RADIO & TELEVISION

RADIO'S *Complete* MAGAZINE

25¢
CANADA 30¢

HUGO GERNSBACK
EDITOR

AMATEUR & EXPERIMENTAL RADIO — FEB.

CONSTRUCTIVE RADIO ARTICLES — 1941

BACK IN 1924

This advertisement appeared in QST Magazine

Back in the radio magazines of sixteen years ago, you will find the names of many almost-forgotten manufacturers. But you will also find a few names that have survived through the excellence of their products. In this select group, National has a special distinction, for with National even the products themselves have survived.

The Velvet Vernier Dial has survived the greatest endurance test of all, and is *still* the most popular of all dials for amateur work. The DX Condenser has passed the toughest of all efficiency tests; it is still manufactured for commercial and industrial use.

The design features that made these products outstanding 16 years ago have become standard practice. But building to stand the test of time is still, we think, National's most exclusive feature.

NATIONAL COMPANY, INC.

MALDEN, MASS., U. S. A.

Men NOW in Radio who Don't Think they know it All *Read This*

You don't want to see younger, better-trained men push ahead of you, I know. You don't want Radio's new technical developments to baffle you either. I am sure. You want to get ready to "cash in" on Television, Frequency Modulation, too. I have helped many already in Radio to win promotions, to make more money. Read my message below.

If You're NOT Working in Radio Now *Read This*

Do you want to make more money? Do you want to cash in on your present interest in Radio, Television, Frequency Modulation? Do you want a full-time job with good pay in one of Radio's many fascinating branches? Or do you want to make extra money in your spare time to boost your present income? If you want to do either of these things—you owe it to yourself to find out how I have trained hundreds of men for jobs in Radio. MAIL THE COUPON BELOW—TODAY.

J. E. SMITH, President
NATIONAL RADIO INSTITUTE
Established 25 years

He has directed the training of more men for Radio than anyone else—has helped men already in Radio to get ahead, and men not in Radio to get into Radio and win success.

Make Me Prove I Can Train You at Home for RADIO and TELEVISION

Clip the coupon and mail it. I'm certain I can train you at home in your spare time to be a Radio Technician. I want to send you a sample lesson free; to examine, read. See how clear and easy it is to understand. See how my Course is planned to help you get a good job in Radio, a young, growing field with a future. You don't have to give up your present job, or spend a lot of money to become a Radio Technician. I train you at home nights in your spare time.

Many Radio Technicians Make $30, $40, $50 a week

Radio broadcasting stations employ operators, technicians, and pay well for trained men. Radio manufacturers employ testers, inspectors, servicemen in good-pay jobs with opportunities for advancement. Radio jobbers and dealers employ installation and servicemen. Many Radio Technicians open their own Radio sales and repair businesses and make $30, $40, $50 a week. Others hold their regular jobs and make $5 to $10 a week fixing Radios in spare time. Automobile, police, aviation, commercial Radio; loudspeaker systems, electronic devices, are newer fields offering opportunities to qualified men. My Course includes Television and Frequency Modulation which promise to open good jobs soon.

Charles F. Helmuth, 419 N. Mass. Ave., Atlantic City, N. J., writes: "I started Radio in the Marines. Later I took the N. R. I. Course. Now I am my own boss, and get jobs over others who were sure they had them. I owe plenty to N. R. I. Training." James E. Ryan, 119 Pebble St., Fall River, Mass., writes: "I was working in a garage when I enrolled with N. R. I. I am now Radio service manager for the M—— Furniture Co. for their four stores."

Many Make $5 to $10 a Week Extra in Spare Time While Learning

The day you enroll, in addition to my regular Course, I start sending you Extra Money Job Sheets—start showing you how to do actual Radio repair jobs. Throughout your Course I send plans and directions which have helped many make $5 to $10 a week extra in spare time while learning. I send special Radio equipment; show you how to conduct experiments, build circuits. My 50-50 training method makes learning at home interesting, fascinating, practical. I devote more than 10 Lesson Texts exclusively to Television, and in addition Television fundamentals are covered by my regular Course.

You Get This Professional Servicing Instrument

This instrument makes practically any test you will be called upon to make in Radio service work on both spare time and full time jobs. It can be used on the test bench, or carried along when out on calls. It measures A.C. and D.C. voltages and currents; tests resistances; has a multi-band oscillator for aligning any set, old or new. You get this instrument to keep as part of your N. R. I. Course.

Get Sample Lesson and 64-Page Book Free — Mail Coupon

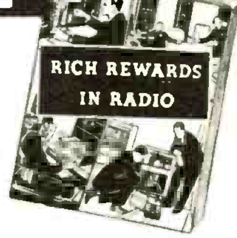
Act today. Mail coupon now for Sample Lesson and 64-page Book. They're FREE. They point out Radio's spare-time and full-time opportunities and those coming in Television; tell about my Course in Radio and Television; show more than 100 letters from men I trained, telling what they are doing and earning. Read my money back agreement. Find out what Radio offers you. Mail the coupon in envelope or paste on penny postcard—NOW!

J. E. SMITH, President
Dept. 1BB3, National Radio Institute
Washington, D. C.

SAMPLE LESSON FREE

I want to prove that my Course gives practical, money-making information; is easy to understand—is what you need to master Radio. My sample lesson text, "Radio Receiver Troubles—Their Cause and Remedy," covers a long list of Radio receiver troubles in A.C., D.C., battery, universal, auto, T.R.F., superheterodyne, all-wave, and other types of sets. And a cross reference system gives you the probable cause and a quick way to locate and remedy these set troubles. A special section is devoted to receiver checkup, alignment, balancing, neutralizing and testing. Get this lesson FREE. No obligation. Just mail coupon

GOOD FOR BOTH 64 PAGE BOOK SAMPLE LESSON FREE



J. E. SMITH, President, Dept. 1BB3
National Radio Institute
Washington, D. C.

Dear Mr. Smith: Mail me FREE, without obligation, your Sample Lesson and 64-page book, "Rich Rewards in Radio," which tells about Radio's spare-time and full-time opportunities and explains your 50-50 method of training men at home to be Radio Technicians. (No salesman will call. Write plainly.)

(Please Check)
☐ I AM doing Radio work. ☐ I am NOT doing Radio work.

Name .... Age ....

Address ....

City .... State 14X1

RADIO & TELEVISION

The Popular Radio Magazine

February — 1941
Vol. XI No. 10

HUGO GERNSBACK, Editor
H. WINFIELD SECOR, Manag. Editor
ROBERT EICHBERG, Television and Digest Editor

In March Issue

In This Issue

GENERAL FEATURES

RADIO CONSTRUCTION

AMATEUR RADIO

NEW FEATURES

ELECTRICAL EXPERIMENTS

TELEVISION NEWS

MISCELLANEOUS

Certified Circuits

When you see this seal on a set it is a guarantee that it has been tested and certified in our laboratories, as well as privately in different parts of the country. Only constructional—experimental sets are certified.

You need not hesitate to spend money on parts because the set and circuit are bona fide.

This is the only magazine that renders such a service.

Cover Composition by Hugo Gernsback and Thomas D. Pentz

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What Do YOU Think?

WHAT ONE READER THINKS OF R. & T.

Editor,

Just a scribble to let you know how much I'm enjoying your magazine.

I note in the "What Do *You* Think" column, that one reader wants more "1 and 2 tube hook-ups." I have several copies from 1932 to 1935, 36 of them. Perhaps I should mail them to him. If your readers have been buying the magazine very long from newsstands, they should have, by now, all the 1 & 2 tube hook-ups they will want to play with for a lifetime. Maybe he's a new-new beginner. He should ask some of the local boys for some help on set construction. I suppose I'm a little too hard on beginners, not remembering "once upon a time" I was a beginner, too.

I'm in radio for fun—it's a hobby with me. The XYL gets a "bang" out of it, too. She says it keeps me at home where she can watch me. Maybe that's the bang she gets! What!

M. E. Van Nattan,
6151 Walnut Ave.
Long Beach, Calif.

(There are new hook-ups now and then, you know.—Editor)

A YUGOSLAVIAN SHORT WAVE LISTENER

Editor,

I am a Yugoslav for the first time in the U.S.A. and am a wireless operator on a Yugoslav ship. I am also a Radio Amateur and SWL Fan.

I have at home in Split, Yugoslavia, a Hallicrafter Super-Skyrider receiver but my wish is to have one transmitter and to work with the fellows throughout the world. At present we cannot have a transmitter in Yugoslavia for private use.

For years I have received very good phone signals from all continents, and I am sorry that I cannot show you proof of the success of my constant labors.

My greatest wish is to join the Short Wave League and to have a membership in the V.A.C. Club.

All fellows and SWL's who wish to know something about radio in Yugoslavia, and who will write me or send their cards, addresses, etc., may do so. I am enclosing my address and I will be very glad when they write: I will answer all.

With best wishes to R. & T. magazine, I remain,

Josip A. Mladina,
Solinska cesta 40,
Split, Yugoslavia,
Europe.

IMPATIENT FOR EACH NEW COPY

Editor,

The tenth of each month finds me at the news-stand anxiously waiting for my copy of Radio & Television. I truthfully believe that your magazine is the most complete and understandable radio magazine. I am typical of hundreds of other Short Wave Fans who are just starting to explore the

(Continued on page 640)

Editorial

YOU Are the Editor

By HUGO GERNSBACK, Editor

BELIEVE it or not, *you*—the readers—are the real editor and it makes little difference what magazine or newspaper you read. It just means that it is always the reader who influences the editorial contents of *any* publication. Obvious as this is, it is seldom realized by the average reader who often has the erroneous idea that an editor is a sort of super-human creature who knows more about every subject than any one else. Nothing could be further from the truth. The editor only *interprets;* he may have set ideas of his own about certain subjects, but if he is a good editor he will keep these ideas in the background. After all, it is the reader who buys the publication, and unless he is satisfied with the ideas expressed in it, the publication won't last long. The great trouble with most readers, however, is that they take a magazine too much for granted, and the minute they do not agree with its policy, they drop it like the proverbial hot potato. Others when they do not agree with the editorial policy, immediately begin writing letters to the editor in no uncertain terms—*and that is precisely what the editor wants them to do.* No publication is worth its salt if it is not criticized, if suggestions are not given day in and day out by readers who either disagree or who think differently on certain subjects.

Here in RADIO & TELEVISION we are fully aware of these problems and we have always been alert not only to new trends, but to criticisms, particularly when such criticism is of a constructive variety.

The editor does not pretend to know it all—far from it—it is his business to present radio progress and other radio material in such form as he believes, that you, the reader, would like to have it. The editors have no preconceived notions as to what should go into the magazine and that is why they must use the guiding heads of its readers.

With all this in mind and feeling that it is possible to get every really worthwhile new and constructive idea from you, the readers, the editor would like to turn this page over to the readers in order to get the best radio thoughts in America.

RADIO & TELEVISION does not want this service for nothing. As announced on this page, the best editorial, or editorial suggestion, which is sent in during the month will be printed here, and the writer of the best letter will be awarded every month, until further notice, a valuable radio receiving set.

Remember that what is wanted are new or novel ideas or suggestions—how radio or television can be used to better advantage; how radio instrumentalities can be used more efficiently; what radio can do to help defense. Or any other worthwhile suggestion that may further the advance of radio in some way.

Other short reader editorials might be on the subject of your viewpoint on radio matters that will arouse discussion with other readers. What we do not wish to print on this page are laudatory letters regarding the magazine itself, or pet peeves on subjects that are not important to radio in general.

It is not necessary that your letters be long. Indeed, they can be quite short. Anywhere from 50 words up, but not more than 500 words, is desirable.

All that you and we want is "meat" and the shorter and the more concise each of your editorials, the better the readers and the editors will like them.

We are giving a few samples of readers' editorials which came in the mail, so you will understand what is wanted.

FREE RADIO SET

A VALUABLE RADIO SET TO BE AWARDED MONTHLY

Every month, until further notice, RADIO & TELEVISION will award to one of its readers who submits the best short editorial, to be printed on this page, a valuable radio set. Other letters published on the editorial page will receive a free subscription to RADIO & TELEVISION magazine.

All letters for the next month's contest must be received by the editors by the 10th of the month.

For other details of this editorial contest, read further on this page.

THE CODE BUGABOO

If it's all boiled down to the bare facts, I think that learning the code has proved a bugaboo that has enlarged in so many minds that it scares many an embryo ham completely out. I know, it had me scared out too. Then one night I said to myself, "Forman, you're just plain lazy, learn that code or forget Ham Radio." I had a lot of wild ideas about how I'd build a transmitter and all that goes with it, I guess everyone does, but there's that ticket looming up in the way. Well, I worked for an hour and a half memorizing the code and by that time I could spell out the name of anything in the room. I'm picking up speed little by little and eventually I'll have it up to where I want it, but the hardest part, as I see it, is over with.

Bob Forman, Monmouth, Ill.

RADIO TREASURE HUNTING

If anyone tells you that Treasure Hunting with modern radio equipment, including an unromantic head, cannot be made a profitable business—dismiss the thought, for several are paying considerable income tax on account of discoveries of man hidden valuables. They do not use one type of equipment and carry something in their heads as well as hands. Their finds go unheralded for they know it is possible to pay a large premium for talking too much and in the wrong company. Opportunities beckon to those who are willing to make the investment in knowledge before expecting the dividend to come their way. Success in treasure hunting is based on knowledge and the ability to play "dumb" if occasion demands. Those who do not believe in the efficiency of modern equipment may be made into an invaluable aid if proper methods are used.

Thomas E. New,
Santa Monica, Calif.

"ENGLAND CAN TAKE IT"

Editor's Note: (As one half of the world never knows how the other half lives, the writer of the following letter deserves commendation for the fact that he takes the time to tell Americans regarding present-day English conditions.)

I have taken the trouble of sending you all these notes, etc., because I think you may find them interesting, particularly as there are now no amateur transmitters operating in this country, so I guess you will be interested to know what is going on here.

(COPY OF MAIN DETAILS FROM LETTER FROM ENGINEER-IN-CHIEF'S OFFICE [RADIO BRANCH], HARROGATE, ENGLAND, IN ANSWER TO QUESTIONS ASKED BY THE NORTH MANCHESTER RADIO & TELEVISION SOCIETY REGARDING AMATEUR RADIO TRANSMITTING, ETC.)

1. Relative to the confiscation of amateur radio transmitting apparatus, I have to inform you that it is the intention to return such apparatus to the owners after the war and applications for restoration should be addressed to this department on the cessation of hostilities.

2. You can be assured that every reasonable precaution will be taken to ensure the safe custody of apparatus whilst held by the Post Office.

3. The call signs previously held by licensees are cancelled simultaneously with the relative licenses, and no claim to the use of a particular call in any future license could be allowed.

(Continued on page 637)

Colored Television on Standard Receiver with New Disc

A *standard* television receiver was made to pick up colored television images in a demonstration by Dr. E. F. W. Alexanderson to members of the National Television Systems Committee and George H. Payne, member of the F.C.C. The picture shows Dr. Alexanderson and Mr. Payne looking at the receiver.

The demonstration was staged at Dr. Alexanderson's home, where he had installed a *two-color* 24-inch revolving disk about a foot in front of the picture end of the cathode ray tube of his standard type receiver. As this whirled at 1,800 revolutions per minute, its transparent field of *orange-red* and *greenish-blue* reproduced the studio program in realistic colors. To do this, Dr. Alexanderson explained, a similar colored disk revolved before the iconoscope pick-up tube of the transmitter. Other than the two disks, everything was the same as with black-and-white television at *both* studio and receiver.

Dr. E. F. W. Alexanderson and George H. Payne, F.C.C. member, inspect the new two-color filter which converts black and white receiver to reproduce colored television images.

"In our early experiments we tried both two- and three-color disks," Dr. Alexanderson said. "With two colors and a speed of 1,800 r.p.m. of the disk, the same color succeeded itself 30 times per second. With three colors, they succeeded each other 20 times per second, producing a color flicker. So that is why we decided upon the two colors for the present. We found it did not detract much from the three-color picture. This gives very good results without flicker, and we feel it is most practical with standard commercial receivers."

The demonstration is still of a developmental nature, and *General Electric has no plans for introducing color to its television programs* for the present.

Prominent among members of the committee which attended the demonstration was Dr. P. C. Goldmark, in charge of television engineering for the Columbia Broadcasting System, which is also interested in adding color to its programs. While in Schenectady the members of the NTSC visited General Electric's television and new FM stations in the Helderbergs and, after the demonstration at Dr. Alexanderson's home, met with G-E scientists for a conference in the company's research laboratory.

Don Lee Television Station Has Novel Features

With excavation completed on the swimming pool atop Mount Lee, workmen recently reached the halfway mark on television station W6XAO, the new $100,000 building to be the first structure erected exclusively for the electronics art.

A novel feature of the building is that it is entirely shielded with one-ounce copper sheeting on all four sides and the roof. The copper armored pure electro sheets came in sixty-inch wide 120-foot linear rolls and had to be applied with great precision. Especial care had to be taken in soldering the seams between sheets. More than 22,600 square feet of copper were used. The metal was applied to eliminate outside and intra-building interferences with the delicate cathode tube cameras, according to Thomas Lee, president of the Don Lee Television System.

Purpose of the swimming pool will be to provide a compact stage of operation for "telecasts" of aquatic events. The pool measures 20' x 50'.

The two-story building will have one television stage 60' x 100' and another 25' x 40' with monitor rooms in addition to complete office facilities, transmitter room, experimental laboratory, scene storage rooms, makeup room, lounge viewing room, performers' lounge and other theatrical facilities. Since December 23, 1931, the Don Lee organization has spent more than $350,000 in television.

With W6XAO located on top of the 1700-foot mountain the television range will be about sixty miles and will bring images to homes in San Fernando Valley, points beyond Malibu, Huntington Beach and Pomona, as well as all sections of Los Angeles and Beverly Hills, said Harry R. Lubcke, Director of Television.

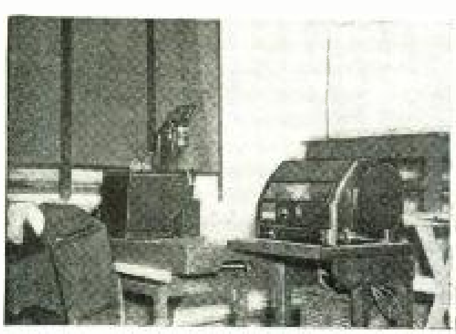
MOBILE UNITS ACTIVE

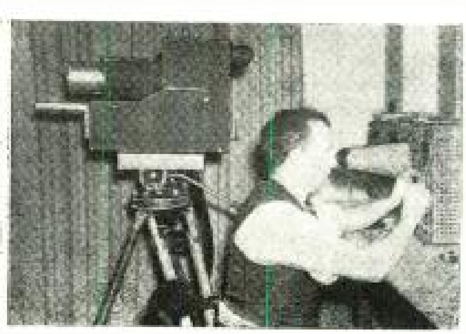
Since broadcasting election returns, NBC's television station, W2XBS, has been making mostly remote pickups. The trucks have brought televiewers wrestling, hockey, boxing, football, and basketball this autumn and winter.

Du Mont Discloses Election Return Methods

Somewhat tardily Du Mont engineers have released information as to how they covered election returns over W2XWV. It was done by means of a ticker tape projected on a screen and scanned by use of the usual pick-up tube. This was an experimental broadcast over a 50-watt transmitter and few persons in the metropolitan area knew that it was on the air. It did not compare in coverage to the NBC telecast on election night, which was described in last month's issue of R. & T.

The accompanying pictures show first the arrangement of the teletype printer feeding directly into the ticker tape projector, which flashed the images onto a translucent screen. The second picture shows how the screen was set up to be scanned. In the third picture an operator is seen checking the patterns on an oscillograph. A hood is provided over the cathode-ray tube, so that it may be seen clearly in an illuminated room. This permits accurate monitoring of the program.





Alexanderson's Daughter Christens New FM Station

While her father and mother, Dr. and Mrs. E. F. W. Alexanderson, and her friend, Miss Ellen Wellman watched, Mrs. James H. Burnham crashed a high vacuum tube against the base of the General Electric's new FM antenna for station W2XOY in the Helderbergs near Schenectady. (Company engineers endeavored to create the best possible vacuum for use in this tube, but when it was broken it released no less than 370 quadrillion molecules of various gases, including some 5,000,000 molecules of Xenon, a gas so rare that only a few cubic centimeters of the pure gas are in existence.)

This official christening is seen in one of the accompanying pictures. Another shows a complete view of the new station.

The initial broadcast was put on in Proctor's Theatre at Schenectady, where Phil Spitalny's All-Girl orchestra played before a capacity crowd of 3500. Other features were short talks by FCC member George H. Payne, Charles E. Wilson, President of General Electric, Dr. W. R. G. Baker, manager of the company's radio and television department and chairman of the National Television Systems Committee, and Dr. R. S. Peare, the company's manager of broadcasting.

In his talk, Mr. Wilson cited frequency modulation as *"a new and great achievement."* He said: *"Unlike the conventional method of broadcasting, which just grew, the development of FM has been carefully planned and controlled. During several years of experiment in competition with established methods, for many purposes, it has proved itself a superior means of sending radio programs into your home, as well as for many kinds of regular and emergency communication."*

Mrs. James H. Burnham, daughter of Dr. and Mrs. Alexanderson, christens new FM station with "bottle of nothing", as parents and friend watch.

A view of the new FM station, christening of which is shown in the photograph above.

The program of music and talks was also broadcast from amplitude-modulated station WGY, and short-wave stations WGEA and WGEO.

A standard General Electric FM transmitter is used for the new FM station, which covers an area within a radius of about 50 miles from the Helderberg antenna and including Schenectady, Albany and Troy, N. Y. As FM has the characteristics of television, in that the present-type wire lines will not carry the programs, a short-wave transmitter sends the signals from W2XOY's studio in Schenectady to the transmitting station in the Helderbergs.

A G-E three-bay turnstile antenna of new arrangement is being used for W2XOY. Providing a considerable signal gain over previously available similar designs, this antenna has been built to withstand one inch of ice and a hundred-mile-per-hour wind.

RADIO GIVES CODE & SPANISH LESSONS

Radio code classes for all students wishing to learn or brush up on code are being conducted each Monday evening at 9:00 p.m., E.S.T., over world-wide short-wave Station WRUL on the frequencies 6.04 mc. (49.6 meters) and 11.73 mc. (25.6 meters).

The lessons are for beginners, to give them a firm foundation for the study of code as a hobby or profession. Later a period of instruction for those more advanced in code practice will be inaugurated by WRUL under the direction of W. W. Chamberlain.

Students of this class of the air, from Canada to Florida and Puerto Rico, may submit their lessons after each broadcast for correcting and suggestion for study. Papers are graded and returned to students.

Spanish lessons for radio listeners are also being conducted over world-wide short-wave Station WRUL in Boston on Friday evenings at 9:30 p.m., E.S.T., on the frequencies 6.04 mc. (49.6 meters) and 11.73 mc. (25.6 meters). The classes are repeated on Friday afternoons at 5:30 p.m., E.S.T., on the frequencies 11.79 mc. (25.4 meters) and 15.25 mc. (19.6 meters), to better reach audiences of students, teachers, parents, and those interested in languages as a hobby.

The course begins with simple grammar as a basal text for students who desire to read, speak and write Spanish with the least possible delay. The Inter-America Division will examine and correct all exercises submitted by listeners, and each month there will be a review period.

FM SPEEDS USE OF RADIO IN ADULT EDUCATION

Cleveland's pioneer high-frequency educational radio broadcast station, WBOE, operated by the Cleveland Board of Education, has been authorized by the F.C.C. to change its type of transmission from amplitude to *frequency* modulation.

First station to operate in the ultra-short wave band set aside for educational stations in 1938, WBOE has been broadcasting from its own studios to receivers in each of Cleveland's 151 schools since November, 1938.

Now, as commercial FM broadcasting gets under way and high-frequency FM sets become available to the public, WBOE's programs may find listeners in homes as well as in classrooms.

Due to the British blockade, few items are received from continental Europe as mails from Nazi occupied areas seldom come through.

Fluorescent Flag Glows at Night in "Black Light"

The American flag, glowing with all the intensity of democracy's spirit, shines in a darkened room when treated with certain chemicals. In daylight these flags, made by Dr. J. W. Marden, Assistant Director of Research, Westinghouse Lamp Laboratories, and Dr. N. C. Besse, assistant, appear to be plain white cloth; each, however, has been given a coating of fluorescent materials in the pattern of the flag. Two such flags have been made and a pair of ultra-violet lights is used to illuminate them. Different compounds have been used on each of the flags: one responds to one of the ultra-violet projectors and the other to the second projector, but each is unaffected save by its own projector.

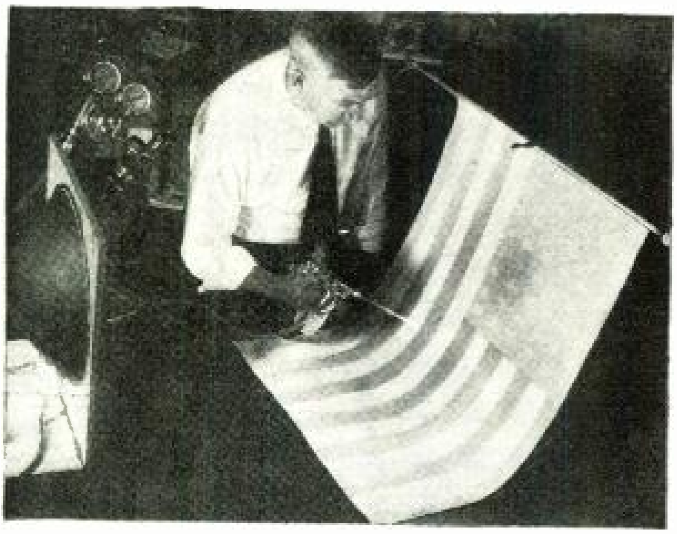
Ultra-violet has many wavelengths from short to long, like the familiar color spectrum. Organic and inorganic fluorescent materials, of which there are literally hundreds in the world, are activated by many different wavelengths according to their own peculiar characteristics. One "note" of the ultra-violet scale may cause a certain phosphor to fluoresce but fail completely to affect another. The object of research has been to discover the proper wavelengths for activating a great number of different fluorescent compounds.

One flag is a "short-wave" banner which takes on its proper colors only when within reach of short-wave ultra-violet radiations. The staff is coated with zinc silicate and the knob on top with zinc beryllium silicate. The staff becomes green and the knob yellow white when fluorescing. The red stripes are cadmium borate; the blue field, calcium tungstate; the white stars and bars, magnesium tungstate. The second flag is of a "long-wave" variety and composed of entirely different fluorescent compounds.

The ultra-violet source is a specially designed water-cooled lamp, called a "hydrogen-discharge" lamp. This lamp is necessary because it gives a nearly continuous spectrum in the portion of ultra-violet investigated.

To make photographic records of this phenomenon, fluorescent powders are spread on a clear gelatin film mounted in front of an ordinary panchromatic plate. A yellow, photographic K2 filter is then inserted between the powders and the photographic plate to halt all but visible light.

When the lamp is turned on, ultra-violet radiations cause the fluorescent powders to become alive with light at the point where the ultra-violet would normally hit the photo negative, thereby recording in black and white, their response to the various wavelengths of ultra-violet. Thus the negative is darkened by only the visible fluorescence of the compounds and permanent records made.



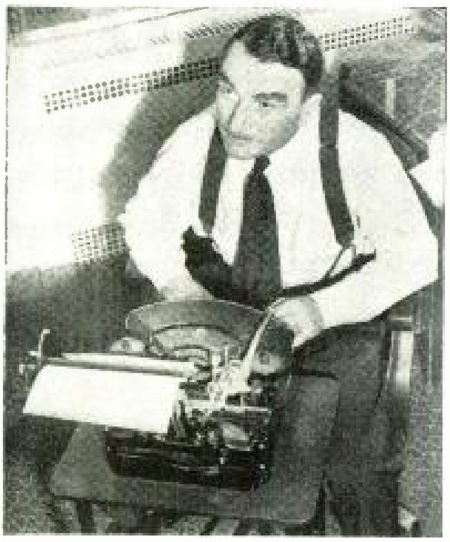
Technician sprays cloth with fluorescent dyes to make it glow with flag's colors in "black light".

NAVY "NET" NEEDS MEN

In an exclusive story the *New York Times* reports that the office of Naval Communications in the Navy Department is seeking the co-operation of Hams throughout the U. S. to fill a shortage of about 5,000 men in the personnel of the Naval Communications Reserve. The readers of this magazine are urged to co-operate.

BOAKE BACK

Boake Carter, famous *newscaster* whose voice has been missing from the ether waves for two years, is now heard thrice weekly over the WOR-Mutual Network. There was considerable talk in which it was alleged that Carter was "suppressed" when he left the air in 1938. His return should terminate such ugly rumors. One of the most popular commentators, Carter's return proved welcome to listeners.



SCHOOLS GET U.H.F. BAND FOR EDUCATION

When the Federal Communications Commission approved FM in May, 1940, and recommended it for all ultra-short wave broadcasting, because of its qualities of more faithful sound reproduction and absence of static and interference from other stations, it cleared a range in the high frequencies from 43 to 50 megacycles for commercial broadcasting.

At the suggestion of U. S. Commissioner of Education John W. Studebaker, representing more than 300 universities and colleges and hundreds of school systems and other educational organizations, the F.C.C. moved the educational band to an adjoining position at 42-43 megacycles.

In explaining educational radio's request for a position tangent to the commercial band, Commissioner Studebaker pointed out that FM commercial broadcasting would lead to large scale retail distribution of FM receivers capable of tuning in programs from educational studios.

Cleveland's school board is one of several preparing to enter this new phase of education by radio. San Francisco's Board of Education has received a construction permit for its proposed FM station, KALW. San Mateo (Calif.) Junior College and school systems of Chicago and New York have indicated they will file applications soon. New York's school system, like Cleveland, has been operating a high-frequency AM station, WNYE, which it expects to change to FM.

Another New York educational institution, the College of the City of New York, has expressed an interest in an educational station. The University of Kentucky operates WBKY, an AM high-frequency station which broadcasts educational programs to schools and community listening centers in rural Kentucky areas. Oklahoma A. and M. is considering establishing a similar service.

Rensselaer Polytechnic Institute is reported to be building an FM station, the Universities of Illinois and Wyoming, and New River State College, Montgomery, W. Va., are collecting equipment, and an alumnus has offered the University of Michigan equipment for an FM station. Nearly a score more educational institutions and school systems are developing plans for stations in the educational band.

WBOE's new frequency allocation is 42.5 megacycles and its power has been doubled to 1000 watts.

THEATRE TELEVISION COMING

According to apparently well founded rumors, the National Broadcasting Co. is equipping a midtown New York theatre to receive large screen television images. Reports are that the images will be about 12 x 16 feet.

PHOTO-ELECTRIC PHONOGRAPH RECORDS FOLK SONGS

A *newly* invented phonograph pick-up, created by Philco Corporation engineers and designed along the same basic engineering principles as applied in its recently announced photo-electric radio phonograph, promises to open a new field in music research.

Students of folk music have made collecting trips into backwood regions. The inadequacies of noting down by ear and hand the melodies which they heard were so obvious that at the first advent of the Edison phonograph they adapted it to their purposes. As years passed and improvements were made in recording, the inadequacies of the early records in turn became obvious. The cylinders, which had been recorded on machines somewhat resembling a modern Dictaphone, became more brittle and fragile with age, and since the precious material they contained could only be brought to life again by pressing a hard diamond or heavy steel point into their grooves, they had to be guarded with great care and only played infrequently for special problems of research.

Since these cylinders contained the only authentic record of the folk music of the last generations, it became of paramount importance to find some means of transcribing it onto newer and more durable discs.

The photo-electric phonograph pick-up recently announced by the Philco Corporation seemed to offer the most promise and therefore the engineers of the Library of Congress Phono-duplication Laboratory brought their problems to the attention of David Grimes, Chief Engineer of Philco Corporation, who offered to attempt to design a new lightweight reproducer suitable for work with the old cylinders. After about two months of intensive research, E. O. Thompson, Philco Corporation engineer, working with Jerome B. Wiesner, Chief Engineer of phono-duplication for the Library, produced a machine which gives every promise of being satisfactory. Now installed in the Library of Congress, it has successfully performed every test assigned it thus far.

This will mean that the American public shortly will be able to hear thousands of old American folk songs, Indian songs and voices of personalities long deceased. In addition, it is expected that composers and lyricists will edit many of the old musical renditions and create new American music which will be based upon long forgotten melodies.

By use of a slightly different application of the principle of the pick-up arm of the new photo-electric phonograph, these old cylinders are being transferred onto flat disk records, so that they may be played without fear of damage to the sound grooves.

Thousands of these records, which for years have remained in dusty cases because of the danger of scratching away the valuable words and music, can now be made available to research students.

Basic reason for the better results of this experiment is the very slight 5 gram downward pressure of the sapphire stylus in comparison to the approximate 25 gram pressure on the original reproducer stylus.

The sapphire stylus need only *float* gently in the grooves to produce the necessary motion; as a result the delicate impressions in the wax cylinder are not gouged out and destroyed.

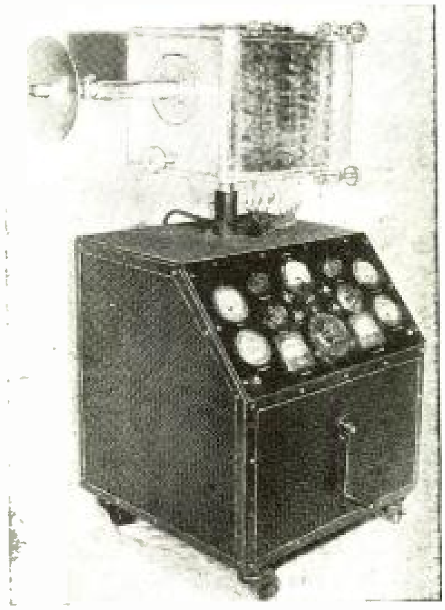
The *photo-electric* pick-up has been placed on a standard cylinder machine replacing the original pick-up. The photo-electric pick-up is connected in turn by wires to the recording unit. The sound from the wax cylinder is transcribed from the cylinder through the recorder onto a flat disc type record from which any number of additional impressions can be made.

Recently, the first extensive job of transcription was started. Percy Grainger, the renowned pianist and composer, arrived at the Library with over two hundred cylinders, recorded in all parts of the world. The Division of Music in the Library of Congress anticipates that this will be followed by the transcription, not only of the records already in the Archives, but also of other important private collections, and that the wealth of material thus obtained can eventually be made available in useful and durable form to every interested scholar.

CENTIMETER WAVE SIGNAL GENERATOR FOR 3000-4000 MC.

A *signal* generator designed for laboratory research involving the study and development of new radio equipment to operate in the 3000 to 4000 mc. portion of the radio spectrum generates test signals of adjustable intensity and frequency. As it operates at unusually high frequencies, its design is somewhat unconventional.

The oscillator is an end-plate magnetron tube, having a maximum output of about 1 watt in the frequency region of 3000 mc.



(9 cms. wavelength; 1 cm. = 0.4 inch). However, in the signal generator, outputs of 0.01 watt are ample for most tests. The oscillator feeds an antenna from which the generated signal is radiated. Control over the signal strength is obtained by means of an attenuator, and a specially designed thermocouple is used to indicate the output.

At these very high frequencies, which are in the quasi-optical range, difficult problems are encountered in shielding, lead filtering, and also in modulation. The signal generator incorporates new methods of overcoming these difficulties. *(Photo courtesy of RCA)*

13TH ANNUAL SCIENCE AND ENGINEERING FAIR

O*pen* to all junior and senior high school students who have outstanding experiments or demonstrations to exhibit, the 13th Annual Science and Engineering Fair is an ideal place to show what has been accomplished in the construction phase of club and classroom work in science. All exhibits at the Fair must be the actual creation of student participants. Cash prizes amounting to $3,000 will be awarded for the best displays. Although the Fair, which is a continuation of the American Institute's annual industrial fairs which began in 1828, is held in New York City, schools from every part of the United States are represented. Last year over 27,000 people visited the Fair to view 326 exhibits representing working models, experiments, live animals and plants, and technical and mechanical projects. Entries are due March 15, 1941.

All interested students are invited to write to the American Institute Science and Engineering Clubs, 60 East 42nd Street, New York City, for complete information regarding these activities and the general club program.

BROADCASTS TO AMERICA

P*hilip Noel Baker, M.P.*, is seen below giving one of the "Britain Speaks" talks which he broadcasts in the BBC's North American service.

A very large number of letters from

overseas listeners arrive daily and each one receives an individual reply. Letters from listeners are welcomed by the BBC, for careful analysis.

FM FOR NASHVILLE POLICE

A*fter* operating an amplitude modulated emergency communications system for five years, the city of Nashville, Tenn., has ordered a complete FM system from the General Electric Company.

The system for Nashville will include 1 250-watt and 24 25-watt transmitters, and 30 receivers. A 200-foot tower, to be constructed, will support a half-wave antenna of new design that provides complete lightning protection.

Nashville is the first Southern city to adopt frequency modulation for police communication.

