for them—but they have the assurance that their sets are going to stay sold and they *know* that the ample factor of safety means long life. They can't afford to take a chance—and save a few cents. And neither can you!

You can forget the Condensers—if they are Dubiliers.

Dubilier Light Socket Aerial

If it doesn't work on your set—your money back

And we mean it! If it doesn't give you smooth reception, reduce static and interference and give you plenty of volume the dealer will give you your money back within 5 days. Uses no current. Just attach to your set and plug in to a convenient light socket. Price $1.50.

Free catalog, just off the press, fully describing these and other quality Dubilier products.

DUBILIER Devices
Reg. U.S. Pat. Off.

Dubilier
CONDENSER CORPORATION

4377 Bronx Blvd. — New York

Six Issues for $1.00

SAVE money. Get the next 6 issues of "RADIO" for one dollar—fifty cents less than they cost if purchased from a news dealer. The next six issues of "RADIO" will be better than ever. Let us mail the magazine to your address, starting with the October issue, out on September 25th.

Mail coupon now. Attach a dollar bill, check, money order or $1.00 in stamps and mail NOW.

Name.....

Street and No.....

City and State.....

In the Sets Designed by Leading Engineers

Faradon Capacitors are specified as standard equipment where electrostatic condenser long life and durability is essential.

Faradon Capacitor marks quality. Keep this in mind when considering a new set, kit or replacement parts.

WIRELESS SPECIALTY APPARATUS CO.

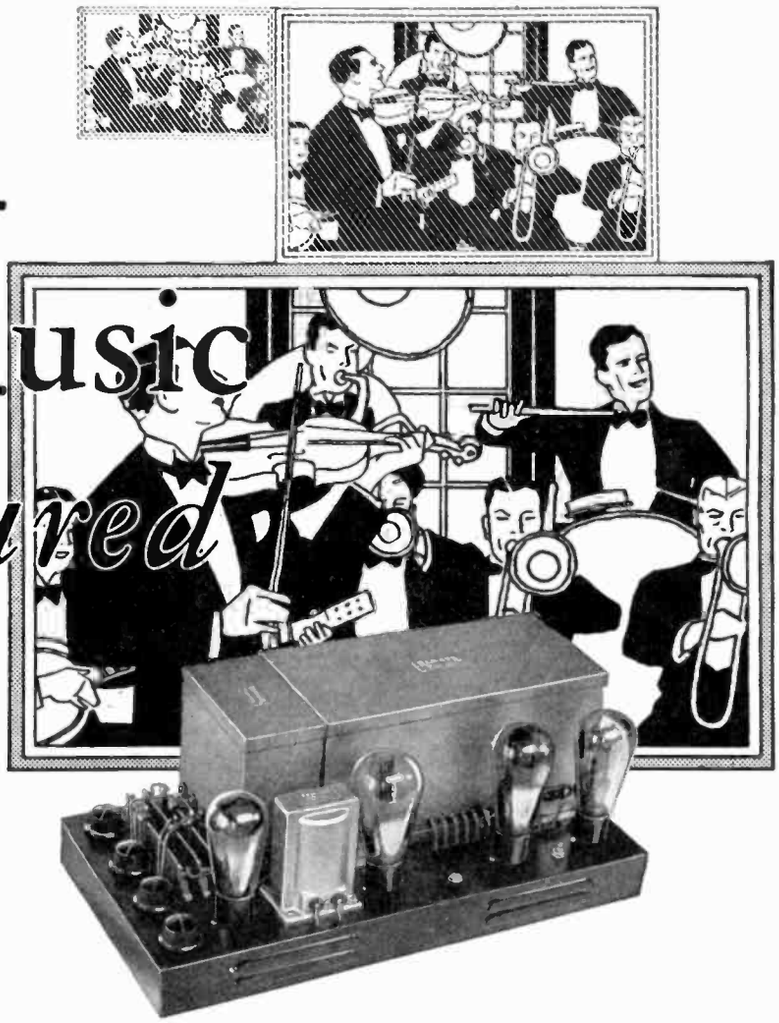
Jamaica Plain, Boston, Mass., U. S. A.

Established 1907

Faradon

Electrostatic Condensers for All Purposes

2202



Lost Music *Captured*

BY THE *Remler* Power *Amplifier*

ATTACH the Remler Power Amplifier to **your** set. Let it capture and bring to your ears the music you've been missing.

Resonance of bass viol and tuba, life and vigor from piccolo and flute, blend with added overtones from the "middle range" instruments to produce a richness of tone quality such as you never expected to hear from your set.

Designed—not for **louder** music, but for **more** music—it brings orchestra details to your ears just as field glasses bring landscape details to your eyes. It balances the instruments, calling in the bass and treble notes to their proper volume.

Three principles guided the Remler engineers in perfecting this marvelous amplifier. First, no tubes were to be "crowded." Only by keeping amplification well below maximum could tone perfection be realized.

Second, transformers must be specially designed to handle all frequencies smoothly, without performance "peaks."

And, third, a reliable source of plate and grid voltage supply should be available for the whole set as well as for the amplifier.

Months of concentration on these problems resulted in their solution. Now this power amplifier and "B" supply may be attached to practically any good set with vastly improved results. Full directions accompany each unit.

If you do not care to assemble it yourself

the nearest radio dealer or professional set-builder can do it for you at negligible cost. Just show him this ad.

The coupon will bring you details on this and other Remler products.

Remler Radio Leadership

The Power Amplifier is the latest addition to a line of radio parts which for ten years have made the name, "Remler" stand for "radio reliability."

These other parts are in constant demand by set-builders who know that they can rely on Remler items.

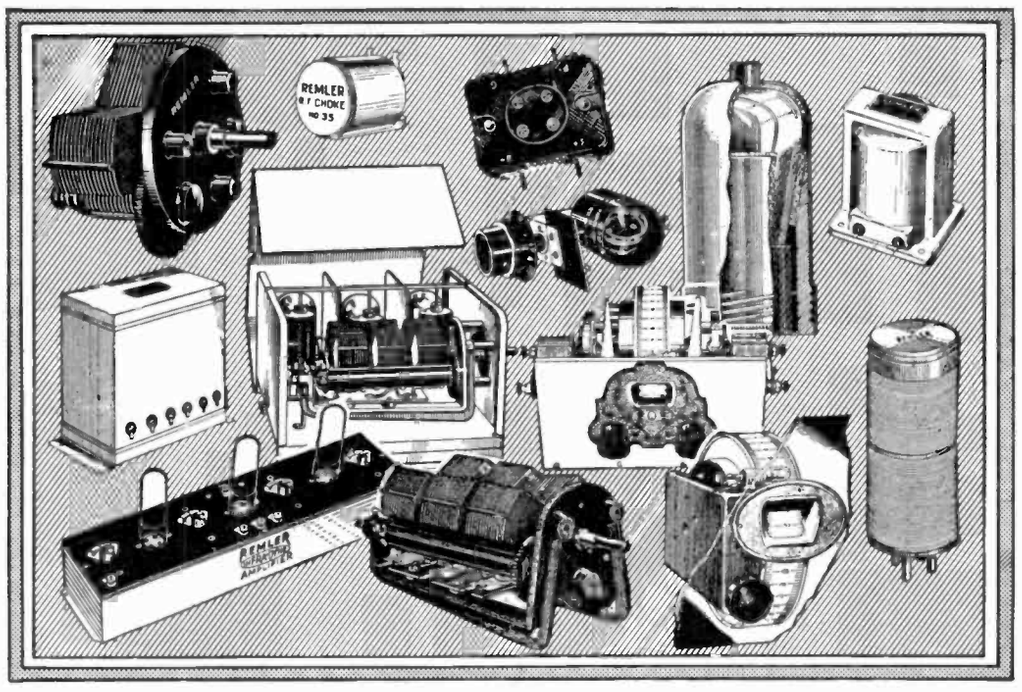
The Twin Rotor Condenser, and the two and three gang condensers built on the same principle, are favorites that grow in popularity from year to year. The Drum Dial is a necessity to the builder who is competing with factory-made products. The new Audio-Transformers raise reproduction to new standards of efficiency.

If you want to know the details of the entire Remler line, check the coupon for the 20 page catalog folder.

Remler Power Amplifier and Plate Supply

Power Tube: CX 350 (UX 250)
Rectifier Tubes: Two CX 381 (UX 281) Half-Wave Rectifiers
Voltage Regulator Tube: CX 374 (UX 874)
Power Supply: 110-volt Electric Light Mains
Over-All Dimensions: 10⅛" wide by 20" long; total height, with cover, 8½"
Wiring: Semi-complete. Blueprint and wire supplied with Foundation Kit
"B" Eliminator: Will supply ample plate current for any receiver. Continuously variable voltage adjustments. Wire-wound resistors
Power Transformer: Tapped for various line voltages

Parts, less tubes, $112.50



REMLER
Division of
GRAY & DANIELSON MFG. COMPANY
260 First Street, San Francisco
NEW YORK CHICAGO

REMLER DIVISION, GRAY & DANIELSON MANUFACTURING CO.
260 First Street, San Francisco, California.

Gentlemen: Please send me:

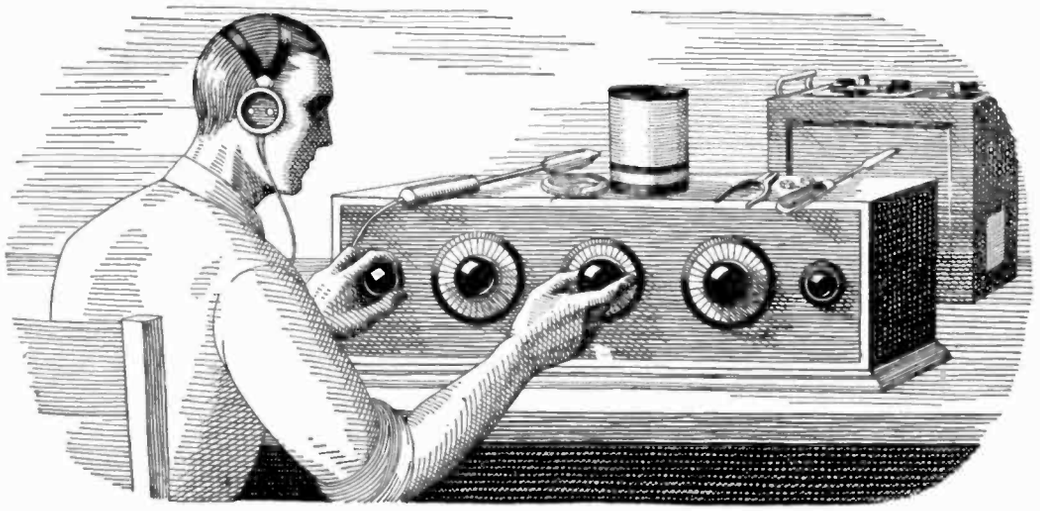
☐ All the "dope" on the Power Amplifier. ☐ Bulletin Service for Professional Set Builders. ☐ Twenty-page Catalog.

Name..... *Address*.....

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

Do you build and sell sets?.....

RADIO-10



If all the Radio sets I've "fooled" with in my time were piled on top of each other, they'd reach about halfway to Mars. The trouble with me was that I thought I knew so much about Radio that I really didn't know the first thing. I thought Radio was a plaything—that was all I could see in it for me.

I Thought Radio Was a Plaything

But Now My Eyes Are Opened, And I'm Making Over $100 a Week!

$50 a week! Man alive, just one year ago a salary that big would have been the height of my ambition.

Twelve months ago I was scrimping along on starvation wages, just barely making both ends meet. It was the same old story—a little job, a salary just as small as the job while I myself had been dragging along in the rut so long I couldn't see over the sides.

If you'd told me a year ago that in twelve months' time I would be making $100 and more every week in the Radio business—whew! I know I'd have thought you were crazy. But that's the sort of money I'm pulling down right now—and in the future I expect even more. Why only today—

But I'm getting ahead of my story. I was hard up a year ago because I was kidding myself, that's all—not becuase I had to be. I could have been holding then the same sort of job I'm holding now, if I'd only been wise to myself. If you've fooled around with Radio, but never thought of it as a serious business, maybe you're in just the same boat I was. If so, you'll want to read how my eyes were opened for me.

When broadcasting first became the rage, several years ago, I first began my dabbling with the new art of Radio. I was "nuts" about the subject, like many thousands of other fellows all over the country. And no wonder! There's a fascination—something that grabs hold of a fellow—about twirling a little knob and suddenly listening to a voice speaking a thousand miles away. Twirling it a little more and listening to the mysterious dots and dashes of steamers far at sea. Even today I get a thrill from this strange force. In those days, many times I stayed up almost the whole night trying for DX. Many times I missed supper because I couldn't be dragged away from the latest circuit I was trying out.

I never seemed to get very far with it, though. I used to read the Radio magazines and occasionally a Radio hook, but I never understood the subject very clearly, and lots of things I didn't see through at all.

So, up to a year ago, I was just a dabbler—I thought Radio was a plaything. I never realized what an enormous, fast growing industry Radio had come to be—employing thousands and thousands of trained men. I usually stayed home in the evenings after work, because I didn't make enough money to go out very much. And generally during the evening I'd tinker a little with Radio—a set of my own or some friend's. I even made a little spare change this way, which helped a lot, but I didn't know enough to go very far with such work.

And as for the idea that a splendid Radio job might be mine, if I made a little effort to prepare for it—such an idea never entered my mind. When a friend suggested it to me one year ago, I laughed at him.

"You're kidding me," I said.

"I'm not," he replied. "Take a look at this ad."

He pointed to a page ad in a magazine, an advertisement I'd seen many times but just passed up without thinking, never dreaming it applied to me. This time I read the ad carefully. It told of many big opportunities for trained men to succeed in the great new Radio field. With the advertisement was a coupon offering a big free book full of information. I sent the coupon in, and in a few days received a handsome 64-page book, printed in two colors, telling all about the opportunities in the Radio field and how a man can prepare quickly and easily at home to take advantage of these opportunities. Well, it was a revelation to me. I read the book carefully, and when I finished it I made my decision.

What's happened in the twelve months since that day, as I've already told you, seems almost like a dream to me now. For ten of those twelve months, I've had a Radio business of my own. At first, of course, I started it as a little proposition on the side, under the guidance of the National Radio Institute, the outfit that gave me my Radio training. It wasn't long before I was getting so much to do in the Radio line that I quit my measly little clerical job, and devoted my full time to my Radio business.

Since that time I've gone right on up, always under the watchful guidance of my friends at the National Radio Institute. They would have given me just as much help, too, if I had wanted to follow some other line of Radio besides building my own retail business—such as broadcasting, manufacturing, experimenting, sea operating, or any one of the score of lines they prepare you for. And to think that until that day I sent for their eye-opening book, I'd been wailing "I never had a chance!"

Now I'm making, as I told you before, over $100 a week. And I know the future holds even more, for Radio is one of the most progressive, fastest-growing businesses in the world today. And it's work that I like—work a man can get interested in.

Here's a real tip. You may not be as bad off as I was. But think it over—are you satisfied? Are you making enough money, at work that you like? Would you sign a contract to stay where you are now for the next ten years—making the same money? If not, you'd better be doing something about it instead of drifting.

This new Radio game is a live-wire field of golden rewards. The work, in any of the 20 different lines of Radio, is fascinating, absorbing, well paid. The National Radio Institute—oldest and largest Radio home-study school in the world—will train you inexpensively in your own home to know Radio from A to Z and to increase your earnings in the Radio field.

Take another tip—no matter what your plans are, no matter how much or how little you know about Radio—clip the coupon below and look their free book over. It is filled with interesting facts, figures, and photos, and the information it will give you is worth a few minutes of anybody's time. You will place yourself under no obligation—the book is free, and is gladly sent to any one who wants to know about Radio. Just address J. E. Smith, President, National Radio Institute, Dept. 22-R, Washington, D. C.

J. E. SMITH, President,
National Radio Institute,
Dept. 22-R, Washington, D. C.

Dear Mr. Smith:

Please send me your 64-page free book, printed in two colors, giving all information about the opportunities in Radio and how I can learn quickly and easily at home to take advantage of them. I understand this request places me under no obligation, and that no salesman will call on me.

Name.....

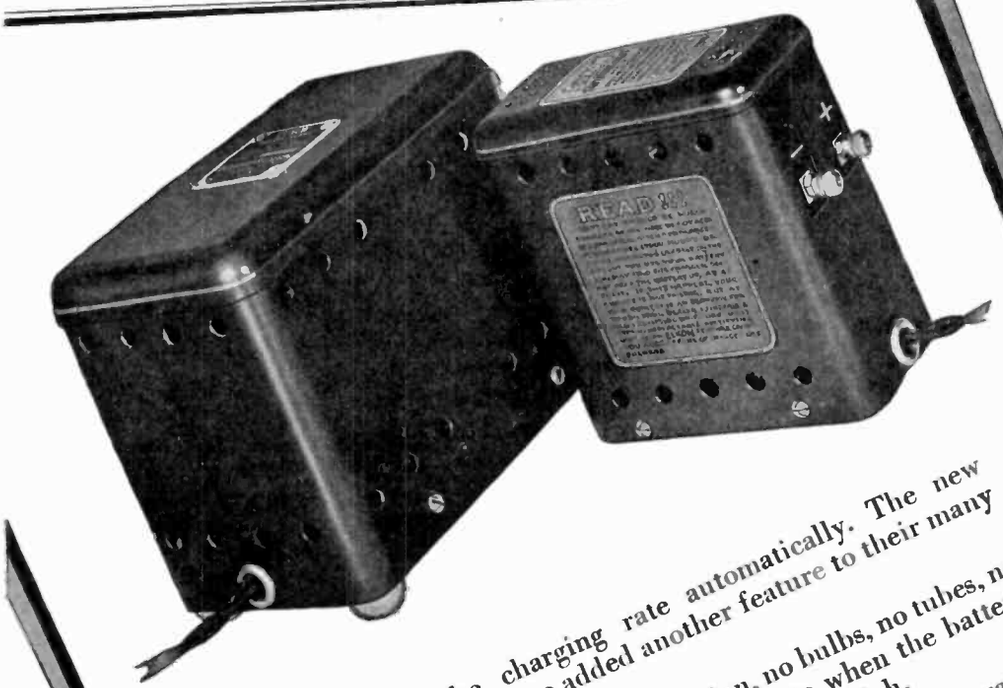
Address.....

Town.....State.....

Occupation.....

Tell them you saw it in RADIO

THE NEW TAPERING CHARGERS



TAPERING the charging rate automatically. The new Elkon Chargers have added another feature to their many advantages:—

Dry—no acids, no water, no corrosion, no bulbs, no tubes, no noise, no moving parts, high charging rate when the battery is low, low charging rate when the battery is high.

The Tapering Charger, 1 Ampere, maximum charging rate is the ideal power supply for the storage battery. Leave it on all the time, without interfering with reception and without injuring the battery. Long life. Instructions and Guarantee printed on container.

The 3 Ampere Tapering Charger is ideal for the rapid charging of either radio or automobile batteries. Has all the advantages of the smaller charger.

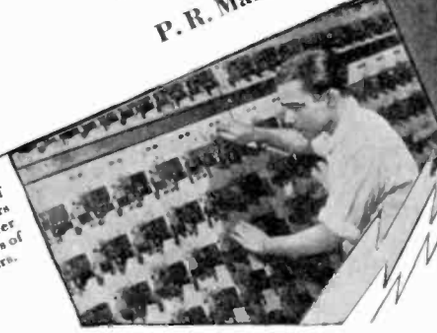
No attention needed—just plug them in and forget them. Elkon Rectifiers are self-healing! They are not affected by accidental overloading or line surges!

ELKON, INC.
PORT CHESTER, N. Y.
Division of
P. R. Mallory, & Co., Inc.

ELKON Replacement Rectifiers

This exclusive feature of the Elkon Rectifiers is saving customers millions of dollars! Afteralongtime—5000 hours for battery chargers—a year or so for "A" Eliminators, renewing the rectifier will prove to be an economy. The old rectifier may be slipped out and the new one put in—only a minute required—and the unit is as good as new.

If you have a power unit using a dry rectifier, ask your dealeraboutthe Elkon Replacement Units. Remember Elkon is the only unitauthorized by Fansteel to replace the acid jars in the Balkite power units.

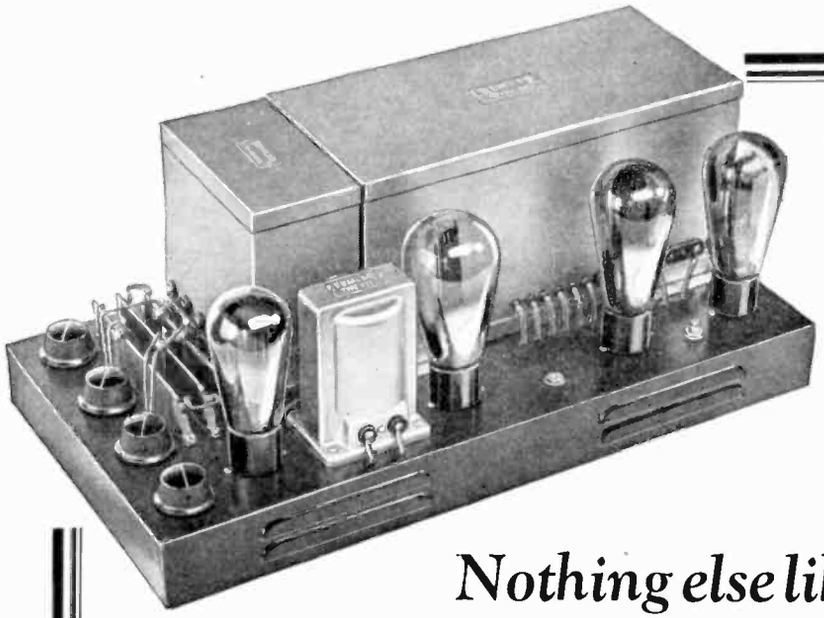


Row upon Row of Elkon Rectifiers reasoned under the careful eyes of skilled workers.

Radio Department, ELKON, INC.
260 Fox Island Road, Port Chester, N. Y.
Send me complete information on the Elkon Radio Products.

Name.....

Address.....



Here is a Real DYNAMIC Speaker Amplifier

Nothing else like it on the market

Remler Audio Transformers are Different

Because They are Designed for Dynamic Speakers

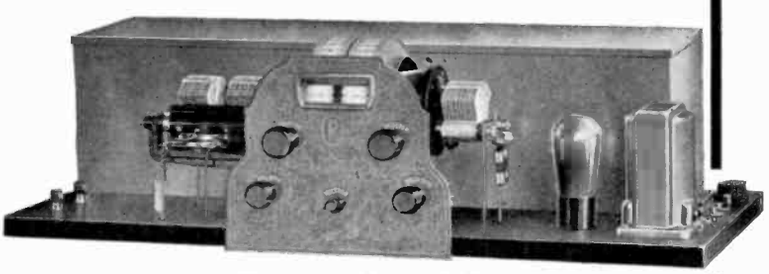
NO HUM from this super power amplifier and *B* eliminator—even with the husky "250" power tube. Remler has so thoroughly engineered this power amplifier that the hum is eliminated. By scientific placing of parts and by skillful engineering Remler makes it so simple for you to assemble this amplifier that you are assured in advance of complete success. The new Remler audio transformer in the last stage—designed especially for the dynamic loud speaker and the new Remler output transformer—the only one of its kind available—allows you to get the most out of a dynamic speaker for the FIRST time. There is no other output transformer like it on the market. Nothing just as good. It's a brute in size and a sure-fire performer. It delivers better and purer tonal qualities to the loud speaker than any other known amplifying device. You will marvel at the fidelity of reproduction. You have never heard anything like it before. Only Remler gives you this modern up to date equipment. This amplifier is known as the No. 950. The metal base goes with the kit. Everything is included—even the screws, nuts, wire and a simple diagram of connections.

Price for All Parts—Less Tubes, $114.00

The New REMLER 29

A RECEIVER that looks as good as it works. Finished in beautiful lacquered copper. Screen grid amplifier unit with individual compartment shields. The entire unit is assembled, wired and laboratory matched and balanced in the Remler factory. Clean cutting 10 KC. selectivity. The new Remler audio transformer gives reproduction such as you have long waited for.

Price for Complete Kit....$131.25



A Professional Job

HERE is a receiver for the most discriminating fan. It can be assembled in a few hours. Simple, explicit wiring charts and instructions make it a pleasure to assemble this new kit—the best of any we have seen this season. Metal chassis with all holes punched. Beautiful escutcheon plate. The illustration fails to do justice to this new "29" Remler SUPER. Acknowledged by engineers as the finest thing in radio for the season.

Set Builders—Dealers:

ORDER your Remler equipment from us. We make prompt deliveries anywhere. Out of town set builders and dealers can wire us for immediate shipment. Express or parcel post delivery to out of town customers. Over-the-counter deliveries to local trade. We carry a complete stock of the best known national lines. Get your tubes, batteries, speakers, eliminators and other supplies from us. Let us convince you that our service is better than ordinary. Usual discounts allowed to set builders and dealers.

UNITED RADIO SUPPLIES CO.
1062A Howard Street, San Francisco, Calif.

THIS COUPON SAVES TIME

UNITED RADIO SUPPLIES CO.
1062A Howard St., San Francisco, Calif.

Per your ad in "RADIO" send me at once the following new REMLER items, for which remittance of $50.00 is enclosed, balance to be paid by me C.O.D.

.....

.....

.....

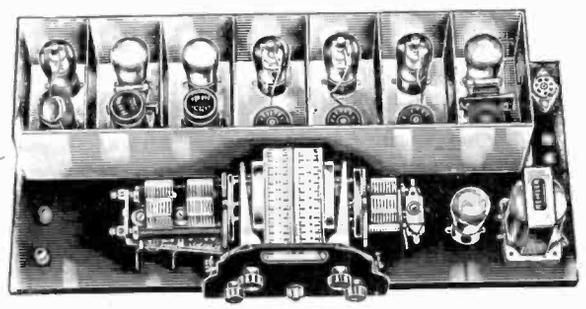
Name.....

Street and No.....

City and State.....

REMLER NEWARK ELECTRIC CO. **FROST**

The Sensational Set of the Season



LIST OF PARTS REQUIRED

1 Remler No. 712 Shield Grid Selector and Amplifier, including all wiring	$70.00
1 Remler No. 752 Foundation Kit	15.00
1 Remler No. 920 First Stage Transformer	12.00
2 Remler No. 110 Universal Drum Dials	9.00
1 Remler No. 632 Two-in-line Condensers	12.00
1 Remler No. 638 Twin-Rotor Condensers	5.00
1 Frost No. 1895 500,000 Ohm Volume Control	2.00
1 Frost No. 1896 2,000 Ohm Sensitivity Control	2.25
1 Frost No. S1910 10 Ohm Gem Switch Rheostat	1.00
1 Frost No. 780 Cable Plug	2.25
1 Frost No. 782 Cable Plug Socket	.75
Complete Kit List Price	**$131.25**

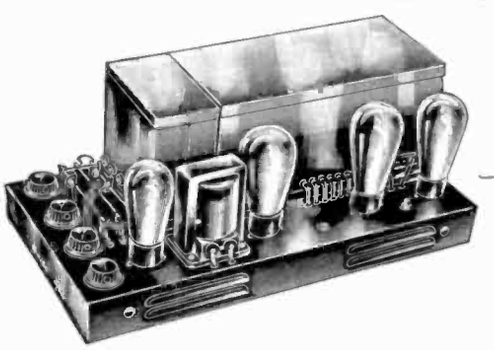
New REMLER "29"

Complete Parts In Stock--Ready To Ship

AFTER you have read the amazing story of this newest and greatest receiver you will naturally want to build one for your own use. You can easily duplicate the remarkable selectivity, the ease of control, the extreme volume on distant stations and the wonderful tone quality of the original laboratory receiver. No other circuit with such wonderful performance has ever been offered to the public that could be built by the Listener in just a few hours' time. Simple two dial tuning control permits razor edge selectivity. Perfection of tone quality assured with the new Remler Audio Transformers. And just as this new circuit is the logical one for you to build, so also, is the Newark Electric Company the logical place for you to secure your parts. Complete stocks of all parts exactly as recommended—always in stock ready for immediate shipment. Dealers and Set Builders should write at once for schedule of discounts.

REMLER No. 950 POWER AMPLIFIER and "B" Supply

TONE quality has already become the most important feature of radio receiver design. The new Remler power amplifier designed especially for use with the new Remler "29" receiver reproduces the full range of musical frequencies with a vividness and coloring which seems to bring the broadcasting artists into your own home. Many months of engineering research backed by the years of experience in specialized manufacture have brought the new Remler Audio Transformers to a degree of perfection which we feel will make them the first choice of those who truthfully appreciate perfection of tone. The new Amplifier is easily built by anyone in a few hours' time by following the simple blue prints furnished. Complete kits of parts always in stock ready for immediate shipment. Dealers and Set Builders should write immediately for discounts.



LIST OF PARTS REQUIRED

1 Remler Transformer and Choke	$45.00
1 Remler No. 952 Foundation Kit	12.00
1 Remler No. 921 Audio Transformer	12.00
1 Remler No. 923 Output Transformer	20.00
1 Frost No. 300 Resistance Kit	9.00
3 Frost No. 1405, 2 Mfd. Filter Condensers	12.00
2 No. 1104 Frost By-Pass Condensers	2.50
Complete List Price	**$114.00**

FROST

NEWARK ELECTRIC CO.

"Nothing but Radio"

226 WEST MADISON STREET
CHICAGO,
ILLINOIS

FROST

OUT-SELLING ALL

Single Dial Control
Verniers for long distance tuning

"De Luxe Model"
SARGENT-RAYMENT SEVEN
Uses Four Screen Grid Tubes, Detector, and Two Audio

A Station for Every Dial Degree

THAT is the average performance of the Sargent-Rayment Seven over the entire dial. Tuning from slightly over 200 meters up to 550 meters, this receiver will, under average night-time conditions, receive 100 stations per evening.

The outstanding performance of this receiver is due to very careful design throughout. Four stages of screen grid tube amplification are used. Each stage is completely isolated by heavy aluminum shielding. Lap Shield joints are used to insure against any possibility of having the slightest leakage from stage to stage. Each screen grid, plate and filament wire is by-passed and nine radio frequency chokes are used to prevent inter-coupling. As a result, the set is not critical to operate and does not oscillate at any wave length. Even with the full power turned on at 200 meters the receiver is fully stable.

THE ANTENNA CIRCUIT

An entirely new type of antenna circuit is used. This input circuit at once assures fine selectivity and good sensitivity, and at the same time it is so connected that antenna capacity does not affect the setting of the gang condenser. Thus, although the antenna is sharply tuned, it is not necessary to compensate for changes in wave length. This is a special feature released for the first time in this set.

The full power of four screen grid tubes gives a degree of sensitivity that has never before been attained in anything that has been placed on the radio market. No suppressors or other counteracting devices are used to prevent oscillation, so that the full amplification of each tube becomes useful. As a result, the receiver will produce a louder signal on a distant station than any other set that can be put up against it, and the selectivity, which is 10 kilocycle in most cases, enables the owner to get long distance reception during the early evening hours when all the local stations are on.

A Guarantee by the Designers

Some very broad claims have been made in our advertising of the Sargent-Rayment Seven. Were it not for the fact that this set is unique in design these claims could not rightly be made. The Sargent-Rayment Seven has been thoroughly tested under the most adverse conditions and is unconditionally guaranteed to do everything claimed in our advertising. In case anyone desiring to purchase one of these sets is in doubt about this point, we will be glad to arrange so that that person can obtain the set on a ten day money back trial basis.

We are perfectly willing to stake our professional reputations as radio designers on this circuit and will leave it to the judgment of the radio fans at the end of the season whether or not any misleading statements have been made.

(Signed) E. M. SARGENT, L. C. RAYMENT

Seven Outstanding Features

1 Ten kilocycle selectivity all over the wave band.

2 More power, more amplification, more sensitivity than ever before available in any receiver.

3 All present distance records smashed. Sets a new standard.

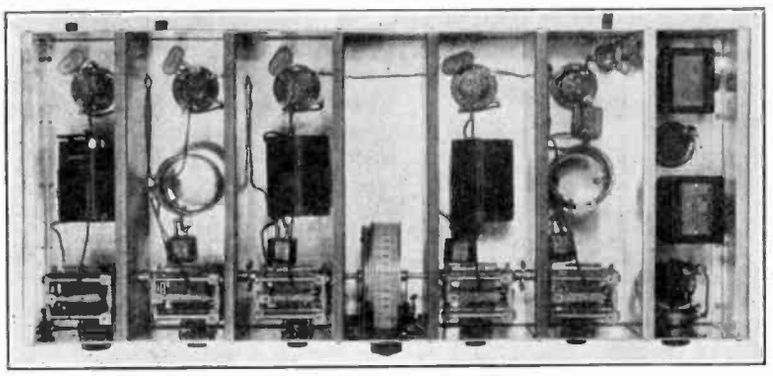
4 Efficient all over the wave band. Plenty of power on the long waves.

5 Tone quality unsurpassed. Uses the latest audio transformers. 210 or 250 tube can be used in last stage if desired.

6 Tuning controlled by handsome, illuminated revolving drum. Only one control for master selector. Fine tuning verniers available for use when wanted.

7 Requires no cabinet. Finished in grained aluminum with black and white trimmings, or in brown, crackle, crystalline lacquer.

THE OTHER KITS!



"Built Like a Battleship"

NOTE THE CONSTRUCTION

The above illustrates a top view of the receiver with the cover removed, giving an idea of how substantially this set is built. It shows the complete isolation of each radio frequency stage, the single drum control on gang condensers and the spacing and angling of the coils to prevent feed back. This is a triumph in radio set construction and at the Radio Shows at which it has been exhibited it has attracted widespread attention and comment.

THE AUDIO SYSTEM

The audio system employed in the Sargent-Rayment Seven is noted for its clearness of tone. The small-sized Clough transformers Nos. 255, 256 and 251 have been purposely selected because they do not over-emphasize the base notes at the expense of the high ones. More powerful transformers could have been selected, but as the set contains plenty of radio frequency power a distinct gain was made by choosing the less powerful but clearer small transformers.

WHAT FINISH DO YOU LIKE?

The Sargent-Rayment Seven is supplied in two finishes. For the dyed-in-the-wool radio fan there is a standard grained aluminum finish, while for those who prefer a darker set which will better harmonize with living room furnishings we are prepared to supply the usual brown, crackle, crystalline finish. The set can be obtained either built up or in kit form, with finish desired at the prices given below. The models are identical in every respect except for the finish.

The De Luxe model is put out exclusively by Radio Constructors Corporation and can only be bought from us or from jobbers listed on this page. All parts are manufactured by Silver-Marshall and the De Luxe Finish is applied by us.

We especially recommend this model. It is unexcelled in appearance and harmonizes with all furnishings.

PRICES—FOR THE COMPLETE KIT

The SM-710 Sargent-Rayment Seven Kit is complete in every respect. All parts are inspected at the Silver-Marshall factory for both electrical and mechanical defects and are fully guaranteed by both Silver-Marshall and by Radio Constructors Corporation to be in first-class condition. Everything is carefully packed to withstand shipment. Complete instructions for assembling and wiring the kit are included. These instructions are so explicit and so well illustrated that the novice will have no difficulty in following them.

All hardware, screws, nuts, washers, brackets—everything necessary to build the set—is included. There is nothing additional to be bought. The kit includes even the "cabinet."

No. 710 Standard Model, Grained Aluminum Finish, Code Word "Mercury" $130.00
No. 810 De Luxe Model, Brown, Crackle Crystalline Finish, Code Word "Venus" $140.00

FOR THE BUILT-UP SET

The completely built, wired, and tested Sargent-Rayment Seven receiver is carefully packed in a specially cushioned packing case. It exceeds the parcel post size limits and hence must be shipped by express. Full instructions for connecting the set to the power supply and operating it are included.

No. 711 Standard Model, Code Word "Neptune" $150.00
No. 811 De Luxe Model, Code Word "Jupiter" $160.00

IMMEDIATE DELIVERY

RADIO CONSTRUCTORS CORPORATION

357 Twelfth Street — Oakland, Calif.

Dealers

These jobbers can supply you with either the kit or built-up set

WASHINGTON

WEDEL CO.,
520 Second Ave., Seattle, Wash.
HARPER-MEGGEE, Inc.,
4th at Blanchard St., Seattle, Wash.
INLAND RADIO CO.,
922 West First, Spokane, Wash.
HARPER MEGGEE & CO., INC.,
4th and Blanchard Sts., Seattle, Wash.
HARPER MEGGEE & CO., INC.,
South 214 Howard St., Spokane, Wash.

OREGON

STUBBS ELECTRIC CO.,
75 6th St., Portland, Ore.
UNIVERSAL SPECIALTIES CO.,
40 N. Ninth St., Portland, Ore.

SOUTHERN CALIFORNIA

HERBERT H. HORN CO.,
1629 S. Hill St., Los Angeles, Calif.
C. C. LAWTON,
1125 Wall St., Los Angeles, Calif.
RADIO SUPPLY CO.,
912 S. Broadway, Los Angeles, Calif.
RADIO MFRS. SUPPLY CO.,
1000 S. Broadway, Los Angeles, Calif.
MODERN ELECTRIC CO.,
308 West Center St., Anaheim, Calif.
SUNSET ELECTRIC CO.,
1141 1st St., San Diego, Calif.
WILLIAMS AND KLENTZ,
409 5th St., Santa Ana, Calif.

