RADIO'S LIVEST MAGAZINE

A GERNSBACK PUBLICATION

November
25 Cents

Radio-Craft

HUGO GERNSBACK Editor

29

283 - Service Bench
281 - Business

The
"Half-Wave Mast-Antenna"
See Page 269

SPEED

RADIO TUBES

FOR ALL NEW RECEIVERS

EVER ABREAST OF THE RADIO TIMES

SPEED has achieved tremendous success with these NEW tubes. The reason is obvious—QUALITY

247
New power amplifier Pentode, for use in the output stage of AC receivers.

Here They Are!

No. 235
New screen grid tube—designed to reduce cross modulation and similar distortion.

No. 551
New screen grid tube—designed for same purpose as type 235, although having slightly different characteristics.

No. 230
New general purpose tube, operating economically at 2 volts, giving unusual service though using very little power.

No. 231
New amplifier using 2 volts and extremely low current consumption in same group as types 230 and 232.

No. 232
New screen grid tube—for use as radio frequency amplifier, operating at 2 volts.

No. 233
New power amplifier in the Pentode group, operating on 2 volts with low current consumption.

No. 236
New screen grid tube used mainly as R.F. amplifier or detector in automobile sets. In same group as type 237 and 238. Also for use in D.C. sets.

No. 237
New general purpose tube—especially adapted to automobile use. Can be used either as a detector or amplifier. Also for use in D.C. sets.

No. 238
New power amplifier Pentode for use in automobile receivers designed for it. Gives unusual volume for small input signal strength.

No. S 84
Developed expressly for replacement of type C 484 in Sparton sets. Somewhat similar in characteristics to the type 227.

No. S 82 B
Developed expressly for replacement of the the C 183 in Sparton sets, possessing all peculiar characteristics necessary for this purpose.

No. S 83
Developed expressly for replacement of the C 183 in Sparton sets, possession all the peculiar characteristics necessary for this purpose.

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SPEED

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RMA MEMBER RADIO MANUFACTURERS ASSOCIATION

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Train *with* R.T.A. *for* Radio *Service* Work

Important and far-reaching developments in Radio create sudden demand for specially equipped and specially trained Radio Service Men.

This excellent set analyzer and trouble shooter included with our course of training

MANY skilled Radio Service Men are needed now to service all-electric sets. By becoming a certified R. T. A. Service Man, you can make big money, full time or spare time, and fit yourself for the big-pay opportunities that Radio offers.

We will quickly give you the training you need to qualify as a Radio Service Man . . . certify you . . . furnish you with a marvelous Radio Set Analyzer. This wonder instrument, together with our training, will enable you to compete successfully with experts who have been in the radio business for years. With its help you can quickly diagnose any ailing Radio set. The training we give you will enable you to make necessary analysis and repairs.

Serving as a "radio doctor" with this Radio Set Analyzer is but one of the many easy ways by which we help you make money out of Radio. Wiring rooms for Radio, installing and servicing sets for dealers, building and installing automobile Radio sets, constructing and installing short wave receivers . . . those are a few of the other ways in which our members are cashing in on Radio.

As a member of the Radio Training Association, you receive personal instruction from skilled Radio Engineers. Upon completion of the training, they will advise you personally on any problems which arise in your work. The Association will help you make money in your spare time, increase your pay, or start you in business. The easiest, quickest, best-paying way for you to get into Radio is by joining the Radio Training Association.

This amazing Radio Set Analyzer plus the instructions given you by the Association will transform you into an expert quickly. With it, you can locate troubles in all types of sets, test circuits, measure resistance and condenser capacities, detect defective tubes. Knowing how to make repairs is easy; knowing what the trouble is requires expert knowledge and a Radio Set Analyzer. With this Radio Set Analyzer, you will be able to give expert service and make big money. Possessing this set analyzer and knowing how to use it will be but one of the benefits that will be yours as a member of the R. T. A.

Write for No-Cost Membership Plan

We have worked out a plan whereby a membership enrollment need not cost you a cent. Our thorough training and the valuable Radio set analyzer can be yours. Write at once and find out how easily both of these can be earned.

Now is the time to prepare to be a Radio Service Man. Greater opportunities are opening up right along. For the sake of extra money in your spare time, bigger pay, a business of your own, a position with a future, get in touch with the Radio Training Association of America now.

Send for this No-Cost Membership plan and Free Radio Handbook that will open your eyes as to what Radio has in store for the ambitious man. Don't wait. Do it now.

RADIO TRAINING ASSOCIATION OF AMERICA
Dept. RCA-11 4513 Ravenswood Ave. Chicago, Ill.

Fill Out and Mail Today!

RADIO TRAINING ASSOCIATION OF AMERICA
Dept. RCA-11 4513 Ravenswood Ave., Chicago, Ill.

Gentlemen: Send me details of your No-Cost Membership Enrollment Plan and information on how to learn to make real money in radio quick.

Name ....

Address ....

City .... State ....

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Radio-Craft

FOR THE SERVICE MAN · DEALER · RADIOTRICIAN

HUGO GERNSBACK, Editor-in-Chief

R. D. WASHBURNE, Technical Editor

LOUIS MARTIN, Associate Editor

VOLUME III
NUMBER 5

NOVEMBER 1931

Contents of This Issue

In Forthcoming Issues

SOME NOTES ON THE DESIGN OF R.F. COILS. An informative article from a different angle on a subject which always is of interest to radio men.

SELLING MULTI-WAVE SUPERHETERODYNES. How to increase your income by selling to your customers in its most convenient form a radio receiver of advanced design.

INSIDE A COMMERCIAL RADIO LABORATORY. Every technician has his own idea of just what constitutes a "perfect" laboratory; the comparison, therefore, will be of interest.

RADIO ON HORSEBACK. The modern King Arthur rides to the fray on a horse caparisoned with "radio saddlebags"; while the rider's lance has become an antenna.

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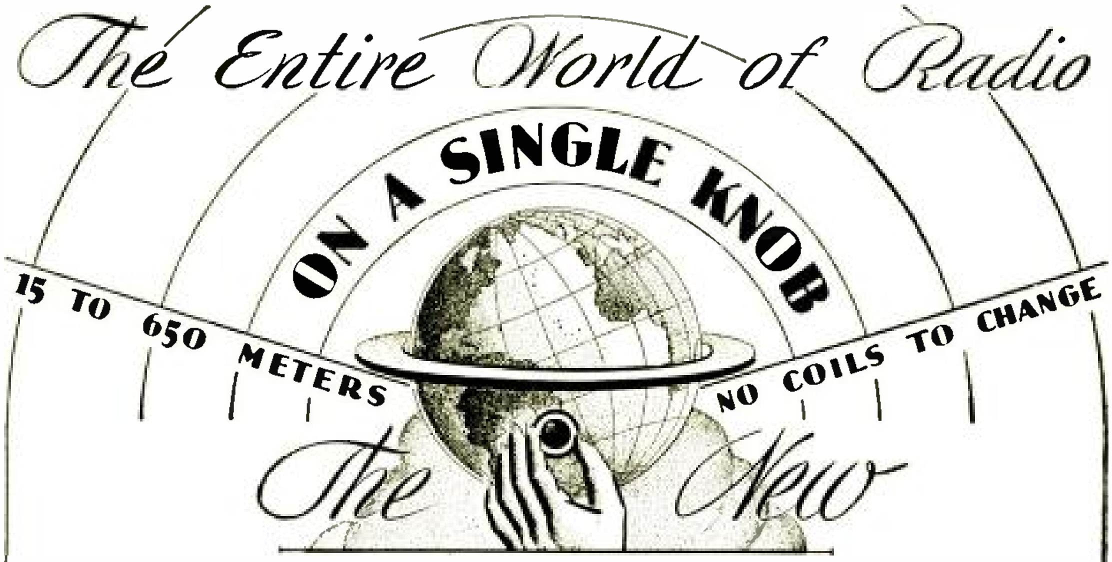
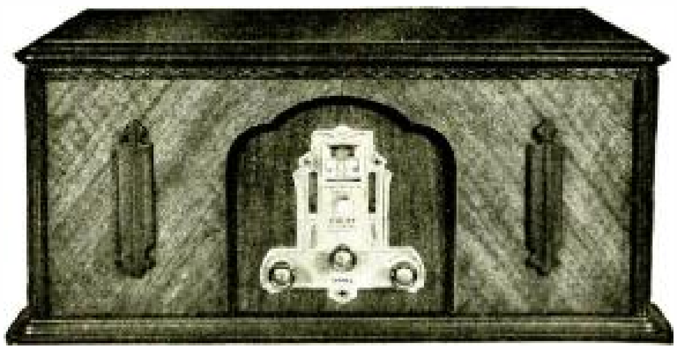
Pilot Achieves Radio's Greatest Sensation!



PILOT
UNIVERSAL SUPER WASP RECEIVER



Partly assembled "Universal" for the man who likes to "roll his own". With walnut cabinet, less tubes and speaker.

85.00

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

Universal Features Revolutionizing the Short Wave Art

Complete coverage all wave bands from 15 to 650 meters *without coil changing*. Complete A.C. operated *chassis in cabinet*. (Also available in battery model) . . . All *Metal* Chassis . . . Highly sensitive and selective circuit . . . Screen Grid TRF amplifier *plus* Screen Grid *Detector* . . . 227 First Audio Stage . . . Two 245's in push-pull output stage . . . Stations can be logged *permanently on dial* . . . Regeneration control does not alter tuning . . . Provision for *Phonograph Pick-up* . . . Earphone Jack on *Front Panel* . . . Illuminated Dials . . . Handsome Walnut Cabinet . . . Most advanced construction yet used for short wave work . . . In kit form for easy home assembly; no drilling or cutting, all parts fully prepared.

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

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FREE Questions and Answers Service

Schematic Diagrams of All Latest Midget Receivers

Expert servicing or installation of radio receivers requires that the dealer, service man or radiotrician be thoroughly experienced in handling sets of any manufacture. Needless to mention how important are modern methods of servicing, and how easy it is to complete any service job when the OFFICIAL RADIO SERVICE MANUAL *is on hand. The NEW 1932 MANUAL contains a Full Radio Service Guide and a most Complete Directory of all 1931-1932 Radio Receivers as well as models of older design. Everyone employed in the Radio Industry should have a copy available for his own use.*

$5.00

The Copy

HUGO GERNSBACK,
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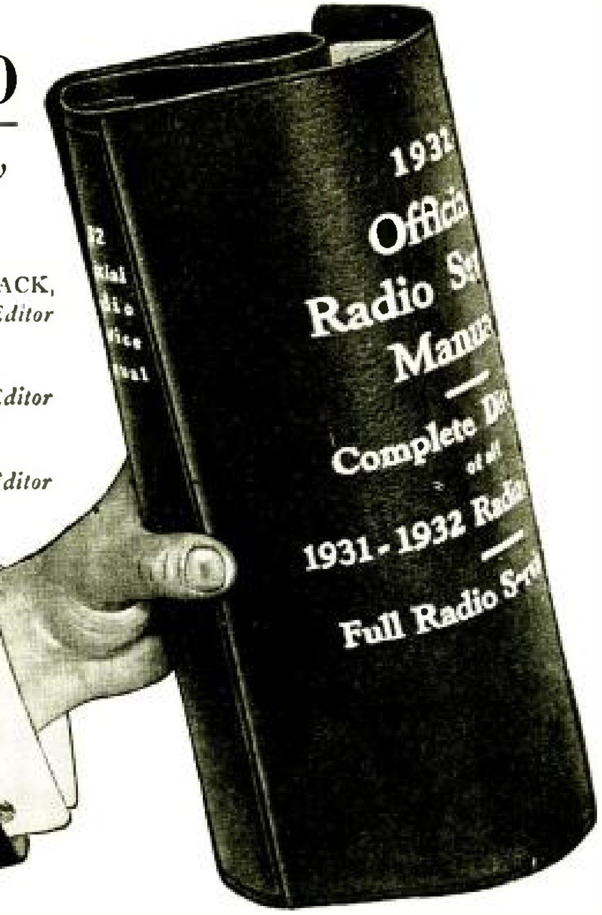
Managing Editor

Clyde Fitch,
Managing Editor



Partial Contents of the Manual

A step-by-step analysis in servicing a receiver which embodies in its design every possible combination of modern radio practice; it is fully illustrated and thoroughly explained. It is the greatest contribution to the radio service field.

Chart showing the operation of all types of vacuum tubes, whether new, old or obsolete. An exclusive resumé of the uses of the Pentode and Variable Mu Tubes and their characteristics.

Complete discussion of the superheterodyne and its inherent peculiarities. Also a special chapter on tools used on superheterodyne circuits.

Schematic diagrams and circuits complete with color codings.

Important chapters on commercial aircraft radio equipment; new data on commercial short wave receivers and converters.

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Complete Directory
of All 1931 - 1932
Radio Receivers

Full Radio Service Guide
For Radio Service Men, Dealers, Jobbers, Manufacturers and Set Builders

Clip Coupon NOW!

GERNSBACK PUBLICATIONS, Inc., RC-11
96-98 Park Place, New York, N. Y.

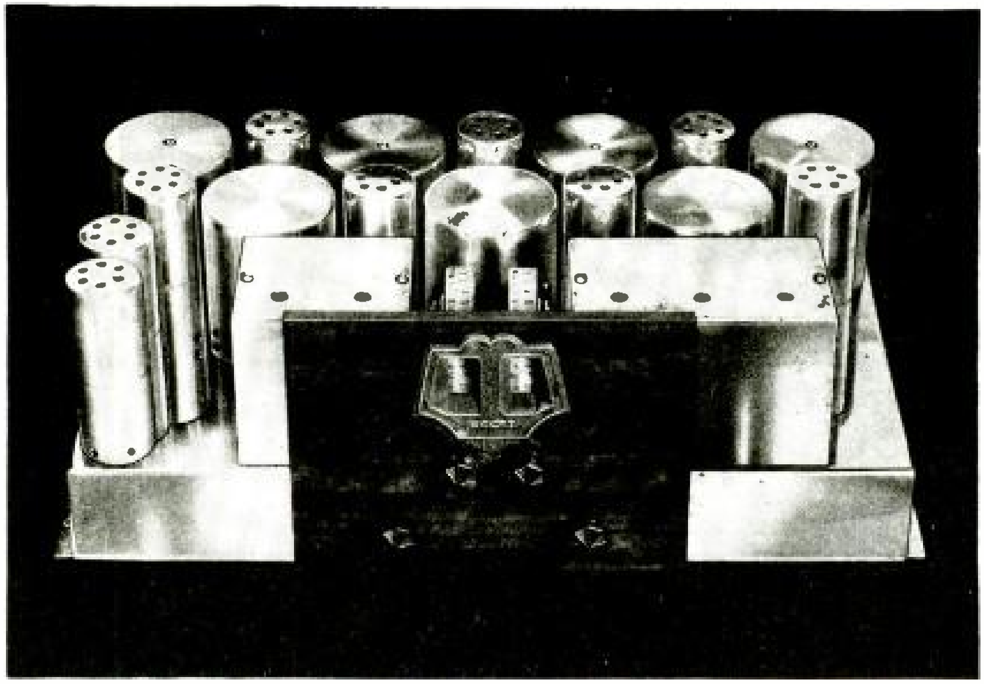
I enclose herewith remittance of $5.00, check or money order preferred, for which you are to send me the NEW 1932 OFFICIAL RADIO SERVICE MANUAL. I understand that all the New material will be included in the Manual and Supplements will be mailed FREE every 60 days.

Name ....

Address ....

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

Why be satisfied with less than 'Round the World Reception?



There is a new thrill in Radio—the thrill of actually tuning in the other side of the world—Japan, Indo-China, France, England, Australia, Germany and South America. Not code, but voice, music and song, loud and clear—often so perfect that its quality matches the finest nearby domestic stations. Such is the daily service being given by Scott All-Wave Receivers located in all parts of the country and operating under all sorts of conditions. And the tone of the Scott All-Wave is *naturalness* itself. Think of it! England and Japan, thousands of miles away from each other, yet only a quarter inch apart on the dial of the Scott All-Wave. A fractional turn of the tuning control and either is yours to listen to with an abundance of loud speaker volume. Unbelievable? Read the letters reproduced below. They are but a few of the hundreds received!

The truly amazing performance of which the Scott All-Wave is capable is the natural result of combining advanced design and precision engineering. The system of amplification employed in this receiver is far in advance of any other—and the Scott All-Wave is built in the laboratory, by laboratory experts to laboratory standards so that its advanced design is taken fullest advantage of. Each receiver is tested, before shipment, on reception from either 12RO, Rome, 5SGW, Chelmsford, England, or VK3ME, Melbourne, Australia.

Why be satisfied with less than a Scott All-Wave can give you? The price of this receiver is remarkably low. Mail the coupon for full particulars.

Read What Scott All-Wave Owners Say About This Great Receiver

England on an indoor aerial . . .
"London, England, comes in with great volume on an indoor aerial, which I have to use on account of static. Can get all the volume I want with the volume control turned up most of the time only one-quarter."
—*W. J. McD., Intervale, N. H.*

'Round the world . . .
"Have heard 'Big Ben' strike midnight in London; Grand Opera from Rome; the 'Marseillaise' played in France and at 8:30 a. m. have heard the laughing jack-ass from VK2ME at Sydney, Australia."
—*C. L. B., Chicago, Illinois*

China, too . . .
"Static conditions have been extremely bad this Summer. However, we have been getting regular reception on G5SW at Chelmsford, England, 12RO at Rome, Italy, F3ICD, Indo-China, and VK3ME at Melbourne, Australia."—*S. F. S., Lock, Utah.*

Paris for 3 hours . . .
"Yesterday I tuned in station FYA at Paris and received them for three hours with considerably more volume than Rome; El Prado, Ecuador, comes in very clear and loud every Thursday evening."
—*S. O. K., Tuskegee, Alabama*

Records Australia . . .
"Last Saturday night I received VK2ME, Sydney, Australia, loud enough to make a recording on my home recorder. It certainly gave me a great thrill to hear the announcer say, 'The time is now 20 minutes to 4, Sunday afternoon' when it was 20 minutes to 12 Saturday night here."
—*J. R. C., Highland, Mass.*

Germany to Australia . . .
"I hear England, France, Italy, daily while Ecuador, Colombia, Honduras and Germany and Manila come in quite often. VK2ME at Sydney, Australia, comes in very well."
—*J. M. B., Wierton, West Virginia*

Austria . . .
"I have tuned in VK3ME at Melbourne with enough volume to be heard across the street. I listened last evening to France, Italy, Austria, as well as G5SW in England and several other European stations. The SCOTT is all you claim and then some."
—*R. N. B., Fullerton, Penna.*

E. H. SCOTT RADIO LABORATORIES, INC., 4450 Ravenswood Ave., Dept. C-11 Chicago
(Formerly Scott Transformer Co.)

The SCOTT
ALL-WAVE
15-550 METER SUPERHETERODYNE

Clip-----------------------------

E. H. SCOTT RADIO LABORATORIES, INC.
(Formerly Scott Transformer Co.)
4450 Ravenswood Ave., Dept. C-11 Chicago, Ill.

Send me full particulars of the Scott All-Wave.

Name ....

Street ....

Town .... State ....

RADIO

Manufacturers, Distributors, Jobbers *and* Dealers

If in need of Service Men wire or write us and we will send you the name and address of Service Men in your city or vicinity.

THIS SERVICE IS FREE TO THE RADIO TRADE.

OFFICIAL RADIO SERVICE MEN'S ASSOCIATION, Inc.
98 Park Place, New York, N. Y.

Radio Service Men—Join the ORSMA

EVER since the appearance of the commercial radio broadcast receiver as a household necessity, the Radio Service Man has been an essential factor in the radio trade; and, as the complexity of electrical and mechanical design in receivers increases, an ever-higher standard of qualifications in the Service Man becomes necessary.

The necessity, also, of a strong association of the technically-qualified radio Service Men of the country is forcing itself upon all who are familiar with radio trade problems; and their repeated urging that such an association must be formed has led us to undertake the work of its organization.

This is the fundamental purpose of the OFFICIAL RADIO SERVICE MEN'S ASSOCIATION, which is not a money-making institution, or organized for private profit; to unite, as a group with strong common interests, all well qualified Radio Service Men; to make it readily possible for them in keeping up with the demands of their profession; and, above all, to give them a recognized standing in that profession, and acknowledged as such by radio manufacturers, distributors and dealers.