CONNECTING PHONES TO RECEIVER

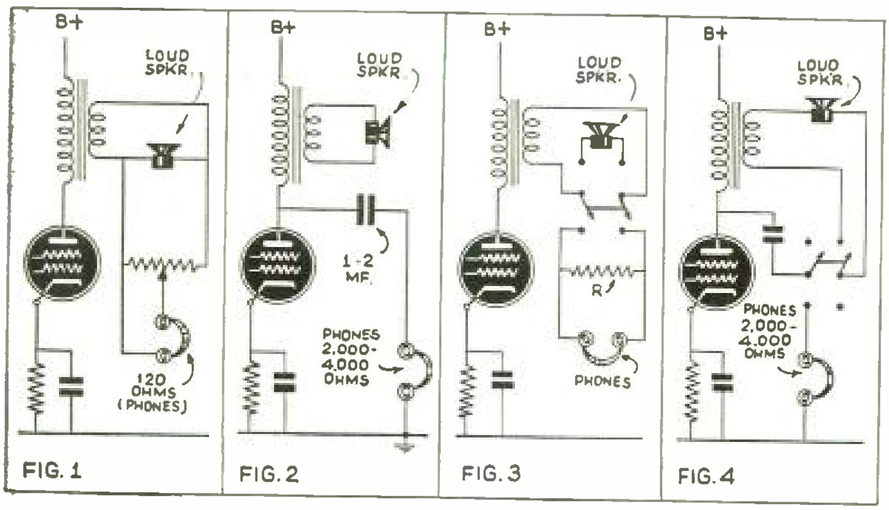
● SEVERAL different methods of connecting a pair of headphones to the output of a radio set which is already provided with a loudspeaker are shown in the latest issue of *Electronics and Television & Short-Wave World*. In Britain, phones with resistance as low as 120 ohms seem to be common, although these are not found very frequently on this side of the Atlantic. However, Figures 1 and 3 show desirable methods of connecting low resistance phones. You will notice that these place the phones across the secondary of the output transformer. This reviewer does not think that with 120 ohms phones, much of a "match" would be secured, particularly using the method shown in Fig. 3, as American speaker voice coils usually have an impedance of 10 ohms or less—not a very good match to 120 ohms.

Figures 2 and 4 will probably be more satisfactory for the average American headphones of 2000 to 4000 ohms impedance. In Fig. 2 the phones are used without cutting the loudspeaker out of the circuit, but in Fig. 4 a switch-over system is used to kill the speaker when the phones are in use. Likewise in Fig. 3 the speaker is killed, while in Fig. 1 it remains in use.

In Figs. 2 and 4 the blocking condenser has a capacity of 1 or 2 mf. and a working voltage equal to the maximum plate voltage plus the peak A.C. component. This will probably not be much in excess of 500 volts working voltage.

An additional condenser on the other side of the phones should be used if the set is an A.C.-D.C. receiver.

It is recommended that the resistance shown in Fig. 1 should be about twice the impedance of the voice coil and that in Fig. 3 about 1½ times the voice coil resistance.

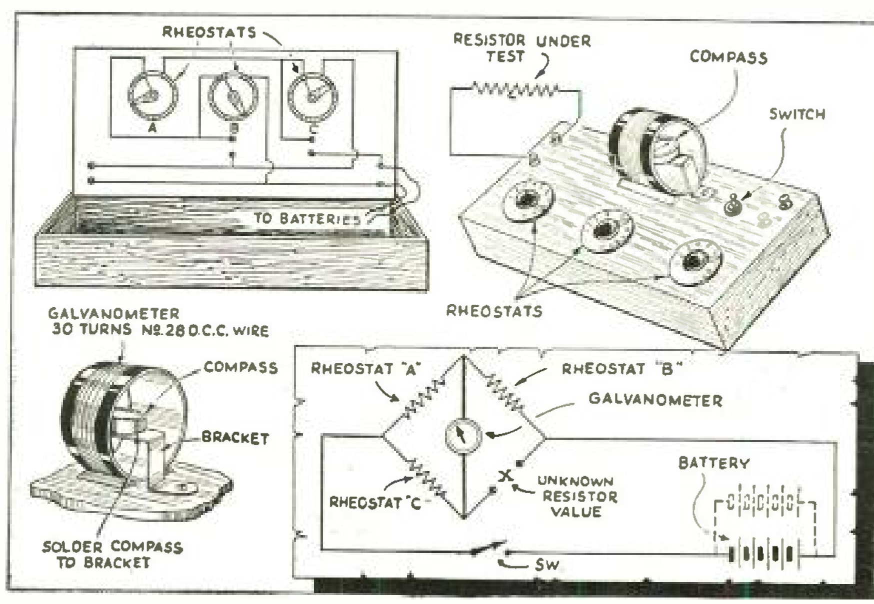


3-TUBE A.C. SET

● A TINY 3-tube A.C. receiver was recently described in *The Australasian Radio World*. It is a set which has proven highly popular in that part of the world, and is a fourth redesign of a circuit originally issued in 1937. Basically, it employs a dual purpose tube as R.F. amplifier and detector, together with a pentode output.

The set mounts on a chassis 9 x 5¼ x 1½" and employs a midget 40 ma. power transformer. The two coils are extremely simple and may either be purchased or home-wound for the desired band. The tuning condenser has a capacity of .00035 mf. and is equipped with a trimmer on each section. An additional trimmer is used as a fixed regeneration control. The high voltage output of the power transformer is 325 volts and self-bias is provided. The antenna coil is mounted above the base and the R.F. coil below to isolate the 3 units and provide short wiring. Each coil is further equipped with its own shielding can. No difficulty should be had in following the diagram below.

EXPERIMENTAL WHEATSTONE BRIDGE

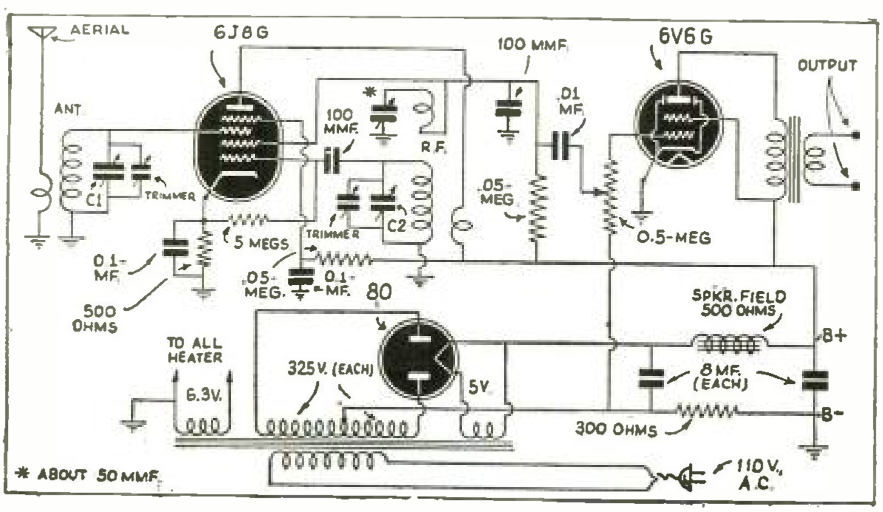


(See Diagram Above)

● A SIMPLE and effective Wheatstone bridge can quickly be made from three rheostats, a battery, and a sensitive meter. This last may be a homemade galvanometer, which consists of no more than a compass surrounded by about 30 turns of No. 28 d.c.c. wire on a 1½ inch form.

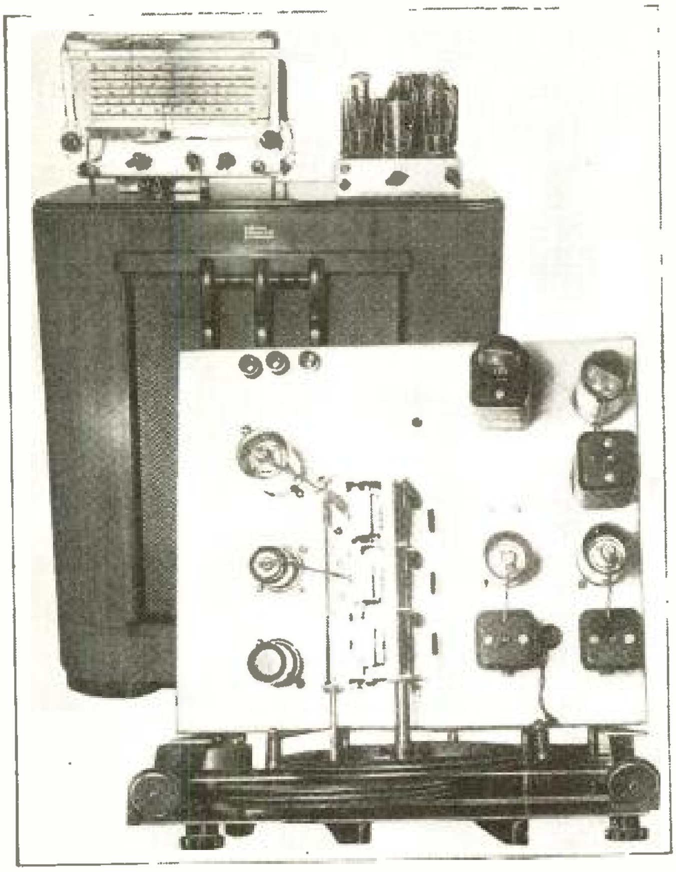
The rheostats are mounted as shown in the diagram given above, and the resistance under test is connected across the binding posts marked X. The writer in *Radio Revista* of the Argentine suggests that each rheostat may have a value of 1000 ohms, or any other values may be used to raise or lower the range of the instrument.

The usual simple calculations of Wheatstone bridge operation are employed with this instrument. Formulas can be found in any textbook on the subject.



High-Fidelity All-Wave Tuner

Herman Yellin, W2AJL



The picture above shows the all-wave tuner on top of the Jensen high-fidelity loudspeaker, and the small inset picture shows a top view of the all-wave tuner.

As the author points out—those who have listened to F-M broadcasts have suddenly become "fidelity-conscious" listeners. To provide a better equipped tuner for the ordinary broadcast, so that high quality reproduction could be obtained (in connection with the F-M audio amplifier previously described), the author built the tuner here described. A ready-built 5-band coil-switching unit was employed, which simplifies the construction immensely.

● THE rapidly increasing number of F-M broadcasting stations has increased the number of *fidelity-conscious* listeners. After spending some time at an F-M receiver, the average listener becomes increasingly critical of ordinary A-M broadcasts, resulting in a desire for a broadcast receiver that would reproduce the program with as great a fidelity as possible. While the TRF (tuned radio frequency) type of receiver has often been used for high-fidelity reception, it has a serious drawback in its unsuitability as an effective *all-wave* receiver. With proper design, however, a superhet can deliver a good signal and faithfully reproduce the output of the occasional high-fidelity broadcaster.

It was for these reasons that the writer built an all-wave high-fidelity tuner, capable of being used with the same audio amplifier-speaker system used with his F-M tuner, and able to deliver signals not too inferior in quality when compared with the F-M signals.

Ready-Made Coil-Switching Unit Used

In order to simplify construction, a ready-made 5-band coil-switching unit was obtained. This unit tunes from 530 kc. to 32.4 mc. with a special 280 mmf. tuning condenser. Especially made for amateur receivers, which demand the ultimate in tuning ease in the highly crowded Ham bands, the 3-gang condenser has a small rotary trimmer section in parallel with each large condenser section. This really gives us two tuning condensers in one, one for ordinary tuning and the other smaller section, for *band-spread* tuning. This *band-spread* feature is highly effective and a necessity not only on the Ham bands, but on the foreign *broadcast* bands, where it provides that ease of tuning so sadly missing on the average "all-wave" radio. If the band-spread feature is not desired, an ordinary 3-gang, 280 mmf. condenser can be used, in which case the special band-spread dial with two knobs will not be necessary. Also, if desired, the coil unit can be procured with a different tuning range—42 mc. to 132 kc.—which includes many *long wave* services. A 3-gang 410 mmf. condenser will be needed with this latter coil unit. Either combination of coil switching unit and condenser gang can be used in this tuner, but be sure to get the correct dial since they have directly calibrated scales.

Tube Line-Up

Now to the tube line-up. The R.F. stage uses an 1853—well suited for operation on the higher frequency bands, while the detector-mixer employs a 6K8, used only for *mixing*, since a separate tube—a 6J7GT—is used as the high frequency oscillator. In the I.F. stages we have a pair of 6K7GT tubes, followed by a 6SQ7GT performing two functions. The two diodes are paralleled for use as the second detector, while the triode section is used as a beat-frequency oscillator. Note the use of the bantam type glass tubes; these have a metal base connected to the number one pin and a sleeve type of shield can be slipped over the glass envelope, affording effective shielding. The bantam tubes are in some respects superior to the metal type and bid fair to eventually supersede the metal type.

The output of the second detector is fed through a volume control into the output jack on the back of the chassis, and thence to the external amplifier. No power-supply was built onto this tuner chassis, since the writer's amplifier furnishes sufficient power for this purpose. As the power-supply contained a regulated 105 volt supply, it is used not only for the high frequency oscillator but for the beat frequency oscillator, as well as the 6K8 screen. If a power-supply not having this regulated voltage is used, a 25 watt slider type voltage divider (15,000 ohms) can be connected across the 250 volt supply and adjusted to about 100 volts.

Fidelity on the "Broadcast" Band

Returning for the moment to the subject of *fidelity*, it must first of all be remembered that *broadcast* stations are assigned frequencies ten kilocycles apart, and since they have two side-bands, are limited to an audio band width of 5000 cycles. An exception is the case of broadcast stations just above 1500 kc. which are licensed for a greater band width. Although the former stations are not supposed to transmit audio frequencies higher than 5000 cycles, they do so, but the beat note between the higher frequencies of two adjacent channel stations is not heard because of the narrow band width of the ordinary tuner, which may cut off at much less than 5000 cycles. Increasing the band width to make these higher frequencies audible is desirable in those instances where the desired station is not flanked by adjacent channel stations within range of the receiver.

A happy solution to this problem of band width is the use of *variable* band width I.F. transformers. Using I.F. transformers having 3 degrees of band width, it is possible to

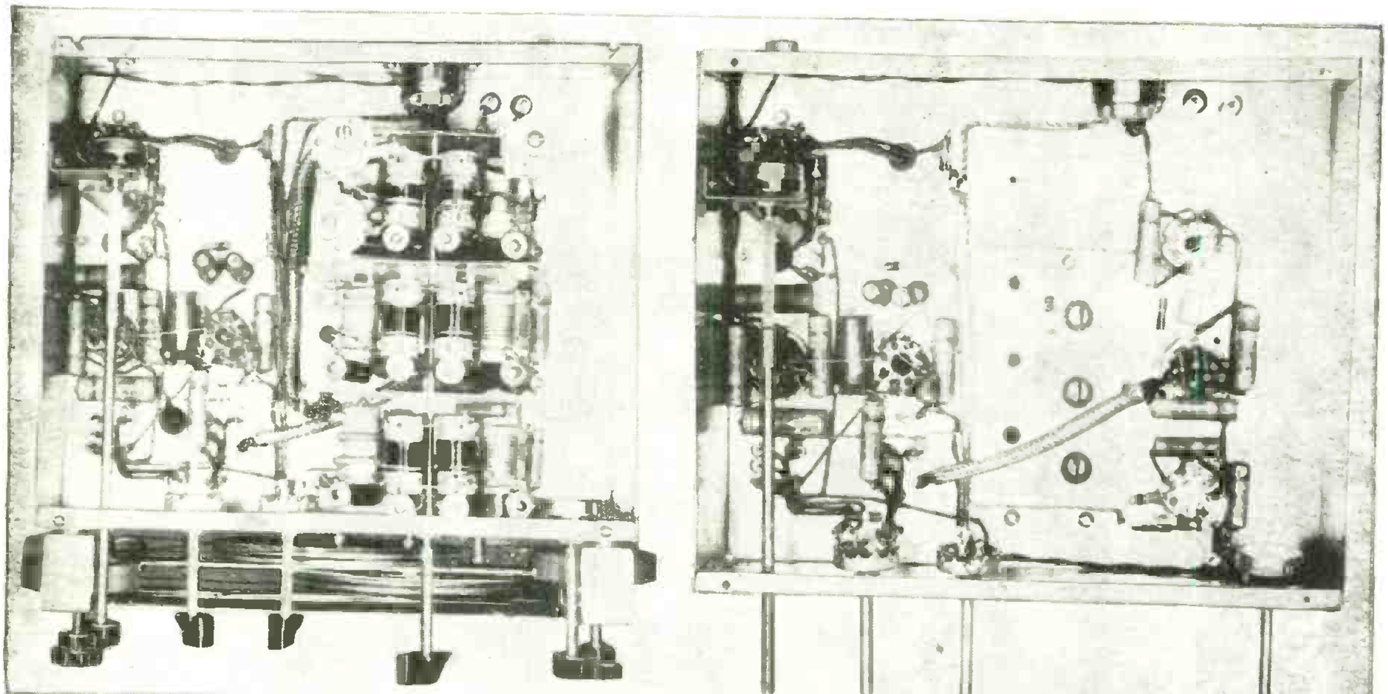


Photo at left shows all-wave tuner with switch coil unit in place. Photo at right—view of tuner before coil unit was installed.

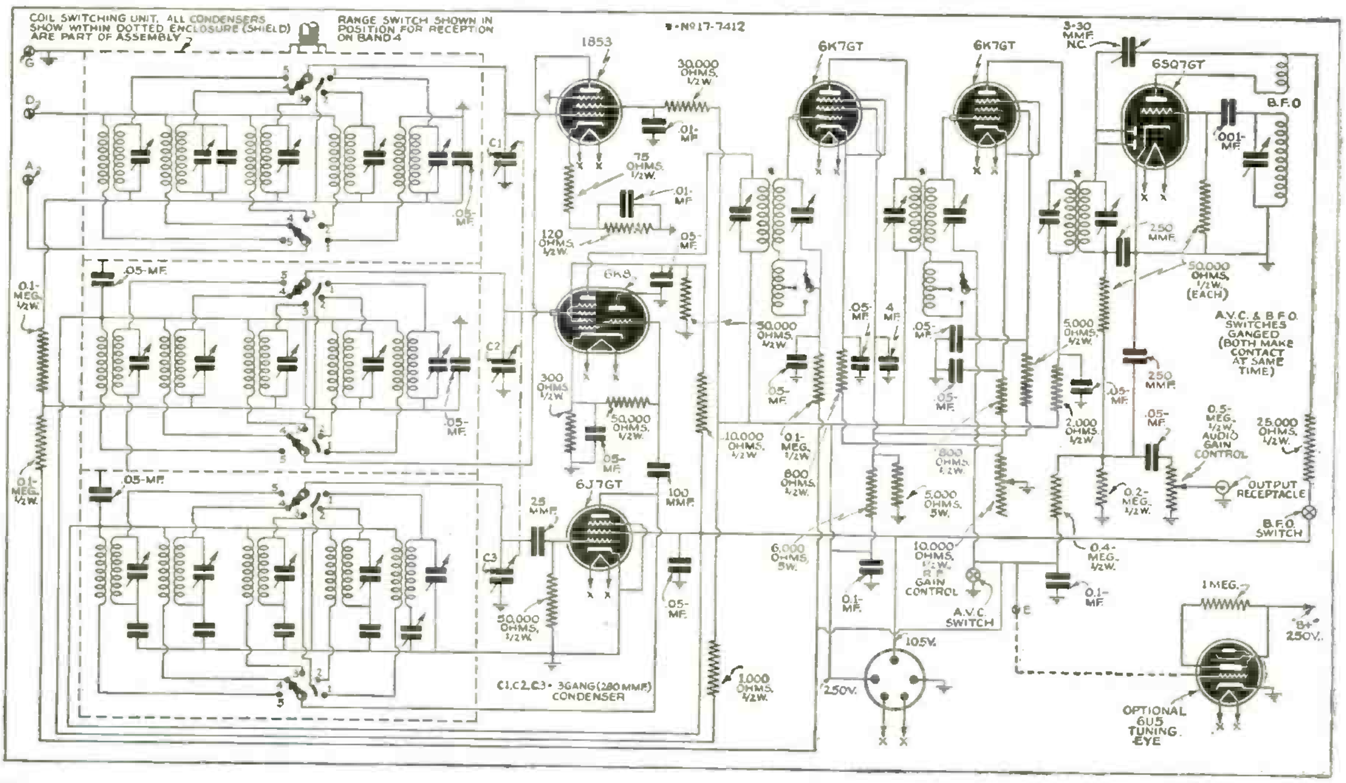
vary the band width from the quite *sharp* position, desirable for tuning in the Ham bands or the crowded *foreign* broadcast bands, to the *medium* position suitable for ordinary work. The third position gives increased band width for listening to the *high-fidelity* stations, or some of the broadcast stations. It will be found that the high fidelity position of the I.F. band width switch cannot be used on many of the stations, especially on the high frequency end of the broadcast band because a high-pitched whistle will be heard caused by the heterodyning between that station and the station in the adjoining channel.

Beat-Frequency Oscillator

The *beat-frequency* oscillator was incorporated, since it didn't involve the use of an additional tube and more important, it is extremely helpful in locating those weak, distant short-wave stations. For receiving *code* (C.W.) signals, for which this tuner is eminently qualified, the BFO becomes a necessity. Coupling between the BFO and second detector diode plates is accomplished by a 3-30 mmf. trimmer—adjusted on a weak signal for loudest beat note. A convenient knob atop the BFO transformer allows the beat note to be adjusted to the most pleasant tone.

The coil assembly requires the use of a chassis 4 inches deep, but as this was unobtainable except in a prohibitively large chassis, a chassis 3 inches deep and 12 x 10 inches wide was used. This resulted in the coil assembly protruding beneath the chassis, but four one inch brass spacers raise the chassis high enough so that the coils do

Wiring diagram for the high-fidelity all-wave tuner unit here described by Mr. Yellin.



not touch the cabinet shelf. No ill effects were observed as a result of this abbreviated chassis and the unconventional appearance is not apparent when the chassis is mounted inside a cabinet.

Assembly and Wiring

In mounting and wiring the components, the tuning condenser should be mounted directly above the coil assembly, with the "front end" tubes mounted close to the condenser gang, in the positions shown in the photos. This placement will result in the shortest R.F. leads, and also will place the coil assembly right over the three steatite sockets, necessitating the wiring of these sockets, before the coil assembly is mounted inside the chassis. As a matter of fact, it would be well to wire everything on the chassis and leave the coil assembly for the last, obviating the possibility of damaging any of the coils. If the band-spread dial is used, it will be necessary to support it by bolting it to the chassis.

The lead from the 6K8 plate to the first I.F. transformer is a little long, so it was shielded—not with ordinary shielding, but with the *low-capacity* type. The plate lead is covered with a piece of half-inch diameter spaghetti or sleeving, and over this is pushed some large shielding braid which is *grounded to the chassis.* The large diameter of the spaghetti keeps the shielding far enough away from the wire to keep the capacitance between wire and braid quite low. The same method of shielding is used over the antenna leads coming out of the antenna section of the band-switch assembly, which go to the antenna binding posts at the rear of the chassis.

The remainder of the wiring is quite straightforward, and should offer no difficulty since there is really very little of it. The audio volume control is mounted on a small bracket near the rear of the chassis with a brass shaft extension to the chassis front. The 2-pole, 3-position rotary switch used for selecting the I.F. band width is mounted next to the audio gain control and next to this is the AVC-BFO switch which turns off the A.V.C. when the BFO is turned on. At the extreme left of the chassis is the R.F. gain control.

Alignment Procedure

Alignment should preferably be done with an all-wave *signal generator.* The I.F. transformers should first be peaked to 450 kc. with the band expansion switch in the sharp position. Either a magic-eye tube or an output meter may be used as an indicator for I.F. as well as R.F. alignment. The all-wave coil assembly is aligned at the factory, so that, if the coils and trimmers are not touched, signals will be heard even without aligning the front end. However, for best results, it is advisable to go over the trimmers. Start off with the lowest frequency band. The tuning condenser should be set at about ten per cent of its maximum capacity, and a signal fed into the receiver —corresponding to the frequency marked on the dial at that point—and the oscillator trimmer adjusted for maximum output as indicated on the indicator. Then adjust the antenna and R.F. (detector) trimmers for maximum output. The tuning condenser is then turned to about 80 per cent of its maximum capacity and a signal fed into the receiver corresponding to the frequency shown on the dial, and the oscillator padder adjusted for maximum response. The condenser should then be turned back to the first alignment frequency and the antenna and R.F. trimmers rechecked for maximum response at that frequency. Don't retune the oscillator padder. This procedure is followed on each of the other bands. On the two highest frequency bands, however, there is no adjustable oscillator padder, as the coils have been adjusted at the factory for proper "tracking."

A good all-wave type of antenna, with twisted-pair feeders should be used for most effective results.

Parts List

BUD RADIO

1—3" x 12" x 10" chassis; No. 1195

I.R.C.—(Resistors)

1—75 ohm ½ watt; type BT½
1—120 ohm
1—300 ohm
2—800 ohm
1—1000 ohm
1—2000 ohm
1—5000 ohm
1—10,000 ohm
1—25,000 ohm
1—30,000 ohm
4—50,000 ohm
2—100,000 ohm
1—200,000 ohm
1—400,000 ohm
1—5000 ohm 10 watts; type AB
1—6000 ohm 10 watts; type AB
1—500,000 ohms potentiometer; type 13-133
1—10,000 ohm pot. wire-wound; No. W-10,000

NATIONAL UNION—(Tubes)

1—1853
1—6K8
1—6J7GT
2—6K7GT
1—6SQ7GT
1—6U5

AMERICAN PHENOLIC—(Miscell.)

1—5-prong plug in flush motor shell (for power-supply); No. 61-CP5
1—5-prong female plug; No. PF5-11
1—Chassis output connector; No. PC1M
1—Output plug; No. MC1F
1—6-prong plug (female); [for magic-eye tube]; No. PF6

MEISSNER MFG. CO.—(Coils I.F. Trans. & Sockets)

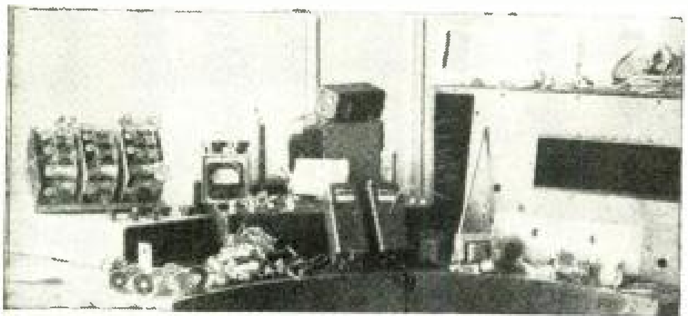
1—All-wave coil-switching assembly. (530 kc.-32.4 mc.). No. 13-7617
1—280 mmf. band-spread tuning condenser; No. 21-5143B
1—Electrical band-spread dial; No. 23-8211
2—456-kc. band expanding I.F. transformers; No. 17-7412
1—456 kc. I.F. transformer; No. 16-5711
3—Octal steatite sockets; No. 25-8437
3—Octal bakelite sockets; No. 25-8209
1—3-30 mmf. trimmer; No. 22-5255

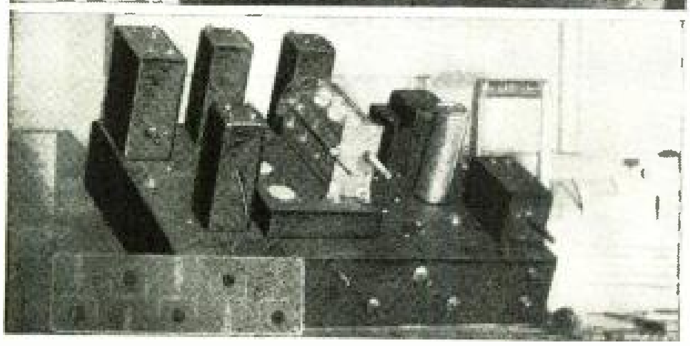
CORNELL-DUBILIER—(Condensers)

2—.01 mf. 400 volt condensers; No. DT-4S1
9—.05 mf. 400 volt condensers; No. DT-4S5
2—.1 mf. 400 volt condensers; No. DT-4P1
2—.0001 mf. mica condensers; No. 5WL-5T1
2—.00025 mf. mica condensers; No. 5WL-5T25
1—.000025 mf. mica condenser; No. 5WL-5Q25
1—4 mf. 450 volt electrolytic; No. BR-445

We Will Pay

regular space rates for good construction articles giving novel and original ideas for building such simple radio apparatus as short wave converters, receiving sets, television and frequency modulation receivers, recording equipment, power supplies, simple set and tube testers, facsimile recorders, etc.





The three photos show respectively—completely finished Communications receiver (above); complete kit of parts (top left), and below—at left—the receiver partly assembled.

A Low Cost, Highly Efficient Communications Receiver

Charles R. Leutz

The accompanying article describes a 14-tube de Luxe Communications receiver. The average set-builder and Ham will be interested in this set, because all of the delicate tuned sections are factory-wired and pre-aligned, thus insuring perfect results as soon as the set is assembled and wired. The set features tuned R.F. stage, noise silencer, crystal filter, variable pitch BFO, and a direct-reading "R" meter.

● EVERY amateur needs a first-class communications receiver, but with manufactured sets costing several hundred dollars each, a good many "hams" are financially stymied. Attempts to construct a good composite receiver are complicated and usually unsuccessful due to the lack of test apparatus for the final lining-up operations.

A solution for the above problem is the Meissner 14-tube "Traffic Master" Communications Receiver which is available in kit form. The kit includes a complete tuning unit which is factory wired and prealigned, which simplifies matters considerably. The intermediate R-F transformers are also factory peaked. The entire kit, tubes and a good speaker can be purchased for a surprisingly nominal amount.

Fig. 1 shows the complete kit parts laid out ready for assembly. Not including the miscellaneous hardware, there are 166 different parts including the 14 tubes and speaker. Fig. 2 shows the assembly of the kit parts up to the point of chassis completion. The completed receiver, ready for operation, is shown in Fig. 3. The complete schematic wiring diagram is given in Fig. 4 and Fig. 5 shows the wiring of the factory pre-aligned five band tuning unit. Detailed information on this tuning unit appeared in the July 1940 issue of RADIO & TELEVISION in an article by the author, entitled "*How to Extend the Tuning Range of Your Receiver.*"

Design Features of the Set

This communications receiver has the following essential design features:

1. A direct tuned R-F stage to insure favorable image ratio, using a modern tube especially efficient on the higher frequencies, in this case the 1853 "television" tube.
2. "Iron core" Ferrocart Intermediate R-F transformers with air dielectric trimmers.
3. An efficient "Lamb" noise silencer circuit to reduce ignition and similar abrupt electrical disturbances.
4. A Crystal-Filter and crystal-phasing condenser to regulate the obtainable degree of selectivity.
5. A variable-pitch Beat-Frequency Oscillator, free from frequency drift.
6. Stable operation insured by using a Voltage Regulator tube to feed the plate and screen-grid circuits of the oscillator tube, and the plate circuit of the beat frequency oscillator tube.
7. A direct reading "R" Meter.
8. Full frequency coverage from 530 kilocycles to 31 megacycles in five bands, with a liberal over-lap between bands.
9. A *band-spread* tuning condenser.
10. A separate oscillator tube, efficient over the entire frequency coverage, used in connection with a good mixer tube, in this combination—a 6J7 oscillator and 6K8 mixer.

While this kit is ordinarily used complete, any individual parts or combination of parts may be secured separately. The builder therefore has considerable latitude and can utilize good parts which may be on hand. Or, individual parts such as the Crystal-Filter Assembly, Beat-Frequency Oscillator Assembly or Noise Limiter Circuit parts may be secured and added to existing receivers. This 14-tube receiver design represents the result of considerable qualified development and research work and variations are not suggested unless for some good technical reason.

The tube array is as follows:

1. Pre-aligned tuning unit, 1853 R-F amplifier, 6K8 mixer and 6J7G oscillator
2. Intermediate R-F amplifier. 6L7 first IRF, 6K7 second IRF and 6H6 full-wave detector.
3. Lamb circuit. 6J7 and 6H6.
4. Audio, 6C8G inverter and two 6V6 or 6V6G's in push-pull, class AB.
5. Power-supply, 5V4G full-wave rectifier and VR-150-30 voltage regulator.

Construction Procedure

Construction of this multiple tube receiver is relatively simple. The kit is accompanied by a large pictorial wiring diagram showing all the various component parts, their location and their connections. A corresponding schematic wiring diagram is available for a check-up. The chassis and front

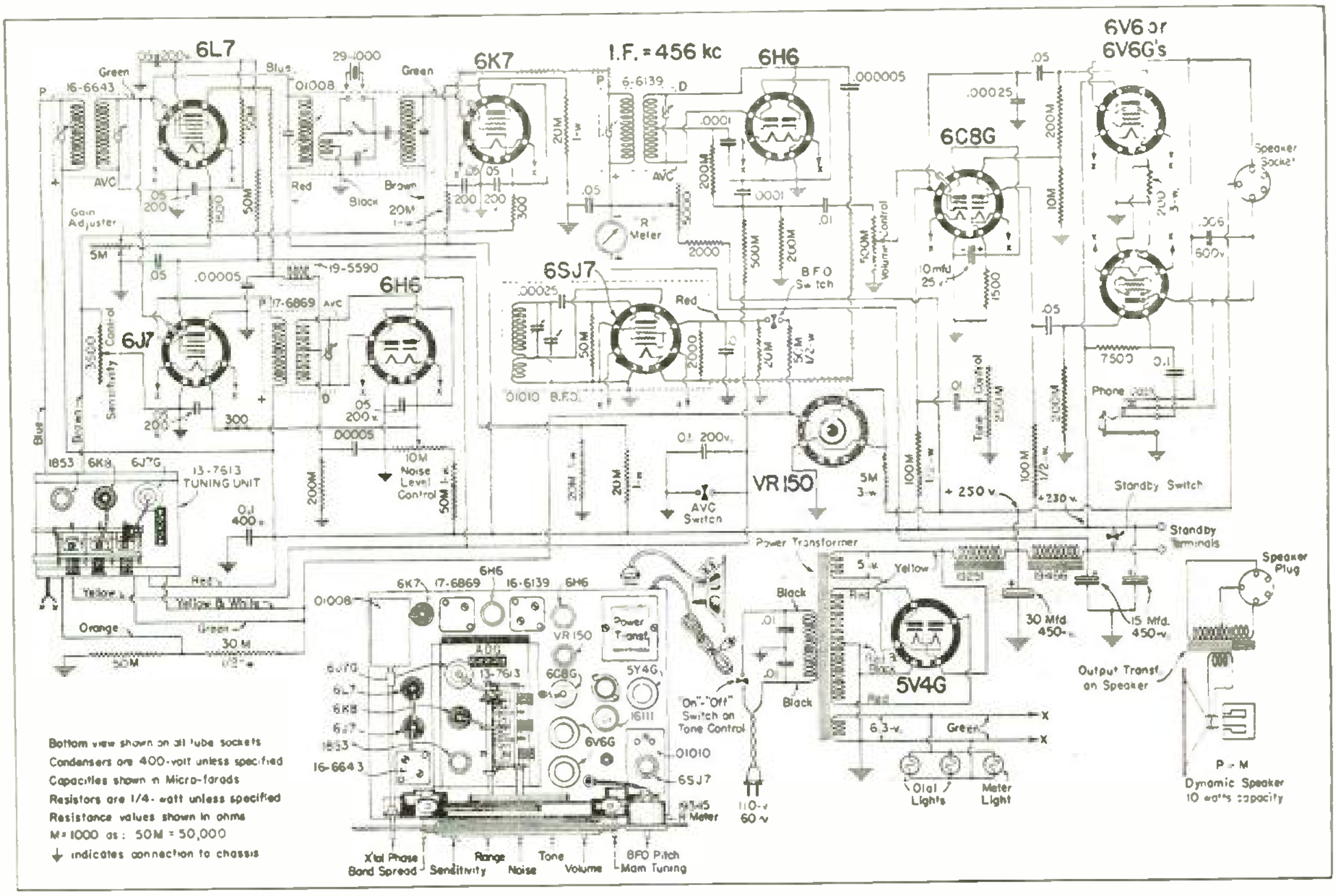


Fig. 3. Schematic wiring diagram for the 14-tube Communications receiver.

panel are drilled and all parts are ready for assembly. The assembled and wired tuning unit is the last item added to the chassis.

The construction is started by mounting the sockets into their chassis position, making sure the "key" points in the proper direction in each case. The heavy parts can then be fastened into place, including the Power Transformer, Filter Condensers, IRF Transformers, Crystal-Filter Unit and the Beat-Frequency Oscillator assembly. After wiring the 5V4G socket, and connecting all the Power Transformer leads, the two power-supply filter-chokes can be mounted and connected.

After completing the filament wiring, the smaller components can be inserted and connected, including the speaker socket, R-F choke, tie lugs, fixed resistors, fixed condensers, variable resistors and the two adjustable resistors.

The toggle switches and phone jack are assembled after adding the front panel, the latter being held to the chassis with spacers and holding screws.

It is not necessary to follow any rigid procedure during wiring; however, it simplifies matters by first connecting the various leads which extend from component parts, for example the leads from the Power Transformer, IRF Transformers, Crystal-Filter, Beat Oscillator, etc. The necessary other long leads can then be connected, including the filament wiring. Then only the connections for the various resistors and condensers remain and these can be made in a very neat manner.

As each connection is made, it should be checked off on the pictorial wiring diagram, using a colored pencil. Following that procedure carefully, it is almost impossible to make a mistake or omit any of the connections. During wiring care should be taken to make sure no bare leads are accidentally *grounded*, also that no small bits of solder or wire fall into positions which will cause grounds or short-circuits.

After completing the chassis wiring, the tuning unit assembly can be inserted. There are nine connections from the tuning unit which are now connected to the chassis. These leads are *coded* and *readily identified*.

The variable condensers in the tuning unit are set to the fully meshed position and then the dials can be lined up. The main tuning dial pointer is fastened at the extreme low frequency end of the calibration. The band-spread dial is set at zero and fastened.

Mounting the front panel, "R" meter and dial lights completes the assembly.