NORTHERN CALIFORNIA

ELECTRIC SUPPLY CO.,
370 11th St., Oakland, Calif.
COAST RADIO SUPPLY CO.,
648 Howard St., San Francisco, Calif.
GILSON ELEC. SUPPLY CO.,
1106 Madison St., Oakland, Calif.
KIMBALL-UPSON CO.,
607 K St., Sacramento, Calif.
OFFENBACH ELECTRIC CO.,
1452 Market St., San Francisco, Calif.
PACIFIC RADIO SALES CO.,
357 Twelfth St., Oakland, Calif.

COLORADO

VREELAND RADIO CORP.,
1639 Tremont St., Denver, Colo.

NEW MEXICO

PACKARD SERVICE STATION,
417 West Gold Ave., Albuquerque, N. M.

UTAH

LUND RADIO CO.,
Fairview, Utah.

NEVADA

RENO MOTOR SUPPLY CO.,
Reno, Nevada.

DEALERS—SET BUILDERS

Get established now in your community as headquarters for the Sargent-Rayment Seven. Fill in the attached coupon and send it to us for full information.

Radio Constructors Corporation,
357 Twelfth Street,
Oakland, Calif.

Please send me at once full details regarding the Sargent-Rayment Seven. I am a dealer or professional set builder and buy my supplies from the jobbers listed below.

Name .....

Address .....

City and State .....

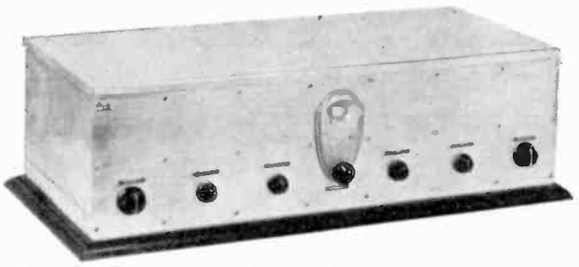
Name of Jobber .....

Name of Jobber .....

Dealers! *We Specialize on this Receiver*
SARGENT-RAYMENT SHIELD GRID "7"----

"Beats Them All"

ORDER your Sargent-Rayment "7" now. Protect yourself against further delays. A tremendous demand for this remarkable receiver has taxed the capacity of the factory but we can still make prompt deliveries if you send us your order right now. Within a few weeks it will be impossible to promise quick deliveries. This receiver is taking the country by storm. It's a knockout. Sold either in kit form or completely built and wired.



The cabinet goes with the kit at $130.00. Aluminum, grained, finish. Brown crackle lacquer finish $10.00 additional.

ONLY receiver on the market with the 7 exclusive features. New Clough audio transformers. Marvelous tone and great volume on "DX" stations. So selective that you can bring in two stations within one degree of the dial setting. Not critical—very easy to tune and absolutely stable in operation. In all our history of radio merchandise we have never heard the equal of this Sargent-Rayment "7." Get your kit or built up set TODAY.

RADIO DEALERS SUPPLY SERVICE
Wholesale Division of
OFFENBACH ELECTRIC COMPANY
1452 Market Street,
San Francisco, Calif.

Send me

V .....SM-710 Sargent-Rayment Kit, unwired, List $130.00.

V .....SM-710 Sargent-Rayment Set, completely, wired, List $150.00.

for which I attach a deposit of $40.00, the balance to be paid for C. O. D. upon receipt of shipment.

Name.....

Street and Number.....

City.....State.....

SET BUILDERS AND DEALERS—

Send the coupon now for your Sargent-Rayment Seven kit, or completely wired receiver. Telegraph orders promptly filled. Mail order service to all parts of the world. All tubes and accessories can be purchased from us at regular dealer discounts.

ORDER DIRECT FROM
Radio Dealers Supply Service
Wholesale Division of

OFFENBACH ELECTRIC COMPANY

"The House of a Million Radio Parts"

1452 Market Street San Francisco, California

EASTERN MAIL ORDER
and
Wholesale Distributors

Specializing on

Sargent-Rayment 710 (7 tube kit)

Silver-Marshall 720-730-740

KITS AND POWER EQUIPMENT

Dealers and Set Builders

Write the Largest New England Distributors for
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or

Send your order to be shipped C. O. D. subject to Maximum Discount

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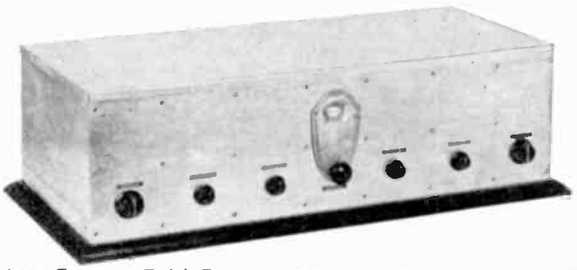
ANNOUNCING

Mail Order Service From the Best Known Radio House in New York

All Popular Kits ✓ *Immediate Shipment*



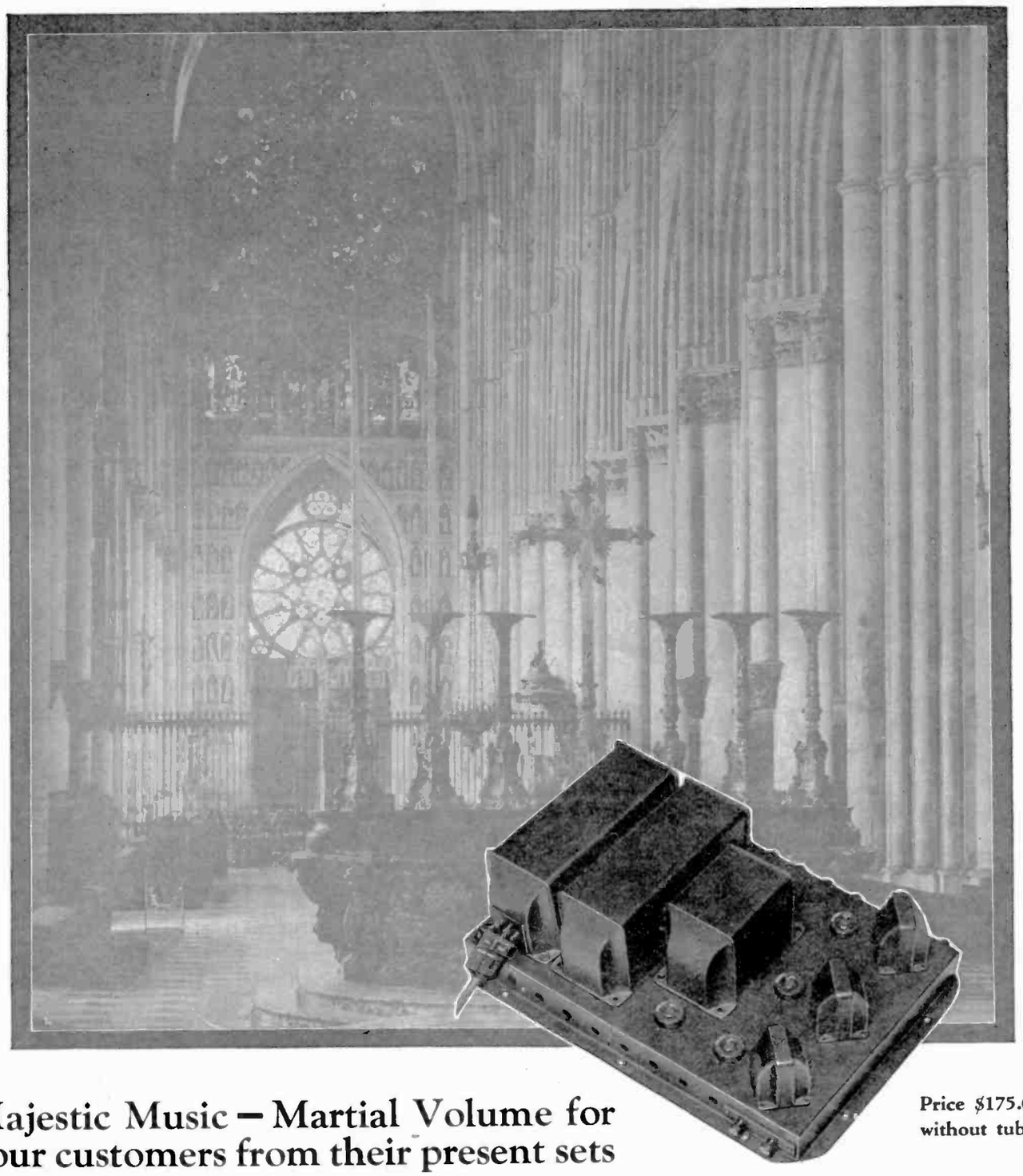
S-M 720 Screen Grid Six S-M 740 Coast to Coast Four
S-M 710 Sargent-Rayment Seven
S-M 730 Round the World Four
All Other S-M Kits and Parts

We are pleased to announce the addition of a complete mail order department, to better serve the interests of the dealers and set-builders of the entire United States and Canada, to whom quick and reliable service is a dire necessity.

Our large buying resources and a complete up-to-date stock, allow immediate shipment of all S-M kits and parts and other popular kits.

Send for our free mail order catalog at once, and become acquainted with the excellent service we can give you.

Royal-Eastern Electrical Supply Co.
16 West 22nd Street ✓ ✓ New York, N. Y.



Majestic Music — Martial Volume for your customers from their present sets

Price $175.00 without tubes

equal to the coronation music of Rheims Cathedral, can be obtained by adding a Samson PAC2 which will also eliminate all A, B and C batteries with their attendant care and replacement.

Rich bass notes, remarkable clarity and a volume which can be controlled from a whisper to dance hall proportions can be obtained. The PAC2 will operate 1 to 16 loud speakers or 500 to 700 headsets.

The Samson PAC2 Power Amplifier and ABC Eliminator are designed to meet AIEE Standards and Underwriters' Requirements. The Amplifier is of the two stage transformer coupled type using a 227 tube in first stage and two 210's in push pull for second stage. Compensation is provided for 105 to 120 volt, 50-60 cycle current. External voltages are 45, 90 and 135B, —4½ C, and AC filament current for two 227 and five 226 tubes. An 874 regulator tube is used to maintain constant B voltages.

PAC2 Amplifiers, when used in conjunction with tuning units, are ideal for supplying music or instruction to schools, hospitals, apartments, clubs, etc. They will modernize the many battery operated sets in your neighborhood or greatly increase the resale value of your traded-in sets.

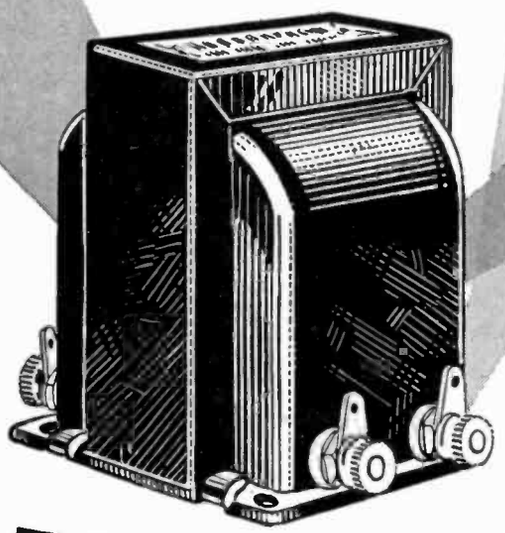
Send for folder R.R. describing this unit and many others.

Main Office: **Canton, Mass.**
Manufacturers Since 1882

Samson Electric Co.
MEMBER R.M.A.

Factories at Canton and Watertown, Mass.

A NEW NOTE IN AUDIO AMPLIFICATION



THORDARSON R-300 AUDIO TRANSFORMER

SUPREME in musical performance, the new Thordarson R-300 Audio Transformer brings a greater realism to radio reproduction. Introducing a new core material, "DX-Metal" (a product of the Thordarson Laboratory), the amplification range has been extended still further into the lower register, so that even the deepest tones now may be reproduced with amazing fidelity.

The amplification curve of this transformer is practically a straight line from 30 cycles to 8,000 cycles. A high frequency cut-off is provided at 8,000 cycles to confine the amplification to useful frequencies only, and to eliminate undesirable scratch that may reach the audio transformer.

When you hear the R-300 you will appreciate the popularity of Thordarson transformers among the leading receiving set manufacturers. The R-300 retails for $8.00.

THORDARSON ELECTRIC MANUFACTURING CO.
Transformer Specialists Since 1895
WORLD'S OLDEST AND LARGEST EXCLUSIVE TRANSFORMER MAKERS
Huron and Kingsbury Streets — Chicago, Ill. U.S.A.

Power Supply Transformers

These transformers supply full wave rectifiers using two UX-281 tubes, for power amplifiers using either 210 or 250 types power amplifying tubes as follows: T-2098 for two 210 power tubes, $20.00; T-2900 for single 250 power tube, $20.00; T-2950 for two 250 tubes, $29.50.

Double Choke Units

Consist of two 30 henry chokes in one case. T-2099 for use with power supply transformer T-2098, $14; T-3099 for use with transformer T-2900, $16; T-3100 for use with transformer T-2950, $18.

Power Compacts

A very efficient and compact form of power supply unit. Power transformer and filter chokes all in one case. Type R-171 for Raytheon rectifier and 171 type power tube, $15.00; Type R-210 for UX-281 rectifier and 210 power tube, $20.00; Type R-280 for UX-280 rectifier and 171 power tube, $17.00.

Speaker Coupling Transformers

A complete line of transformers to couple either single or push-pull 171, 210 or 250 power tubes into either high impedance or dynamic speakers. Prices from $6.00 to $12.00.

Screen Grid Audio Coupler

The Thordarson Z-Coupler T-2909 is a special impedance unit designed to couple a screen grid tube in the audio amplifier into a power tube. Produces excellent base note reproduction and amplification vastly in excess of ordinary systems. Price, $12.00.

THORDARSON ELECTRIC MFG. CO.
500 W. Huron St., Chicago, Ill. 3583-G

Gentlemen: Please send me your constructional booklets on your power amplifiers. I am especially interested in amplifiers using.....tubes.

Name.....

Street and No......

Town.....*State*.....

Tell them you saw it in RADIO

The broadcast of the Army-Navy game last year was enjoyed by hundreds of thousands of fans all over the country.

Phillips Carlin broadcasting at one of the big football games.

The Big Game Comes Over--BETTER--CLEARER

MILLIONS of enthusiastic football fans are listening this fall to the play by play broadcasts of America's greatest games. They are experiencing almost as keen enjoyment as if they were sitting in the stands. The voice of the announcer comes to them clearly and distinctly because their receiving sets are Aluminum equipped.

Leading radio manufacturers are using Aluminum extensively for shielding, for condenser blades and frames, for chasses, sub-panels, front panels and for many other parts—because Aluminum so ideally meets the varied conditions that radio design presents.

It combines remarkable shielding properties, high electrical conductivity, great strength and extreme lightness.

Examine the set you contemplate buying. If it is Aluminum equipped you may rest assured that the manufacturer has done everything in his power to give you the finest possible reception.

And if you are building a receiving set use Aluminum for finest results.

We will gladly send you the booklet, "Aluminum For Radio," which explains the varied radio uses to which Aluminum is adapted.

ALUMINUM COMPANY OF AMERICA

ALUMINUM IN EVERY COMMERCIAL FORM

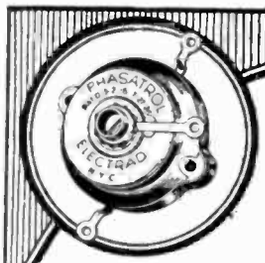
2463 Oliver Building
Pittsburgh, Pa.

Offices in 19 Principal American Cities

ALUMINUM

The mark of Quality in Radio

The Ultimate *in* Controls!



Licensed by Rider Radio Corporation.

Patented 5-2-'16; 7-27-'26. Pats. Pending.

PHASATROL

Reg. U. S. Pat. Off.

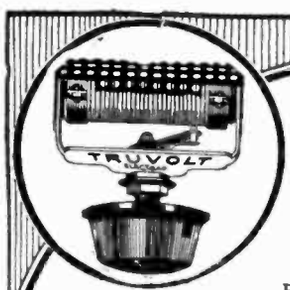
A True Balancing Device for Radio Frequency Amplifiers

Phasatrol is an unusually efficient device for controlling radio frequency oscillations and thus eliminating the disturbances to reception which they cause. Adapted to any type of receiver using R.F. amplification. A wonderful improvement for the new A.C. circuits where the elimination of noise is often a problem. Price $2.75 each.

ELECTRAD Resistances are specifically designed to assist the builder of eliminators and receivers in solving the important problem of control in all its phases.

They are constructed in the most approved designs according to the highest standards of quality and workmanship. Exhaustive tests for mechanical and electrical exactness assure the unsurpassed accuracy and dependability of these units.

Electrad Specializes in a Full Line of Resistances for All Radio Purposes.



TRUVOLT ALL-WIRE Resistances

U. S. Patent 1,676,869 and Patents Pending

Truvolt Variables simplify B-Eliminator construction by eliminating difficult calculation and making all adjustments easy. 22 Stock Sizes $3.50 each.

Truvolt Fixed resistances are adjustable to different set values by the use of sliding clip taps—an exclusive Truvolt feature!

Tear out and Mail Coupon for Full Information.

ELECTRAD Inc.

ELECTRAD, INC.,
Dept. H-10, 175 Varick St.,
New York.

Please send me descriptive circulars on the following products and put me on your mailing list for similar literature.

.....General Circular
.....Tonatrol Volume Controls
.....Phasatrols
.....Royalty Variable Resistors
.....“Electrad Control Manual” (Enclose 10c for mailing)
.....“What B Eliminator Shall I Build?” (Enclose 10c for mailing)
.....Truvolt Divider Manual

I am particularly interested in.....

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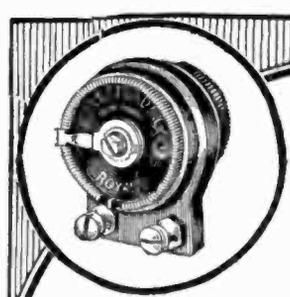
Name.....

Address.....

Pacific Coast Offices:

905 Mission Street

SAN FRANCISCO, CALIFORNIA



Exclusively Licensed by Technidyne Corporation Under U. S. Patent No. 1593658.

ROYALTY VARIABLE HIGH RESISTANCES

Recommended for use wherever variable high resistances are required in high frequency circuits. Superior in design and construction. Made with only the best insulating materials. No harmful capacity or inductance effects. 11 Types, Type A to L. Potentiometer in all sizes $2.00. All other types $1.50.

RADIO

VOLUME X OCTOBER, 1928 No. 10

Radiotorial Comment

AN ADVERTISEMENT of an "eight tube radio" which is equipped with seven amplifying tubes and one rectifying tube prompts the question, "when is a tube not a tube?" Should a set having two r.f. stages, detector, and two a.f. stages be called an eight tube set because its plate voltage is supplied by two rectifiers and controlled by a glow tube? A technical answer might be yes, but in the generally accepted meaning it should be no. A positive answer involves a species of misrepresentation and fraud. Popularly, a tube is not a tube when it is a rectifier.

* * *

IN THEORY, it is possible for several stations to broadcast the same program simultaneously on the same wavelength. This theory has been proved practical by two widely separated stations. And now the Columbia Broadcasting System announces that it will try to synchronize all the stations on its chain.

These tests, if successful, could pave the way for relieving the present congestion in the broadcast spectrum. Instead of tying up half the available channels for the transmission of one program, as has frequently been the case, all the stations in a chain could use one channel and leave the other channels open for the use of other stations or chains. This is made possible by the use of quartz crystals which hold the radiation to one constant frequency without deviation.

A great deal of experimental work yet remains to be done. The expense to the stations would be tremendous. Many of them would be loath to surrender the wavelengths that they are now using. But none of these objections should prove insurmountable. However it is to be hoped that the Radio Commission will not continue to postpone action until the engineer has solved these problems.

THE ultimate success of the efforts to perfect radio moving pictures is assured by the indomitable spirit of the scientist. This spirit finds characteristic expression in a confession of Professor Albert A. Michelson who is quoted as saying: "My greatest inspiration is a challenge to attempt the impossible."

* * *

RADIO advertising is raw when overdone, thus differing from meat and other edibles. Subdued publicity, which may be a builder of goodwill, is so rare nowadays that many listeners purposely avoid tuning in programs which are known offenders.

* * *

MATHEMATICAL analysis of the problem of atmospheric interference to radio reception as published by John R. Carson, noted telephone engineer, in the July I. R. E. Proceedings, forces the conclusion that static, like the the poor, will always be with us. He finds that a directional antenna will afford some relief when the predominant atmospheric interferences come from a direction other than that of the desired signal. He also concludes that no arrangement for balancing out the static by means of an auxiliary circuit can lessen the interference—signal ratio for radiotelephony, though such methods offer a slight theoretical possibility for reducing static interference to telegraph signals.

The practical answer to the problem has been found in using more power at the transmitter. Thereby the desired signal can be made stronger than the undesired static. But wherever and whenever the static impulses are stronger than the signal impulses, the latter are obliterated. Thus does science confute the claims of static-eliminator inventors.

* * *

MUSIC has two mechanistic elements, rhythm and tone. The poorest radio set will reproduce rhythm, the beat which stimulates such

bodily activities as marching and dancing. But it requires a fine set to give fidelity of tonal reproduction. This is the reason for the popularity of transformers with a uniform response curve, power tubes with the reserve energy needed to bring out the low notes, and dynamic speakers.

The appeal of jazz to the untutored mind comes from its rhythm. But its monotony soon tires the cultured mind which derives greater pleasure from a more flexible varying rhythm, as in the waltz.

Good music is characterized not only by rhythm, but also harmony of tone. Tone consciousness gives the appreciation of good music which is innately possessed by most people, regardless of their musical education. A fine radio set is a versatile musical instrument which stimulates tone consciousness. As such it should be in every home.

* * *

PRODUCTION schedules of radio manufacturers provide for an output of about two million complete sets during the present season. More than half of these are to be made and sold by five manufacturers. Over forty per cent of them are console models, most of which are equipped with loudspeakers. Of the probable loudspeaker output, about sixty per cent are of the electro-magnetic type and forty per cent of the electro-dynamic type.

These are the models which are being shown at the Fall radio shows. Most of them represent an improvement in design which is reflected as an improvement in quality of reception, particularly of the low notes which for years were the lost chord of radio.

It is estimated that nearly ninety per cent of the output will use raw a.c. for filament supply. This represents a corresponding drop in the probable sale of battery charging equipment and batteries. Battery-operated sets are still made for isolated districts where alternating current is not available or for sets employing shield-grid or other special types of d.c. tubes.

The shield-grid tube, by the way, has not yet been adopted by the standard manufacturers. So its advantages are available only in custom or home-built sets. It is being subjected to rigid laboratory experiments and with a.c. filament supply may be the great new feature of the 1930 models.

One noticeable feature in some of the new sets is the use of a high-voltage detector voltage output so that it is possible to secure sufficient grid swing to actuate one final audio stage with one or two power tubes. This not only eliminates the cost of one transformer and tube, but also removes one possible source for the introduction of distortion.

Because of improvements and refinements, prices are still on the up-grade. There are notable exceptions to this general trend, but the average complete receiving set of today costs about three times as much as the average set of five years ago. But it is much more than three times as good.

Claims for long-distance reception are conspicuous by their scarcity. Emphasis is placed upon fidelity of tone reproduction from local stations. Thus is a radio set becoming more and more a musical instrument which happens to be actuated electrically rather than an electrical instrument which happens to perform musically.

* * *

WHY the a.c. hum is not always heard in some of the lower priced sets which use a.c. filament tubes is a question which has sometimes puzzled those who are trying to clear up such trouble in sets that they or others have built. The answer to this question usually is found in the use of an audio frequency amplifying system which does not reproduce the low notes.

It is relatively easy to design transformers and speakers which suppress the very low notes. In fact the great difficulty is to bring them to life. Yet the casual listener does not notice the absence of notes below 120 cycles if the low notes above this frequency are strongly accented. So if the a.c. hum is not heard there may be a reasonable suspicion that no other 60 or 120 cycle notes can be heard.

Another expedient which helps to solve the difficulty is the use of a heater type instead of a filament type of a.c. tube. With a good filter-rectifier system for plate voltage supply, and with heater tubes throughout, it is possible to greatly minimize the hum. But the expense of doing this must be reflected in the price of the set.

Canada's Arctic Radio Stations

By JAMES MONTAGNES

A SEA ROUTE from the Canadian West is to be opened in 1930, via the Hudson Bay and the Hudson Straits to the Atlantic Ocean. A railway is nearing completion, running northeast from Winnipeg to Fort Churchill; an aerial survey of weather conditions and ice traffic is being made, and this summer four permanent radio stations were installed in this district, which lies directly south of the Arctic Circle.

To cut the cost of grain transportation to Europe this new sea route has been deemed necessary. It is now in its final stages of completion. Radio has and will play a big part in its use, a large force of government operators and the latest equipment for ship to shore communication having gone to the Far North this summer.

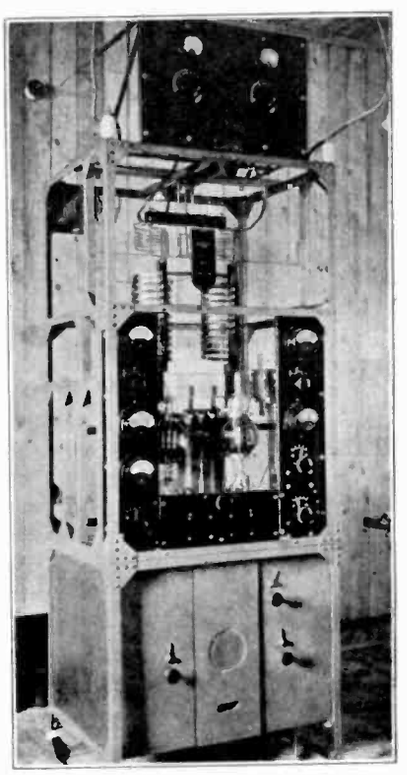
Three temporary stations along the Hudson Straits were installed in 1927, when the aerial survey went north. They have kept in constant touch with Ottawa, sending valuable information on the daily surveys made from the air. The stations were situated at Port Burwell at the southeastern extremity of the Straits, at Wakeham Bay near Ungava Bay on the south shore of the Straits, and at Nottingham Island at the western entrance to the Straits.

The station at Wakeham Bay, being between the other two, was the control station. It was in daily touch with Ottawa. This station and the one at Port Burwell are being closed, having served their purpose, and two new stations will replace them, one at Cape Hope's Advance, near Wakeham Bay, and the other on Resolution Island at the northeastern end of the Straits, opposite Port Burwell. The station at Nottingham Island is being made into a permanent installation and a fourth station will be at Fort Churchill on the western shore of the Hudson Bay at the end of the railway from Winnipeg.

Radio Station on Nottingham Island, Hudson Bay

It is significant that each of these stations, in addition to its regular equipment, will be equipped with direction finding apparatus. This follows the Canadian Government's policy to equip its shore stations with this latest means of guiding mariners. The apparatus will be similar to that installed at the various stations on the Canadian Atlantic and Pacific coasts.

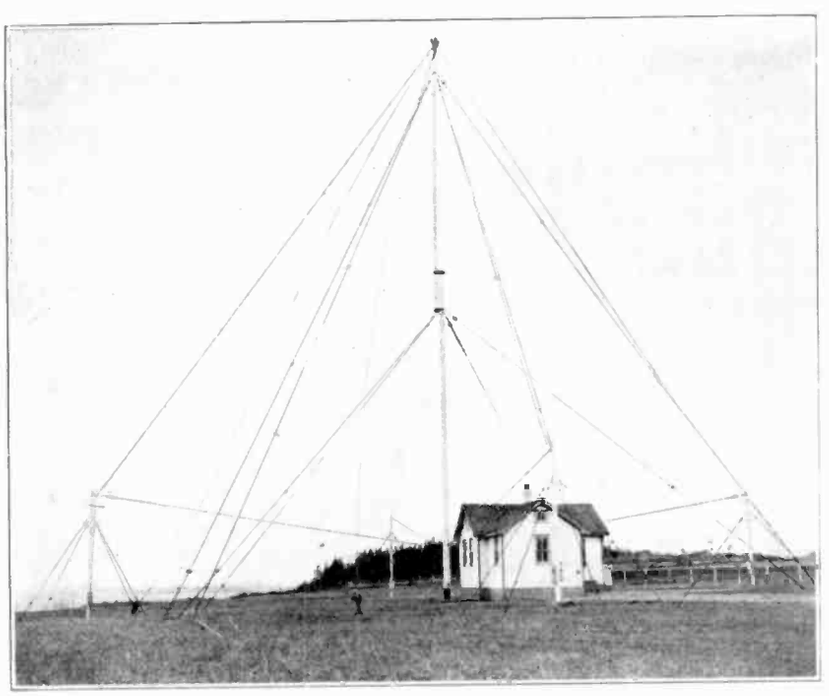
At each station along the Straits there will be a 500-watt C. W. and I. C. W. long wave transmitter, operating on 600, 800, 1700 and 2100 meters. The station at Resolution Island, the farthest east station of the chain, and the new control station, will also be equipped with short wave apparatus for direct communication with Ottawa. Power and wavelengths to be used on the short wave have not yet been chosen. The call letters at this station will be VAW, at Nottingham Island, VCB, and at Cape Hope's Advance, VAY.



Short-Wave Transmitter at Wakeham Bay

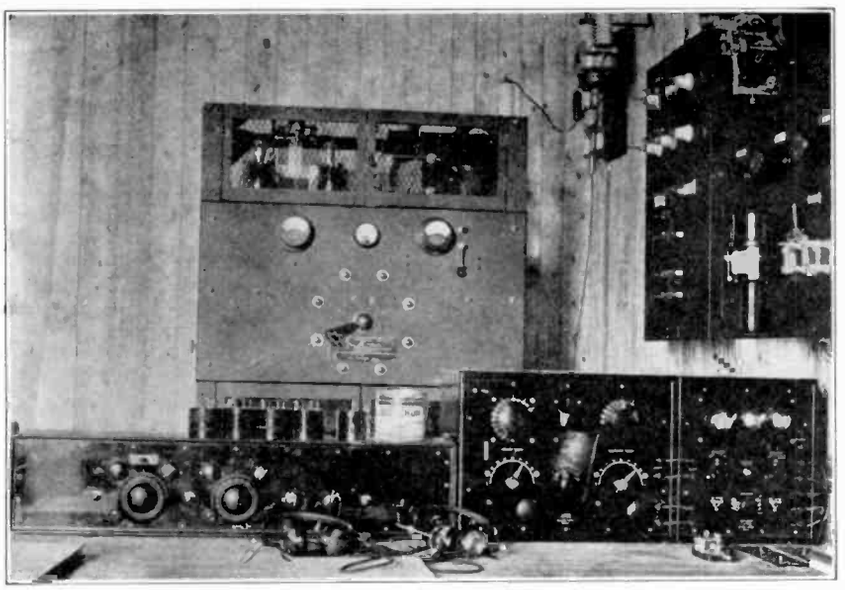
The station at Fort Churchill, VBY, will be the most powerful of the group. A 1600-watt C. W. and I. C. W. set is being installed for long wave work. A 500-watt set for short wave transmission and a 100-watt radiotelephone equipment will be installed in addition to the direction finder. It will use the same wavelengths as the three other stations, and will be able to communicate by means of the short wave apparatus with Winnipeg and Ottawa.

An officer-in-charge and three operators will be stationed at each post. These



Direction Finding Station at St. John, N. B., Showing Type for Hudson Straits District

will be relieved every year. They will communicate with ships coming in and going out in the same way that shore operators in more civilized waters are accustomed to do. Most of the apparatus and the majority of the men left during July for their places at Canada's most northerly stations. The stations will be on the air in the near future as everything must run smoothly when navigation opens in the spring of 1930.



Receivers and Long-Wave Transmitter at Wakeham Bay

NEON TUBES

Neon is an inert gas which is obtained by the fractional distillation of liquid air. There is about one part of neon in 200,000 parts of air. It is used in glow tubes to give a constant 90 volt output from a rectifier filter system and it is used in television to convert variations in electric current to variations in light.

Its use in a voltage regulator tube depends upon the fact that the tube gives a constant voltage drop averaging 90 volts across the tube for any current flow from 10 to 50 milliamperes. Two of these tubes may be placed in series to give 180 volts, with a center tap between them to provide 90 volts. It is necessary to limit the maximum current to 50 milliamperes by means of a series resistance. In normal operation one of these tubes draws from 10 to 15 milliamperes so that it cannot be used in with a 65 m.a. rectifier which is supplying more than 50 m.a. to a set at specified voltages. It also acts as a condenser across the output, bypassing the a.c. component of the rectified output.

Its use in television depends upon the fact that its brilliancy varies with the amount of current fed to it. Its brilliancy is low for small voltages and high for large voltages. Thus all the contrasting lights and shadows of a broadcast picture can be registered on a receiver screen.

Chain Broadcasts on One Wavelength

By S. R. WINTERS

THE feasibility of assigning a single frequency to a chain of broadcasting stations, as suggested by Dr. J. H. Dellinger, technical advisor to the Federal Radio Commission, and the practical demonstration of operating a station at St. Louis, Missouri, and one at Columbus, Ohio, on the same wavelength, are developments fraught with hopeful possibilities in unraveling the tangled skein of broadcasting. Dr. Dellinger, believes in "the possibility of the use of special piezo-oscillators in broadcasting stations, which hold the frequency so close that several such stations can operate simultaneously without heterodyne interference on the same frequency."

The Columbia Broadcasting System will attempt synchronization of the individual stations comprising its chain. This far-reaching and elaborate test will have for its guidance the experience of a similar experiment conducted by WAIU of Columbus, and KMOX of St. Louis, links in the Columbia broadcasting chain. This synchronization experiment is still in progress and the methods employed and results obtained are described in a communication to the Federal Radio Commission from H. V. Ackerberg, chief engineer of the Columbus station. His detailed report follows:

"The WAIU transmitter during these experiments is not crystal-controlled, the usual crystal-oscillator being replaced by a manually-controlled master-oscillator completely shielded, and accurate in maintenance to frequency to within 15 cycles over a period of five hours. KMOX employs a standard Western Electric 4-A transmitter which has been found to be accurate within 25 cycles over a like period of time. We determine their variation of frequency by the usual method of beating their carrier with a constant frequency oscillator located in Columbus. During the actual synchronization we use a calibrated local oscillator at the transmitter. This oscillator is absolutely accurate at 1000 kilocycles. We beat our carrier against this local 1000 kilocycle oscillator instead of against KMOX at St. Louis.

"Our observers give us the correction before the program starts. This correction, usually in the neighborhood from 100 to 500 cycles, is easily made at the transmitter—the local constant-frequency oscillator corrected accordingly and the program continued. At intervals during the program the observers give us additional corrections. These corrections are made at once at the transmitter.

"We find that there is an entire absence of heterodyning and the only problem that we have not yet quite overcome is that of cross talking during announcements. We have worked out a plan whereby we are dividing the announcing time—each station utilizing half of the 15-second intervals allotted by the chain for our local announcements. We are very carefully studying the distortion factor. As yet we have experienced no serious distortion of audio-frequencies due to time lag, or due to either one of the two transmitters being slightly out of phase.

"We would very much like to carry on these experimental tests, employing thermostatically-controlled crystals. For your information, we have been successful in beating two thermostatically-controlled crystal oscillators for a period of seven days, with the result of no more than a 5-cycle deviation over this period of time.

"It is my opinion that this method could be very successfully applied to the synchronization of two stations—another noteworthy factor in the ability to hold our transmitter to a given frequency continually is an unusual type of antenna design. We are using at the present time, and have found it by far the least susceptible to frequency changes due to variation of capacity, atmospheric changes, etc., a system comprising two 40-ft. 8-in. diameter, 6-wire horizontal cages.

"These cages are suspended between towers 200 feet high. They are tightly stretched between the towers, this tension being maintained by an automatic compensator. The down lead is composed of a 50-ft. 4-in. 6-wire cage at the upper end. At the bottom of this vertical cage the six wires are bunched, continuing 130 ft. straight down to the coupling house. This so-called 'rat tail

(Continued on Page 44)

Home Contacts for the Traveling Man

Provided by a Portable Short Wave Radio Transmitter and Receiver Which Is Here Described

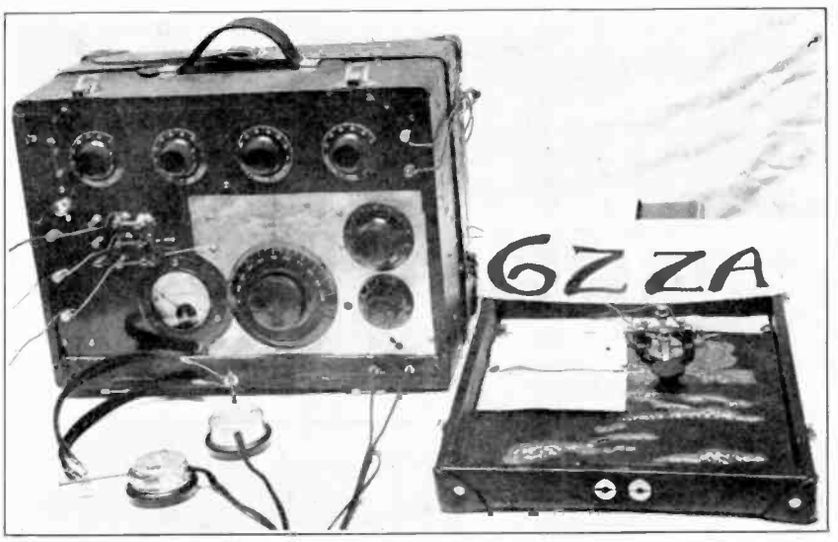
By DON C. WALLACE

By means of a small transmitter and receiver, which is carried in a hand satchel, the writer has been able to telegraph to his wife from distant hotel rooms for an hour or so each evening for several months. After a concentrated two week's course in code practice Mrs. 6AM passed the examination for an operator's license and qualified to operate the short-wave transmitter at 6AM, Long Beach, California.