To give Service Men such a standing, it is obviously necessary that they must prove themselves entitled to it; any Service Man who can pass the examination necessary to demonstrate his qualifications will be elected as a member and a card will be issued to him under the seal of this Association, which will attest his ability and prove his identity.

The terms of the examination have been drawn up in co-operation with a group of the best-known radio manufacturers, as well as the foremost radio educational institutions.

We shall not attempt to grade the members into different classes. A candidate will be adjudged as either passing or not passing. If the school examining the papers passes the prospective member as satisfactory, we shall issue to him an identification card with his photograph.

If the candidate does not pass this examination the first time, he may apply for another examination three or six months later.

There is absolutely no cost attached to any service rendered by the Association to its members, no dues, no contributions.

If you wish to become a member, just fill out the coupon below and mail it to us. We will send you all the papers necessary to become a member.

The following firms have cooperated with us in formulating the examination papers.

The Crosley Radio Corporation, Cincinnati, O. Mr. D. J. Butler, Service Mgr.

Grigsby-Grunow Company (Majestic), Chicago, Ill. Mr. L. G. Wilkinson, Service Mgr.

Stromberg-Carlson Telephone Mfg. Co., Rochester, N. Y. Mr. E. S. Browning, Service Mgr.

Colin B. Kennedy, Corp., South Bend, Ind. Mr. B. F. McNamee, Prod. Mgr.

RCA-Victor Company, Inc., Camden, N. J. Mr. H. C. Grubb, Vice-President.

Stewart-Warner Corporation, Chicago, Ill. Mr. T. N. Golten, Service, Mgr.

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MAIL COUPON TODAY!

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98 Park Place, New York, N. Y.

I wish to become a member of your Association. Please mail me the examination papers and application blanks.

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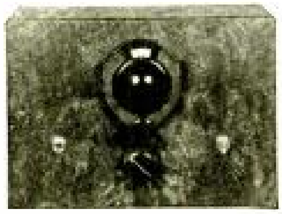
Town.............................. State..................

AMAZING World Wide Aero Short Wave Receiver

Only $6.45

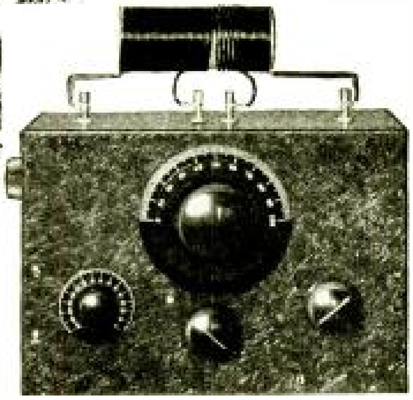
Listen in Direct to LONDON PARIS BERLIN BUENOS AIRES

Aero Short-Wave Converter



$12.50

Convert your AC or DC radio set into a short-wave Superheterodyne. With this converter on your regular set you will be able to tune in short-wave stations from many different parts of the world. The Aero Converter contains its own filament supply. B voltage can easily be obtained from your regular set, or you may use a single 45-volt B battery. No plug-in coils. Single tuning dial. Very easy to tune. No whistles or squeals. Uses two UX227 tubes, one as oscillator and one as mixer. Price, AC model, less tubes, ready for operation, $12.50. DC model for battery-operated sets, $11.50. Two matched UX227 tubes at 75c each, $1.50; one 45-volt battery, $1.45.



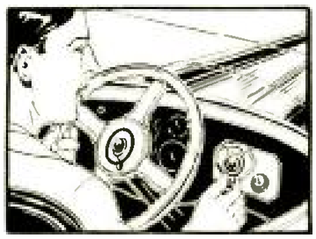
A new radio thrill for you. Span the world with this set. Enjoy unique foreign programs from strange lands. Hear broadcasting stations from all over the world, via short waves. Your ordinary receiver cannot tune in these low-wave stations. World-wide receiver gets 14 to 550-meter stations with surprising clarity. Price of set, including 6 coils, $6.45; price in foreign countries, $7.75, postpaid.

NEW AERO MIDGET

Using the Latest-Type PENTODE and MULTI-MU Tubes

Price, $16.50. Here is a midget radio that everyone can afford, that has performance, distance and tone qualities like the larger and much more expensive sets. Wonderful tone quality and selectivity. Full dynamic speaker. Full vision dial. Phonograph pick-up plug. Beautiful walnut finish cabinet. This is a 5-tube set and sells for $16.50. Price of complete set of 5 tubes is $6.00.

ASTOUNDING . . . AUTO RADIO BARGAIN



This is the latest model 6-Tube Aero Pentode Auto Radio. Due to the use of the latest Pentode tubes, this set is equal, in performance, to many 8-tube receiving sets. The circuit used is one which will be embodied in most of the expensive 1932 model auto radios. The complete set can be clamped on the steering post of your car, or can be operated by remote control from the dashboard. Price of set only $20.00. The set complete with tubes, batteries, dynamic speaker, antenna equipment and noise suppressors, $39.50.

Send for Latest Catalog of Parts and Equipment

CHAS. HOODWIN CO.

4240 Lincoln Avenue Dept. L-150 Chicago, Ill.

CHAS. HOODWIN CO., Dept. L-150
4240 Lincoln Avenue,
Chicago, Ill.

You may send me the items I am filling in in the space below. Enclosed is my remittance to cover. It is understood that you guarantee your merchandise to be in first-class condition when delivered. (If cash is sent with order you may deduct 5% from the amount of your purchase. Should you order C.O.D. a deposit of $1.00 is required on the short-wave receiver or short wave converter. A deposit of $5.00 is required on the Aero Midget or Auto Radio.)

Items Wanted..................................

Name ....

Street and No..................................

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

Build Your CUSTOMERS The Revolutionary STENODE

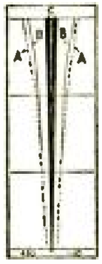
The Receiver That Is NOISE FREE on SHORT WAVES or BROADCAST

A STENODE demonstration will create more new custom set prospects than any radio receiver ever did before. People listen in amazement when they hear stations free of background noises and absolute silence between stations. When you tune out heterodynes and whistles and stations STAY IN strong and crystal clear, owners of all other sets gasp in astonishment. The former chief of wireless research of the British Royal Air Force, Dr. James Robinson has given an entirely new principal to radio in STENODE.

By the STENODE principal the highest selectivity ever attained as well as unprecedented tonal range is now made possible. All engineers agree that it is impossible with ordinary superheterodynes.

STENODE amplifies signals most and static least. That's why YOU want to build an 11 tube STENODE to work with a SHORT WAVE adapter when it is not used to log and listen with enjoyment to more broadcasters than can be heard on any other type of radio. STENODE selectivity is 5 to 1 greater than that of so called 10KC Supers. The noise does not get in along with the high audio frequencies, and the STENODE reproduces perfectly higher frequencies than ever heard on any other receiver giving

500% BETTER SELECTIVITY
1000% MORE FREEDOM FROM NOISE
INFINITELY BETTER QUALITY



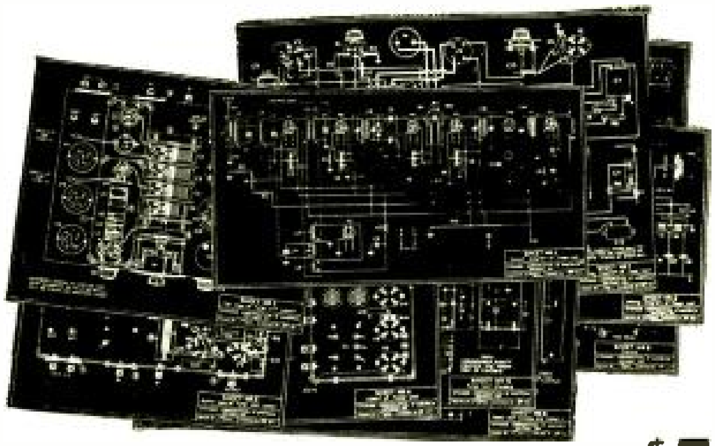
STENODE selectivity curve makes 10KC selectivity, so-called, look like broad tuning.

STENODE selectivity is compared, at left, to that of ordinary receivers. All background noise is contained in outer curve. Stenode's curve, shaded, contains but 1-10 the *total* noise.

Made in England

STENOTUBE. Only one required in each Stenode. This heart of the Stenode circuit consists of a quartz crystal ground to 175KC frequency and mounted in tube form for easy handling. Standard UX socket base. Price $15.

None genuine without the inventor's signature.



9 Blue Prints - Data Book - Direction Book Now $5

Increased demand for Stenode Data Book, Instruction Book and Blue Prints permits our cutting former price in half. Those who have already sent in full price will receive our check for $5. We are not interested in making profit from our engineering service. Our profits come solely from Royalties paid us by our licensees.

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Hempstead Gardens, L. I., N. Y.
Enclosed find ☐ Money Order, ☐ Check, for $.......... Please forward me ☐ STENOTUBE, ☐ BLUE PRINTS, DATA BOOK and DIRECTION BOOK for building STENODE.

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City .... State ....

The STENODE opens up new fields for short-wave and television work, as well as broadcasting. Full details of all sorts of applications are given in the STENODE Data Book. Nine full-sized diagrams show where to place every part. How to make every connection is clearly told in STENODE Book of Directions. Your finished STENODE will put you into a new field of radio. Fill in and mail the coupon with your money order for the biggest value ever offered custom set builders.

STENODE CORP. OF AMERICA
HEMPSTEAD GARDENS, L. I., N. Y.
(FORMERLY AMERICAN RADIOSTAT CORP.)

IF IT ISN'T A STENODE IT ISN'T A MODERN RECEIVER

NOVEMBER
1931
Vol. III—No. 5

Radio-Craft
FOR THE
SERVICE MAN · DEALER · RADIOTRICIAN
"Takes the Resistance Out of Radio"
Editorial Offices, 96-98 Park Place, New York, N. Y.

HUGO GERNSBACK
Editor

Extra Money For Service Men

By HUGO GERNSBACK

THERE are some Service Men—and their number is increasing rapidly—who seem to feel that there is very little money left in the radio servicing game.

Nothing could be more erroneous; and it may be safely said that the Service Men who voice these sentiments are not only still in the minority, but certainly, they do not use up-to-date and aggressive service methods mixed with a goodly amount of gray matter.

Radio dollars do not tend to grow on trees. You have to go and look for them, exactly as for any other kind of dollars. When times are difficult, like the present, and people do not spend as freely as of yore, a certain amount of ingenuity is needed in order to get extra sales. For that reason, the up-to-date Service Man these days does not content himself with just servicing sets, which is his trade. Of course, if there are enough sets to be serviced, it is certain that the Service Man will find no cause for complaint. If, on the other hand, he has a limited clientele, whose sets do not happen to require servicing, there is still a good deal of money to be made from extra efforts which have nothing to do with servicing itself, strictly speaking.

When things are dull, the radio Service Man can easily become a radio salesman and supply his customers with all sorts of radio merchandise; and, if you once have an entree to the customer, it is usually an easy matter to "sell" your prospect.

Most of the sets made prior to 1931 contained no Pentodes. It should not be difficult to convince a set owner of the better quality, greater volume, etc., that can be had through the use of the new Pentodes. It is no trick at all, with most sets, to change them over from the old-type tubes to Pentodes at a decent profit to the Service Man. Most set owners, these days, cannot afford to get new sets; but they welcome having their sets brought up to date, if it can be done.

In this issue there is described a new "Tune-A-Lite," also known under the trade name of "Flashograph." This new tuning device is an elongated neon tube, which is already built into several 1932 sets. The main idea is that the neon bulb flashes to the highest point when the set is in resonance with a certain station. This is a brand new device that is sure to interest the average set owner. During the next few months, it will be possible to buy a complete Tune-A-Lite section that can be attached to the outside of the radio set, and it will also be possible, with a little cabinet work, to fit one into a present-day set. A demonstration of such a light is sure to make a sale.

I have spoken before of short-wave adapters. Now-a-days, people wish to tune in foreign countries direct, and get the thrill of hearing the European and other world broadcasts that fill the air. A large amount of such adapters are already to be had, listing from low prices up to the more expensive models. If the Service Man carries one of these adapters with him, and shows the owner how comparatively simple it is to tune in a foreign program, the sale can easily be made.

Electric (A.C.) clocks are becoming the rage all over the country. They are not only cheap, but they keep time most accurately. The consumption of current is almost nil. An ideal position for such a clock is on top of a radio set; and many Service Men are making slight structural changes in existing cabinets, to fit electric clocks into the standard receivers. A sample of the clock, carried around and demonstrated, will frequently result in a sale.

Then, of course, tone controls, of which many can be had, and at reasonable prices, are still good sellers. They take but a few minutes to install; and a simple demonstration to your prospect nearly always results in a sale. There seems to be a certain reluctance, in most people, when it comes to listening to lectures and talks over the radio. In most sets not equipped with tone controls, the talk is usually sharp and "brilliant." This the tone control can "mellow down," and thus make the talk far more agreeable to the individual taste. One Service Man reports that four out of five demonstrations result in sales.

The itch for distance seems to be on the increase, even on the long-wave broadcast set. For a time, most people wished only to get local programs; now it seems they are hunting for distant stations again, if the many letters that we receive are a true indication of this. As a rule, successful "DX" (long-distance) reception pre-supposes a good aerial. A large proportion of present aerials were installed in a hurry, and are not good in the electrical sense. Set owners who use indoor aerials, and light-socket connector aerials, should be sold on the idea that their set will give them far greater volume if a good hundred-foot outdoor aerial—providing there is sufficient room—is installed.

Then, there is, of course, a tremendous market for line-noise filters. Radio set owners who live in apartment houses, if they have a sensitive set, know that they will get a click every time a light is switched on in the house. Then there are disturbances from refrigerators, vacuum cleaners and a host of other appliances. There are now on the market a number of efficient noise filters, and an up-to-date Service Man should always carry a few with him. Once the prospect understands what it is all about, he will not hesitate to spend a few dollars if he knows that his reception will be relieved of a great deal of man-made static.

I have only sketched a few of the more obvious ways in which the Service Man can pick up dollars right and left, if he only goes after them. There are, of course, many other methods which he will find if he uses his head.

Television Aids The Blind

How an ultra-modern use of television components, principally the "PE" cell and scanning disc, enables the blind figuratively to "see"

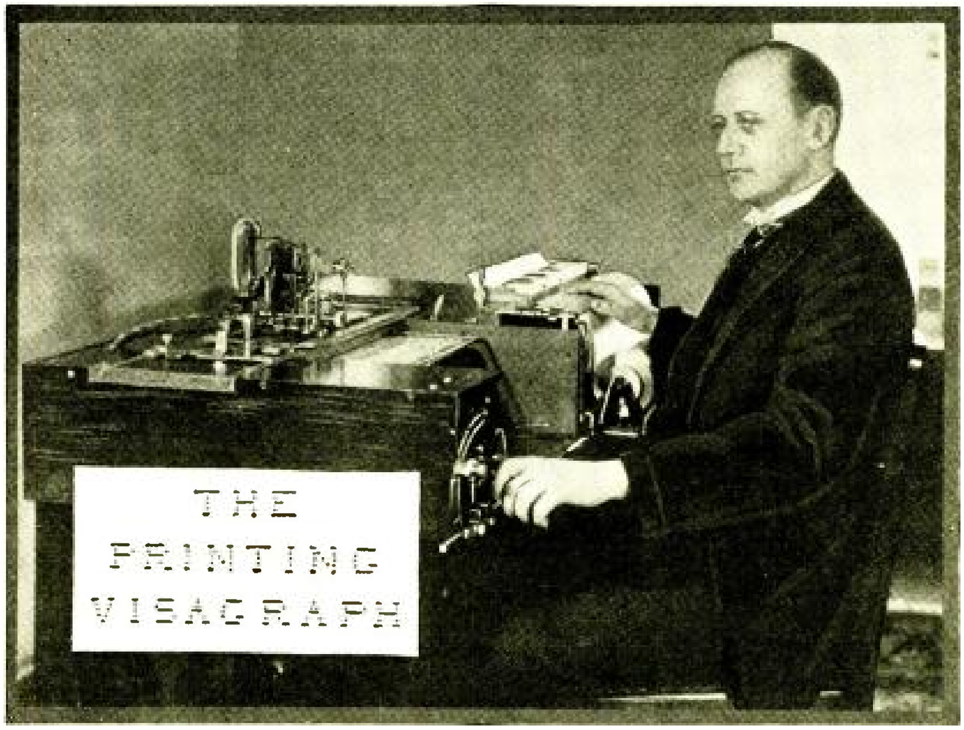


Fig. A
The printing Visagraph in action. The operator is manipulating the apparatus with one hand, while the other is "reading" a manuscript.

WRITERS of scientific fiction for some years, discussed the possibility of creating a robot which would look on the printed page, and read it aloud. With our present art of writing, and haphazard method of pronunciation, we may consider this to be practically impossible. With an absolutely phonetic language, certain characters would convey certain sounds; but the pitch and stress of the voice are not indicated in printing, and even with a phonetic alphabet the voice of the robot would be unendurably monotonous.

However, there are those who are unable to read printing of the ordinary kind, no matter how good their education—the blind. For their benefit, books have been translated or transcribed into "Braille." This indicates a method of embossing letters from beneath into the paper, so that the delicate fingers of the sightless can determine their form, and thus translate them into sensory impulses.

Since the demand for books for the blind is small, most works of this nature are produced one at a time, by hand, as the old manuscripts were copied, except that a punching machine comparable to a typewriter is used. There are in the New York Public Library about five thousand volumes, in various types of raised printing for the blind. These, however, being necessarily bulky, because of the thickness of the impressed sheets, and the fact that the letters must be large enough to be felt quickly with the finger tips, contain a comparatively small amount of text as compared with printed books.

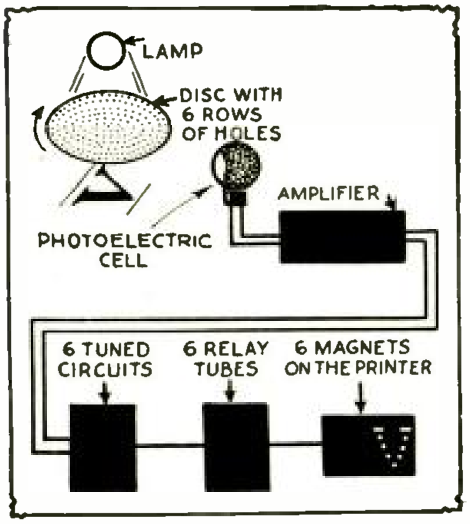


Fig. 2
The letter (V) is scanned by the disc. The reflected rays striking the "PE" cell are amplified and actuate a stylus which embosses the letter in aluminum foil.

The idea of applying the principles of television to produce a reading machine, or rather an automatic transcribing machine, for the blind occurred to an inventor, Robert E. Naumburg, and resulted in the production of the remarkably ingenious device, the Visagraph, which is illustrated here in Fig. A.

While the method might be applied very easily to the production of sounds, their meaning must be very conventional, in view of the irregular spelling of words in all languages—unless perhaps Esperanto. It would be impossible to relate them to spoken English, French, etc.

The Visagraph attains its end by perforating a magnified image of the letters over which it passes its electric eye, in a sheet of paper, cardboard or thin aluminum. A sample of the work is reproduced in insert, Fig. A, in which, however, the raised letters have been blackened so that they may be visible. The sheet, however, is itself plain in color, as it is meant to be read by touch, not sight.

From the specimen of Braille letters, Fig. 1, it will be observed that their shape is conventional. The Visagraph, however, preserves the outline of the letters which it copies from the printed page.

For many purposes, a copying machine is used which transfers a pattern mechanically from one surface to another, either enlarged, fac-simile or reduced.

However, ordinary printing leaves practically no impression upon the surface of the paper; it is therefore necessary to "feel" for the characters with a photoelectric cell.

Since it is necessary to produce the letter bit by bit—the photoelectric cell recognizes area of illumination, but not shape, a scanning disc is used, somewhat similar in principle to that used in television, only smaller in size. This has six rows of holes which, it will be noted, correspond to the six rows of long and short impressions which make up the letters of the insert, Fig. A.