Check with Pictorial Diagram

The pictorial wiring diagram, which has been marked off in colored pencil, to indi-

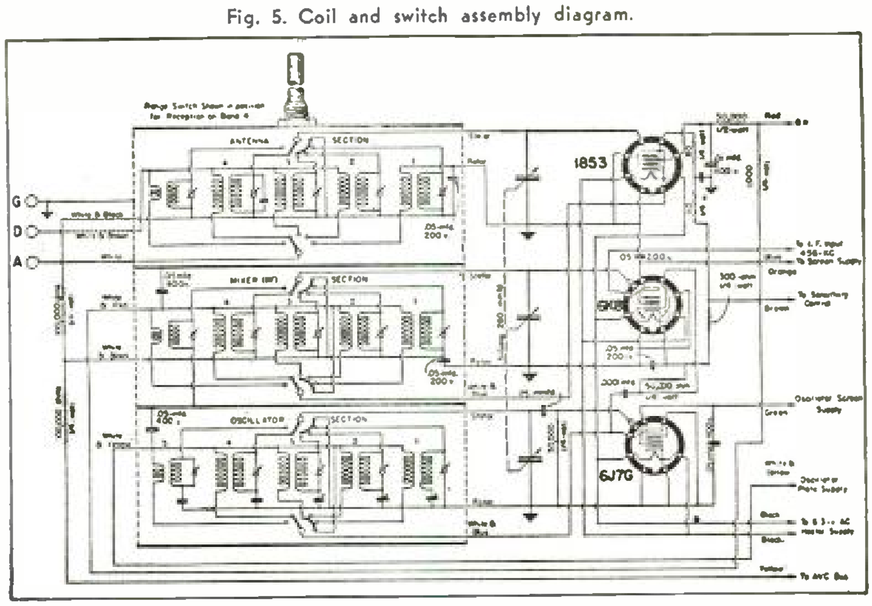


Fig. 5. Coil and switch assembly diagram.

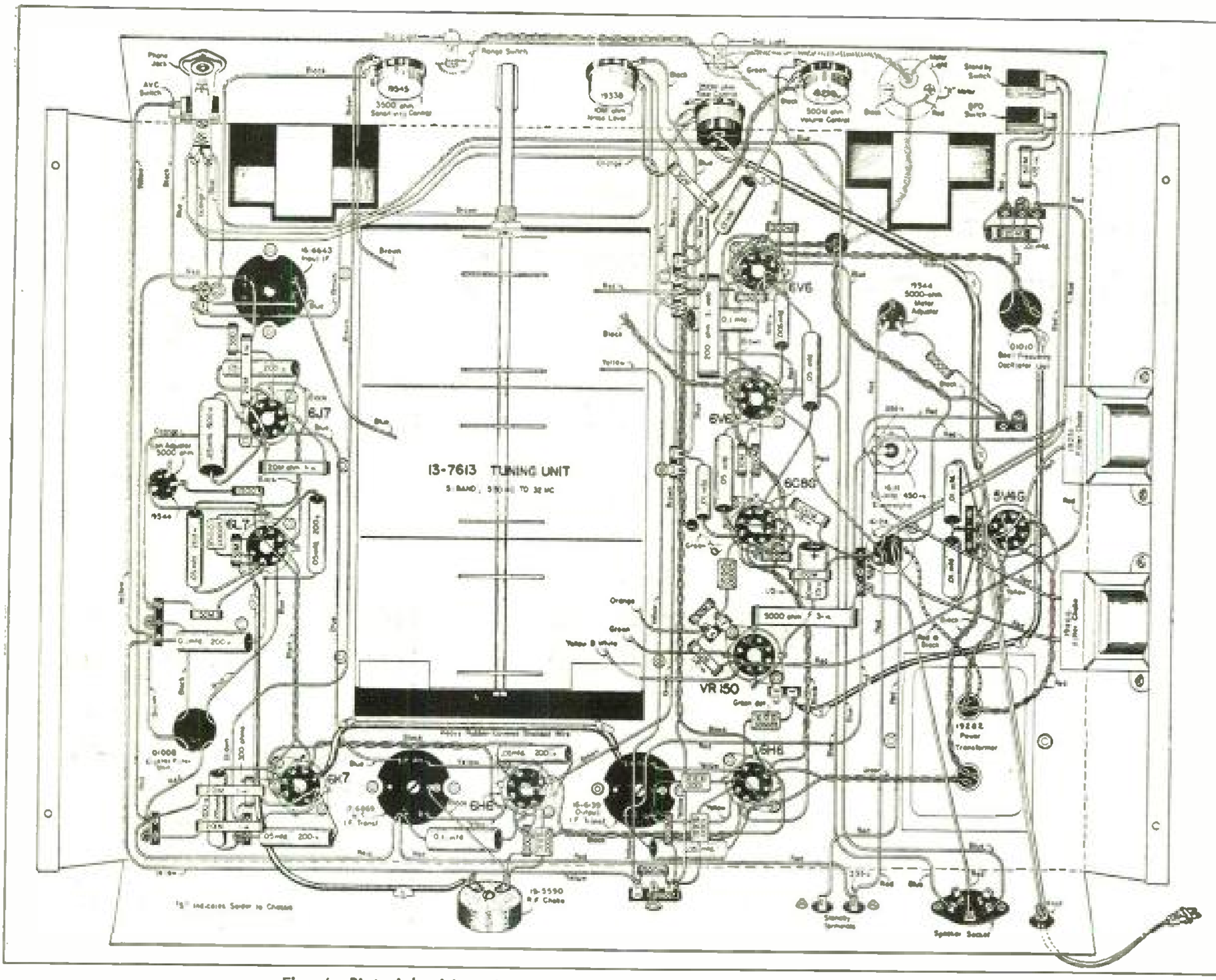


Fig. 6. Pictorial wiring diagram for the 14-tube Communications receiver.

cate wiring progress, should now be examined to determine if any wires have been omitted.

A preliminary voltage test should be made at all sockets, after inserting the tubes and connecting the speaker to the chassis. At the output of the first filter choke a voltage of approximately 250 should be obtained. At the output of the second filter choke the voltage should be about 250. Each tube plate and screen grid can be checked for proper normal voltage, taking into consideration some of the circuits are transformer-coupled and some resistance-coupled.

After checking voltages, the receiver can be given an "air" test. Provided instructions have been followed carefully and none of the factory adjustments altered, satisfactory performance can be expected without further alignment. However, if satisfactory results are lacking, the alignment should be checked in accordance with the instruction book.

For a reasonable fee, a qualified radio technicion with a good service oscillator can be called in to check over the entire receiver, in which case top-notch performance can be expected.

Excluding miscellaneous hardware, the complete list of parts making up the receiver are as follows:

*All parts, unless marked otherwise, supplied by Meissner.

List of Parts—Communications Receiver*

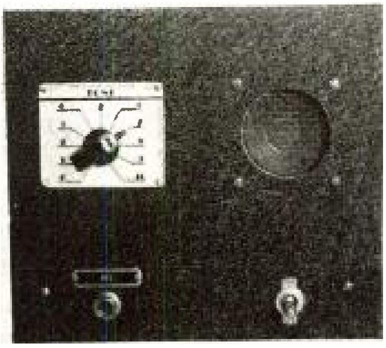
1—Tuning unit, wired and pre-aligned, No. 137613
1—Calibrated dial and escutcheon, No. 23-8229
1—Punched chassis, No. 11-8223-A
1—"R" meter and light assembly, No. 9119
1—Complete crystal filter unit, No. 01008
1—Complete beat frequency oscillator unit, No. 01010
1—Input I.F. transformer, No. 16-6643
1—Output I.F. transformer, No. 16-6139
1—Noise-silencer I.F. transformer, No. 17-6869
1—Power transformer, No. 19282
1—Filter choke, No. 19251
1—Filter choke, No. 19466
1—30 mf., 450 v. electrolytic condenser, No. 16111
1—15-15 mf., 450 v. electrolytic condenser, No. 16124
1—R.F. choke, No. 19-5590
10—Moulded octal sockets
1—5-prong wafer speaker socket
1—250,000 ohm tone control, with switch, No. 19287
1—500,000 ohm volume control, No. 19258
1—10,000 ohm noise-level control, No. 19338
1—3,500 ohm sensitivity control, No. 19545
2—5,000 ohm midget adjusters, No. 19544
3—Toggle switches, S.P.S.T., No. 19354
1—Phone jack, circuit-closing, No. 19360
1—10 mf., 25 v. electrolytic condenser
2—.1 mf., 400 volt and 1—.1 mf., 200 volt paper condensers
4—.05 mf., 400 volt, and 6—.05 mf., 200 volt paper condensers
5—.01 400 volt paper condensers
1—.006 mf., 600 volt paper condenser
1—.00025, 2—.0001, 2—.00005 and 1—.000005 mf. mica condensers
1—200 ohm, 3 watt fixed resistor
1—5000 ohm, 3 watt fixed resistor
1—50,000 and 4—20,000 ohm, 1 watt fixed resistors
2—300 ohm, 2—1500 ohm, 1—2000 ohm, 1—7500 ohm, 1—10,000 ohm, 1—20,000 ohm, 3—50,000 ohm, 5—200,000 ohm and 1—500,000 ohm ¼ watt resistors
1—30,000 ohm, 1—50,000 ohm and 2—100,000 ohm, ½ watt resistors
7—Single insulating tie lugs, 5 double and 1 triple insulating tie lugs
1—A.C. cord plug
1—Steel cabinet, No. 11-8224, and panel, No. 11-8219
1—Set of miscellaneous hardware

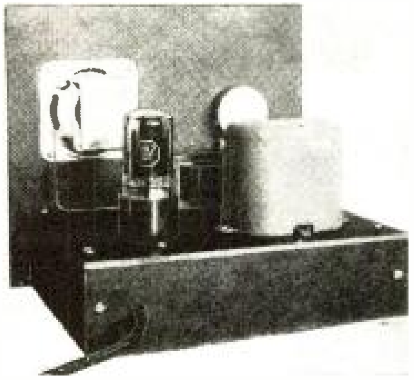
RCA (Tubes)

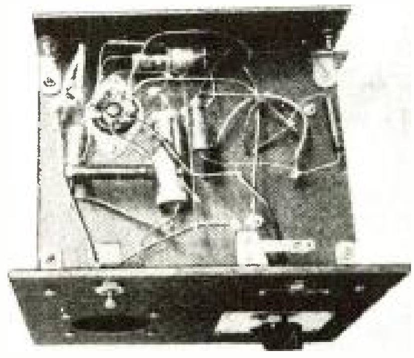
1—1853	1—6J7	1—6C8G
1—6K8	1—6K7	1—VR150
1—6J7G	2—6H6	1—5V4G
1—6L7	1—6SJ7	2—6V6 or 6V6G

UTAH (Speaker)

1—10" P-M dynamic speaker, 8 watt or more with output transformer for push pull 6V6's in class AB (primary impedance 10,000 ohms)







The photos in the accompanying group show the code oscillator from various angles; picture above shows front view; upper right photo shows rear view, and lower right photo—bottom view of the oscillator.

A Code-Practice Oscillator

William D. Hayes, W6MNU

● WITH the increasing emphasis that is being placed on national defense and the need for capable code operators, there is a certain simple piece of equipment which should increase in popularity. The instrument referred to is the *code practice oscillator*. Many old timers may feel that such an instrument is beneath their dignity and that it is intended only for beginners who are struggling with the job of distinguishing "Y" from "Q." However, such is not the case. While it is true that an audio oscillator is valuable to the beginner, there is no reason to believe that it would be any less beneficial to the *self-styled* "speed-demon" who submerges his letters, and especially his numerals, *in a sea of dots!* As a matter of fact a certain "W5" was received at this station recently who was using *eight dots* on every "5"!

This is probably something of a record, but the operator who puts six dots on a "5" and five dots on a "6" *is by no means rare!* If these dot dispensers would spend a few minutes each day in keying an audio oscillator and listening critically to their own sending, there might be some improvements made. As it is now, the operator who is trying to receive one of these "dotty" stations feels like Old Mother Hubbard and her children who lived in a shoe—he has so many dots he doesn't know what to do.

Of course there are many other faults besides excessive dottiness such as *running letters together; improper proportioning of the length of the dot with the length of the dash*, etc. However, we all know what the pitfalls are; the difficulty comes in determining which ones we are falling into. And that's where the code practice oscillator comes in!

The output of the oscillator described in this article is sufficient to permit the sending of practice material to a group of a dozen or so persons if desired, and the pitch of the note is *continuously variable* from zero up to about 1500 cycles per second.

Circuit

Since there is no need for high voltage in a unit of this kind, and since, as always, it is desirable to keep costs down, a half-wave rectifier circuit was chosen for the power supply. This eliminates the necessity for a power transformer, and also permits the oscillator to be operated on either A.C. or D.C. lines.

Only one tube is used, a type 70L7GT, which does *double duty* by serving as half-wave rectifier and oscillator tube combined. Since this tube requires a heater current of only 150 ma., the power drawn from the line when the unit is operating is only about 18 watts. Another advantage of the low heater current is that a small 10-watt resistor is adequate for furnishing the necessary voltage drop in the heater circuit. In wiring the heater circuit of the 70L7GT, the No. 2 pin should be connected to "B" negative, and the No. 7 pin to the 300 ohm dropping resistor. Needless to say, "B" negative should *not* be grounded.

A resistance-capacity filter is used for smoothing out the ripple instead of the more common inductance-capacity combination. The only advantage of a choke over a resistor as a filter component is that the choke introduces a much smaller D.C. voltage drop for a given impedance, thereby consuming less power. However, in this particular application the direct current voltage drop and the small amount of power consumed are of no consequence, so that a resistor is the logical choice. The effectiveness of the filter is evidenced by the excellent character of the note.

In order to stabilize the output voltage and to prevent any tendency for the oscillator to chirp when keyed, a 25,000 ohm bleeder is connected across the output filter condenser. This resistor loads the power supply very lightly, but results in a note that does not vary in pitch with keying.

To form the oscillator proper, the tetrode section of the 70L7GT is triode connected, i.e., the screen and plate are tied together, and the output transformer is connected in series with the positive lead. The 50,000 ohm variable resistor in series with the cathode controls the pitch of the oscillator, the more the resistance in the circuit, the higher the pitch. This feature of *continuously variable pitch* not only allows the operator to choose a note to suit his own tastes, but also lessens listening fatigue by making possible a slight shift in the pitch at any time.

If components other than those specified in the parts list are used in the construction of the unit, it may be necessary to change the value of R1 in order to secure correct operation. Values between 10,000 ohms and 50,000 ohms should be tried.

The speaker employed is an Oxford "Little General" which has a two-inch cone and is ideally suited for the purpose. Although the impedance match is not at all critical, an output transformer which is intended to match 7000 ohms to a four-ohm voice coil was found to be very satisfactory, and is therefore recommended. The audio transformer used is of the usual 1:3 step-up variety.

Construction

Those who dislike struggling with a steel chassis will be pleased to hear that the oscillator is built up on Masonite. Because the Masonite is so extremely easy to work with, the time needed for construction is reduced over what it would be if steel or aluminum were used. Actually there are many pieces of equipment for which steel offers no particular advantage over Masonite, unless, of course, you enjoy the additional exercise.

The panel is 3/16 of an inch thick and is black crackle finished. It measures 7 inches high by 8 inches long and is cut down from a standard 7x10 panel (ICA No. 810). A small hole about two inches in diameter accommodates the speaker, and a piece of galvanized screening protects the cone from stray screw-drivers and hungry goats. The mounting screws for the speaker can be forced through the mesh of the screening, thereby holding it in place. Natural finished Masonite 1/8 of an inch thick is used for the chassis which is 7 inches long, by 6 inches deep, by 2 inches high. The three pieces of Masonite are fastened together with one-inch brass angle brackets.

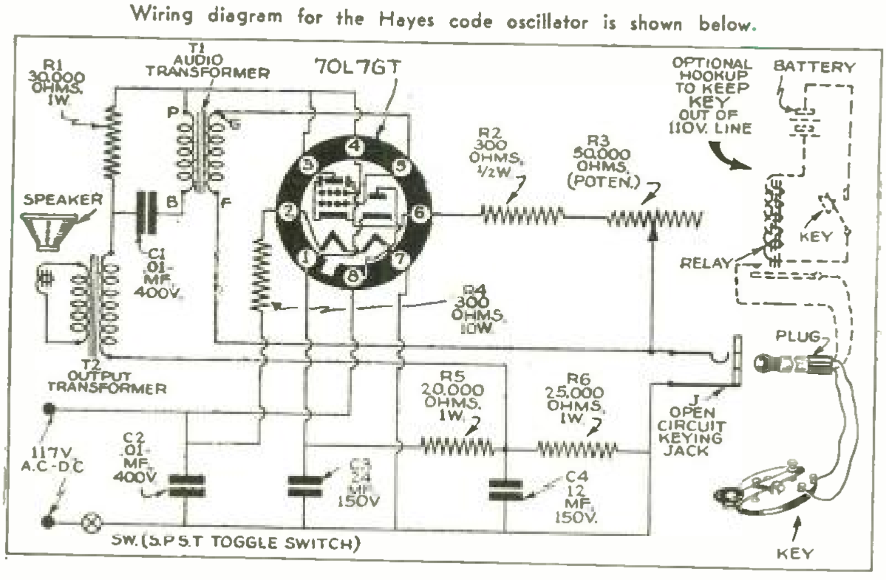
Precautions

Since the key is connected to the 110-volt line, the operator should *avoid connecting himself between key and ground*, and it is advisable to connect the base and level of the key to the cathode circuit of the oscillator rather than to "B" negative.

Other Uses

This little oscillator can serve also as a *keying monitor* by connecting it across a section of the relay that keys the transmitter, or across a pair of auxiliary contacts on the key itself. By tapping across the primary of the output transformer, the tone can be used to modulate an ultra-high frequency rig or for testing a phone transmitter on the lower frequencies. In all of these applications, the characteristic of continuously variable pitch is of advantage, and still other uses will probably suggest themselves to the constructor. A glance at the circuit diagram will show that the unit is exceedingly simple, a squint at the parts list will show that it is inexpensive, and a little experience with it will convince even

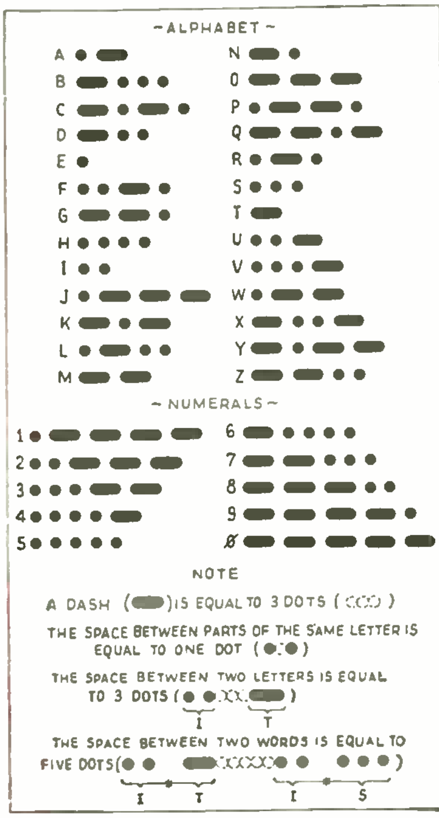
Wiring diagram for the Hayes code oscillator is shown below.



the "man from Missouri" that it is a very useful gadget to have around.

Parts List

R1—30.000 ohms. 1 watt (IRC)
R2—300 ohms. ½ watt (IRC)
R3—50.000 ohms pot. (Centralab 72-103)
R4—300 ohms. 10 watts (Ohmite)
R5—20.000 ohms, 1 watt (IRC)
R6—25.000 ohms, 1 watt (IRC)
C1—.01 mf.. 400 volt paper (Aerovox)
C2—.01 mf., 400 volt paper (Aerovox)
C3—24 mf., 150 volt electro. (Aerovox "Dandee")
C4—12 mf., 150 volt electro. (Aerovox "Dandee")
T1—1:3½ audio transformer (UTC S-1)
T2—7000 ohm plate to 4 ohm voice coil (Thordarson T-13S37)
Speaker—2-inch permanent magnet (Oxford 2 ZMP)
J—Open-circuit keying jack (Yaxley)
S—S.P.S.T. toggle switch (Arrow)
Tube—RCA 70L7GT
Nameplate—Crowe



BRITONS CONFISCATE ALIEN APPARATUS

GERMANS, Austrians and Italians, who are engaged in the practice of medical shortwave diathermy, are out of luck if they live in Great Britain. There, the authorities have confiscated their equipment because such apparatus may easily be converted into radio transmitting stations. Such equipment is virtually a radio transmitter and might easily be connected to an antenna and ground, whereupon its signals could be heard in enemy territory.

HOLLEY MEDAL AWARDED TO ARMSTRONG

● THE Holley Medal of the American Society of Mechanical Engineers was given to Edwin H. Armstrong, Professor of Electrical Engineering at Columbia University and inventor of the superheterodyne and other useful apparatus for radio. The award was made at the society's annual dinner at the Hotel Astor. Engineers and executives from all over the country attended this important event.

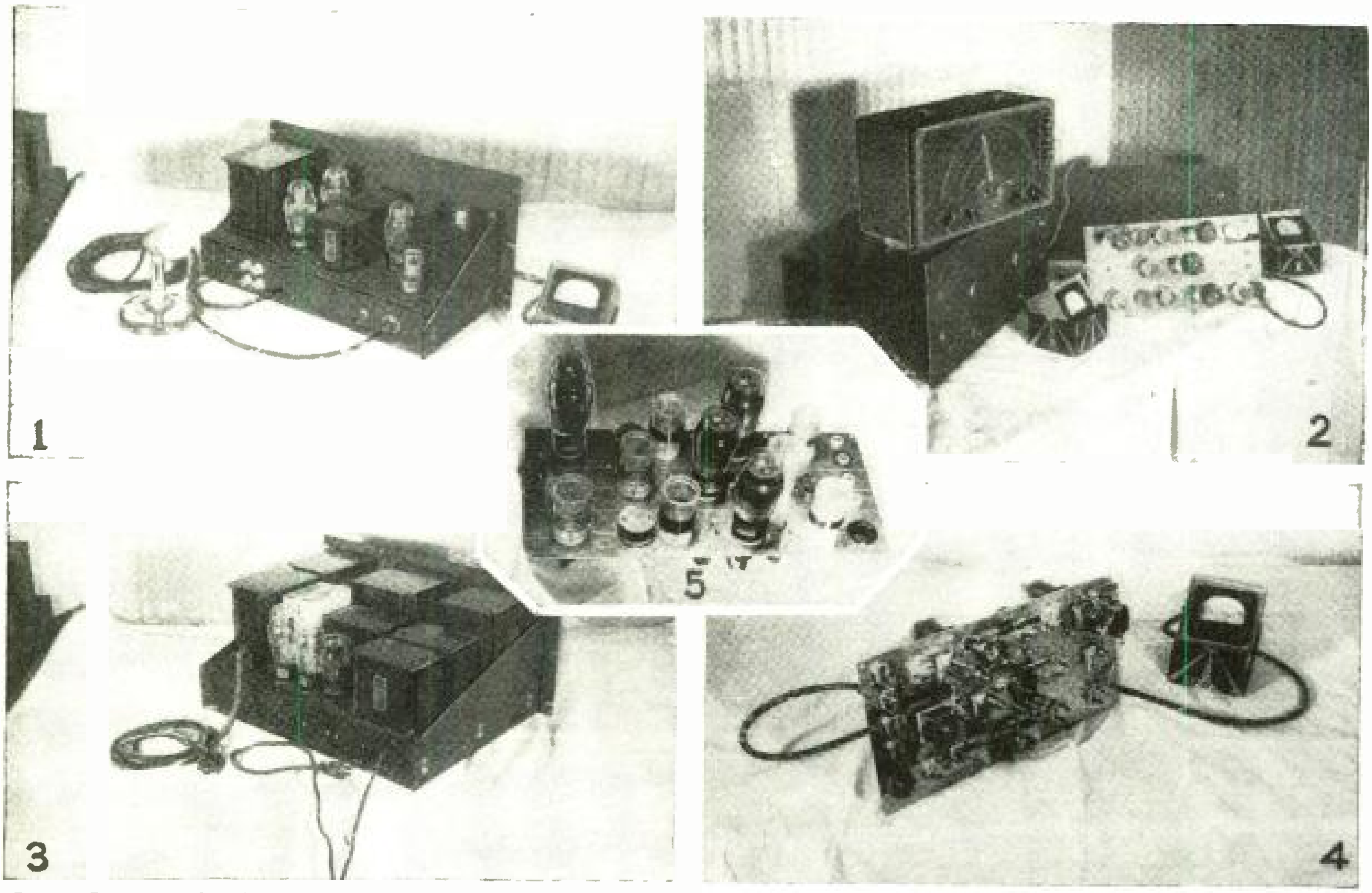


Fig. 1—Experimental audio amplifier. Fig. 2—Complete test set-up for preliminary "pull-swing" F.M. investigations. Fig. 3—Power supply for F.M. Fig. 4—Experimental F.M. modulator. Fig. 5—Top view of F.M. oscillator.

A "Pull-Swing" Frequency Modulation System for the Amateur

Ricardo Muniz*; Donald Oestreicher**; Warren Oestreicher***

Radio amateurs everywhere will be interested in this brand new system of "wide swing" frequency modulation transmission and reception here described by Mr. Muniz and his associates. A vast amount of laboratory research work has been done on this new system by the authors—all for the purpose of providing a more suitable and greatly simplified method of constructing F.M. transmitters and receivers for the Ham. RADIO & TELEVISION is glad to present this new and original F.M. system to the Ham Fraternity. This is the first of a series of articles on this subject.

● THE R. & T. reader is undoubtedly familiar with the systems of F.M. (Frequency Modulation) transmission in use today (i.e., Armstrong's system of *Phase Modulation*, and the system known as *Reaction Modulation*). These systems present definite and easily recognized disadvantages to the average experimenter. Complexity of equipment and circuit and, therefore, expense is perhaps the greatest reason why amateurs have not wholeheartedly engaged in F.M. experimentation.

The authors have developed a new F.M. system based on an original idea by W. J. Oestreicher. It is simple, straightforward, easily constructed, adjusted and controlled. Quality satisfactory for *amateur communication* is easily obtainable, while careful design will result in a *high-fidelity* transmitter.

Basic Principle. The experimenter has probably come across the phenomenon of oscillator "pulling," especially in superheterodyne receivers. The fact that a stable oscillator will control a less stable oscillator's frequency when they have the proper relative amplitude and frequency difference can be experimentally and mathematically proven. (It is felt that the mathematical proof, or explanation of this system is outside the scope of this article.) It is upon this fact (i.e., oscillator control) that the system here described is based.

A pair of crystal-controlled oscillators, which have output frequencies forty kilocycles apart, are modulated in amplitude and out of phase 180 degrees. The outputs are coupled to the grid circuit of an electron-coupled oscillator tuned to a frequency midway between the crystal oscillators' output frequencies. (See Fig. 1.) The frequency of the electron-coupled oscillator is pulled toward the stronger of the two signals when the coupling is correct. Since the control oscillators are varying in strength with the modulating signal, the master oscillator's frequency is swung back and forth in accordance with this signal. (See Fig. 2.)

Theory. The *intelligence-carrying* part of any modulated radio wave is its sidebands. For distortionless transmission, the amplitude of a given sideband should be directly proportional to the signal amplitude and independent of the signal frequency. If a conventional audio system is used with a

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***Student, Electrical Eng., Cooper Union, Night.

frequency modulator, the amplitude of the *intelligence-carrying* sidebands is *inversely* proportional to the modulation frequency. That is, if the signal amplitude is held constant while the frequency is varied, the amplitude of the sidebands at 10,000 cycles modulation will be one-tenth the amplitude at 1,000 cycles. It is necessary therefore to correct this condition by designing the audio system so that the amplification is proportional to the frequency. We then have the sideband amplitude proportional only to the signal *amplitude*, and thus fulfill the conditions for intelligent transmission.

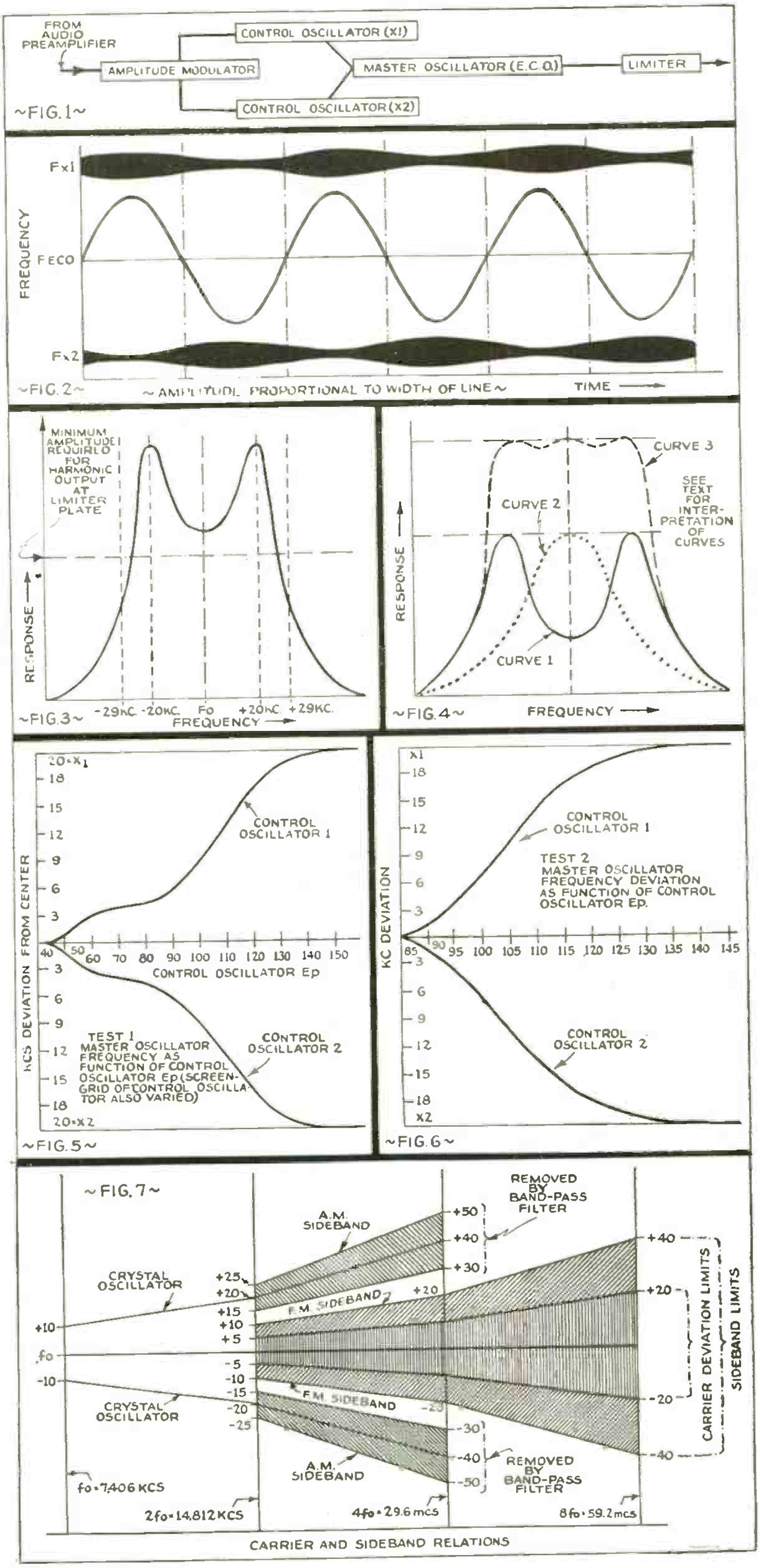
The output of the *master oscillator* is a complex wave containing components of *twice the frequency* of the wave in its grid circuit, where the modulation actually takes place. These components, or sidebands, are a maximum of 10 kilocycles different from the *deviation* limits of the control frequency, since in this communications model we have limited the audio range to speech frequencies. A band-pass filter has been included at the output of the master oscillator, designed to pass a band of about 50 to 58 kilocycles. It will therefore exclude the control oscillators' frequencies and modulation components. The band-pass filter is usually a critical circuit to design. However, the *limiter* stage is especially designed to remove amplitude variation as do the following class "C" stages, therefore a flat-top band-pass is not absolutely essential. The "M" type curve which results from any coupling and "Q" in the neighborhood of those required for ideal flat-top band-pass circuits is perfectly usable. (See Fig. 3.)

Since the second harmonic output of the limiter, in the five meter band, has amplitude variation caused by the "M" curve peaks, the conventional resonance curve is used to raise the center frequency response. (See Fig. 4.)

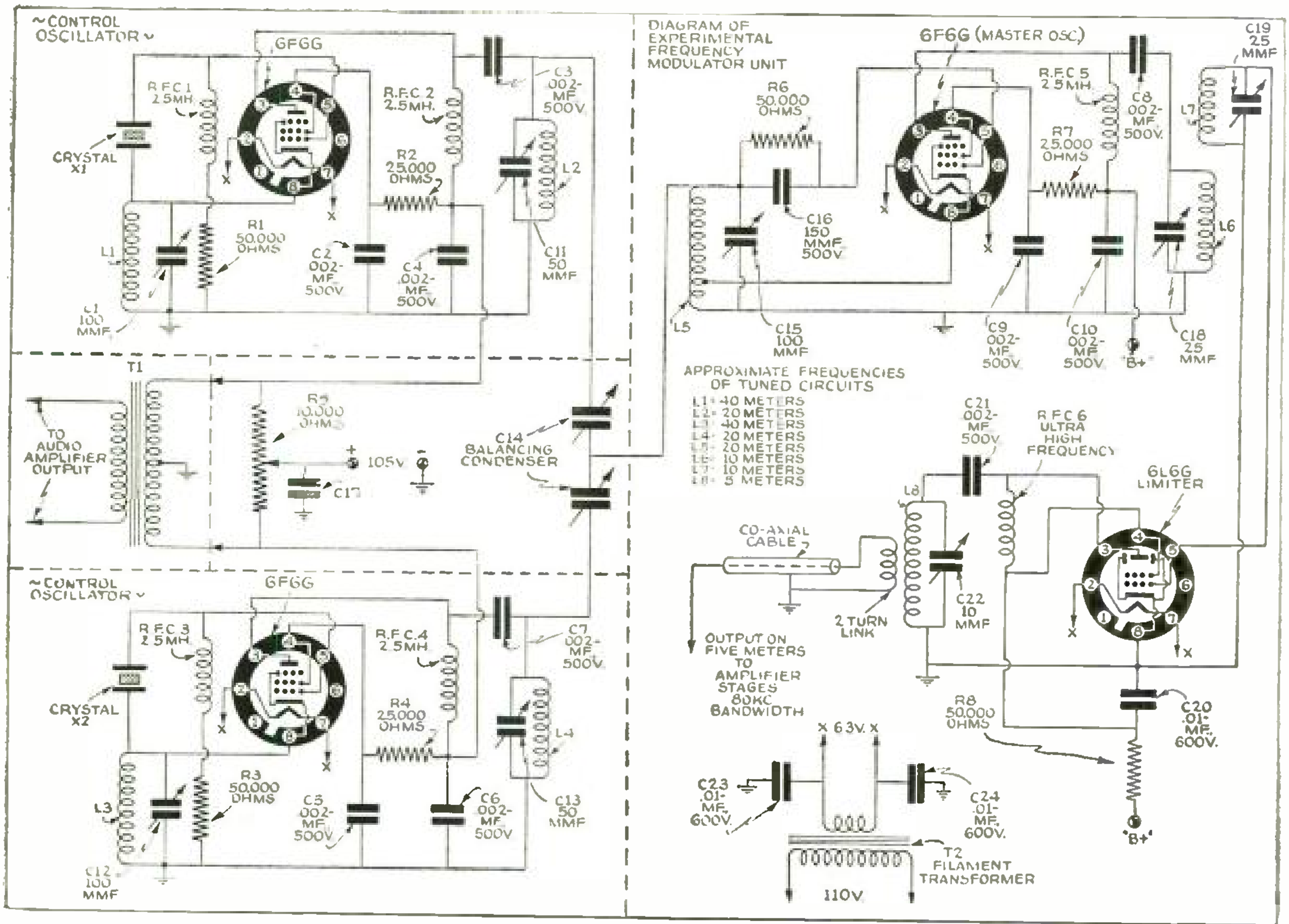
The output of the limiter is represented by curve 1 (Fig. 4). The resultant of all the resonance curves of following stages is represented by curve 2. These curves are *broadened* by damping resistors until they are of approximately a shape to give a resultant curve 3, when combined with curve 1. Any minor amplitude variation left will be unimportant as limiting action at the receiver will remove it.

A series of experiments were performed in order to determine the linearity of modulation. The graph, Fig. 5, shows the results of the first experiment. It will be noticed that in this first set-up the deviation is not proportional to the signal voltage (horizontal axis). After biasing the control oscillators 100 volts positive, the almost linear curve of Fig. 6 resulted. Now the control oscillators, biased 100 volts positive, are modulated 180 degrees *out of phase*. Since it is necessary to keep on the linear portion of the deviation curve the minimum control oscillator voltage had to be 85 and the maximum 115, corresponding to 30% modulation. Because of the effect of the action of one control oscillator on the master oscillator, while considering a positive peak on the other, the percentage of modulation has to be twice this, or 60%.

Design. The crystal oscillators are conventional tri-tet circuits in every respect. The outputs are capacitively coupled to the master, or electron-coupled oscillator grid circuit by means of a balancing condenser.



Diagrams showing various actions taking place in the F.M. circuits here described.



This diagram shows the new arrangement worked out by Mr. Muniz and his associates, utilizing two control oscillators, which in turn control a master oscillator. In subsequent articles the authors will describe a practical F.M. transmitter, including audio system, complete with power supply and R.F. amplifier circuits, especially designed for Amateur use.