During his long trips Mr. 6AM carried the outfit here illustrated, using a portable Zepplin antenna on 40 meters. At 500 miles range the average audibility of the portable transmitter was R-8 at 7 p. m. and R-7 at noon.

Half wave self-rectified current is used to supply the plate of the transmitting tube. AC is used on the filaments. It has been found that the same transformer cannot be used for both filament and plate, because of the unsteadiness. Consequently the lightest available toy transformer was used here. It has a variable voltage tap, which allows proper filament voltage to be used regardless of the line voltage. This also allows the *B* eliminator transformer to be rewired so as to deliver 800 volts, from what is really a 600-volt transformer.

The method of securing this voltage is shown in Fig. 2. The two filament windings are connected in series to give 13 volts; this 13-volt winding is then connected in series with the 110-volt winding so as to reverse the flux caused in the core by the 110-volt winding.



Complete Set Ready for Operation

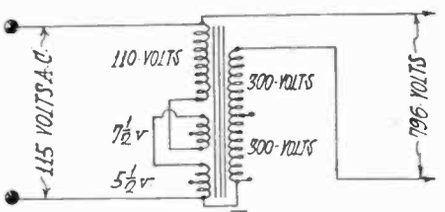


Fig. 2. Method of Securing 800 Volts from 600 Volt Transformer

This actually will reduce the turn ratio 13/110, giving a like increase in output of the same ratio, i.e. adding 71 volts onto the 600 already secured from the transformer (300 volts on each side of the mid tap). Then this total of 671 volts is connected in series with the 110-volt line voltage which is usually 115, giving a total of 796 volts or approximately 800 volts.

This has proved to be just the correct voltage for the CX 310 tube used for transmission, inasmuch at that voltage it does not heat, runs steadily, and shows

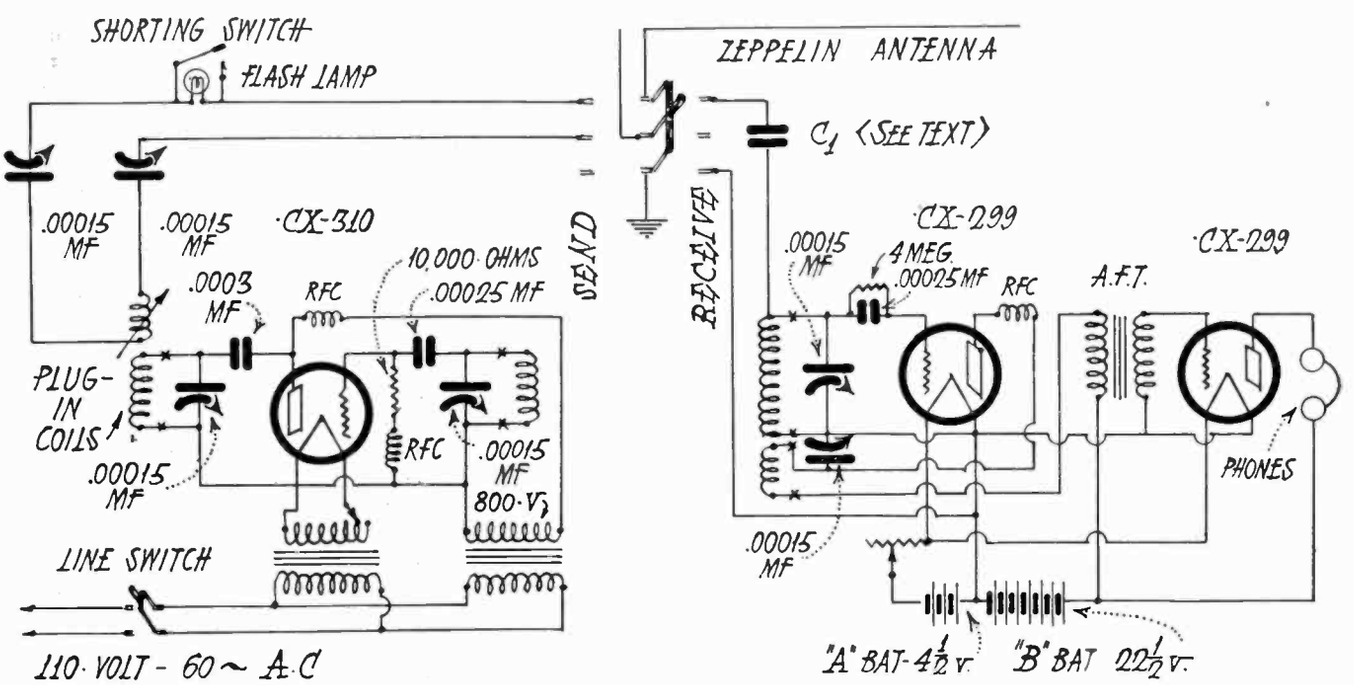


Fig. 1. Circuit Diagram of Portable Transmitter

good output. The wave becomes unsteady around 1000 volts, and with 600 volts the output is considerably less. With a heavy duty transformer the overload, especially with intermittent service such as in keying, will not hurt the transformer. In this way, standard apparatus can be used, doing away with the necessity of having to wind a special transformer.

All the receiving condensers used as plate-blocking condensers promptly blew, so finally an old UC 1015 RCA condenser was installed, doing away with trouble from that source. The .00025 mfd. condenser used for the grid is one of the new midget type mica condensers.

Ordinary sockets caused trouble so one of the old RCA porcelain UR 541 sockets was used. All the transmitting condensers are the Midget type, equipped with 2-in. rheostat knobs to conserve space.

The r.f. chokes, coil mountings, and coils are of standard makes, the coils being 1⅜ in. in diameter, wound with No. 14 wire on a celluloid form. Rather than paint the coil with dope, the wire was heated until it meshed into the celluloid. The result is a highly efficient and durable transmitting coil which takes little space. Coils for both 20 and 40 meters can thus be taken along as the space requirements are slight. Coil dimensions and data for both the transmitter and the receiver are given in the accompanying table.

The receiver was originally designed with but one tube, whereby communication with 6AM was very easy from San Francisco and Oakland, 500 miles away. Body capacity was bad, due to the headphones in the plate circuit of the detector tube. To do away with this required shielding, and an audio stage made signals much more pleasant to copy. With the one tube only, amateur signals from Uruguay, New Zealand, Australia and Tahiti were all heard during the space of ten minutes listening while at a hotel in Oakland. The Uruguay station, by the way, was using voice transmission, and could be made out quite well on this single 199 tube.

Lynch resistors are used in both the receiving and transmitting portion of the set. The receiving is a 4 meg metalized resistor, and the transmitting a 10,000-ohm 10-watt type.

The receiving batteries are very light, the *B* being the smallest size, and the *A* being an ordinary *C* battery. The entire set is light enough to be easily carried.

The small condenser C_1 is the capacity formed by twisting two pieces of rubber-covered hookup wire, for a distance of 2 in. Space and weight are thus secured, retaining the necessary rigidity.

Inasmuch as the transmitter and receiver are so close to each other, both sides of the 110-volt AC line must be opened, or else there is a bad inductive hum in the receiver. This switch is made from the smallest knife switch material found on the market, and the entire switch is mounted right in the cord, at a convenient arm's length from the receiver.

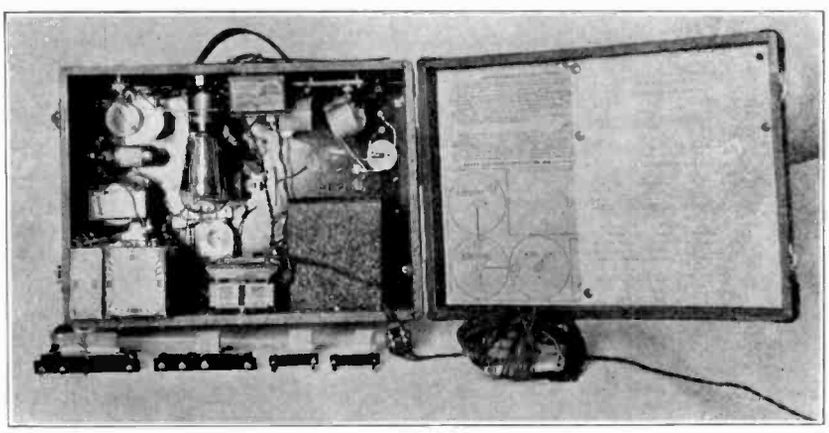
The entire box is reinforced with brass angle irons, bolted inside the corners of the main box and on the lid. The key is mounted right in the corner, and is arranged to fit closely into the panel with the lid in place.

The antennas most successful for hotel use have been zepplin type, using two r.f. feed lines spaced each 3 ft. with small dowel sticks 3 in. long, boiled in paraffin, and held in place with rubber bands for simplicity and convenience. The forty-meter antenna is 66 ft. long (made with loop wire), and the feeder wires each 35 ft. long. The twenty-meter antenna is just half this size, i.e., 33 ft. for the antenna and 17 ft. for the feeder wires.

In testing out this set with its own antennas at 6AM, communication was established with Japan, Call AJ-1AW, using the 20-meter portable zepp out the window and about 3 ft. over the roof of a one-story bungalow, held in place with string. String, by the way, is always used, as string is good temporary insulation, and a ball of it can be dropped or thrown out most anywhere to put up an antenna in a hurry. When it is desired to take down the antenna, a quick jerk does it nicely. Ten minutes is often all that is necessary for the complete set-up, including antenna installation and tuning in of distant 6AM.

Other tests at 6AM indicated that the 40-meter antenna strung over the back yard at a height of 3 ft., would give R-8 signals at points over 500 miles, and in one such half-hour test two or three stations reported R-8. In addition, several East Coast, Mid-West, and Western stations were "worked."

The ease and convenience of the whole arrangement is really delightful, and it just goes to show how easily even now, the portable sending and receiving set may be built and used.



Rear View of Portable Set

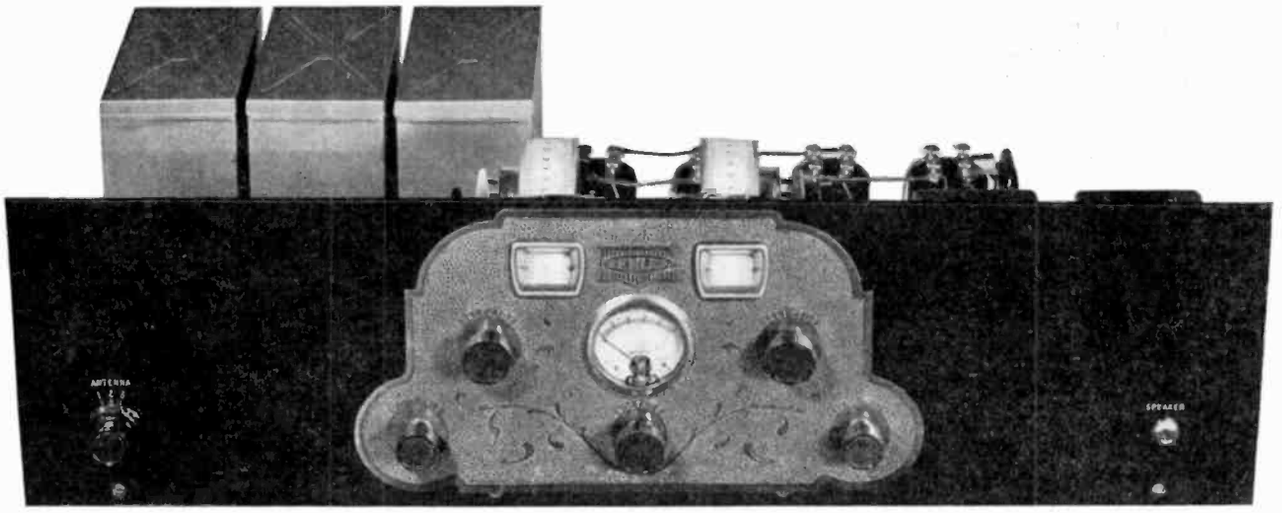
COIL DIMENSIONS AND DATA

RECEIVING COIL DATA

Wave	*Turns Secondary*	*Spacing*	*Turns Tickler*	*Diameter*	*Size of Wire Spaced*
18-26	13	⅛"	10	1⅜"	No. 20 SCC
26-37	15	⅛"	15	1⅜"	No. 28 SCC
36-47	26	⅜"	24	1⅜"	No. 28 SCC

TRANSMITTING COIL DATA

Wave Band	*Plate Turns*	*Grid Turns*	*Turns*	*Diameter*	*Size of Wire Spaced*
18.7-21.4	8	6		1⅜"	No. 14 SCC
37.5-42.8	12	12		1⅜"	No. 14 SCC
Antenna Coil			13	1⅜"	No. 20 SCC



Panel View, Showing Brass Escutcheon Plate

Revamping the 45 Kilocycle Superheterodyne

How to Add a Stage of R.F. Amplification with Shield-Grid Tube So As To Minimize Heterodyne Interference

By G. M. BEST

FOUR years does not seem like a long time to most of us, but that period in the radio industry represents a lifetime for the average radio receiver. With very few exceptions, receiving sets which were built during 1924 are now hopelessly obsolete, since they are usually unselective, have poor tone quality based on present-day standards, and have too many controls.

The most popular radio receiver, judging from the number of kits sold, and inquiries received, during 1924 was the 45 kilocycle superheterodyne which was first described in May 1924 RADIO. This circuit was subsequently copied by nearly every parts manufacturer in business, and the number of circuits which appeared in the columns of our contemporaries under different names were legion. Based on reliable estimates, there must be several hundred thousand of these receivers in existence today.

The original model used a three-tap regenerative loop, with eight dry cell tubes. It had two controls, was easily constructed and, strange to say, usually worked as soon as the tubes were placed in their sockets and the batteries connected, which is more than can be said for some of the popular circuits of later years.

This set today, in the region of the large broadcasting centers, where there are many stations on the air at one time, is not selective enough to cut out these local stations and receive distant ones like it did in 1924, because the locals are invariably sending out many times the power they did four years ago, are more numerous, and are closer together in frequency assignment. For the latter reason, the set is often afflicted with interference between local stations, due to the fact that the two settings of the oscillator dial conflict with each other, and hence some of the local stations are heard only with the heterodyne whistle from another local superimposed on it. This is a very unsatisfactory condition, and the method by which the old model can be rebuilt into a selective, modern receiver, using as many of the old parts as possible, will undoubtedly be of great interest to many of our readers.

The design which was found to be most satisfactory is shown in the pictures, and the circuit in schematic form is shown in Fig. 1. A stage of completely shielded r.f. amplification with shield grid tube, a shielded oscillator and first detector, are followed by a three-stage intermediate amplifier, second detector, and two stages of transformer coupled audio amplification. This requires one more tube than was needed in the original set, but does not take up any more baseboard or panel space, except that the panel is made 7 in. high instead of 6 in.

The loop antenna is not used, since an exposed loop is no longer popular,

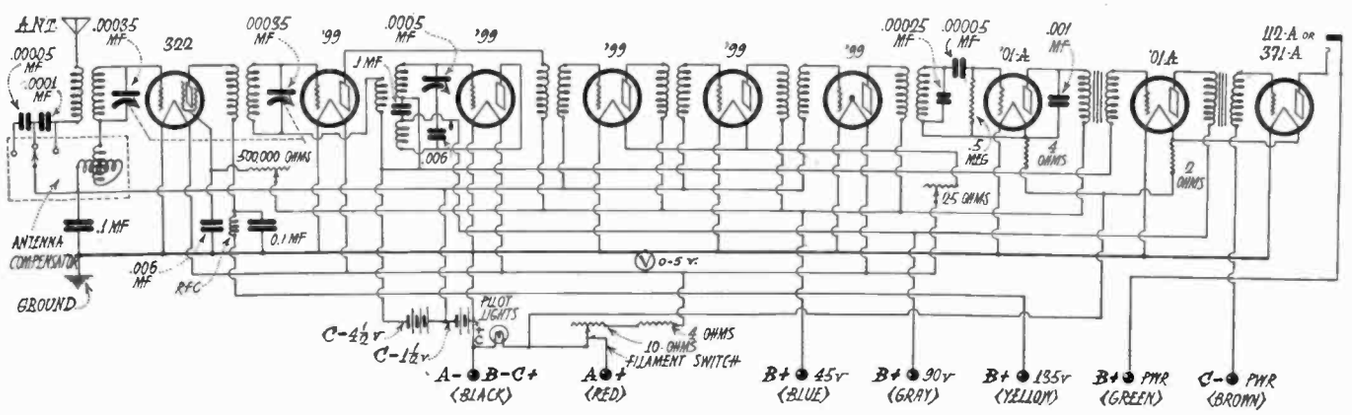


Fig. 1. Schematic Wiring Diagram of 45 K.C. Superheterodyne

is difficult to tune in connection with gang control of the condensers, and is unsightly. In its place is an aperiodic antenna coil, loosely coupled to the secondary coil, with two series condensers arranged for easy connection by means of a switch located on the front panel. This switch is a part of the antenna compensator; an inductive type of trimmer used successfully in such circuits as the infradyne and the 115 k.c. superheterodyne, and if this control is not desired, the right size of fixed condenser can be permanently connected at the time the set is adjusted.

The r.f. and oscillator coils are placed in individual compartments of copper, 3 x 5½ x 5¾ in., the same as are used for the 115 k.c. superheterodyne recently described in RADIO. They can be obtained ready-made, in knock-down form, or they can be made from sheet copper or brass in the dimensions given above. The three r.f. coils are all wound on 1½-in. bakelite forms, 4 in. long, and the bottoms of the coils are equipped with bases identical with that of the standard X base vacuum tube, so that they may be plugged into a vacuum tube socket.

The antenna coil primary consists of 20 turns of No. 28 silk wound in bundle fashion on a 1¼-in. diameter, and placed inside the secondary coil at the bottom. The secondary consists of 110 turns of No. 25 double silk wire, wound on the 1½-in. form. The r.f. transformer has a secondary of 114 turns of No. 25 double silk wire, on the 1½-in. form, with primary of 100 turns of No. 30 cotton covered wire wound on a ½-in. spool, and placed at the bottom of the secondary. The oscillator coil has two stator windings of 49 turns each of No. 25 double silk wire, for the grid and plate coils, and the coupling coil consists of 18 turns of No. 25 double silk on a 1¼-in. tube, placed inside the two stator coils.

Connection of these coils to the tube bases used to plug into the coil-mounting sockets is as follows: The antenna coil primary is connected to the two small prongs of the tube base, so as to connect to the *G* and *P* terminals of the socket. The secondary coil is connected to the two thick prongs of the tube base, with the top end of the secondary used as the grid terminal, and connected to the negative filament terminal of the tube socket used as the coil mounting. The r.f. transformer primary is connected to the two small prongs of its base, and the secondary to the two thick prongs the same as for the antenna coil. In the case of the oscillator, the plate coil is connected to the two thin prongs, and the grid coil to the two thick prongs. The coupling coil is brought out to two switch points fastened on the sides of the 1½-in. tube, at the bottom, and so arranged as to touch two springs which are mounted on the coil socket, as can

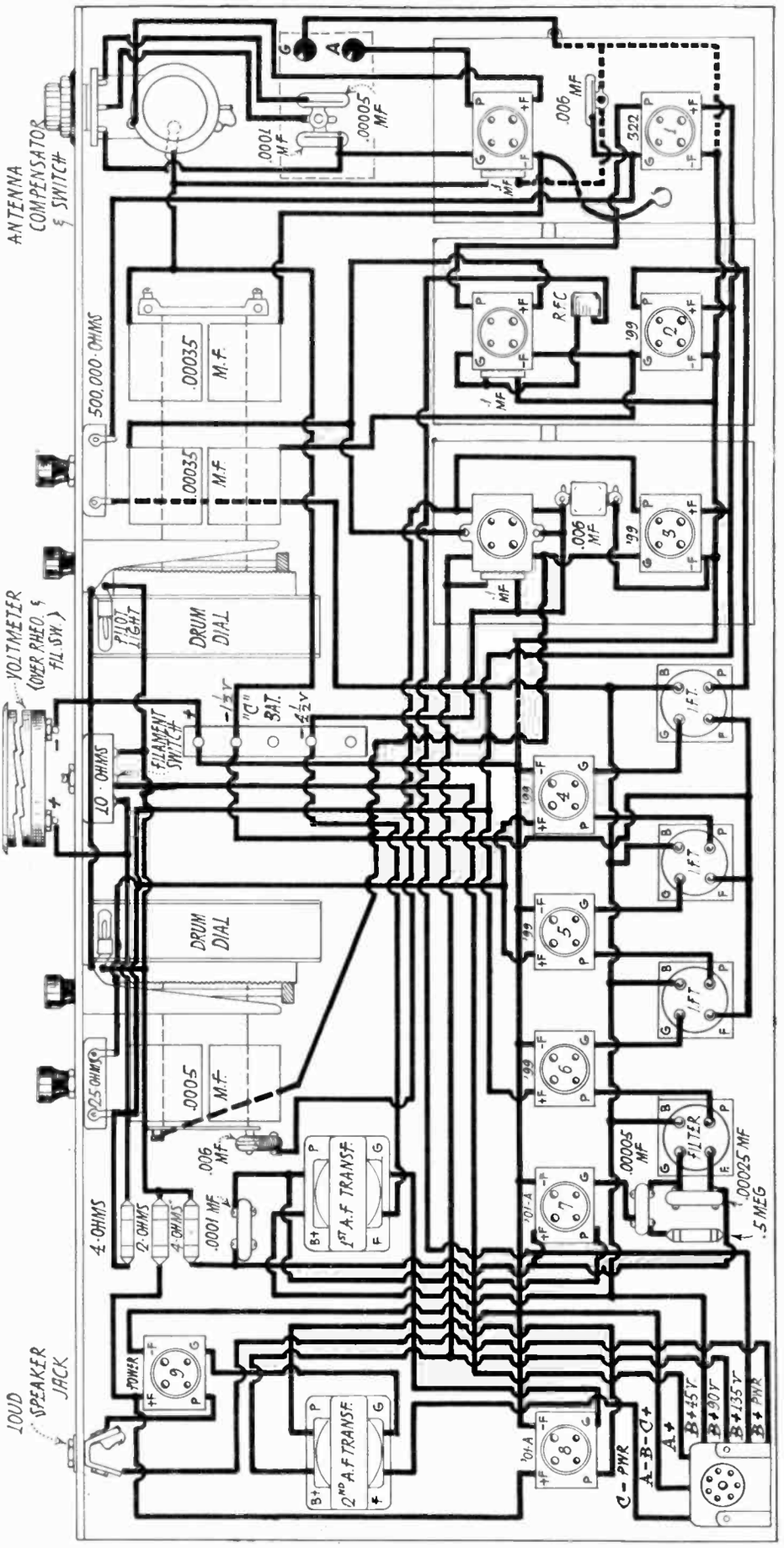
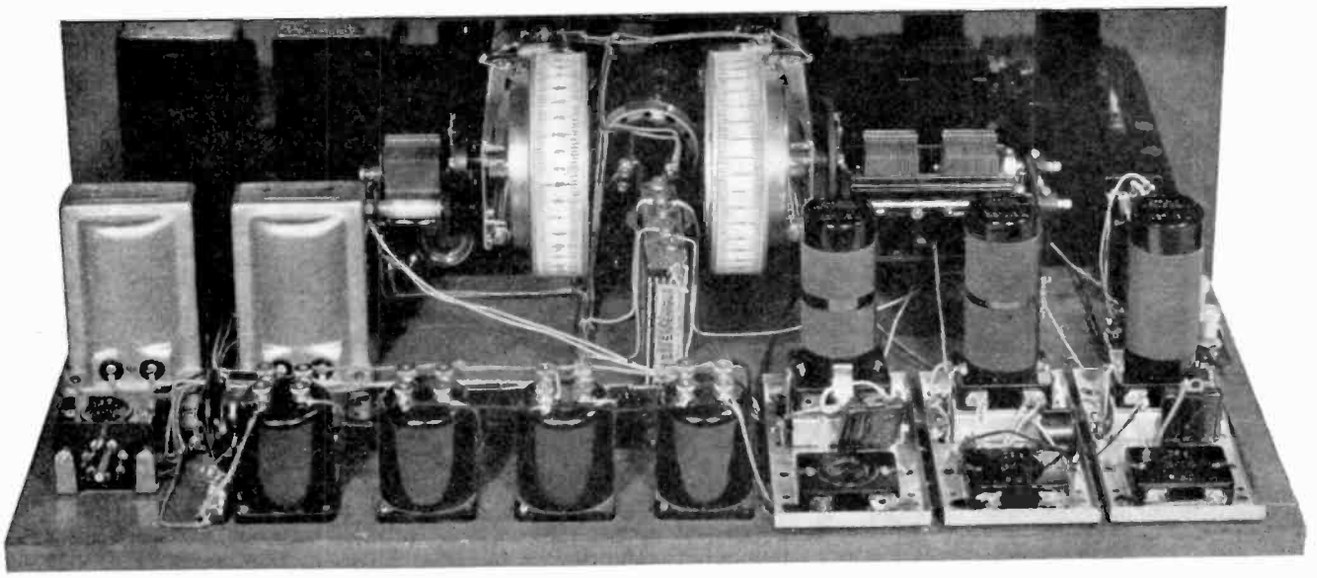


Fig. 2. Actual Assembly and Wiring of Receiver

be seen from the pictorial diagram, Fig. 2. The detailed connections of these coils can be followed from this diagram, which shows the actual connections to all the parts. Ready-made coils such as were used in the 115 k.c.



The Revamped 45 K.C. Superheterodyne

super can be used equally as well, the inductance units being the same design except that only one r.f. transformer is used instead of two.

The three shield cans are mounted on the rear of the baseboard, at the right, and a slot is cut in the baseboard, 1½ in. from the right-hand rear corner, to permit passing the connecting wires between the shield bases, underneath them. This slot is 5 in. wide, and 9 in. long, with a ⅝-in. margin along the back edge of the baseboard. As can be seen from the picture, these bases are placed about ¼ in. apart, and the three tube sockets are mounted at the rear end of each base, while the sockets for the inductance coils are placed on small brass brackets 1⅛ in. high, which raise the sockets above the shield base sufficiently to place a .1 mfd. bypass condenser underneath the socket. The factory-made shields have these brackets included along with the necessary mounting screws.

The three i.f. transformers and the filter are mounted in a row along the back edge of the baseboard, with about 3¼-in. spacing between transformers. The three i.f., second detector and first audio tube sockets are placed in a row in front of the i.f. transformers, and at the left-hand rear end of the baseboard, a cable plug terminal is mounted. The two audio transformers are placed as shown in the picture, and between these transformers and the front panel the power tube socket, and the fixed filament resistances are mounted.

The front panel, which is 7 x 26 x 3/16 in., supports two illuminated drum dials, one for the .0005 mfd. oscillator condenser, and the other for the two-gang condenser controlling the r.f. amplifier circuit. Between these two dials the panel voltmeter is placed, and below the latter, a 10-ohm rheostat-switch is mounted. Looking at the picture of the front panel, the antenna-compensator and series-condenser switch is seen at the left-hand end, and at the right is the speaker jack. To dress up the panel and give it that "factory-built" appearance, a brass plate, as shown in the picture, was used, and as this plate is already drilled and embossed for the two drum dials, voltmeter, and the rheostats, it is only necessary to lay the plate on the panel and mark out the holes to be drilled through it for the various pieces of panel apparatus.

PARTS REQUIRED

2 Drum Dials.
1 Escutcheon Plate for Panel.
1 Two Gang condenser with insulated rotors and stators—.00035 mfd.
1 .0005 mfd. variable condenser.
3 Shield cans 3 x 5½ x 5¾ in.
12 Tube sockets—(at least 3 UX base for coils).
3 No. 600 i.f. transformers from old 45 k.c. super.
1 No. 610 filter transformer from old 45 k.c. super.
2 Audio transformers.
1 Voltmeter—0-5 volts.
1 500,000 ohm variable resistance.
1 10 ohm rheostat-switch.
1 25 ohm variable resistance.
2 4 ohm fixed resistances.
1 2 ohm fixed resistance.
3 .1 mfd. by-pass condensers.
3 .006 mfd. fixed mica condensers.
1 .001 mfd. fixed mica condenser.
1 .00025 mfd. fixed mica condenser for filter transformer.
2 .00005 mfd. fixed mica condensers.
1 .0001 mfd. fixed mica condenser.
1 Antenna Compensator.
2 R.F. coils (see text).
1 Oscillator coil (see text).
1 R.F. choke (at least 1 millihenry).
1 Battery cable with terminal connector.
1 C battery—7½ volts with taps each 1½ volts.
1 Single circuit jack.
1 Panel 7 x 26 x 3/16 in.
1 Baseboard 11 x 25 x ¾ in.

The main volume control is the 25-ohm rheostat mounted at the right of the rheostat-switch, and at the left is the 500,000-ohm variable resistance used to control the gain of the shield grid tube. Between the drum dials, on the baseboard, is a 7½-volt *C* battery used to furnish 1½ volts negative for the i.f. amplifier tubes, and the shield grid tube, and 4½ volts negative for the oscillator, first detector and first audio tubes. If extra wires are run in the battery cable, this *C* battery can be located externally, or a *C* battery eliminator associated with the *B* power plant can be used. The 7½-volt size battery is used, as it is the only one on the market which has a 1½-volt tap; the remaining 3 volts above the 4½ volts required are not used.

From the above data, and the pictures, it can be seen that the material which can be salvaged from the old set consists of the i.f. transformers and filter, the oscillator condenser, tube sockets, audio transformers, volt meter, and some of the miscellaneous resistances and bypass condensers. If the audio transformers are several years old, they are probably obsolete, and should be replaced with new ones which have a better frequency characteristic. This is a matter for the set-owner to decide, as some transformers which are two or three years old are still excellent as compared with some of the 1928 models. The shield grid tube will require an X base socket, and if the old style sockets used in the 1924 model sets have loose springs, they should be replaced with X base sockets. Note that the grid condenser and leak in the second detector circuit have different values than customarily used, to improve the output of the second detector at the higher frequencies, as described in more detail in the "Technical Briefs" column in this issue.

All wiring in this set was done with solid insulated wire of the "push-bak" variety, as this wire is quite flexible, is easily cabled, and the insulation at the ends can be pushed back with the fingers to expose a portion of the tinned wire for the soldered connection. The filament leads, positive *B* and negative *C* battery wires were cabled together, but all grid and plate leads were run by the shortest route and were kept out of the cable form. The two oscillator con-

denser leads were run directly from the oscillator shield base to the condenser terminals, these leads being at an angle with nearby wires so as to avoid paralleling the i.f. amplifier wiring as much as possible. The coupling coil between the oscillator and first detector circuits is placed in the filament end of the first detector grid return, a .006 mfd. bypass condenser being connected between the *C* battery end of this coil, and the filament of the first detector to prevent coupling through the *C* battery. The old oscillator coil used in the original model can be used if the coupling coil shaft is cut off, but it makes a very tight fit into the shield can, and a larger can will be required. The oscillator coil used in the rebuilt model was designed for a 115 k.c. circuit when used with a .00035 mfd. tuning condenser, so that by using the old .0005 mfd. condenser, the coil will oscillate over a band of frequencies suitable for a 45 k.c. circuit.

There should be little difficulty in lining up this set after it is rebuilt, as the i.f. amplifier and audio circuit is practically the same as the original circuit, the only difference being in the front-end amplifier. The antenna compensator is used as the trimmer adjustment for the end section of the two gang condenser, so that after the two dials have been roughly logged, a station around 400 meters should be located on the oscillator dial, and the r.f. dial set at maximum volume for that station. Then, if no adjustment of the antenna compensator knob produces a sharply defined maximum in the sound, the variable mica trimmer associated with the variable condenser shunted across the r.f. transformer secondary should be adjusted until moving the antenna compensator knob produces a maximum at about the center of its swing.

Local and distant stations should be free from heterodyne whistles caused by harmonics of the oscillator, and while there will be two settings of the oscillator dial for any given station, these settings should not interfere with reception of other stations. Once adjusted, the amplification control of the shield grid tube, which is the 500,000-ohm variable resistor, should not require further attention, and the volume can be controlled by the 25-ohm rheostat in the i.f. amplifier filament circuit. The power tube used depends on the amount of volume required. If the '71-A tube with more than 135 volts plate is used, an output transformer will be required; as most electrodynamic speakers have an output transformer already built into the speaker, it may not be necessary to purchase an output transformer for the set.

Finding Buried Treasure by Radio

By SAMUEL G. McMEEN

WE SHRINK at the somewhat sensational title to this writing, but it expresses what we have to say. So why apologize? By the term "treasure" is meant anything that is metallic. Pearls and diamonds barred. One of the purposes of the device here described is the location of natural deposits of metals.

The great Faraday used to say, when confronted by a new phenomenon brought to him for observation, "Tell me what to observe." This for fear that his mind might be drawn off into some channel other than the right one for the purpose in hand, even though the diversion might be of vastly greater import than the original. Accordingly, please

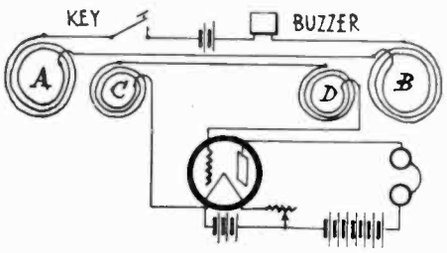


Fig. 1 Balance and Amplifier

observe that in Fig. 1 there are four coils, lettered *A*, *B*, *C*, and *D*, and that coils *A* and *B* are serially connected in company with a battery and a buzzer. As long as this connection is maintained and the battery holds out, the buzzer will operate. These two coils, *A* and *B*, are connected to each other in such a manner that their windings oppose each other in direction.

The coils *C* and *D*, similar in form to *A* and *B*, are connected so that when the buzzer is operated there is no sound —or little sound—in the telephones operated by the amplifier. For the rest of the rig is simply that, with the output of the coils *C* and *D* connected to the grid and filament, and the head set and *B* battery connected to the plate and *A* battery, a very faint train of impulses in the balance is made plainly audible.

The coil *C* lies horizontally above the horizontal coil *A*, and similarly *D* over

Fig. 2 Actual Relation of Coils

B, all as shown in Fig. 2. This relation should be made adjustable, so that by varying it, the required condition of no sound in the telephones may be attained when there is no metal near either coil *A* or coil *B*. By varying the separation of one pair of coils while the other is stationary this condition of least sound may be attained.

The ability of the device is of this order: when a conductor of any kind lies in the neighborhood of one pair of coils and there is no exactly similar conductor in the neighborhood of the other pair of coils, a sound will be heard in the head set. This is the fact to the degree that if a good coin be placed near one pair of coils and a counterfeit imitation of it near the other pair (and exactly the same distance from it) a sound will be heard because of the difference in the conductivities of the noble and base metals.

For practical use as a metal finder, the pairs of coils should be mounted on wood supports about 15 ft. long, so as to get the two coils well apart and so to accentuate the difference in field caused by the nearness of the sought metal. This wood structure should also carry the batteries and the amplifier. The whole outfit is then carried over the region in which the metal is hoped for, listening while this search progresses. It will be found that the searched-for metal lies directly below the point of loudest response in the telephones.

Care should be exercised not to expose the ears to the maximum response from the balance, as it is sometimes very strong. In regular use, however, the sound swells from nothing to louder gradually, so that there is ample notice of the approach of the dangerous condition.

Each of the coils *A*, *B*, *C*, and *D* should carry about 300 turns of No. 32 wire.

It is important to omit from the wood structure all metals, such as bolts, nuts, nails and screws. Lashings of thongs or cords should be used instead of such metallic fastenings.

The voltage drop caused by a resistor connected in series in a circuit is equal to the product of the resistance in ohms and the current in amperes. Conversely the required resistance value in ohms is equal to the quotient of the voltage drop by the current. Thus to find the size of the resistor necessary to reduce a 6-volt supply to the 5 volts necessary for the operation of six '01A tubes, each requiring .025 amperes, first find the voltage drop, 6—5=1, then find the current in amperes, $6 \times 0.25 = 1.5$, then divide 1 by 1.5=.66 ohms. Likewise to find the resistor size to reduce a 6-volt supply to the 3 volts necessary for the operation of seven '99 tubes each taking .06 amperes: 6—3=3 volts drop, $7 \times .06 = .42$ amperes, 3÷.06=50 ohms.

Radio Picture Transmission and Reception

Photoelectric Equipment and Methods for Visual Communication

By JOHN P. ARNOLD, *Departmental Editor*

THE transmission and reception of moving pictures by wire and radio was demonstrated on August 8 in the laboratories of the Westinghouse Electric and Manufacturing Company. The pictures were sent over two miles of wire from the laboratories in East Pittsburgh to Station KDKA, and the radio wave was picked up on a receiver in another part of the laboratory building.