Full details of the machine are not released by its inventor, but from the diagram (Fig. 2) and the result obtained, the general method can be determined. When a black area passes between the light-source (lamp) and the photoelectric cell, it intercepts the light, and the impulse (passed through the amplifier) is applied to the tuned circuit which corresponds to the particular row of holes in which the scanning ray is intercepted. This operates the relay, and a stylus, resembling that used in Braille writing is forced from beneath against the paper or metal on which the record is being

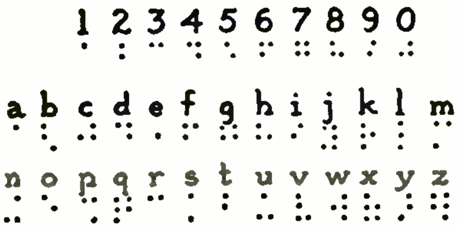


Fig. 1
An example of "American Braille." The arrangement of the dots constitutes the letter.

copied. This forces up the upper surface, and produces the impression. Five lines, it will be observed, form a letter 1/3-inch high; while a sixth is, presumably, reserved for the "descenders" or parts of letters

(*Continued on page 301*)

"Half-Wave Mast Antenna"

A 665-ft. Steel Structure Which Constitutes a New Departure

Fig. A

The mast antenna and the transmitter house.

ALONG one bank of the Pequannock River, in Wayne Township, at a point near Paterson, N. J., rises a majestic structure toward which the eyes of the engineering world are turning. In general appearance, it differs but little from most previous forms of radio "masts." Its novelty, however, lies in the fact that this semi-self-supporting, 665-ft. structure is the antenna of the transmitter; which technically is called a "half-wave mast-antenna," Fig. A.

This "mast-antenna" (a new term in radio) is part of the new 50,000-watt transmitter which is designed to supplant, except for emergency use, the old one of station WABC; and is a new type of broadcast aerial construction which breaks away from tradition, and establishes a precedent.

The bank of the river is about 1,000 feet from the development, but its bed extends inland at this point, so that the river flows underneath the station, six feet below the surface of the ground (in spots this is quick-sand, and made construction extremely difficult).

An investigation of the rise of the Pequannock River for the past 50 years showed that the maximum level attained during this period was about six feet. In view of this, the "transmitter building" was constructed on a huge mat of steel and concrete, the first six feet of the building above ground being waterproofed. If the level of the river ever should rise to the six-foot mark, the building could be approached only by means of a row-boat, although the station would function as usual.

The single mast, shown in the illustration, is the antenna proper, and is tuned to one-half the wavelength of the station, which operates on a wavelength of 348.6 meters, or 860 kc.

The mast is constructed of specially treated steel, the joints being fastened by means of galvanized nuts and bolts (especially designed for the purpose). There are four guy wires (broken up by strain insulators, of which there are 28—seven to each guy wire); one end of each being fastened to the mast at a point 250 feet above the ground, and the other anchored 315 feet from the base of the mast.

Eight feet from the ground the mast terminates in a large porcelain "socket," 12 feet across, that fits over the 8-foot ball-shaped top of a big porcelain base, which is imbedded in a concrete foundation—thus it is seen that a socket-and-ball mounting permits the mast during high winds to "give" in any direction, without straining the base mounting, Fig. 1.

Current leakage to ground during wet weather is kept to a low value due to the shape of the porcelain base, which is designed to have a long leakage path, and to the fact that the potential between the base of the antenna and ground is very low, thus greatly reducing the tendency toward leakage.

Since this tower compares in height with the Woolworth Building, it may have occurred to the technician that the structure presents a hazard to 'plane avigation. However, this possibility was one of the first factors to be considered in the design, the result being that the mast-antenna, the buildings, and the entire surrounding acreage, are flood-lighted.

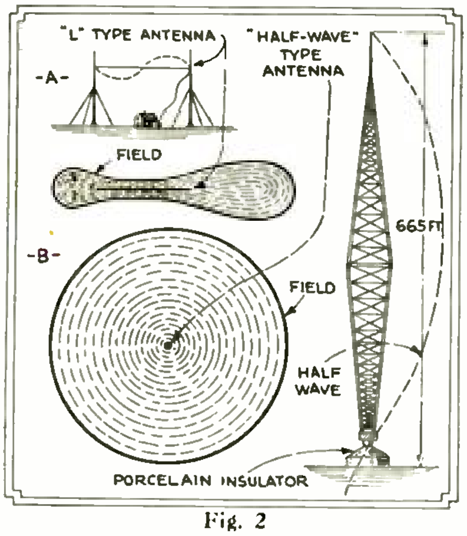


Fig. 2

The "service area" obtained when using a horizontal antenna, A; and a vertical antenna, B.

Going back now to the remote studio, we find that long-lines connections carry the program over wires run above-ground to within 1,000 feet of the "transmission house," the intervening distance being traversed through underground cable; a precautionary shielding measure which prevents pick-up of the powerful electrostatic and electromagnetic fields surrounding the mast-antenna when it is in operation. The telephone lines terminate at the "speech input" room, where the program is monitored, and then fed to the modulator tubes.

From the "transmission house," (40 feet high), the 50,000 watt output is carried by a two-wire transmission line, on 15-foot poles, to the little 12-foot "coupling house," which is only five feet from the mast; in Fig. A, it is shown nestling close to the base of the mast-antenna. A single, heavy lead runs from the "coupling house" to the base end of the mast-antenna.

As is well known, every antenna radiates both a "sky" wave and a "ground" wave. The sky wave travels upward at an angle until it reaches an ionized layer called the "Heaviside layer," when the sky wave is reflected and refracted, returning to earth at some distant point; it is this wave that accounts for the long distance transmission of some stations. The ground wave, on the other hand, travels close to the ground, and it is this wave that supplies the energy for local reception. Therefore, the more energy we can get into the *ground* wave, the more stable will be local reception.

The novel WABC mast-antenna solves this problem by concentrating most of the energy in the ground wave, thus minimizing the possibility of fading within the most desirable, or "service" area, Fig. 2.

Still another feature of this type of radiator lies in its directional qualities. The usual "L" antenna radiates more energy in one direction than in another, while the energy distribution by the mast-antenna is approximately the same in all directions.

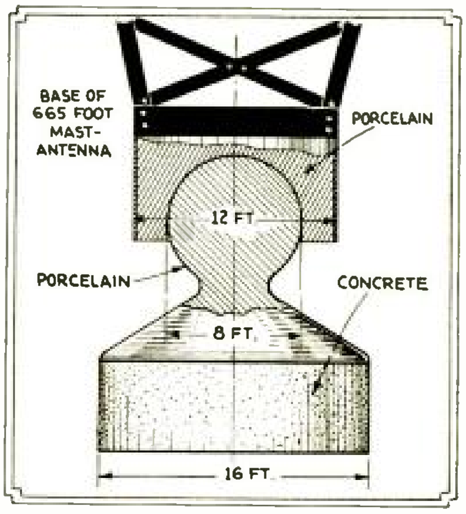


Fig. 1

At the base of the mast. One reason for small leakage is the long path from the base-to-ground length.

The new WABC installation is expected to be in operation in a short time, with a 24-hour watch. Technicians are awaiting with great interest the reports of reception from the new WABC "tower aerial."

The Dynamic Microphone

An interesting description of a new Western Electric unit

By LOUIS MARTIN

MANY experimenters have, in the past, conceived the idea of using the loud speaker, of either the magnetic (moving iron) or dynamic (moving coil) type, as a telephone transmitter or "microphone." Even Alexander Graham Bell after developing the telephone receiver (the forerunner of our present-day magnetic loudspeaker), in 1877, experimented with it as a transmitter, or magnetic microphone.

Reviewing the successive steps in their development we find that the loudspeaker has outstripped the microphone in general efficiency, due mainly to the use of the "dynamic" principle of operation, in that a "moving coil" actuated by voice frequencies is arranged to float in a magnetic field (which, if produced by a field-coil designates the device as an electro-dynamic loudspeaker; or, where permanent magnets are used instead, a magneto-dynamic loudspeaker).

Although we have known all these years of the reversibility of the moving iron mechanisms, and the many advantages of a moving coil type of construction, it remained

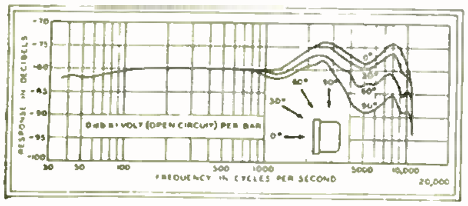


Fig. 3

Curves of response versus angles of incidence of sound.

for the Bell Telephone Laboratories to design a high-efficiency magneto-dynamic instrument, manufactured by the Western Electric Company, that adds a new word to radio terminology, namely, the "Moving Coil Microphone," Fig. A.

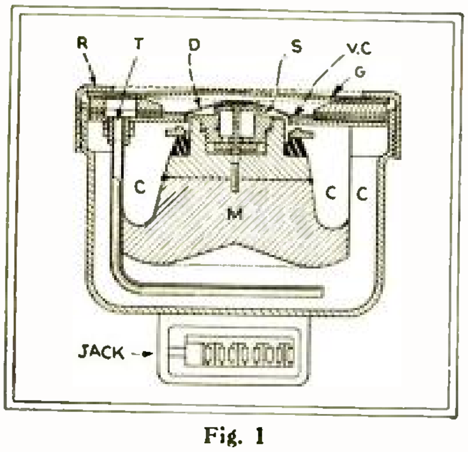


Fig. 1

Cross-section of the Dynamic Microphone, in which the letters have the following meaning: R, clamping ring; T, pressure-equalizing tube; D, diaphragm; S, air gap; VC, voice-coil; G, protective grille; M, permanent magnet; C, cavities.

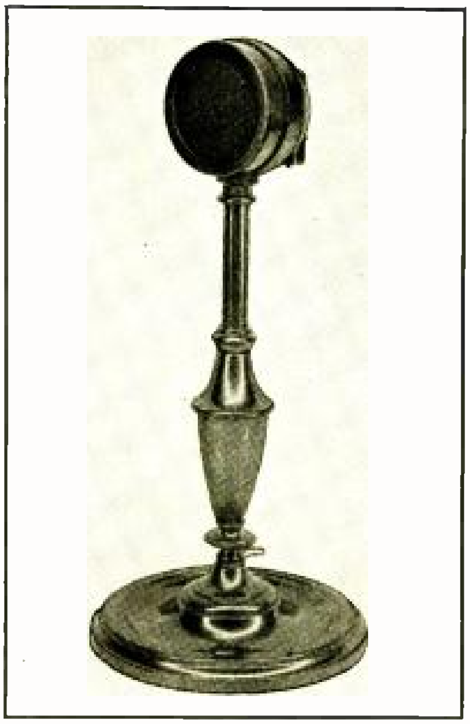


Fig. A

The Dynamic Microphone mounted in the "announcer"-type stand.

Types of Microphones

The microphone has advanced to its highest state of perfection in its "carbon" type, since it is capable of relatively high energy output (—36 DB), and is fairly sensitive and rugged; and yet, this instrument possesses the following disadvantages: First, its frequency response is not sufficiently good at the higher frequencies to warrant its use for real high quality broadcast transmission; second, the use of an energizing battery is necessary to secure reasonable sensitivity, and; third, the carbon granules weld or "pack," making the operation of the microphone extremely erratic.

The announcement of the "condenser" microphone, (consisting of two parallel plates, one of which is movable with respect to the other), with its excellent frequency response characteristic, was a boon to high quality reproduction. Still, although undoubtedly one of the best that can be secured, it has several physical disadvantages which materially limit its use. In the first place, its high impedance necessitates the use of a high voltage exciting battery, connected to it through a resistor of high value. The battery in itself is not only an inconvenience, but its associated microphone unit and resistor form a high-impedance line which absolutely requires that an amplifier be located within a few inches of the assembly; of course, this amplifier must have its quota of batteries and cables.

To eliminate the above-mentioned difficulties (or at least minimize them) has been the aim of almost every acoustical engineering laboratory; and the outgrowth of a long series of experiments, the purpose of which was to design a microphone that would retain all of the excellent features of the condenser type, and at the same time remove its limitations, is the new Western Electric Type 618-A "moving coil" microphone shown in the photograph.

The Magneto-Dynamic "Mike"

Essentially it is composed of a diaphragm A supporting a voice-coil VC of fine aluminum ribbon, wound *edgewise* in the field of a permanent magnet M, as shown in the cross-section view, Fig. 1. When sound waves impinge on the diaphragm, the coil (to which it is rigidly attached) vibrates with a plunger-like motion, cutting the lines of force, and thus generating across two terminals a potential which is substantially constant from about 35 to 10,000 cycles. The use of the permanent magnet obviates the necessity of utilizing any exciting batteries; and since the impedance of the voice coil is only 25 ohms, that of the line load also is low. These factors combine to eliminate the batteries and the local amplifier.

The diaphragm A, is made of duralumin .0011-in. thick, and has a dome-shaped center portion which extends to the inner edge of the moving coil. This type of construction stiffens the center so that the diaphragm has a plunger action throughout the entire audio-frequency range.

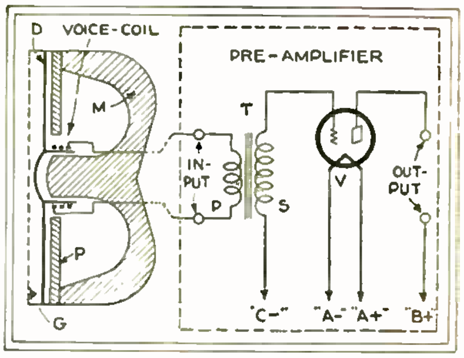


Fig. 2

Circuit for Type 618-A microphone and remote pre-amplifier (not always needed). Transformer T matches the "mike," and tube V.

The moving coil VC consists of about 65 turns of aluminum ribbon, .001-in. thick and .008-in. wide, edgewise wound; the turns are insulated with phenol varnish which serves also as a binder for holding together the adjacent turns. The coil is fastened to the diaphragm with spar varnish which is baked at a temperature sufficiently high to drive off any of the volatile matter that may be present. This insures a rigid bond between the adjoining surfaces.

Clamping of the diaphragm to the periphery of the housing is effected by the use (*Continued on page 301*)

"PERMEABILITY TUNING"

200 *to* 550 *Meters Without the Use of Variable Condensers*

An amazing method of tuning without recourse to variable condensers. Wide-awake Service Men, set builders, and experimenters will acquaint themselves with the fundamental facts concerning this new development in radio receiver design.

By R. D. WASHBURNE

Fig. A
The Permeability Tuner.

THE radio public have, in the past, been deluged with propaganda tending to create the impression that this or that idea is one of the outstanding achievements of modern science. As a result, the public has become pessimistic regarding the practical outlook of such speculative advances—and justly so. In presenting this discussion on "permeability tuning," RADIO-CRAFT does not imply that it is radically new, but rather that it represents a very decided advancement in the design of modern radio receivers. The use of condensers as a means of tuning has been utilized for such a long period of time, that it becomes difficult to think of tuning without the use of them.

Should this method of tuning ever become universally adopted, we may expect increased efficiency in ganging tuning controls, increased compactness, higher gain, band-selection tuning and the elimination of that very troublesome device—the variable condenser.

DEEP-ROOTED in most of us is the idea that variable condensers; or, at least, a variometer construction, is absolutely necessary (but for a few well-known exceptions) in order to tune a radio receiver. Therefore, it comes somewhat as a shock to find that we must revamp all our old ideas, and look forward to the appearance of radio sets which, without benefit of variable condensers or interleaving coils, tune over the 200- to 550-meter band by changing the inductance of a coil through variation of its "permeability." The completed instrument, illustrated in Fig. A, is the "Permeability Tuner" which crowns the laboratory work of Mr. W. J. Polydoroff of Chicago.

Of course, the fundamental system for changing the resonant frequency of a tuning circuit (in simple words, "tuning-in") was to vary the number of active turns in an R.F. coil; for instance, by winding and unwinding wire on a tube—one of the first "tuners" consisted of two tubes, one an insulator and the other a conductor, the unused portion of the tuner wire (which was bare) being shorted out of action by winding it onto the conductive tube, as shown at A, Fig. 1; also, by tapping the coil (using for this purpose a tap-switch or a slider), as shown at B in the same figure (an expedient in controlling the tuning range is to shunt across the inductance a fixed condenser C1).

By reversing, as shown at C, the operation illustrated at B—that is, replacing the variable inductance and fixed capacity, by a fixed inductance and variable capacity, L2 and C2, respectively, we arrive at the manufacturers' idea of good receiver design.

Among the many intermediate stages of development, we must not forget the old Electro Importing Company's collapsible helix construction, shown at D, in Fig. 1:

(*Continued on page 299*)

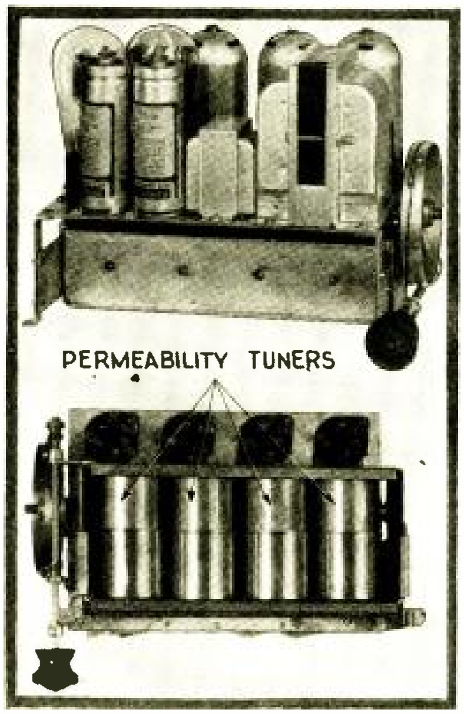


Fig. C
A perfected laboratory receiver.

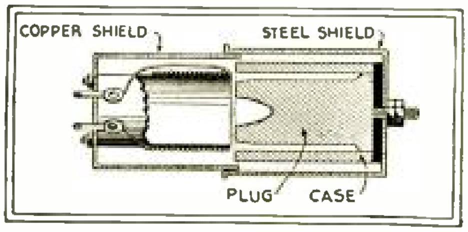


Fig. 4
Cross-section of an assembled tuner.

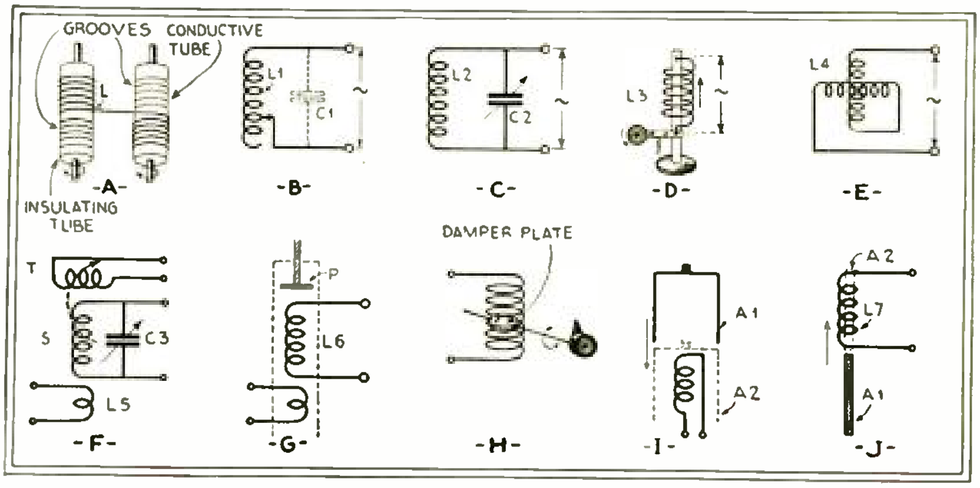


FIG. 1 *Various methods of "tuning" a radio receiver. "Permeability tuning" is obtained if a magnetic material is adjusted with respect to the coil of wire, an example of the principle is J.*

The NEWEST and MOST IN-

The latest radio equipment is described here for

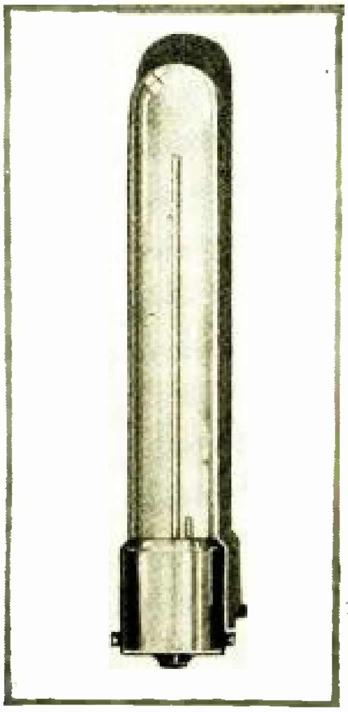


Fig. A
The neon station indicator.

neon resonance indicator
flashograph (neon V.I.) pentode radio
improved screen-grid automotive set
superheterodyne-type condenser gang
new radio service tools
caesium-type photoelectric cells
battery-powered superheterodyne
pentode-receiver power transformer
combination line- and volume-control

WITH the increasing complexity of radio receivers, various methods have been used by set manufacturers to facilitate the tuning-in of broadcast stations. Milliammeters connected in the plate circuits of the detector or amplifying tubes, and gas-filled bulbs connected across the loud speaker terminals, have been successfully used in the past. A new device, known as the "Tune-A-Lite," Fig. A, has recently been announced, whose principle of operation and method of connection have aroused considerable interest of late.