The outputs of the crystal oscillators are on their second harmonics and the grid circuit of the ECO operates midway between these two output frequencies. The crystals, Bliley type BC-3, are ground to 7396 kc. and 7416 kc., making the control oscillators' outputs 14,792 kc. and 14,832, respectively. The master oscillator is tuned to the *center* of these or 14,812 kc. and its output is at 29,624 kc. plus and minus 20 kc. Since part of the control oscillators' output comes through the master oscillator, the band pass filter, used to keep the response within the band uniform, must also be designed for very low response at the frequencies of the inmost modulation components of the control oscillators. As the sideband caused by the 5 kc. modulation of the control oscillator is 10 kc. from the edge of the F.M. band, the edge of the band-pass curve must change from minimum to maximum in 10 kc., and the "M" type curve, with its sharp rise offers a distinct advantage. Side-band and carrier relations are shown in Fig. 7.

Amplitude limiting occurs when a tube is greatly over-excited, so that the plate is driven to saturation on positive peaks and the grid is driven far past cutoff on negative peaks. This is also an ideal condition for frequency multiplication and the limiter is therefore an efficient doubler. *Limiting action* is best accomplished by operating the stage at low plate and screen grid voltages (about 100 volts), with no grid bias, and insuring that the exciting voltage is sufficient to swing the grid from well past cutoff to well above the saturation region.

In the test model, little attention was given to *drift* in the master oscillator (due to temperature changes). However, the stability encountered was quite satisfactory. In the finished transmitter it is planned to include temperature compensation, if necessary, so that the drift will be held to an absolute minimum.

In order to test the preliminary model a versatile audio system was built. The system had to be of adequate power and frequency range, since it was impossible to accurately predict required power for modulation. The amplifier shown in the photos was designed and built, and while the power required for the final model was not nearly the maximum output, it was satisfactory in every respect. Since the amplifier is subject to redesign, it is considered advisable not to describe its construction now.

The power supply and audio system used in tests were designed about Kenyon "T-Line" components. A detailed description of the power supply will appear in a future article.

In a series of subsequent articles the authors will describe a practical F.M. transmitter, including audio system, complete with power supply and R.F. amplifier circuits. The transmitter is especially planned for *amateur* use; simplicity of design and construction combined with ease of adjustment and control were prime considerations.

The authors wish to extend thanks to R.C.A. for the generous loan of instruments, and to the many other companies whose cooperation made these experiments possible.

Parts List

BLILEY ELECTRIC CO.
X-2 7416 kc. BC-3 type crystal
X-1 7396 kc., BC-3 type crystal

I.R.C. (Resistors)
4—50,000 ohm. BT-1; R1, R3, R6, R8
3—25,000 ohm. BT-1; R2, R4, R7
1—50,000 ohm. type E, wire-wound, 9 watt; R5

KENYON TRANSFORMER CO., INC.
1—T-378 6.3 volt fil. transformer; T2
1—T-494 multimatch mod. transformer, on audio amp.; T1

NATIONAL UNION
3—6F6G tubes
1—6L6G tube

TRIPLETT ELECTRICAL INSTRUMENT CO.
2—0-100 ma. sq. meters, M-327
1—0-150 ma. sq. meter, M-327

A. D. CARDWELL MANUFACTURING CORP.
3—100 mmf. var. cond., ZU-100-AS; C1, C12, C15
2—50 mmf. var. cond., ZU-50-AS; C11, C13
1—Balancing cond., EU-100-AB; C14 cap. 100 mmf.
2—25 mmf. var. cond., ZR-25-AS; C18, C19
1—10 mmf. var. cond., ZR-10-AS; C22

AMERICAN PHENOLIC CORP.
9—5-prong steatite sockets, SS5
1—6-prong steatite socket, SS6
4—Super-mip octal sockets, 54-8
8—5-prong 912-B coil forms, 24-5P
1—6-foot length of No. 72 flexible co-axial cable

CORNELL-DUBILIER ELECTRIC CORP.
10—.002 mf., IR-5DZ, 500 volt wking; C2, C3, C4, C5, C6, C7, C8, C9, C10
2—.00015 mf., IR-5T15, 500 volt wking; C16
2—.002 mf., 9M-22020; C21, C17

BUD RADIO, INC.
5—2.5 mh R.F. chokes, CH-920; RFC 1, 2, 3, 4, 5
1—U.H.F. R.F. choke, CH-925; RFC 6

P. R. MALLORY & CO.
4—Jack plugs, No. 75
4—Midget closed circuit jacks, No. A-2
3—.01 mf. 600 volt cond., TP-410; C20, C23, C24
—1½ inch bar knobs, No. 366
2—2.5 volt pilot bulbs, No. 170

INSULINE CORP. OF AMERICA
8—Flex. shaft couplings, No. 2143
8—6-inch extension shafts, No. 1249
1—7" x 12" aluminum sheet, No. 1195

Coil Specifications

All wound on 1½ inch Amphenol 912-B forms
L1, L3—No. 16 B. & S. enam., 10 turns, close wound
L2, L4—No. 16 B. & S. enam., 8 turns, close wound
L5 5 turns No. 20 enam., spaced in 1 inch tapped, 1½ turns from bottom
L8 No. 16 B. & S. enam., 3 turns spaced in 1½ inches
L6, L7 on one form; 4 turns No. 20 enam. (L7 var. coupled to L6)

A Meissner table Model F.M. receiver Type 9-1023 was used in some of the tests. A slight modification of the oscillator frequency was found sufficient to make it bring in 5-meter band F.M. signals.

BOOK REVIEW

THE RADIO HANDBOOK—Seventh Edition. Size 7 x 10 inches, stiff cloth covers, 608 pages, profusely illustrated. Published by Editors and Engineers, Ltd., Santa Barbara, Calif.

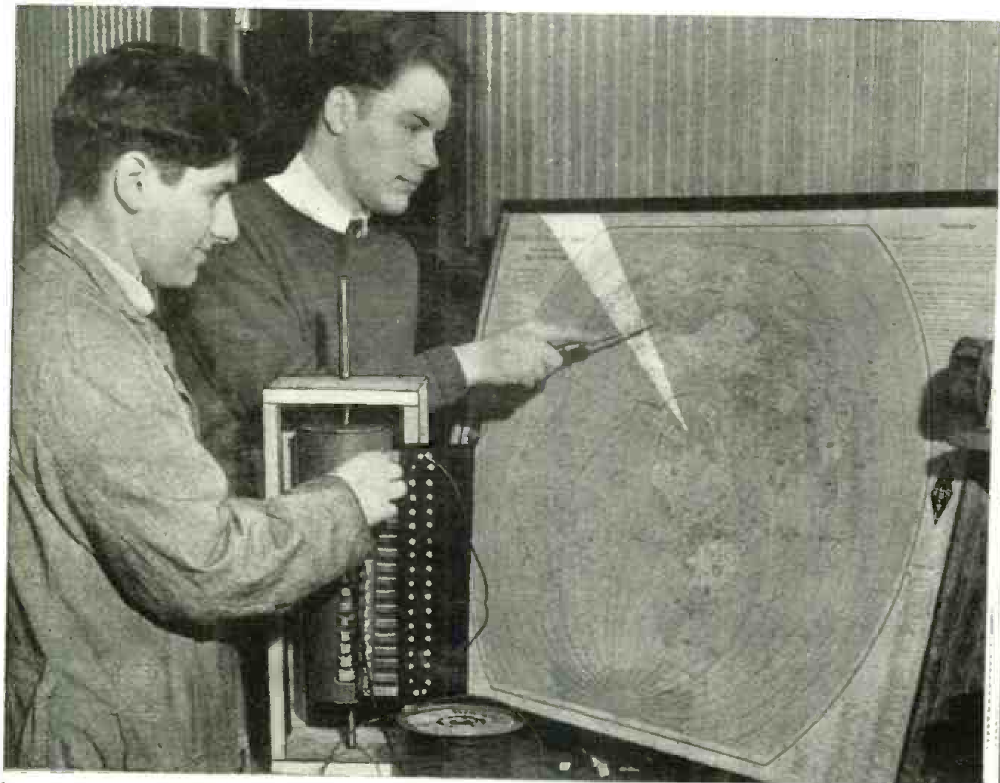
A most valuable book for every radio student and experimenter. Every Ham needs a copy of this book and no student should be without it. The opening chapters deal with learning the code, fundamental radio and electrical theory, different types of vacuum tubes and how they work, various types of circuits such as the regenerative, super-regenerative, mixer-oscillator, IF and crystal filters, etc. Complete tables covering all the different receiving types of tubes is given, also bottom view of all the tubes, sockets for wiring references, etc. Following chapters deal with details, coil data, etc., on radio receiver construction, including superheterodynes, pre-selectors and converters. Next the book takes up transmitter theory and does a fine job on various types of modulation, speech amplifiers, and includes a chapter on "frequency modulation." Transmitting tubes are thoroughly covered, with complete tables of all the different types; also exciters and data on low-power transmitters. Data on building 600 watt speech and modulator unit is given, and then follows chapters on power supplies, transmitter design, a 200 watt R.F. amplifier, a 400 watt phone transmitter, etc. Other chapters deal with cathode-ray oscilloscopes (with diagrams and construction data), signal generators, various types of UHF antennas, rotary arrays, directive antennas, matching stubs, including a section on "micro-wave" transmitters.

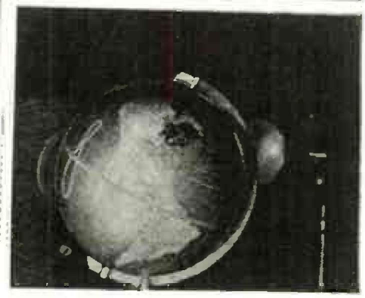
ELEMENTS OF ACOUSTICAL ENGINEERING, by Harry F. Olson, E.E., Ph.D. Stiff cloth covers, size 6¼ x 9½ inches, 344 pages, illustrated. Published by D. Van Nostrand Co., New York, N. Y.

The serious student of acoustic engineering will find this new work invaluable, coming as it does from an outstanding authority in the field. (Dr. Olson is Acoustic Research Director of the RCA Manufacturing Co., and whatever he has to say is sure to be of the highest caliber.)

Some of the interesting and vital subjects discussed by Dr. Olson in the opening chapters are —plane and spherical waves, exponential horns, vibrating strings, open and closed pipes, wave filters, corrective networks, etc. The design engineer will find this work extremely valuable, as a vast number of technical formulas are given, having to do with the design of horn and other acoustic chambers. Electromagnetic and other types of driving systems are discussed, and a number of useful formulas provided. Later chapters deal with such subjects as multiple loudspeaker designs, double-coil and double-cone speakers, loudspeaker baffles, cabinet reproducers, acoustic phase inverters, feedback as applied to a loudspeaker, etc.

A valuable chapter on microphones and their action is included, including velocity and unidirectional microphones. A new treatment is given on the important subject of telephone receivers, with typical receiver curves for different types of receivers. Phonographs are discussed, from the acoustic engineering point of view, including "pick-up action." Closing chapters deal with measurement and calibration of microphones, testing of loudspeakers, measurement of acoustic impedance, etc. Other important topics covered are dispersion and collection of sound, acoustical problems in auditoriums, complete reproducing systems, frequency reception of the human ear, loudness of sound, etc., etc. A most valuable and timely treatise.





Donald Levenson makes a contact on the drum, the map lights on a 22½ degree angle, while Gilbert Devey points to the lighted section. Two photos at right show globe and selector switch, also the rotary selector switch as mounted on the beam.

Directional Radio Beam Indicator

Leon M. Leffingwell

● TWO radio amateurs transmitting and receiving over station W8NKI from the fifth floor of Engineering Hall, Carnegie Institute of Technology campus, Pittsburgh, have invented a simple, fool-proof directional SW radio beam indicator for determining the direction their beam antenna is transmitting.

Over a 4½-month period this direction finder has resulted in a 75% increase in the percentage of completed contacts.

Needing the direction finder because they had found it impossible to tell with better than 45-degree accuracy the direction they were transmitting, operators Donald Levenson and Gilbert Devey, sophomores in the School of Electrical Engineering, built the direction finder in one month of spare time.

Before thinking of their new direction finder, operators Levenson and Devey set a convex mirror on the roof of a wing of the building 15 feet out from the transmitting-room window, and set a 200-watt electric light on a flat platform underneath the antenna to illuminate the antenna at night. The mirror reflected the position of the beam.

With the new direction finder installed correctly, says Mr. Levenson, we can transmit accurately within 22½ degrees of the desired location. The indicator consists of an azimuthal map, mounted on a 30-by 40-inch framework with sheet-metal pie-sections in back, dividing the 360-degree map into sixteen sections of 22½ degrees.

Material Costs About $30

Working under the direction of Professor Charles Williamson, Assistant in the Physics Department, the operators bought an ARRL map, and 1500 feet of rubber-covered No. 18 twin-stranded lead-in wire for $10. Then from ½-inch stock yellow pine they made a map case, 30 x 40 x 6 inches. From No. 20-gauge galvanized sheet steel they cut 16 pie-sections, each 22½-inches wide.

Three 60-watt clear-glass candelabra lamps illuminate each pie-section, and strips of one-eighth by one-quarter inch black felt glued between the pie sections, keeps light from passing from one pie section to another. Underneath the ARRL map a piece of ground glass evenly diffuses the light so that the separate lamps will not dazzle the eyes. On top of the map a double thickness of clear, ground glass keeps the map clean. With the $20 forty-pound map case complete, the operators attached two brass plates to the back and hung it on the wall.

Rotary Switch Selector Operates Unit

The heart of the system consists of a rotary selector switch with a bakelite drum 4 inches in diameter and 11 inches long. Sixteen metallic wedges, staggered along the surface of the drum, make contact with the contact fingers, lighting each pie-section separately. A hard-rubber contact strip with 16 brass contact fingers (use as many fingers as you desire) has Elkonium contact points between the contact fingers, and a brass plate connects the return leads to the separate contact fingers. Next, brass tubing placed on the drum makes contact between the contact fingers and the brass circuit-return strip. The operators then mounted the contact strip on the framework of the beam tower and mounted the drum on the beam's axle. (See Fig. 2.)

A 17-wire cable runs between the rotary selector and the ARRL map. The station operates via a beam antenna which has three parallel arms, manipulated by a worm-drive "remote control" device. The beam antenna, mounted on the roof of the building directly over the broadcasting room, regiments radio waves in one desired direction. (Fig. 3.)

Another method of operating, similar to the wall map, requires the mounting of a selector switch on a globe of the world and connecting it to the rotary selector switch on the beam.

If it costs too much to run a multiple wire cable from the transmitting room to the antenna, substitute a rotary selector switch, says Mr. Levenson, who operates this set-up on his home transmitter, W8TIN. He mounted a black plastic selector switch on the globe. Then he adjusted the telephone dial by reversing its mechanism, so that the contact springs within the dial touched each other when a direction

RULES WAIVED FOR RADIO OPERATORS

● AS a particular convenience to licensees drafted or otherwise called into military service, the Federal Communications Commission has suspended until January 1, 1942, that part of its rules and regulations requiring proof of satisfactory service in connection with renewal of *commercial* and *amateur* radio operators (Section 13.28 governing commercial operators, and Sections 12.26 and 12.66 affecting amateurs). This blanket exemption pertains to nearly 100,000 operators of both classes.

General waiver of these provisions was considered at a conference of Commission officials with representatives of interested labor organizations, including the International Brotherhood of Electrical Workers, Commercial Telegraphers Union of North America, American Communications Association, Maritime Committee of the C.I.O., National Federation of Telephone Workers, Federation of Long Lines Telephone Workers, and the Association of Technical Employees of N.B.C.

The controlling factor in the formulation of this broad and simple procedure was the mutual desire to relieve those called into service of routine details. The Commission is aware of the importance of maintaining the present high standards of proficiency of licensed operators, and also of guarding against a shortage of such skilled workers. It will, accordingly, continue to give these problems careful attention, and should experience indicate the need for change the Commission will act accordingly.

FROM THE F.C.C. MAIL BAG

A fake "SOS" marine distress call has been traced by Federal Communications Commission field inspectors to a New England *amateur* radio operator. Investigation developed that the signal which caused useless concern and wasted valuable time was part of a dramatic program reproduced by the amateur in question to give his fellow hams "code practice." The Commission warns the amateur that transmission of this danger signal is inappropriate for code practice, or in any other situation when an actual emergency does not exist.

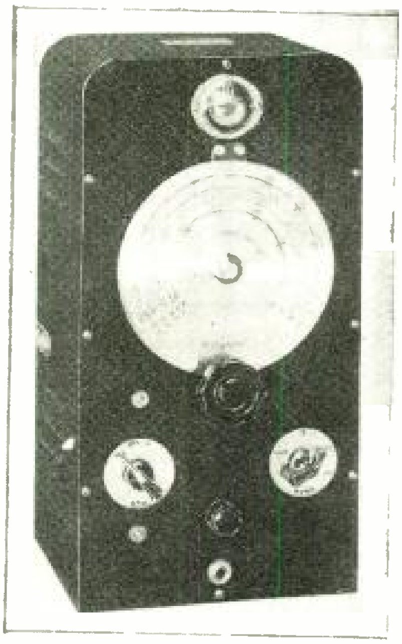
On the other hand, the Commission has taken cognizance of the valuable contribution by amateurs in providing emergency communication during the recent Texas flood, when regular wire facilities were temporarily disrupted.

A New Yorker is advised that the holder of a radio operator's license from the Commission who applies for another class of license is required to pass only the added examination elements for the new classification.

A Michigan inquirer is informed that the Commission issues lists of radio stations in various services, but none of ship stations. However, the Bureau of the International Communication Union, Berne, Switzerland, publishes lists of radio stations of the world, among which is a "List of Coast Stations and Ship Stations."

Nor is the Commission in a position to comply with frequent requests for names and addresses of radio operators in various States. Since the Commission daily handles more than 100 such applications for new licenses, renewals or changes, the compiling of special lists is out of the question.

The call letters KHASB have been assigned the radio station in the private plane (non-scheduled aircraft) of Robert Taylor, the movie star, operating from Culver City, Calif. The last three letters—ASB—are the initials of the reel Taylor's real name, Arlington Spangler Brough.



A Precision Frequency Monitor

F. J. Gaffney*

This instrument employs the heterodyne method of checking frequency; a method of calibrating the meter is explained.

● THERE are in general two methods which may be employed for determining frequencies of amateur transmitters. The first of these is by means of an absorption meter and the second by the utilization of the heterodyne principle. The former method of measurement consists in bringing a tuned circuit close to the transmitter whose frequency is to be measured and adjusting the frequency of this tuned circuit until a dip is noticed in the reading of the oscillator plate meter or until an indicator such as a flash-light bulb connected in series with the tuned circuit indicates resonance. This method is perhaps the only reliable one for determining the fundamental frequency of the device being measured. It will not serve as an accurate frequency measuring device, however, since numerous factors such as the closeness with which it is coupled to the circuit being measured and the sharpness of the indicating device affect its reading.

In using the heterodyne method of frequency checking, the radio frequency voltage of the circuit being measured is mixed with the voltage from an accurately calibrated oscillator whose frequency may be adjusted to obtain zero beat with the transmitter frequency. The frequency of the transmitter is then read from a dial on the shaft of the variable condenser of the calibrated oscillator. The calibrated oscillator need not of necessity cover the same range of fundamental frequencies as does the transmitter whose frequency it is desired to check, since harmonics of the calibrated oscillator may be beat with the fundamental of the transmitter whose frequency is being measured. From this it may be seen that a variable oscillator covering any range of frequencies of *2* to 1 can be used to check any frequencies in the spectrum. If it is attempted to make the variable oscillator cover a range of frequencies of *2* to 1, however, it will be found that the accuracy with which the dial may be read is rather poor as compared to that obtainable with smaller frequency ranges. It will be remembered that the amateur bands are rather narrow bands having a harmonic relationship to each other. This fact makes possible the design of a frequency meter to cover these bands alone which is capable of a high degree of accuracy. It is the purpose of this article to describe a few of the design points of such an instrument.

The characteristics which a heterodyne frequency meter should have are listed below:

1. A circuit arrangement such that the variable oscillators of the frequency meter may be accurately checked against WWV or a standard broadcasting station.

2. Band-spread of the variable oscillators such that the amateur bands cover substantially the entire dial.

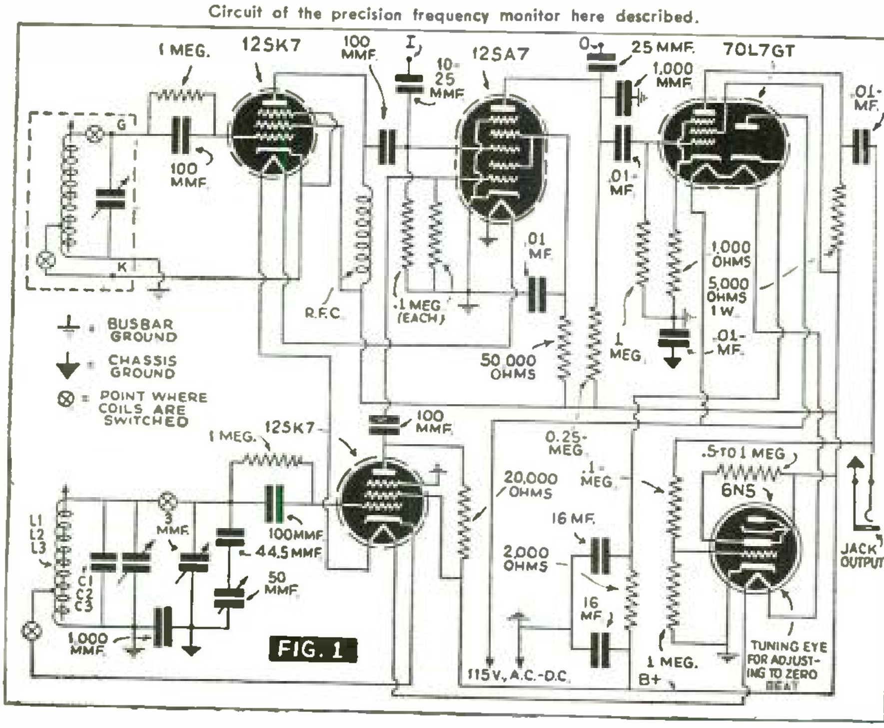
3. A stability sufficiently good to enable accurate checks to be made over short periods of time without having to re-set the variable oscillators on calibration.

4. Circuit and controls so arranged that accurate checks may be made rapidly.

To accomplish requirement 1 above, the circuit shown in Fig. 1 was devised. In addition to the variable oscillators which are accurately calibrated, this circuit employs a built-in mixing tube and audio amplifier so that no apparatus other than the frequency meter itself is required for a frequency check. The circuit also incorporates a stable 100 and 1000 kc. oscillator (either frequency may be selected by means of a switch). This allows checking the variable oscillator at many points throughout the range of each band. Three bands are employed on the variable oscillator to give complete band spread on all of the amateur bands as will be explained presently. The 100 and 1000 kc. oscillators are extremely stable and may accurately be set on calibration by beating their frequency in a radio receiver against WWV or a standard broadcasting station. The accuracy of station WWV is within one part in 5,000,000 while that of a standard broadcasting station is within 20 cycles (this corresponds to one part in 27,500 at the low frequency end of the broadcast band). Either of these accuracies far exceeds that required for amateur use.

The operation of the device is briefly as follows: The variable oscillators are turned off and the 100 kc. oscillator turned on. Station WWV or any broadcasting station on a multiple of 100 kc. is tuned in on a radio receiver. A short wire con-

Circuit of the precision frequency monitor here described.



*Chief Engineer, Browning Laboratories.

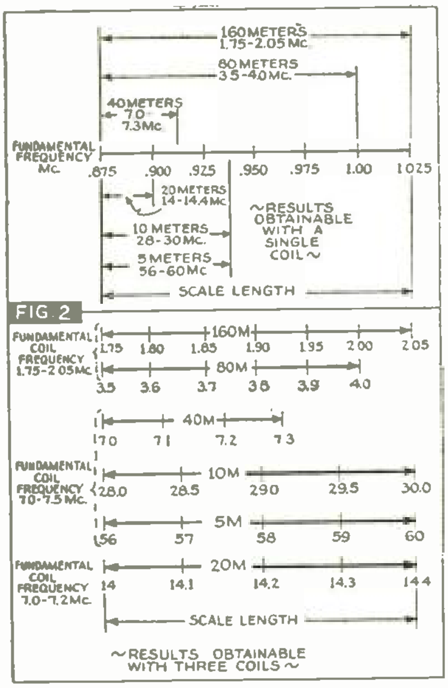


FIG. 2

Fig. 2 above shows comparison between the results obtained with three oscillators, and those obtained with a single oscillator.

nected to the plate of the mixer tube through a small condenser is brought close to the antenna input of the receiver. If the 100 kc. oscillator is slightly off calibration, a low-pitched beating tone will be heard in the loud speaker of the receiver. A threaded brass plunger inserted in the coil of the 100 kc. oscillator and rigidly held in position by means of a spring washer is advanced or retarded slightly to change the inductance of the coil so that the 100 kc. oscillator is brought to exactly 100 kc. as indicated by zero beat in the loud speaker. The variable oscillator which it is desired to use is then switched on and the dial adjusted to any point which is a multiple of 100 kc. and which is close to the point on the dial at which it is desired to check a transmitter frequency. Frequencies which may be checked against harmonics of the 100 kc. oscillator are clearly indicated on the dial. Phones inserted in the output of the audio amplifier incorporated in the frequency meter indicate whether or not the variable oscillator is accurately on calibration. Should the variable oscillator be slightly off calibration, a tone will be heard in the phones. The variable oscillator is then adjusted by means of a small trimmer until exact zero beat is obtained in the phones. The 100 kc. oscillator is then switched off and the short lead connected to one of the mixer grids is very loosely coupled to the transmitter. The dial of the variable oscillator is then rotated until zero beat is obtained as indicated in the phones. The transmitter frequency is then read directly from the dial of the frequency meter.

To facilitate accurately setting to zero beat, a tuning eye is incorporated. As zero beat is closely approached, the iris of the tuning eye will flutter, finally opening wide at exact zero beat. This enables much more accurate setting than would be possible with the phones alone.

All of the above procedure takes much longer to explain than it does to actually perform in practice. The checking of a transmitter frequency including a check of the 100 and 1000 kc. oscillator does not require more than a minute's time. Once the 100 kc. oscillator has been accurately set, frequency adjustments of the transmitter may be made and each frequency check will require less than 30 seconds.

The accuracy of heterodyne meters such as the one described above depends primarily upon the accuracy with which the dial may be read. It is thus desirable to spread the amateur bands over substantially the complete dial to obtain the greatest accuracy. Inasmuch as the amateur bands are all in harmonic relationship, it might be thought that this would be possible with a single variable oscillator. This is not the case, however, inasmuch as the widths of the amateur bands are not proportional to their base frequencies. For instance, the 40-meter band covers a range of from 7 to 7.3 mc., whereas the 20-meter band covers a range of from 14 to 14.4 mc. Thus if a range of frequencies of 7 to 7.3 is spread over the complete dial, the second harmonic of this range will cover a band of frequencies of from 14 to 14.6 resulting in incomplete spread for the 20-meter band. It has been found that to give substantially complete band spread on all of the amateur bands from 160 meters to 5 meters, three variable oscillators are required. This is illustrated in Fig. 2 where the results obtained with three oscillators are compared with those that could be obtained with a single oscillator. Using three variable oscillators and a 5½" dial mounted directly on the shaft of a 270° straight line frequency condenser, it is possible to obtain readings on the 160-meter band to within one kc. of the correct frequency and on the 5-meter band to within 10 kc. of the correct frequency.

Several design features affect the stability of a heterodyne type frequency meter. In general the factors affecting stability may be grouped into two classifications. (a) Those affecting variation in frequency with line voltage; and (b) Those affecting variation in frequency with temperature. Much can be done to satisfy the voltage stability requirement by appropriately placing the cathode tap on the oscillator coils and by running the oscillator tubes at low voltage. Stability with temperature variation is best obtained by locating the coils in such a position that they will change temperature the least amount during warm-up of the apparatus. The coils in the instrument being described are located under the chassis (the chassis is about 7 inches from the bottom of the cabinet), so that all of the heat from the tubes, resistors, etc., which tends to rise in the cabinet will be carried away from the coils. An A.C.-D.C. circuit is employed, thus eliminating the need for a power transformer which is one source of heat. A tube complement is chosen which makes a dropping resistor for the tube filament unnecessary.

To afford a rapid frequency check, the dial of the instrument is directly calibrated in frequency. This prevents the necessity for the use of time-consuming calibration charts. In order to align the variable oscillators so that they accurately track the dial, it is necessary to have control of both the inductance and capacitance of the variable oscillators. The inductance of the variable oscillators is controlled by means of a brass plunger similar to that described in connection with the 100 kc. oscillator. The capacitance is controlled by means of small trimmers across each variable oscillator coil. A 3 mmf. variable condenser brought to a front panel control is common to all of the oscillators and is used for accurately setting the oscillator it is desired to use on calibration at any point in its range which is a multiple of 100 kc.

It is believed that the apparatus described above meets all the requirements for accurately checking amateur frequencies on any of the bands between 160 and 5 meters. In fact, although a calibration is not given on the dial, the instrument may also be used for checking 2½ meter transmitters by simply multiplying the frequencies on the 5-meter range by two.

Compressed Dipole Aerials

E. L. Gardiner, B. Sc.

IN a recent article* were described a few simple measurements of field strength illustrating the advantages of directional aerial systems in the reception of short-wave signals. Even the addition of a reflector to the usual dipole was shown to yield a very useful improvement in signal-to-noise ratio. Unfortunately, however, the simplest directional array occupies considerably more space than a plain dipole, and when it is designed for use at wavelengths between 10 and 50 meters, cannot always be accommodated in the space available. The additional wires and spreaders will often be regarded as unsightly, whilst their weight demands the provision of well designed and strongly constructed masts. For example, a dipole and reflector resonating in the 20-meter band will involve two parallel wires each some 32 feet long, and about 17 feet apart. It is not easy to design a self-supporting arrangement of this size, whilst a wooden framework to support conductors of that length is by no means unobtrusive. These difficulties are accentuated when it is desired to erect the whole structure in a rotatable form.

For shorter wavelengths in the neighborhood of five to seven meters it fortunately becomes practicable to construct the dipole and reflector of metal tubing, which can be strong enough to support its own weight in a high wind. Even at these short wavelengths, however, there will be occasions when a reduction in bulk would be very acceptable. Experiments in direction finding may be quoted as an example. Just before the war the writer constructed a dipole and reflector supported by a light wooden framework which could easily be transported by car. This was employed in the field to locate a hidden five-meter transmitter. The latter radiated vertically polarized waves, and the procedure was to rotate the receiving aerial system until signals were at a minimum, when the reflector will be in the direction of the incoming waves.

In this way it was found possible to determine direction with an accuracy of about five degrees, provided of course that the direction of arrival of the waves had not been modified by intervening objects. The aerial structure was 8 feet high and 4 feet wide, and could be fairly easily handled when mounted upon a stout camera tripod fitted with a rotating head. It could hardly be termed convenient, however, and too much time was needed in setting it up, so that the need for a more compact arrangement giving, if possible, more pronounced directional effects was very evident.

Consideration of the possibilities of such an improvement naturally directed attention to the compressed dipole. This form of aerial has been known for many years, and is used by certain commercial organizations as a television receiving aerial in locations where space is very limited. It is barely mentioned, however, in most handbooks, and very little information seems to be available concerning its general use in short-wave reception. Thus there seemed good reason for carrying out practical tests on similar lines to those described in the previous article already mentioned, and in which the field strength measuring equipment could be pressed into service.

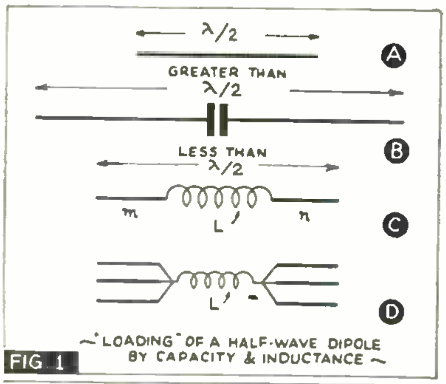
*"Aerial Reflectors," The Wireless World, October, 1940.

Half-wave Aerial Characteristics

The ordinary dipole, or more correctly the Hertzian half-wave aerial, resonates to a certain wavelength by virtue of the distributed inductance and capacity of the conductor. In open space the resonant wavelength is slightly more than twice the length of the dipole, which is therefore slightly less than a half-wavelength long. The proximity of buildings or of other conductors increases the electrical capacity of the wire, and thus reduces the length necessary to resonate at any particular wavelength.

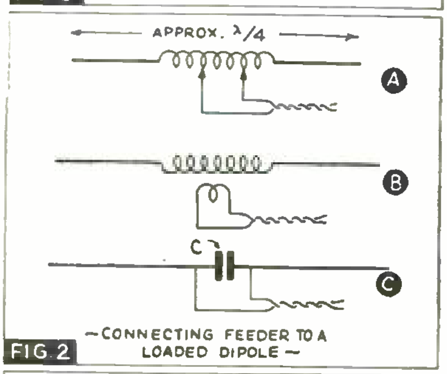
An interesting example of the effect was noticed by the writer when adjusting the length of a 20-meter aerial, one end of which was only a few feet above roof level, whilst the other was 20 feet higher. It was found that the lower end could be reduced in length by some two feet to restore resonance, thus making the two halves of the aerial unequal by that amount with respect to its electrical center. Similarly, the resonant length of a dipole can be increased if the distributed capacity of the wire be reduced. This can be done in practice by the introduction of a condenser into the center of the aerial, and shown at C, in Fig. 1 (b). Since the capacity of two condensers in series is always less than that of either alone, and the added condenser acts in series with the distributed capacity of the aerial wire, the effective value of tuning capacity is reduced. The aerial thus resonates to a shorter wavelength, or must be increased in overall length to resonate at the wavelength to which it responded before the condenser was inserted. It is possible to tune the aerial over a limited range by varying the capacity of the added condenser.

Various methods of shortening dipole aerials are shown herewith; this technique is very important, especially where there is little space to erect dipole antennas to cover the longer waves.



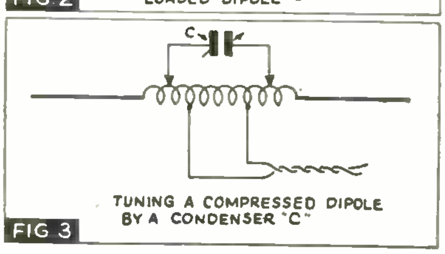
"LOADING" OF A HALF-WAVE DIPOLE BY CAPACITY & INDUCTANCE

FIG 1



CONNECTING FEEDER TO A LOADED DIPOLE

FIG 2



TUNING A COMPRESSED DIPOLE BY A CONDENSER "C"

FIG 3

Reducing Aerial Length

As a rule, however, there is no advantage in increasing the length of a dipole, and it will be more useful to decrease it. By analogy with a tuned circuit employing a coil and condenser, the wavelength will be increased, or the aerial shortened for a fixed wavelength, if either its distributed capacity or inductance be increased. It is inconvenient to increase the capacity to any material extent. To do this by adding a condenser would imply connecting this between the two free ends of the dipole, and would only be possible by the addition of long leads which would modify the action of the whole system profoundly, or by bending the aerial round until the free ends are in close proximity. In either case the aerial becomes a closed loop, and whilst it will in fact resonate to a considerably longer wavelength than before, it is no longer a dipole, and is not within the scope of this discussion.

It is, however, quite convenient to increase the inductance of a dipole by the addition of a coil, which can be inserted at the electrical center as shown at L in Fig. 1 (c). This coil acts in series with the inductance of the wire, increasing the effective value, and thus increasing the resonant wavelength. The distributed capacity is little changed, and the overall length of the dipole must be reduced to bring it back into resonance with the original wavelength.

Being shorter, the aerial is termed a compressed or loaded dipole.

As the value of added inductance is increased the overall length must be reduced to maintain resonance at a particular wavelength, and this shortening process can be continued until finally the dipole itself vanishes, leaving only the loading coil which now resonates by virtue of its own self-capacity. In such an extreme case there would clearly be little radiation from or reception by the "aerial," which has become a closed circuit consisting of a small coil of wire. Some intermediate case must be investigated, and for the purpose of these tests it was decided to choose a value of loading coil which would reduce the overall length to one-half of its original value, or to about a quarter wavelength. The accompanying table gives an idea of the lengths and sizes of loading coil found suitable for wavelengths of from 5 to 20 meters. No. 16 SWG enamelled copper wire was used throughout in constructing the aerials, and the loading coils were wound on a Trolitul former 1¼ in. in diameter, the turns being spaced by approximately the diameter of the wire. It must be appreciated, however, that whilst the figures given will form a satisfactory starting point from which to work when trying out compressed dipoles, they cannot be regarded as exact. The resonance of these aerials is noticeably sharper than that of a half-wave aerial, and for best results the length should be trimmed experimentally, since it will be determined to some extent by the exact materials used, and particularly by wire diameter and turn spacing.

Approximate design data for compressed dipoles having a length of one-quarter wavelength

Wave-length meters	*Approx. length of comp. dipole ft.*	*in.*	*Turns in loading coil*	*80 ohm feeder tapped across turns*
5	4	0	12	2
7.0	5	6	16	3
10	8	0	22	4
20	16	0	40	6

In order to keep the conditions as simple as possible, the remainder of the dipoles were composed of straight single wires. It is possible to employ as the portions *m* and *n* of Fig. 1 (c) either conductors of larger diameter, such as copper tubes, or several spaced parallel wires joined together at the terminals of the loading coil, as sketched in Fig. 1 (d). By so doing the distributed capacity of these portions is further increased, and either the overall length or the inductance of the loading coil can be decreased somewhat. Clearly the possibilities are extensive, and for the present no attempt has been made to examine the properties of aerials which are compressed to less than a quarter wavelength, or in which multiple wires are used. Probably the chief advantage of increasing the diameter of the arms *m* and *n* lies in the established fact that by so doing the "Q" of the aerial is reduced, and it resonates more broadly over a wider band of wavelengths. This may be important in the particular case of television reception, where some slight loss in image detail may result from the excessive selectivity of a compressed dipole in which a single wire composes the arms, and for which three wires in parallel spaced by about 2 inches can be recommended. A second case which might justify this procedure would be where a fairly uniform performance over the whole of a wave-band was desired, rather than the best possible performance at any one frequency.