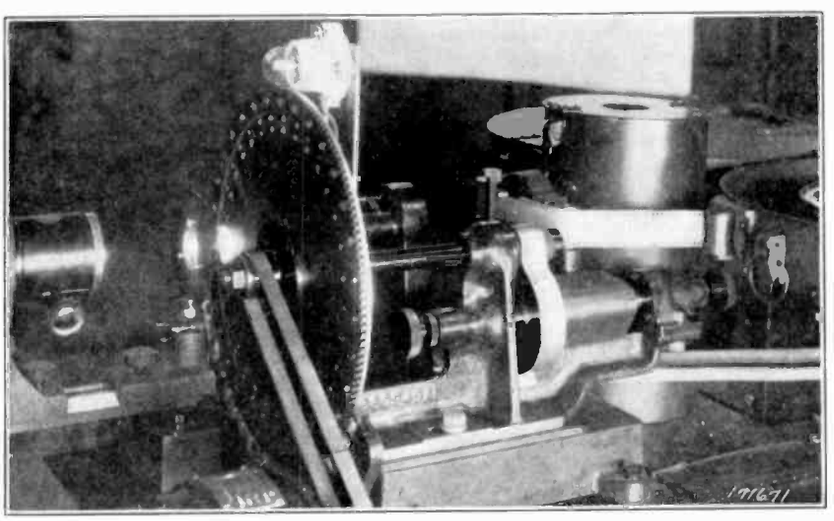
The system devised by the Westinghouse engineers may be considered as a combination of both phototelegraphy and television, since it solves some of the most serious problems of television by methods employed in "still" picture communication. It has been a by-word of experimenters in this field that the reception of moving pictures in the home will be developed before the transmission of images of natural moving scenes is perfected. The present demonstration indicates that this is likely to be the case, as the results which were obtained are said to be much more satisfactory, as far as the quality of the received pictures is concerned, than the more difficult problem of actual television.

Although it is difficult to present a technical description from the information at hand, some of the most interesting features of the system may be gathered from the pictures and data presented here. At the transmitter, the subject, which is a standard moving picture film, is scanned by a beam of light passing through the usual Nipkow disc and the film, and subsequently falling on the cathode of a caesium photoelectric cell. The intensity of the light varies in accordance with the density of each small area of the film to which the beam is directed by the rotation of the scanning disc. These varying intensities produce, in the output of the photoelectric cell, a current which is proportional to the light and shade of the film.

Radio Movie Projector as Operated by Frank Conrad

The advantage of such a transmitting system lies in the fact that extremely powerful lamps may be used in scanning a film which would be intolerable if the subject happened to be a human being. Again, the fact that the photoelectric cells are not required to collect the reflected light from the scene is another point gained. The resultant efficiency of such an optical system removes the necessity of employing a tremendous amplification of the photoelectric current.

In this system the efficiency of the scanning disc is increased by the use of square instead of circular holes arranged in the conventional spiral around the disc. Each small picture of the film is scanned by one revolution of the disc and the film is moved before the disc at the rate of sixteen pictures per second.



Close-up of Westinghouse Radio Movie Transmitter

The caesium photoelectric cell is not used as often for practical engineering work as is the potassium hydride, gas-filled cell. Caesium, an alkali metal, is much more difficult to prepare than potassium, due mostly to its lower melting point. A cell of pure caesium is more sensitive, especially to the longer wavelengths of light, than potassium; but potassium can be readily sensitized by converting it to a hydride and filling the bulb with an inert gas such as argon. Some investigators report that cells of caesium hydride are not particularly successful, and it is likely that a pure metal cell was used for this demonstration.

The picture signals embrace a frequency range of from 500 to 60,000 cycles, since 16 pictures per second of a definition comparable with the 60-line screen of photo-engraving processes are transmitted. The quality of such pictures is much better than the usual television results where the pictures are composed of 20 or 30 lines to the inch instead of sixty. It is also possible that it was not necessary to transmit the highest frequencies involved without causing distortion, as was found in the case of the Bell demonstrations. It would seem, however, that frequencies lower than 500 cycles might be involved.

The signals are picked up on a radio receiver and control the intensity of a mercury arc lamp which varies in brightness in accordance with the light or shade of the moving picture at the transmitter. Another scanning disc distributes

these light values to their proper place in order to reproduce the picture which is thrown on a ground-glass screen.

Both scanning discs are turned over at the same speed, so that each hole in the receiving disc is in exactly the same relative position as the corresponding hole in the transmitting disc. For this purpose a 5000-cycle signal is produced by a tuning fork and transmitted over a separate channel from that used for the picture signals. This signal is received on a special receiver and controls the synchronous motors which drive the scanning discs at both stations.

A neon lamp is also used as a part of the synchronizing system. It is located above the scanning disc in the pictures shown here. Whether it is used as a part of the control system or as merely an indicator is not apparent from the information at hand, although the thought occurs that the Westinghouse engineers may have taken advantage of the peculiar property of the neon lamp to oscillate at a frequency determined by capacity of a condenser in parallel with the electrodes of the lamp and a resistance or inductance placed in series with the source of supply. This property of the neon lamp will be described in a forthcoming issue of the magazine in the connection with a neon lamp stroboscope.

The development of this system was undertaken by Dr. Frank Conrad, of the Westinghouse laboratories, and within two months' time had advanced far enough to give a practical demonstation of the work. Although the moving pictures were only transmitted over a total distance of four miles, the range in the case of radio transmission is of course limited only by the distance at which the signals may be received without serious fading, interference or atmospheric disturbance.

The officials of the company have announced that the regular transmission of motion pictures from KDKA would begin within a few weeks time and that commercial receivers are to be sold through the Radio Corporation of America.

"B" in Phototelegraphy

The late Edgar Saltus remarked that greater writers almost invariably have surnames of two syllables with the accent on the first. In an idle moment we note that the names connected with picture communication begin with a "B"—witness Bain, Bakewell, Bidwell, Baird, Berjonneau, Belin and Baker; the Bell and Bartlane systems. Should this discovery enable any one to prove anything we shall be happy to be so informed.

PREMATURE PUBLICITY

THE writer of these pages has been guilty of many crimes (none of them trivial, thank goodness), but never has he failed to give the devil his due. *In re* this television furor, which has fluttered our tympanic membrane these many moons, our attitude has been as light and flippant as a chorus girl's opinion of third marriages. While we confess to a total inability to get excited over the immediate prospect of a practical form of television descending among us, we have not intended to create the impression that we mean to slight the endeavors of serious investigators of this problem. Rather than do that, we would chuck this word-mill out the window and go to work.

The thought has occurred that our readers require of us (plurals are used throughout this writing to discourage attempts of assault and battery) some explanation of our gay treatment of serious topics. In order that the misunderstanding may not be mutual, we hasten to exclaim that we admire greatly all earnest workers of scientific miracles and that we do not give three whoops down the neck of a twenty-foot horn for publicity seekers. To elucidate—probably at length—is our dire purpose.

Back in the good old days lived a clever fellow named Archimedes, a very absent-minded man, as another scribe rather casually reports. One day he rose from the bath and, in dishabille (it couldn't have been completer), he dashed through the streets of Syracuse shouting "Eureka!" What he had discovered was specific gravity—whether it was found in the water or in good King Hiero's golden crown the deponent knoweth not. Now, after clothing himself in a tunic or it may have been a blanket, did the modest Archimedes sit himself down in the portico (or is it the frieze?) of the temple and tell every passerby that they could now have specific gravity right in their homes? No, sir, he just explained that what he had discovered was after all only experimental specific gravity and the people would have to wait a little while before it would be suitable for every-day use.

We have not, unfortunately, any record of how the newspapers of that day proceeded to write up this discovery, but dimes to doughnuts the headlines read: *Archimedes Solves Specific Gravity; System Soon Available in Every Home.* Yet we all know from our classical studies that it took many years of concentrated effort for the perfection of specific gravity and all the people of Syracuse had to be satisfied with the ordinary kind of gravity, although they were disappointed many times by premature announcements that all the problems had been solved.

We return with dignified haste to the present and to the subject of television. In this day and age we find men working among their retorts and alembics and, no matter whether their immediate object is gain or fame, they are deserving of respectful attention and the utmost sympathy if the outcome of their efforts makes life brighter or more interesting for the rest of us. As a criterion of their labors we ask nothing more of them than that, when they make a new and important discovery, they tell us truthfully, without obscuring the issue, just what they have really succeeded in doing and, where possible, demonstrate, in order that we may judge for ourselves what has been accomplished. Whom we do distrust is the creature who pokes his head out of a laboratory, hollers his "Eureka" and then tells a wild yarn to the newspaper boys.

It may not be understood by our wide audience (as wide, we hope, as this effusion is long) the advantages of doing what is commonly—and how commonly!—known as "shooting off the mouth." Do you know why folks fly the Atlantic, fly the Pacific, fly a kite? No? Well, for the sake of publicity. Furthermore, publicity is unpaid-for advertising; advertising is said to pay, and you can tell this cross-grained world it does. In more and other words, you get something for nothing, and no one ever quibbles over the means of obtaining that. Without drawing the parallel finer, is it necessary to indicate why, in the case of television, it is profitable to howl about something you haven't got or to exaggerate the value of what you have?

For this reason we have been somewhat light-hearted in the matter of television; because, in lieu of proof, we have been fed the sauce of apples. There has been but one *bona fide* demonstration in recent years of its possibilities. Moreover, the actual results were published for the world to read. Nothing more could be asked. In addition, this demonstration made clear that a practical system of television has not yet been developed for reception in the home. Who shall say—certainly not this prognosticator—when this time will arrive. Furthermore we do not expect that television will come from the hands of the self-advertisers.

DARK SAYINGS

One does not begin to appreciate the vast potentialities of language in matters of lucidity and excellence until it becomes necessary to study the literature of patents. Among treasured gleanings from this storehouse comes the magnificent description of "an apparatus comprising an electron emitting cathode, a grid and plate in *thermionic cooperative array.*" Others less gifted than a patent attorney would hardly recognize the UX 201A under this bristling disguise.

TELEVISION IN THE OPEN

ENGINEERS of Bell Telephone Laboratories recently disclosed the further progress which they have made by demonstrating a new transmitting device which is capable of putting outdoor scenes upon a television circuit. On the roof of the laboratories actors boxed, danced, swung baseball bats and tennis rackets which appeared in brightly illuminated pictures in another part of the building.

The present apparatus differs radically from that of the first demonstration when the scene to be transmitted was illuminated by a powerful artificial light and only the actor's head and shoulders appeared in transmission. With the improved apparatus the scene is illuminated by ordinary sunlight and covers the area occupied by two men engaged in a boxing match.

In the first form of apparatus demonstrated in April, 1927, the scene was illuminated by a rapidly oscillating beam from a powerful arc light and that limited the scene to be transmitted to a very small area. The new development frees television from one of its limitations.

The scene or event to be transmitted is reduced to the form of an image by a large lens, this image being scanned by a rapidly rotating disc similar to that previously employed but much larger. The lens serves somewhat the same purpose in the television apparatus as the large lens of an astronomical telescope, and like the latter, it should be larger to gather as much light as possible.

The experiments show that moving persons and objects can be successfully scanned although at a considerable distance from the lens and therefore in such a position that the focus of the lens does not require changing from moment to moment. Light passing through the lens and scanning disc is made to actuate a photoelectric cell and generate an electric current which, after amplification, may be transmitted either by wire or radio.

This development in television is due to Drs. Frank Gray and Herbert E. Ives. They illustrate the progress of the telephone engineers in the problems of television, but the engineers themselves refused to prophesy as to future developments or applications. They pointed out that the improvement was in the television transmitter and that its use required no fundamental change in the two types of receiving equipment for use by either single individuals or larger audiences, which were developed and demonstrated a year ago.

PICTURE RECEIVING METHODS

III. Miscellaneous Devices

To conclude this review of picture receiving methods we have yet to describe those instruments whose most prominent characteristic is a high frequency of response. Hence these are usually more suitable for television than for phototelegraphy, but they have been proposed or employed at one time or another for still picture transmission and should therefore be considered at least for the sake of completeness. The neon lamp, the cathode ray oscillograph and the several types of Kerr cells are those which we will describe. In phototelegraphic systems these instruments are used with photographic methods of recording. Considering the expense of the oscillograph tube and the inconvenience of working with the neon lamp, the Kerr cells alone are the most adaptable for this purpose; but for television, as we approach the problem today, nothing appears to be more satisfactory than the neon lamp or the cathode ray oscillograph.

The Kerr cell, as employed by Rignoux and Fournier in their television experiments, consists of two Nichol prisms between which is placed a tube containing carbon bisulphide, a liquid which changes its refractive index (that is the ratio of the speed of light in air to the speed in any other medium) under the influence of electrostatic or magnetic fields. In Fig. 1, L is a source of monochromatic light, N and N', Nichol prisms, and CB a tube containing carbon bisulphide, around which is wound a coil of wire. If the Nichol prisms are set at the polarizing angle, no light falls on the receiving cylinder on which has been placed a photographic film. When a current passes through the coil of wire corresponding to the tone values of the original picture, the amount of light falling on the film will vary with the current, since this changes the refractive index of the carbon bisulphide and hence the angle of polarization.

The Karolus cell, which was also developed for a television system, is an instrument of this type, differing only

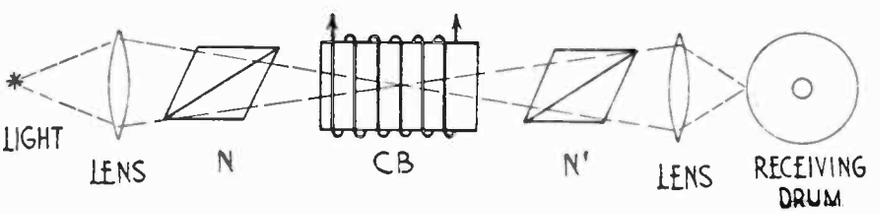


Fig. 1. Kerr Cell

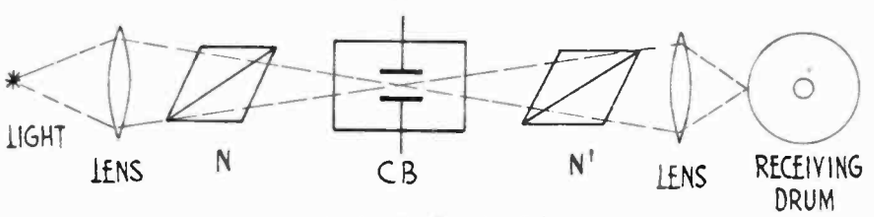
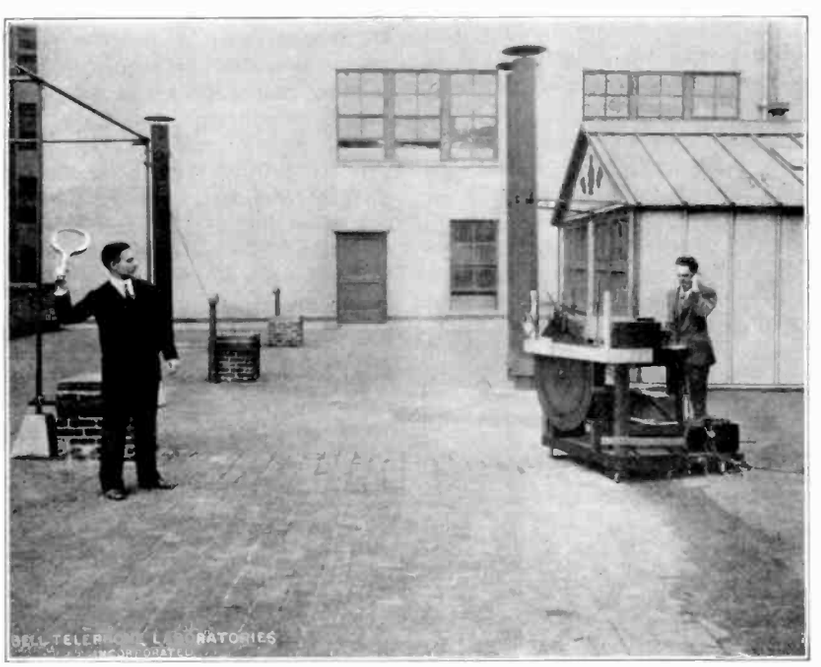


Fig. 2. The Karolus Cell



Set-up of Equipment for Outdoor Television

in that instead of wrapping a coil of wire around the tube, two plates forming a small condenser are immersed in a liquid which is then subjected to an electrostatic instead of a magnetic field, (Fig. 2). Further information regarding such electro-optical shutters may be found in a paper by J. W. Beams in the *Journal* of the Optical Society of America, (Vol. 13, p. 597; Nov., 1926).

The neon lamp is too well known to require an extensive description since few have failed to observe the characteristic pink glow that winks at us from many advertising signs. For the purpose of television, for which it is generally used, the brightness of the lamp varies with the received image currents. The observer looks directly at the plate of the neon tube through a scanning disc which rearranges the lights and shades of the original scene in the correct order. It is hardly worth while to employ the neon lamp in still picture transmission due to the low intensity of the light and the color, which is not very satisfactory for photographic recording.

Alexanderson discusses the merits of the Karolus cell and the neon lamp for television as follows: "The first choice to be made was to select a source of light. This choice was soon narrowed down to two alternatives—the light-control developed by Professor Karolus of Leipzig and the neon lamp developed by D. McFarlan Moore of the Edison Lamp Works of the General Electric Company. Tests of these two sources of light for television soon convinced us that each has its own distinct field of usefulness. When a large volume of light is needed for projection on a screen, the Karolus system is preferable. . . . While the neon lamp does not compare with the Karolus light in brilliancy, it is more sensitive and easier to operate."

The Braun tube or cathode ray oscillograph is an instrument which may be used either for phototelegraphy or television. In its most suitable form (Fig. 3) the tube contains a filament in a highly exhausted bulb supplying a stream of electrons which are directed upon a fluorescent screen (crystals of zinc sulphide, zinc silicate, calcium tungstate, etc.) which is rendered luminous by the impact of the electrons. By the use of coils or plates, as in the case of the Kerr cells, the movement of the spot of light on the fluorescent screen can be controlled by the application of magnetic or electric fields controlled by the picture currents. The size and intensity of the luminous spot can also be varied by adjusting the filament and anode voltage. Possessing little or no inertia the cathode ray oscillograph is quite likely to have a prominent place in the development of television, since it will respond to the high frequencies necessary for this form of visual communication.

This description of the various methods of receiving has preceded any attempt to describe a complete phototelegraphic receiver suitable for working on radio communication channels; chiefly for the reason, as has been pointed out elsewhere in this department, that the design of such a receiver is largely governed by the transmitting system and, until it is known just what type of equipment the broadcasters will install, construction articles are practically worthless. As soon as picture broadcasting becomes well established, these essential facts will be published; but in the meantime it is advantageous to become familiar with some of the various methods of receiving for the experimenter can often adapt several of these to the particular apparatus which he has installed.

Newspaper reports have it that another system of picture transmission has been demonstrated in London. From meager descriptions reaching this side of the Atlantic, this system, designed by Captain Otto Fulton and called the "Fultograph," is somewhat reminiscent of the earlier systems of phototelegraphy. It appears that a photo-engraving is made on copper (presumably using insulating material such as fish glue) and this is placed on a revolving metallic drum. At the receiving station, the picture is printed by passing a current through chemically treated paper. Synchronism is carried out "electromagnetically." The system can be used either for wire communication or for radio, and the receiver is to be placed on the market for amateur use.

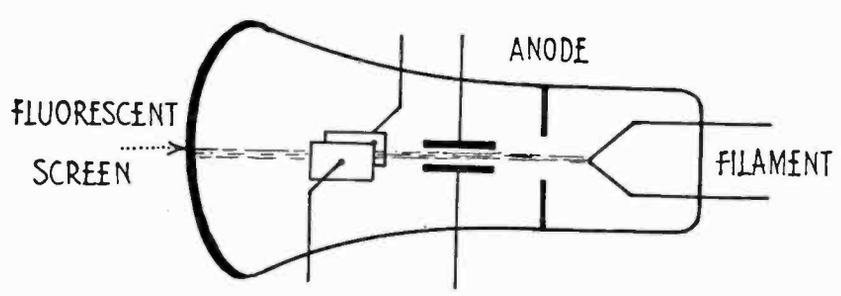
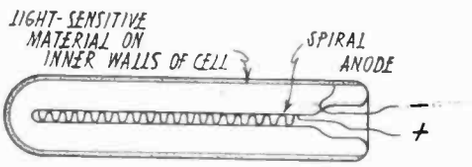


Fig. 3. Braun Tube or Cathode Ray Oscillograph

III. LIGHT SENSITIVE CELLS

The alkali metal photoelectric cell shown here is one of the few cells which have been especially designed for television. It was developed by Dr. Herbert E. Ives and three of them were used in parallel in the transmitting apparatus demonstrated by the Bell Laboratories. These cells differ from the conventional type in that they have an exceptionally large area (40 square inches) of light-sensitive material and have an aperture of 120 square inches to collect the reflected light from the subject to



The Ives Photoelectric Cell

be transmitted. The cells, which are 14½ inches long and 3½ inches in diameter, are probably the largest that have ever been made. The cathode material, deposited on the inner walls of the glass bulb, is potassium hydride and is contained in an atmosphere of argon to increase the current output by ionization of the gas. The anode consists of a spiral of wire extending down the center of the bulb. The necessity for such large cells is due to the fact that they must be operated from the diffused light reflected from the scene or object to be transmitted and at the same time "generate" a current large enough to override the noise level in vacuum tube amplifiers.

The Federal Radio Commission has approved of several applications to operate or to construct stations for the experimental work and the actual transmission of television signals. These stations have been assigned 100 kilocycle bands between about 47 and 125 meters. The authorizations were granted the following:

8XI. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. 63.83 to 62.5 meters and 19.86 to 19.73 meters. 20,000 watts. This wavelength will be shared with 2XBW of the Radio Corporation of America.

6XC. Robert B. Parris, Los Angeles, Calif. 4500 to 4600 kilocycles, (66.7—65.2 meters). 15 kilowatts.

2XBU. Harold E. Smith, Beacon, N. Y., 4800 to 4900 kilocycles, (62.5—61.22 meters). 100 watts.

1XAY. J. Smith Dodge, Lexington, Mass. 4800 to 4900 kilocycles, (62.5—61.22 meters). 500 watts.

3XK. J. Francis Jenkins, Washington, D. C. 4900 to 5000 kilocycles, (61.22—60 meters). Also 6420 kilocycles (46.72 meters). 5 kilowatts.

4XA. Station WREC, Inc., White Haven, Tenn. 2400 to 2500 kilocycles (125 to 120 meters). 5 kilowatts.

An A. C. Screen-Grid Five Receiver

Some Interesting Suggestions for the Experimenter

By FRANK C. JONES

THE advent of the a.c. screen-grid tubes makes possible the design of receivers having exceptionally high amplification for a given number of tubes. They are similar in characteristics to the d.c. models and are of several types. The main difference seems to be in the filaments, one type using a heavy round filament operating on 1 volt like the UX 226 amplifier tubes. Another type has a 15-volt heater with cathode grounded to one side, while the tubes used in this receiver have filament characteristics similar to a UY 227. This last type of tube may have the filaments wired in parallel to the UY 227 detector tube, providing the filament power supply transformer will deliver sufficient current without overheating.

An experimental receiver, shown in the photographs, was designated with several points in mind. First, it was desirable to have a great deal of amplification without using more than two screen-grid tubes.

Second, lack of selectivity, which is troublesome with ordinary circuits using screen-grid tubes, was a real problem to overcome. The circuit shown in Fig. 1 works out very well, as will be shown later.

Third, was the problem of selectivity without too much audio distortion due to side band cutting in the radio frequency amplifier and detector circuits. This can be solved by using a large number of tuned circuits, in which case the overall resonance curve is more nearly square in shape. Four tuned circuits are used here, since with less the loss of high audio frequencies due to side band cutting was noticeable. This occurs when more regeneration is used in order to obtain the same apparent selectivity—the resonance curve is more peaked.

The fourth problem was the use of an audio amplifier system which would give good quality reproduction and still not make the a.c. hum bothersome. If an audio amplifier is used in which the transformers will efficiently repeat 60 cycles, the a.c. hum in a good dynamic speaker is objectionable. Most of the 60 cycle a.c. hum, audible as 60 cycle and higher harmonics in the speaker, originates in the detector circuit, with perhaps a little in the r.f. amplifier. So an audio amplifier should be designed to cut off above 60 cycles if the residual hum in the speaker is to be minimized.

Most commercial a.c. tube receivers use audio amplifiers which are "down in the mud" on low frequencies in order to minimize the a.c. hum. The same thing has been done in this receiver except that the cut-off is sharper than in most a.c. receivers. This allows better low frequency amplification down to, say 100 cycles per second. The cut-off was made sharper and more complete by resonating the primary of the first transformer with a 0.1 mfd. condenser, C_{16}, Fig. 1. This condenser resonates at about 100 cycles per second with the primary of the first audio transformer,

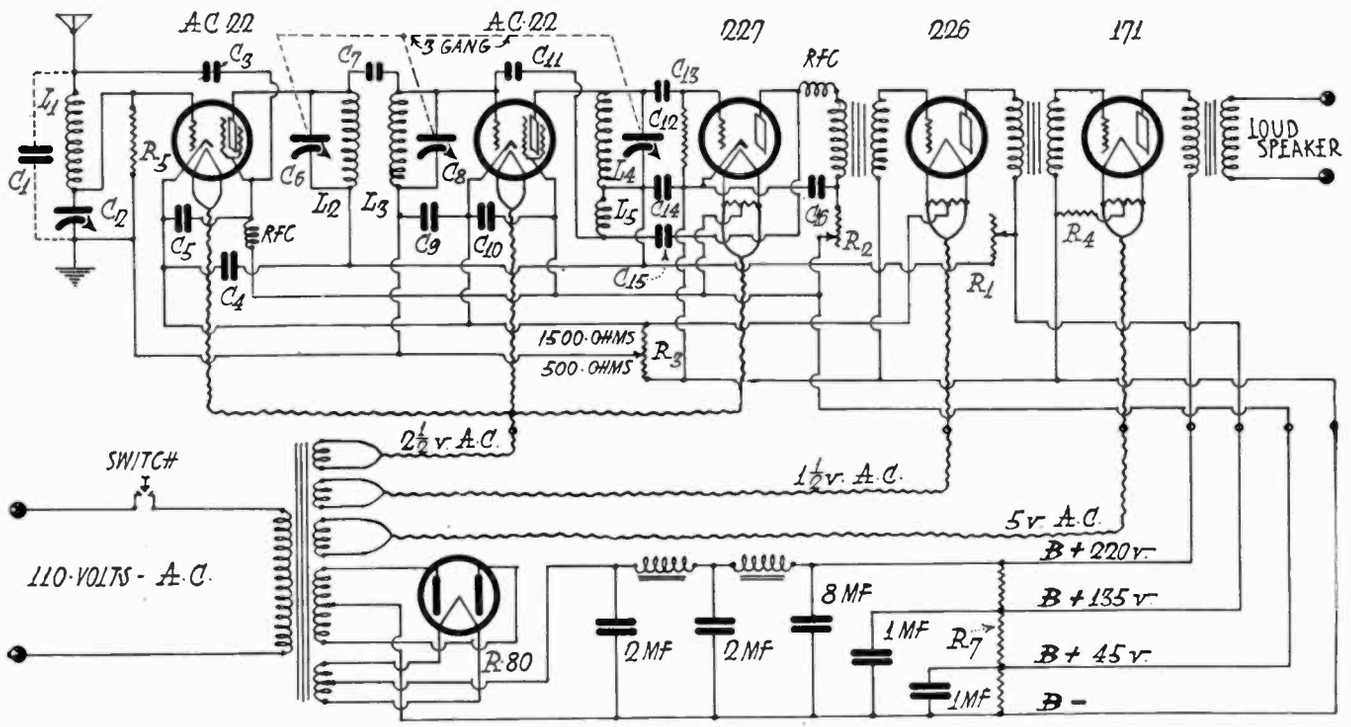
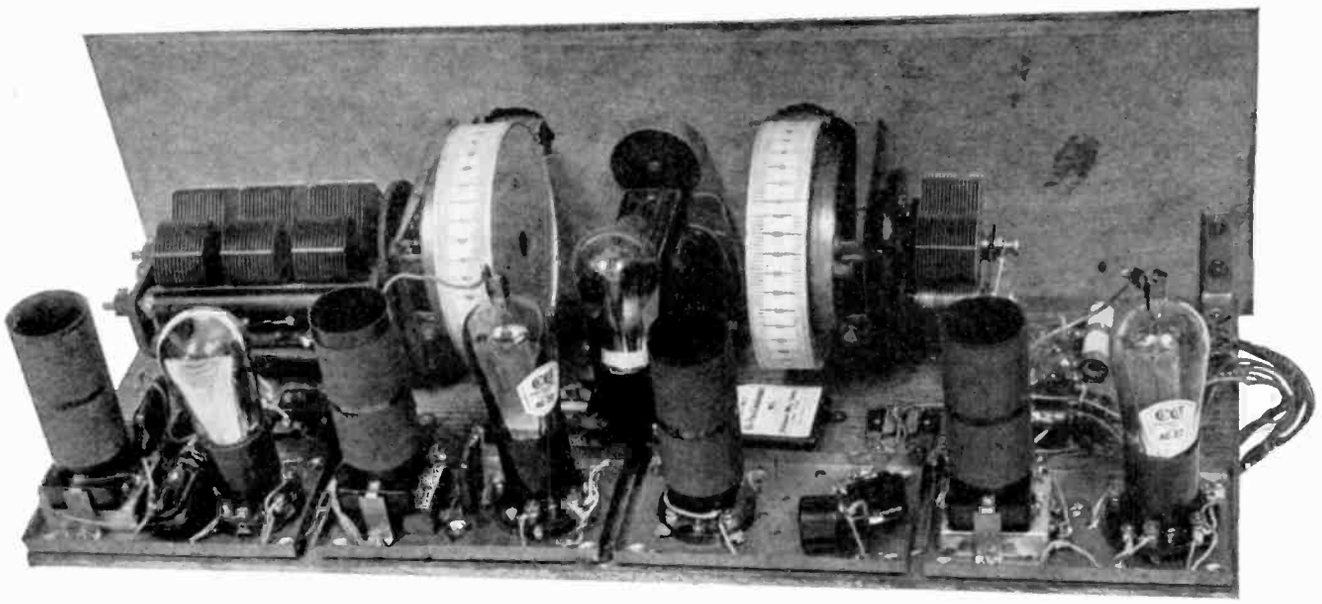


Fig. 1. Circuit Diagram of A.C. Screen-Grid Receiver and Power Plant

C_1=.001 mfd.
C_2=.0005 mfd. max. variable.
C_3=.0001 mfd. max. semi-variable (feedback)
C_4=1. mfd.
C_5=.00025 mfd.
C_6, C_8, C_{12}=3 gang variable condenser .00035 mfd. max.
C_7=2 to 20 mmfd. semi-variable condenser. (coupling).
C_9=.01 mfd.
C_{10}=1. mfd.
C_{11}=2 to 20 mmfd. semi-variable condenser. (neutralizing).
C_{13}=.00025.
C_{14}=1 mfd.
C_{15}=.0005.
C_{16}=0.1 mfd.
R_1=0-500,000 ohm variable resistance.
R_2=0-500,000 ohm variable resistance.
R_3=2000 ohm grid bias resistor tapped at 500 ohms.
R_4=2000 ohm grid bias resistor tapped at 500 ohms.
R_5=0.1 megohms.
R_6=2. megohms.
R_7=25,000 ohms. (25 watt size).
L_1, L_2, L_3, L_4=Tuning inductances for broadcast range.
L_5=Feed-back coil=20 or 30 turns.
R.F.C.=1⅛ millihenries.
Audio Transformers=3:1 ratio.
Output Transformers=1:1 ratio.
Tubes=2 AC 222—r.f.
1 Type 227—r.f.
1 Type 226—1st audio.
1 Type 171—Power.
1 Type 80—Rectifier.



Rear View of A.C. Screen-Grid Receiver

which gives increased amplification there and much less down towards 60 cycles. The resonance effect is not very great, since the detector plate impedance is part of the series resonant circuit. However, it is enough to make the amplifier better.

The variable resistance R_2, Fig. 1, acts as a regeneration control for the r.f. transformer primary through the condenser C_{17}. This resistance was made large enough so that even with the detector tube nearly oscillating, over 100,000 ohms resistance is still in the circuit.

The amplifier has several unique features. The first part of the circuit consists of a tuned antenna system with the control grid of the tube across the tuning condenser. The screen-grid feeds back through the condenser C_8 to the antenna coil in the familiar modified Colpitts' oscillator circuit in order to obtain some regeneration. Regeneration makes this circuit tune more sharply and, since energy is fed back to the control grid circuit, greater signal response is obtained. The by-pass condenser C_5 shunts most of the screen-grid r.f. energy to ground, so that only a small portion is fed back to the control grid through C_8 and the antenna coil.

The plate circuit of the first tube consists of a tuned impedance and is coupled to the next tuned circuit through the very small coupling condenser C_7. This arrangement greatly improves the selectivity, since it adds another tuned circuit. The reaction between the two screen-grid tubes is lessened somewhat also. By making C_7 large enough, 5 to 15 mmf., a band pass effect is obtained, since a double resonant hump is secured, due to closeness of coupling between the two tuned circuits.

The second screen-grid tube is also connected across tuned circuits, both grid and plate. This stage is neutralized since there is some grid to plate capacity in the tube and between the grid and plate circuit tuning condensers to cause oscillation. Neutralization is accomplished with a condenser C_{11} and a winding coupled to the tuned circuit following this tube. By having this stage neutralized, it is possible to use any amount of regeneration in the detector without throwing the r.f. amplifier into oscillation. The winding can also be used as the tickler feed-back coil for the detector with very little unbalance. This winding is in the proper direction for both purposes when it makes a continuous winding with the tuned circuit coil.

The detector is of the usual grid leak-condenser system with controllable regeneration. The variable resistance R_2 controls regeneration, and R_1 controls volume. These two are both 0-500,000 ohm variable resistances and are controlled by knobs on the panel. R_1 controls the r.f. amplification by change of plate voltage. Since the plate current drain of the two screen-grid tubes is quite small, the change of load on the plate supply unit is negligible. The detector, and the two tuned circuits preceding it, are tuned by means of a three-gang condenser so that there are only two tuning controls in the form of two drum dials.

As shown in the pictures, the experimental receiver was made up in two units, one including the r.f. amplifiers, detector and first audio stage; and the other unit, the last stage of audio and the *A, B, C* power unit.

All *C*-biases are obtained by means of resistances in negative *B* leads. The peculiar biasing obtained by means of R_3, Fig. 1, is necessary in order to maintain nearly a fixed bias on the grids of the two r.f. tubes. Changing the volume control setting R_1 changes the plate current of these two tubes and so changes the current through part of R_3, but the percentage change of voltage across R_3 is changed very little. This should be nearly constant, since the total drop across R_3 provides *C* bias for the first audio tube. The plate current of this audio tube, a type '26, is large so that practically constant *C*-bias voltages are available from the resistance R_3. R_3 should be a total of about 2000 ohms tapped at 500 ohms from the —*B* lead. The resistance R_4 also consists of about 2000 ohms to provide *C* bias for a type '71 power tube.

All plate voltages are obtained from a voltage divider of 25,000 ohms. This resistance is shunted across the power supply, and is tapped at 45 and 135 volts. There is nothing unusual about the power supply unit and amplifier, and it might well be crowded into much less space than the one shown in the picture. The main requirement is that it supply about 220 volts across the voltage divider so that about —40 volts *C* bias and 180 volts *B* supply are available for the type '71 power tube.

The filament winding for the heater-type filament tubes should be capable, without overheating, of supplying 5¼ amperes at 2¼ volts for the two r.f. tubes and detector. A type 80 full-wave rectifier tube was used in preference to a gaseous rectifier because of less voltage drop. This makes it possible to use a power pack with high voltage winding of 220 to 250 volts on each side of the center tap.