Meters connected in the plate circuit of tubes, for the purpose of indicating when a station has been tuned to resonance, possess a few undesirable features. Gas lamps connected across the loud speaker terminals, while instantaneous in responding to changes in signal strength, indicate by varying their *intensity* of illumination.

The "Tune-A-Lite," described herein, incorporates all of the advantages of the gas-filled tube and at the same time indicates changes in volume by the *varying height* of a column of red neon light.

As shown in the illustration, Fig. A, this new tube mounts in an ordinary automobile headlight socket; it measures 3½ in. high and ½ in. in diameter. Internally, the tube has two elements; a long *cathode* 3 3/16 in. in length, and a short *anode* ½-in. in length. The space is filled with *neon* gas.

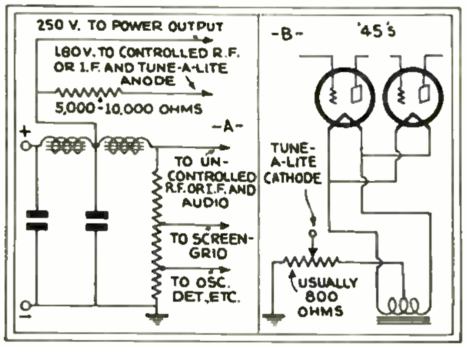


Fig. 7
Using the neon tube to indicate distortion in A.F. amplifiers. At A, the anode connection; at B, the cathode.

Resonance in Height of Neon

As the voltage across any gas tube is increased from zero, a particular value of voltage will be reached where the tube will just *begin* to glow. This voltage is called the "ignition" voltage. If the potential across the tube be further increased, the *intensity* of the glow increases, but in this particular tube it is spread out so that the *length* of the glow increases.

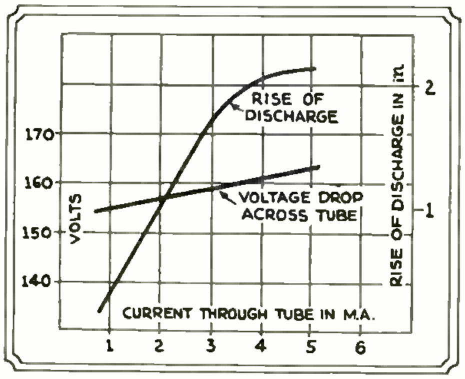


Fig. 1
Electrical characteristics of "Tune-A-Lites."

This is the important feature of the tube. The chart of Fig. 1 shows how the rise of the glow discharge varies as the current through the tube is increased.

To determine the ignition voltage, and the potential at which the tube will "go out" (called the "extinction" voltage—they are different in the majority of gas tubes) the circuit of Fig. 2 is used. The value of R is increased from zero until the tube *just glows*. The value indicated by V is the ignition voltage. If the resistance R is decreased, from a high value, until the tube *just goes out*, the value of the potential as read by V will be the extinction voltage.

The circuit of Fig. 3 may be used to determine the approximate length of time that these tubes may be used at their rated-maximum current of 8 ma.

A brief review of the theory underlying the principle of operation of this type of volume indicator will not be amiss.

Automatic Volume Control

These tubes are especially adapted to receivers employing A.V.C., that is, automatic volume control; although they may be used

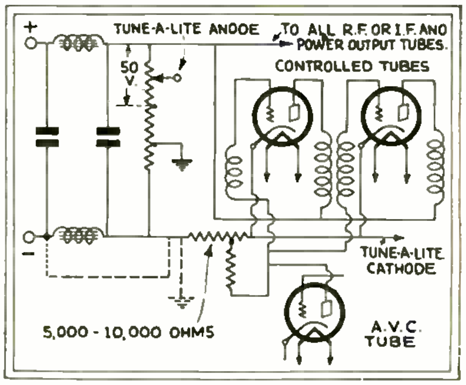


Fig. 8
Connection required for receivers employing a separate A.V.C. tube.

with manually operated V.C. receivers. When a signal is applied to the grid of an amplifier tube, the plate current of course alternately increases and decreases with the signal, the *average* plate current remaining the same. The signal voltage passes to the V.C. tube which, as a consequence of its action, increases the grid bias of the amplifier, thus *lowering the average plate current*. The actual plate voltage therefore rises due to the decreased voltage drop in the plate circuit of the tube. The Tune-A-Lite takes advantage of this situation and uses it for its operating principle.

From the theory of operation outlined above, it is obvious that the tube should be connected between those points in the circuit, whose voltage will increase and decrease with the signal. Suppose the amplifying tubes that the A.V.C. controls all have their "B+" leads connected together at a common point before entering the power unit, and a high resistance be placed between this common connection and the power unit as shown in Fig. 4. Now if the Tune-A-Lite be connected between the common point and the bleeder resistance in the power unit, it will function for the following reason.

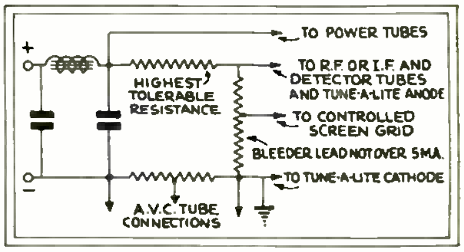


Fig. 6
Connections for receivers using resistance filtering.

(*Continued on page 301*)

TERESTING RADIO DEVICES

the trade, Service Man, and home-constructor.

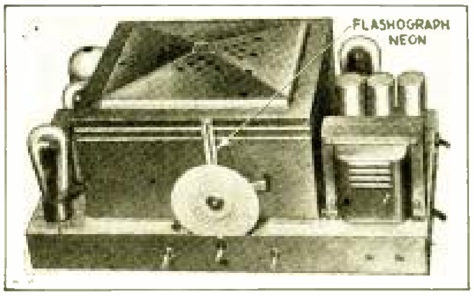


Fig. A

The Fada "Flashograph" models "48" and "49."

THE FADA MODELS "48" AND "49"

WITH the coming of Fall, manufacturers have been advertising their latest contributions to the radio field. The Fada models "48" and "49" are alike electrically; the model "48" is a Lowboy and the "49" a Highboy) recently announced, possess some rather unique features which warrant attention.

The chassis of these receivers, Fig. A, is of the superheterodyne type, employing four type '35 variable-mu tubes in the single R.F., *first detector* and two intermediate stages; three type '27 tubes for the oscillator, second detector, and first A.F.; two '47 pentodes in push-pull for the final audio stage, and an '80-type rectifier. The use of variable-mu tubes reduces to a considerable extent hum, hiss, cross-talk and other background noises.

To avoid the effect of internal vibrations (microphonics, etc., which sometimes are encountered because of vibrating tuning condenser plates), the entire variable condenser assembly is shock-mounted.

The A.F. component of the output of the second-detector, Fig. 1, is passed on to the first A.F. tube, while the D.C. component is used to change the grid bias on the R.F. and I.F. tubes for automatic control of volume.

Instead of using the conventional tuning meter for visual indication of station resonance, these receivers employ the new neon "Flashograph" which is described in this issue. "Fada" products are manufactured by F. A. D. Andrea, Inc.

SCREEN-GRID AUTOMOTIVE RECEIVER

AN exceptionally sensitive and selective automotive receiver employing standard "A.C."-type tubes is the "Advance" Automotive Radio Set illustrated in Figs. B and C. This chassis has been tested by RADIO-CRAFT Laboratories and merits special attention.

On a cross-country trip of considerable length, this receiver easily met all expectations, bringing in not only the programs of nearby stations, but also those originating at considerable distances. Of considerable interest was the manner in which stations could be heard in so-called "dead spots"; and it was only when passing big power plants or going under large metallic structures (bridges, etc.), that any change in results was noticed. In the former instance a certain amount of static was picked up; and in the latter, the signal volume was temporarily reduced.

Figure C illustrates the convenience of the control-unit placement. A single box comprises the tuning knob, tuning dial, volume-control knob, and a key-lock switch. The control cable from this, leads underneath the instrument-board, as shown in Fig. C; and continues on through to the opposite side of the dash-board, as shown in Fig. B.

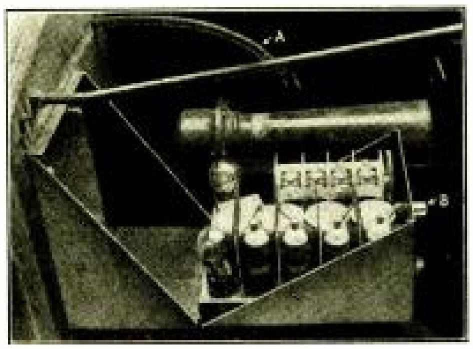


Fig. B

View of the Advance automotive receiver chassis; and tuning cable, A.

The structural conveniences built into this chassis should appeal to every Service Man installing one of these receivers; and should appeal also to the consumer, who may be called upon from time to time, to replace a tube or two. As shown in Fig. B, the metal cabinet (which acts also as a shield) is divided into two sections; one of which bolts to the dashboard, while the other is hinged, and drops to the position shown, for convenience in installation and service. Thus, the "Advance" set may be serviced in less time than almost any other automotive chassis. The aligning condensers are readily accessible.

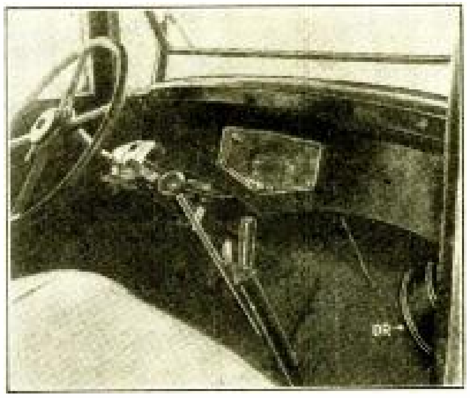


Fig. C

Control unit (on steering post) and dynamic reproducer, DR.

The tuning shaft A must be disengaged from the gear system controlling the tuning condensers, when the cabinet is open; in the closed position, it locks into a receptacle, B.

The "Advance" chassis, which is manufactured by the Advance Radio Co., incorporates cathode- or heater-type tubes, thus eliminating the noise pickup in the tubes preceding the output power tube; four '24's, and a '71A power output tube being used.

A particularly convenient and efficient installation, showing the position of the dynamic reproducer is illustrated in Fig. C. This unit, DR in the figure, is of the "automotive" type, and therefore incorporates design features which overcome the difficulties incident to operating a radio set in a moving car.

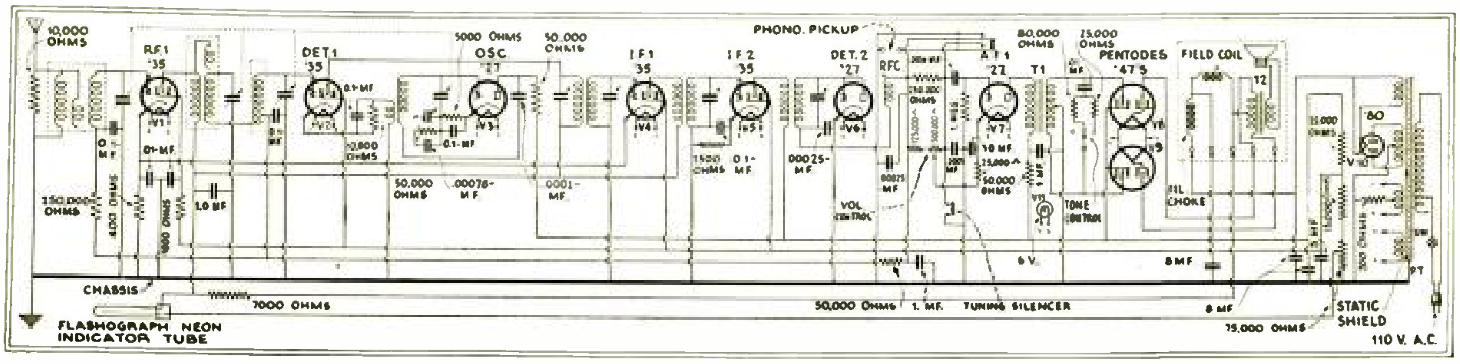


Fig. 1

Diagram of the Fada models "48" and "49" receivers. This chassis is of the superheterodyne type employing a diode detector, a Tune-A-Lite for indicating maximum response; and is equipped with an automatic volume control and push-pull pentodes.

SUPERHETERODYNE-TYPE CONDENSER GANG

A NEW line of gang tuning condensers, the recently announced models "300-A" and "400-A" (the former illustrated in Fig. A), has several features that are worthy of mention.

The entire assembly is completely shielded, and each condenser in turn, is shielded from the one adjacent to it. This unit is particularly adapted to superheterodyne receivers. When the R.F. tuning condensers are connected to a coil of 232.7 microhenries and the oscillator condenser to a coil of 187.7 microhenries, the receiver will tune from 550 to 1500 kc.

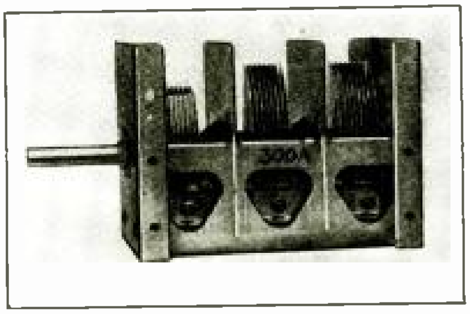


Fig. A
The type "300.A" superheterodyne-type 3-gang condenser.

The most important feature of this "superheterodyne-type" variable condenser gang, which is manufactured by Precise Products Co., Inc., is that it eliminates the "padding" condensers previously required in order to maintain correct ganging over the entire tuning band.

A "DOG" FOR SERVICE WORK

A RECENT development in the field of radio service instruments is the introduction of a "dog" or clamp for the purpose of tightly holding a condenser, dial, or volume control shaft while adjustments are being made on the receiver; this unit is the "shaft catch" illustrated in Fig. 1.

The "shaft catch" is designed to fit all standard radio sets; and may be attached or removed in a moment. A felt pad on one face of a "U"-shaped piece prevents marring the panel.

The "dog" itself is only 3½ ins. long and about ½-in. wide, and consequently should find a place in the Service Man's kit.

This tool is distributed by Blan the Radio Man, Inc.

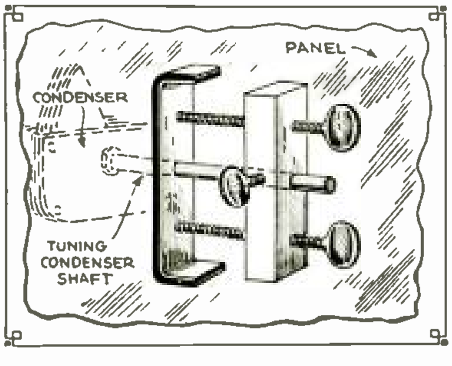


Fig. 1
When the thumb screws are turned, "frozen" shafts are easily removed.

THE NEW PHOTOELECTRIC CELLS

PHOTOELECTRIC CELLS have been used in the past for a variety of purposes, and to further popularize their utility, two new cells have made their appearance on the market. One is a *potassium* cell shown at left, Fig. B; and the others are of the *caesium* type.

The potassium type has a sensitivity of 5 microamperes per lumen. It has an anode of nickel ribbon, the bottom of which is

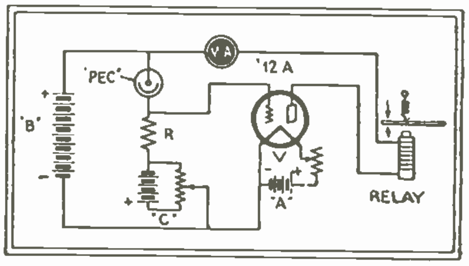


Fig. 2
Diagram of connections for the "PE" cells.

screened to prevent any leakage between the anode and cathode.

The caesium cell has a much higher sensitivity, or 28 microamperes per lumen. The photo-sensitive surface is coated with a very thin layer of caesium—hence the name.

Figure 2 illustrates the manner in which a light-sensitive or *photoelectric* "PEC" may be connected so as to operate a relay, which in turn may actuate any electrical circuit desired. When a potassium cell is used the value of R should be about 10 megohms,

Fig. B
Left potassium cell. Right, and center caesium cells.

and the "B" approximately 135 volts. If a caesium cell is used then R should be about 2 megohms, and the "B" potential 90 volts.

These cells are manufactured by the Arco Tube Company.

A BATTERY-OPERATED SUPERHETERODYNE

THE new RCA-Victor Model R-43 Radio Receiver illustrated in Fig. C is "self-powered." It is an 8-tube battery-operated superheterodyne receiver employing the Eveready "Aircell" type of "A" battery, and four heavy-duty "B" batteries. There are five type '30 "general purpose" tubes, and three screen-grid '32's in this receiver.

Since the aircells are rated at 600 ampere-hours, and since the current drain of the receiver is only 0.48-amp., it is possible

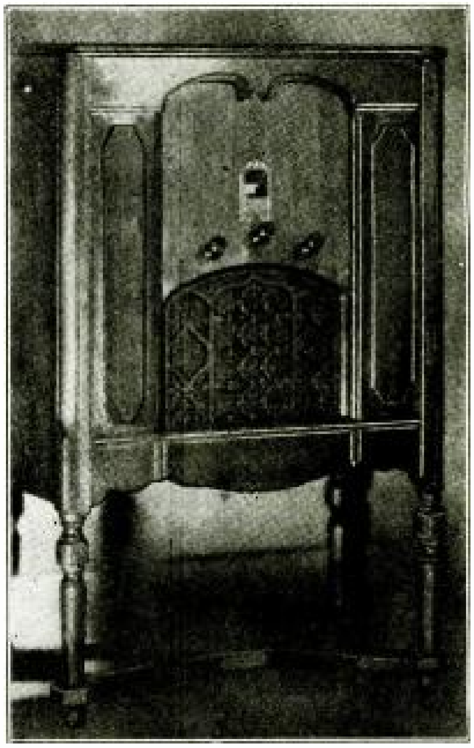


Fig. C
RCA-Victor Radiola Console R-43.

to obtain 1200 hours of operation.

This chassis brings to those who are located in "D.C." districts, or where there is no power supply at all, the numerous desirable features of its big brother, the "electric" set.

High power output is obtained through the use of two type '30 tubes in push-pull; their output is fed to a magneto-motive (or permanent magnet) type of dynamic reproducer; built into it is a special frequency-compensating circuit.

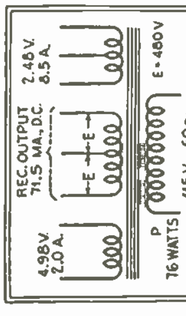
A PENTODE-TYPE POWER TRANSFORMER

A NEW power supply transformer especially designed to accomodate three to five heater-type tubes, a pentode, and an '80 rectifier, has been offered to manufacturers of "small-space" receivers.

This new unit, illustrated in Fig. D, is built with a single shield for "through chassis" mounting, and is equipped with conveniently located soldering lugs, arranged for an efficient circuit layout.

There are four windings; a primary, a high-voltage (480 volts on either side of the center-tap) secondary, an '80 filament winding, and a heater winding.

Figure 3 is a schematic illustration of the instrument, which is manufactured by the Thordarson Electric Mfg. Co.



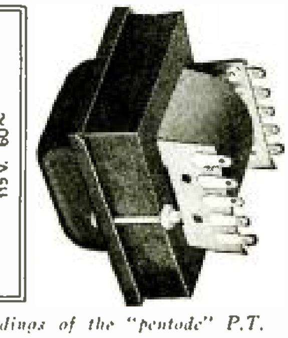


Fig. 3, left. Windings of the "pentode" P.T. Fig. D, right. Photograph of the transformer.