Feeder Connections

Before experimental tests can be made with a compressed dipole it must be connected by a non-radiating feeder to the transmitter or receiver. Whilst any of the recognized types of feeder could be used, the aerial is symmetrical about its electrical center, and therefore lends itself to a balanced twin-wire transmission line, rather than to the concentric type. Since it is particularly necessary that only the aerial shall radiate, a low-impedance line was preferred to one of a higher impedance, in which the two conductors would be spaced by several inches, because the latter is more likely to become unbalanced during the course of adjustments. A proprietary cable of 80 ohms nominal impedance was selected, having the useful property that the radiation from it was too slight to be measured by the equipment used, even when the cable was not exactly matched to the aerial impedance.

The simplest and most widely used method of coupling is to break the dipole at its electrical center, and, on the assumption that its impedance at this point has the theoretical value of 72 ohms, to insert a cable of about that impedance directly. This system works well in practice, but suffers from the disadvantage that if any steps are taken which change the impedance at the center of the dipole, a mismatch to the feeder must occur. The presence of a reflector near to the dipole will have the effect of lowering this impedance, and thus tends to destroy the desired correct matching between feeder and aerial.

Matching Impedances

In the case of loaded dipoles a better method of coupling is fortunately available, since it would not be advisable to break the continuity of the loading coil. The feeder may be tapped across a few turns equally placed on each side of the center of the coil, as shown in Fig. 2 (a). Whatever the exact impedance of the feeder or of the aerial, it is now possible to get an exact match, for the impedance across a portion of the loading coil will vary from zero when the two feeder wires are attached at a common central point, up to a comparatively high value when they are separated by the whole coil. At an intermediate point, therefore, an impedance equal to that of the feeder will always exist, and can be found by trial.

An alternative method exists in the form of inductive coupling between the loading coil and a coil of a few turns connected across the ends of the feeder cable, as shown in Fig. 2 (b). For the sake of completeness a method of coupling to the extended dipole of Fig. 1 (b) may be mentioned. Here the feeder is joined directly across the series condenser, as shown in Fig. 2 (c), and the capacity of the latter is selected so that its reactance matches the impedance of the feeder. In this way an exact match to cable of any impedance is possible at one particular wavelength only, but unlike most other arrangements the system will not operate satisfactorily at harmonics of this, since the reactance of the condenser will then be different.

It will be remembered that the performance of various arrangements was measured in the present case by connecting the aerial under test to a transmitter adjusted to deliver as far as possible constant power and observing the readings of a field strength meter placed at some two wavelengths from the aerial. It can be safely assumed that the behavior of the aerial under receiving conditions will be complementary to that when tested as a radiator, since the same physical factors are involved in the two cases, and provided that the incoming waves can be assumed to arrive from the direction in which measurements are made.

It was decided first to determine how the radiated field from a compressed dipole of the dimensions given in the table compared with that from a plain dipole. The latter was first set up, under the conditions of the preceding article, and the field strength at a point broadside to the aerial was noted. In this case the feeder was tapped directly into the center of the dipole. A compressed dipole was then erected in the same position, and the same feeder connected across a few turns of the loading coil, as in Fig. 2 (a). This tapping was varied until the radiation from the aerial was at maximum, no change being made to the coupling of the other end of the feeder to the transmitter, or to the adjustments of the latter, which was, of course, crystal controlled. It was noted with great surprise *that the field strength from the two aerials was almost identical*, whilst in the second case the feeder current and estimated current in the aerial had increased. The experiment was repeated several times, and on a number of wavelengths, with similar results. It was found that the reduction in overall length of the compressed dipole to one-half of the original was not accompanied, as had been anticipated, by a reduction in the radiated field to 50 per cent or less of its former value, but that if the feeder current was maintained the same in the two cases, the field strength was reduced to between 70 per cent and 80 per cent only, whilst if the feeder tapping point on the loading coil was adjusted to optimum performance as first described, *there was practically no reduction observed*. Secondly, it was noticed that, whilst no accurate method for measuring the oscillatory current within the dipoles was available, it was clear, from the usual tests of coupling a neon tube or small lamp to the aerial wire, that both the current near the center of the compressed dipole and the voltage at its free ends was greater.

Unexpectedly Good Results

It is generally assumed that the most effective portion of a dipole in radiation or reception is that near the center, in which maximum current flows. It would therefore be expected that, if this portion be coiled up and rendered ineffective as a radiator, the radiation from the whole aerial would suffer considerably. From the evidence it seemed that this was not altogether true.

Whilst calculation of the current distribution within a loaded dipole would not be simple, it seemed likely that the following two effects were mainly responsible for the relatively good performance. First, the "Q" of the compressed dipole had been increased, as was evident from its sharper tuning, and a given amount of power induced in it would thus be expected to set up a larger oscillatory current. The radiation resistance of the aerial was almost certainly lower than that of a plain dipole, and so there would be less damping through radiation. Secondly, it was possible to reach a very effective impedance match into the feeder by the tapping adjustment, and this would still be possible when the aerial formed part of an array, and its impedance was upset by the presence of other elements. The transfer of energy into the aerial was therefore somewhat better, and in conjunction with the former point, these two factors seemed approximately to compensate for the reduced size of the aerial.

As a *receiver* the compressed dipole may not show up quite so well, since the improved impedance matching will not hold over any wide band of wavelengths. Attempts to confirm this by reception tests over a period indicated that in general signals were noticeably but not seriously weaker than from a full-length dipole, but that *when it was possible to tune the aerial exactly to the wanted signals*, this difference largely disappeared. A simple and apparently effective method for tuning the aerial was evolved, and is of particular assistance in tuning loaded reflectors. It consisted in joining a small variable condenser across a few turns near the center of the loading inductance. In the case of the five-meter band, the feeder cable was tapped across two turns of the coil, and a 15 mmf. condenser across four turns; Fig. 3. This enabled the aerial to be tuned over some two megacycles, and was fine for *reception*.—Courtesy *Wireless World*, London.

RADIO AMATEURS ON DEFENSE BOARD

● RESPONDING to the request of James Lawrence Fly, Chairman of the Defense Communications Board, that it appoint a representative and six regional advisors to the *Amateur Radio Committee* of the Board, the *American Radio Relay League* has announced the following appointments:

As representative: George W. Bailey, of Weston, Mass., president of the League. As alternate and expert advisor: Kenneth B. Warner, West Hartford, Conn., secretary of the League.

As regional advisors, the following: H. L. Caveness, Raleigh, North Carolina; William A. Green, Abilene, Texas; Kenneth T. Hill, Douglaston, Long Island, N. Y.; J. L. McCargar, Oakland, California; Fred H. Schnell, Chicago; and Dr. Burton T. Simpson, Buffalo, N. Y.

Other members of the *Amateur Radio Committee* include representatives of the Federal Communications Commission, Army, Navy, and the National Youth Administration. The purposes of the committee include the study of all phases of amateur radio facilities. Based on national defense requirements, the committee is expected to consider all questions relating to amateur radio and its place in the defense structure. It will recommend "precautions and restrictions with respect to amateur operations under various emergency conditions, and the allocation of such amateur facilities required by the Army or Navy."

"CQ"

Larry LeKashman, W2IOP

● AMATEUR activity is reaching the peak of the winter season. The snow and cold weather keeps the boys busy indoors. The surest sign of increased activity is the fact that 40 meter CW signals actually cover up the South American phones. Good signs bring to mind a letter in the current issue of QST. W9LEM suggests, since there already are "weeks" for everything, we have a National QSL Week. It sounds like a fine idea and there is no reason why everyone interested in cards shouldn't participate. The purpose would be to get everyone to swap cards for all their QSO's of the particular week designated as National QSL Week. It would be an opportunity to fill in cards from states that haven't QSL'd, if the entire gang got into the spirit of the thing. More than that though, it would probably revive a great deal of interest in QSL'ing, which would make for continued swapping of cards in the future.

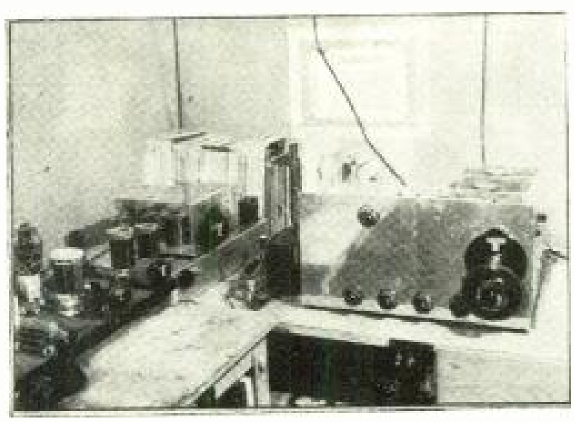
Letters are continually arriving with various comments on "CQ". While they are all appreciated, unfortunately they do not add to the material for the column. Information is still needed and clubs and individuals are invited to contribute.

W2MUO is sorely beset with BCL trouble. Already threatened with lynching by irate neighbors, Fred is really in a quandary. Most perplexing angle is the fact that W2MUO hasn't been on the air at any time the neighbors complained. Spooks! W2IOP has been testing some new equipment, including an RCA AR77; a 7 watt CW rig; and a 900 watt CW rig. W2VY is busy working at the new WEAF station, located at Port Washington. Next time you complain about an antenna falling down think of WJR's 700 footer which collapsed during a freak windstorm in Detroit. W2IJU is on 80 CW now. W2LYR is still a 10 meter phone bug.

W6QMI/2 is also becoming a 28 MC. convert after the results he has been getting with an indoor antenna. With a new receiver practically purchased, W2HP will soon be back on the air. Incidentally W2IOP is now working at Sun Radio in New York City. W2LNY is getting prouder and prouder of his new rig. You would too, if you had just knocked off KC4USB.

The DC Century Club files have been closed for the "duration of the war," or until world conditions justify its continuation. W2GT, Ed Hopper of Bergenfield, New Jersey, with 152 confirmed countries.

A QSL card received "before the war" from GM6WD, Scotland; lower left—Transmitter, Receiver and E.C.O. of station W9YXO; lower right—A Japanese Ham—J5CC.



is top man. Those 152 confirmations will probably keep Ed there for a long time! Those who believe in the real amateur spirit might well take W2GT as their shining example. With all credit to Ed's modesty, and if he knew we were writing this it would never get in print, he is one of ham radio's great characters. Using low power in so far as DX men are concerned, a single 35T, and an HRO receiver, with no rhombics, V beams, or trick gadgets W2GT set up this amazing record. On good authority we have been told of times when W2GT would sit back for hours at a time and actually pass up XU's; J's, and the like, in the hopes of hearing something new. Just let's not forget Mrs. W2GT, without whose cooperation 152 countries would just be a myth.

W2BO, W8OE, and W2LNY waste half their lives in 3 ways. W2MVJ is increasing his power. Oscar Corwin, a super SWL from Frankfort, Indiana, received a fine write up in the local steel publication. From Vic Politi of Fairfield, Conn., we received some information on a few of the locals. W1IBH is off the air because of overtime on his job and lack of DX to keep him hunting. W1MFT received his ARRL code proficiency certificate for 25 WPM. KC4USA, K6IQN, and lots of Cubans are rolling in on 20 meter phone.

While not an amateur station a new Japanese station, JLG-4, is on the 19 meter band and is heard with R9 signals during the morning. W2KHR's brother is now W2MID. W9RFA is sporting W2NET, now that he lives in New York. W2KIK may be found operating army ham station W2MAP.

Shortwave listening shack of Oscar Carwin of Frankfurt, Ind.

O.M. Have You a Harmonic?

Editor,

Here I sit. Beside me is a rack and panel outfit containing limiting amplifier and monitoring amplifier, in front of me a broadcast transmitter, and on the other side, a 14 tube communications receiver, and in front of that, a copy of RADIO & TELEVISION, open at the *"What Do You Think?"* page. Now, I too have a pet grievance to air.

First, I want to say that I am everybody's friend, and being a Ham myself have not the slightest intention of reporting any amateur for any reason, but did you ever try to watch the meters on a broadcast transmitter, watch your audio levels, and at the same time *copy press* at between 35 and 40 w.p.m.?

The other day I was sitting here, "cans on" and fingers tricklin' over this keyboard to the tune of W C X, press station on 7850 kc. Suddenly I hear a bang, a hiss, and a half dozen other audio frequencies besides the one I was copying, or by that time, "tryin' to copy," and behind that conglomeration, some son-of-a-so-and-so tryin' to make his young sister say hello into a mic (yes, I could hear him through the beat oscillator and he was about 400 miles away). Now, did you ever hold a match under a thermometer and watch the mercury go up? Well, if you haven't, try it some time when there's a thermometer in the shack you don't want, and, when the mercury gets to the top, watch, with your eyes well away, and you'll see what happened to my temper. To heck with the news. I turned off the beat oscillator and inside of 5 minutes had logged a half a dozen 75 meter phone stations on and near 7850 kc.

Now I don't have to tell you that a transmitter is not working at *peak efficiency* with a harmonic like that! All that power that is being radiated at *twice your frequency* isn't doing you any good, but sure can cause someone else a lot of grief, and when it falls *outside the Ham bands* it's inexcusable! So how about you 75 meter boys giving your "rigs" the once over?

MAX FISHER (B.C. Station CJIC),
83 Summit Ave., Sault Ste. Marie,
Ontario, Canada.

Practical Antenna Hints

Matching Stubs and Rotary Beams

Larry LeKashman, W2IOP

● IF all the material written about antennas was laid end to end, there probably wouldn't be enough bare space on the face of the earth to erect even a *vertical*.

We shall not attempt to go into the theory of the antenna. Instead, leaving that phase to more complete texts, let us see if we can extract sufficient material from acknowledged designs to really put our antenna to work. Keeping in mind that every antenna installation presents its own problems, no attempt will be made herein to discuss mobile design.

The beginner is often troubled with the *tuned* vs. *untuned* feeder arguments. The feeder system serves no other function than to transmit energy from a transmitter to the antenna itself; or conversely to transmit energy from an antenna to amplifying stages of a receiver. Thus a tuned antenna simply implies you are tuning the feeder to effect the maximum transfer of energy by achieving an impedance match. An *untuned* line, when operating correctly, is superior to the tuned line since it requires less apparatus to set up and operate. For example, it is possible to load up a transmitter using tuned feeders, without the flat-top radiating any energy—the load being entirely absorbed by the feeders. Such a condition, while it is not uncommon, is much less likely to occur in an untuned line. Generally speaking, if an untuned antenna draws normal current it is working satisfactorily.

The simplest type antenna, other than a mere piece of wire, is of course the *untuned half-wave*. At this point let us consider the most glaring drawback of any untuned antenna. This fault is their limit to *one-band* operation, *which means a separate antenna for each band*. The antenna data chart accompanying this article shows 16 of the most fundamental antennas. Incidentally, it is from the 1941 edition of the Stancor Hamanual which is available from any amateur dealer. The *concentric line* antenna types are only practical for the *ultra-high* frequencies, because the concentric line is in itself quite expensive. However, its wonderful transmission efficiency makes it well worth consideration, wherever possible. Needless to say that in calculating dimensions, several unknown factors must enter into your figures, but principally height above ground and capacity of surrounding objects. When erecting your antenna in most cases, you must use the "cut and try" method to determine these unknowns—cutting the antenna until it "loads" correctly. Next month we will show several methods of determining length with meters and neon bulbs.

To "straddle the fence" for a moment, let us go on record as a believer in *tuning units* in the station. For general experimental work an antenna tuner is invaluable. Two variable condensers and a coil, sufficiently large to tune to the lowest frequency band worked, is all that is needed. A clip or else a plug system makes it possible to switch condensers from series to parallel, and *short* turns on the coil if necessary. There are countless methods of mounting these units; our particular "brand" will be shown next month.

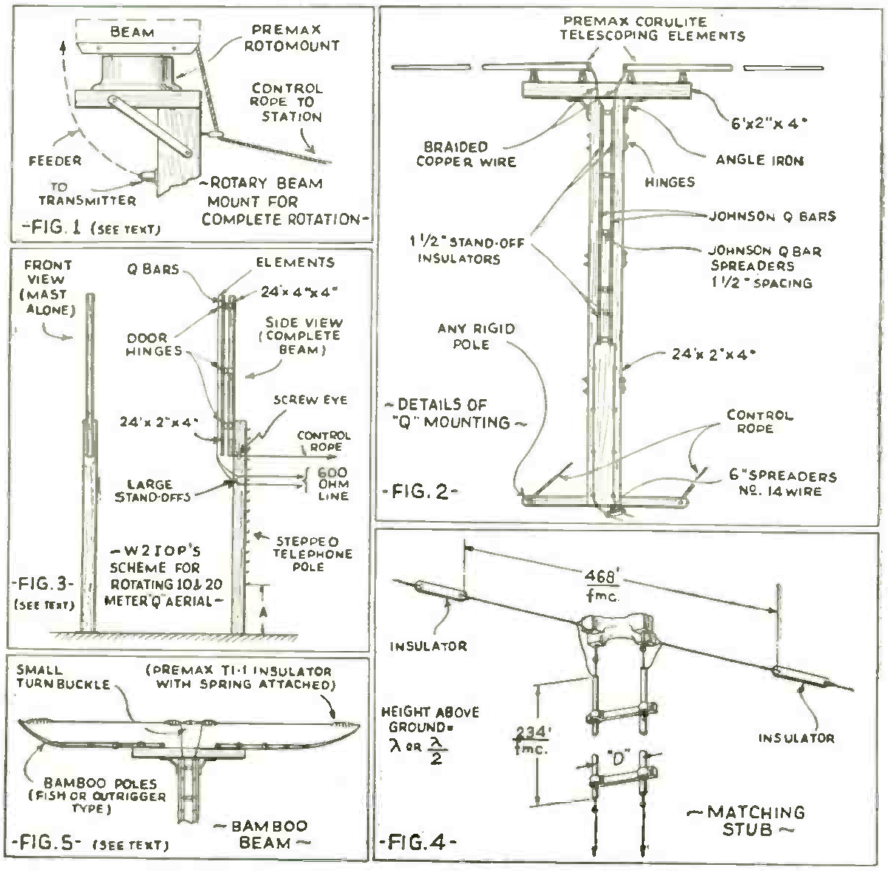
It is possible to match a tuned antenna without tuning the feeder, by the use of a *matching stub*. The stub is extremely difficult for the beginner to handle. At present we will leave that phase of antenna construction to any of the radio handbooks. However, there is on the market an excellent kit, the Johnson "Q," which makes use of a *stub*. See Fig. 4. The remainder of this article will be devoted to a simple rotary beam, using the Johnson "Q."

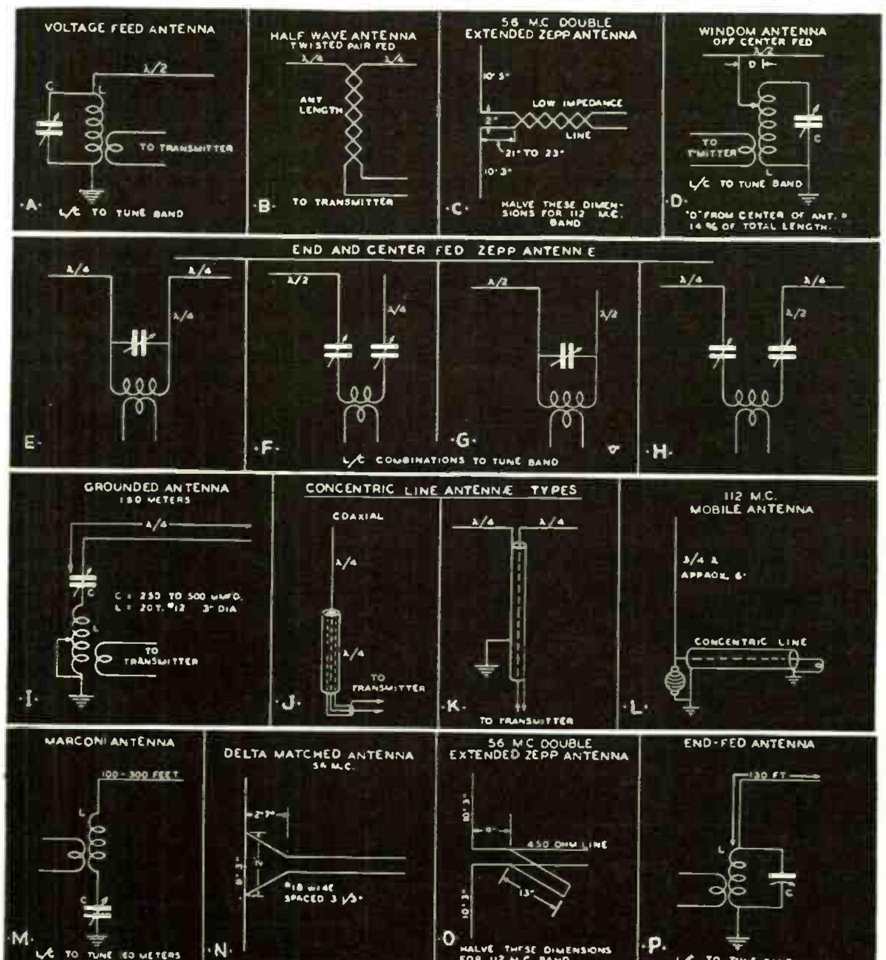
The antenna, because it has untuned feeders which are matched to the flat-top, is very efficient. The antenna is a half-wave, which radiates from the front and back, and has little gain off the ends. Since it is extremely bi-directional, 180° rotation will give 360° coverage. This eliminates costly rotary mechanism and makes possible several novel installations.

Figure 3 shows the arrangement used at W2IOP to rotate a Johnson 20 meter and 10 meter "Q." Fig. 2 shows details of the Q mounting. Premax elements were substituted for wire and adjusted to length on the ground. While elements of this sort are highly recommended, there are two substitutes that are somewhat less expensive. One is ½" thin-wall electrical conduit, which is available from any electric supply house. The other substitute is *bamboo*. In this case the poles are put under pressure and wire fastened as shown in Fig. 5. Copper-weld wire, which will not stretch, should be used and is supplied in the Johnson "Q" kits. The basic idea of hinging the "Q" to a central support, or as a matter of fact hinging any bi-directional antenna, is applicable to numerous installations. Those illustrated are merely one particular application of a flexible system.

The *rotary beam* need not be elaborate, even after leaving the efficient and remarkably effective rotary half-wave. The first problem to be approached is of course 360° rotation. In the next article we shall treat in detail one more 180° rotary beam—the "8JK." From that point on, to get complete coverage with our antenna, we must have *complete rotation*. Fig. 1 illustrates a simple and inexpensive method of obtaining complete rotation. The Premax *rotomount* will easily support the weight of a 4-element beam. The diagram shows the rotomount as a hand-driven unit. This system is only practical where a direct line may be run to your operating position, otherwise a motor should be used. Motor drive, as well as further antenna facts, will be taken up next month. Ponder over these for a while and you'll begin to see why Hams get gray.

(This is the first of a series of antenna articles designed to offer helpful suggestions on your antenna problem, and if possible give you some ideas that will make your antennas work better.)





The illustrations above show various ways of mounting rotary beam antennas as suggested in Mr. LeKashman's article. A very light beam frame may be made of bamboo, as indicated in one of the pictures. A "matching stub" forms an easy method of turning these beams.

Principles of Frequency Modulation

F. L. Sprayberry*

● THE basic theory of *frequency modulation* is by no means new. It was put in use to a limited extent before the widespread use of the vacuum tube. In fact, it was the outstanding alternative in *modulating systems* before the vacuum tube made it possible to amplify audio frequencies. Certain applications of frequency modulation appeared in technical literature as early as 1911, and one form of frequency modulation adopted a few years later, remains in use to the present day. It is used in the "compensated wave" arc transmitter at present.

Although the uses to which frequency modulation has been put have not been extensive, the results of even this meager effort have been so revolutionary that the subject is most worthy of serious study and investigation.

We can best approach the subject of frequency modulation (FM) by a simple comparison of it with amplitude modulation. Amplitude modulation as you know from your previous studies, consists of changing the amplitude of the carrier energy in accordance with a given signal. Frequency modulation on the other hand consists of *changing the frequency of the carrier* in accordance with the changes of the modulating signal. Great care in amplitude modulation is taken so as not to change the carrier frequency; conversely in frequency modulation great care is taken not to change the carrier amplitude.

Comparing the two modulating methods graphically as in Fig. 1, we have at A, a regular amplitude modulated envelope with which you are familiar. At B, we have a frequency modulated wave modulated by the same audio sine wave or signal as the wave at A. These graphs are of the same type—that is, amplitude of the carrier voltage is plotted vertically while the horizontal distances represent time. The audio wave form is perfectly obvious at A, as it determines the shape of the envelope. At B, however, for FM, the exact audio wave form is less obvious. Since the audio wave form is not clearly indicated in Graph B, we sometimes represent the frequency modulated wave in another way as at C. This curve (C of Fig. 1) is simply a graph of the frequency changes during modulation. Note in Fig. 1C that, as modulation progresses, the carrier actually changes in frequency, increasing to a maximum at f2 and decreasing to a minimum at f1. The dotted base line f0 shows where the carrier would remain if there were no modulation. The frequency f0 is the "base" or assigned "mid-carrier" frequency—the frequency at which the transmitter is radiating energy when it is not modulated. Frequency f1 is a lower frequency and f2 is a higher frequency than the unmodulated value.

The sine wave or curve shown at C of Fig. 1 represents the manner in which the carrier frequency changes when modulated. Note that, as modulation progresses, the carrier frequency at first increases from f0 to f2 and then returns to f0 and continues reducing to f1 finally returning to f0 at time T3, which is the end of one audio cycle. The values of f1 and f2 will be discussed later but for the time being suffice it to say that f2 is greater than f0 and f1 is less than f0 by the same amount. Although this graph shows carrier frequency (vertical) plotted against time (horizontal) the exact nature of the carrier frequency changes are obvious and this curve represents equally well the wave form of the modulating signal—a sine wave in this case.

The graph of Fig. 2 is of the same type as that of Fig. 1C but is intended to show the effect of various modulation amplitudes and modulation frequencies on the ultimate carrier. The vertical dimensions of this graph represent kilocycles deviation above (+) and below (−) the assigned or unmodulated carrier f0. The horizontal distances are graduated in very short units of time; namely, milliseconds or thousands of a second. Waves A, B and C all complete one cycle in 1 millisecond and hence are, therefore, 1000 cycle waves but are of three different amplitudes. If they complete 1 cycle in 1/1000 of a second, naturally they would complete 1000 cycles in 1 second. A of Fig. 2 is an audio wave of small amplitude, B is of medium amplitude and C of larger amplitude. Notice carefully that amplitude or height of each wave in this case is *not measured in voltage or current but in frequency deviation.* Wave D completes ½ cycle in 2 milliseconds which would mean 1 cycle in twice this time or 4 milliseconds. Its frequency is, therefore, 1000/.004 or 250 cycles. Its amplitude being ½ that of C causes just half of the frequency deviation of wave C, while the frequency deviation occurs just ¼ as fast.

From this information, we see that the amplitude of modulation or degree of modulation expresses itself in frequency deviation—the larger the audio amplitude (amount of audio voltage) the greater the *frequency deviation* of the carrier and a strict proportionality is preserved with regard to amplitude and frequency of deviation—that is, the ratio $\frac{\text{audio volts}}{\text{cycles deviation}}$ is always the same value or constant regardless of the value of the modulation frequency.

The modulation frequency expresses itself (in the frequency modulated system) simply as the number of times per second that the frequency changes. None of the alternations in any way affects the carrier voltage or ultimate power. When modulation ceases the carrier returns to its fixed frequency value and continues radiating at the same power. Fig. 1B clearly shows that the carrier voltage has a fixed maximum ampli-

Fig. 1 shows at A—amplitude modulated wave; at B—frequency modulated wave. C shows FM audio wave form. Fig. 2 shows effect of modulation amplitudes and frequencies on the carrier.

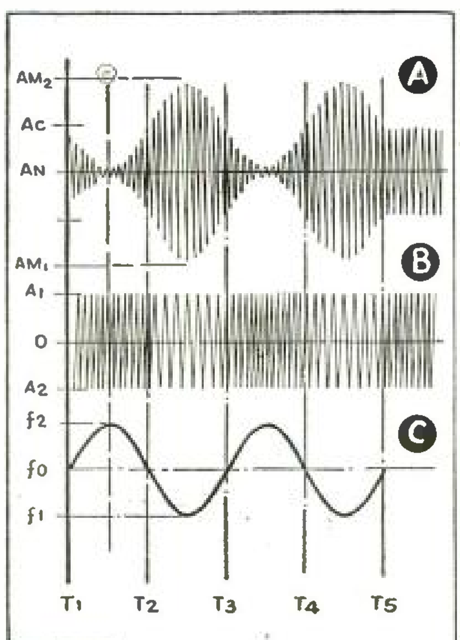


FIG. 1

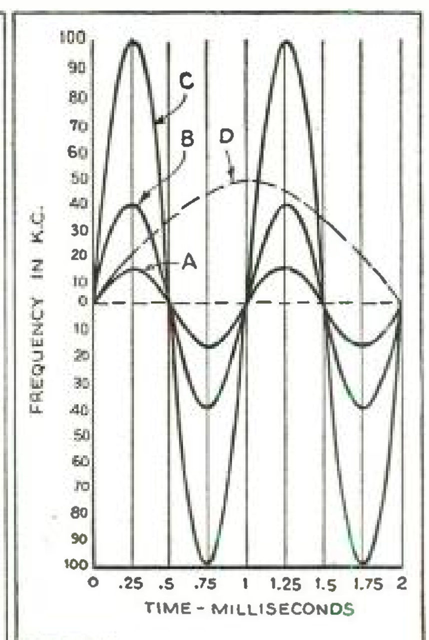


FIG. 2

*President, Sprayberry Academy of Radio.

tude for each high frequency cycle at all times whether modulated (time T1 to T5) or unmodulated (time beyond T5).

Reactance Tube Method of Frequency Modulation

So far there have been two practical methods of FM used in transmitting circuits. These are: (1) varying the frequency of the master oscillator circuit and amplifying and multiplying this frequency until the desired carrier frequency deviation and power output has been achieved and (2) using a fixed frequency oscillator and varying the frequency by a special means in some following circuit and likewise amplifying and multiplying as above.

The first method mentioned makes use of a so-called "reactance tube" which we will consider in the following. Fig. 3 shows a practical circuit by which we may follow the action.

From our former studies, we know that the frequency of oscillation of the 6SJ7 oscillator is determined primarily by the values of the tank circuit units, L2-C4-C5. We recognize this fact from the familiar basic relationship of L, C and F in the formula:

$$F = \frac{1}{2\pi\sqrt{LC}}$$

Now for frequency modulation we must actually change the frequency of this tank circuit both slowly and quite rapidly—in fact from 30 or 40 times per second up to high audio frequencies—10,000 cycles or more per second. For periodic changes according to a fixed wave form this might conceivably be done mechanically with a motor-driven condenser or a motor-driven coupler associated with the coil, as we find this done in FM signal generators. To make these changes in frequency corresponding with amplitude changes in a voice wave, an entirely automatic and non-mechanical method must be employed. While it is true that we might place a condenser microphone across the tank circuit and let voice waves vary the capacity and thus the frequency, there are many practical limitations to this method.

The first practical method of making proper frequency changes in a circuit like that of Fig. 3 made use of a well known principle of the vacuum tube as will now be explained.

One of the main things which characterize an inductance is the fact that the voltage across it leads the current through it by a phase angle of nearly 90°. Any *other* electrical device regardless of its nature or construction which can *exhibit these properties* will act like an inductance to this extent at any rate. It may not fulfill all of the properties of inductance such as lower power factor, energy storage, etc., but it may be used in place of an inductance in circuits which require only the above mentioned properties.

There is no known way mechanically to vary the inductance value of a coil quickly. Therefore, we have to resort to a substitute inductance and the vacuum tube best fulfils this requirement.

Although no vacuum tube has these properties at any two terminals in ordinary use, we can *force* it to display these properties to a satisfactory degree. Let us first examine the phase relations of a *normally operated* tube and then see how we can convert its operation so that its plate signal voltage will lead its plate signal current by nearly 90°. These phase relations are to be found in Fig. 4. As we have learned, the plate current (Ip) is in phase with the grid voltage (Eg) as clearly shown here. By "in phase" we simply mean that the grid voltage and plate current are maximum (most positive) at the same instant, and both are at minimum at the same instant. This is perfectly obvious at A in Fig. 4, and is an operating characteristic of circuits such as are shown at B and C of this figure. Now as the plate current of any amplifying tube increases, it means that the load current, in increasing, produces a higher voltage drop (across the load) in direct proportion to the plate current, and hence the voltage at the plate (Ep) is in opposite phase to the plate current. At the highest value of plate voltage the plate current is lowest.

This is true in amplifiers such as in circuits B and C, Fig. 4, because the plate load resistance in the first case has no effect on the plate voltage-plate current phase, while in the second case (C, Fig. 4) it is just as true at resonance because the impedance formed by C and L forms a pure resistance equivalent. Obviously, any external reactance *would cause some phase change* in the voltage-load current phase and these conditions as previously described would not be fulfilled.

It is quite obvious in Fig. 4 that the plate signal voltage is simply the amplified grid signal voltage—180° displaced—that is, the plate signal voltage is in reverse phase to the input grid signal voltage Eg.

To carry the thought of making a tube act like an inductance further suppose we simply disregard the plate voltage wave (Ep) at A in Fig. 4 and supply a different plate voltage signal directly to the 6L7 plate from an oscillator source as in Fig. 3. Note that the oscillator has no relation to the input grid of the 6L7 at all. The oscillator is also independent of the plate current of the 6L7 tube. The *new* plate signal voltage which we shall supply from the oscillator may be of *any phase* that we choose (with respect to the input grid of the 6L7 tube) and as we have seen, we want this voltage to *lead* the plate signal current (Ip) wave by 90° in order for the tube to exhibit inductive characteristics. By way of information we indicate a leading phase on a graph always by moving the wave to the *left*, and for 90°, it will be moved ¼ cycle to the left (because $\frac{360}{4} = 90$).

Of course, by now we have completely given up the idea that the 6L7 tube is *intended to amplify*. In this application we supply a signal to both the grid and plate and wish to make use of the reactance (inductive) properties of the tube rather than its amplifying qualities.

Refer to Fig. 3 again and note that the R.F. signal at the grid end of L2 is fed directly to the plate of the 6L7 modulator, but a blocking condenser C2 is used to prevent the D.C. applied to the 6L7 plate from being shorted to ground through L2. The value of the blocking condenser C2 is 250 mmf. and it was chosen to have a very small reactance as compared to the A.C. plate resistance of the 6L7 tube to prevent serious phase shift from the oscillator inductance L2 to the 6L7 plate. For example, the A.C. plate resistance of the 6L7 is given as greater than 1 megohm while the reactance of the 250 mmf. condenser at say 2000 KC. is approximately 350 ohms. The phase angle of a resistance and reactance in series is always "arctan (arc tangent or angle whose tangent is) X/R" expressed in the simplest terms. The numerical value of X/R by substitution, considering R to be 1 megohm, is 350/1,000,000 or .00035 which is the arctan of an angle very considerably less than 1/10th of 1 degree, a phase angle which can be entirely neglected. These values may be found in a regular trigonometric table of "natural tangents."

This simply means that the A.C. changes in the plate current of the 6L7 due to this plate signal are substantially in phase with the high frequency voltages applied to the plate from L2.

By means of R4 and the attendant network C3 and R5, the inner control grid of the 6L7 is also supplied with the high frequency voltage from the same point: namely, the top of coil L2. Analyzing this circuit, we find the inner-control-grid input capacitance of 7.5 mmf., to be in parallel with C3 which we will say is adjusted to 7.5 mmf. In parallel, these will total 15 mmf. These two capacities are in turn shunted by a .5 meg. resistor R5, and the group is in series with a 50,000 ohm resistor (R4).

First, we must note that the reactance of a 7.5 mmf. condenser at 2000 KC. is approximately 10,600 ohms.

In all of the work to follow, the accuracy is not intended to be better than 1/10th of 1% as only three significant figures are retained.

(1) $$Xc = \frac{1}{2\pi FC}$$

$$Xc = \frac{1}{6.28 \times 2 \times 10^6 \times 7.5 \times 10^{-12}} = 10,600 \text{ ohms approx.}$$

Where: Xc is in ohms
$\pi = 3.14$ $(2\pi = 6.28)$
$F = 2,000,000$ cycles (2×10^6)
$C = 7.5 \times 10^{-12}$ fd.

Now two condensers of equal capacity would have just half of this total reactance or 10,600/2 = 5,300 ohms. The impedance of these capacities with the 500,000 ohm resistor across them would be as expressed by the following formula:

$$Z = \frac{RXc}{\sqrt{R^2 + Xc^2}}$$

which by substitutions equals—

$$Z = \frac{500,000 \times 5300}{\sqrt{(500,000)^2 + (5300)^2}} = 5,299.7 \text{ ohms}$$

We must resort to mathematics to find the phase angle between the voltage across and current through this entire combination. However, the student familiar with such work can see at a glance that the phase angle is very nearly -90°—that is, voltage lagging current. We will show the method of arriving at the value without depending on estimation entirely.