Because of the circuit design, it is not necessary to completely shield the r.f. stages and detector. However, it is quite necessary to shield the coils and tubes from each other. Copper cans 3 x 6 x 5½ in. in size were used for each tuned circuit. These cans are made with removable sides and tops, so the job of wiring is quite simple. All wiring is done by means of insulated wire in the most direct fashion possible. Most of

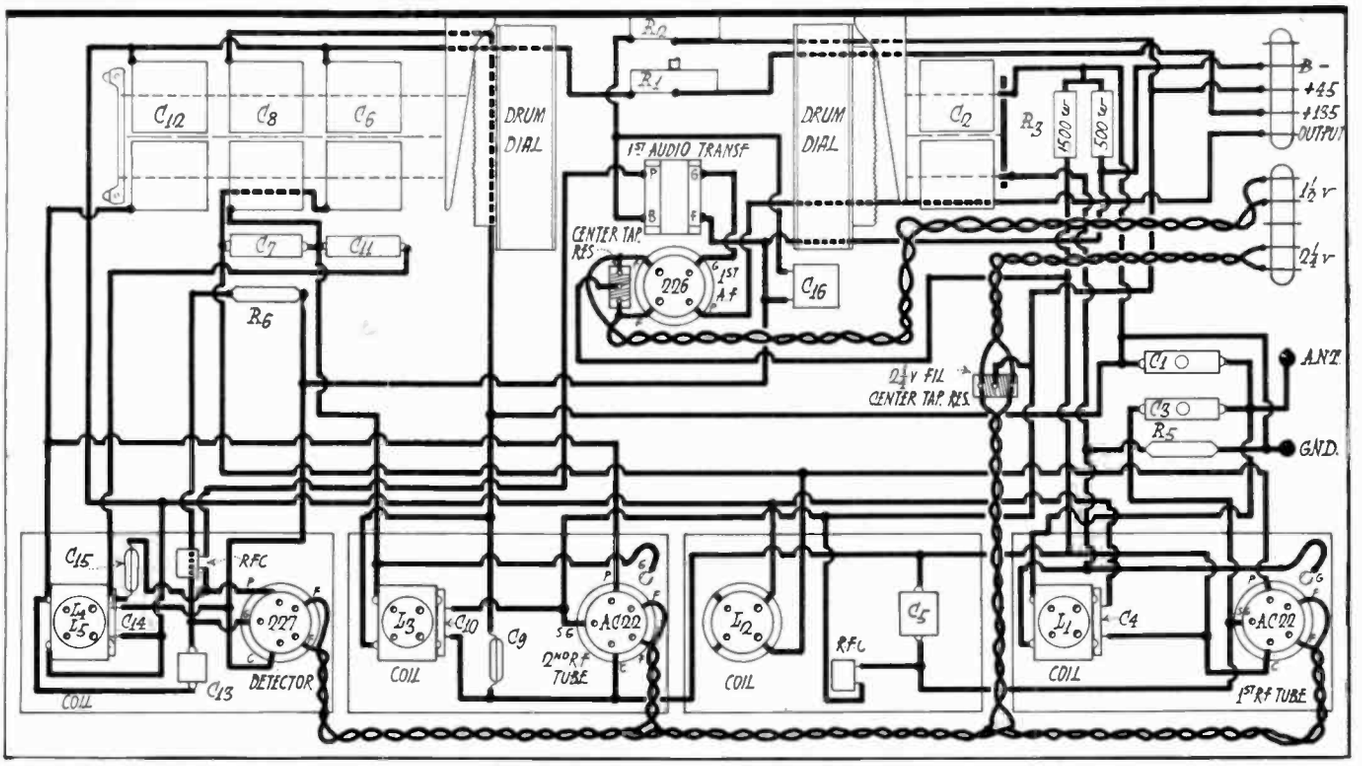


Fig. 2. Layout of Apparatus for A.C. Screen-Grid Receiver

the leads are run through holes in the subpanel and run along underneath this panel. All a.c. filament leads are run in twisted pairs, using at least No. 16 gauge wire. All shields, drum dial frames and transformer cases are grounded to —B. The large by-pass condensers are generally mounted underneath the plug-in coil sockets.

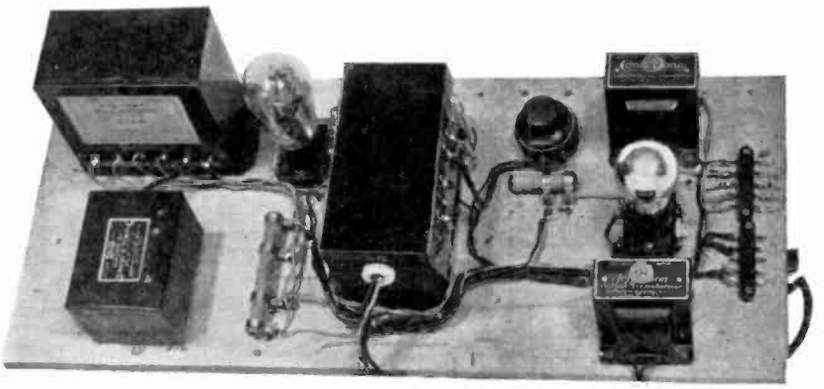
The coils consist of about 120 turns of wire on a 2½-in. tube arranged for plug-in mounting into X sockets. They are wound in two sections with the grid and filament leads coming out at the center instead of the ends. This gives a smaller field and allows the use of the relatively small shielding cans. Any coils suitable for the broadcast range may be used if desired.

The antenna coil may be of the same size as the others, in which case a .001 mfd. condenser C_1 will probably have to be shunted from aerial to ground unless a very large antenna is used. This condenser simply increases the antenna effective capacity in case a small antenna is used. Somewhat greater signal strength, and a little less selectivity, will be obtained by omitting it and adding more turns to the antenna coil. The exact number would depend upon the size of antenna used, so that taps should be made every 40 or 50 turns so as to get approximately the correct number. The condenser C_2, having a maximum capacity of .0005 mfd., should then cover the broadcast range. Since the condenser C_2 isolates the control grid from ground, a grid leak R_6 should be used to obtain C bias as shown. R_5 should be from .1 up to .5 megohms in value.

The detector feed-back coil should consist of about 20 turns, though this value is not critical. The winding should be in the proper direction so that the detector will oscillate when R_2 is decreased in value.

The feed-back condenser C_3 should have a maximum value of .0001 mfd.

The by-pass condenser C_{16} should be .1 for the particular type of transformer used. For other makes of transformers, other values of condensers would be necessary, since a .1 mfd. might resonate at 60 cycles with some other make, causing the a.c. hum to be emphasized instead of diminished.



Power Plant and Second Audio Stage

and the corresponding by-pass condenser C_5 should be .00025 mfd. The radio frequency chokes may be of any type, since none of them are at very high r.f. potential. The other by-pass condensers, C_4, C_9, C_{10}, C_{14}, may be of any value from .1 up to 1 mfd.

The coupling condenser C_7 and neutralizing condenser C_{11} should both be semivariable with a range of from 2 to 20 mmfd. The grid condenser C_{13} and

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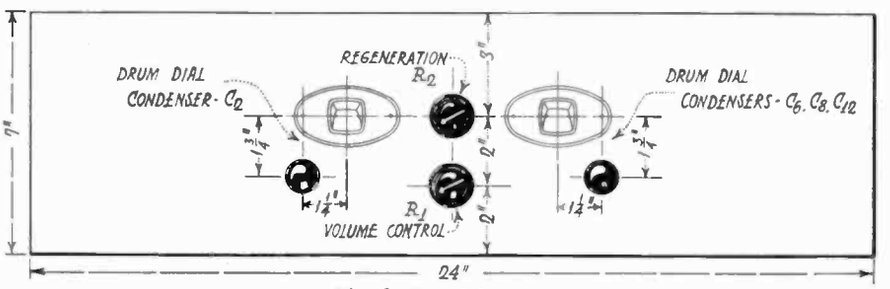

Fig. 3. Panel Layout

A Portable Short-Wave Receiver

By CLINTON OSBORNE

WHEN the Commander Byrd expedition to the South Polar regions sailed from the United States in August, one of the many pieces of radio equipment carried along for use after the expedition reached its permanent base was the short-wave receiver shown in the pictures. This receiver, a gift from his business associates and friends to Mr. Joseph Rucker, the official motion-picture photographer of the expedition, is being taken along, not for the purpose of establishing communication with the United States as might be assumed, but for the entertainment of its owner and his companions on the "long winter evenings," when home seems far away, and the phonograph records have worn out.

Short-wave broadcasts from the North American continent and Europe are being picked up nightly in all parts of South America and Oceania, so that it is not beyond the bounds of reason to presume that successful reception of WGY at Schenectady and other short-wave stations will be had in the Antarctic Zone with a regenerative detector and two stages of audio amplification.

The first requisite of this set was that it should be compact in size, and the second was lightness in weight. Loaded down with cameras, personal luggage and other equipment, the addition of a forty or fifty pound radio set would be too much of a burden, so that by careful placement of parts and the use of the well-known shelf design, as shown in the picture of the set, the parts were mounted on a 6½ x 14-in. panel, and placed in a cabinet only 6 in. deep.

Naturally, to be portable, the set was dry cell operated throughout, necessitating the use of type '99 tubes. The range could have been increased somewhat by the use of a shield grid tube ahead of the detector, but this type of tube requires 135 volts of *B* battery, and the weight of such a battery, even though small-sized cells were used, would be prohibitive.

Portable Short-Wave Receiver in Carrying Case

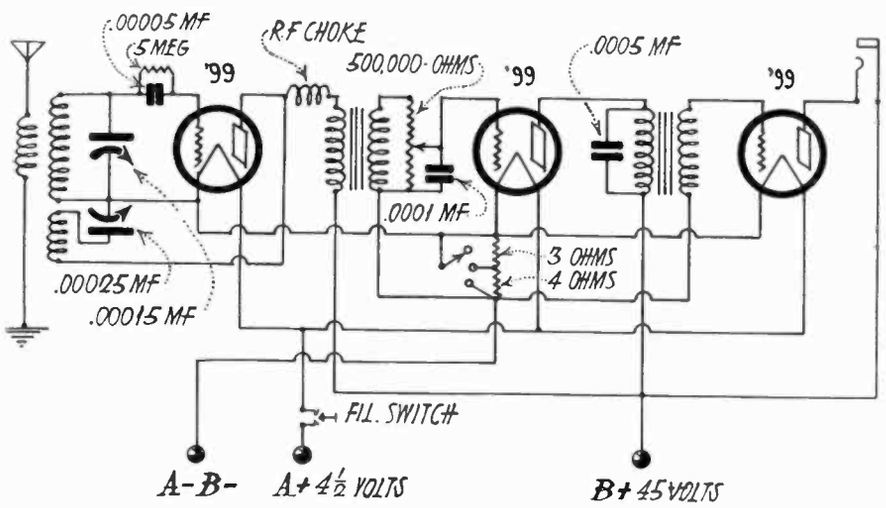

Fig. 1. Circuit of Portable Short-Wave Receiver

The circuit is shown in Fig. 1, there being three type '99 tubes in the conventional regenerative detector and two stages of transformer coupled audio amplification. The tuned circuit was made from a standard short-wave plug-in kit of coils, with mounting, so as to cover the waveband from 15 to 125 meters. To cut down on the height of the panel, the hard rubber mounting which came with the kit of coils was dispensed with, and the four-coil jacks were mounted on the bakelite sub-base which supports the tube sockets, chokes and audio transformers. By the use of a pair of alumni-

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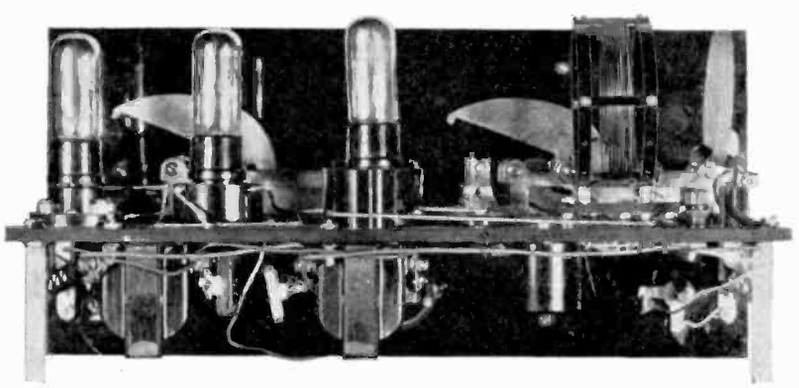


Rear View Showing Sub-panel Assembly

A Portable A. C.-D. C. Test Kit

By H. W. ANDERSON

A COMPLETE outfit for testing a.c. or d.c. radio sets can be assembled at reasonable cost by mounting a 0-1 m.a. milliammeter and an a.c. voltmeter together with suitable resistances and switches on a panel fitted into a carrying case. The milliammeter reads direct current and voltages and the voltmeter indicates a.c. filament and line voltages.

As can be seen from the circuit diagram in Fig. 1, the milliammeter is used as a high resistance voltmeter by employing different sizes of multiplier resistances, so that scales of 100, 250 and 500 volts can be had by installing resistors of 100,000, 200,000 and 500,000 ohms respectively. Accurate resistances with adequate current-carrying capacity are now being made to replace the rather inaccurate lavite resistances which were previously in general use in home-made high resistance voltmeters. By the use of these resistances in connection with a 1 milliampere scale milliammeter, a voltmeter having a resistance of 1000 ohms per volt is thus obtained.

By using shunt resistances across the milliammeter terminals, the range of the meter was increased to values of 50 and 200 milliamperes, and 5 amperes. For practical purposes, a milliammeter can be considered as a voltmeter reading the voltage drop across the resistance in shunt.

When the resistance of the moving coil, and current necessary to operate the meter are known, it is an easy matter to calculate the resistance of the necessary shunts. To find the voltage necessary to operate the meter, Ohm's Law is used, where the voltage equals the current times the resistance. In this particular test set, a Western Model 301 milliammeter was used, and the resistance of the meter, as given in the catalogue, is 27 ohms. Other makes of meters can be used equally as well, provided that the resistance of the meter is known, or can be determined with fair accuracy. By substituting in the formula, the voltage to operate the meter is .027 volts. (*E* equals *IR* equals .001 mils x .27 ohms equals .027 volts.)

Portable A.C.-D.C. Test Set

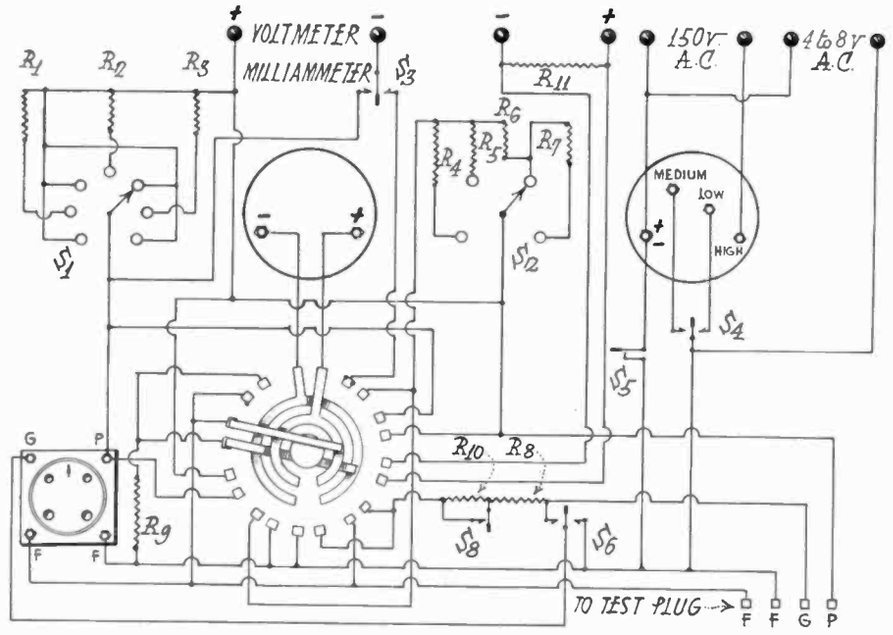


Fig. 1. Circuit Diagram of Test Set

For a 10-milliampere shunt the necessary resistance is one which gives a drop of .027 volts. This resistance is found to be 2.7 ohms. The other resistances for 50 mils, 200 mils and 5 amperes are .54, .135, and .0054 ohms, respectively.

The resistances used for shunts for the 10, 50 and 200 milliampere scales were fixed filament resistors of wire-wound type, unwound to the exact values needed. The 5-ampere shunt was made of about 10.3 inches of No. 18 wire. The fixed resistors were mounted on a seven-point inductance switch. Every other point was connected together and then tied to the common side of the shunts so as to place a short across the meter when switching from one scale to another.

While it is possible to calculate the resistance of the shunts it is very necessary that the milliammeter be calibrated with an instrument of known accuracy. Any high school would be willing to do

this. The voltmeter range is accurate enough, so that calibration is not absolutely essential, although it is desirable.

A bi-polar switch is convenient to make the various tests. The switch for checking tubes was made from an old filament control jack of the single-pole double-throw variety and was mounted on the panel so that it could be operated by a push button. The pictures show this more clearly. The test plug was made from the X base of an old '99 tube. The cable connecting this plug should have leads sufficiently heavy so as to have no voltage drop through it when testing a.c. tubes.

Since the pictures were taken some improvements have been developed in the test set, and these are shown in the circuit diagram. For this reason the picture of the set panel shows one extra binding post. Also the 50-volt scale was changed to 100 volts.

The toggle switch is for the purpose of shorting out a 50,000-ohm resistance in the grid circuit, giving a choice of 50 volts for normal working conditions and 100 volts for use with the '50 tubes. A suggestion for those who might care to use it, would be to place a reversing switch in the *C* bias test circuit, making it possible to read the space charge voltage on the grid of a '22 tube.

For testing a.c. sets, an a.c. meter was used to cover the filament voltages of the a.c. tubes. Another range was also included in the meter for the checking of house-line voltages. This meter is operated through a switch so that it can be connected across the filament terminals of the socket in the test set.

The test kit was made as compact as possible and is contained in a case 6½ x 10½ x 4½ in. The case used was an old vibrator case, but the constructor may find some other box that will suit his purpose. The apparatus was mounted on the panel to form as symmetrical and convenient a layout as possible. The builder may have ideas of his own as to panel layout and, therefore, no dimensions are given. The pictures and circuit drawing should enable the builder to ascertain the manner in which it was constructed.

LIST OF MATERIAL USED

R_1	3 ohm resistor.
R_2	4/7 ohm resistor.
R_3	¼ ohm resistor.
R_4	Super Davohm 10 M Ohm.
R_5	Super Davohm 100 M Ohm.
R_6	Super Davohm 250 M Ohm.
R_7	Super Davohm 250 M Ohm.
R_8	Super Davohm 50 M Ohm.
R_9	Super Davohm 10 M Ohm.
R_{10}	Super Davohm 50 M Ohm.
R_{11}	10.3 in. of No. 18 Wire.
8	Binding Posts.
S_1	7 point inductance switch.
S_2	4 point inductance switch.
S_3	SPDT Switch.
S_4	SPDT Switch.
S_5	Filament Switch.
S_6	Push button S. P. S. T. Switch.
S_7	Weston Bi-polar Switch.
S_8	Toggle Switch.
M_1	Weston Mod. 301 0-1 Milliammeter.
M_2	A.C. Voltmeter, 0-4-8-150 volts.

The operation of the test set is very simple, requiring the same precautions that would be taken with any laboratory instrument. Take, for example, the testing of any tube being operated with direct current on the filament. First remove the tube from the set and place it in the socket of the test set. Then put the plug in the socket to be tested. Before going any further it is well to see that the voltmeter and milliammeter are on the right scales. When in doubt as to the voltage and current being used in connection with the tube, always use a higher scale and drop back towards the lower scales after you have ascertained what the approximate voltage and current are.

The first position of test on the bi-polar switch is *A* voltage. If the meter reads backwards, turn to the next position, which will reverse the voltmeter leads to the socket. Position No. 3 connects the milliammeter in the plate circuit of the tube to be tested. In this position the operator has the choice of three milliampere scales, as previously described. Position No. 4 connects the voltmeter in the plate circuit and again gives the operator the choice of three voltmeter scales. It might be well to warn the operator to always be careful to select the proper voltmeter scale here. Positions No. 5 and 6 are *C* battery and *C* battery with the *A* reversed. This gives a true *C* battery reading.

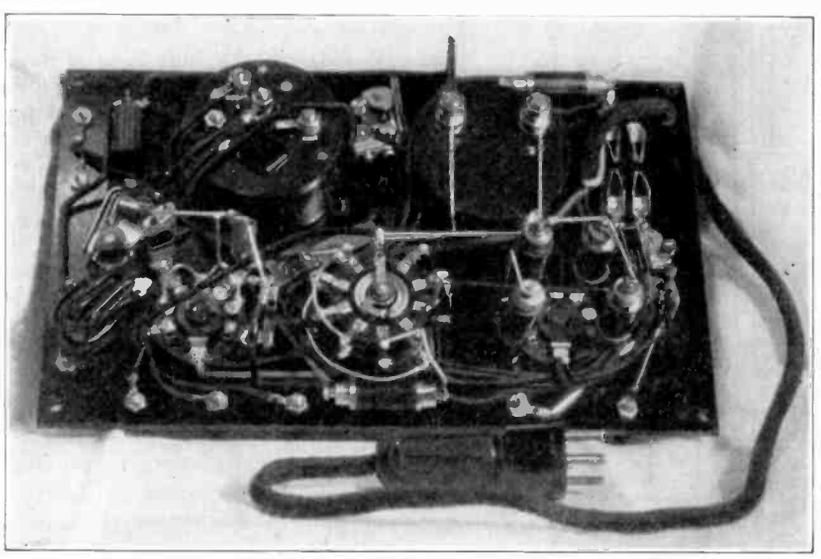
When the tube employs a.c. on the filament the procedure is somewhat different for the *A* circuit, all other tests being the same as the d.c. tube. The switch marked a.c. or d.c. should be set for the former. The switch which selects either the 4 or 8 volt scale should be set to the voltage specified by the tube manufacturer as, for instance, the '26 and '27 tubes will come within the 4 volt range and the power tubes will all come within the 8 volt range.

Suitable adapters will be necessary, adapting the five-prong tube to the four-prong socket or the four-prong test plug to the five-prong socket to be tested. These adapters may be constructed or they may be purchased.

Further operation of the bi-polar switch to position No. 7 gives an ammeter range on a pair of external binding posts for the use of testing various chargers. Position No. 8 of the switch connects the milliammeter to an external binding post with the choice of three milliammeter ranges. In doing this it is necessary to see that the meter switches as are set to the proper position. Position No. 9 connects the voltmeter scales to the same binding post by merely operating the meter switch again. The a.c. meter is also available on external terminals, one pair carrying the 150 volt ranges and the other pair carrying the 4 or 8 volt scales as selected by the 4 and 8 volt switch.

The set will also determine the condition of tubes by inserting the tube in the test set and placing the plug in the socket of the tube to be tested. The bi-polar switch is rotated to plate mils and the milliammeter switch is set to the proper range. Now by pressing the button marked *Grid Test* the *C* bias is removed from the grid of the tube and there is a corresponding increase in the plate current if the tube is in good condition. A table of scales showing what the different tubes should test can be obtained by checking a few of the tubes of various styles.

In making these several tests for voltages the set will clear up many problems such as burned-out audio transformers, on both primary and secondary, open grid resistances, open radio frequency transformers, run-down batteries and deactivated tubes.



Test Set Panel, Showing Assembly of Parts

TECHNICAL BRIEFS

THERE seems to be a lack of information on the subject of the testing of tubes, especially the a.c. models, insofar as operating limits are concerned, and so we are presenting the circuit of the tube testing device used in our laboratory, together with a table of limits which will serve for all practical purposes. This test set is primarily intended for measuring the normal plate current, and the filament emission of any of the standard tubes, except the type '50 power tube. More elaborate outfits for measuring the amount of gas present in the tube, its gain in Transmission Units, or its power output, can be constructed, but at a greater expense than is warranted in most home testing outfits. The test circuit is shown in Fig. 1, and the outfit can be built at relatively low cost, with two meters as shown. These can be used for other purposes when the test set is not in use, so that the meter connections can consist of jacks, whereby the meters are temporarily plugged into the circuit.

Two tube sockets are required, one for d.c. tubes, with flexible connector for the grid of the shielded-grid tube, and one for heater type a.c. tubes. The heater of the type '27 a.c. tube is lighted from a battery rather than a.c., to avoid complicated connections, the heater current being limited by the main filament rheostat, which is adjusted so that the filament voltage is 2.25. Three filament rheostats of different values of resistance, as shown in Fig. 1, are connected in series, so as to enable the adjustment of filament voltage on any tube to its proper value, using the same 6-volt battery. The switch *S*, which may be a double pole, double throw jack switch, has two positions, one for measuring the normal plate current, with 3 volts negative grid and 67½ volts plate, and the other for measuring the filament emission, by connecting the grid and plate in parallel, with the same *B* voltage.

The procedure for testing a tube is as follows: for d.c. tubes, insert the tube in its proper socket, first seeing that the filament rheostats are set to maximum resistance. Set the switch *S* to the filament emission test, and cut out resistance in the rheostat group until the plate milliammeter reading is between 3 and 5 milliamperes, depending on the type of tube, as shown in the table below. Read the filament voltage required to produce this emission, and if the voltage is equal to or lower than the corresponding voltage as given in the table, the tube is O. K. If the emission current cannot be made to equal the values given in the table without increasing the filament voltage above the stated limits in the table, then the tube needs reactivating. In the case of the a.c. tubes, reactivation is not possible, so that the above applies only to the d.c. tubes. In testing CX-310 tubes, a special milliammeter having a range of at least 100 m.d. must be used.

Next set the switch *S* to the plate current position, increase the filament voltage to the normal value, and read the plate current on the milliammeter. If the current is not within the limits given in the table, even though the fila-

TEST LIMITS FOR STANDARD TUBES

	EMISSION TEST		PLATE CURRENT TEST	
Type	*Emission-current at Fil. volts indicated in next column*	*Fil. Volts*	*Rated fil. voltage*	*For good tubes Plate current should be*
CX-310	100 m.a.	6.0	7.5	11-25 m.a.
CX-11 or 12	3.0 m.a.	1.0	1.1	1-5 m.a.
CX-299	3.0	2.9	3.3	1-4
CX-220	3.0	2.8	3.3	4-10
CX-322	3.0***	2.8		
CX-301-A	5.0	3.9	5.0	1-4
CX-340	5.0	3.9	5.0*	0.1-1
CX-112-A	5.0	3.5	5.0	2-8
CX-371-A	5.0	3.7	5.0**	5-15
CX-326	5.0	1.0	1.5	2-8
C-327	--	--	2.5 a.c.	1-6

* Reduce grid bias to zero for CX-340.

** Reduce plate volts to 45 for CX-371-A.

*** Plate, grid and shield connected together.

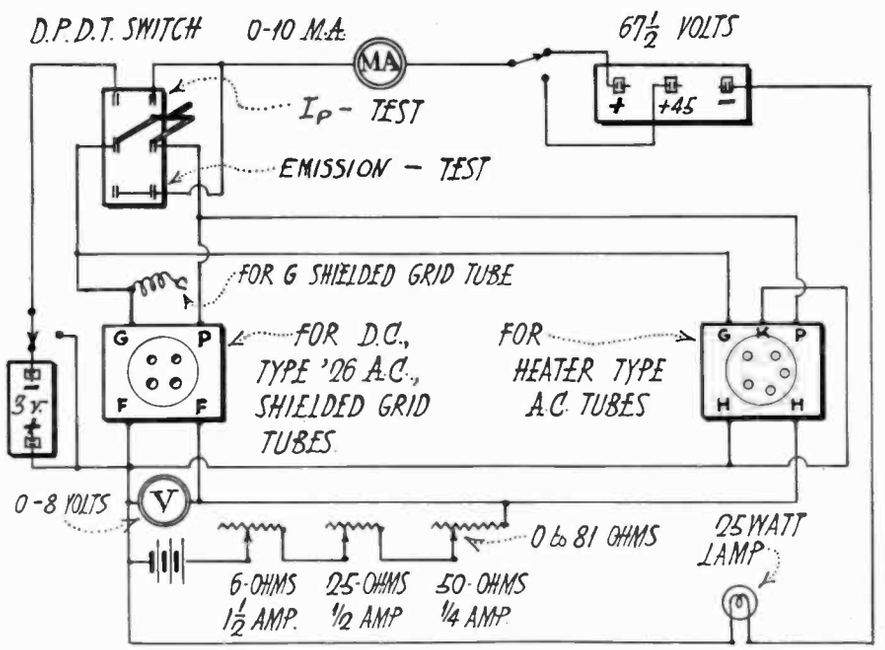


Fig. 1. Circuit of Tube Tester

ment emission is good, the tube would probably not be suitable for use as an all-purpose tube.

THE correct value of grid leak and grid condenser for the detector tube is a much-discussed question. Practically all circuits, including factory-built jobs, use a .00025 mfd. grid condenser, shunted by a 2 megohm leak. Sometimes the grid leak is connected directly between the grid and filament of the tube, thereby shunting the tuned circuit ahead of the detector, as well as the grid condenser, but the effect is the same for all practical purposes.

The size of the grid condenser, as well as the resistance of the grid leak, has a definite effect on the higher frequencies in the audio frequency output of the detector. It has been found that a marked improvement in the output at frequencies above 3000 cycles is obtained by lowering the capacity of the condenser to 50 mmf. (.00005 mfd.) and the grid leak to ½ megohm. This is particularly useful in the case of a superheterodyne, where the use of filters having a frequency band only 3 or 4 k.c. wide cuts off the higher frequencies of the modulated carrier, and in the loud speaker, the high notes are lacking in volume.

By changing the grid condenser and leak to the lower values specified, the detector output at 5000 cycles can be brought up by 5 transmission units or more, while the output at the lower frequencies is not changed appreciably. If the audio frequency amplifier or loud speaker of a tuned r.f. set is deficient at the higher frequencies, this change in the detector circuit may greatly improve the tone quality, without affecting the sensitivity of the receiver enough to be noticeable, even on distant stations.

MANY of the new models of a.c. sets are provided with automatic control of line voltage. While the ballast lamp, such as has been used in the Radiola models for a number of years, is an excellent voltage-control method, it is suited to only one type of set having a certain power consumption. Hence, it cannot be used with any type of a.c. set.

The most practical type of primary voltage control so far introduced has been a ballast resistance of the exposed type, placed in series with the primary of the power transformer, which is wound to 100 volts instead of 110 or 120. The resistance absorbs the additional 10 or 20 volts which are not required by the transformer, and, being made of iron wire, varies in resistance according to the temperature. So that in case the line voltage rises, the resistance increases as the wire temperature increases, thus smoothing out the fluctuations providing they are not too violent. The control is effective only when the voltage fluctuations are gradual, as the heating of the resistance wire is slow, and the action of the regulation is sluggish. This method permits the service man to take care of local conditions, where the ballast resistor is found to cut down the voltage to a point too low for satisfactory operation of the set, so that turns can be removed from the resistor until the effective voltage across the transformer is the right value.

ONE of our readers kindly points out an error in the answer to Question 7 of Group 1 of the Questionnaire published in July RADIO. In discussing the difference between the peak, average and effective values of alternating currents, the relation between the instantaneous maximum value of the voltage and the instantaneous value is as follows: $e = E\text{-max} \sin 2\pi ft$, where e is the instantaneous value, E-max is the instantaneous maximum value, the angle $2\pi ft$ is in radians, and t is the time in seconds. If the time of one complete cycle is T, f equals 1/T.

Speaking of this Questionnaire, we are also criticized for calling it a questionnaire for "Radio Engineers." One correspondent stated that he had several "soldering iron experts" at twenty-five dollars a week who could pass the examination satisfactorily, so that he was wondering what the definition "Radio Engineer" comprised. Undoubtedly most college graduates in science or electrical engineering could pass the first group of questions perfectly, but the fact remains that in the radio manufacturing business there are hundreds of men earning good incomes who are fine practical radiomen, experienced in the handling of problems relating to radio frequencies, and with a smattering of knowledge of d.c. and a.c. theory, but who could not pass an examination based on the questions in Group One without consulting a textbook. If the Questionnaire has been of any help to this class of readers then we will feel quite satisfied in having accomplished something worthwhile. As to the definition of Radio Engineer, since no university, to our knowledge, awards a degree of R. E., one answer is as good as another.

THE question is often asked as to what results will be obtained by the use of shielded grid tubes in place of the type 99 tubes in the intermediate amplifier circuit of the average superheterodyne. On first inspection it might seem that this change could be made by a slight circuit change and the insertion of flexible wires leading to the control terminal on the top of each shield grid tube. While this is quite true, there are other factors which are much more important than changes in the circuit.

In the first place, most intermediate frequency amplifiers in superheterodynes built during the past three or four years are unshielded, and were designed for tubes having a voltage amplification not to exceed 7 or 8, so that by using tubes giving much higher voltage gain, the coupling between stages would be enormous, and the amplifier would oscillate uncontrollably. By completely shielding each stage, the oscillation troubles could be partly cured, but unfortunately, the average intermediate transformer has a turns ratio of 4 or 5 to 1, which is entirely too high for the shielded grid tube at frequencies where most i.f. transformers are peaked. Several experimental amplifiers of this type were tested with shielded grid tubes, and it was found that by using two i.f. stages, carefully shielded, a stable amplifier could be constructed, but due to the enormous amplification, the amplifier was so broad as to be useless when used in a receiver having a loop antenna.

By employing at least two sharply tuned r.f. stages ahead of the first detector, a fair degree of selectivity with high sensitivity was obtained, but by substituting transformers having a higher primary impedance and much lower turns ratio, a more selective set resulted. Hence it can be assumed that it would be a waste of time or money to attempt to use the shield grid tubes with high ratio, iron core intermediate transformers, unless the set is to be located where good selectivity is not an important factor.

SOME very interesting facts about the screened grid tube were recently brought out by *Experimental Wireless*, in an article on the theory of the screened grid tube. It was found that the residual capacity between the plate and the control grid of the tube is equal to the capacity between the control grid and the screen, divided by the amplification factor of the tube when the screened grid is used as a control grid.

The maximum possible amplification factor of the tube is equal to the product of the "mu" of both the control and screen grids. But whenever there is any secondary emission from the electrodes, the "mu'" is lower than the above value. The mutual conductance of a screened grid tube is equal to that of a corresponding three electrode tube, considering the screen grid as an anode, minus a percentage due to the electrons intercepted by the screen grid. Thus, the mutual conductance falls off rapidly as the screen grid mesh is made very close.

Judging by the performance of most screened grid receivers developed in the United States since the tube was introduced, most of the tubes must have a very high secondary emission, as the amplification per stage is very much lower than the theoretical maximum.

With the Amateur Operators

A COLPITTS SHORT WAVE TRANSMITTER

By WILLIS L. NYE

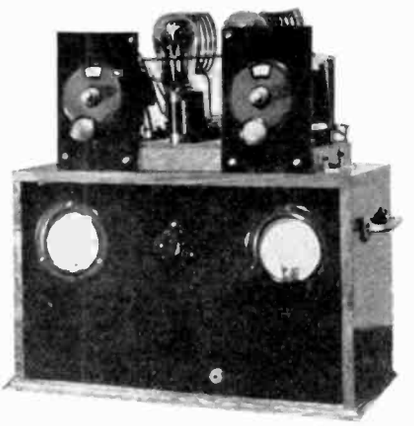
THE favorite system of the transmitting amateur today using short waves resolves itself either to a Hartley or Tuned Grid and Tuned Plate circuit for use in communication. These two circuits are immensely popular with the operators and each has its own apparent advantages. However, another system that combines the two others mentioned is the Hoffman modification of the Colpitts oscillatory circuit.

The Hoffman arrangement of the Colpitts system is known as the Split Colpitts and has proven to be an ideal transmitter for the high frequency wavebands down as low as 5 meters. With a UX-852 tube this system has been proven satisfactory to as low as 1 meter in wavelength. The Hoffman modification splits the inductance of the original system into two separate coils with the plate stopping condenser between them. Around this is built the entire circuit. The chokes are connected to the plate stopping condenser, one going to the plate supply and the other to the grid leak to the filament center tap, which is taken between the two series capacities that are shunted across the two inductances, thus forming the oscillatory circuit.

The modifications Hoffman made in the original Colpitts work out to great advantage to the operator. As the two capacities are in series there are no critical adjustments in frequency. This also enables much greater power to be applied without undue sparking between the plates. The center tap is easily placed between the two tuning condensers and does away with any clipping arrangement. The two sections can be adjusted in relation to each other, thus permitting variable coupling to the antenna and also making the power input variable if the operator so chooses. These modifications all tend to make the circuit extremely simple to operate and once the tubes are lighted the circuit bursts into oscillation immediately and does not require any tuning circuits, etc., to bring it into resonance.

Because all the capacities directly affecting the tube are wired in series, any changes in tube capacities have no effect on the emitted frequency. This helps to steady the wave and the note. If this circuit is run at a constant output that is not overloading the vacuum tube oscillators no trouble from "wobbulation" should be experienced. All the above characteristics of this circuit have a direct bearing on the efficiency of the system as a whole. The note emitted from this type of transmitter is generally superior to notes emitted by other systems using the same forms of plate supply from raw a.c. to d.c. or supply from a high frequency alternator.

The circuit is suitable for use with any type of antenna system, including voltage feed with a single wire feeder line. The antenna is coupled to the system through a coil which is placed between the two inductances of the oscillatory circuit. The coupling should be varied for proper output.



View of Completed Transmitter

Fig. 1 shows how the circuit can be adapted to self-rectification by adding one more special choke, two stopping condensers and one more tube, along with the usual sockets, clips, screws, etc. This will appeal to the builder seeking economy. Of course the note emitted is not equal to a rectified tone but is pleasant to copy, it being 120 cycles in frequency.

The set was built along similar lines to the *"Bumblebee"* transmitter recently described in RADIO. This design is efficient, besides looking well and giving accessibility for adjustments or repair. The set should be wired in accordance with the diagram given. Be sure to place the coils in proper relation as specified.

All the parts are of standard design. The main tuning condensers are double spaced. The gridleak is a heavy resistance capable of carrying 100 watts constantly without heat. The stopping condensers are mica type. The chokes are home-made, as are the 3/16-in. copper tubing inductances. The filament transformer is of 8 volts or 10 volts as desired. The plate transformer is a special built unit made by 6EX at his laboratory. It is tapped from 550 to 850 volts. The set was built with all parts capable of carrying an output of 203-A tubes though the original set uses the new type of heavy construction UX-210 tube.