A SIMPLE TEST PROBE

A SIMPLE TEST probe, that may be carried in the vest pocket, and used for a variety of purposes, has been offered to the radio service field. The general construction of the device is illustrated in Fig. E; a small flashlight lamp, housed in a partially concealed socket is the indicator. Some of the purposes for which this probe may be used are: Locating condenser opens or

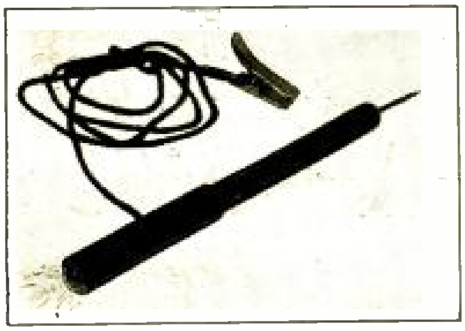


Fig. E

The test probe and battery leads.

shorts, burned-out resistors and wiring, checking the presence of filament or heater voltages, testing the continuity of all low-resistance circuits, checking the correctness of tuning coil polarity, aligning tuning condensers, and for testing high voltage and low current with a neon tube. It is also a very handy trouble lamp.

This simple and convenient device is produced by the Electrical Manufacturing Corp., Boston, Mass.

Fig. F

A new combination volume control and line switch.

A COMBINATION LINE AND VOLUME CONTROL SWITCH

COMBINATION line and volume control switches have been in use for some time, but should be especially adaptable in present day midget, automotive and aeroplane receivers; in fact, in any location where space is at a premium. One of several new combinations recently announced, is indicated in Fig. F.

They are products of the Clarostat Manufacturing Company.

RESISTOR REPLACEMENT GUIDE

AT some time or another, every Service Man has had occasion to replace resistors in a receiver, but was at a loss to know the exact size or type required. While service manuals are the ideal solution to the problem, they are necessarily bulky, with the result that many men do not carry them

(*Continued on page* 308)

"Haywire Antennas" vs. the Antenaplex System

(Part II)

By E. JAY QUINBY*

THE advantages to be gained by the installation of the "Antenaplex System" of radio reception in a typical apartment house or multi-family dwelling are obvious to those of us who have already been initiated, but for the benefit of those who have not had the experience of struggling along under the handicap of the usual topsy-turvy tangle of antenna wires and crossed-up lead-in lines, the outstanding points are listed herewith:—

1—Elimination of the disorderly and unsightly jungle of wires and their makeshift supports, which clutter up the roof and make for inconvenience and hazard to the persons desiring to use this valuable open-air space for other purposes.

2—Elimination of the unsightly lead-in wires usually run down through court yards and along side of building walls, which present an encumbrance to awnings, flower boxes, and balconies, and which often mar the otherwise pleasant vistas from the windows of the various apartments.

3—Elimination of the noisy and intermittent reception and interference so often caused by various antenna wires and lead-ins swinging together.

4—Elimination of extended interruptions to programs caused by a carelessly erected antenna falling across several others, and creating short circuits and grounds.

5—Elimination of the interaction, caused by re-radiating receivers connected to antenna wires run in close proximity to other antennas.

6—Elimination of the fire hazard caused by improperly installed antennas with unauthorized types of lightning arrestors, or without benefit of any lightning arrestors.

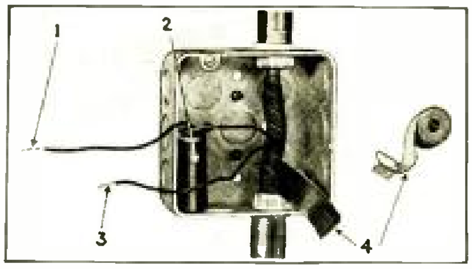


Fig. F

An oversized outlet box is used for the convenience of the installers. The antenna lead is shown at 1, the taplet, 2, ground lead, 3, and rubber tape, 4.

7—Elimination of the broad-tuning effect so often caused by excessively long lead-in wires, which are necessary to reach the rooftop antennas of tall buildings.

8—Elimination of the local interference so often picked up by long lead-in wires, from such sources as X-ray or violet-ray devices, electric refrigerators, oil burners, elevator motors and controls, signal systems, telephone systems (particularly the dial type) vacuum cleaners, thermostat regulators (in electric irons, heating pads, light flashers, etc.), flashing electric signs, neon lights, and a host of others too numerous to mention.

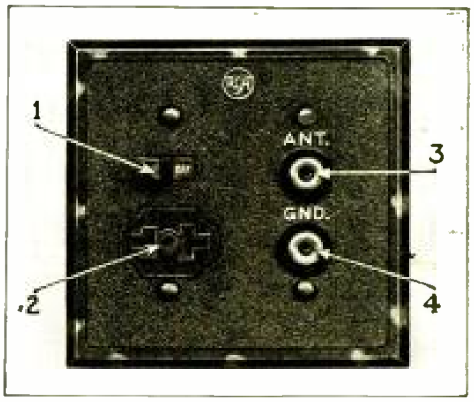


Fig. G

Combination radio outlet, line receptacle and line switch.

9—Elimination of the wear and tear on the premises, caused by the continual construction and reconstruction work on antennas, as old tenants leave and new tenants arrive—and as permanent tenants change their ideas on the subject of antenna construction.

10—Elimination of the handicap endured by tenants on the lower floors, who never get as good results as those situated closer to the roof—and the antenna.

These are *some* of the reasons why the Antenaplex system adds to the comfort and enjoyment of the dweller in a multi-family house.

The process of installing the system in new construction work and in existing structures is very simple. First, we will describe the procedure in a new construction job, beginning with the original layout work, or "survey."

Survey and Layout

If the building construction has advanced sufficiently far, it is advisable to make an actual test at the top of the structure to determine the best location for, and direction in which to run the antenna, employing a portable battery type receiver for this purpose. If, however, the building is still "on paper," it will be necessary, of course, to defer this operation until a later time. The "antensifier," Fig. A, or group of "antensifiers," as the case may be, should be located in a pent house, as near as possible to the proposed antenna lead-in.

(*Continued on page* 302)

** National Sales Engineer, Centralized Radio, RCA Victor Co., Inc.*

REMOTE CONTROL of Public Address Sound Amplifiers

(PART IV)

Continuing the discussion of high-power amplifier systems as engineered for the best operation in large institutions.

By ELI M. LURIE, B.E.E.

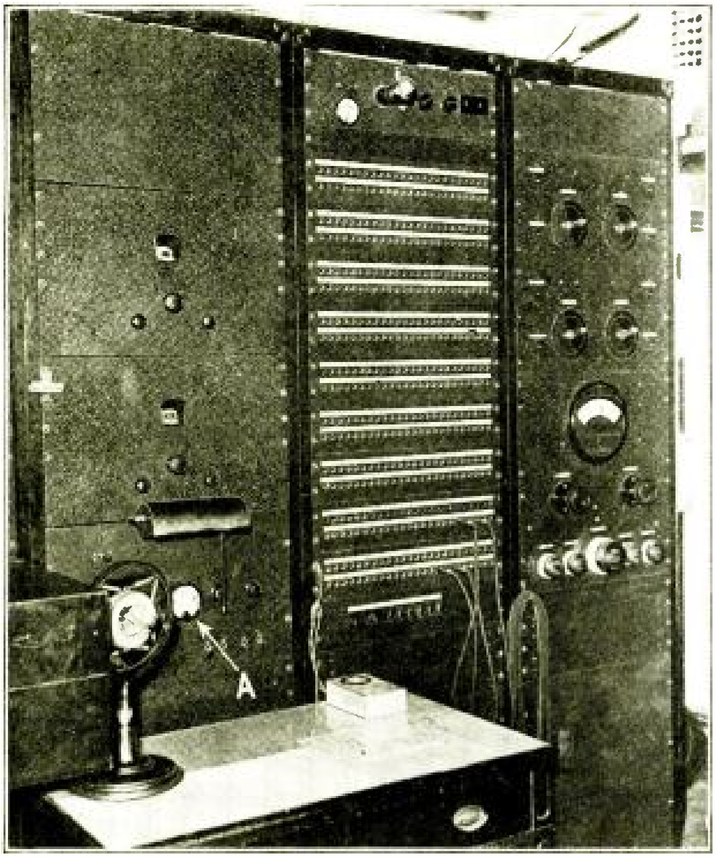


Fig. C
A photograph of the control panel of the Hotel New Yorker, showing the distribution jacks; and, A, volume-level indicator.

IN this article, the fourth in a series (the third article describing this installation, and entitled, "Remote Control of Radio Reception," appeared in the August, 1931 issue.—*Tech. Ed.*), we continue with a description of the remote controlled Public Address System in the Hotel New Yorker.

One of the notable features is the method of remotely connecting the speakers. On the remote control box are six buttons. Five of these buttons are arranged to operate speaker relays, which place various speakers into operation by connecting the voice coils to the line. The sixth, or the button labeled "Reset," when pushed, disconnects all the voice coils from the line. Thus it is possible to go into any of the public rooms, plug the remote control box into an outlet, tune in a broadcast station and then by merely pushing the speaker buttons, transfer the signal to any or all of the other public rooms.

The schematic circuit of the relays (Note 1) used for this purpose is shown in simplified form in Fig. 1 and a photograph is shown in Fig. A. The wires A, B, C, D, E and "Reset" go directly to the remote control box outlets. When the remote control box is placed into operation, these wires are connected to the buttons on the box. As a button is pressed, the relay corresponding to that button operates and pulls down an iron lever or relay arm which throws the voice coil of that speaker into the output circuit of the P. A. The lever arm continues to remain in this position until the use of the speaker is no longer desired. When the "reset" button is pushed, all the speakers are simultaneously disconnected from the output circuit of the system.

In addition to the five remotely controlled dynamic speakers there are portable speaker outlets placed throughout the building. Therefore, any number of speakers may be connected, but only the five main speakers are operated remotely. A "Lectern" or speech re-enforcement speaker is also used. This speaker consists of a "cluster," or group, of three dynamic speaker units operating together, and is used almost entirely for speech re-enforcement in the center of the Grand Ball Room.

Phasing of Reproducers

The dynamic speakers used in the New Yorker have an impedance of 15 ohms. The fields each require 110 volts at .75-ampere; this is supplied by the D.C. lighting system of the hotel. Each speaker or group of speakers has an impedance-matching transformer mounted directly at the speaker. It matches the impedance of the speaker to the transmission line, which has an impedance of 500 ohms.

A very important test that must be made when a group of speakers are operated together is that of correctly "phasing" them. To be correctly phased, the voice coils of all the speakers must "push and pull" together. If a speaker unit is "out of phase," then its voice coil will be "drawn in," while the voice coils of the other speakers are "pushing out." Under such conditions the sound emitted by the "out-of-phase" speaker will actually represent the back wave of the ordinary dynamic speaker operating with a baffle board. If the baffle board of a dynamic speaker is removed, then the low notes immediately disappear. This phenomenon is due to the back wave, generated by the back of the cone, meeting and neutralizing the front wave from the front of the cone.

To phase the speakers it is only necessary to apply the field voltage to the speakers, and then connect a dry cell to the voice coils and notice the direction of motion of each coil when the dry cell voltage is applied. The polarity of the dry cell should be the same on all voice coils. By touching the cone on each speaker its direction can readily be determined. When the phasing is correct, all of the voice coils should push out, and draw in, together. Reversing the connections of any individual voice coil will change its direction of motion. By using this method it is a simple matter to phase any number of speakers that are operating together.

In the New Yorker, only direct current is available. The Radio Division of the hotel therefore utilizes several motor-generator

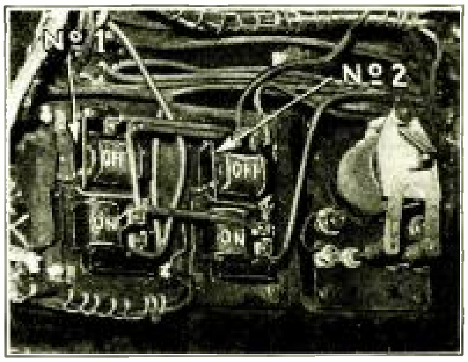


Fig. A
Speaker off-on relays Nos. 1 and 2; and, extreme right, channel A.C. input relay.

sets in order to obtain alternating current. In Fig. 2 is shown the relay system for starting the public address system. As mentioned previously, the entire P. A. System is remotely controlled and, therefore, when placing the system in operation it is imperative that starting devices be used in order to eliminate any possibility of the apparatus being overloaded.

On opening the remote control box, a button inside it is released, which automatically closes the circuit through relay No. 1, (Note 2) Fig. 2, and starts up a 2 horsepower motor. At the same instant, the dynamic speaker field voltage is applied to all speaker fields by the closing of relay No. 2, and the A.C. generator field voltage is applied by relay No. 3. The motor, therefore, begins to turn over. The automatic starter regulates the armature current and gradually brings up the motor speed. As it increases, the A.C. generator also increases its speed and begins to produce voltage. As soon as the generator voltage is high enough, the A.C. relays (Note 2) 4, 5 and 6 operate, throwing the public address system across the generator line. The generator, therefore, does not start up under load conditions.

Time Delay Relays

The plate voltage on the power tubes is not applied until the time delay relays, a photograph of which is shown in Fig. B, and a diagram in Fig. 3, operating in the plate circuit, have allowed the filaments to heat up, and then, after a period of about a minute, these relays close and the entire public address system is in operation.

The relay is actually a thermostatic relay (Note 2) operating in conjunction with a second, or main relay. On starting, the thermostatic relay is connected directly across the A.C. line. The thermostat heats up and the unit expands until it closes the gap at point X. As soon as this connection is closed, the line voltage is connected directly to the main relay coil. The coil magnetizes the upper lever arm and pulls it down closing the line circuit to the plate transformer. The instant the main relay coil pulls the upper lever arm down, the thermostatic relay is disconnected from the circuit and the main relay coil continues to obtain voltage from the line. However, when the system is shut down, the generator stops and the main relay coil then releases the lever arm and the spring pulls the lever arm back, connecting the thermostatic relay once again across the line, ready for service when operation is once more desired.

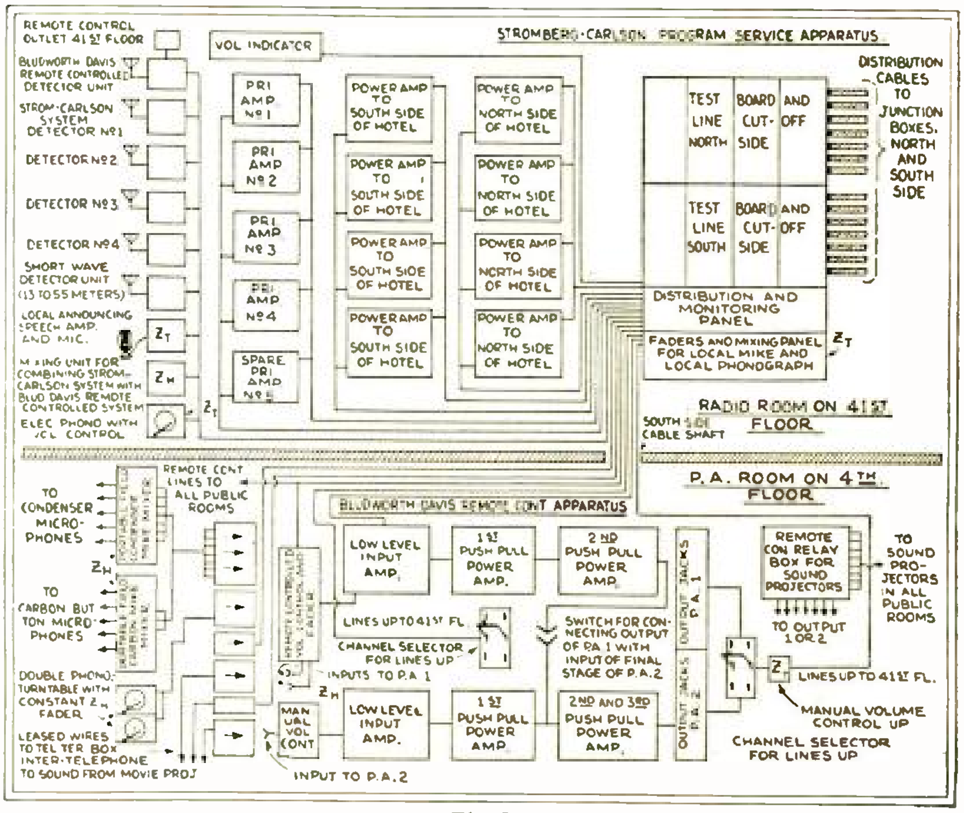


Fig. 5

A block diagram of the entire installation of the Hotel New Yorker. Note the use of the volume indicator for the guidance of the control operator in the Radio Room.

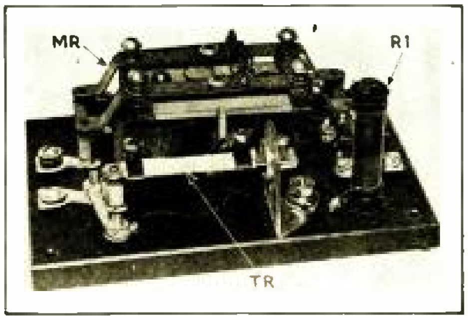


Fig. B

The plate-voltage thermostatic relay.

Many people have asked why the loudspeakers in the guest rooms were not of the concealed, flushed wall type. The answer is very simple. The use of enclosed wall speakers presented several difficulties that possibly could be eliminated if the installation were anywhere except in a hotel. Most people that stay at a hotel expect to be able to sleep at any time that they are so inclined. Naturally, therefore, the first asset of any good hostelry is not to have disturbing elements which will tend to antagonize a guest. If an enclosed speaker is set into a wall, the air column in that wall will be set into vibration when the speaker is in operation, resulting in vibration of adjacent walls; thus the people in all the surrounding rooms will be disturbed by the sound.

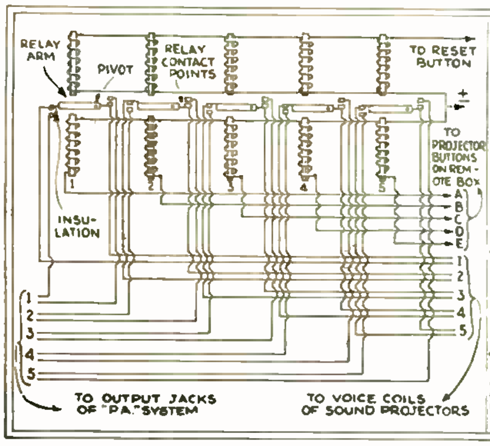
If, on the other hand, the loudspeaker be mounted externally, as in the New Yorker, then the wall in the room itself will be the only vibrating factor. Now, if the walls are made of sturdy material, and the speaker is mounted on rubber lugs so that the vibrations of the cone are not transmitted to any great extent to the wall itself, then there is little possibility of exciting the inner air chamber. If the chamber is excited, the vibrations will not come from the speaker, but from the entire room itself, which in most cases is not enough to cause serious disturbance in adjoining rooms.

Measurements made by both Stromberg-Carlson Company and the Radio Division of the New Yorker indicate that the correct level is approximately 10 decibels.

Decibels

The question of "decibels" or "DB" is one which has caused considerable confusion. Most technical writers refer to this measurement as a "ratio between certain powers," but fail to give to the layman workable

(Continued on page 304)



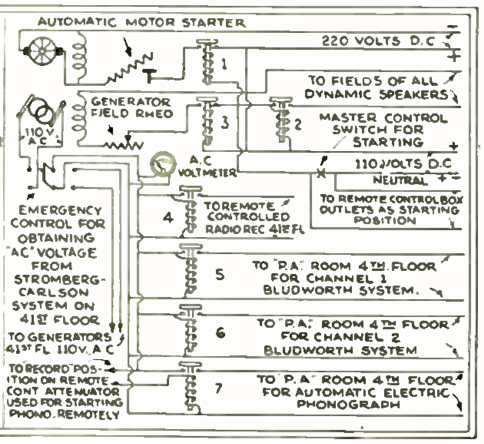


Fig. 1 **Fig. 2**

Left. The relay system for remote control of speaker operation. When the "reset" button is pressed all speakers are disconnected. Right. Relay system for control of motors and transformers.

Magic in

PART

Much material has been presented in past procedures in adapting meters to the require- first of a series, Mr. Clifford E. Denton, (who is on meters), discusses the factors which

By CLIFFORD

A modern Vacuum Tube Voltmeter (front view).

IN the last few years the use of electric meters for quick and accurate testing of radio and sound equipment has increased by leaps and bounds.

Looking at commercial meters today, we can hardly visualize the path of heartbreaking development that has extended through hundreds of years; groping for the fundamental principles, wading through false beliefs and hypotheses, all of which finally led to the development of the first *measuring* instrument—the "galvanometer."