From the geometry of the vectors forming these values we may obtain—

$$\tan \vartheta = \frac{R}{X}$$

Substituting values in the inverted expression—

$$\vartheta = \tan^{-1} - \frac{R}{X} =$$

NOTE: This is read: Theta equals the angle whose tangent is minus R over X. Also, may be written $\vartheta = \arctan - \frac{R}{X}$ and read: Theta equals arc tangent minus R over X.

$$\vartheta = \tan^{-1} - \frac{500,000}{5,300}$$

$$\vartheta = \tan^{-1} - 94.3$$

$\vartheta = 89°\ 25'$ approximately (from table of natural tangents)

You could substitute the proper values in either the "sin" or "cos" functions, and by referring to complete tables of trigonometric functions, find the same angle: namely, nearly -89½ degrees and hence very nearly -90°.

From the above calculations, we find that there is no longer any reason to consider the 500,000 ohm resistor because it has an insignificant effect on the phase angle of the circuit. In other words, it changes the phase from -90° (for a perfect condenser) to -89½ degrees, an amount of phase shift which could not ordinarily be measured. From the A.C. viewpoint, we could, therefore, ignore the 500,000 ohm resistance R5 and simply consider the reactance. However, we are actually more interested in the method than the answer, and so we shall continue the exact analysis.

Since the condenser-resistance combination which we have just studied is in series with another resistance, we may express their sum as—

(2) $$Zt = Z1 + Z2$$

Where: Zt is the total impedance from the top of L2, Fig. 3 to ground,
Z1 is 50,000 ohms and
Z2 is 5,299.7 ohms.

The numerical addition of these two impedances is a complicated procedure but is relatively easy to follow even if you are not familiar with the mathematical principles. Z1 is a pure resistance, and of course, has no phase angle. On the other hand, Z2 has a resistance element R5 and a reactance element X (of C3) and that part of it which is a pure reactance has a phase angle of -90° or is at right angles electrically to the resistance part which, of course, has an angle of 0°. In other words, we may consider the condenser-resistance combination to be made up of two series elements as well as these parallel elements. These must be expressed as though they were in series in order to add the two impedances. The facts that we have at hand are the impedance value (5,299.7) and the phase angle (-89°25'). These two completely describe the impedance when written as—

5,299.7 $\angle -89°25'$ and read
5,299.7 phase minus 89 degrees 25 minutes.

The equivalent series circuit which would be identified exactly as above would have a resistance and condenser in series. The resistance element is found by multiplying

Fig. 3—"reactance tube" F M modulator. Fig. 4—diagrams used to explain F M action. Fig. 5—curve showing voltage lagging the current.

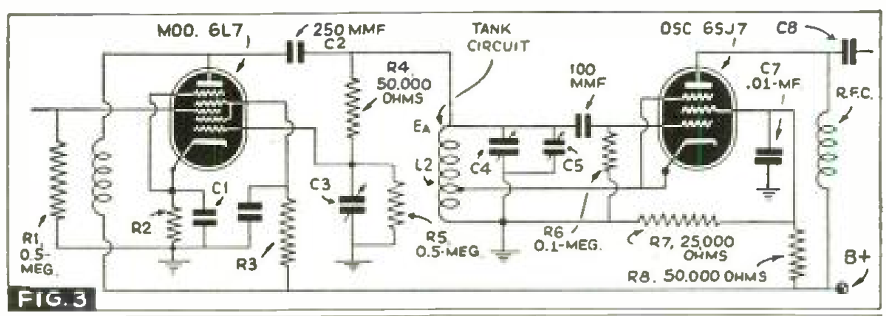


FIG. 3

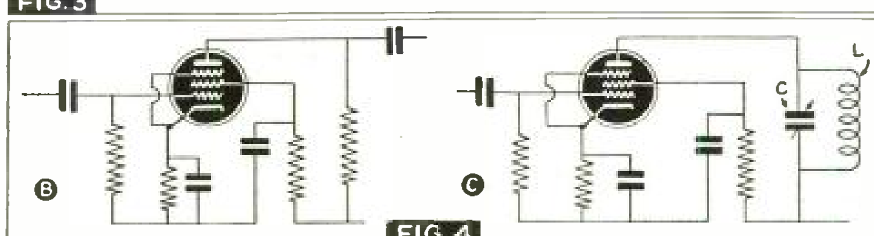
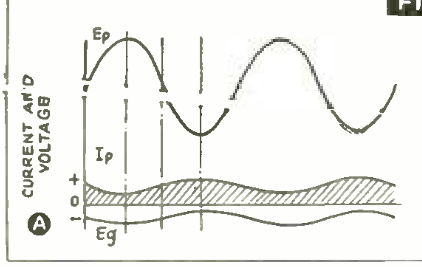


FIG. 4



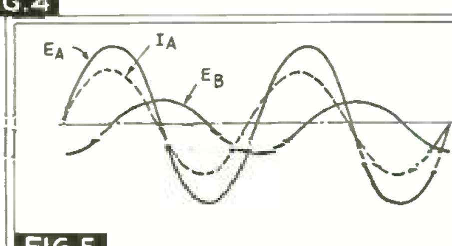


FIG. 5

The theory behind the operation of this unit is not at all difficult to understand. You will notice that the grid return is 22½ volts minus, with respect to the filaments of the tube. If the photo-cell were pulled out, this negative voltage on the grid of the tube would be sufficient to cause plate current cut-off. However, with the photo-cell tube in its socket, we find that there is a grid return path, through the photo-cell tube to plus "B" also. Photo-cells have a characteristic similar to a resistor and when light falls on the cathode surface the resistance effect changes, depending upon the amount of light that reaches it. This means that more or less plus voltage gets onto the grid of the tube, as the light is varied, and the plus voltage bucks the negative voltage already there. Therefore the net negative voltage on the grid is lowered, causing plate current to flow and pull down on the relay armature. The 3 megohm potentiometer is varied until the proper action is obtained with the amount of light you are using.

Many circuits have appeared for A.C.-D.C. operation in the past. This unit will find application where portability is required. It isn't necessary to use as large an "A" and "B" battery as is shown in the photograph, as long as the "B" battery used has a 22½ volt tap.

There isn't much to putting this little unit together, as you can see. The chassis is only 4" x 2" x 2" but you can make it any size you prefer. A chassis like the one used in this model can be purchased already formed and punched. If a chassis as small as this is used it will be necessary to mount all parts except the relay and finish the wiring up to the relay, leaving leads just long enough to mount and wire the relay afterwards.

The sensitivity control has a screw-driver slot on the shaft. A three-screw terminal strip is mounted on the back of the chassis. The center terminal is wired to the armature of the relay and the two outside terminals are each connected to one of the contacts. In this way you have a choice of a "normally open" or "normally closed" relay control circuit.

Since the greatest *change* in light gives the surest action, it is important that no extraneous light be permitted to fall on the photo-cell. It is a good idea to build a light tight box to fit over the entire photo-cell relay unit. Cut a hole about 1½" in diameter on the side just in front of the photo-cell. If a lens whose focal length is equal to the distance between the opening and the photo-cell is mounted over the opening, still better action will result.

The light used should, if possible, be in the form of a concentrated beam which may be secured by means of reflectors or lenses. A 32 candle-power automobile headlight bulb makes a good light source. It can be operated from a storage battery or 6 volt step-down transformer. However, even a good flashlight will work.

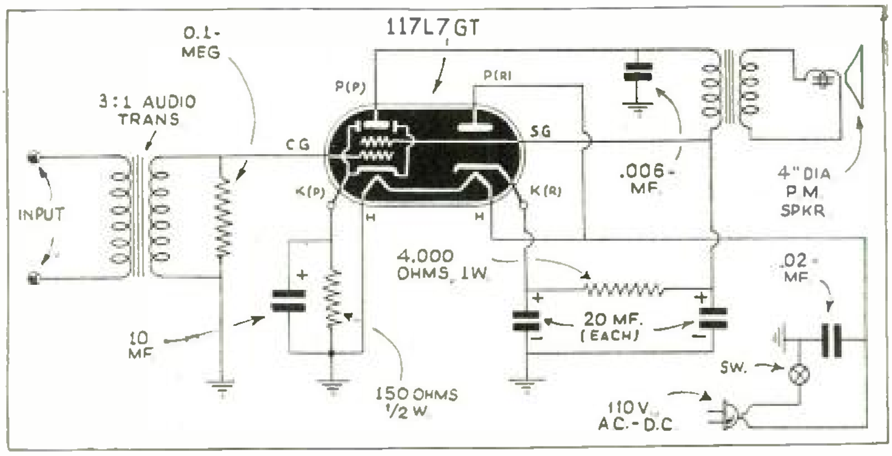
List of Parts

1—Ajustment control, 3 megohms
1—Knight S.P.D.T. relay, 5000 ohms
2—4-prong sockets
1—G.M. photo cell
1—Knight type 31 tube
1—3 megohm, ½ watt resistor
3—feet 4-wire cable
1—3-lug terminal strip
1—Drilled chassis base
1—"A" battery, 1½ volts
2—"B" batteries, 45 volts
2—"B" battery plugs
Miscellaneous hardware

Diagrams of Interest

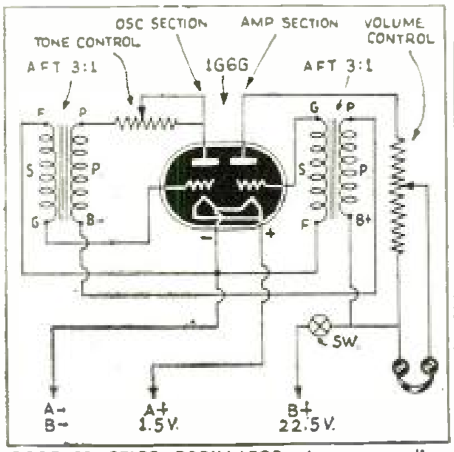
This is a new department. If you have a new Hook-Up, send it along; a pencil diagram will do. Be sure to include a brief description.

All diagrams and descriptions accepted and published will be paid for at regular space rates. Diagrams may be for receivers, adapters, amplifiers, etc. Send them to Hook-Up Editor, RADIO & TELEVISION, 20 Vesey St., New York City.



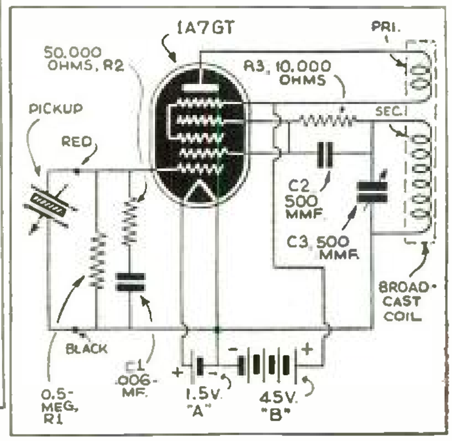
ONE TUBE AMPLIFIER: This one-tube audio amplifier submitted by Homer L. Davidson, Fort Dodge, Iowa, can be used with one and two tube receivers as well as crystal sets. This circuit will appeal to many radio beginners as it operates directly from the lighting circuit. The small PM speaker can be picked up cheaply and the cost of the other parts is very nominal.

Cover Feature



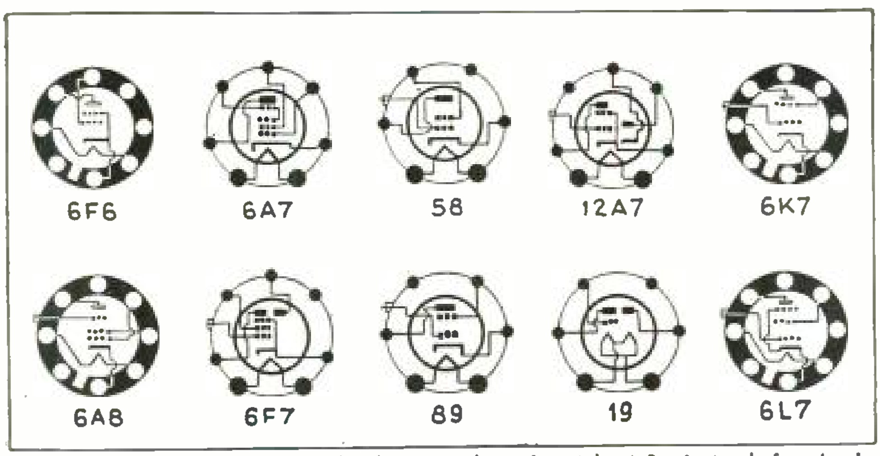
CODE PRACTICE OSCILLATOR: As many radio-minded fellows are now feverishly studying the radio code signals, they will be interested in this simple and flexible code oscillator, contributed by Robert Jacobson, Washington, D. C.

PHONO OSCILLATOR



This phono oscillator, which may be used with portable phonographs, may be battery-operated as shown. It was contributed by Daniel Teitler, Bronx, N. Y.

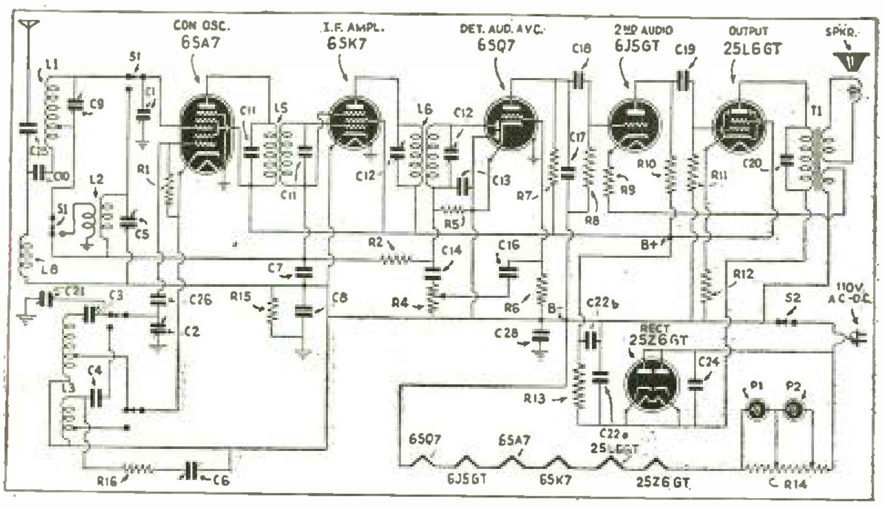
WHAT'S WRONG WITH THIS DIAGRAM?



Be honest with yourself and study the diagrams above for at least 3 minutes before turning to the answers on page 640.

to the Radio Experimenter

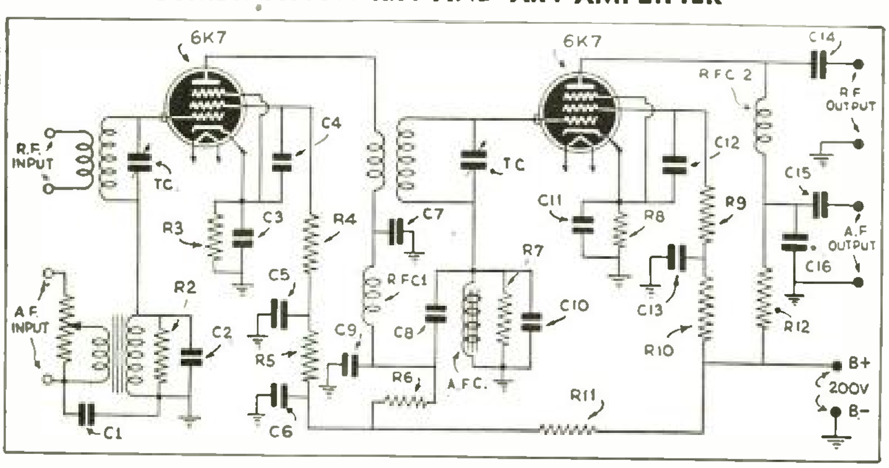
6-TUBE, 2-BAND RECEIVER FOR A.C.-D.C.



The diagram shown above is for a G.E. Co. 110 volt A.C.-D.C. superhet for shortwave and broadcast band operation. The values of the various condensers and resistors are given below. The I.F. is 455 kc. and the speaker is a 6½-inch PM type.

Symbol	Description
C-1	Antenna section tuning condenser
C-2	Oscillator section tuning condenser
C-3	"B" band padder
C-4	3900 mmf. mica capacitor ±5%
C-5	2-20 mmf. "D" band antenna trimmer
C-6	2-20 mmf. "D" band oscillator trimmer
C-7	.05 mfd. paper capacitor
C-8	0.1 mfd. paper capacitor
C-9	2-15 mmf. "B" band antenna trimmer
C-10	.01 mfd. paper capacitor
C-13	470 mmf. mica capacitor
C-14	.002 mfd. paper capacitor
C-16	.02 mfd. paper capacitor
C-17	220 mmf. mica capacitor
C-18	.005 mfd. paper capacitor
C-19	.005 mfd. paper capacitor
C-20	.01 mfd. paper capacitor
C-21	2-15 mmf. "B" band oscillator trimmer
C-22a	30 mfd. 150 V. dry electrolytic
C-22b	30 mfd. 150 V. dry electrolytic
C-24	.05 mfd. paper capacitor
C-25	.01 mfd. paper capacitor
C-26	47 mmf. mica capacitor
C-28	0.1 mfd. paper capacitor
L-1	Beam-a-Scope
L-2	"D" band antenna coil
L-3	Oscillator coil
L-5	1st I.F. transformer
L-6	2nd I.F. transformer
L-8	1½ mh antenna choke
P-1	Dial lamp, Mazda No. 44
P-2	Dial lamp, Mazda No. 44
R-1	33,000 ohms carbon resistor
R-2	2.2 megohms carbon resistor
R-4	2 megohms volume control
R-5	470,000 ohms carbon resistor
R-6	15 megohms carbon resistor
R-7	470,000 ohms carbon resistor
R-8	1.0 megohm carbon resistor
R-9	3300 ohms carbon resistor
R-10	39,000 ohms carbon resistor
R-11	470,000 ohms carbon resistor
R-12	150 ohms carbon resistor
R-13	100 ohms carbon resistor
R-14	BL-42-D ballast resistor
R-15	470,000 ohms carbon resistor
R-16	100 ohms carbon resistor
T-1	Output transformer

COMBINATION R.F. AND A.F. AMPLIFIER



Frank H. Tooker of East Orange, N. J., sent us this diagram. The values of the various condensers and resistors are as follows:

C1=0.1 mf.
C2=.0001 mf.
C3=0.1 mf.
C4=.01 mf.
C5=0.1 mf.
C6=1.0 mf.
C7=.0001 mf.
C8=.01 mf.
C9=.001 mf.
C10=.0001 mf.
C11=0.1 mf.
C12=.01 mf.
C13=0.1 mf.
C14=.00025 mf.
C15=.01 mf.
C16=.001 mf.
R1=100,000 ohms
R2=100,000 ohms
R3=2000 ohms
R4=10,000 ohms
R5=50,000 ohms
R6=20,000 ohms
R7=100,000 ohms
R8=2000 ohms
R9=10,000 ohms
R10=50,000 ohms
R11=20,000 ohms
R12=20,000 ohms
AFT=audio frequency transformer, ratio 3:1
AFC=audio frequency choke, 700 henries
RFC-1 and RFC-2=R.F. chokes, 25 m.h.
T.C.=tuning condensers, ganged

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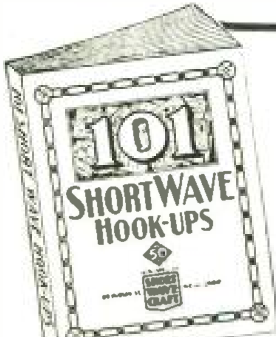

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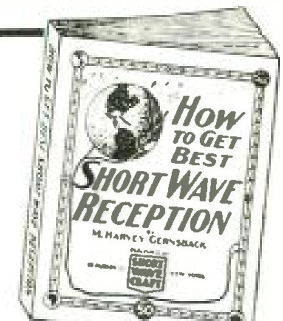

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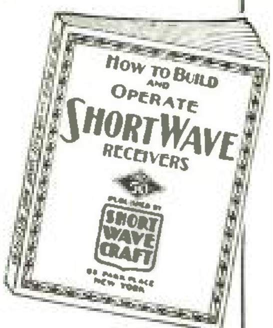

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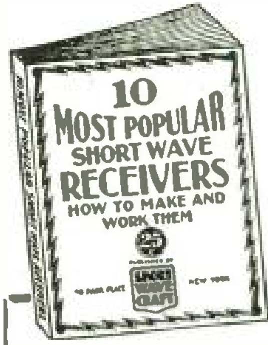

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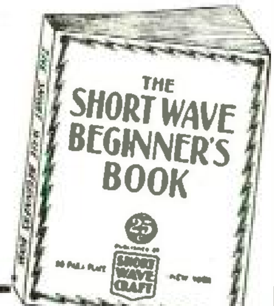

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Short-Wave Receiver

? *Please publish a diagram of a short-wave receiver, using a 6K7, 6C5 and a 6F6 tube.—S. Kalista, Coaldale, Pa.*

A. Shown here is a 4 tube T.R.F. receiver answering your specifications. Either 6K7 or 6SK7 tubes may be used in the R.F. and detector circuits. Condensers C-1 and C-3 are 35 mmf. tuning condensers, while C-2 and C-4 are 100 mmf. band-setting condensers. The coils can be any two-winding, all-wave plug-in

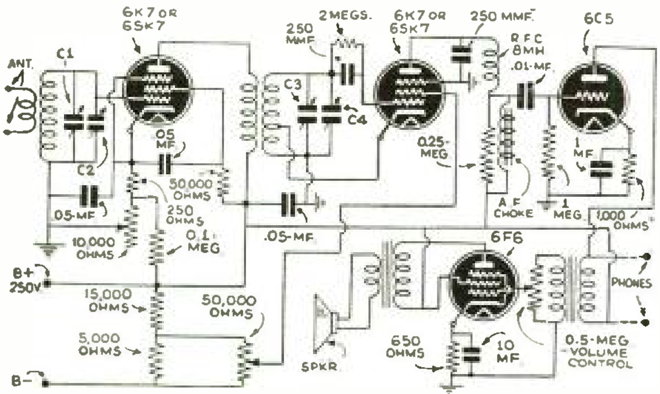


Diagram for 4-tube T.R.F. receiver of the regenerative type. No. 1246.

coils. The detector grid coil is tapped about 20 percent of its length above ground. If it is desired to use phones, they may be connected across the primary of the interstage audio transformer. Use an output transformer having a primary impedance of about 4000 ohms. The audio choke in the plate circuit of the detector is one of the 500 henry low-current types of chokes.

Eliminating Ignition Noises

? *How can I eliminate ignition noises picked up by the antenna lead-in on my auto radio?—L. Morosic, McCook, Nebraska.*

A. The antenna lead-in—that is the connection from the antenna proper to the receiver, can and should be *shielded* by using low capacity cable. This is similar to ordinary shielded wire except for the much greater thickness of the cable caused by the increased space separating the inner conductor and the outer shield braid. This outer braid should be well *grounded* at the receiver end, while the inner wire is connected to the antenna terminal post of the receiver.

Regeneration Receiver Trouble

? *I recently completed the receiver described on page 22, volume 2, of the Gernsback Educational Library. I am using a type 36 tube instead of the one diagrammed and incorporating an A.C. power-supply. However, the set appears to be insensitive and no oscillation can be obtained.—H. S. Emigh, Jackson, Miss.*

A. The most common cause of lack of regeneration and non-oscillation in regenerative receivers is a *reversed* tickler winding. Always try reversing the two leads to the tickler or plate winding. We would also suggest, if you have not already done so, to use a 15,000 or 25,000 ohm control in series with the cathode for controlling volume, instead of the filament control shown in the original set. Either *ground* one side of the filament or ground the center tap of the filament winding.

Space Charge

? *What is meant by the* space charge *of a vacuum tube and what effect has it on the operation of the tube?*

A. Not all the electrons emitted by the cathode or filament of a vacuum tube are attracted to the plate. Some of them, having low velocities, remain bunched up around the cathode and act as a *screen*, lowering the plate current: that is, causing a plate current lower than would result if there were no space charge. These electrons around the cathode keep falling back on the cathode, giving way to other low velocity electrons which also remain near the cathode, only, in turn to be drawn back to the cathode. Increasing the plate voltage, will, of course, reduce the space charge effect for a given filament temperature.

Time Signals

? *Is there any meaning or code to the signals preceding the sending out of the time signal or dash at the exact hour?*

A. The time signal, as transmitted by American Naval stations, begins at five minutes before the hour. It consists of the transmission of a dot for every second, omitting the dot at the following seconds:—

29, 51, 56, 57, 58, 59 during the first minute.
29, 52, 56, 57, 58, 59 during the second minute.
29, 53, 56, 57, 58, 59 during the third minute.
29, 54, 56, 57, 58, 59 during the fourth minute.
29, 51, 52, 53, 54, 55, 56, 57, 58, 59 during the fifth minute.

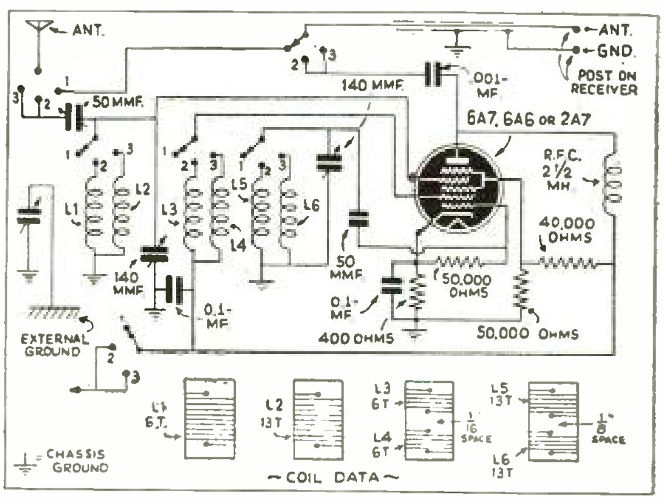
At the end of the 60th second of the fifth minute, a one second dash is sent, the beginning of which *is the time signal.*

NAA at Arlington, Virginia, sends time signals almost every hour on a number of frequencies. Their schedule follows. Time is GMT. using the 24 hour clock.

113 kc. at 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23 and 24 o'clock.
4390 kc. at 2, 3, 8, 9, and 10 o'clock.
9425 kc. at 2, 3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 15, 16, 17, 19, 20, 21 and 22 o'clock.
12,630 kc. at 2, 3, 8, 9, 10, 14, 15, 20, 21, 22 o'clock.
17,370 kc. at 14, 15, 20, 22, and 21 o'clock.

Short-Wave Converter

? *Can you send me more detailed information on the converter shown on page 648 of the March issue?—E. S. Iwasko, Lansing, Mich.*



Hook-up of short-wave converter, together with coil data. The different coils covering the various short wave-bands are switched into circuit by a ganged switch, in the manner made clear in the diagram. The wire shown connected to points 2 and 3 of the switch, in the lower left-hand corner, goes to B plus. No. 1247.

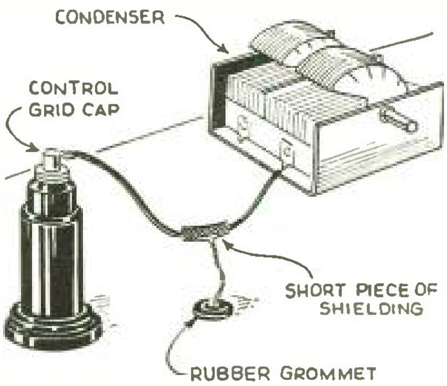
A. We are reprinting the diagram of this efficient short-wave converter. All parts values as well as coil information are shown. The coils can be wound with No. 20 wire on 1¼" diameter forms, 3¼" long, space wound to fit the available space. Covering the 13 to 30 meter and 30 to 60 meter bands, it has a novel switching arrangement built around the 6-pole, 3-position switch. On two of its positions, the converter is connected to the receiver as a converter on one of the two short wave bands, while on the third position or position No. 1 in the diagram, the converter is disconnected from the antenna and the antenna is connected to the receiver. The switch can be of the 3-deck rotary type, with two poles per deck.

Queries to be answered by mail (not on this page) should be accompanied by fee of 25c (stamps, coin or money order). Where schematic diagram is necessary, our fee is 50c up to 5 tubes; for 5 to 8 tubes fee is 75c; over 8 tubes, fee is $1.00. *No picture diagrams can be supplied.*

The Cover Kink
First Prize Winner

IMPROVISED FIXED CONDENSER

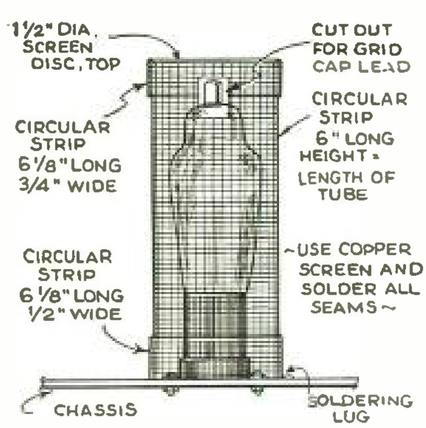
When I need a very small fixed condenser I use the following kink. I substitute one of the wires in the circuit, to which the capacity connection must be made, by a shielded wire from which the shield has been removed for a short space. To this shield a wire is soldered and the condenser is ready.—*Oleg Melnikoff.*

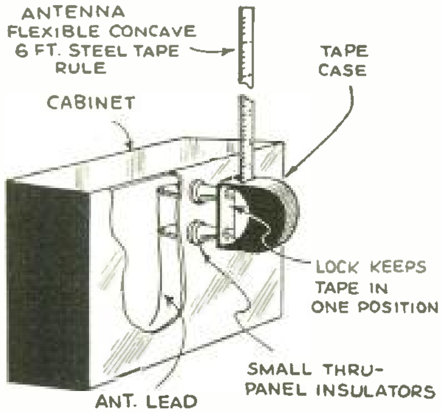


TUBE SHIELD

This tube shield is made of copper screen, used for window screening. First cut a piece the height of the tube and about 6" long. Cut a notch about 1/4" x 1 1/2" in the center of the 6" edge to pass the grid cap lead. Bend this piece into a 1 1/2" circle and solder. It is advisable to use acid core solder. Next cut a piece 6" x 1/2" and bend it into a slightly larger circle and solder it to serve as the base. Two soldering lugs are soldered at the bottom in positions where the socket bolts can go through them, to hold down the base and *ground* it. Then cut another piece 6" x 3/4" for the top circle and form a circle slightly over 1 1/2" and solder. A 3/4" x 1/2" notch is cut in this piece also. Last of all a piece about 1 1/2" in diameter is cut for the top and soldered to the top circle.—*Bruce H. Stribling.*

(Copper or other metallic screen makes a very good shielding material, whenever sheet metal is too expensive or is not available for shielding purposes. Due to the overlapping fields set up between the wires forming the screen, the effect is the same as if solid sheet metal was used. A ground connection can be easily soldered to such wire screen, and for many purposes a "screen" shield like this will fill the bill very nicely.)



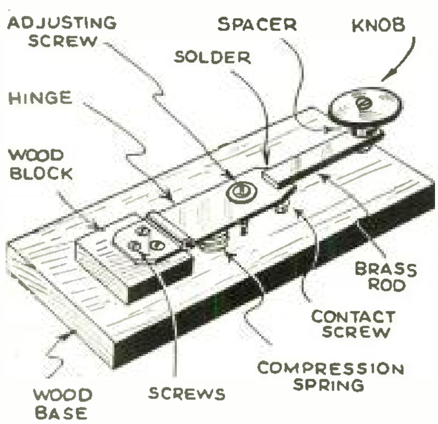


"STEEL RULE" ANTENNA

A steel rule of the collapsible concave type makes an excellent antenna for portable radio sets. It is especially convenient for transmitters, since the radiating portion can be adjusted quickly to the exact desired length. Depending on the construction of the cabinet of the portable outfit, the case of the rule can be mounted inside or outside. Two "midget" size feed-through insulators make an excellent support.—*Kurt Rutter.*

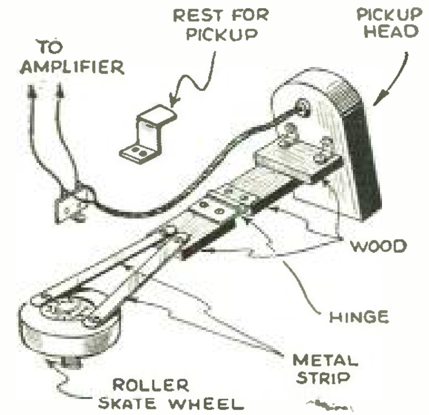
HOME-MADE TELEGRAPH KEY

Here is a home-made telegraph key that really works. All materials needed, including the lock hasp, are indicated in the diagrams. Mount the hinge section of the hasp on a wood block on a wood base. Set the compression spring in a hole bored in the base and put in the contact screw. The adjusting screw (with a washer to keep it from slipping through the hole in the hasp) is next put in place. With the knob attached to the brass rod, it is soldered onto the end of the hasp. The contact space and spring tension is adjusted by using the adjusting screw and the contact screw. The key is then ready for operation. In place of the lock hasp any small hinge could easily be substituted.—*Robert Vadney.*



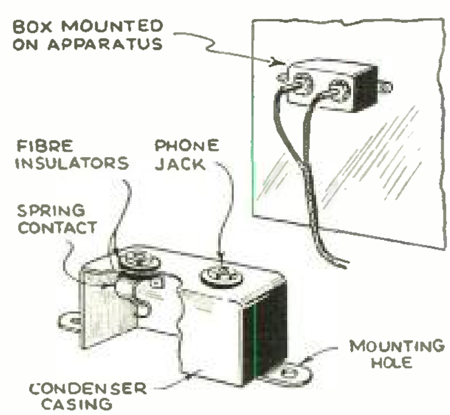
MAKESHIFT PICK-UP ARM

Here's an emergency arm for the phono pickup. Although it is not streamlined it works just as well. The bearing for the arm is an old roller skate wheel, onto which are soldered two nuts to hold the arm. The two metal strips which fasten to these nuts in turn hold a small wooden strip which is cut in half and held together by an easy action hinge. The other end of the wood can then be fastened to the pickup head with small angles. The wire from the pickup is allowed to ride free in the air and is anchored to a binding strip to one side. Two small angles are also used to provide a rest for the pickup. The roller skate wheel and the hinge provide easy action in all directions, and there is not any excessive weight on the record.—*Butler Roberts.*



TERMINAL POST

The construction as you see is very simple. The only thing you need, which can be obtained easily enough from an old radio set, is the can-type by-pass condenser. It can be used for many things. The materials you need are two phone jacks and four washers; the holes are already drilled. It makes a nice appearance on sets that are exposed. It is also useful for the workbench, where meters have to be quickly connected and disconnected.—*James Barrett.*



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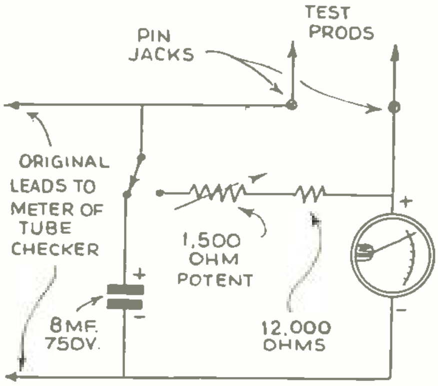
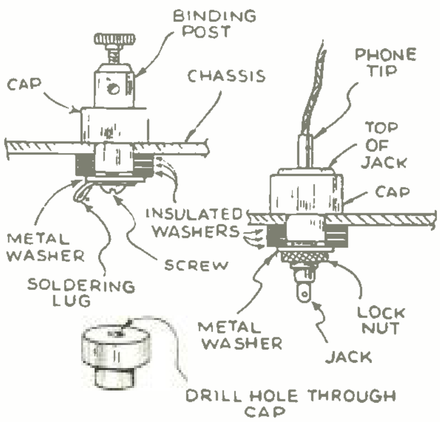


READING HI OHMS ON TUBE CHECKER

The high voltage obtained from the 80 tube and electrolytic condenser removes the necessity for usual copper oxide rectifier or B battery. Even though the meter has a low sensitivity (of say 125 ohms per volt) and reads 0-5 or 8 ma. instead of the usual 0-1, it is possible to use it as an ohmmeter without impairing its original function. Simply disconnect one lead and follow the diagram. Potentiometer, SPDT switch and two pin-jacks are mounted on the panel. The fixed resistance is determined by the internal resistance of the meter used. The 0-8 meter I use requires 12,000 in series with a 1500 ohm potentiometer, in order to adjust the indicator for zero reading at full scale, when test prods are connected. If not sure of the resistance necessary, try high ones first and then substitute lower ones until the full scale reading is obtained. Then using several known values across the prods, a scale can be calibrated easily. The limit of good measurability with my set-up—using 0-8 meter, plus an 8 mf. electrolytic condenser, is about 2 megohms. —*Don Chamberlin.*

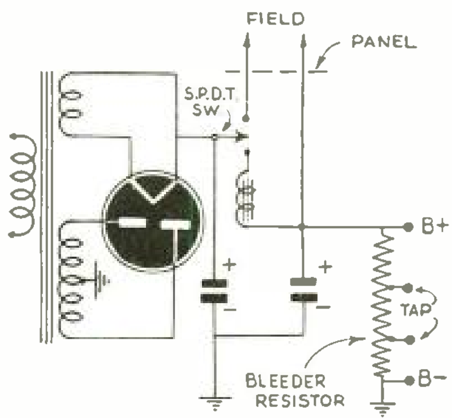
TOOTH-PASTE TUBE CAPS AS INSULATORS

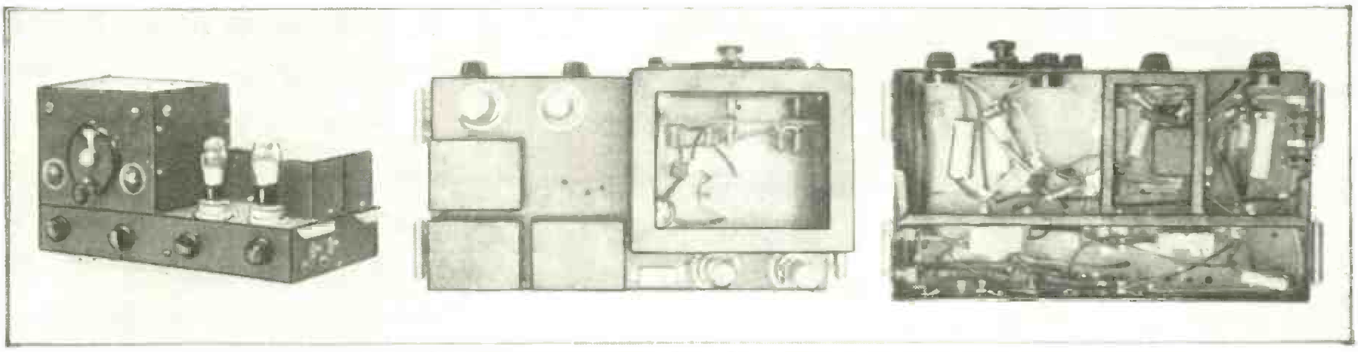
Here is a use for the composition cap of tooth-paste and shaving cream tubes. By drilling a small hole through it, each cap makes an excellent extruded insulated washer for mounting binding posts on metal chassis. By using the larger sizes and drilling a larger hole, they can also be used to insulate phone tip jacks from metal chassis. In either case, flat insulated washers of suitable thickness and diameter are slipped over the end of the cap, to take up the slack when cap extension does not come flush with the inside of the panel. These caps are usually of different colors, which makes for quick and easy identification in various applications. A great variety of sizes is also available.—*G. A. Soderlund.*



FILTER WRINKLE

Here is a filter kink I used on a recently constructed power supply. I wanted to hitch up a dynamic speaker on a small set with low plate drain. At the same time I didn't want to use the field winding as a filter choke permanently in the supply. I solved the problem with a S.P.D.T. switch, two binding posts, and a little re-wiring.—*William Whitehead.*





Several views of the 4-tube regenerative receiver here described are shown in the accompanying photos.