The chokes are wound on hard rubber tubing, 125 turns being used for the plate chokes and 80 turns for the grid choke. The forms are wound with No. 26 enameled wire. The diameter is 1 in. The small center tapped choke in the grid lead is a 50 turn winding on ½-in. diameter dowel stick. This prevents ultra high frequency oscillations between the two tubes. It is wound with No. 30 wire and center tapped at the 25th turn. All chokes are mounted on small nickel-plated angle clips.

The set is easily adjusted. The coupling to the antenna coils must be very loose and the set must be operated on either a fundamental system antenna or one that requires a coupling coil with double feeders. After the working wave is chosen and the set is loosely coupled, place the antenna into resonance with the transmitter. This will be indicated by a rise in the plate milliammeter reading. Listen in with the receiver and adjust the coupling until the note is as smooth as when the antenna is disconnected. This is the point where the set is functioning cor-

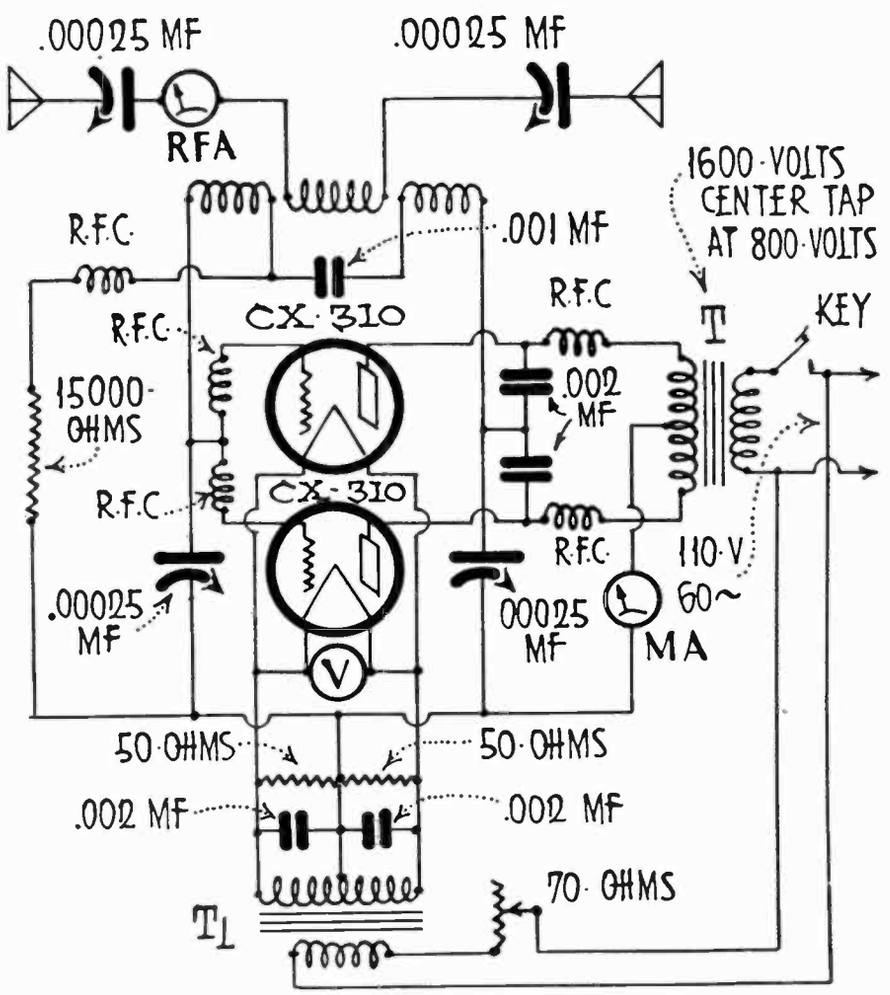


Fig. 1. Split Colpitts Self-rectified Transmitter at 6DDN

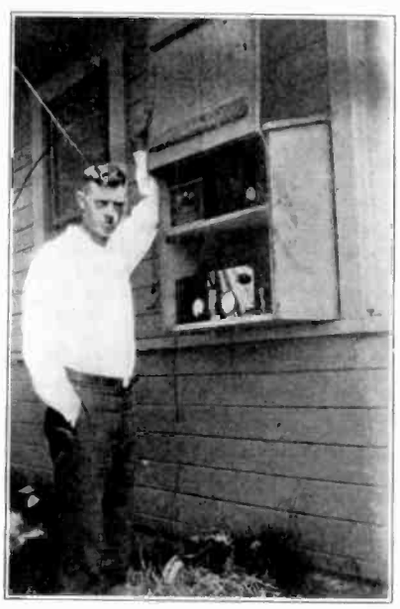
rectly with a good tone. If the set is coupled too close to the antenna the note is rough and the plate current is unsteady. It is advisable to detune the antenna about ten per cent off the point of resonance. Never allow the plates to become red in color as this tends to roughen the note.

Both tuning condensers are set at approximately the same reading on the dials, which should be vernier. The plate milliammeter should read to 200 m.a. and the filament voltmeter to 15 volts. The plate milliammeter is placed in the plate center tap lead. It will record the reading of the two tubes. The coils are wound in the same direction and are 2½ in. in diameter. They should each have 8 turns while the coupling coil would have 7 turns of 2-in. diameter.

The self rectified transmitter in order to produce a good note should have a very low plate current in the tubes. This necessitates a high resistance grid leak in the neighborhood of 15,000 to 17,000 ohms, the last being about the highest value permissible, as beyond that value the tubes become unsteady. With the high resistance leak the plate current is small. The power transformer should be tapped exactly in the center, otherwise the input to each tube is apt to be unequal. The core should be designed so as not to produce distortion of the 60 cycle a.c. line current. The oscillator tubes should be checked for filament emission and for internal capacity so as to be identical.

This set is keyed in the plate primary, thus permitting the use of break-in system, as the filament hum is very sharp with this arrangement. The power variation switch is mounted in the cabinet, as is a double fuse block with 6 ampere plug fuses for protection to the line current. The cabinet is mounted on small countersunk casters, permitting the whole transmitter to slide back and forth easily as the antenna unit is mounted on the window near the lead-in. The filaments are adjusted by a rheostat as shown and properly center-tapped with large by-pass condensers.

The input with 850 volts on the tubes is approximately 54 watts which is about as much as the tubes should be pressed or else the tone will roughen. This set is adaptable to any frequency if the coils are of the plug-in type. This set has proven itself to be well adapted to any make of tube.



Outside Transmitter at 6BDR

A clever scheme for installing a portable short wave transmitter is pictured herewith, being that of 6BDR at Bakersfield, Calif. The 7½ watt transmitter as well as the power transformer and receiver batteries are placed in a box outside the house, and the sending key and receiver on a table just inside. Russell Estep, the owner, is a former ship operator who has learned to make the most of cramped quarters.

DESIGN AND CONSTRUCTION OF ¾, 5 AND 10-METER TRANSMITTER

By A. Binneweg, Jr.

Transmitting arrangements and circuits for use on the shorter waves, below 20 meters, need special design and construction if good results are to be obtained. Effects that are entirely negligible at the lower frequencies become exaggerated and the circuits and layouts must be modified for the new conditions.

In some rough measurements with a "dummy" antenna at 10 meters, on the 10-meter set shown in the illustrations, the output was reduced by using a filament clip, and was increased by using a tuned choke in the plate circuit and small midget stopping condensers, where possible. Bringing the hand up to the oscillating-circuit condenser causes the output to drop to less than half, usually; this is not caused by detuning, for with the hand on the vernier, the original output cannot be restored by retuning the oscillating circuit slightly. It seems that the body either causes increased r.f. resistance or "shunts" some of the energy to earth, or both, causing the decreased input to this antenna.

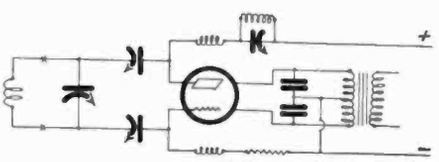


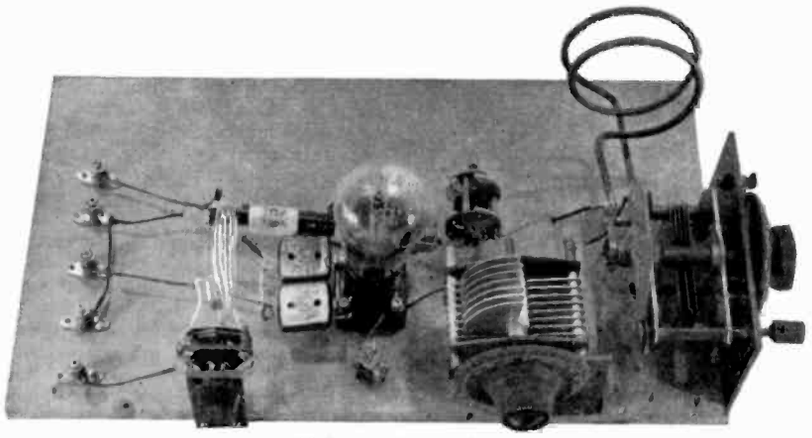
Fig 1. Circuit Diagram of 10-Meter Transmitter

For best results, the oscillator should be well away from surrounding, grounded objects and should preferably be hung from the roof of the shack in some convenient manner. It is only by "isolating" the transmitter, that a good fraction of the power will reach the antenna.

The r.f. chokes are quite important and small basket-weave coils may be used to advantage. Since any coil has some distributed capacity, it will have a natural period at which its impedance to the passage of r.f. currents will be high. At some frequencies it will allow the r.f. currents to flow through with little impedance.

It is difficult to wind such a coil having the proper natural period. The best way out is to connect a choke of approximately the right value to the plate of the tube, as shown in Fig. 1, and in series with it, a parallel circuit, the natural period of which can be adjusted so that a high impedance may be obtained anywhere in the wave-band. If the basket-weave choke functions properly, little change in plate current will be noticed when the tuned choke is tuned to the operating frequency.

The tuned choke for 10 meters, should consist of a 15 mmfd. variable midget condenser and a coil of about 3 turns, 3 in. in diameter. The tuned choke can be used to compare the various chokes tried, at this frequency. With a large *L-C* ratio and a small drop across the parallel-circuit, the loss is small and the operation of the transmitter is improved.



10-Meter Transmitter

The grid choke is not subjected to such high voltages and is less important. A good value to use is 30 turns of fine wire in a 1 in. basket winding for both chokes.

With a high value of inductance and small value of capacity in oscillating circuit, the r.f. drop across it will be large and large sparks can be drawn from the circuit. High values of inductances, however, tend to cause an unsteady wave, when transmitting, because of the small capacity used in the tuning circuit. The capacity used in the tuning circuit, being in parallel with the grid-plate capacity, should be large so that any change in the latter, due to tube-heating, will have little effect. If one uses about two 3-in. turns of copper tubing at 10 meters, good results will be obtained.

The grid and plate-stopping condensers used in short-wave transmitters are usually much too large and cause a large oscillating current to pass through the tube capacity. This current will depend upon the voltage between grid and plate (across the oscillating circuit, approximately) and this will depend upon the *L-C* ratio used. It is not uncommon for the grid-lead on a 250-watt tube to be burned out in an amateur station, because of this effect.

The amateur ordinarily has no way of determining exact values of small capacity, so the best way is to use small variable condensers here. The plate condenser must have good plate-spacing, but this is not as important in the circuit shown; because no filament clip is used, the total voltage is thus not directly across this condenser. In the set illustrated, a small "midget" was used in the grid.

Both condensers should be reduced in value until oscillations cease and increased somewhat beyond this value, for best re-

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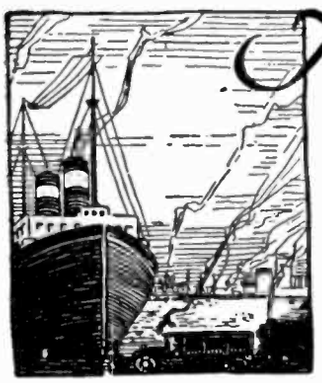
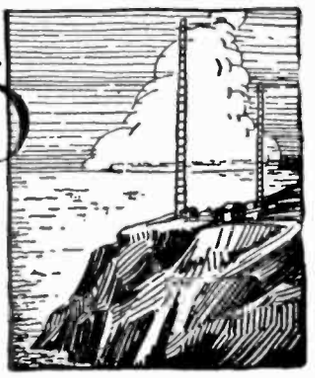


The COMMERCIAL BRASSPOUNDER

A Department for the Operator at Sea and Ashore



Edited by P. S. LUCAS
R. O. COOK, *Assistant*

After reading Radio Service Bulletin Number 135 (June 30, 1928), it seems fitting that something should be said about the changes in call letters effective October 1, as a result of Article 14 of the International Radiotelegraphic Conference of 1927. A glance at the list of revamped call signals shows that the Radio Division has done its usual fine job in handling a very tedious and difficult task. It was extremely wise to revamp the list in time so that the new call signals will appear in the fall edition of the "International List of Radio Telegraph Stations Alphabetically by Call Signals," and the June 30 edition of "Commercial and Government Radio Stations of the United States." FB! It will save many an op the time, trouble and confusion of searching through various bulletins in search of the new four letter call of some ship, or perhaps, the new three letter call of some coastal station! Fortunately, very few PG coastal stations had four letter calls prior to the new assignment. "The Voice of Labor" at Chicago is one of the few to save labor under the new assignment.

It is gratifying to note that some of the steamship lines having large fleets of vessels have obtained a "slice of the alphabet." That is, call letters in alphabetical order. We emphatically call it a step in the right direction! It would even be wise to reserve call letters to assure alphabetical continuity as more ships are added to the various fleets. There are more than enough available call letters to take care of future growth for some years to come anyway. A general call signal should also be assigned to each of the various large fleets, perhaps heading their particular alphabetical list of call letters. Such arrangements could be worked out nicely and then referred to the Radio Division for approval if the Division would sanction such action. In the past, the Radio Division has cooperated along constructive lines, thanks largely to a very capable Chief.

Getting back to general calls—whoever is responsible for the call letters assigned to the Bureau of Lighthouses should be commended for his foresight and ability. The Bureau has WWLH as its general call—a *very* appropriate one. Why not follow the example and have the general call for all coastal stations WCS instead of WTM, all merchant vessels WAMV instead of WKW or WGBG, all U. S. warships NUSW instead of NOB or NERK? General calls would have a chance of serving a very useful purpose if more ops were able to use them fluently. Some don't even know such a thing exists.

For years the op with the cumbersome four letter call has envied his more fortunate brother, but October 1 he can sit back with a smile of satisfaction as he hears many old fists trying to behave while pounding out newly assigned call letters. Some of the new calls have even been changed to start with a K instead of a W, and vice versa. It's a bit hard to imagine a ship like KII signing WMCE, WSN signing WSBN, etc. Still, ships like GFWV have used four letter calls for years. The coastal ops will probably be caused the greatest inconvenience by the new assignments. Some years hence we shall undoubtedly hear them speak of "the good old days when some ships had three letter calls."

We hope that the new assignments will not result in the use of the last two letters of a four letter call rather than the full call. This practice comes under the heading of false signals and will result in trouble as as well as confusion if practiced to any extent. It's great to be brief, but don't be lazy OM's.

—R. O. C.

THE SE-1420 FROM THE INSIDE

(The following article describes very minutely the 1420 receiver which is in use on a great many United States ships. Although every operator has used one of them at one time or another, very few have seen the insides, or worked out the circuit, due to the fact that the old type apparatus was usually clouded in shrouds of secrecy. Therefore, we feel that for those who occasionally get the urge to build a stage of R. F., an external loading arrangement, or what have you? this article will come in very handy. We hope so, anyway. For business reasons the writer asks to use a nom de plume.)

The 1420 is intended for reception of signals between 235 and 7500 meters.

The antenna circuit comprises a coil variable in 6 taps, and a variable air condenser .0014MF connected in series between antenna and ground binding posts of the set. The antenna coil has 658 turns of Litz, wound on a threaded form 4" in diameter and 5½" long, coil winding space is about 4¼" long. The form is threaded 36 turns to the inch left, hand turn. It is tapped as follows:

First tap	20 turns	1 bank wound
Second tap	42 turns	2 bank wound
Third tap	83 turns	3 bank wound
Fourth tap	159 turns	4 bank wound
Fifth tap	312 turns	5 bank wound
Sixth tap	658 turns	6 bank wound

There are a total of 658 turns and a little subtraction will give the number of turns per tap or bank. The antenna condenser is of the double rotor type. Each rotor section has 17 plates and each stator section has 16 plates, making a total of 34 rotor and 32 stator plates.

The secondary circuit comprises a coil variable in 6 taps and a variable air condenser .0007MF connected in parallel between the terminals of the detector system. The secondary condenser has 17 rotor and 16 stator plates.

The entire receiver is enclosed in a grounded sheet copper case or lined box (I have seen aluminum used for lining also).

The antenna and secondary circuits are separated by a sheet copper partition. Electrostatic coupling between antenna and secondary is prevented by a shield coil wound over the secondary or coupling coil.

Magnetic coupling between antenna and secondary is obtained by means of a coupling coil connected in series with the secondary coil (sometimes called secondary load coil), and forming part of the first tap. The coupling coil is wound on the rotor of antenna vario-coupler which is of the 45 degree angle mounting type—0° to 180° rotation. The coupling coil is provided with an electrostatic shield to prevent capacity coupling between antenna and secondary circuits. This shield consists of an additional winding placed over the coupling coil, one end of which is connected to ground potential and the other end is left open or dead ended.

The rotor of antenna coupler or coupling

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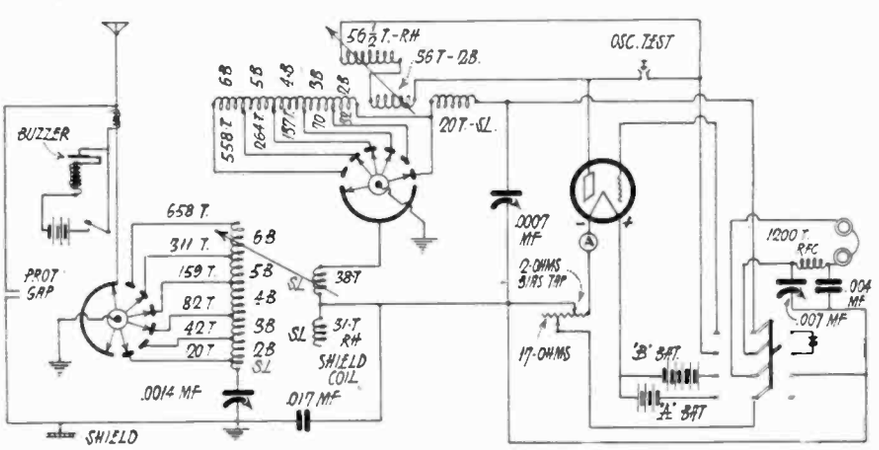

Type 1420 Receiver Circuit Diagram

Inside Stories of Factory Built Receivers

II. The Majestic "70"

The new Majestic receiver is a 7-tube tuned r.f. completely shielded set, with all-metal chassis and separate power supply unit, so designed as to fit into several types of console cabinets of different prices. The receiver, a front view of which is shown in Fig. 1, consists of three stages of tuned r.f. controlled by a four-gang condenser, which can be seen at the right end of the set. The three r.f. tubes, which are of the type '26 a.c. are contained in the cylindrical cans in back of the condensers.

At the left of the chassis are the two audio transformers and the output transformer, which are enclosed in metal cases, in which they are sealed so as to be air-tight. The circuit diagram, shown in Fig. 2, will enable a better understanding of the picture of the under part of the chassis, which is shown in Fig. 3. The three r.f. transformers are placed in individual copper compartments, at the left in Fig. 3, the transformers being of the small diameter, low external field solenoid type, as can be seen in the case of the center r.f. transformer, the shield for which has been removed.

The antenna is connected to the slider of a 10,000 ohm potentiometer, through a piece of shielded wire, the potentiometer shaft being the right hand one in Fig. 3. This serves as the volume control, as can be seen in the diagram, and for long antennas, a .0001 mfd. fixed condenser is placed in series with the slider of the potentiometer to cut down the effective length of the antenna. The antenna coil is mounted at the upper right hand corner of the picture, Fig. 3, it being tuned for the first section of the four-gang condenser.

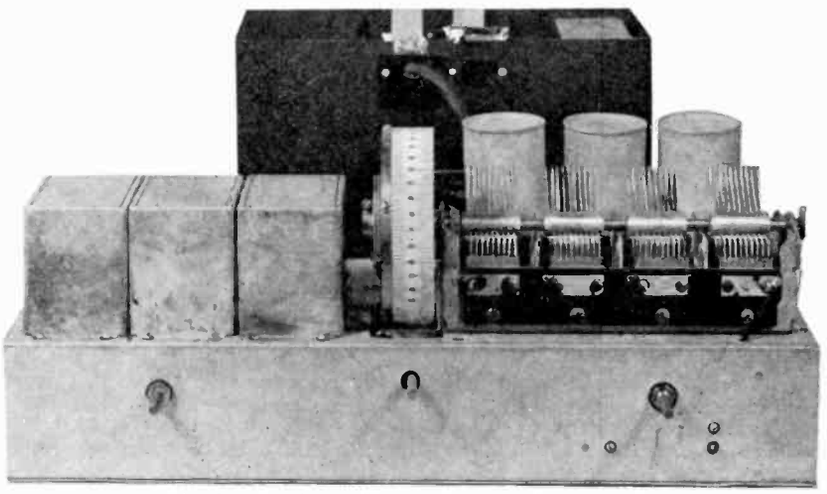

Fig. 1. Chassis and Power Plant of Majestic "70"

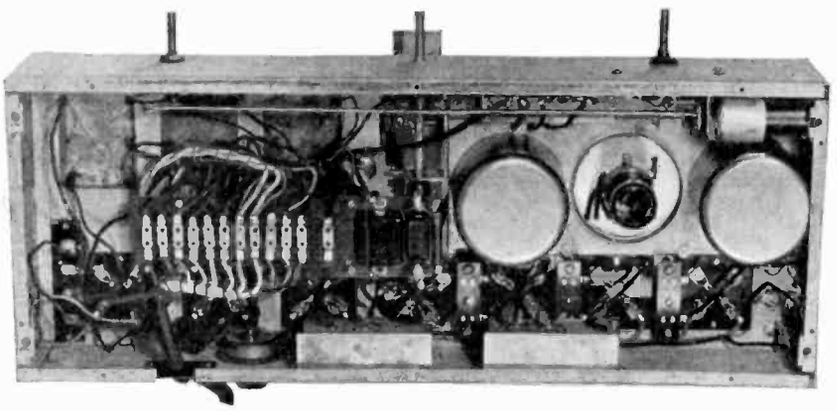

Fig. 3. Underpart of Chassis

The trimmer condenser for this tuned circuit consists of a cylindrical shield which fits down over the coil, and is varied by means of the lever arm and shaft at the left end of the panel. The shield as it fits over the coil changes the tuning of this coil slightly, and so adjusts it to resonance with the r.f. transformer secondaries. The effectiveness of this method of volume control and resonance adjustment, as well as the shielding of the set can be attested by the fact that when no antenna or ground is connected, no signals can be heard at the maximum setting of the volume control, even when the set is within a few yards of a powerful station.

(Continued on Page 52)

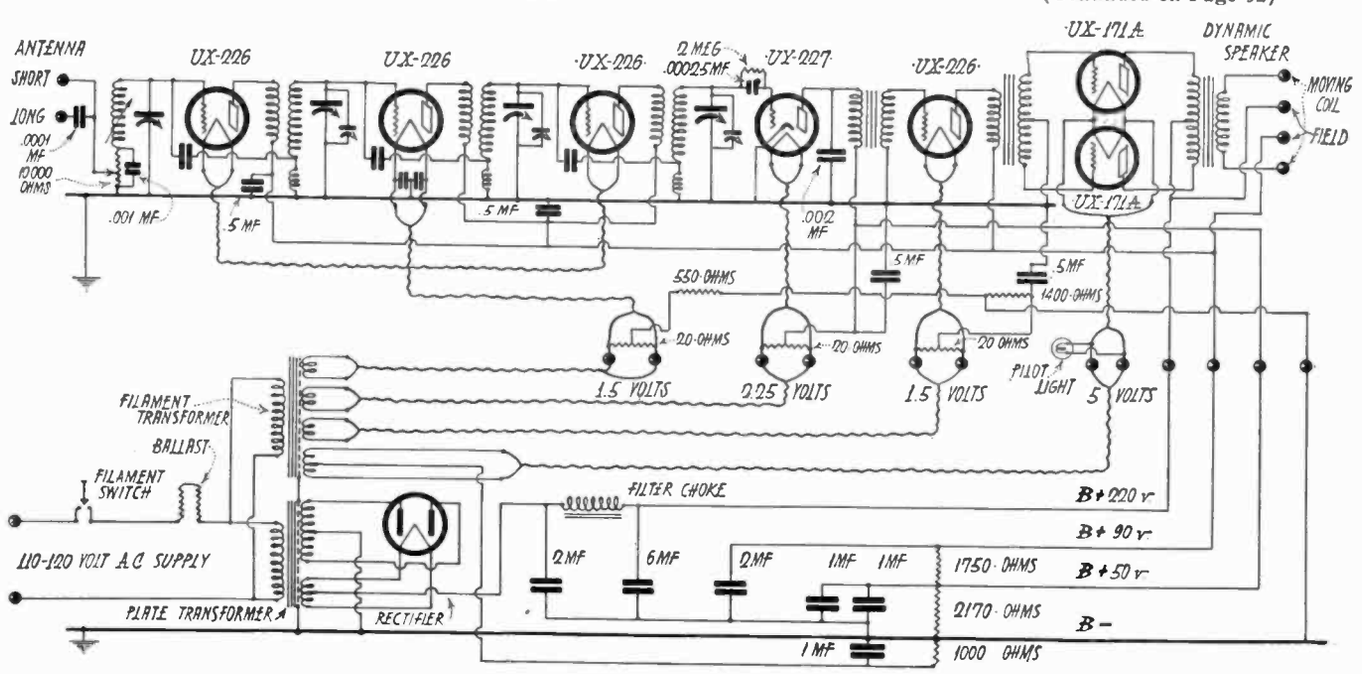

Fig. 2. Circuit Diagram of Majestic Receiver

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CHAIN BROADCASTS

(Continued from Page 20)

lead' is composed of six No. 10 enameled copper wires woven together. This lead is also under tension.

"The fundamental wavelength of the antenna system is in the neighborhood of 326 meters. The series condenser is used to work at 1060 kilocycles and 1000 kilocycles. We have found this type antenna indispensable in maintaining an exact frequency. The counterpoise system is used due to very high ground resistance.

"I am working with KMOX at the present time to have them install a temperature controlled crystal so that we may further develop that idea."

The official statement of Dr. Dellinger commits, for the first time, the Bureau of Standards to the feasibility of assigning a single wavelength to a chain of broadcasting stations. The practice of tying up 30 or 40 channels for the transmission of the same program has not only resulted in an extravagant use of half of the available wavelengths allotted for broadcasting, but radio fans have justly condemned the system because of the duplication of tuning from one end of the dial to the other.

Chain broadcasting systems, when confronted with the suggestion of synchronization of a group of stations on one frequency, ordinarily have rebuffed the idea with objections. For example, C. W. Horn, chief broadcast engineer of the Westinghouse Electric & Manufacturing Company, told this writer that the cost of converting a group of stations to a single standard of operation would be relatively large. Other engineers have voiced objections on the grounds of heterodyne interference—though synchronization experiments between the Columbus and St. Louis broadcasting stations disprove this, there being an entire absence of heterodyning. In fact, two stations in Massachusetts—WBZ and WBZA—have been operating on one wavelength for two years or longer.

The special piezo-oscillators to which Dr. Dellinger refers govern the frequency with great precision. For instruments of this type, equipped with temperature control, national and international comparisons have shown that they are reliable to a few parts in 100,000. The Bellevue Naval Research Laboratory, according to claims, has developed a frequency standard that is accurate to a few parts in a million. This is known as the "Navy's primary frequency standard." A similar degree of accuracy has been attained by the Bell Telephone Laboratories, Inc., in the design of frequency standardization instruments.

For the A.C. Set Builder

The name—"WESTON" on any meter you select is the highest guarantee of long life and dependable service with the lowest cost of instrument upkeep. The following three models are recommended for those having professional or technical interest in radio set construction—builders, transmitting and repairmen and all others who demand the best obtainable operating performance.

Model 301 D. C. Milli-ammeter

3¼" diam. Also Model 506 2" diam.

Use of Milliammeter in the Plate Circuit

For checking plate current and plate and grid battery conditions. Low B and C battery voltages determined by direction of fluctuation of the pointer when strong signals are received. Placed in the B-battery lead this instrument checks the set as a whole, or it checks any one radio or audio stage when placed in the plate circuit of that stage. Price, $8.00.

Model 489

1000 Ohms per Volt

D.C. Portable Voltmeter—1000 ohms per volt resistance guaranteed. For checking output of battery eliminators. Also made in lower resistance models for general D.C. testing service. Price $13.50 to $28.00.

Triple Range A.C. Voltmeter

150/8/4 volts. A compact, light-weight, portable instrument with red and black mottled bakelite case for testing A.C. supply and tube voltages of socket power A.C. receivers. Also made as double-range voltmeters up to 600 volts, and as single-range ammeters and milliammeters. Price, $13.50 to $18.50.

Model 528 3 Range

150 8 4 Volts

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Graybar Electric Company, Inc. 84 Marion St. Seattle, Wash.

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WESTON RADIO INSTRUMENTS

STERLING

SOCKET POWERS

Sterling "A" Power Supply with proper "B" unit, makes a good D.C. tube set completely electric.

R-81 "B" Power

R-81 is one of Sterling's most successful products. It is the most compact "B" Socket Power Supply on the market. Voltage regulation for detector, amplifier and a master control to regulate voltages proportionately. Operates from 115 volt, 50-60 cycle. Size 7½ x 4½ x 5½. **Without tube, $25.00. B. H. Raytheon tube, $4.50.**

R-93-V Dri-A Power

R-93. Used with Sterling "B" Power to make good D.C. tube set completely electric. Voltage regulated: one point control.

Complete with bulb, $39.50.

R-375

PRE-AMPLIFIER

***R-375 Sterling Screen Grid Pre-Amplifier* Gives to Old and New Radio Sets the Advantages of the 222 Screen Grid Tube.**

The Pre-Amplifier, using the 222 screen grid tube, may be used on practically all 6-volt D.C. tube sets to obtain more distance, better tone, greater selectivity and less static. The Pre-Amplifier is connected in ahead of the 6-volt D.C. receiver.

It is ideal for sections where a radio set must bring in stations hundreds of miles away in order to get really desirable programs.

Model R-375 Sterling Pre-Amplifier is equipped with switch and power cable having marked leads. Easy to install. Two tone bronze case. Size 7½ x 4½ x 5½". Shipping weight in lots of 6, 22 lbs.

R-375 for 6-volt, without tube $13.00
Radiotron UX-222 Screen Grid Tube $6.50

TESTERS

One lost sale would equal the cost of several Sterling testers.

R-512 Sterling A.C. Tube and Set Tester for the radio service man. Tests plate current, tests for open grid circuits and "A" and "B" power supply; locates defective tubes and sockets; tests the set wiring, etc.

R-512 Tube and Set Tester

Price $35.00

R-510 A.C. and D.C. Tube Tester; tests all tubes. **Price $35.00.**

R-417 Sterling A.C. Line Voltmeter enables the service man to make correct power adjustment for A.C. tubes. Simply screw the plug into the electric light socket and the true line voltage is obtained at a glance.

R-417 A.C. Line Voltmeter

One set of tubes saved by testing more than pays for this device. Pocket size, simple and efficient.

Price $7.50

DYNAMIC AND VARI-TONE SPEAKERS

Blind tests—in which the identity of various speakers was unknown—conclusively proved that the new Sterling speakers reproduced tone more faithfully than all others in their price class.

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Cleveland, Ohio

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Wholesale Division of

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Replace your old radio!

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6 tube GEMBOX AC ELECTRIC $65

You will not be satisfied with your old set after you hear one of the new Crosley's. The new full toned power speaker Crosley sets are 1928's greatest radio achievement. Compare a Crosley set with any other and you will find it to be up-to-date—genuine neutrodyne, selective, sensitive, illuminated dial, completely shielded, volume without distortion and adaptability for installation in any type console cabinet.

Show Box $80

Band Box $55

Musicone $15

Band Box Jr. $35

FIVE DAYS FREE TRIAL IN YOUR OWN HOME

Crosley Dealers are authorized to home demonstrate any Crosley Receiver. This is the only way to buy radio. Visit your nearest dealer or write Dept. 19 for his name and address.

CROSLEY

The Crosley Radio Corporation
Powel Crosley, Jr., *Pres.* CINCINNATI, O.
Montana, Wyoming, Colorado, New Mexico and West prices slightly higher
Prices of Crosley Radio Receivers do not include tubes

TELEVISION

although still in an experimental stage, has now advanced sufficiently to enable amateurs to build outfits that will give edifying results.

Write today for our price list of television apparatus.

Photo Electric Devices, Inc.
594 Fifth Ave. Brooklyn, N. Y.

A PORTABLE SHORT-WAVE RECEIVER

(Continued from Page 34)

num brackets, and a strip of ¼ in. bakelite 2¼ x 14 in. long, apparatus can be mounted on both sides of the strip, thereby cutting the depth of the set in half, as compared with the customary bread-board style of mounting generally used in short wave receivers.

The audio transformers were selected not so much because of their tone quality as for compactness and rugged mechanical construction; for headphone reception, the tone quality on WGY at 3000 miles distance was excellent.

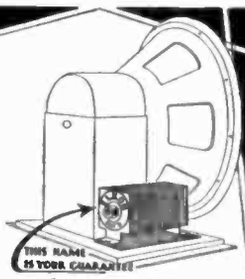
Underneath the subpanel adjacent to the coil mounting, the plate r.f. choke was mounted, and the antenna binding post was placed at the right hand end of the base. Two fixed resistances, one of 3 and the other of 4 ohms, are also mounted on this base, to control the voltage of the 99 tubes. In order to eliminate a voltmeter and panel rheostat, these resistances were selected so as to reduce the voltage across the three filaments from 4½ to 3.3 volts when the dry cells are new, and by means of a flexible wire with clip, the 3 ohm resistance can be cut out when the dry cells have dropped .6 volt. When the cells have dropped to 3.3 volts, the entire resistance group can be cut out, and while this removes the *C* bias from the two audio tubes, it enables getting the last watt out of the batteries, an important consideration when several thousand miles from the nearest source of supply.

The panel apparatus consisted of the two tuning condensers, with vernier dials, a filament switch, volume control resistance, and output jack. The volume control consisted of a 500,000-ohm potentiometer shunted across the secondary of the first audio transformer, and while not absolutely necessary, is a handier control of volume than the tickler condenser.

In the picture of the set installed in the cabinet, the relative size of the outfit can be seen. Below the set, in the box, are three standard size 1½-volt dry cells, and two small 22½-volt *B* batteries. The dry cells for the filament will last for about 150 hours of intermittent use, and the *B* batteries for about the same period, so that with two sets of spares, nearly 500 hours of service is possible with the set. The two stages of audio are designed to give as much amplification as possible for headphone reception, and hence the last audio tube will not operate a loud speaker. If a loud speaker was required, at least 90 volts and 4½-volt negative grid would be needed for the last audio tube for any sort of volume.

The complete set, with batteries, tubes, cabinet, headphones, and three sets of coils, weighs 20½ lbs., of which

(Continued on Page 48)



Bought Your New Dynamic Speaker Yet?

WELL, when you do, look for the Elkon Rectifier—you'll find it on good dynamic speakers about in the position shown above—no matter whether in sets, cabinets or separate units. You can't fail to recognize it, by its solid, husky appearance.

For your own protection make the dealer show you the Elkon name plate on the end of the rectifier.

ELKON RECTIFIERS

Standard equipment on the better DYNAMIC SPEAKERS, A ELIMINATORS *and* BATTERY CHARGERS

Gerald M. Best's

BLUEPRINTS

for the 115 K.C. Super

In Two Colors

25 CENTS POST PAID — Also a Complete Manual of Instructions

"RADIO"

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THE BARAWIK CO. has, all these years, been famous for its variety of radio supplies, which it offers at money-saving prices. Newest dynamic speakers, "B" eliminators, socket power equipment, A-C harness, fine cabinets and furniture, amplifiers, latest amateur equipment, tubes, batteries; in fact, anything you can ask for is here, ready to ship, at a saving in price. Quality merchandise, selected goods by reliable makers — just what you want — at big discounts.

Your Savings are Tremendous

Ask any of the quarter million Barawik customers why they trade here, and they'll tell you that, **quality considered**, our prices can't be beat. That's something to think about! Quality comes first—new, fresh, good reliable merchandise, but the price always means a tremendous saving, nevertheless. Get our catalog and prove this to yourself. Don't spend a nickel until you see our offerings first.

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Jensen
DYNAMIC SPEAKER

The new Jensen cabinet models are in full production in both Jensen factories. Orders, regardless of quantity, are being shipped promptly. Jensen distributors throughout the country have these new models in stock.

Above is shown the new Jensen Model 7 Console. List prices range from $75.00 to $90.00 depending upon the type of Jensen Dynamic Speaker unit installed in the cabinet.

FULL PATENT PROTECTION

Jensen Dynamic Speakers are manufactured under the patents of the Lektophone Corporation, and also under Electro-dynamic patents which name Peter L. Jensen as co-inventor. Additional patents are allowed and pending covering exclusive Jensen features.