Magnetic and static electricity was known as early as 600 B.C., but even then, and until 1600 A.D., no one realized the distinction between the two.

Later, a relation between electricity and magnetism was established, and from Ampere's idea of a simple needle suspended above a wire carrying current, came the findings of Pouillet, in 1837, where the *degree of deflection* of the needle from its original position indicated the intensity of the current flowing in the circuit.

It was realized early in the development of the art that a system of convenient standards would be necessary. Consequently, a system of practical units was adopted, which were derived from the C.G.S. (centimeter, grams, second) System.

This system of units led to the development of various complicated but interesting devices for the accurate determination of electrical values. (A detailed discussion of this system and its uses will be found in S. Gernsback's *"Radio Encyclopedia,"* Second Edition.—Tech. Ed.)

"Absolute" Measurements

The first method was shown by Faraday. He placed a pair of clean copper plates in a solution of sulphate of copper (blue vitriol) and passed an electric current through the solution. The current dissolved some of the copper from one of the plates and deposited an equal weight of copper on the other plate. Faraday showed that there is an exact relation between the strength of the current and the amount of metal removed or deposited.

Lord Rayleigh employed silver plates and a solution of silver nitrate. He found that there is deposited in one second, .001118 gram of silver, or 4.025 grams per hour. The amount of current causing this deposit is called an "Ampere." One ampere will deposit 1.177 grams of copper per hour.

The "International Standard Ampere" is now legally defined by International agreement in terms of the amount of silver deposited by it, as stated above. Figure 1A is a rough outline of how the measurements were made.

In 1898, Professors Ayrton and V. Jones designed a device called an "ampere balance." This instrument is illustrated in

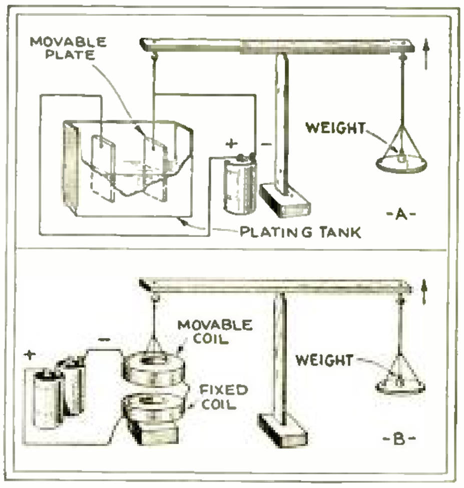


Fig. 1

At A is illustrated the electro-deposition method of measuring current; at B, dynamic method.

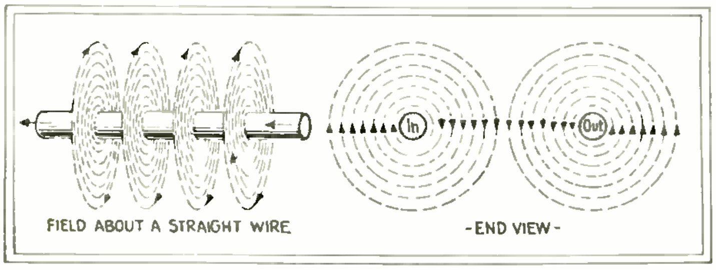


Fig. 4, above

The magnetic lines of force at right angles to the direction of flow of current in a wire.

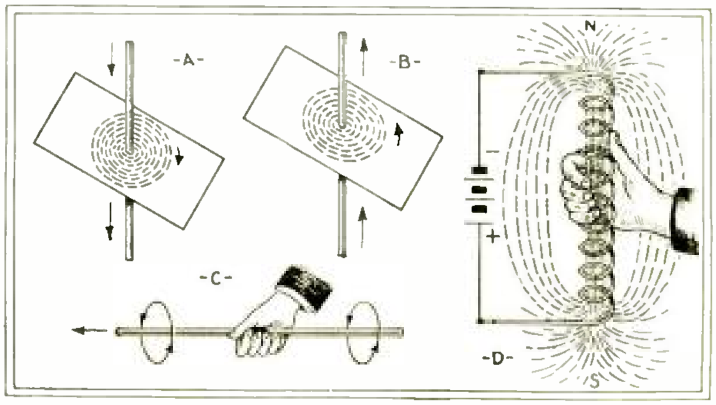


Fig. 5, right

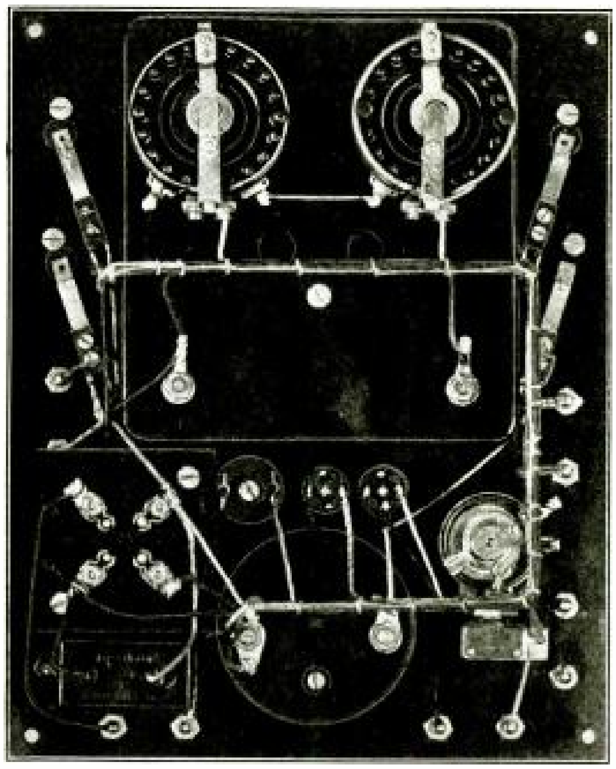
Specimens, A and B, of the magnetic field around a wire. Use of the "rule o' thumb" is indicated: at C, for a wire; and D, for a coil.

Meters

I

issues of RADIO-CRAFT, *describing the various ments of radio service work. In this article, the well-known as a radio writer, and who lectures enter into the design and use of meters.*

E. DENTON



A modern Vacuum Tube Voltmeter, rear view.

Figure 1B, and consisted of a very delicately balanced pair of scales, on one scale of which were placed weights of known value, and from the other was suspended a large movable coil. The latter then was placed above a fixed coil rigidly mounted on a base.

The scale was adjusted to balance by adding weights to counteract the weight of the suspended coil. Upon passing current through the coils, the moving coil was pulled down by the magnetic lines of force. The additional weights necessary to bring the scale back to balance gave an accurate indication of the *weight* or force of the electric current. Thus it was determined that the addition of every "gram of weight" represented 980 "*dynes* of force."

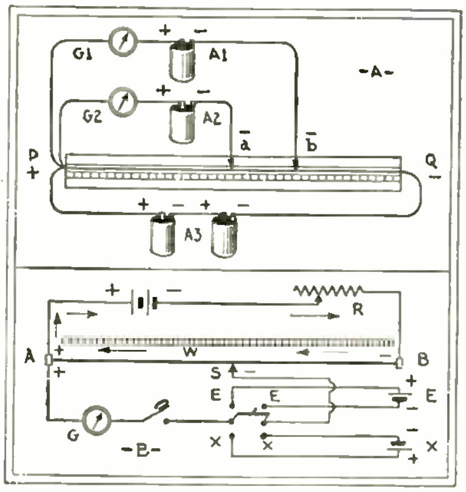


Fig. 2

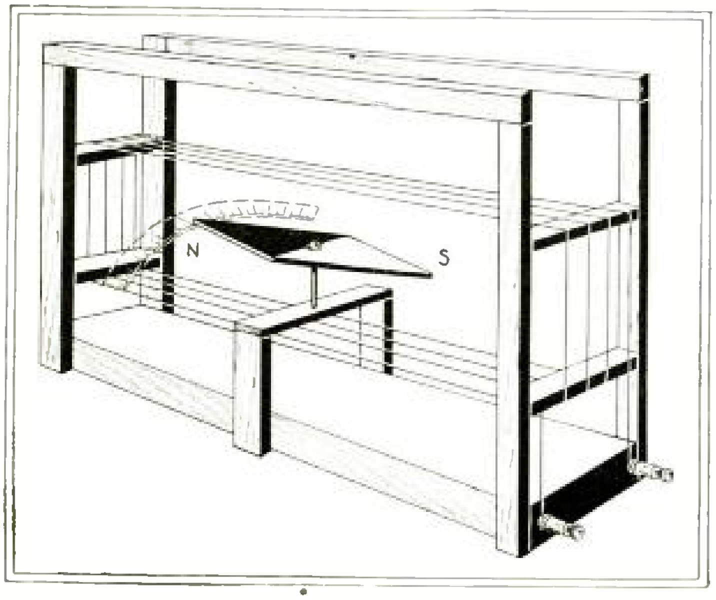
At A, above, the Poggendorff "potentiometer, and: B, a commercial adaptation.

The difficulty of applying this system was the spur which caused Professor Fleming to devise, in 1883, a much easier scheme for measuring voltages or currents. He made use of a then-existing instrument called a "potentiometer," Fig. 2, devised by Poggendorff in 1841, and modified by Fleming.

If a resistance "slide-wire" P-Q is stretched over a scale, and a steady (battery) current is passed through it, a drop in voltage across this wire will result.

Connected to the positive end of this wire are two other wires 1 and 2, with sliding contacts on the free ends, and in series with these wires are placed two galvanometers G. It will be seen that current flowing through P-Q will be partially deviated through wires 1 and 2 and the galvanometers connected in series.

In the circuit of wires 1 and 2 are inserted two different sources of electricity, A1, A2, so placed that their E.M.F.'s. (electro-motive-forces) or "voltages" (the term honors *Alessandro Volta*, an Italian physicist) tend to oppose the voltage drop produced in the wire P-Q by the current source A3. If the sliding contacts be moved until the voltage drop from the sliders to the negative end of the main wire P-Q just balances the E.M.F. of the inserted cells, A1, A2, the galvanometer will indicate zero. That is, the E.M.F. in each circuit being opposite in polarity and equal in strength, no current can flow through the galvanometer. The E.M.F. of the two cells is then proportional to the E.M.F. drop across P-a or P-b (depending upon which meter is being read). The slide-wire may be calibrated by the substitution of known values of E.M.F.



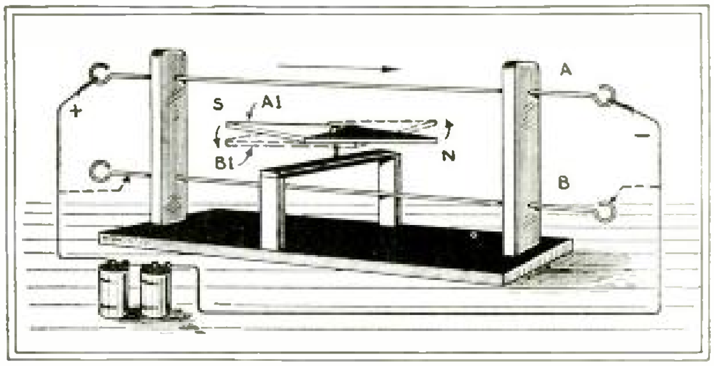


Fig. 3, above, Oersted's deflection demonstrator; Fig. 6, left, Schweigger's "multiplier."

The simple slide-wire type of potentiometer thus proves useful for *comparing* "voltages," and is commercially available today; being rated as of low-potential or high-potential type, depending on the resistance of the slide-wire. See Fig. 2. (See also, "A Home-made Slide-wire Bridge" in the Feb., 1931 issue.—*Tech. Ed.*)

The principle of operation of the commercial slide-wire potentiometer is the same

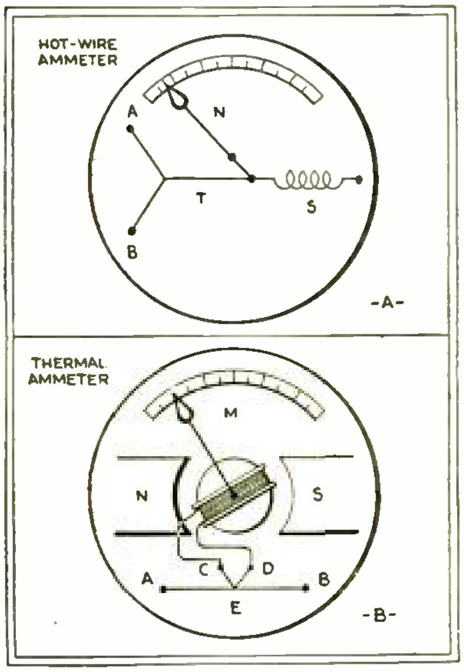


Fig. 7

"A.C." meters. At A, "hot-wire" type, and; B, a "thermocouple" instrument.

as above described, and the scale is calibrated in the proportion of the total resistance of the wire, or in volts. In Fig. 2B the standard voltage is shown at E, and the voltage to be measured at X.

First Principles

The fact that a current from a battery when passed along a length of wire would create a "magnetic field," was first noticed by H. C. Oersted, of Copenhagen, in 1820. He found that a suspended magnetic compass needle always set itself when near a current-carrying wire, so as to lie at right angles to the length of the wire; and the north-seeking pole of the needle deviated to one side when the wire was *above* the needle; and to the opposite side when the wire was laid below the needle, Fig. 3. He correctly concluded that this was due to the current creating a magnetic field of force around the wire, the direction of these lines of force being in circles, which lie in planes perpendicular to the direction of the wire, as shown in Fig. 4.

There is a definite relation between the direction of current flow and the direction taken by these lines of force, as shown in A and B, Fig. 5, a fact which enables us definitely to determine the *polarity* of any "electromagnet."

Rule O' Thumb

A useful reference is called the "rule of the thumb,"C, Fig. 5. Simply grasp the wire in the right hand with the thumb extended along the wire in the direction of the current flow, "+" to "—". The curved finger tips will then indicate the direction of the *magnetic field.*

In the instance of a coil, grasp the solenoid with the right hand *so that the fingers point along the wires in the direction of the current flow.* The thumb then points to the north pole—that is, the thumb points in the direction of the magnetic flux passing *inside* the coil, D, Fig. 5.

A man named Schweigger, about 1821, modified Oersted's original idea, and wound many turns of silk-covered copper wire over and under a pivoted magnetic compass needle, in the manner illustrated in Fig. 6. This was called a "multiplier" because it

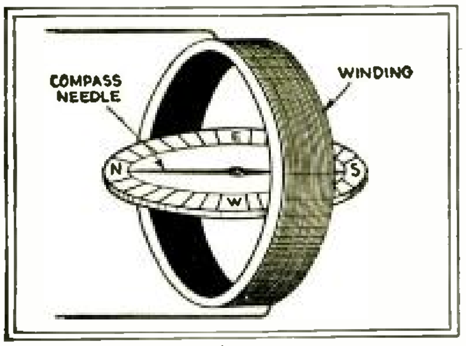


Fig. 8

The "tangent galvanometer."

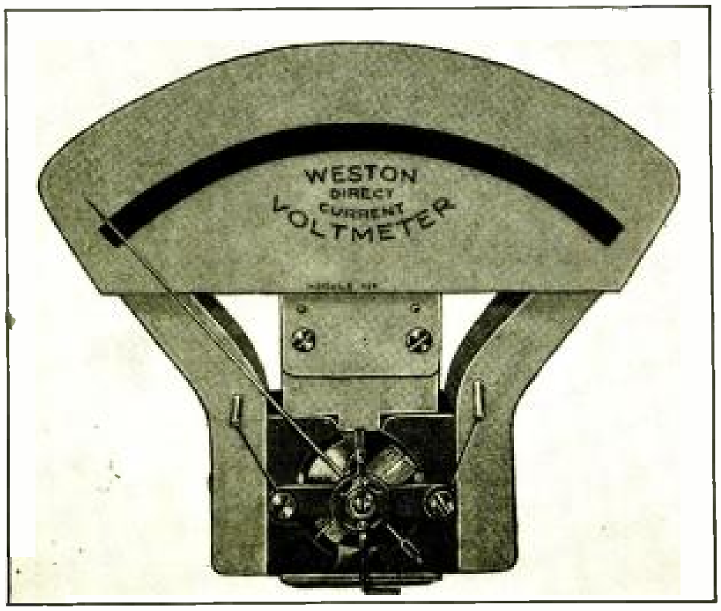


Fig. A

A commercial meter of the "D'Arsonval type. The moving coil turns between the tips of an inverted "U" permanent magnet. Its connections and polarity are shown in Fig. 9. Actually, the direction of current flow is a matter of definition; although it is generally assumed that current enters a meter at the terminal marked "positive," and leaves at the "negative."

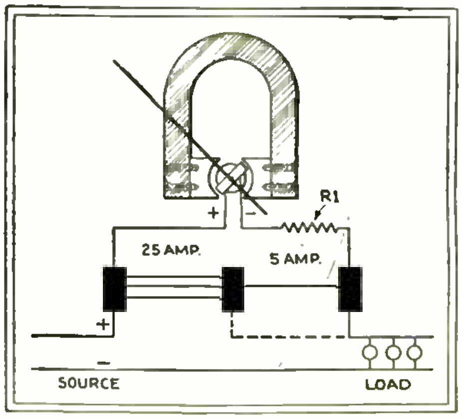


Fig. 9

Schematic circuit of the meter illustrated in Fig. A. Resistor R1 compensates coil constants.

increased the effect of the current on the needle. This apparatus was the first "galvanometer" ("galvano-", after *Luigi Galvani*, an Italian physicist).

Since the invention of the galvanometer, measuring instruments have been developed for measuring electricity in all its ramifications.

There are meters for measuring the *quantity* of electricity flowing in D.C. and A.C. circuits; for measuring the *force* at which the electricity circulates through the circuit; and for measuring the *power* developed by the combination of this quantity and force.

Galvanometers sometimes were called "rheometers," from the Greek *rheo,* meaning "to flow," and *metron,* meaning "measure." The "rheostat" (-stat," Greek *statos,* "standing") is the only survival of this terminology; meaning a resistance which can be varied to regulate the flow of current.

Meters may be classified into two major types: (A) Those operating on magnetic principles, and; (B), Those known as "hot wire" instruments which operate by virtue of the expansion of a resistance wire when

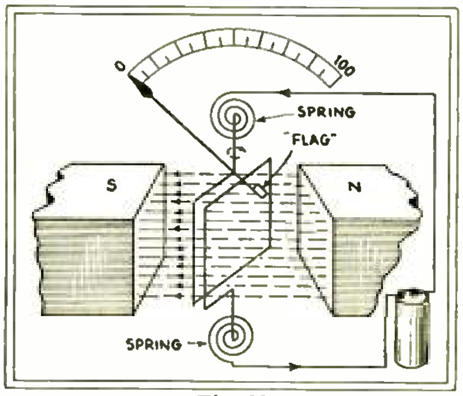


Fig. 10

The D'Arsonval principle of operation.

heated by an electric current. Figure 7B, shows a modification of the magnetic principle where an alternating current heats two *dissimilar* metals; C and D make contact with the hot wire A-B. The heat produced at the junction or "thermo-couple," E, generates a voltage which is carried to the D.C. meter, M, which indicates in proportion to the amount of current flowing in its circuit. (The theory for this odd effect is still in doubt.) These methods are used to measure "high frequency" currents.

The hot wire ammeter depends for its action upon the expansion of a metal wire

(Continued on page 306)

The Service Man's Forum

Where His Findings May Benefit Other Radio Technicians

RECEPTION UP NORTH

Editor, RADIO-CRAFT:

I received the issues and wish to thank you for the prompt mailing; they happen to contain exactly the points in circuits and experiments that have been missing links in my study of the best R. C. A. models.

I am not a professional, but only making gifts to people in remote districts of Canada, after I have exhausted all information possible in order to keep them advised on how to operate successfully the Radiola "28" and "VIII," especially.

They report Cuba and Mexico, as well as coast to coast in the United States; except for the northeastern United States and eastern Canada, which still remains a "dead spot," even for research engineers. The point is on the west coast of Hudson Bay, 500 miles from any radio station. With RADIO-CRAFT'S advice, wonderful success has been enjoyed.

VIRGINIA B. WALLS,
12 *East Division St., Chicago.*

RECTIFIER REPAIRS

Editor, RADIO-CRAFT:

Recently it was necessary to service an old Hammarlund-Roberts set, which was equipped with a Philco "B" power unit; the "Philcotron" jars were in bad shape, and no replacements were available in the vicinity. Nevertheless, the set must be in order that evening, since some relative of the owner was making her debut at a broadcast studio. Well, Service is our motto!