4-Tube Regen. De Luxe Receiver

W. Ward

For those who hate to tackle the building of a superhet receiver, this super-refined "regenerative" receiver, which has given such remarkable results for Mr. Ward, will find a ready welcome. Remarkable "foreign" station reception has been accomplished with this set using only a short aerial, in a congested city section.

● THIS four-tube regenerative receiver has given such excellent satisfaction that the writer feels sure other readers, especially beginners in radio set construction, will want to know the details. By means of *plug-in* coils all the short-wave bands are covered and the *broadcast band* stations as well. Extra smooth regeneration control is provided by means of a dual potentiometer scheme which the writer has worked out. Even with a short antenna, in a crowded city apartment, surprising results have been obtained with this set.

Main Points of Interest: Each point has its own advantage, but taken collectively they really do things to, or rather for, the old reliable regenerative circuit.

Vernier Antenna Trimmer—2 condensers used.

Vernier Tuning Condenser—2 condensers used.

Vernier Regeneration—2 potentiometers instead of one.

Twin Filter System—using 2 chokes.

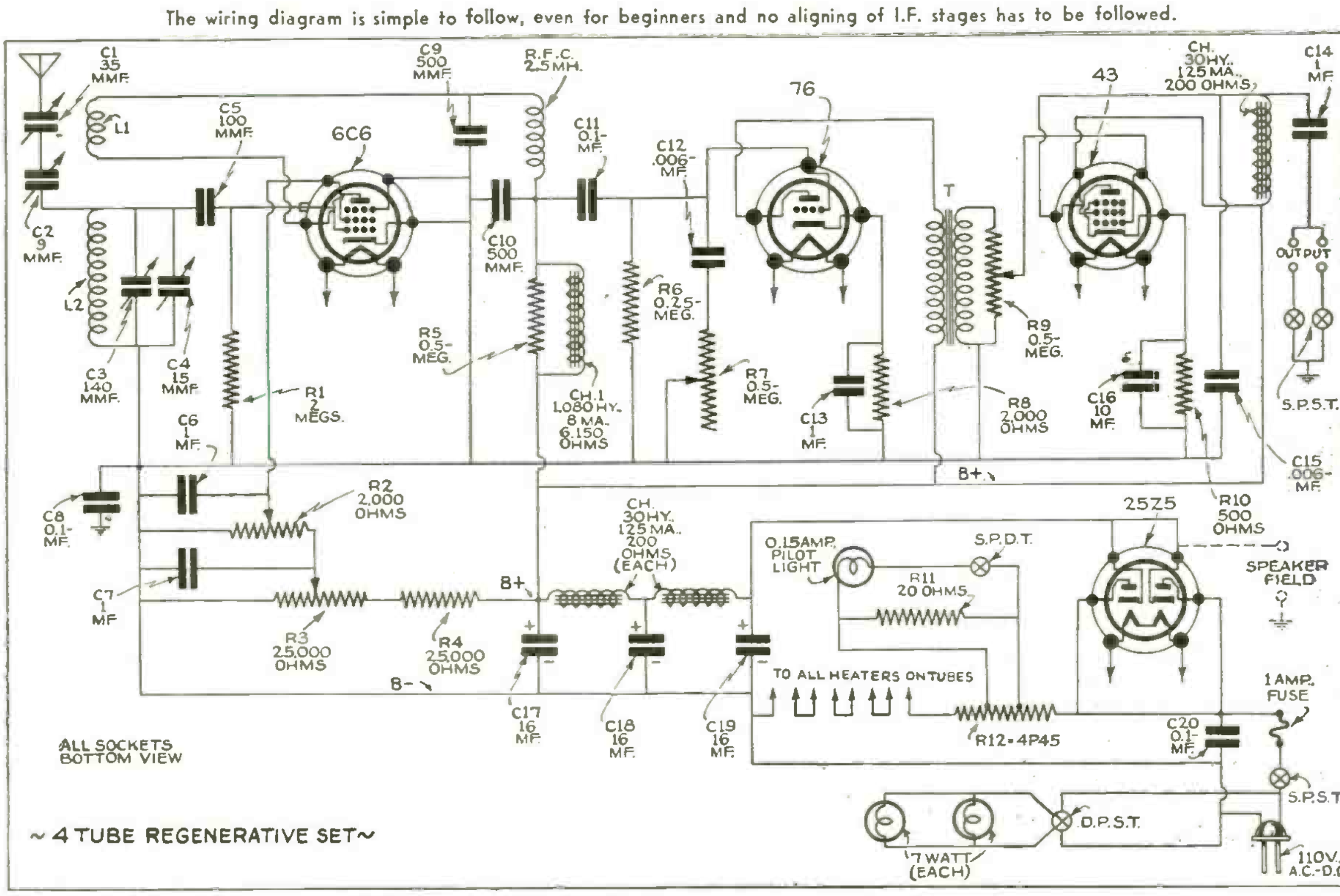
Dual Light Switch for *on* and *off*.

Dual 110 V. Pilots—Illuminate interior, check on power.

1 Amp. Fuse.

Dual electrical outlets on rear of chassis.

The wiring diagram is simple to follow, even for beginners and no aligning of I.F. stages has to be followed.



1 Power Cord plug-in (to table or desk lamp, or transmitter).
Dual jacks in output—separate switch for each.
1 Speaker—magnetic or PM. dynamic.
2 Phones or extra speaker.
Tone Control and noise eliminator for C.W. (code) reception.
Audio volume control permits operation of regeneration control at its peak, or *most sensitive* position.
Tubes exposed on chassis for better cooling, plus visual indication of set being turned on.
Partition shielding of each stage is one of the main reasons for this receiver's high stability and selectivity.
Ground connections are made to a separate network mounted on small standoff insulators, thereby removing the hazard of a *grounded* chassis. The only connection between chassis and ground is through a 0.1 mf. condenser.

Details of Set

The antenna control condensers are of two different types:

C1—is a National 35 mmf. dual spaced experimenters' type variable, which connects to the antenna and a Bud 1-9 mmf. 6L6 neutralizing semi-variable condenser between the National Condenser and the Hammarlund coil. The National is set at 50 on the dial and the Bud is then set to give smooth regeneration on the band in use. The Bud must be set with a fibre screwdriver or 10" dowel-stick. The 2000 ohms regenerative control No. 1 is set at center position; the 25,000 ohm control No. 2 is then advanced until regeneration occurs, and left in this position. Regeneration is now controlled by the No. 1 2000 ohm control. The 15 mmf. condenser is set around 10 on the National "B" dial, then the 140 mmf. is set at the bottom of the band and left there, all tuning being done with the 15 mmf. condenser. If two stations interfere, tune the one you want to its loudest point and adjust the antenna condenser slightly and the "offender" will disappear. There is a minimum amount of static disturbance on this receiver, but when used on C.W. (code) even this may be removed by setting the tone control properly. The advantage of the audio volume control is immediately apparent to the veteran, but even the novice will soon recognize its value. With this control almost *off*, the European stations roll in at *room volume;* with it on, they chase you out of the house! Amateur *phone* at Puerto Rico and California are clearly heard and held during three to four contacts. One West Coast Ham was held for one hour and fifteen minutes.

I can hear you say that a Broadcast Station antenna system must have been used to get these results. I will try to explain my location as best I can.

A brownstone house in the heart of New York City; receiver located in rear basement, right near the window—a thirty-five foot antenna with double insulators spaced one foot apart, running from fence to house—the outside insulators spaced about four feet from both ends. The lead-in is only eight feet long, which I believe is the main reason for my success. Once again, keep your lead-in as *short* as possible!

I used the same length antenna elevated up in the air ten floors, with its corresponding *long* lead-in, and the noise was *terrific*, with no gain in signal strength! I might add that this house is surrounded by all steel buildings and for a period of one year this set has performed the same way, even during the hottest summer days! The author has incorporated in this receiver all the refinements and advantages which he believes to be essential for good results. After all, that is the one thing that counts in any receiver—*RESULTS!*

The fourth can in the parts list, not shown in the picture, sets in the space behind the first audio tube No. 76, and covers the Thordarson choke No. 1. The Bud 1-9 mmf. antenna condenser fits into the space to the left of the 6C6 detector tube.

It is of prime importance that the builder try to use the same parts as here described, in order to obtain the same results—use parts with the exact values specified.

Parts List

HAMMARLUND
L1 and L2 One SWK4-17-270 meter kit and one SWK4-250-560 meter kit (B.C. coil)
1—4-prong isolantite socket
1—2.5 mh. R.F. choke

BUD
C2—One 1-9 mmf. 6L6 neutralizing condenser

NATIONAL
C1—35 mmf. dual-spaced midget condenser
C3—140 mmf. single-spaced midget condenser
C4—15 mmf. dual-spaced midget condenser
Type "B" Vernier dial and illuminator

CENTRALAB
R2—2000 ohm regeneration control
R3—25,000 ohm regeneration control
R7-R9—½ meg. tone and volume control

SPRAGUE (Condensers)
C5—100 mmf. mica, 600 v.
C6, C7—1.0 mf., 400 v. condenser; paper
C13, C14—1.0 mf., 400 v. condenser; paper
C8, C11, C20—0.1 mf., 600 v. condenser; paper
C12, C15—.006 mf., 600 v. condenser; paper
C17, C18, C19—16. mf., 250 v. condenser; electrolytic
C16—10 mf., 50 v. condenser; paper
C9, C10—500 mmf. mica, 600 v.

I.R.C. (Resistors)
R1—2 megohm, ½ w. resistor
R4—25,000 ohm, 1 w. resistor
R5—½ megohm, ½ w. resistor
R6—¼ megohm, ½ w. resistor
R8—2000 ohm, 1 w. resistor
R10—500 ohm, 2 w. resistor
R11—20 ohm, 1 w. resistor

AMPERITE
R12—4P 45 ballast tube

THORDARSON (Trf. and Chokes)
T—3 to 1 audio transformer
CH—3 chokes, 30 henry, 125 ma., 200 ohms
CH—1 choke, 1080 henry, 8 ma., 6150 ohms

LITTELFUSE
1—Metal covered fuse mount
1—Fuse, 1 amp., 250 v.

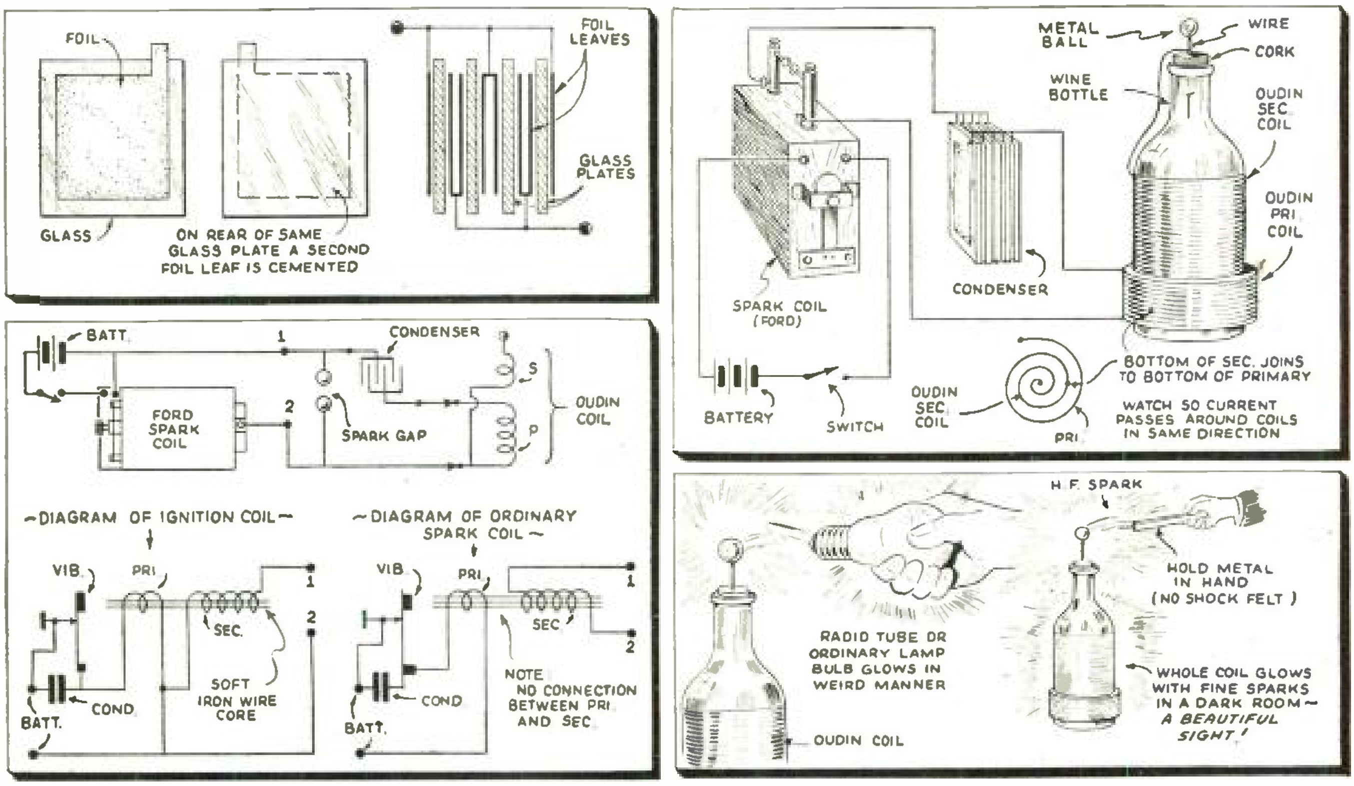
AMPHENOL
2—6-prong sockets, above chassis type, 1 standard type
1—5-prong socket, above chassis type
1—4-prong socket, above chassis type

E. F. JOHNSON
14—Standoff insulators, 5/8" high, 6/32 hardware

MISCELLANEOUS
2—Etched metal dial plates, 0-100, 1¾" diameter
2—Bar knobs for above
4—Round bakelite knobs with arrow
2—Jewelled pilot brackets with candelabra bases for 7 w., 110 v. bulbs, 1 red, 1 green, ½" diameter
2—Jewels: 1 red, 1 green, ½" diameter for sides
2—7 w., 110 v. pilot lamps
1—D.P.S.T. switch
3—S.P.S.T. switches
1—No. 40 brown bead, 0.150 ma. dial light
1—Chassis base, 18" x 10" x 3"
1—Detector can, 9" x 7½" x 7" H
4—Choke cans, 4" x 3" x 3½" H
4—Handles
2—¼" x 1" brass spacers
3—1¼" x ¼" shaft couplings
1—12" fibre shaft
1—Piece of bakelite ¼" x 9" x 6" for mounting tuning, band-spread and antenna condensers
2—Panel bearings
5—On-off switch plates
Machine screws, nuts, washers, rubber grommets, spaghetti, fibre washers

How to Build

A Small OUDIN Coil



The small "bottle-type" Oudin coil here illustrated can be built at insignificant cost, and it will provide many weird and interesting effects. The Oudin coil consists of a single layer of fine copper wire wound on an old wine bottle, together with a primary of a few turns of heavy wire wound around the base of the coil. The exciter is simply an ordinary spark coil of the ignition type; the condenser is made from a few glass plates, such as old photo negatives, coated with tin-foil.

● THE electrical experimenter can have a lot of fun with a small Oudin coil wound on an old wine bottle, as shown in the accompanying picture. This small, yet powerful, high frequency coil can be excited from a spark coil of the ½ inch variety, more frequently known to the experimenter as an *ignition* coil. Some people know them more affectionately by the term of Ford spark coil.

The cost of making this apparatus is practically nil, provided you can pick up a second-hand Ford coil from your local garage; or possibly you already have a similar spark coil on hand.

The other parts necessary are a fixed spark gap, comprising a couple of small balls, a glass plate condenser constructed as hereafter described, and the Oudin coil itself, which only requires a small amount of wire wound evenly on a glass bottle (or even a cardboard tube about the size of a one-quart wine bottle).

The glass plate condenser may comprise half a dozen old photo negatives, or else pieces of thin window glass, measuring about 5 x 7 inches each. Each side of the window glass is coated with a piece of tin or other metal foil, cementing the foil to the glass by means of thin shellac or banana oil. The foil leaves are cut ½ inch smaller all around than the size of the glass plate, to avoid sparking over the edges from one plate to the other. Every other metal foil plate is connected to a common terminal, as indicated in the diagram.

The Oudin coil has a primary and secondary winding as the diagram shows. The secondary winding comprises a single layer of about No. 28 insulated or bare copper wire, the turns being spaced a slight distance apart. This can be done easily in a lathe, or if wound by hand—this spacing can be done by winding on a small string or thread along with the wire, the thread being removed afterward (or left in place for that matter).

At the lower end of the Oudin coil a primary winding is arranged, and this may consist of from 6 to 8 turns of No. 12 or 14 rubber covered wire, wound in a single layer about one inch greater in diameter than the diameter of the bottle. One easy way to wind this primary coil is to wind a strip of cardboard (such as used for packing purposes) around the bottom of the Oudin secondary, so that the cardboard is about ½ inch thick. The primary winding may then be wound over this cardboard. In the event that bare wire of No. 12 or 14 gauge is to be used, the turns should be spaced about ¼ inch. The advantage of the bare wire is that spring clips may be used to make connections to the condenser, and these permit varying the number of turns in use.

The upper end of the Oudin secondary coil is connected to a brass or copper rod, supporting a small metal ball at the top. In order to obtain the maximum discharge of high frequency sparks from the metal ball on top of the Oudin coil, the following adjustments should be made. The vibrator of the spark coil may be adjusted for best results; next the number of glass plates and tin-foil leaves in circuit in the high voltage condenser may be varied; and thirdly, the number of Oudin primary turns in use may be varied by means of the clips as aforementioned.

For those who have the time to do a little experimenting different types of windings may be tried on the Oudin coil; also different types and diameters of primary coils may be tried. As long as no spark takes place between the primary and secondary windings on the Oudin, the smaller the diameter of the primary, the more intense the sparks produced at the free end of the Oudin secondary. Next, the greater the number of turns of fine wire used in the Oudin secondary, the higher the voltage and the longer the sparks produced; but there is a happy medium here, as with too fine a wire, the sparks are too thin and stringy to be spectacular. No. 28 or 30 has been found very effective for this size high frequency coil. Like all other electrical apparatus, the more electrical energy we pump into the Oudin coil, the more spectacular the high frequency spark discharges produced. This size coil may have a considerably greater amount of energy supplied to it than that available from a small half-inch ignition coil, and if you happen to have a larger size spark coil of the vibrator type, you can try it on the Oudin.

When excited by a ½ to ¾ inch ignition

coil, such as the Ford type, high frequency sparks 2 to 3 inches or more in length will be liberated from the ball terminal atop the Oudin.

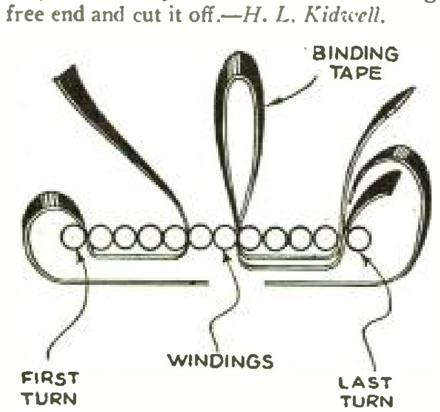
A number of interesting experiments for home lectures, radio clubs, etc., can be performed with a small Oudin, such as the one here described. Evacuated tubes, including old radio tubes and incandescent lamps, may be lighted by holding them in the hand and approaching the metal base toward the ball terminal of the Oudin. A spark will jump between the ball and the base of the lamp, and it will be illuminated with a weird bluish glow. Lamps may be lighted in this way without any shock, if one keeps his fingers away from the metal lamp base.

To draw sparks into the body from the ball terminal on the Oudin, hold a piece of metal such as a screw-driver or pair of pliers in the hand. The high frequency sparks will jump to the piece of metal and no unpleasant shock will be felt. A slightly disagreeable shock is felt if the bare finger is approached toward the Oudin high voltage terminal. Many other experiments will suggest themselves to those who build the Oudin coil, such as "electric duels," the production of an illuminated cone between two rings of wire, one much smaller than the other and one ring grounded, etc.

While Oudin coils have been excited from vacuum tube oscillators, such as used for radio transmitters, the size and power of the transmitting tube required to produce equivalent results is prohibitive to the average experimenter with a limited pocketbook, compared to the method here described. Of course with larger Oudin or Tesla coils, giving sparks from one to five feet in length, the exciting circuit utilizes a high voltage transformer, a rotary spark gap being used in the condenser circuit feeding the Oudin primary, and of course no vibrator is used with the transformer.

LOCKING IN "END-TURNS"

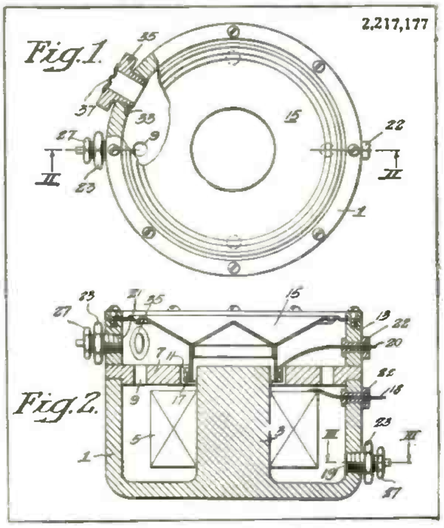
For the first turn, lay a piece of tape under and come to the second turn: bring the free end over the first turn, under the second turn and wind on two or three more turns, then pull the free end tight and cut it off. For the last turn, six or seven turns from the last, lay on a piece of tape and wind on one or two turns: then lay on loop, allowing a couple of inches in the loop, then wind on three or four turns and lay the free ends back over the winding and wind on the last turn. Hold it, slip the free end of the single strip between the free ends of the loop, and pull the loop through and out, then take up the slack in the remaining free end and cut it off.—*H. L. Kidwell.*



Digest of Recent Radio Patents

GAS-FILLED LOUDSPEAKER

● FRANK MASSA, assignor to RCA, recently received this patent No. 2,217,177 on a gas-filled loudspeaker. As the drawing shows the container for the speaker mechanism is constructed in a gas-tight manner so that gas may be pumped into the chamber and improve the operating efficiency of the receiver. By filling the housing, for

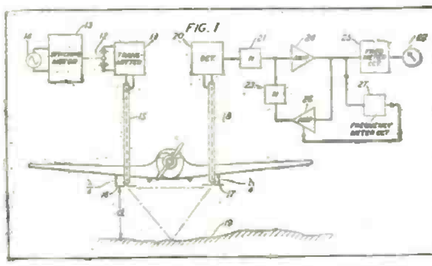


example, with a gas having high thermal conductivity, the head generated in the loudspeaker coils will be conducted more easily to the radiating surface of the housing, thus making it possible to increase the power rating of the loudspeaker. Also the temperature rise of the voice coil of the loudspeaker will be greatly reduced, if a highly thermal conductive gas is used as the conducting medium in the magnetic gap in which the voice coil operates.

ALTITUDE INDICATOR

● RICHARD F. LANE and Russell C. Newhouse of Orange, N. J., assignors to the Bell Telephone Laboratories of New York, have recently received U. S. patent No. 2,206,903 on a Radiant Energy Distance Measuring System. One of the applications of this distance measuring device, is that of determining the height of an airplane above the ground. The distance is measured by radiating waves from one point to another, and receiving these waves reflected back at the first point.

The time interval between radiation and reception is a measure of the distance, and is determined by cyclically varying the frequency of the transmitted waves, at a known rate and over a known range. The frequency difference between the wave being transmitted and the received reflected wave, is therefore, a measure of the distance to the reflecting surface. The measurements are



obtained by beating together the transmitted wave and the echo wave, and measuring the frequency of the resultant difference frequency beat wave.

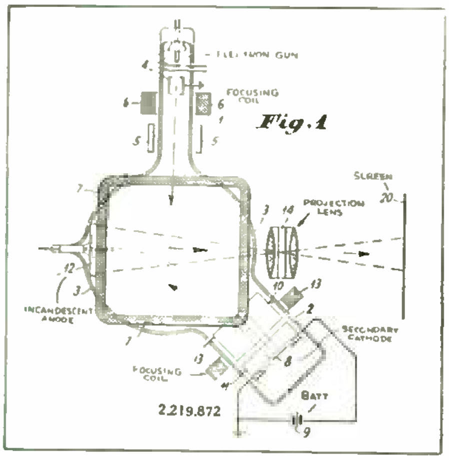
RECEIVER VOLUME CONTROL

● ROBERT B. FOSTER of Los Angeles, Calif., was awarded patent No. 2,219,302 for an improved volume control for use on radio receivers. The claims in this patent can best be visualized by a study of the eleventh claim in this patent which reads as follows:

In a radio control apparatus, the combination with a cabinet, a radio receiver therein, the receiver having a variable tuning means adjustable to different broadcast station positions, means for shifting the same, and a loud-speaker. Further, means are provided of varying the volume of the loud-speaker, an adjustable cam for each broadcast station of the variable tuning means, means for operatively connecting the volume varying means with all of the cams of the variable tuning means, but with one particular cam at a time, the latter cam corresponding to and depending upon the specifically shifted station-tuning position of the tuning device, and separate means at the outside of the cabinet for each of the cams for separately adjusting each of the cams, said adjusting means being spaced and located in positions corresponding to the station positions of the tuning means.

TELEVISION IMAGE PROJECTOR

● LEONARD MORRIS MYERS of Middlesbrough, England, assignor to RCA, recently received this patent No. 2,219,872 on a very interesting and unusual method of producing television images in the form of modulated heat patterns, suitable for projection on a large screen. This invention reproduces television pictures or images, *not* by fluorescent effect in a fluorescent



screen, but by heating a picture reproducing electrode to incandescence and thus obtaining pictures by light, due to heat. The diagram shows how a secondary cathode is heated by a battery or other source of current. The images projected on to it by the usual cathode-ray gun are, in turn, reflected on to an incandescent anode. From this point the images are radiated through the projection lens on to a screen.

DIRECTIONAL ANTENNA

● PHILIP S. CARTER of Port Jefferson, N. Y., recently received a re-issued patent No. 21,609, covering a clever system of directional antenna which does not use a reflector.

The present invention obviates the necessity for reflectors and provides an antenna which is nearly aperiodic over a wide range of frequencies. Use is made of the phenomena of attenuation along radiating wires in order to obtain unidirectionalism without the use of reflectors.

Generally speaking, the invention comprises a pair of approximately equal length antenna radiating sections which are relatively long with respect to the length of the communication wave and angularly disposed with respect to each other, each section, in turn, being composed of a plurality of radiating elements connected together by means of phasing members. In practicing the invention, it is essential that the radiating elements comprising each section be substantially coaxial with respect to one another so that they extend in the same direction and that the phasing elements connecting the radiating elements together shift the phase of the energy an amount just enough to make the ears of the radiation patterns of the different elements in each section add. It will thus be appreciated that the phasing elements which serve to provide maximum radiation from the system and thus maximum attenuation due to radiation should not reverse the phase of the currents between adjacent radiating elements.

An U.H.F. Receiver

For "FM" and "AM"

S. Gordon Taylor

● THE public is showing definite signs of active interest in the new FM broadcasting. Already *broadcast* listeners are buying receivers capable of tuning in *both* the regular and FM programs. But what is the radio enthusiast whose interest extends beyond *broadcast* programs going to do about it. Is he going to be satisfied to have equipment which tunes only a single limited range of the ultra-high frequency spectrum—the range of 40 to 50 megacycles where FM is to hold forth, for instance? Or will he want to "go the whole hog" and equip himself to tune over the entire presently useful portion of the U.H.F. range of any from 30 to 100 mc. or higher? And isn't he going to want to listen in on services other than FM in this range?

Many hams and experimenters of the type that pioneered the now ordinary shortwaves have been pondering these questions—and many have come to the conclusion that they want to "shoot the works" by building or otherwise procuring equipment which will tune in not only the FM broadcasters, but the other FM and AM regular and experimental stations, the 5-meter and 2⅛-meter "ham" bands, the television *audio* broadcasts, etc. There is however, considerable doubt as to just what provisions all this calls for in a receiver. It is hoped that the following brief description of a receiver made available to the public in recent months for these very purposes will help to clear up these doubts, or at least prove suggestive, both to those who plan to design and build their own equipment and those who plan to buy.

The Hallicrafters Model S-27 is a strictly *ultra-high* frequency receiver designed to provide complete reception facilities for the various types of services now operating (or planned) in these frequency ranges, with the exception of the video portions of television and the actual transcription of facsimile broadcasts.

It covers the continuous range of 27 to 145 megacycles in three bands of 27-45, 45-82 and 81-145 mc. and switches from one band to another in the same manner on the conventional shortwave receiver—and this, incidentally, is something which many have believed impossible without serious losses. But with demonstrated sensitivity of better than one microvolt throughout the 27-46 mc. band, two microvolts for the 45-82 mc. band, and 4 microvolts in the least sensitive spot of the 81-145 mc. range, this receiver definitely disproves the supposition that band-switching prevents attainment of high sensitivity.

The S-27 is a "communications" type receiver, with a relatively large number of controls to provide the needed flexibility for all-service operation. Its primary difference from the communications receivers so popular for tuning the lower frequencies lies in its provision for FM reception, including a much wider range of adjustable selectivity, and an audio system capable of super fidelity.

Its flexibility in operation is indicated by the following summary of the controls provided on the front panel. These include: Tuning "wheel" with illuminated main and *bandspread* dials, A.V.C. off-on switch, manual R.F. and audio gain controls, antenna trimmer condenser to insure accurate R.F. tracking despite loading variations of different antennas, broad-sharp I.F. expansion switch, automatic noise-limiter off-on switch, AM-FM changeover switch, beat-frequency oscillator off-on, B.F.O. pitch control, send-receiver switch, 4-position audio-filter tone control switch, band switch, headphone jack, and meter balance adjustment. The main dial is fully calibrated in megacycles and the *band-spread* dial carries the conventional 0-100 calibration. The meter, which is an "S" meter for AM operation, is automatically switched to serve as a carrier-center indicator for accurate FM tuning.

Diagram of the new Hallicrafters Model S-27 "FM" & "AM" Receiver.

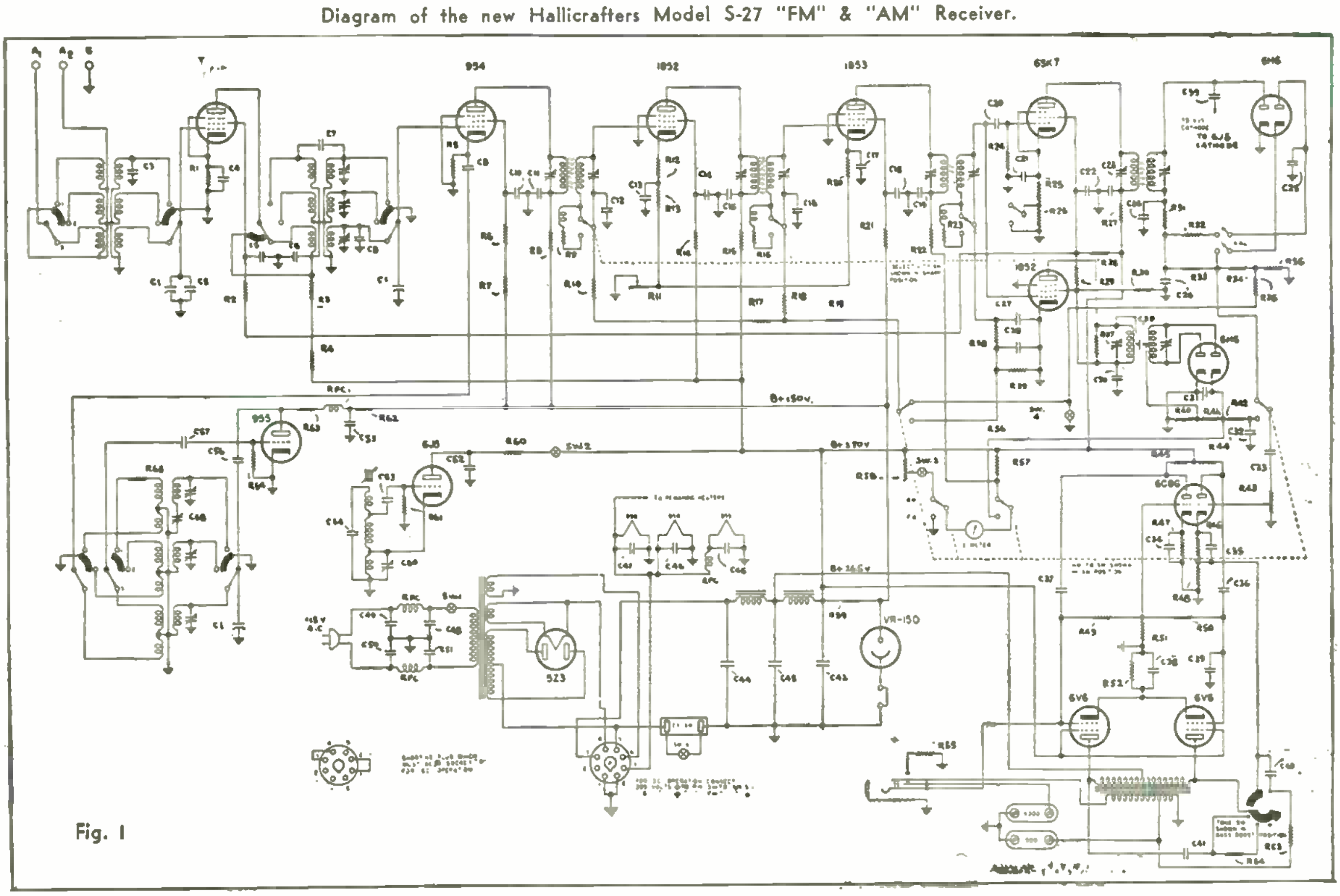
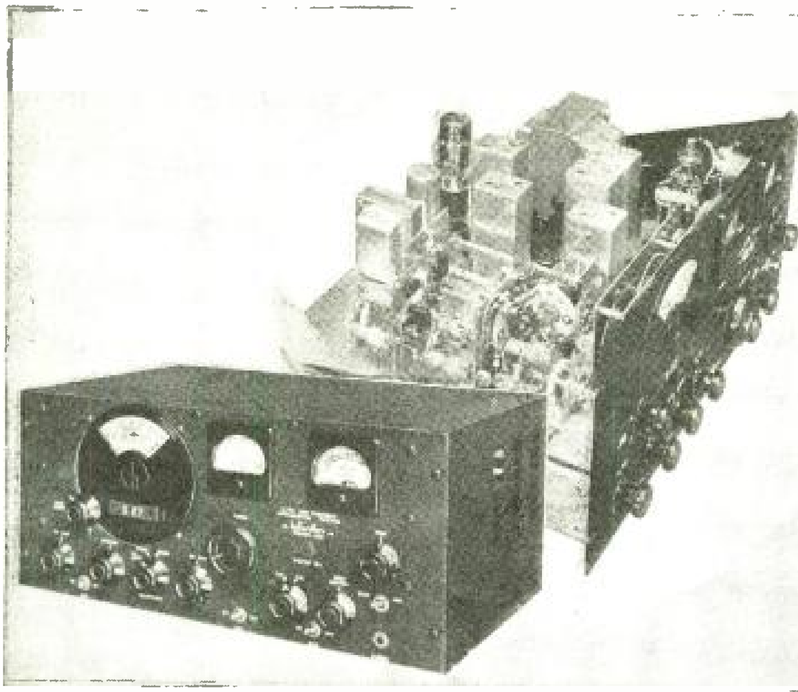


Fig. 1



Front View—Combining the wide flexibility of a Communications receiver, with the tone quality of a fine broadcast receiver, this new model provides reception of both "FM" and "AM" stations, throughout the range of 27 to 145 megacycles.