No other dynamic speaker offers such advantages: licensed under Lektophone and Dynamic patents and constructed under additional exclusive Jensen patents.

SIFTING THE DYNAMIC SPEAKER FIELD

The new Jensen Model 6 Cabinet (shown above) sets a new vogue in truly artistic and finely finished cabinet design. Prices range from $55 to $70, depending upon type of Jensen Dynamic Speaker Unit installed in cabinet.

Jensen Dynamic Speaker Units for installation in radio or phonograph cabinets are priced at $40, $43 and $55. Made in types to operate with 6 to 12 volt D.C., 100 to 120 volt A.C. and 90 to 180 volt D.C.

Jensen Dynamic Speakers are fully protected by licenses and patents as follows:

Licensed under Lektophone Patents . . Licensed under Magnavox patents . Jensen patents allowed & pending

DEALERS, jobbers and manufacturers have quickly learned to sift the dynamic speaker field. Jensen continues as the standard of comparison, and Jensen popularity increases each day as the real advantages of a true tone dynamic speaker are understood.

But this steadily increasing leadership is a perfectly logical result for no other dynamic speaker has these five points of excellence—typical Jensen features.

1. Manufactured under both Lektophone and Dynamic patents.
2. Exclusive features in design covered by Jensen patents allowed and pending.
3. In quantity production for over a year with uniform high quality maintained.
4. Selected by leading radio set, cabinet and coin operated phonograph manufacturers as standard equipment.
5. Two factories in full production; deliveries apace with demand for the first time.

Five proven advantages—and the reason for Jensen leadership in the dynamic speaker field.

Write or wire us regarding wholesale or retail distribution in your territory.

Jensen Radio Manufacturing Company

212 Ninth St., Oakland, Cal. 338 North Kedzie Ave., Chicago, Ill.

Console Model. A beautiful walnut finished cabinet, furnished in 6-tube and 7-tube push-pull. Equipped with "Peerless" Speaker.

Size 26"x40"x16" deep.

Your Own Label On This Radio

Your Best Business Builder!

There's no business-builder in the world like a good radio in action! And *no* radio can deliver better than the Premier. Put *your* private label on it—and *get ALL THE BUSINESS THAT IT BUILDS!*

Private-label radio brings you longer profits; its flexible price meets any kind of competition or market; it frees you from top-heavy inventories and territorial contracts; you order only what you need. And—*private-label radio preserves your trade identity, your most valuable possession.*

Material and manufacture—*not advertising!*—determine the quality and salability of a receiver. Premier Private-Label Radio is equal to any on the market in performance, looks, quality and salability. Table and Console Models—furnished standard in 6-tube and 7-tube Push-Pull.

Chassis Specifications

All-metal chassis; rigid, strong, stays put. Unconditionally guaranteed. Apparatus 100% shielded. Licensed under U. S. Navy Patents and Hogan Patent No. 1,041,002.

Write for price and full details. No obligation.

PREMIER ELECTRIC COMPANY

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50,000 Feet of Radio

50,000 square feet of floor space in a large modern building devoted exclusively to radio. Tremendous stock of latest kits, parts and sets in improved designs and styles. Write for Catalog "E-1." Wholesale Prices.

Allied Radio CORPORATION

711 W. LAKE STREET, CHICAGO

A PORTABLE SHORT-WAVE RECEIVER

(Continued from Page 46)

the batteries weigh more than half, so that the set can be termed a truly portable outfit. The cabinet was made of cedar, and with the handle weighed less than 2½ lbs., and was provided with a sliding panel at the front, to cover up the dials and front panel, and afford complete enclosure of the set and batteries.

This sort of a receiver would be ideal for a summer camp or automobile trip, where it was desired to keep in touch with events at home, at places where distance reception with an ordinary broadcast receiver would be out of the question. Only a short antenna is required; on this particular model, WGY was received in California with only 10 feet of wire indoors, and with good headphone volume; ample proof that 25 or 30 feet of wire thrown up into a tree, or suspended a few feet above the earth, will be sufficient.

BYRD EXPEDITION TRANSMITTERS

The Byrd Antarctic Expedition is equipped with three transmitting and receiving sets to be employed on ships and at the base station. Three transmitters of the 500-watt, intermediate-frequency type have been supplied by the Radiomarine Corporation. One is aboard the S. S. *City of New York,* and another aboard the S. S. *Chelsea.* The third is intended for use at the base station of the expedition, which will be established on the ice. Three short-wave receivers have also been supplied, to accompany the transmitters. These will maintain communication at least with stations in South America, New Zealand and Australia. It is also expected that communication will be maintained between the base station and the planes of the expedition.

Commander Byrd has laid out an elaborate system of contact between the various parties of his expedition. He has selected five experienced radio men to accompany him and be responsible for the operation of the radio equipment.

In addition to the stations on the supply ship and at the base, each of the exploring parties, whether flying by airplane or traveling by dog-sled, will have portable short wave transmitters and receivers. Five of these sets, which are alike, have been designed and built by the C. F. Burgess Laboratories, Inc., Madison, Wisconsin.

The transmitters as well as the receivers are powered by dry batteries. To retard any reduction in service due to the low temperatures which may fall to 75° below zero, special battery boxes have been constructed and heat insulated with balsam-wool.

Marvelous Reception

Full tone over the entire receiving range by equipping your Power Amplifier with a Potter Condenser Block.

No. T2900 where one 250 Type Power Tube is used **$20.00**

No. T2950 where two 250 Type Power Tubes are used **$22.50**

Highly Efficient—Long Life

The Choice of Leading Radio Engineers

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Dealers and Set Builders

THE NEW 1929 Catalog is crammed full of the FINEST, NEWEST, Nationally known A.C. sets, consoles, cabinets, dynamic speakers, kits, eliminators and accessories at LOWEST PRICES. Largest stock of radio parts. Prompt delivery.

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"The Big Friendly Radio House"

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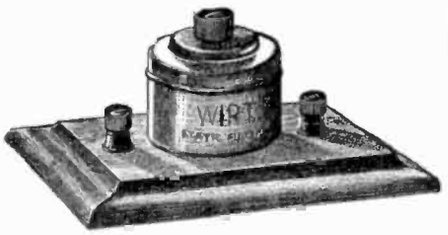
The complete working plans in full size for building the new incomparable Gerald Best 115 Kilocycle superheterodyne with full instructions for building.

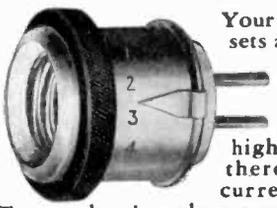
25c Per set. Postpaid anywhere in the U. S. Send remittance by cash, check or money order. Stamps also accepted. "RADIO," Pacific Bldg., San Francisco, California.



Cut down static

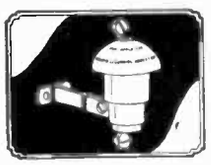
Wirt Static Filter *works!* Only $2.25. Put it in series with aerial, adjust to suit—once set, it stays set. Sharpens selectivity, takes out static, improves music and speaking voice. Guaranteed. Try it. If it doesn't please you, you can have your money back. Only $2.25.

Don't burn out tubes



Your A-C tubes and sets are built to do best on 110 volts. In many places the normal voltage is higher. In addition there are frequent current "surges". Too much voltage burns out tubes and set. Stop it! Use Wirt Voltage Regulator, only $2.25—makes tubes last longer, suppresses line noises.

Keep out lightning



Safeguard set, and house, with a *real* lightning arrester, the Wirt. Air gap type. Made of bakelite and brass—"petticoat" insures ample insulation, even in rainy, snowy or sleety weather. Terminals are extra heavy—and so arranged that aerial can be connected without cutting it—much the best practice for better reception as well as for complete protection. Bracket insures rigid fastening. Only $1.00.

Any radio dealer can get you Static Filter, Regulator, and Lightning Arrester. Or send check—we'll ship postpaid by return mail.

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Makers of "Dim-a-lite" *and* "Dim-a-Lamp"

Do You Run Your Radio—Or Does It Run You?

Do you control your loud speaker volume to fit the occasion—from soft, mellow musical background to loud, sharp, fascinating and attention-arresting entertainment? "THE GATEWAY TO BETTER RADIO" tells how to make the radio do *your* bidding, how to avoid distortion, deals with a hundred and one things. 25c a copy and worth it many times over. From your dealer or direct from

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SETBUILDERS SUPPLY CO.
Dept. 14-2 Romberg Bldg. Madison and Market Sts. CHICAGO, ILL.

THE 1420

(Continued from Page 41)

coil is a rubber or bakelite form 2⅞" in diameter and 2" long. This form is slotted or grooved so as to leave a winding space 2¾" in diameter and 1.84" long; it is then threaded 22 threads per inch left hand, and wound with 38 turns of Litz., 36 per inch. Over this form and coil is slipped the shield coil form. This is thin tubing 2¾" inside diameter and 2" long. This tube is threaded 18 threads per inch *right hand* thread and wound with 31 turns of Litz. Owing to the difference in diameters in coil forms and the slot cut in the rotor there is about ⅛" space between coupling and shield coils.

The sec. coil or load coil is wound on a 4" micarta form 6.25" long. The secondary and part of plate coils are both wound on this form. Looking at the set from the rear you will notice that there seem to be 3 windings or sections and that a rotor shaft comes through the tube between the first and second sections of 1.375" from the left hand end of the tube. On the first section, which is about ⅝" long, 20 turns start .55" in from the end, are connected in series with the coupling coil and make the first tap of the secondary. The remainder of the secondary starts 2.25" in from the end and is wound as follows. Litz. 36 turns per inch, left hand:

Second tap	32 turns	2 bank wound
Third tap	70 turns	3 bank wound
Fourth tap	137 turns	4 bank wound
Fifth tap	264 turns	5 bank wound
Sixth tap	558 turns	6 bank wound

Total 558 turns.

Regeneration and oscillation are obtained in the plate circuit by the use of a tickler in the form of a variometer, having a stationary coil wound on the same tube as the secondary, (and between first and second sections of secondary, in series with a rotor coil which is wound on a spherical form mounted inside the secondary. When the movable part is in the 180 degree position its coupling adds to that of the stator coil, when in the zero position its coupling is subtracted from that of the stator and practically neutralizes it. The shaft on the rotor is ¼" in diameter and is 1.375" from end of tube. The stator winding of the tickler is about 7/16" long, starts 1.55" in from the end and has 36 turns, two bank wound 36 turns per inch, left hand. The rotor form is about 3⅝" by 1.84" and shaped like any ball rotor. It is wound with 56½ turns Litz. *right hand* turn.

We can all see the tube socket and squirrel cage rheostat. The latter has 17 ohms, with a 2-ohm bias tap.

The telephone condenser is a high capacity affair connected between the tickler and filament to act as an r.f. by-pass around the phones and *B* battery. It is built up of copper sheets 1.25" in diameter, and .005" thick, and mica sheets 1.50" in diameter and .005" thick. These are tapped as follows: 15 plates, 1 plate, 2, 3, 4, 5, 8 and 7 plates, or a total of 45 copper and 46 mica plates, and giving a fixed capacity of .004 MF and a variable capacity of .007 MF.

A radio frequency choke coil is used to keep the r.f. out of the phones. This is made up of 1200 turns of No. 36 SS enameled copper wire.

A grounding condenser grounds the filament and battery circuit, and is made of 55 copper sheets 1.70" by .40", .005" thick, and 56 mica sheets 1.40" by .60", .0015" thick.

The above data were used in building some of the 1420's during the war, and as it is sort of obsolete in the Navy now, I guess it will be o.k. to use it.

DEAD-END SWITCHES

The high inductance sections of the antenna and secondary coils are resonant at

Helps You Pass Government Radio Examination

An Excellent Book

"PRACTICAL RADIO TELEGRAPHY"

380 Pages

$3.00 SENT TO YOU POSTPAID

"RADIO"

Pacific Bldg. San Francisco, Calif.

Earn $75.00 a week *In Your Spare Time*

As a member of the Radio Association, you can earn $3 an hour in spare time, learn to install, repair, build sets, buy at wholesale, train for $3,000 to $10,000 radio positions, secure a better position, take advantage of the success-tested, money-making plans of the Association. **Your membership need not cost you a cent if you act now.**

Earned $500 in Spare Hours

Hundreds earning $3 an hour as "Radio Doctors". Lyle Follick, Mich., has already made $500 In his spare time. Werner Eichler, N. Y., earns $50 a week spare time. F. J. Buckley, Mo:, makes as much in spare time as he receives from employer. W. E. Thon, Chicago, as result of Association, secured a position at a 220% salary increase. K. O. Benzing. Ia., went from clerk to owner and is now making 200% more.

A membership in the Association starts you in business if you wish. It has increased salaries of many. Scores of our members are now with big radio companies.

Becomes A Radio Engineer Quadruples Income

A year ago, Claude De Grave knew nothing about Radio. Today, he is on the staff of a famous radio manufacturer and an associate member of the Institute of Radio Engineers. He attributes his success to joining the Association. His income now is 350% more than when he joined.

If ambitious to become a Radio Engineer, to fit yourself for a $3,000 to $10,000 opportunity, join the Association and receive the comprehensive practical and theoretical training you need and the aid of our Employment Department. Learn of the amazing ways the Association can help you. Write today.

ACT NOW—for No-Cost Membership

Send for details of Special Membership Plan that need not—should not—cost you a cent. Write today for our book, "Your Opportunity in the Radio Industry" that will open your eyes.

Radio Association of America
Dept. R-10 **4513 Ravenswood Ave. Chicago**

Send me your book and details of your Special Membership Plan.

Name .....

Address .....

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

CeCo

RADIO TUBE *for* A-C *sets*

THE unqualified endorsement of CeCo Radio Tubes by the leading radio engineers including Cockaday, Lynch, Hurd, Bernard and many others, is conclusive evidence of their proven performance.

Their uniformity, extreme clearness of reception, and absence of A.C. hum, are largely due to the exclusive CeCo process of evacuation.

You owe it to your radio to try a set of CeCo tubes to gain the utmost in radio reception. A CeCo dealer will gladly advise you which types to use.

CeCo MANUFACTURING Co. Inc.
PROVIDENCE, R. I.

wavelengths near the operating ranges of the low inductance sections and therefore would weaken signals on lower wavelengths. To overcome this the inductance switches are provided with fine blades, so as to short circuit unused portions of inductance. A pointer driven by the inductance switches indicates, on the proper one of six circles on the condenser dial the wavelength to which the circuit is tuned.

A Federal anti-capacity switch is provided for connecting battery circuit and crystal detector. In the send position the filament and plate batteries are both disconnected. In the Crystal-R.F. positions the detector tube is disconnected so that the tuning circuit can be hooked up to an r.f. amplifier or a crystal detector hooked onto the set. The dials are white metal 4.50" in diameter and $\frac{1}{8}$" thick. One half of the dial is engraved 0° to 180° or 0° to 100°, and on the other half are engraved six half circles. These are .25" apart, and wavelengths are engraved on them after the receiver is calibrated.

I would advise anyone interested in building a set similar to this one to get a copy of RADIO for June, 1923, or December, 1922, and read D. B. McGowan's article on a portable receiver for 150 to 5000 meters. The enclosed data were, as I understand, used on the original 1420, and although various improvements have been made, the coils and condensers remain the same.

The shield coil has been disconnected in some, as has the choke coil. Some later models use a grid-leak and condenser instead of the bias tap.

In commercial adaptations of this set the antenna series condenser is a little larger, .0015 MF instead of .0014 MF, and the secondary condenser is .00075 MF instead of .0007 MF. These changes of course allow the set to tune to a higher wavelength. Some sets have binding posts so that external load coils may be attached for longer wavelengths.

LETTERS TO THE EDITOR

"Radio Conditions"

Sir: Discussions of the Radio "game" afloat, in this department, have been absorbing—especially the always interesting contributions of Mr. Gillis, comment by the department editor and many others. However, for the instant, look at the job afloat, not as a so-called "game," but as it stands stripped of superfluities—simply a wage earner's occupation beset by supposedly insufferable conditions. (No one but the operator regards it as a "game.")

The occupation carries certain impedimenta of tradition, fascination, mild adventure, some romance, bits of mild egotism and what-not, which collectively cloud facts and befog issues.

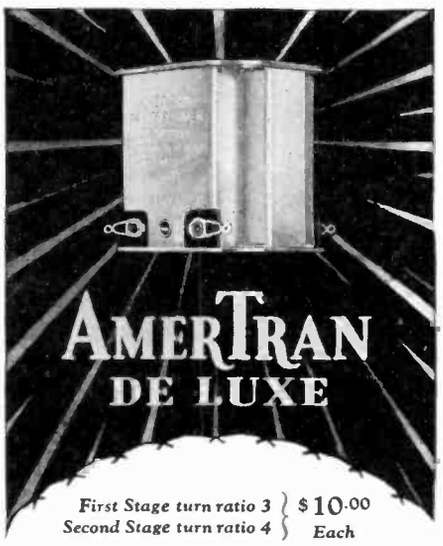
The ship operator's job leads him into a cul-de-sac. In strictly ship radio work, promotion is impossible. Amelioration of conditions is limited to a betterment of the local situation on an increase in pay.

Given local conditions, in general, afloat, affect most all ship's officers in practically equal degree. Operators have scant hope of dictating conditions to which other officers are subject.

Increase in pay has been attempted by: (1) individual effort; (2) mistaken efforts to "increase operator's efficiency"; (3) by organization; (4) by strike or (5) through radio companies.

In general, individual efforts to increase salary are nil in result.

"Increase in operator's efficiency," to gain wage increase, is a hollow mockery, and a boomerang. Through radio service contracts, in general, employment of operators, and as actual agents of the steamship company, the radio concerns automatically take care of the "efficiency" of operators—hiring and firing as the service demands. Radio



First Stage turn ratio 3 } $10.00
Second Stage turn ratio 4 } *Each*

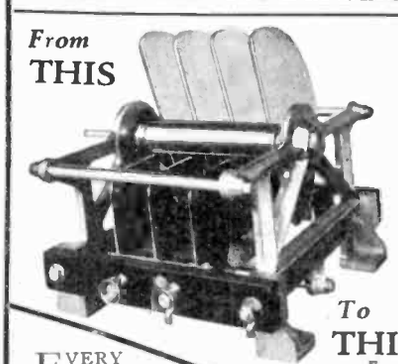
Standard of Excellence in Audio Amplification

AmerTran De Luxe Transformers are but two of more than 30 quality Radio Products bearing the name AmerTran, including power transformers, choke coils, push-pull systems and allied products. Each AmerTran device is designed for a specific use. Full and authoritative information will be given on any audio or power problem.

AMERICAN TRANSFORMER COMPANY
Transformer Manufacturers for 28 Years
273 Emmet St., Newark, N. J.

CARDWELL CONDENSERS

From THIS



To THIS

EVERY Cardwell Variable Condenser embodies the same basic design, proved fundamentally right and sound.

A folder, now in preparation illustrating and describing several special types of transmitting condensers recently supplied for high powered installations will be mailed to you if you wish it, or your request for recommendations for your job will be promptly complied with.

High voltage transmitting condensers,
Transmitting condensers for medium and low power,
Fixed (air dielectric) transmitting condensers,
Receiving condensers.

There is a Cardwell for every tube and purpose

The Allen D. Cardwell Mfg. Corp.
81 Prospect Street Brooklyn, N. Y.

"The Standard of Comparison"

concerns furnish men and conduct operations to the satisfaction of the steamship company. Otherwise radio contracts are either cancelled or not renewed, being placed elsewhere. Gaining the sentiment ($) of shipping companies by "increase in efficiency" of operators is a pretty (and apparently mighty tempting) hallucination in which the uninitiated set great store—but which has been exploded innumerable times since the advent of radio afloat. Sight should not be lost of the fact that demands for "increase in efficiency" of operators pass directly to the radio company—not directly and primarily to operators—at least from the contracting steamship company's point of view. In general, present "efficiency" satisfies shipping companies. Novices should not thrust upon the steamship company what it has not demanded—not expected—neither, in excess of that which it has contracted for, and is paying for.

Of organized efforts to gain greater wages, little has been accomplished. With industries in the hands of corporations, the concrete efforts of employees' organizations along these lines have been doubtful. Witness the boundless evidence of the invalid efforts of craft unions in the United States—except purely locally, or temporarily—or in scattered spots, and—or under extraordinary or unique conditions. Notwithstanding, every industry, every group, every syndicate of employers in the country are organized and more or less interlocked throughout the country—and can so function if business reasons demand. Sadly enough, employees often fail to see benefit in organizations themselves. Organization and interlocking relations both together constitute a fundamental essential of all effort and progress—de facto, a veritable key to the universe, down to the last single electron.

Attempts to force increase in salary, as regards this vocation and many others, remain abortive. Evidence is abundant that strikes in the United States are becoming, more or less, a thing of the past—in general, the effect being futile (perhaps a bitter fact, yet undeniable).

Alliance with radio concerns to effect an increased wage in ship work, also remains abortive. A high official of a world-wide radio concern told the writer: "We would like to see operators afloat obtain reasonable, even high, wages for their highly skilled work. But we must preserve our own scalps. Through contracts we are, in effect, servants of the steamship company—actually a subdepartment. Undesirable or not, as it may be, we are helpless to aid the operators in this direction. The operator must fight his own battles—and keep his slate clean with us." A very comprehensive and final statement.

Some caustic, some futile, some unreasonable, some misleading and some infantile comment appears in publications from time to time regarding conditions and causes for present conditions afloat. True it is that exasperation crops up and with good apparent reason, yet internal strife defeats any common objective. One singularly obnoxious phase of the matter is the derogation of American operators—by American operators. Most of this comes from uninformed sources, or from spur of the moment repartee. American radio communication systems are the premier of the globe, not because we just like to think so, but because traffic handled and men and equipment employed prove it.

Another matter. Amateur and commercial radio telegraphy do not readily mix. The hue and cry for the necessity of amateur radio has a proper and admirable genesis and the amateur has a desirable niche in the scheme of things, but not at sea on merchant ships. The utter essentiality of the amateur's usefulness during the war is often overstressed, especially as regards the Navy. In contrast,

(Continued on Page 54)

The New Knapp "A" Power Kit

This is the "A" power after you have assembled it. A professional job! Operates on 105 to 120 volts, 50 to 60 cycles AC. Supplies ripppleless DC current for operating any set using Standard 5 or 6 volt tubes and power tubes.

Greater Efficiency—

Improved Design and Appearance—Lower Price—Money-making Plan for Set-Builders

You radio fans who made my "A" power the largest selling "A" power last spring have made it possible for me to offer the finest "A" Power ever developed—in Kit form—even more complete than before. Study the illustrations—read the improvements—and you will wonder how I was able to reduce the price. You are the answer. I sold 5 times as many "A" Powers as I expected to—and this season I am counting on you to help me again by buying even more.

The 8 Improvements

1. **Larger Filter System — 3 Elkon Condensers instead of 2. Ideal for Super Hets and Short Wave Sets.**
2. **Improved Choke Coils**
3. **Pendant Switch Controlling "A", "B" Eliminator & Set**
4. **Dial for regulating voltage**
5. **Celeron Front Panel**
6. **Baked finish**
7. **Heavier gauge metal cover**
8. **Die Cast Base Plate instead of wood**

COMPLETE KIT—EASILY ASSEMBLED

Like my Kit last year, the New Knapp Kit is a tooled job—the parts seem to fall into place. Every hole is drilled—all that it is necessary for you to do is to put the screws and nuts in place and connect a few wires. Everything is supplied. Nothing for you to buy extra. The fool-proof instruction sheet makes it easy for anyone to assemble.

THE SET-BUILDER TAKEN CARE OF

You set-builders played with me (as the saying goes) and I am going to continue to play with you. My engineers have designed an "A" Power which is well-nigh perfect—my production men, based on tremendously large quantities have cut their cost, so that I can keep faith with you by reducing the cost. *And* regardless of what the established trade may think about it—I am going to continue to give you the maximum discounts. The coupon will bring you the full details of both the new "A" Power and the special discounts to set-builders.

David W. Knapp, *Pres.*

KNAPP ELECTRIC, Inc., Port Chester, N. Y.
—Div. P. R. Mallory & Co., Inc.—

Mr. David W. Knapp, *President*,
KNAPP ELECTRIC, Inc.,
335 Fox Island Road, Port Chester, N. Y.

Kindly send me complete information on the Knapp "A" Power and your special discounts for Set-Builders.

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Lessen Static

Tune More Sharply

Bring your set up to maximum sharpness with X-L Vario Densers

Practically all of the popular high grade circuits now use X-L Products. Perfect reception is always assured because of the accurate values and dependable service these well known products give. Endorsed by leading radio engineers, designers and builders and standard in most quality sets. Broad and positive capacity range that assures exact oscillation control easily obtained with both Model "N" and Model "G" Vario Densers.

Model "G" Vario Denser

Genuine Bakelite casing, dust and moisture proof. All metal parts phosphor bronze nickel plated. Only the best imported India mica used. Extreme micrometer capacity advance, exceptional accessibility in close quarters. Model "N" has variable capacity adjustable from 1.8 to 20 micro-micro farads. Price each, $1.00.

Model "G" with grid clips made in three variable capacity ranges, viz: Model G-1, .00002 to .0001 Mfd.; Model G-5, .0001 to .0005 Mfd.; Model G-10, .0003 to .001 Mfd. Price each $1.50.

New BAKELITE INSULATED

X-L PUSH POST

X-L Push Post

The most perfect binding post made. Push down with thumb, insert wire, remove pressure, wire is held firmly. Vibration will not loosen but releases instantly when you wish. No chance to forget to tighten. Positive, permanent. Plain or all standard markings. Also made in all-metal design. Price each 15c.

Strip of 7 on black panel with white markings, price $1.50.

Write for interesting and valuable free copy of our new up-to-date book of wiring diagrams showing use of X-L units in all leading circuits.

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Audio Frequency Transformers

Send 15c in coin for copy of the 1928 Year Book.

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130 West 42nd St., New York, N. Y.

Gerald Best's SUPER BLUE PRINTS

The complete working plans in full size for building the new incomparable Gerald Best 115 Kilocycle superheterodyne with full instructions for building.

25c Per set. Postpaid anywhere in the U. S. Send remittance by cash, check or money order. Stamps also accepted. "RADIO," Pacific Bldg., San Francisco, California.

THE MAJESTIC "70"

(Continued from Page 42)

The variable condenser group is also shielded, this shield having been removed when the picture was taken. This group is controlled by a single drum dial, the control shaft being in the center of the chassis. The individual trimmers for these condensers are adjusted at the factory.

The detector is the usual type '27 a.c. tube, and the audio frequency amplifier consists of a type '26 first stage, and a push-pull second stage using type '71 tubes. The output of the set is fed into an electrodynamic cone speaker, the field of which is excited by 90 volts d.c., obtained from the rectifier system in the power plant, which is shown in back of the chassis in Fig. 1. The power plant consists of a type '80 full-wave rectifier, supplying 200 volts d.c. for the *B* and *C* potentials, as well as the field of the loud speaker, and the usual 1½, 2½ and 5-volt windings on the power transformer supply the filaments of the tubes and the pilot lamp on the drum dial.

The voltage divider resistances are indicated on the diagram, as are the values of the filter condensers, and the various *C* biasing resistances in the set itself. *C* bias is obtained by means of the voltage drop across these resistances, which are placed in the negative *B* supply lead. While the electrical center of the filament circuit for the three r.f. tubes is obtained by means of a center-tapped 20-ohm resistance, of a fixed type, the small amount of residual hum in the receiver is balanced out at the time of installation by a 20-ohm potentiometer across the filament of the first audio tube, this resistance being placed on the back of the chassis, so as to be accessible from the rear of the cabinet.

A liberal use of ½ mfd. bypass condensers localize r.f. currents to their proper paths, and r.f. chokes in the grid return circuits of the r.f. amplifier tubes prevent ultra-high frequency oscillations between stages.

In the power plant, a voltage regulator consisting of a resistance bank is placed in the primary circuit of the power transformer, which is especially designed for this resistance. This assures regulation of voltage to the tube filaments, and of the plate supply, for any ordinary line condition. The output voltages of the power plant are run to a set of binding posts, to which the connecting cable is fastened, and the electrodynamic speaker in turn is connected to four terminals on one end of the receiver chassis. Note in the diagram how the speaker field is connected between the positive 90 and 180-volt *B* taps, instead of between the negative and positive 90-volt *B* terminals. The arrangement of the bypass condensers in the r.f. circuit is such that the r.f. currents follow a very short path to ground, instead of passing through a common *B* positive lead for some distance before reaching the proper bypass through a condenser.

Radio Kit Reviews

THE AERO INTERNATIONAL

The Aero International kit comprises a complete outfit for the construction of a short-wave broadcast receiver comprising one r.f. stage, detector and two stages of audio. The r.f. stage uses a shield-grid tube and plug-in coils which cover the different short-wave bands used by broadcasters.

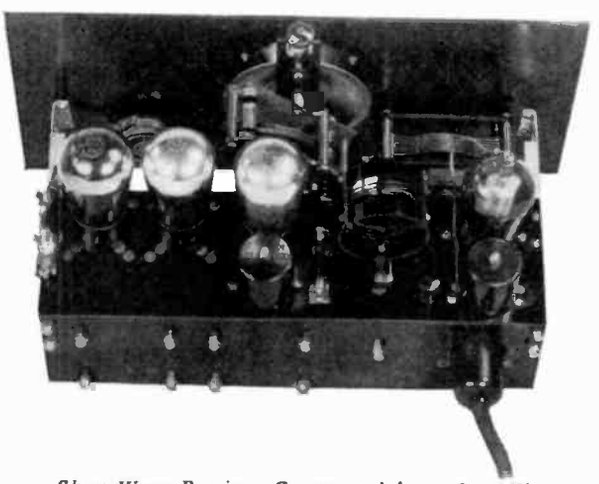
The kit includes bakelite panels, with a completely wired sub-panel so that the unit can be completed by connecting a few wires to the instrument mounted on the front panel. The last audio stage is wired so that either a '71 or a '12 type of tube may be used.

The set has but one tuning control and is non-radiating. It also has a smooth volume control and a filament rheostat, there being but three knobs on the front panel.

KGER of Long Beach, Calif., recently broadcast a unique description of the regatta conducted by the Pacific Southwest Exposition. This was done by means of a portable transmitter on the regatta barge whose radiation was picked up and amplified at a shore receiver and then transmitted by wire to the broadcast studio, whence it was broadcast on 215.7 meters. The portable transmitter, 6XBV operated on a 48.86 meter wavelength.

The Polymet Manual from the Polymet Mfg. Co. of New York City presents engineering data on various types of condensers and resistances used in the construction of radio equipment. From these data it is possible to determine the sizes and types necessary for any desired purpose.

Aerovox condensers and resistors are illustrated and described in a catalog from the Aerovox Wireless Corp. of Brooklyn, N. Y. This contains much interesting information about the selection of filter equipment for socket-power devices. This company has also published "Notes on the Design of Filters" in Nos. 6 and 7 of its "Research Worker."



Short-Wave Receiver Constructed from Aero Kit

A Startling New Principle in *Broadcast Reception*

The AERO "CHRONOPHASE"

Here is proof positive that *you can build better than you can buy.* Aero engineers, after months of experimenting, have developed a new principle in radio frequency amplification. A new system of coupling now makes possible the transfer of a much greater amount of energy between r.f. amplifying tubes than ever before. Shield grid tubes particularly are made to deliver much more of their theoretical amplification than by any other coupling method. This new principle—called the "Chronophase"—results in a remarkable increase in distance range and, by means of a handy control, any degree of selectivity may be obtained, even so that side bands of local broadcasting stations may be cut off oscillation troubles have been overcome and shielding has been made unnecessary.

Kits are Complete

The "Chronophase" principle is incorporated in new 5, 6 and 7 tube receivers. Everything necessary to build these sets is included in complete kits which you can obtain from your dealer. A beautiful two-tone metal cabinet, high-lighted with silver and with a handsome escutcheon plate of oxidized silver, is a part of each kit. Also included are the world-famous Aero Coils, audio transformers of a type heretofore used only in broadcasting stations, condensers and all necessary wires, screws, etc. There is absolutely nothing else to buy. Large schematics and full-size pictorial wiring diagrams make building easy.

Complete Kit for Aero "Chronophase" five-tube receiver $74.50

Complete Kit for Aero-Dyne six-tube receiver 93.80

Complete Kit for Aero-Seven seven-tube receiver 97.85

Kits supplied for A.C., Shield Grid and standard tubes.

Specify what type of tubes you intend to use.

Add Thousands of Miles to Your Receiving Range

Broadcast reception on short waves is remarkably clear and free from static. Programs are brought in from greater distances with the utmost simplicity of control. You can easily build the Aero Short-Wave Converter and receive short wave programs on your present set. Just plug into detector socket. No changes in wiring necessary. We have complete kits for shield grid, A.C. or D.C. Ask your dealer or write us.

Write for information about the New 1929 Aero Green Book containing 25 wonderful circuits.

AERO PRODUCTS INCORPORATED

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ENJOY ANY MIRACO 30 DAYS—

Compare it with Costliest Radios

RETURN EVERYTHING, OUR EXPENSE, UNLESS DELIGHTED

NEW LOW FACTORY PRICES SAVE 50%

Choice of Cabinets AC or Battery Sets

30 Days' Trial

Richly designed genuine walnut console of finest type. Electro-dynamic or magnetic power speaker

Graceful Spinet console, genuine walnut. Choice of speakers. Also comes in Radio-Phonograph Comb'n.

A Lo-Boy Console that costs little. Dynamic Power Speaker.

Popular inexpensive combination. Set on table speaker.

New-type arm-chair console of genuine walnut—latest speakers.

Latest · Powerful · New

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Cathedral Toned, Super Selective, Long Distance Getters

Battery or Electric AC Sets

ENJOY any Miraco 30 days in your home. Return everything, our expense, unless delighted YOUR VERDICT FINAL. Send for latest catalog and Amazing Special Wholesale Price Offer.

America's big, old, reliable Radio Corporation springs its 9th annual sensation! Latest shielded 1-dial, Super-powered, hum-free Electric AC and newest battery sets of finest construction and costliest features at astounding low factory prices.

Compare with radios at 2 to 4 times the price—unless your Miraco proves itself the MOST SELECTIVE, RICHEST, CLEAREST TONED and MOST POWERFUL DISTANCE GETTER, don't buy! Miracos have phonograph pick-up connection.

Delighted thousands report programs from Coast to Coast, Canada, Cuba, Mexico, with magnificent clear, cathedral tone. *3 year guarantee* on each set. Choice of beautiful consoles, metal or wood table cabinets, latest dynamic power speakers, radio-phonograph combinations.

Insure complete satisfaction, save or make much money—deal direct with a big old maker of fine radios—9th successful year. Get amazing offer!

Ultra 8 $49.88

Electric AC-8 $71.50

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Big Discounts and Exclusive Territory to User-Agents on Battery or AC Electric Outfits

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BEAUTIFULLY ILLUSTRATED CATALOG, AMAZING SPECIAL FACTORY OFFER, TESTIMONY OF NEARBY USERS—All the proof you want—of our honesty, fairness, size, financial integrity, radio experience and the performance of our sets—including Amazing Factory Offer—sent with catalog.

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- WITHOUT OBLIGATION, send free catalog, Amazing Special Factory Offer, testimony of nearby users, etc. ☐User ☐Agent ☐ Dealer
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ANOTHER SPECIAL OFFER!

UNI-RECTRON POWER AMPLIFIERS

(Ideal for Use With Dynamic Speakers)

Model AP-935

As the Uni-Rectron stands it is a super power amplifier, which can be used in connection with any radio set and loud speaker. Binding posts are provided for input to the Uni-Rectron and output to the speaker. Requires no batteries for its operation. It obtains its power from the 110 volt, 60 cycle alternating current lighting circuit of your house.

List Price $88.50 Ea. (without tubes)

SPECIAL $19.75 Ea.

Every one new and packed in original factory carton

The UX-210 super power amplifying tube and the UX-216B or 281 rectifying tube are used with this amplifier, which cannot overload. From the faintest whisper to the loudest crash of sound—R. C. A. Uni-Rectron amplifies each note at its true value. High and low notes are all treated alike. The volume and quality delivered will be a revelation.

AMERICAN SALES COMPANY, 19-21 WARREN STREET, NEW YORK CITY

Send for our lists of Radio Bargains

Positive Line Voltage Control *Safe*

PROTECT your A.C. tubes from excessive filament voltage and insure maximum efficiency from your new A.C. receiver, which is designed to operate at a certain specified line voltage. To be safe, you must have some means of controlling the voltage from the light socket, which varies in different localities and during certain times of the day.

PRICE **$3.00**

The Centralab Radio Control Box is the most advanced form of voltage regulator. It is so designed that it will provide absolute positive and safe control of line voltage. A simple manual control is the only adjustment. No meters or technical knowledge required to operate, although meter can be attached at little extra cost if desired.

26 Keefe Avenue

Centralab
CENTRAL RADIO LABORATORIES

Milwaukee, Wisconsin

PUSH-PULL 250!

Sufficient power is obtained to operate several reproducers, and to fill a small hall or outdoor space.

Output transformers are furnished either for high impedance or low impedance (dynamic) speakers. The 541 transformers are supplied in two combinations each containing an input and an output transformer.