Prying off the tops of the four jars, I pulled out their elements and, with a hack saw, cut through the insulation of each aluminum (cathode) rod, half an inch from the bottom, as illustrated at A in Fig. 1.

I had in my kit some 3/8 aluminum rod, from which I cut four pieces, each 3/4-inch long; I drilled a hole half an inch deep to fit the exposed core, threaded for 6/32 aluminum screw at the tap on the side; then slipped the extension on the end of the aluminum core and tightened the screw. The joint between the insulation and the aluminum end insulation was covered with three applications of tire cement, to prevent corrosion at this point. Then I got a pint of distilled water and a small box of borax, and made a saturated solution. After that had settled and cleared, the jars were cleaned and filled to the lower line; and ten cents' worth of castor oil was added to prevent evaporation. The tops of the jars are fastened with No. 14 wire around the groove, twisted tight.

If the Service Man runs across one of these power units and is forty-five minutes from Cortlandt Street (*"Radio Row," in New York City*) he can save three or four dollars and give real service, or build a power unit with these junk parts.

S. M. SMITH,
15 *Franklin Place,*
Woodmere, L. I., New York.

(Nothing seems quite so aggravating to readers outside the metropolis as the casual air with which a city Craftsman writes: "I picked up this part for 38 cents on Cortlandt Street," when explaining how a set was built around it. But there ought to be a few compensations for anyone who has to take a 45-minute ride in the New York subway.—*Editor.*)

CONVERTING A STORAGE BATTERY

Editor, RADIO-CRAFT:

I have been a subscriber since the first publication of RADIO-CRAFT, and I am pleased to say that I am quite sure no other publication can equal it for information and the kind of material it contains for the Service Man and for those who delight in experimenting and rolling their own.

I cannot help thinking that many of the old-timers have fallen by the wayside and no longer build their own as they used to do. I think the reason is that they have been stung so many times by trying the wonderful circuits and constructional ar-

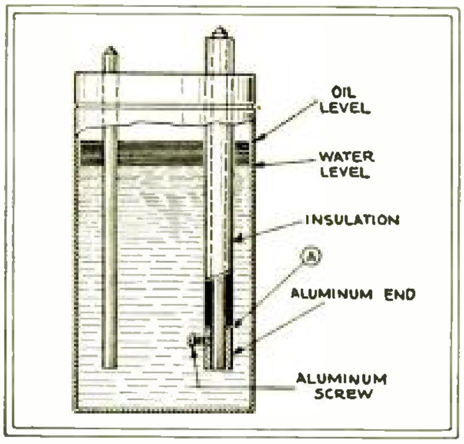


Fig. 1

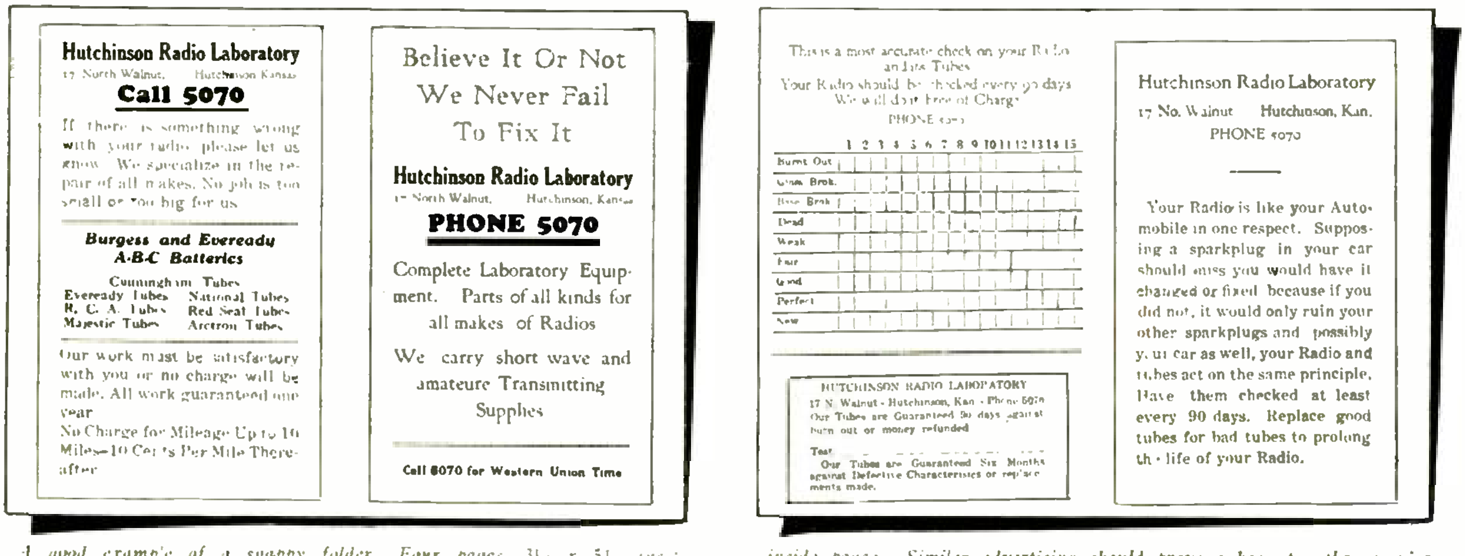
Rejuvenating a Philco "B" power unit. Part of the aluminum cathode of this "B" jar is replaced.

ticles which are published in certain magazines—*not* RADIO-CRAFT—just for the purpose of filling up their pages. I cannot help feeling that such articles must do a magazine considerable harm; whereas a real good constructional one will increase the circulation to a great extent, and help to build up the interest which should not be allowed to drop.

I have been in the servicing business for the past eight years; but find the same slack in the summer time; so I fill in on construction. By the way, I do not know how I would get along without the RADIO SERVICE MANUAL and its SUPPLEMENTS.

I hope to see in the near future an article dealing with the construction of a *real* superhet. with the new '30 D.C. tubes.

(*Continued on page 308*)



A good example of a snappy folder. Four pages, 3½ x 5½ ins.; inexpensive pink stock. Left, the front and back; at the right, the inside pages. Similar advertising should prove a boon to other service organizations.

Favorite Testing

Described In Detail By

Laboratorians, Service Men, technicians in all branches of radio, each have their "pet" improved performance. This month we describe how to "multi-range" an A.C.-type meter; and a very complete service bench.

A 1000-OHMS-PER-VOLT MULTI-RANGE A.C. VOLTMETER

By R. D. Leonard, Design Engineer*

ONE of the important problems in the communication and radio field is the measurement of small A.C. voltages from low power sources at commercial and audio frequencies. The new *rectifier type* A.C. 0-1 milliammeters, such as the Weston Model 301, or the General Electric Type DO 14X, are ideally adapted for this purpose.

It is now possible to construct a multi-range, high-resistance A.C. voltmeter that will provide accurate A.C. measurements.

The circuit diagram, Fig. 1, shows the most convenient method of connecting suitable wire-wound resistors to provide a 0-10-50-100-250-500-1000 volt multi-range A.C. voltmeter. It is extremely important that these specified resistors be used, in order to obtain an accuracy within the limits required for radio servicing.

The correct value of the resistors to be employed may be determined by the use of Ohm's Law.

$$\text{R (ohms) equals } \frac{\text{E (volts)}}{\text{I (amperes)}}$$

In this simple formula, I equals amperes necessary to obtain full scale deflection of the meter, and (in this case) E equals the full scale reading, 0-10 volts.

For example: Using a 0-1 scale milliammeter, that you desire to use as a voltmeter which will have a full scale reading of 10 volts A.C.

$$\text{R equals } \frac{\text{10 volts}}{\text{.001 ampere}} \text{ equals 10,000 ohms.}$$

In the case of the 0-1 *D.C.* milliammeter, 10,000 ohms would be used for the 10 volts step, but in the case of the *rectifier* type 0-1 A.C. milliammeter (the rectifier unit of which has an internal resistance of approximately 1,000 ohms) the proper resistance is only 9,000 ohms.

For small scale readings above 10 volts it is not necessary to make allowances for the 1,000 ohms internal resistance of this meter caused by the rectifier. However, if a value lower than 10 volts is to be read, very careful consideration must be given to the actual internal resistance of this instrument, otherwise, an appreciable error might creep in. Usually, 10 volts is low enough for most A.C. measurements.

* Shallcross Mfg. Company.

MUTUAL CONDUCTANCE METER

By C. H. W. Nason

A TUBE may appear perfectly good as far as the normal conditions of test are concerned and yet fail to come up to the standard of its type. The three factors which really determine the effectiveness of a tube as an amplifier are: the amplification factor (mu); the plate impedance (Rp); and the mutual conductance (Gm). The first two factors are difficult of measurement with ordinary equipment; then, too, either alone fails to give a factor of merit which indicates the desirability of the tube under test as compared with others of its type. The conventional method of measuring the mutual conductance (by checking the change in plate current attending a given change in grid voltage) is clumsy and inaccurate; and it is not a definite indication of the tube under operating conditions.

Not long ago the writer was gainfully employed at a particular labor which demanded the use of tubes of known characteristics. Not only were the operating voltages of each tube checked by means of an analyzer as a matter of daily routine; but each week every tube was carefully checked on a General Radio mutual-conductance direct-reading meter.

After several weeks of regularly trotting my tubes to the whereabouts of a meter, I decided to make the proverbial mountain come to Mahomet.

For various reasons, a simplified meter

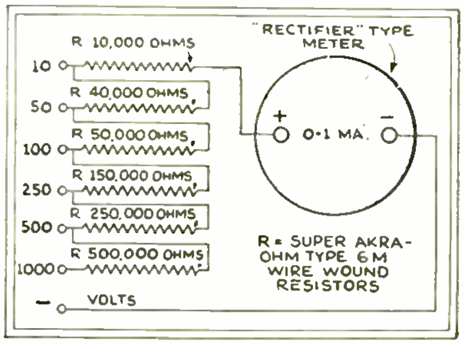


Fig. 1

A "series"-type connection of multipliers.

of the type shown in Fig. 2 cannot be used for extremely accurate tests. The errors present are, however, the same for each type of tube to be tested and, in consequence, they have little or no effect upon the comparative test desired.

As will be seen from the diagram (Fig. 2 at A), the filament supply has two positive leads for use with tubes of low or high current: the low-current rheostat is a 50-ohm unit, for use with tubes having a current rating of up to 0.5-ampere; and the other rheostat, for use with tubes drawing up to 1.75 amperes, has a resistance of 4.5 ohms. A changeover switch, required where the meter is employed with screen-grid tubes, is shown schematically in the sketch.

It should be remembered that the mutual conductance reading indicates, not *what* is wrong with a tube, but the fact that *something* is wrong; whether it be gas, incorrect spacing of elements, low emission or "what have you." Except to admit that a simple bridge structure is the theoretical basis of operation of the device, no discussion of the "why" of its operation seems in order.

The mutual conductance of the tube un-

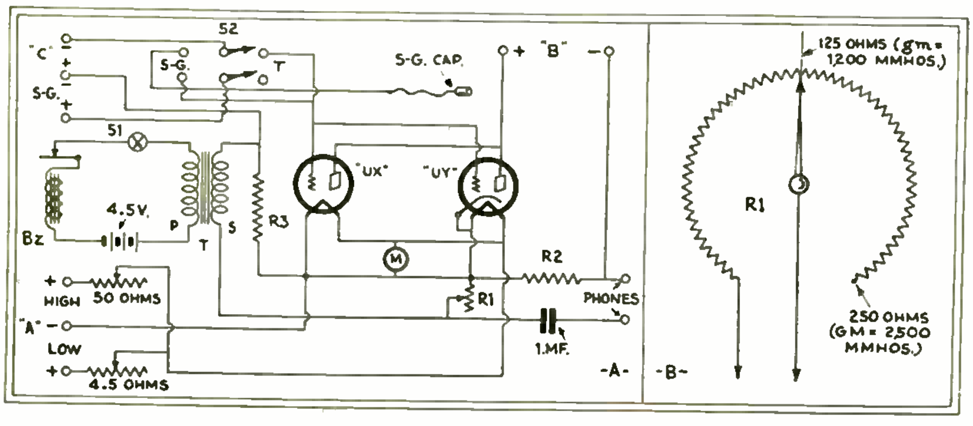


Fig. 2

(A) A "null" method of measuring "Gm." (B) Resistor R1 is adjusted for minimum response.

Equipment

Radio Servicemen

circuit or parts arrangement resulting in meter; a direct-reading tube conductance-Let us hear about yours.

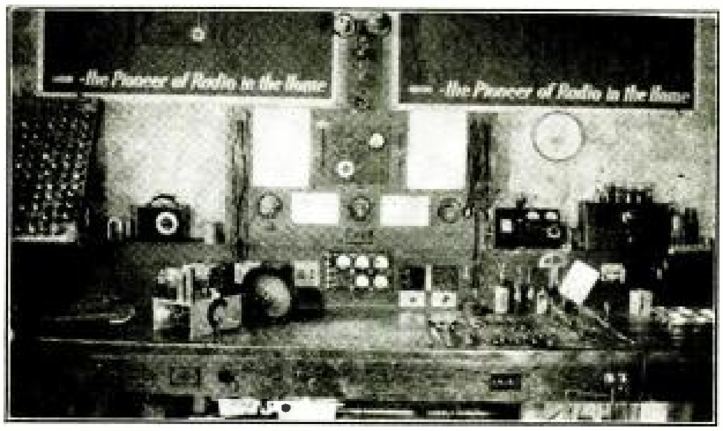


Fig. A

An efficient arrangement of a radio test-table.

der test is read directly from the scale of the variable resistor R1; this is a 250 ohm rheostat and it may be calibrated with fair accuracy—certainly within the limits set by other factors—by the simple process of dividing the arc which the indicator traverses into twenty-five equal portions. The constants of the bridge are such that each division on the scale (each ten ohms of resistance) will correspond to a mutual conductance of 100, and the scale should be thus calibrated from zero to 2500 (as shown at B).

The voltmeter has a range of from zero to 10 volts and may be any fairly accurate D.C. meter.

The method of operation is as follows: with the buzzer in operation and the tube in the socket, adjust the filament voltage to the correct amount by means of the rheostat. Now vary the calibrated rheostat until the minimum sound is heard, and read off the mutual conductance.

The tubes most likely to be tested are listed below together with their operating characteristics.

TABLE I

Tube Type	Volts Fil.	Volts Plate	Volts Grid	Volts S.G.	Mmhos Gm
'11 and '12	1.1	90	4.5		425
12-A	5	135	9		4600
71-A	5	180	40.5		1500
99	3.3	90	4.5		420
01-A	5	90	4.5		740
10	7.5	425	35		1600
22	3.3	135	1.5	45	350
24	2.5	180	1.5	75	1050
26	1.5	135	9.		1100
27	2.25	90	4.5		900
45	2.5	180	34.5		1800
50	7.5	450	84		1800
47	2.5	250	16.5	250	2500
30	2	90	4.5		700
31	2	135	22.5		760
32	2	135	3	67.5	505
35	2.5	180	1.5	75	1100
36	6.3	135	1.5	75	1100
37	6.3	135	9		900
38	6.3	135	13.5	135	900

The values of the parts shown are:

Bz—One high-frequency buzzer;

T—Transformer, about 1/1 ratio, such as used from single '71A output tube into a magnetic speaker;

M—0-10 voltmeter;

R1—250-ohm rheostat;

R2—100-ohm resistor, to carry relatively high current;

R3—1000 ohms;

No great care is necessary in the construction of the bridge; since, even with screen-grid tubes, the effective gain through the tube under test is not large enough to cause any appreciable feedback effect. The greatest amount of care will be required in the operation of the device: be certain that the switch is not in the "Screen-Grid" position when a three-electrode tube is being tested, and that the low-current rheostat is not employed with a tube drawing a high current.

No provision is made for checking the tubes to be tested for internal short circuits; so that a short-circuited tube introduced into the bridge circuit will result in the destruction of the 100-ohm rheostat, through which the short-circuited plate current will flow.

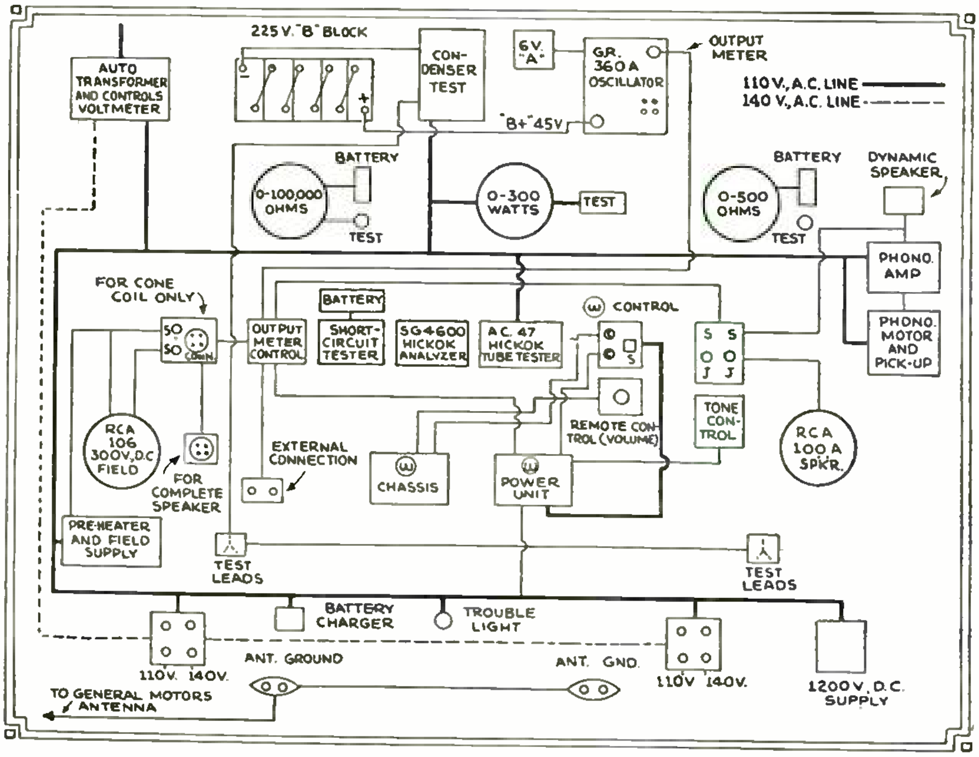


Fig. 3

A block diagram of Mr. Sewell's very complete service station arrangement. A wattmeter is included as part of the apparatus.

A PRACTICAL SERVICE BENCH

By Harry F. Sewell

THE complete and efficient service bench illustrated in Fig. A and shown in block form in Fig. 3 was constructed by the Tafel Electric Co. of Louisville, Ky. It was designed and built by the writer, over a period of two years.

The bench is of the ordinary type, being built of 2 x 12 in. wood, supported by 2 x 4 in. racks, and measures 13 ft. long. The panel-board at the rear of the bench is constructed of stripped ½-in. white pine, glued together, forming a sturdy unit on which to mount apparatus.

Panel mounting of all test equipment is preferred by the author. The equipment located on this panel is of the latest type, consisting of one General Radio type 360-A test oscillator; two ohmmeters, one having a range from 0-500 ohms and the second from 0-100,000 ohms (these, along with the 300 watt meter shown in the center of the panel, were built to the specifications of the writer by the Westinghouse Electric & Mfg. Co.); one type SG-4600 Hickok set analyzer, and; one type AC-47 Hickok mutual conductance tube tester. The balance of the testing equipment was built by the writer.

In the center of the bench at the top of the panel board is located a condenser test set, consisting of one neon lamp, one UX-874

(*Continued on page 309*)

STROMBERG-CARLSON Nos. 19, 19-A, and 20 SUPERHETERODYNES

Particular interest is attached to the Models 19 Lowboy and 20 Highboy superheterodyne receivers produced by the Stromberg-Carlson Tel. Mfg. Co., in view of these being the first of this manufacture to incorporate the superheterodyne circuit. These receivers utilize the Model 19-A chassis.

Values for the components are given below:

Resistors R1, R4, 500 ohms; R2, R6, 600 ohms; R3, R5, 6,500 ohms; R7, 10 megs.; R8, R13, (tone-control resistor) 0.1-meg.; R9, 30,000 ohms; R10, 400 ohms (hum balancer); R11, 750 ohms; R12, 10 ohms; R14, 60,000 ohms; R15, 1575 ohms; R16, 900 ohms; R17 (volume control), 1,000 ohms; R18, 60 ohms; R19, 3 ohms.