Chassis View—Here the receiver is shown with one panel bracket and R.F. shield removed to disclose the assembly of the R.F. section. Acorn tubes are utilized in the R.F., oscillator and mixer stages for maximum sensitivity.

The complete circuit diagram with capacitor and resistor values appears in Figure 1. Of the total of 15 tubes, 11 are used for both FM and AM reception. These include the R.F. stage, mixer, oscillator, 2 I.F. stages, audio amplifier and phase-inverter stage, push-pull output stage, B.F.O., voltage-regulator tube, and rectifier. When the AM-FM switch is set for AM reception an additional, sharply tuned I.F. stage is inserted in the circuit, plus a diode which serves both as detector and automatic noise-limiter. In the FM position a *limiter* tube and the *discriminator-detector* are substituted for these two. The movement of this switch also automatically makes all other necessary circuit changes, including switching of the meter and of the A.V.C. systems.

At the ultra-high frequencies the R.F. circuits become especially critical as to the tubes employed, circuit design and parts layout. The S-27 is one of the first standard receivers to employ *acorn* tubes. Not only are these capable of higher gain, but their low internal capacity is much more favorable for such circuits, where absolute minimum capacities are essential to efficient operation and wide-range coverage. Tubes of this type are employed for the R.F. stage, oscillator, and mixer. They are mounted projecting through the interstage shield partitions in such position that their grid and plate leads (which are at opposite ends of the tubes are right at the circuits with which they are associated. Other leads are kept to minimum length also. This is accomplished by the carefully planned R.F. layout (shown with its shield cover removed in one of the accompanying photos) in which the coils are mounted directly on the gang-switch terminals, the tuning gang is immediately adjacent to the switch assembly, etc.

The entire R.F. assembly is not only separately shielded but is on a separate sub-chassis, point-supported on the main chassis to eliminate microphonic vibration trouble.

To insure normal life for these acorn tubes, their plates have only 150 volts applied. This supply voltage for both oscillator and mixer is held constant by a VR-150 voltage regulator tube. This offsets line-voltage variations, stabilizes oscillator tuning and permits more uniform mixer operation.

One valuable point worth mentioning in particular is the oscillator coupling system in which a small pick-up coil, closely coupled to the oscillator grid coil, transfers the output to the mixer cathode circuit through a 300-mmf. condenser. This arrangement was adopted after all the conventional coupling and injection schemes failed to produce satisfactory results.

It may be well to point out that the intermediate frequency employed is 5.25 mc. This frequency avoids the peaked, side-band cutting characteristic that would obtain with the conventional low I.F. which, when expanded to maximum would not provide satisfactory band-width for FM reception. Also, this high I.F. results in far better image selectivity.

Parts List

RESISTORS

No.	OHMS	WATTS
1	250	1/3
2	1,000	1/3
3	1,000	1/3
4	10,000	1½
5	2,000	1/3
6	1,000	1/3
7	100,000	1/3
8	1 000	1/3
9	8	1/3
10	00 000	1/3
11	0 000	R. F. Gain Control
12	35	1/3
13	120	1/3
14	40 000	1/3
15	300	1/3
16	8	1/3
17	100,000	1/3
18	100 000	1/3
19	00,000	1/3
20	200	1/3
21	1 000	1/3
22	300	1/3
23	8	1/3
24	500 000	1/3
25	300	1/3
26	5,000	1/3
27	1 000	1/3
28	7,500	10 Wire Wound
29	2 000	1/3
30	20,000	1½
31	50 000	1/3
32	1,000 000	1/3
33	100,000	1/3
34	250,000	1/3
35	500,000	1/3
36	250 000	1/3
37	15 000	1/3
38	50 000	1/3
39	250,000	1/3
40	100 000	1/3
41	100,000	1/3
42	200 000	1/3
43	500 000	Audio Gain Control
44	250 000	1/3
45	250,000	1/3
46	5 000	1/3
47	5,000	1/3
48	120	1/3
49	250,000	1/3
50	250,000	1/3
51	100 000	1/3
52	250	1½
53	0,000	1/3
54	4 000	1½
55	5,000	1½
56	600,000	1/3
57	35	1/3 Wire Wound
58	1,500	S. meter Zero Adjust
59	3 200	0 Wire Wound
60	25 000	1½
61	50,000	1/3
62	300	1/3
63	5 000	1/3
64	20,000	1/3
65	35	1/3

CONDENSERS

NO.	CAPACITY	VOLTS	TYPE
1	60 mmf	Per Section	
2	15 mmf	Ant. Trimmer	Air
3	5 mmf		3 Ceramicons
4	.002 mfd		Mica
5	300 mmf		Mica
6	002 mfd		Mica
7	10. mmf		Ceramicon
8	10. mmf		Ceramicon
9	300 mmf		Mica
10	300 mmf		Mica
11	.01 mfd	600	Paper
12	.001 mfd		Mica
13	02 mfd	400	Paper
14	.02 mfd	400	Paper
15	.01 mfd	600	Paper
16	.001 mfd		Mica
17	02 mfd	400	Paper
18	.02 mfd	400	Paper
19	.01 mfd	600	Paper
20	50 mmf		Mica
21	.02 mfd	400	Paper
22	.02 mfd	400	Paper
23	.01 mfd	600	Paper
24	50 mmf		Mica
25	.05 mfd	400	Paper
26	50 mmf		Mica
27	100 mmf		Mica
28	500 mmf		Mica
29	25 mmf		Mica
30	.002 mfd		Mica
31	50 mmf		Mica
32	500 mmf		Mica
33	.05 mfd	00	Paper
34	30 mfd	25	Electrolytic
35	30 mfd	25	Electrolytic
36	.05 mfd	400	Paper
37	05 mfd	400	Paper
38	20 mfd		Electrolytic
39	.002 mfd		Mica
40	.05 mfd	400	Paper
41	05 mfd	400	Paper
42	0. mfd	350	Electrolytic
43	30 mfd	350	Electrolytic
44	10 mfd	400	Electrolytic
45	300 mmf		Mica
46	300 mmf		Mica
47	300 mmf		Mica
48	.01 mfd	600	Paper
49	.01 mfd	600	Paper
50	.01 mfd	600	Paper
51	.01 mfd	600	Paper
52	002 mfd		Mica
53	100 mmf		Mica
54	200 mmf		Ceramicon
55	300 mmf		Mica
56	50 mmf		Ceramicon
57	.001 mfd		Mica
58	450 mmf		Pad
59	2 mmf		Twisted Pair
60	25 mmf		B. O. Pitch Control Air

Latest Radio Apparatus News

New Interference Locator

● THE Interference Locator is an entirely new device, designed in cooperation with outstanding public utility engineers and radio interference specialists to provide an inexpensive, highly sensitive and rugged portable device for the location and isolation of radio interference elimination. It is equally useful in the hands of the radio serviceman who is interested only in "noise" complaints arising from electrical devices attached to power lines, or to the public utility engineer, whose job

An interference locator of improved type and fitted with a directional loop antenna.

it is to eliminate radio noise sources from the power or distribution line itself. In addition, the Sprague IL-2 Locator is ideally adapted for *locating underground pipes.*

The Locator operates either from self-contained batteries for portable operation, or directly from 115 volt A.C. or D.C. lines. It is equipped with directional loop antenna; an extensible pole antenna is also provided.

Tuning ranges selected by a switch are 500 to 1700 KC; 1.7 to 5 MC; and 15 to 32 MC. Sensitivity is such that an input signal of less than two microvolts will produce a deflection of 10% on the output meter scale. In addition to a loud-speaker unit, the Locator is equipped with a two-range calibrated output meter, thus providing a visual as well as audible measure of interference intensity. Headphones may be attached in locations where high extraneous noise levels exist. A calibrated volume control may be used with the output meter to measure interference suppression devices. Loop antenna can be switched to audio input as a search coil for audio frequency interference pick up or for use as a *buried pipe finder.* A special coaxial cable, complete with connectors is also available at extra cost, for remote use of pole antenna as a probe.

New RCA Tubes

● THE Radiotron Division of RCA Mfg. Co. has announced the following new tubes: 3S4 Power Amplifier Pentode (miniature type); 815 Transmitting Push-Pull Beam Power Amplifier; 826 Transmitting Triode (for ultra-high frequency use); 866-A/866 Half-Wave Mercury-Vapor Rectifier; 1625 Transmitting Beam Power Amplifier (with 12.6-volt heater); 1626 Transmitting Triode (with 12.6-volt heater).

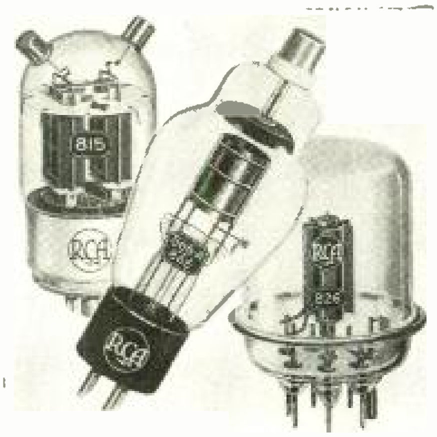
The 3S4 is intended for use in the output stage of light-weight A.C.-D.C. battery-operated portable equipment. This new tube has essentially the same characteristics as the miniature type 1S4, but is designed with a filament having a center-tap to permit of either a series-filament or a parallel-filament operating arrangement. The series arrangement requiring only 50 milliamperes has been provided especially for equipment utilizing a source of rectified power for the filament supply.

The 815 is a new push-pull beam power amplifier designed for radio amateur use at ultra-high frequencies. Its high efficiency and high power sensitivity permit full power input with very low driving power. A single 815 operated in push-pull class C telegraph service is capable of handling a power input of 75 watts with less than 1/4 watt of driving power at frequencies as high as 150 megacycles. The total maximum plate dissipation of the 815 is 25 watts. The 815 is also useful as a modulator and as a multiplier. A single 815 can modulate another 815 as power amplifier. In multiplier service, the 815 can be used as a doubler or tripler and at the same time drive an 815 as power amplifier. Mechanical features of the 815 include its balanced and compact structure of beam units, close electrode spacing, short internal leads to minimize lead inductance and resistance, and a "Micanol" wafer octal base. The heaters of the 815 are arranged for either 12.6- or 6.3-volt operation.

The 826 transmitting triode has been designed especially for use at ultra-high frequencies. It may be used as an oscillator, R.F. power amplifier, and frequency multiplier at maximum ratings at frequencies as high as 250 megacycles and at reduced ratings at frequencies as high as 300 megacycles. Maximum plate dissipation of the 826 is 60 watts in class C telegraph service. The 826 features a double-helical filament center-tapped within the tube so that effects of filament inductance can be minimized. In addition, two short, heavy leads are brought out from the grid and from the plate to individual terminals in order to reduce the inductance of these internal connections. All terminals are placed at one end of the bulb so that short leads can be used in neutralizing circuits.

The 866-A/866 is a new half-wave, mercury-vapor rectifier to supersede the well-known RCA types 866-A and 866. This new tube combines the ability of the 866-A to withstand high peak inverse voltage and the ability of the 866 to conduct at relatively low applied voltage. The 866-A/866 employs a ceramic cap insulator and is constructed in a dome-top bulb. This construction minimizes danger of bulb cracks caused by corona discharge. An edgewise wound ribbon filament made of a new alloy material provides a large emission reserve and improved life. Two 866-A/866's operating in a full-wave rectifier are capable of delivering to the input of a choke-input filter a rectified voltage of 3180 volts at 0.5 ampere with good regulation.

The 1625 transmitting beam power amplifier is similar to RCA-807 but it has a 12.6-volt heater



Three new types of RCA tubes recently introduced—the 815 is a transmitting amplifier; the 826 a transmitting triode for UHF; the 866-A/866 a half-wave mercury vapor rectifier.

and a 7-pin base. Because of these features, the 1625 is particularly suitable for use in aircraft radio transmitters. The high power sensitivity of the 1625 makes it especially useful in frequency-multiplier service where high harmonic output is essential. It may also be used as a crystal-oscillator and buffer amplifier in medium-power transmitters with an input up to a half-kilowatt. The 1625 can be operated at maximum ratings at frequencies as high as 60 megacycles and at reduced ratings at frequencies as high as 125 megacycles. Its maximum plate dissipation rating is 30 watts (ICAS).

The 1626, a transmitting triode of the indirectly heated type with 12.6-volt heater, is designed especially for R.F. oscillator service in applications requiring unusual stability of characteristics. The maximum plate dissipation is 5 watts. The 1626 may be operated at maximum ratings at frequencies as high as 30 megacycles, and at reduced ratings at frequencies as high as 90 megacycles. Because of its 12.6-volt heater rating, the 1626 is particularly suitable for use in aircraft radio transmitters.

10-Channel Marine Radiophone

● TO its line of marine radiophones Hallicrafters, Inc., has added the "Seagoing" Model HT-12, a 50-watt unit which combines wide operating range with the utmost in operating simplicity. Receiving and transmitting channels, ten of each, are crystal-controlled to eliminate manual tuning, and manual switching is avoided through inclusion of a voice-controlled automatic relay system.

A corrosion proofed metal case, 20 inches square by 12 inches deep, houses both the transmitter and receiver sections. On its front panel are arranged the few simple controls, the telephone handset, a built-in loud-speaker and a meter which provides a visual check on transmitter operation. The power supply is a separate unit and is available in two types, one for direct operation from a 12-volt ship's battery, the other from a 110-volt A.C. source. This latter type also serves where the supply is either 32 or 110 volts D.C., a rotary converter being utilized to adapt it to these supplies.

With the receiver channel selector switch set for the channel of the nearest shore telephone station (or for the ship-to-ship channel) the owner can keep in constant touch with what is going on and will hear calls intended for him. In addition, provision is made for connection of an automatic bell ringer which will ring only when his boat is called.

The receiver is a sensitive and selective 7-tube superheterodyne with one stage of pre-selection, built-in I.F. wavetrap and highly effective A.V.C. and Q.A.V.C. systems.

A 10-Channel Marine Radiophone.

New Bulletin by Amphenol

The new Amphenol blue book catalog No. 62 for 1941 has arrived. Every imaginable type of socket, plug, connector, etc., is illustrated and described therein. Also insulating materials and accessories of all kinds for radio, aircraft and electrical purposes. Insulating materials, coil forms, etc., of Amphenol 912-A and polystyrene insulated co-axial cables and fittings for HF and UHF applications are included. The catalog contains illustrations in detail of the newest co-axial cables for amateur use, as well as commercial applications. Steatite sockets and plugs are shown, loktal MIP sockets, a special 20-contact socket and plug for special cable connections, adapters of all kinds, test instrument accessories, miniature sockets and connectors, all types of microphone connectors, circuit-breaking power plugs, etc. Laboratory punch and dies for making holes in chassis are illustrated and described, and a goodly assortment of radio hardware. Plugs and sockets are now available in different colors, which is often desirable for special radio apparatus, especially "test" instruments.

Multi-Section Plug-in Filter

● RECOGNIZING the inefficiency of ordinary plug-in filters, engineers of the Sprague Products Company have designed LF-2, a special multiple section and inductance and capacity filter for use on very troublesome sources of radio interference. Designed for installation at the power outlet to which the interfering device is connected, the LF-2 unit takes much of the guesswork out of selecting the proper filter for any electrical device drawing up to ½ ampere. It has proved effective for interference-producing electrical shavers, hair dryers, erasing machines and similar electrical equipment.

New Raytheon Tubes

● FOUR interesting new tubes have been introduced by the Raytheon Production Corporation. These recently developed tubes are the types 6SD7GT, 6U6GT, 7L7 and 7N7. The 6SD7GT and 6U6GT fall into the bantam category, while the 7L7 and 7N7 are of the "lock-in" type.

These new types may be briefly described as follows:

Type 6SD7GT is a semi-remote cutoff relatively high transconductance pentode, for use as an R.F. and I.F. amplifier.

Type 6U6GT is a beam-power amplifier designed for reasonably high output, at lower supply voltage than normally required.

Type 7L7 is a "lock-in" base sharp cut-off, relatively high transconductance pentode, for use where the higher transconductance types are not required.

Type 7N7 is a "lock-in" base twin triode having separate cathode leads, with consequently increased circuit versatility.

The 6SD7GT pentode, a semi-remote cutoff amplifier of the heater type, may be mounted in any position. It has a small wafer octal 8-pin base with metal shell. The heater voltage is 6.3 volts and the current .3 amp. Maximum plate voltage is 300. Maximum screen voltage 125; plate dissipation 4 watts.

The 6U6GT beam power amplifier is a heater type tube, can be mounted in any position and its base is an intermediate shell octal 7-pin. The tube has 6.3 volt heater and draws .75 amp. Maximum plate voltage is 200, screen voltage 135, plate dissipation 11 watts. The power output of this tube in class A1 is 5.5 watts with 200 volts on the plate.

The 7N7 twin triode amplifier of the heater type has a locking-in 8-pin base. This is a twin triode amplifier tube, designed for use as a voltage amplifier or phase inverter in radio receivers. Heater voltage is 7 and heater current is .64 amp. Maximum plate voltage is 300 and maximum plate dissipation per plate is 2.5 watts. The tube has an amplification factor of 20.

The 7L7 pentode is a sharp cutoff amplifier and has a locking-in 8-pin base. The tube has 7 volt heater and draws .32 amp. Maximum plate voltage 250 volts and maximum screen voltage 125. Plate dissipation 1.5 watts. This tube was designed for use as a high frequency or audio amplifier in radio receivers.

NEW CATALOGS

R.S.L. Issue New Catalog

● A NEW catalog of over 200 pages has just been released by Radio Service Laboratory, 1191 Elm Street, Manchester, New Hampshire. This publication contains up-to-the-minute radio parts and sound equipment information. Easy-to-read type, hundreds of illustrations, and order blanks in the rear of catalog, make it a valuable reference book for anyone connected with the radio industry.

Mallory-Yaxley

● FOR the radio service man, whether his business be large or small, the new Mallory-Yaxley radio service encyclopedia will prove invaluable. All sorts of replacement apparatus, including all types of controls such as potentiometers, by-pass condensers, vibrators, etc., are listed. A great deal of useful information on how to check various circuit troubles is given at the end of the encyclopedia, together with several pages of different types of control circuits. Also several pages of different condenser circuits are included, and a valuable chapter on "vibrators"—together with diagrams—is included.

A second catalog by Mallory-Yaxley shows an elaborate line of approved precision products, including condensers, jacks, selector switches, rheostats, vibrator packs, disc rectifiers for battery chargers, etc., elaborately illustrated and described.

YOU Are the Editor

(Continued from page 581)

4. If, and when experimental wireless facilities are restored, the question of an adjustment of fees and of the grant of fresh licenses will be given consideration. (This was in answer to the following question,—"Will new licenses for transmitting have to be taken out after the war, or will those holding them at the time of confiscation be able to carry on with the old license until the number of months, etc., for which it is still available are ended?"

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Manchester, England.

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FREE CATALOGS and INFORMATION

By carefully reading the advertising columns, you will find many offers to furnish literature containing valuable technical information that will help you in your work. Use this list freely.

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Bliley Electric Co.	Parts Mfr.	Circular	D-2	Free	601
		Engineering Bulletin	E-6	10c	
		Bulletin	E-7	Free	
		Circular	A-7	Free	
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Cowell, R. A.	Publisher's Rep.	Information		Free	579
Dodge's Institute	Radio School	Catalog		Free	579
Goldentone Radio Co.	Set Mfr.	1941 Bargain Catalog		Free	614
Gold Shield Products	Mail Order	Catalog		Free	610,12, 14, 22, 32
Hallicrafters, Inc.	Set Mfr.	Literature		Free	B.C.
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Instructograph Company	Code Machine	Information		Free	615
Johnson, E. F., Co.	Parts Mfr.	Catalog	966W	Free	607
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Meissner Mfg. Co.	Kit & Parts Mfr.	1941 Catalog		Free	595
Midget Radio Co.	Set Mfr.	Information		Free	615
Midwest Radio Corp.	Set Mfr.	1941 Catalog		Free	615
Miles Reproducer Co.	Sound Recording	Bulletins		Free	617
Millen, J., Mfg. Co., Inc.	Parts Mfr.	Catalog		Free	596
National Company, Inc.	Set & Parts Mfr.	Literature		Free	I.F.C.
National Radio Institute	Radio School	64-Page Book		Free	577
National Schools	Radio School	Catalog		Free	579
Nelson Co.	Used Courses	72-Page Catalog		Free	604
N. Y. Institute of Photography	Photography School	Booklet		Free	579
New York Y.M.C.A. Schools	Trade School	Booklet		Free	579
Premax Products	Parts Mfr.	Catalog	R-49	Free	596
Radio & Technical Publ. Co.	Radio Textbooks	Circulars on each book		Free	579
Radiocrafters	Parts Mfr.	Information		Free	601
RCA Institutes, Inc.	Radio School	Catalog		Free	579
Remington Rand	Typewriter Mfr.	Catalog		Free	611
Sprague Products Company	Parts Mfr.	Catalog		Free	601
Sprayberry Acad. of Radio	Radio School	52-Page Book		Free	I.B.C.
Supreme Publications	Publisher	Information		Free	613
Teleplex Co.	Code Machines	Folder	S-2	Free	579
Triplett Electrical Inst. Co.	Parts Mfr.	Catalog		Free	607
Universal Microphone Co., Ltd.	Parts Mfr.	Information		Free	614

New "Hamanual"

● THE fifth edition of the "Hamanual" has just been announced by the Standard Transformer Corporation. This is a 48 page, two color catalog which describes completely twelve different transmitters and six amplifiers. A complete circuit is given on each unit in blueprint form. All the component parts lists are shown, together with the original manufacturers' part numbers.

This year for the first time a complete array of power-supply kits is offered.

Many other new features are incorporated in the book. The Hamanual is available either from the Stancor distributor or direct from the factory at 15 cents net.

Bulletin Analyzes Radio Interference Faults

● SERVICEMEN who have made it a point to study radio interference elimination as a means to increased profits in this rapidly growing phase of the business, will find much of general interest in an entirely new 8-page bulletin, "Radio Interference Elimination for Public Utilities," just issued by Sprague Products Company.

This includes a complete description of the causes and cures of radio interference on power transmission and distribution lines as developed by Sprague engineers in more than three years of field and laboratory work. Although it is written primarily from the angle of the public utility company and deals with problems relating directly to public utility power lines, the booklet should prove helpful to servicemen who specialize in interference elimination work. It will serve as a guide in helping them diagnose radio noise complaints.

A copy will be sent free upon request to bona fide radio servicemen.

New Meissner Catalog

● THE new 1941 general catalog showing the various products of the Meissner Manufacturing Company has come to the reviewer's desk. This is an unusually interesting catalog, as it contains description and illustration of "frequency modulation" chassis and parts for building such a receiver. Also we note complete FM console and table models in cabinets. Television receiver "kits" are also listed and we find a liberal assortment of receiving set kits, including a 12-tube all-wave "home" receiver. Other receiving set kits include 7, 8, and 9 tube jobs; student midget sets; A.C.-D.C. portable superhet; and 4, 5, and 6 tube receiving set kits. Another section of the catalog covers P-A tuners and kits, the new Meissner Analyst (a test instrument for service-men), a signal calibrator, all-wave tuning units, phono oscillators, I.F. transformers of both the air and iron-core type, etc. Other apparatus covered in the catalog are—filters, R.F. chokes, variable condensers, and several interesting dials—including those with "band-spread."

Sun Sound Systems Catalog

● SUN RADIO CO. of New York City has just released an illustrated 24-page public address booklet that should prove of interest to all in the sound field. Among the equipment described and illustrated are amplifiers and sound systems of every type and classification, including portable systems, mobile systems and complete indoor and outdoor installations suitable for the smallest auditorium or the largest arena or stadium. In addition, a number of pages are devoted to such P.A. accessories as microphones, speakers, pick-ups, phono motors, tuners, recorders, etc. A copy of the catalog will be gladly sent to interested persons upon request.

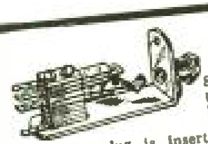
FREE TO YOU!

RADIO PARTS AND ACCESSORIES

HERE is some real BIG NEWS for you! Through a fortunate arrangement which we have been able to make, we can now offer you FREE premiums of such extraordinary value that they overshadow anything we have ever offered in the past with subscriptions to RADIO & TELEVISION Magazine.

NEVER BEFORE, in the 11 years' history of the magazine, have we offered such worthwhile premiums. All of these radio parts and accessories can be used to good advantage by the "ham" or constructor in his daily experiments.

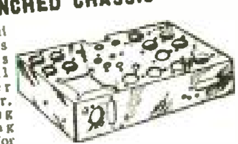
TELEPHONE JACK



Substantial long frame phone jack. 2-circuit filament control type, opens 2 circuits, closes 3rd when plug is inserted. Can be used for variety of control purposes in radio and telephone work. 2⅝" long, 1" high. Ship. weight 4 oz.

Premium No. 1 (3 Pts.) Val. 35c.

PUNCHED CHASSIS



Heavy plated steel chassis with holes punched for 11 tubes, power transformer, speaker plug and tuning dial. Great for large experimental sets, transmitters, etc. Reinforced construction. 13"x7⅝"x2½". Ship weight 3 lbs.

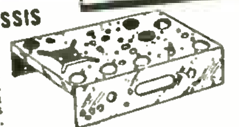
Premium No. 2 (5 Pts.) Val. 25c.

TWO GANG POTENTIOMETER

Well-made Yaxley 2 gang wire wound potentiometer. 2 units are insulated from each other. One is 5000, the other 15,000 ohms. Used as dual action volume control (antenna and bias in broadcast receivers). Also useful in experimental circuits. Ship. weight 1 lb.

Premium No. 3 (5 Pts.) Val. 25c.

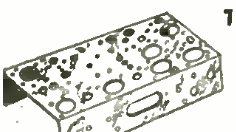
ALLOY CHASSIS



Medium weight alloy metal chassis punched for power transformer and 8 tubes as well as numerous mounting holes. Easily drilled metal. Open ends. Well made 10⅛"x6⅝"x2½". Ship. weight 2 lbs.

Premium No. 4 (5 Pts.) Val. 25c.

7 TUBE CHASSIS



Alloy metal chassis punched for 7 tubes, condensers, etc. Ideal for building small sets or simple apparatus. Metal is easy to drill. Size 10⅛"x5⅜"x 2". Shp. wgt. 2 lbs.

Premium No. 5 (5 Pts.) Val. 25c.

CONNECTING CABLE & TERMINAL

Unusually well made Philco 8 foot, 5 wire cable with spade terminals at one end and terminal block with 8 positions at other end. Wires color coded. Well insulated. May be used for remote control or battery connections, etc. Terminal block 3"x3"x¾". Ship. weight 1 lb.

Premium No. 6 (6 Pts.) Val. 35c.

LOUDSPEAKER UNIT

Kellogg magnetic loudspeaker unit for use with horn speaker. Has adjustable diaphragm. May be used as pillow speaker or attached to acoustic phonograph. Also useful as sensitive microphone for voice reproduction. Threaded (⅞" diam.) throat. Size 2½" diam., 1⅜" deep. Shp. wgt., 2 lbs.

Premium No. 7 (10 Pts.) Val. 75c.

These parts are given to you IN ADDITION to the cut-rate subscription prices we list below:

7 mos. for $1 (saving you 75c over the single-copy price)
16 mos. for $2 (saving you $2 over the single-copy price)
24 mos. for $3 (saving you $3 over the single-copy price)

And, of course, the longer your subscription runs, the more merchandise you obtain FREE. As we expect a tremendous response to this offer, we would suggest that you send your remittance without delay, as our supply of parts is limited and we won't be able to duplicate this offer again.

IF YOU ARE A RADIO EXPERIMENTER, AMATEUR OR SERVICEMAN, TAKE ADVANTAGE OF THIS MARVELOUS OPPORTUNITY NOW!

A SHORT while ago we were informed that one of the largest surplus houses in the East was ready to sacrifice a huge quantity of radio parts and accessories which cost the original manufacturers thousands of dollars.

We entered into an agreement with this house whereby we suggested to them to allow us to offer these parts to our readers in connection with subscription offers.

The surplus house enthusiastically endorsed our plan. We—the publishers—pay the surplus house cash for each of these parts, and you—the reaper of this fortunate arrangement—will get these valuable radio parts and accessories ABSOLUTELY FREE.

This is positively the first time that we have been enabled to make such an unprecedented offer which in many ways sounds too good to be true. Nevertheless, we vouch for it in every way and we know you will not be disappointed.

This special arrangement enables us to offer you this valuable merchandise FREE with your subscription to RADIO & TELEVISION magazine, at a price which is already a tremendous saving over the newsstand cost.

This is how the plan works:— Next to the premium number of each item, we show its point value.

For each 7 months' subscription ($1.00) you receive 15 points' worth of merchandise free.
For each 16 months' subscription ($2.00) you receive 30 points' worth of merchandise free.
For each 24 months' subscription ($3.00) you receive 45 points' worth of merchandise free.

For instance, if you send us a seven months' subscription at $1.00, you are entitled to 15 points' worth of free merchandise. You may order one No. 4 (5 points) and one No. 7 (10 points). Or if you wish, one each of numbers 2, 3 and 4 (each 5 points), or any other combination which totals 15 points.

Similarly, if you send us a 16 months' subscription ($2.00) you may order any combination of merchandise which totals 30 points. On a 24 months' subscription ($3.00), any combination totalling 45 points.

Due to the high cost of the merchandise, we cannot ship the articles prepaid, therefore we show the weight of each piece, packed. If you wish your free parts sent by parcel post, please add to your remittance a sufficient amount to cover postage. Or, if you would rather have us send the parcel express charges collect, we will be glad to do so.

Please remember that we do not sell these articles. You cannot buy them from us at any price.

In order to make sure that you receive your parts promptly, ORDER TODAY. Fill out the coupon, clip and mail to us together with the proper remittance.

ALL RADIO PARTS ARE NEW AND UNUSED
Many are in their Original Packing

●

IMPORTANT TO PRESENT SUBSCRIBERS

If you are already a subscriber or have recently subscribed to the magazine, this offer still holds good for you, too. We merely will lengthen your subscription for either 7 months, 16 months or 24 months, as the case may be. There is a place on the coupon which provides for this.

RADIO & TELEVISION, 20 Vesey Street, New York, N. Y. RT-241

Please enter my subscription to RADIO & TELEVISION for

☐ 7 months—$1.00. Plus 15 points' worth of FREE radio parts.
☐ 16 months—$2.00. Plus 30 points' worth of FREE radio parts.
☐ 24 months—$3.00. Plus 45 points' worth of FREE radio parts.

Canadian and foreign countries add 32 cents for $1.00 subscription; 72 cents for $2.00 subscription; $1.08 for $3.00 subscription.

☐ I enclose my remittance for $......... which includes parcel post charges on the FREE parts I am ordering.
☐ Please send the merchandise to me express charges collect.
☐ I am a subscriber now. Lengthen my subscription for .... months:

I am circling the numbers of the parts I wish to have you send me Free.

Nos. 1 2 3 4 5 6 7

Name .... Address ....

City .... State ....

(Send remittance in form of check or money order. If you send cash or unused U. S. postage stamps, be sure to register your letter.)

DON'T MISS THIS OPPORTUNITY! WE ASSURE YOU THAT YOU WON'T BE DISAPPOINTED. ORDER TODAY! SIMPLY FILL OUT THE COUPON. PROMPT SHIPMENT ASSURED!

RADIO & TELEVISION
20 VESEY STREET
NEW YORK, N. Y.

Index to Advertisers

(While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.)

What Do YOU Think?

(Continued from page 579)

short wave fields, and like the others I rely upon your FB magazine to furnish me with understandable and complete data.

I recently built my first receiver from a circuit appearing in your magazine, and it works very well. I am also planning to build my transmitter from circuits in your magazine, as soon as I am a little more advanced: I can easily follow your diagrams, although I am a beginner. I am a SWL and will swap cards 100% promptly with anyone who desires such.

In closing, I believe that your editorials should be praised, as they put the short wave experimenter in a high position and prove the importance of radio in war and peace, which is especially important in these troubled times.

DICK VESTY,
Box 305,
Alexandria Bay, New York

A SUGGESTION

Editor,

The equipment in my S-W shack consists of three standard receivers. The one to the left is used for my home-made public address system.

I have been reading R. & T. for some time and I do sincerely believe R. & T. is the most complete magazine for all om's & yl's interested in radio. The departments that interest me are: What Do You Think, the Want Ads, and Circuits. It would be very FB if you awarded some kind of trophy or certificate to SWL photos. Your magazine is "tops" with me.

WILLIAM A. WHITE, JR.,
2109 E. 3rd St.,
Superior, Wis.

1933 and '34, especially the "Doerle" sets. This would greatly increase R. & T.'s popularity among us fellows of 14 or 15, who have to work for our money, as these sets cost less to build.

Another suggestion is that you return the *Barter & Exchange* column to its former "free" status.

PHIL ADAMSAK,
4650 Forman Ave.
North Hollywood,
Calif.

(We constantly endeavor to present several simple articles in each issue, which will appeal to the beginner. We think you will agree that some excellent beginner's articles have appeared in recent numbers of RADIO & TELEVISION.—Editor)

HE'LL EXCHANGE CARDS

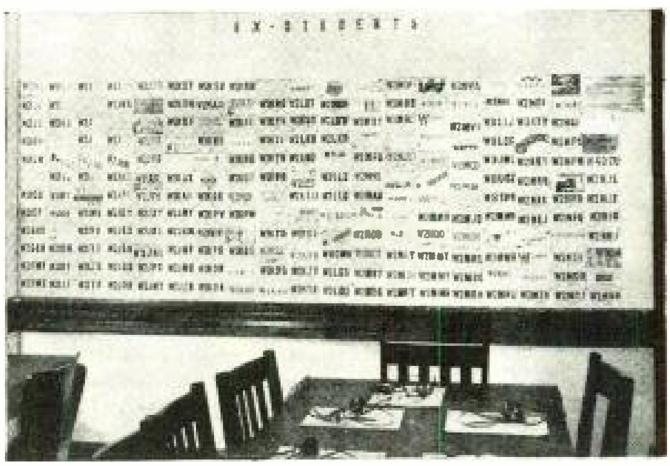
Editor,

The receivers here are a 5-tube Emerson and a 7-tube Zenith. Most of my DXing is done on the 20 meter band. I have logged 32 countries, verified 28 of them. The antenna is a 110 foot Marconi, and a 35 ft. doublet. I have been reading R. & T. for about a year now, and just renewed my subscription. Well, I'll have to be wishing your FB magazine 73 (best regards) now. If any of you SWL's want my card, send me yours, and you'll get mine by return mail.

Yours DXingly,

THORNTON LYFORD,
260 Woodlawn Ave.
Hubbard Woods, Ill.

Here is a "different" QSL card collection—not stations "worked"—but stations put on the air! Photo above shows approximately 600 amateurs put on the air by the American Radio Institute.



A "BRICKBAT"

Editor,

I am just a beginner in the radio game, but I feel entitled to make a criticism of your magazine. It is excellent for hoary-haired hams and their like, but what about us *beginners?* I first bought your magazine because of a couple of beginner's articles in it. The next few months it was OK, and I got into the habit of buying R. & T. as it came on the stands. I was getting my money's worth then, but for the past few months it seems too complicated. I suggest that you reprint some of your articles of

ANSWERS TO PUZZLE DIAGRAM ON PAGE 622

6F6, control grid missing pin #5
6A7, control grid missing, Cap 58, suppressor grid missing, pin #4
12A7, screen grid missing, pin #3
6K7, screen grid missing, pin #4
6A8, screen grid missing, pin #4
6F7, grid missing, triode section, pin #5
89, screen grid missing, pin #3
19, grid missing, output section, pin #4
6L7, screen grid missing, pin #4
Symbols show bottom view of socket.

New High Fidelity

FM-AM TUNER

MODEL S-31

High Fidelity Tuner for Frequency Modulation and Amplitude Modulated Reception.

NOW you can have FM-AM reception by a turn of the bandswitch with the Model S-31 Hallicrafters commercial FM-AM Tuner. Covering the broadcast (AM) band and the 40-51 mc. high frequency (FM) band. The Tuner combines the FM and AM circuits in one chassis with either instantly available at the turn of the bandswitch.

SPECIFICATIONS—9 tubes—Frequency range, band one; 550 to 1600 kc., band two; 40 to 51 mc.—Power output 130 milliwatts undistorted—Output impedances 500 and 5000 ohms—Power consumption 120 watts—Controls: bandswitch, radiophone switch, main tuning, audio gain, tone control, "S" meter adjustment, phone jack. Operating from 115-125 volts, 60 cycles AC. Panel dimensions 19" x 8¾". Dust cover dimensions 17" x 8¾" x 11⅛". Write for prices.

AMPLIFIER FOR MODEL S-31 TUNER

The Model S-31, a Hallicrafters amplifier, delivers 25 watts of high fidelity audio power to either speaker or 500 ohm load. Designed for rack mounting and for use as a companion unit to the FM-AM Model S-31 Tuner, it will provide reproduction of sparkling depth and brilliance.

SPECIFICATIONS—6 tubes—Fidelity 2 DB from 50 to 15,000 cycles gain—Channel No. 1, microphone (high impedance) 96 DB—Channel No. 2, phone (low impedance) 60 DB—Power output 25 watts—Power consumption 100 watts—Output impedance No. 1, 500 ohms; No. 2, 8 ohms; No. 3, 4 ohms. Dimensions: panel 19" x 8¾". Dust cover 18" x 8¾" x10". Write for prices.

the hallicrafters inc.

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