541-C Transformer

541-A Transformer

THE features (reduction of hum on AC operation and large overhead capacity) of the push-pull amplifier circuit render its use with the new type UX 250 (CX 350) power tubes the natural solution for installations demanding the delivery of unusual power to the speaker.

Type 541-A and Type 541-B (for 2000-5000 ohm speakers)
Type 541-A and Type 541-C (for 10-15 ohm speakers)

Price (either combination of two transformers) **$25.00**

GENERAL RADIO CO.

274 Brannan Street, San Francisco, California
30 State Street, Cambridge, Mass.

PROFESSOR HERMANN SCHNITZEL
Of the Ooniversity of Cincinnapolis, O-ho-ho

has written a booklet containing 21 short radio lectures which have been broadcast from many stations. 50 cents per copy, postpaid. You will enjoy this book. *For sale by* "RADIO," Pacific Building, San Francisco

LETTERS TO THE EDITOR

(Continued from Page 51)

in the Army, during the war men were taken from the cattle ranches, the mines, from the back areas of "back beyond" and turned into radio men of the first water—men who coolly carried on under battle conditions which might shake the faith and reason of a saint to the very foundation, and these men, priorly, had never dreamed of such instruments as those of radio, nor ever had so much as a sniff of salt water until they set foot on eastbound transports. I retain in a notebook the following entries:

"Carter, John, (excellent operator) formerly cowpuncher—decapitated by shell burst."

"Lines, Joe, (1st class opr.) gold miner, torso riddled, shell burst."

"Haven, Tommy, (1st class opr.) lumberjack, eight shell splinters, chest."

An additional entry is not a casualty—exactly:

"Bront, Jack—Hungry."

Kindliest regards to all,

JACK BRONT.

Truckee-Carson Irrigation District. Electric Power Section, Hazen, Nevada.

Dear Eddy: Want to let you know that I follow your interesting department at all times and enjoyed reading E. J. Stenman's amusing recital of his "Curiosity" venture in brasspounding.

Can understand friend Gillis' kick as he wrote in the June number. I used to be a strong amateur myself and started that way in the game. What he says is only too true, though, and I know it is the regret of the more sensible of the "ham" bunch.

Now suppose the wireless companies had an "extra" list, something on the order of the W. U. and Postal Telegraph companies when they used to handle lots of men.

In other words the permanent list of operators for a given outfit would be determined by seniority and ability, each weighing equally. Now then, when a "ham" or a man from a school tried to "buck" the list he would be given a chance and if he didn't stick or was given an unfavorable report by his senior operator on his first trip, he would be relegated to the end of the list and some other would be given his chance; thus gradually eliminating undesirable types from the ranks of commercial B. P.

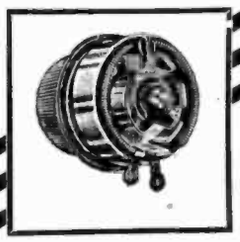
Then again, suppose an old-timer comes in from a trip and finds his hulk is to be tied up for an indefinite period and he is paid off. He reports in to the "office" and the traffic manager of course tries to give him preference in locating, but actually he is just about as bad off as a new man on the list. It seems to me that such a man in first rate standing should be on such a "permanent list" so that he would rate relieving some chap perhaps just newly on the "extra" list and in this way all ops who had put in time and had acquired relative standing, with the company, through seniority and ability, would be sure of regular berths on some tub or other or shore job. But where the steamship company is paying "Sparks," the telegraph company can't exercise such control over the operators supplied from their office, even though they would like to keep their best men regularly "lined up."

Now what about it, Eddy, wouldn't that system keep out the undesirable newcomer as complained of by Mr. Gillis and take care of the man who wants to feel that he has an employment that he can rely upon to regularly sustain his insides and possibly that of a Mrs.? Of course this is in line with what I had to say as given in the July magazine.

As for the matter of unlicensed men holding down these point-to-point jobs, guess that would have to depend on the employers in such outfits. Rather think in most cases they

Tell them you saw it in RADIO

The Choice of the Leaders



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APPROVED RADIO PRODUCTS

JUNIOR RHEOSTAT

When the leading manufacturers of the country choose the Yaxley Junior Rheostat for their finest radio sets you are safe in following their good judgment.

The Junior Rheostat is made to the highest Yaxley standards—a master instrument, with a smooth movement and lots of service stability. Diameter, 1 7/16 inches; mounts in single 7/16-inch panel hole.

Junior Rheostats, with Bakelite Knob, up to 400 Ohms 75c
1000, 2000, 3000 Ohms $1.00

Junior Potentiometers ..... 25c extra

Switches for Junior Rheostats, Self-Contained and easily attached 40c

RESISTANCE UNITS

Absolutely dependable. Run true to rating. Have convenient screw eye and soldering lug for easy mounting and wiring.

Space Wound, 1 to 60 Ohms 15c
100 to 400 Ohms 25c

Tapped Resistances, 6 to 64 Ohms 30c
100 to 400 Ohms 40c

Grid Resistances, 100 to 500 Ohms 25c
600 to 3000 Ohms 35c

Your radio dealer or jobber has them in stock

YAXLEY MFG. CO.

Dept. A, 9 So. Clinton Street
CHICAGO, ILLINOIS

depend on the recommendations of the traffic managers of the wireless companies; so I found it when getting on the Western Air Express when it first started up.

I understand the tropical outfit is conducted along such lines as suggested and while I never worked for them, I know that the average of ability for the marine operators, not to mention their land station stuff, is high, much higher than that of any other marine radio telegraph organization.

I'm trying the C. G. for a spell now; at NGQ. Keep continuous watch on 600 M. So don't miss much of the old stuff at that.

73, W. L. JEPSON.

Yes, something of this sort would probably be a wise and practicable move on the part of the controlling steamship companies. The sad part of it is, however, that the ideas and ideals brought forth in these humble columns do not reach the doorsteps of the aforementioned companies. Why not stir up a circulation of that character? If the men to whom the operators are responsible should get acquainted with operators' ideas by reading these informal discourses, would they not be a little more in sympathy with the desires of their men? Well, then, why not get a little cooperation from you fellows in getting RADIO into the hands of these men? When you see something that your chief or marine superintendent should read, pass it on to him, or send us his name and perhaps we can mail him a complimentary copy. Let's get at the men at the top—acquaint 'em with the operator's point of view—but let's be tactful about it.

Corrections and Additions to the Inter-Coastal and Gulf Weather Schedules

By PAUL OTTO

75th Meridian Time

Arlington.—NAA, 2677, CW, change 10:30 a. m. to 10:00 a. m.

Nassau.—VPN, 600, SPK, 9:15 a. m., local weather.

120th Meridian Time

Mare Island.—NPG, 7006, CW, change 9:00 a. m. to 7:30 a. m.

Marshfield.—KGN, 600, ICW, 8:00 a. m., 12, 4, 8 p. m. local.

Additional word to list used in XDA weather.—Spanish, Decreciendo; English, Decreasing or diminishing.

CARIBBEAN NOTES

By CHARLES H. GRANT, WXE

It may be of interest to the gang on the east coast, as well as those who are running from coast to coast, to know about some ship schedules maintained by the United Fruit liner, *Santa Marta* while in southern waters. During the heavy static season, a majority of the ships in the Caribbean find it rather difficult to clear their traffic, usually meaning an all night grind before the sweating op can pound his ear in peace without worrying about some important message or routine traffic that "should have gone through."

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¾, 5 AND 10 METER TRANSMITTERS

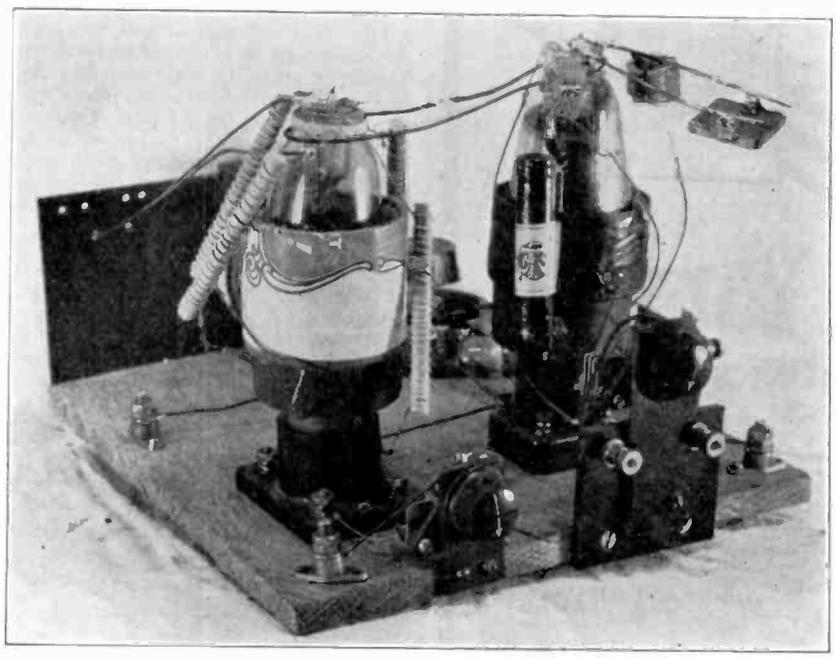
(Continued from Page 40)

sults. Usually an increase in output results when the smaller values are used. At these frequencies, by-pass condensers across the filament have perhaps little merit, but they help some, and are inexpensive; two .001 mfd. mica receiving condensers can be used. A 1500-ohm grid leak is about right for the 310 tube.

The tuned grid and plate circuit operates very well at 5 and 10 meters. The two condensers used should be of the same type, for small changes may throw off the range of one tuned circuit. It is doubtful if any particular transmitting circuit has the advantage over other circuits, if both are properly adjusted. The care used in proper adjustment and arrangement of parts at these frequencies may mean the difference between good and poor results, and this does not necessarily mean to use the shortest possible leads. The circuit in Fig. 1 is perhaps the simplest and may be used at 5 meters with little change. At 5 meters the effects described are more exaggerated than at 10 meters, but with proper adjustment, a transmitter will operate as well here.

tell approximately where the voltage loops are on the antenna by using a small input to the transmitter and moving the hand along near the antenna wires. At positions of high voltage, the plate current of the transmitter usually changes. One can adjust the antenna only approximately in this way, for the presence of the body changes the capacity of the antenna somewhat.

The ¾-meter band is of unusual interest to the experimenter. The ordinary power tubes (such as the 310) have such high internal inductance and capacity that they will not oscillate directly at ¾ meters. A master-oscillator power-amplifier arrangement (as shown in Fig. 2) will not only allow one to put power into a telescoped-tub-



¾-Meter M. O. P. A. Transmitter at 6BX

ing on ¾ meters, but the output will be quite steady.

In the illustration of the ¾-meter set, the 2¼-meter oscillating circuit is clearly shown. The oscillator operates at about 2¼ meters and is overloaded so as to produce strong harmonics. The 310 can be made to oscillate strongly at this wavelength and this wave is used rather than 1½ meters where it is more difficult to secure proper operation with these tubes. The oscillator is coupled to the amplifier by means of the parallel wires with a loop at each end.

The amplifier is a 5-watt tube which is

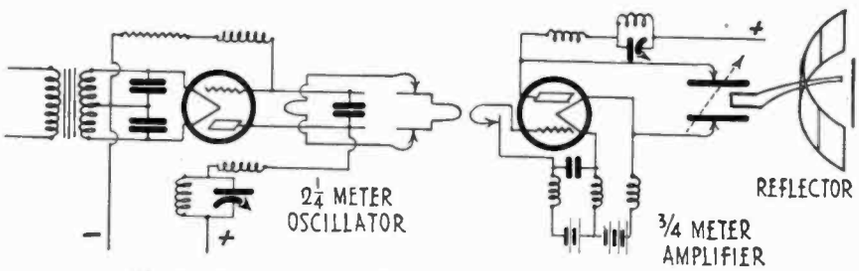


Fig. 1. Arrangement of Apparatus for ¾-Meter Transmitter

For proper transmission, the oscillators should be loosely coupled to the antenna. The "coupling" to the antenna at the higher frequencies consists appreciably of electrostatic coupling also. The tendency is to use too close coupling. The zeppelin antenna is a good one to use, for the radiating part can easily be drawn up into the clear. Small differences in construction will often throw the antenna out of proper balance. One can

somewhat better for the purpose. The parallel wires of the oscillating circuit are about 3 inches long and the wavelength is adjusted by sliding the fixed condenser along the wire. This condenser is .00025 mfd.

The plate "tank" of the amplifier consists of a pair of parallel wires which are trimmed to their proper lengths, this changing both the inductance and capacity for a

(Continued on Page 58)

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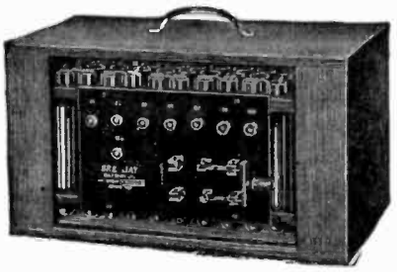

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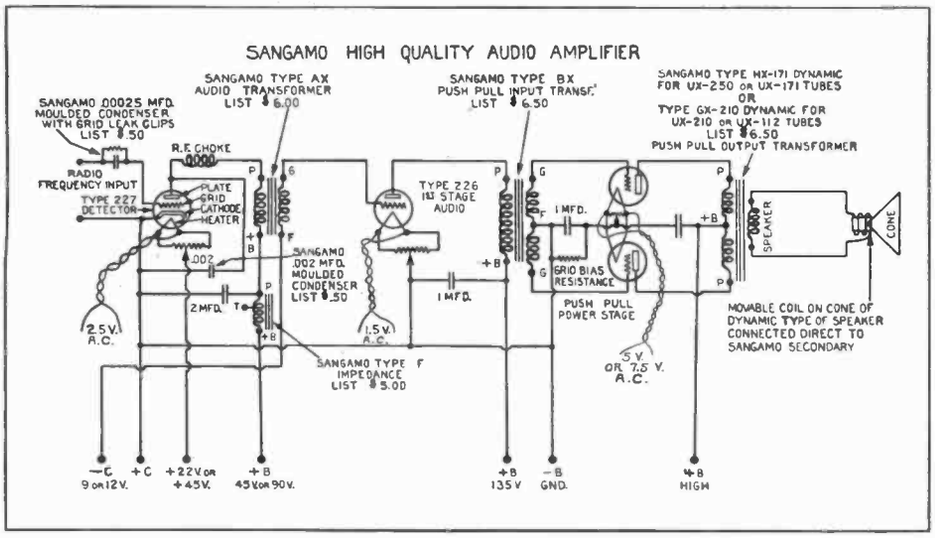

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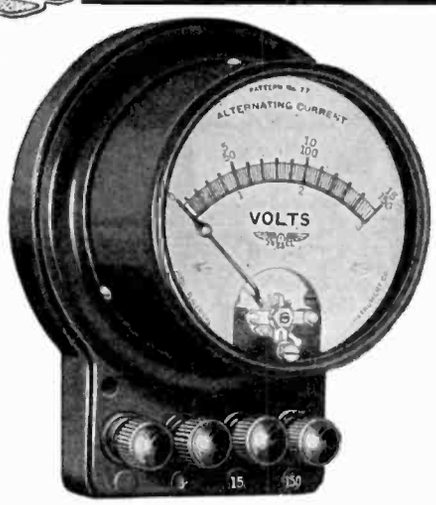

Pattern No. 77

One of the chief troubles in the new A. C. sets using either A. C. tubes or D. C. tubes in series is paralysis or damage to the tubes due to incorrect filament voltage. This invariably can be traced to line voltage, which in some localities varies considerably throughout a twenty-four hour period. In the sets using the new A. C. four and five prong tubes it is very important that the filament voltage is right, as it is sometimes found that a particular filament setting is necessary to eliminate hum.

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Such an instrument and one used by many service men in their work is the Jewell Pattern 77 triple range portable A. C. voltmeter. It is a very desirable instrument for the set owner as it enables him to operate his set at safe filament voltages at all times. The combination range is 0-3-15-150 volts. The scale is silver etched with black characters, and the movement is mounted in a metal case on a bakelite base.

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¾, 5 AND 10 METER TRANSMITTERS

(Continued from Page 56)

given spacing. The r.f. transmission line connecting with the reflector is coupled to the parallel wires by means of the holes in the bakelite at the rear of the set.

The chokes shown on the amplifier consist of about 20 turns wound on a ¼-in. dowel. A small tuned choke is used in the plate circuit. A tuned choke is also used in series with the 30-turn basket coil on the oscillator. The bases of both tubes must be removed. Troublesome "shorts" in the base are prevented by bending each lead back over the glass at the "seal" and holding them in place with a few turns of string, wound around the tube. For 2¼ meters, the tuned choke consists of a midget of about 5 plates and a few inches of wire as a coil. The ¾-meter tuned-choke consists of a midget condenser of 2 plates and an inch or so of wire. This choke should be about the same size as the wave meter which includes the ¾-meter band. The wave meter is calibrated from lecher wires which need only be about 5 ft. or so at this wavelength. The wires are spaced rather close together, so a short copper wire shorting-link can be used. Two such parallel wires, if arranged on a support, and provided with a small centimeter scale, will serve as a direct-reading wave meter.

With simple oscillating circuits of this nature, one can use plug-in tubes to change the wavelength. The tubes are provided with complete oscillating circuits which are adjusted for maximum efficiency at the frequency used. Thus when the wavelength is changed, the oscillator will operate immediately and with maximum efficiency.

The bases of the tubes are removed by heating over a gas flame. The tubes are inverted and sealed into a cardboard box. As the oscillator is overloaded and will heat, a heavier sealing compound than parafine should be used. The inverted tube-container is fastened to a wooden base, one end of which is turned down so as to fit into a UX socket. The various tubes can therefore be plugged into the circuit quite readily. Each tube is fitted with its own oscillating circuit, chokes and grid leak and can be adjusted for good results at operating frequency.

By tuning the "transmission line" between the oscillator and amplifier, the correct harmonic can be emphasized, thus giving a predominating ¾-meter wave for the amplifier. The plate circuit of the amplifier is tuned by cutting the wires, the correct length being about 1 ft. long; the exact length depending upon the tube used. The coupling-line can be tuned by varying the distance between the tubes, the length of the line; and is supported by passing it around the bases of the two tubes. The line could also be tuned by using a very small variable condenser. By tuning the wavemeter which is coupled to the plate circuit of the amplifier, the plate current will increase at ¾ meters, if everything is functioning.

Another interesting field for experimentation is to use small parallel circuits in the line to prevent undesired harmonics from reaching the amplifier. These circuits show some impedance at harmonics of their natural frequency but have a very large impedance at their natural frequency.

The ¾-meter set with its reflector was exhibited at the University of California on "Engineer's Day" and proved to be of considerable interest. The ¾-meter reflector used at 6BX is believed to be the first ever used for actual amateur transmission.

A.C. SCREEN GRID FIVE

(Continued from Page 33)

leak R_6 are of the usual sizes, .00025 and 2 megohms. The detector feed-back condenser C_{16} should be about .0005 mfd. in value. The size of this and the tickler turns can best be found by trial; the values given worked satisfactorily in the experimental receiver. The three-gang condenser C_6, C_8, C_{12} should have trimmer condensers across each section for properly lining up the tuned circuits. The condensers should have a maximum value of .00035 mfd. with the type of coils shown.

Center-tap resistances across the filaments of the 1½, 2¼ and 5-volt tubes may be fixed or variable. A little better balance, less a.c. hum, may be obtained with semivariable resistors.

Fig. 2 shows the apparatus layout in the receiver. This, together with the wiring diagram, Fig 1, and the pictures, should enable anyone to make up a similar receiver. Fig 3 shows the panel layout.

The control grid leads should have small spring clips for connection to the top electrode of the screen-grid tubes. Type UY sockets are necessary for these tubes as well as for the detector. The r.f. chokes may be of some standard type, or may be made by winding 300 or 400 turns of small insulated wire on a spool.

In testing such a receiver it is generally most convenient to test the detector and audio amplifier first. The audio amplifier should have the proper plate voltages of 135 and 180 for the first and second stages, respectively. These voltages, as well as the other plate voltages, should be checked with a high resistance voltmeter when all the tubes are lit. To test the detector and audio amplifier, connect the antenna through the feed-back coil to the grid of the detector and some local station may be used to test the quality of the audio system.

Each stage of r.f. may be checked roughly in the same manner if necessary. After the audio system and detector have been checked as described, the whole set may be lined up. Connect the antenna to its regular connecting lug, set the coupling condenser C_7 nearly at minimum value, and R_1 and R_2 at their maximum values of resistance. Then adjust the two tuning controls for some broadcast station and adjust the trimmer condensers for maximum signal strength and selectivity. This may be most easily done by rotating the three-gang condenser back and forth slightly while adjusting each trimmer condenser. Decrease R_1 and probably the r.f. amplifier will spill over into oscillation, that is, it will squeal on a broadcast station. The neutralizing condenser should then be increased or decreased in value until the r.f. amplifier will not oscillate even when the detector is thrown into

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oscillation by decreasing R_2, the regeneration control. During these tests the feed-back condenser C_3 should be set at a minimum value so that the first r.f. stage does not oscillate when C_2 is varied.

It will be found that there is a fairly critical setting of the neutralizing condenser C_{11} which will allow the detector tube to spill over into oscillation smoothly and with R_2 control turned around furthest. Increasing C_{11} will mean that the trimmer condenser across C_8 will have to be decreased. Fortunately the input capacity of the screen-grid tube is less than the input capacity of the detector tube or of the plate to filament capacity of the preceding screen-grid tube. Because of this, a value of 10 to 15 mmfd. in the neutralizing condenser C_{11} tends to help line up the circuits as well as neutralizing this stage. The detector regeneration can be tested before the circuits are lined up by making sure that this part of the circuit oscillates. It should spill over when R_2 is not much more than half cut out if the feed-back coil has enough turns.

After the rest of the circuit is properly lined up the first stage of r.f. may be adjusted for its proper degree of regeneration. The tuning condenser C_2 should cover the whole broadcast range. If it does not, the shunt condenser C_1 should be changed in value until it does. The feed-back condenser C_3 may then be adjusted so that the r.f. amplifier is tuned to about 300 meters and R_1 is zero. Regeneration in the first tube tends to sharpen the tuning of C_2 and helps to obtain good overall selectivity.

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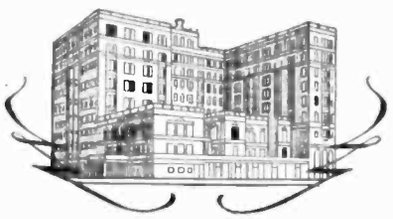

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Ads for the November Issue Must Reach Us by October Fifth

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WANTED—Men to work with National Radio Service organization. No selling scheme. Radio Doctors, Inc., Dept. R, Essex St., Salem, Mass.

DEFECTIVE AUDIO TRANSFORMERS Reclaimed Using Factory Windings, Original Guarantee—$0.90. Reclaimed transformers for sale, most makes, $10.00. Inquiries invited. TRANSFORMER RECLAIMING SERVICE, 9 South Reed Ave., Mobile, Alabama.

SNAP.—$145.00 Grebe 7-Tube Receiver, $70.00. Perfect condition. T. E. Olson, 593 E. 40th St., N., Portland, Oregon.

SELL.—JEWELL RADIO SET ANALYZER, Pattern 133, Complete, Brand New, $45.00. E. M. Heiser, Route 3, Brecksville, Ohio.

FOR SALE!—Gerald Best's "Modernized" 45-KC super exactly as described in the editorial columns of this issue. This receiver was built by G. M. Best for use in gathering editorial material for the story and the publishers of "RADIO" will sell the receiver, complete with tubes, as illustrated in this issue, for $100.00. A fine genuine walnut cabinet with piano hinge is included in the price. In perfect condition and accurately matched and balanced. First money order for $100.00 takes it. Set will be shipped to you express charges collect. PUBLISHERS OF "RADIO," 433 Pacific Bldg., San Francisco, Calif.

TYRMAN 10. Complete set of parts, assembled but not wired. All in excellent shape. Walnut cabinet. No tubes. Used for editorial specification work in our laboratory. Sell for $25.00. Must be shipped by express, charges collect. Also we have one old style Nine-In-Line super, built up and wired. Few parts missing. No cabinet. First money order for $20.00 takes it. A real buy for the experimenter. Publishers of "RADIO," Pacific Building, San Francisco, Calif.

CHILLICOTHE WALNUT CABINETS. 7x26 inches and 11 inches deep. Genuine walnut with full length piano hinge. Several of these are in stock. Never used. Originally purchased for editorial photographing. Retail price $30.00. We will sell these while they last for $12.50, express charges collect. Eight on hand. Publishers of "RADIO," Pacific Building, San Francisco, Calif.

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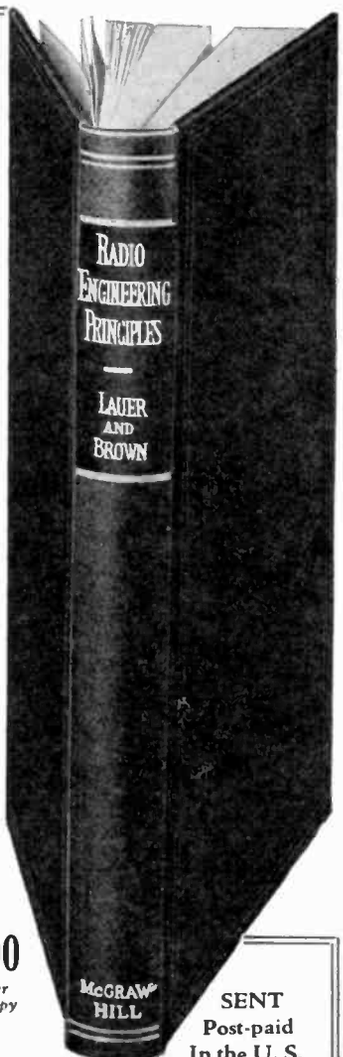

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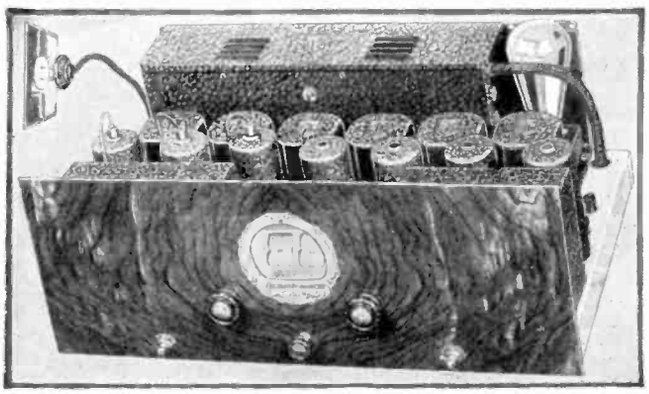
Again Tyrman Conquers!

The pioneers of the Shielded Grid Circuit now introduce advanced features in a new series of A-C and D-C operated Custom Built Shielded Grid Receivers



A FEW short months ago, Tyrman engineers developed and conquered the Shielded Grid Principle in radio circuits. Its introduction was heralded by Set Builders, Engineers and Editors as the greatest advance in radio since broadcasting. Today there is not a receiver using Shielded Grid Tubes which does not bear the ear marks of Tyrman influence.

Now after months of systematic experimenting, backed by unsurpassed working knowledge in Shielded Grid circuits, Tyrman Engineers again conquer principles that reach new peaks in Performance, Tonal Qualities, Beauty and Value in Custom Built Receivers.

Send for free descriptive literature. When you examine the diagrams and layouts you will quickly see why, in the Tyrman Series, you can be assured of hairline selectivity, full, rich tonal quality, unequaled power and distance under most trying conditions.

Tyrman Imperial "80"

Custom-Bilt Shielded Grid

For Complete A-C Socket Operation Using A-C Shielded Grid Tubes

Short Wave Coils • UX250 Amplifying Tube • Phonograph Switch

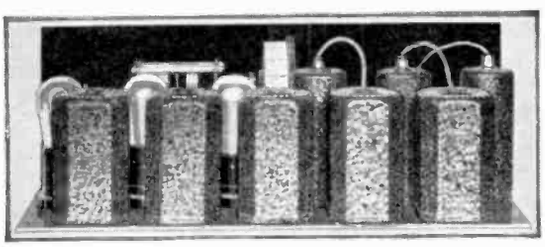
Designed for those who want to build only the finest in A-C Socket Operated Receivers. Note the compact factory-like appearance of the chassis. Tyrman ingenuity in design places the Power Supply with other apparatus on a cadmium plated subpanel platform only 13½ in. x 20½ in. Shielded parts beautifully finished in black crystal. Power Supply designed solely for the "80" and factory assembled. No adjustments.

The actual performance of the "80" is defined by a clear 10 K. C. separation over entire broadcast wave band. Tonal quality of tremendous volume without distortion. DX reception like local without oscillation. Duo Amplification System, a new Tyrman development in the final combination with other features creates unequaled Sensitivity, Selectivity, Stability and Power.

Panel only 8 in. x 21 in. of Genuine Butt-Walnut on metal (Pat'd). New Tyrman Worm Drive Illuminated Drum. Only three controls with 110 A-C and Phonograph Switch on front panel. Simple and quick to assemble.

Receiver Parts, factory packed **$134.80**. "80" Power Supply **$65.00**.

Complete Parts for Imperial "80", short wave plug-in coils and Power Supply, ready to assemble, only **$199.50**

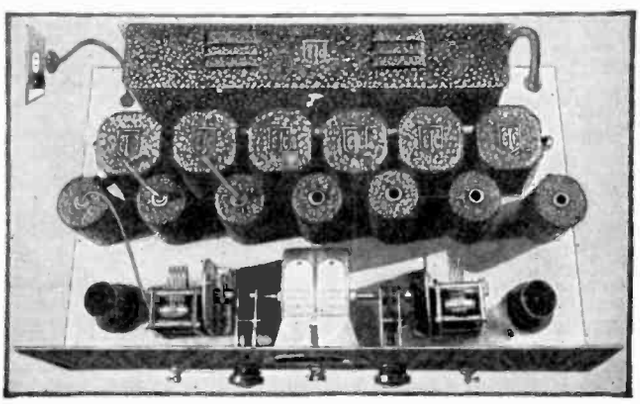


Tyrman "60"

Custom-Bilt Shielded Grid

For Battery or Eliminator Operation

For appearance, tone quality, distance, selectivity, sensitivity, stability and power, the Tyrman "60" is comparable only to other Tyrman Shielded Grid Receivers. An improved design for battery or eliminator operation. Especially designed for Shielded Grid Tubes. Every part made of finest materials, carefully tested and matched. The Tyrman "60" creates a new standard of comparison for performance and value in six tube receivers. Panel only 7 in. x 18 in. equipped with Tyrman Single Vernier Drum Dial. Complete parts, factory packed, ready to assemble, only **$69.50**



Tyrman "72"

Custom-Bilt Shielded Grid

For Battery or A-C Socket Operation

The Tyrman "72" can be assembled for battery, eliminator or Complete A-C Socket operation. Even if assembled as a battery set it is a simple matter to convert to complete socket operation. When assembled for A-C Socket Operation uses A-C Power Supply especially designed for the "72" mounted on subpanel platform. The Tyrman Duo System of Amplification, and Tyrman Audio Coupler System assure rich tonal qualities.

Sensitivity, Stability, Selectivity, Power and Distance comparable only to the Imperial "80". Front Panel only 8 in x 21 in. of beautiful burl-walnut finish on metal. Tyrman Illuminated Worm Drive Double Drum. 110 A-C Switch and Phonograph pick-up Jack on panel. Easily and quickly assembled. Complete parts for either battery or A-C operation, factory packed, ready to assemble **$98.50**

The "72" Power Supply for A-C Socket operation, factory assembled, **$55.00**. Complete set plug-in coils **$10.**

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Underwriters' approved AC snap switch fitted to our Variable High Resistance makes ideal combination. Switch is tested to carry 250 volts at 3 amperes. $2.75 and $3.00.

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Identical with our larger Resistance Units except in size. The Gem is boused in Bakelite case measuring 1⅝ x ⅝ in., thus saving much space back of panel. $2.25 and $2.50.

Frost-Radio Gem Rheostats

Mighty good little rheostats, built to give long service and stand the gaff. Take up but little space, are single hole mounting and are easy to solder to. Supplied plain or with DC switch, the latter offering a remarkable combination at minimum cost, as it combines both rheostat and switch. Plain type, 75c. With switch, $1.00.

Frost-Radio Bakelite Rheostats

The original aircooled Bakelite rheostat with one-piece moulded frame and resistance wire wound on threaded flexible Bakelite strip. Supplied in a wide range of resistances, $1.00. Potentiometers, $1.25 to $2.50.

Frost-Radio Bakelite Rheostat with Switch

Battery operated sets find wonderful service in these Frost Rheostats with switch mounted on Bakelite panel. Switch has positive "off" position, and springs are German silver with sterling silver contacts, 2 to 75 ohms, $1.35.

Frost-Radio AC Snap Switch

Approved, single hole mount AC switch 3 amp., 250 v., 75c.

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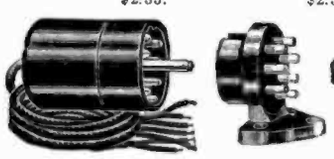
Ideal for smoothing the ripple out of AC current. Easy to regulate with screw driver by means of slotted head shaft, $1.00.



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Windings are on die cut flexible Bakelite strip, minals. .4 to 1000 ohms. with firmly staked ter- Also as center tapped resistances to provide grid return in AC sets, 6 to 64 ohms. 15c to 50c.

FROST-RADIO UNIVERSAL RESISTANCE KIT

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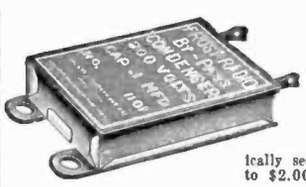

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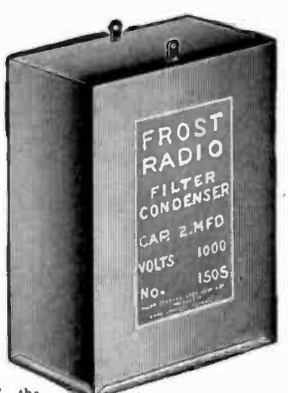

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Like our blocking condensers Frost Filter Condensers are a quality product, made of the finest linen paper and highest grade foil. Conservatively rated. Will give long service. .5 to 2 mfds., $1.40 to $7.00.

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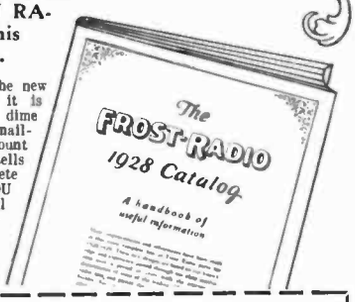

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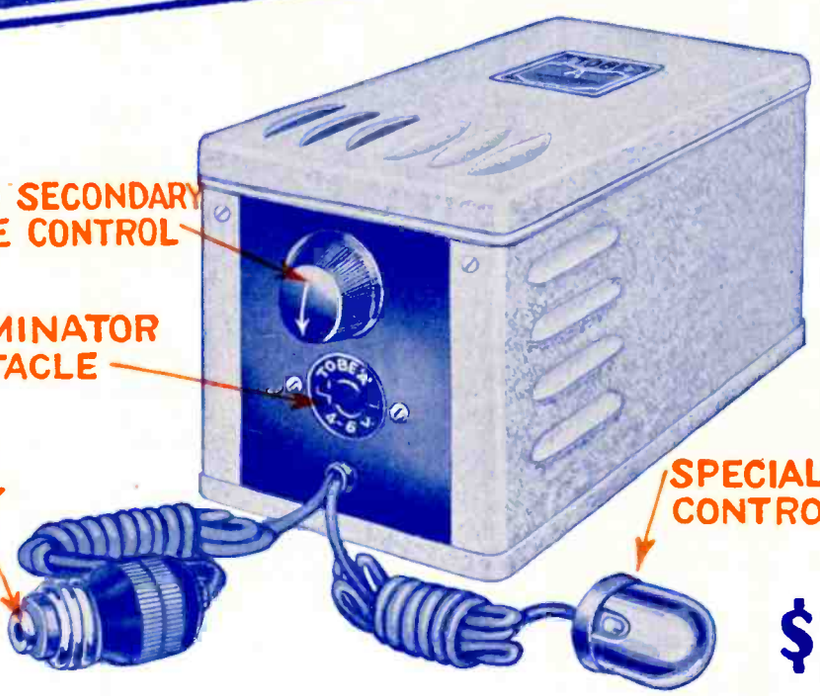

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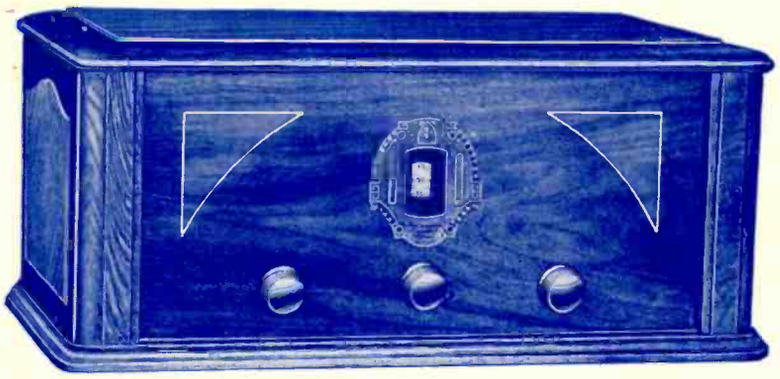

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