Condensers C1, C2, C3, C4, tuning condensers, shunted by trimmers C2A, C3A and C4A; C5, C16, C20, .001-mf.; C6, C7, C8, C9, C10, I.F. transformer trimmers; C11, C26, .04-mf.; C12, input coupling condenser; C13, band selector coupling condenser; C14, C15, C17, C18, C19, C33, C34, 0.3-mf.; C21, .00025-mf.; C22, 0.6-mf.; C23, .002-mf.; C24, C25, C29, C30, 2 mf.; C27, 1. mf.; C27A, C28, C29A, 3 mf.; C31, C32, .01-mf.

The intermediate frequency is 175 kc. This receiver includes a band-selector preceding the first R.F. tube; a capacity network in the oscillator circuit to maintain correct ganging of the tuned circuits; a hum-balancer (resistor R10); tone-control; phonograph pickup connections; tuned filter-choke arrangement; line pick-up noise eliminator (condensers C31, C32); and power-type second-detector (although a grid-leak and condenser are shown, the circuit operation is of the "plate rectification" type). The tone-control is called an "automatic clarifier." A high-low switch in the primary circuit of the power transformer compensates for differences in line potential. The tuning condensers have a maximum capacity of 400 mmf.

The tone-control, and phonograph switch J-S are combined in one unit.

Average operating characteristics for this receiver, at a line potential of 110 volts and the fuse in the "Lo" position, are as follows: Filament potential, V1, V2, V3, V4, 5, V6, V7, V8, 2.4 volts; V9, 4.8 volts. Plate potential (plate to chassis), V1, V2, V4, V5, 160 volts; V3, 87 volts; V6, 202 volts; V7, V8 (plate to center-tap of R10), 250 volts. Control-grid potential (control-grid to cathode), V1, V4, V5, 3 volts; V2, 11 volts; V3 (across R5), 12.5 volts; V6 (across R9), 22.5 volts; V7, V8 (control-grid to center-tap of R10), 47.5 volts. Screen-grid potential, V1, V2, V4, V5 (screen-grid to chassis), 85 volts.

In Stromberg-Carlson literature the first-detector is called the modulator, and the second-detector is called the demodulator.

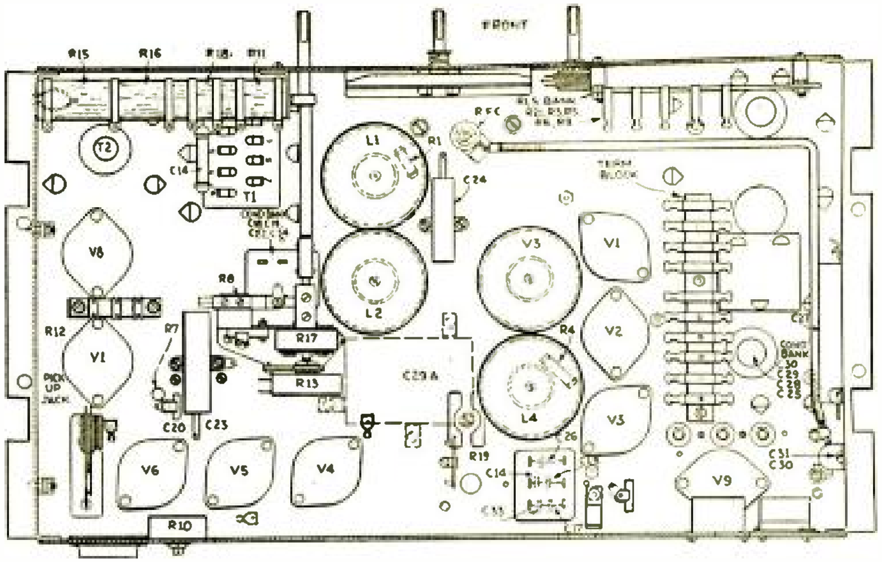
The resistors in these receivers employ the RMA color code.

It may be found that in some instances the magnetic pickup control switch is forced into its operating position (normally obtained only by fully retarding the volume control). Readjust by moving the pickup switch to its normal setting.

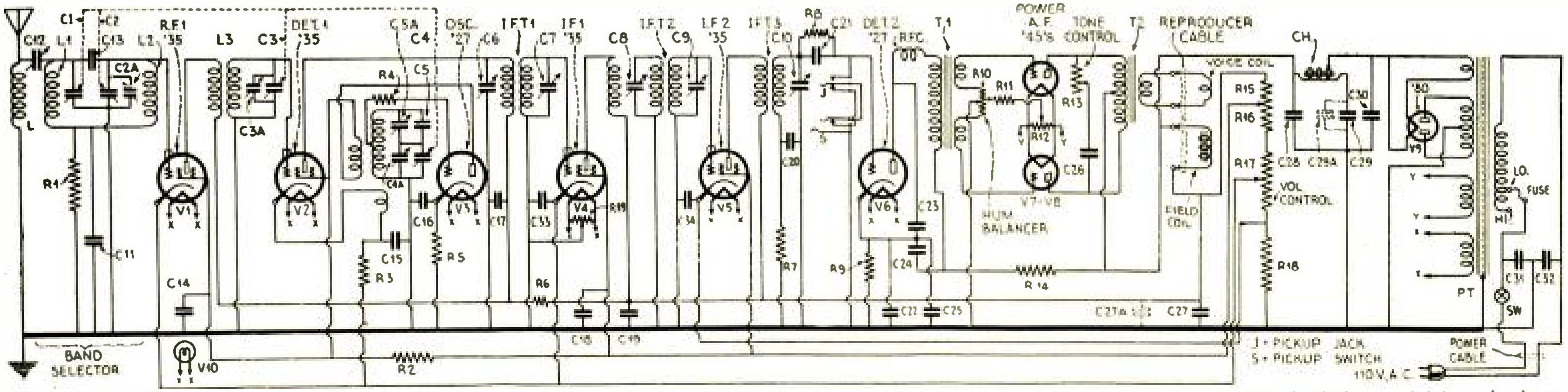
Do not test the chassis without the reproducer properly connected to it. Either the reproducer should be removed with the chassis, or the Service Man should provide himself with a four-conductor extension cord which will connect the reproducer connector plug to the connector socket in the rear of the chassis. Because of the high voltage of the circuit in which this item must be used, it is essential that the insulation be adequate to meet the demands of the filter supply.

Due to the use of a band-selector in the R.F. input circuit, it will be observed that tuning will have a "flat top" characteristic. The gain of the Model 19A chassis is exceptional; consequently, it should be possible in most instances to operate the receiver for satisfactory local reception using for an antenna only such metal-work (lathing, etc.) as may exist in the building.

The schematic circuit of the Model 19A is shown below.



Arrangement of parts on the underside of the new 19- and 20- series chassis. The reference numbers do not coincide with those in the Stromberg-Carlson manual, for this receiver, but correspond with the indicia in the schematic circuit, below.

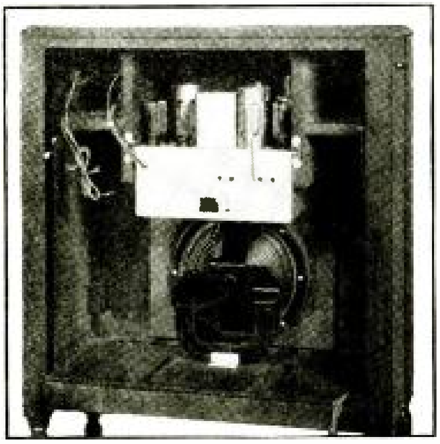


Schematic circuit of the Stromberg-Carlson 9-tube superheterodyne radio set. This is the chassis for the Models 19, 19-A, and 20 receivers. The input circuit is preceded by a band-selector. The oscillator output couples into the cathode of the first-detector (or "modulator") tube, V2.

RCA VICTOR "MODEL R-43" CONSOLE

Also General Electric Model "G. E. S-42B" Battery Console

Although numerous "Aircell"-type radio receivers have appeared on the market (See the April, 1931, and subsequent issues of RADIO-CRAFT), the Model R-43 receiver is the first one offered by RCA-Victor. As he schematic circuit indicates, a superheterodyne circuit is employed. In this chassis are used three screen-grid, 2-volt type '32 tubes, and five general-purpose, 2-volt type '30 tubes.



Arrangement of parts (rear view) in the new Radiola battery-operated 8-tube superheterodyne.

The following values are used for the resistors and condensers used in this receiver:

Resistor R1 (volume-control potentiometer), 50,000 ohms; R2, R4, 6,000 ohms; R3, 15 ohms; R5, 29,000 ohms; R6, 4,000 ohms; R7, 40,000 ohms; R8, R14, 180,000 ohms; R9, 270,000 ohms; R10, R11, 350,000 ohms; R12, R13, 1. meg.; R15, 50,000 ohms (variable); R16, 1,300 ohms; R17, 650 ohms; R18, 8 ohms.

Condensers C1, C2, C3 (tuning units), 18 to 325 mmf.; C1A, C2A, C3A (tuning trimmers), 4 to 50 mmf.; C4, 745 mmf.; C4A (C3 trimmer), 15 to 75 mmf.; C (I.F.T. trimmers), 15 to 75 mmf.; C10 (I.F.T. trimmers), 140 to 220 mmf.; C5, 745 mmf.; C6, C7, C11, 0.25-mf.; C8, 0.5-mf.; C9, C12, C14, C18, 0.1-mf.; C13, 1. mf.; C15, C16, .0012-mf.; C17, .0025-mf.; C19, .0024-mf.

Operating potentials are as follows:

All filaments, 2. volts. The remaining figures are to be read with the volume control set at minimum; voltages are read with respect to the filament. Control-grid potential, V1, V4, 22 volts; V3, 0.5-volt; V5, 5 volts; V6, 2 volts; V7, V8, 15 volts. Screen-grid potential V1, V5, 55 volts; V3, 65 volts. Plate potential, V1, V5, 155 volts; V2, 50 volts; V3, V6, V7, V8, 150 volts; V5, 90 volts. Plate current, V1, V4, V5, zero; V2, 3 ma.; V3, V7, V8, 0.5-ma.; V6, 2.5 ma.

With the volume control set at maximum, the following new readings will be noted: Control-grid potential, V1, V4, 1.5 volts. Screen-grid potential, V1, V4, 55 volts; V3, 60 volts. Plate potential, V1, V4, 155 volts. Plate current, V1, V4, 2.5 ma.

The total high-voltage-battery drain of this receiver is only 8 to 15 ma. The "A" drain is only 0.48-amp.; or a battery life of 1200 operating hours.

The precautions, mentioned in the issue of RADIO-CRAFT referred to above, concerning the correct use of the Aircell type of "A" supply, *must be observed.* Note particularly that this type of battery must not be operated at temperatures below 40 deg. F.; consequently, if it is essential to install one of these sets where operation necessarily might be required at this temperature, it will be necessary to substitute a different type of "A" supply.—for instance, a 2-volt storage-cell. This cell will not require frequent charging, due to the low filament drain of the receiver.

The tubes of the push-pull power output stage are biased to substantially plate current cut-off. The arrangement is such that the output stage may deliver substantially four times the output that would be obtained with the same tubes operated in the usual circuit. This system is very economical, due to there being but a small amount of residual plate current flowing in the output stage. Current is drawn only when a modulated signal is received.

The purpose of the extra secondary (shunted by condenser C19) on output transformer T2, is to provide a fixed high-frequency cut-off for the audio amplifier.

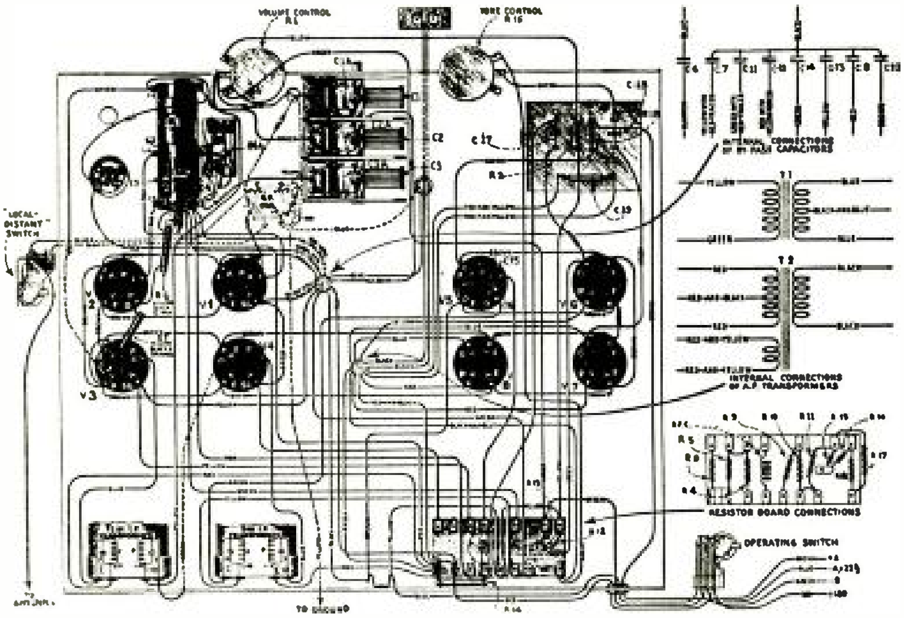
The tone control consists of a 0.1-mf. fixed condenser C18 and 50,000 ohm variable resistor R15, in series, connected across one side of the input grid circuit of the push-pull stage.

Due to the fact that the aircell *must not be overloaded* (as, for instance, by shorting, or testing with a low-resistance test instrument), there has been no attempt to obtain reproducer field current from the "A" circuit; instead, this field is obtained from a powerful permanent magnet. Many previous 2-volt-tube set models incorporated "inductor-dynamic" reproducers; but the Model 43 instrument uses a "magneto-dynamic" loudspeaker.

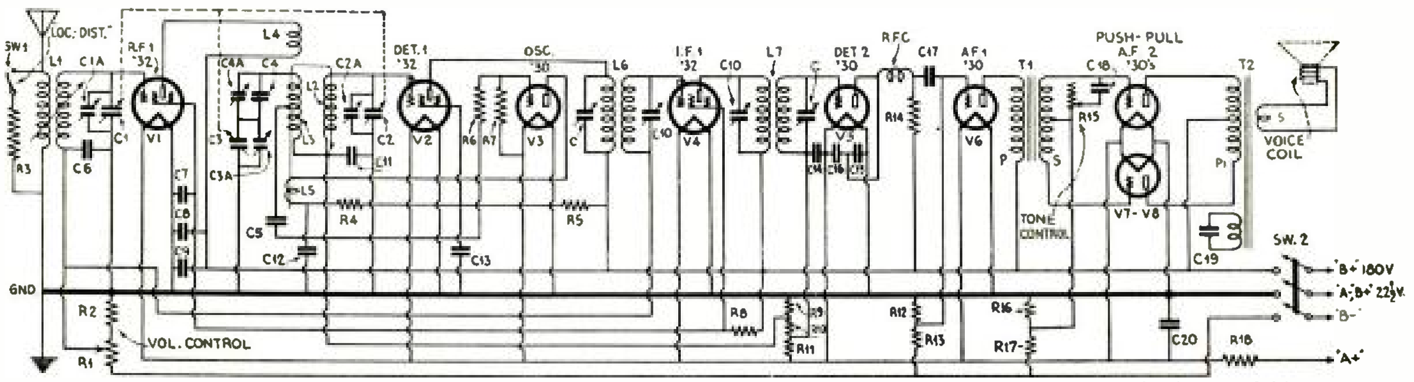
For more detailed information concerning the balancing of the oscillator, the R.F., and the I.F. circuits, reference may be made to the service information concerning a chassis which in these respects is similar—Radiola "Superette" Model R7 (Data Sheet No. 47; August, 1931 RADIO-CRAFT).

Erratic operation may be due to low "B" batteries; replace these units when their output potential has dropped 25% when under normal load.

A peculiarity which at first may not be clear will be observed in the diagram. This is the positive 22½ volts connection. This is the 22½ volt tap nearest the "B" minus tap on the first 45-volt "B" block.



Wiring diagram of the new "self-contained" Radiola model. Electrical values for the components appear in the text.



Schematic circuit of the Radiola Model R-43 receiver, which incorporates an unusual arrangement of the oscillator circuit. In addition to the usual padding-condenser connection, there is a center-tap lead to a coil inductively-coupled to the grid coil of the first-detector, affording input to the oscillator grid circuit, through C5.

Operating Notes

By and for the Practical Radio Service Man

SERVICING SPARTONS, BRUNSWICKS, AND MAJESTICS

By Bertram M. Freed

A COMMON complaint on many Sparton model "600," "610," "620" and "737" (the same chassis is used in all these types) and "740" receivers (since the "595" output tube is the same as the "'50" tube) receivers is lack of control of volume. These models are similar to all late Sparton's except for an additional tuned R.F. stage located in the band pass tuner assembly as shown in Fig. 1.

At the base of the socket for this tube, beneath the shield, will be found a 0.2-mf. condenser, which is used to bypass the cathode bias resistor network of which the volume control, resistor R1, is a part. When this condenser unit becomes shorted, the set operates at full volume because the bias resistor is shorted. This same unit is often the cause of intermittent or fading reception, where it opens or short circuits.

In order to enable the installer or repairman easy access to the sets, the different units comprising the chassis are mounted on a board which slides back from the cabinet. The volume control is mounted on a metal panel which is fastened to this same board. When the board is pushed back into place, the panel is forced back about ¼-in., often shorting the volume control lugs to the R.F. amplifier assembly.

The manufacturers of Sparton receivers have been turning out two model "737" receivers. The only visual differences between the two lie in the chassis color, and the power transformer and push-pull input audio transformer design. One model is sprayed in gold while the other is colored black.

The "black" model employs a power transformer originally designed for their old "301" model, using two '81 rectifiers, and two '50 power tubes. The filament voltage has been cut down to five volts to heat the single '80 and the pair of 183 power tubes by means of resistors in each filament leg. The high voltage output has been decreased by the addition of a large 1200-ohm resistor which is located alongside the '80 rectifier.

The cause of many inoperative "black" receivers will be found in an open resistor labeled "1200 ohms." For some reason or other, this "301" transformer, designed for heavier use does not stand the gaff. Perhaps a hundred of these units have had to be replaced because of shorted primary or high-voltage-secondary windings. When "no filament" is obtained on the '80 or 183 tubes, look to open step-down resistors.

The audio transformer in the "black" job is a Pacent, and is so closely mounted to the 183 tube next to it that the tube cannot fit securely into its socket, being forced to one side. Another hole should be drilled in the metal chassis so that the transformer can be shifted to one side a bit.

In the Sparton 400 midget chassis series, an annoying condition is often found that was at first difficult to trace. Recently one of these receivers was returned to a repair shop with an R.F. plate-to-chassis short. The several bypass condensers were checked but found perfect; as well as the common "B+" terminal located beneath the chassis, which is insulated from the chassis by means of two insulating washers that sometimes shift. All leads (in the R.F. circuits) were tested by unsoldering them from their respective lugs and terminals. It was not until this had been done that the short was located.

This set used red, shielded leads to connect the plates of the type '24 tubes to the R.F. coils. The insulation on these leads is poor and breaks down within the shield, causing the wire to short to the grounded shield. A heavy insulated, *unshielded* lead was installed to replace the defective shielded wire. These leads are indicated by X1 and X2, Fig. 2.

Noisy reception in these receivers has often been traced to dust and small foreign particles between the condenser-gang plates, which are very close together—thus making a condition such as this quite common.

The Brunswick models "14," "21" and "31" receivers employ a tuning-drive-cable arrangement that is far superior to many other systems—in which forcing the tuning knob beyond either end of the scale may snap the drive cable. This is impossible in the Brunswick receivers due to the use of a small friction gear over which the cord passes; turning the tuning knob beyond the tuning range only causing the gear to slip around. However, cases may be found where the knob can be turned without the consequent actuation of the condenser gang. Almost invariably, this is caused by a loose cord, which may be taken up by increasing the tension of the spring located on the side of the dial. The spring is attached to the free end of the drive cord on one end, and fastens to a screw on the other. This screw is in a slotted hole, permitting it to be shifted so as to increase or decrease the spring tension. After the unnecessary slack has been taken up, the screw may be tightened.

Noisy and intermittent reception on these models has often been caused by a defective local-distance switch, the blades of which become loose after some use. The remedy is usually found in replacement; though, tightening the screws holding the blades has sometimes cleared up the difficulty.

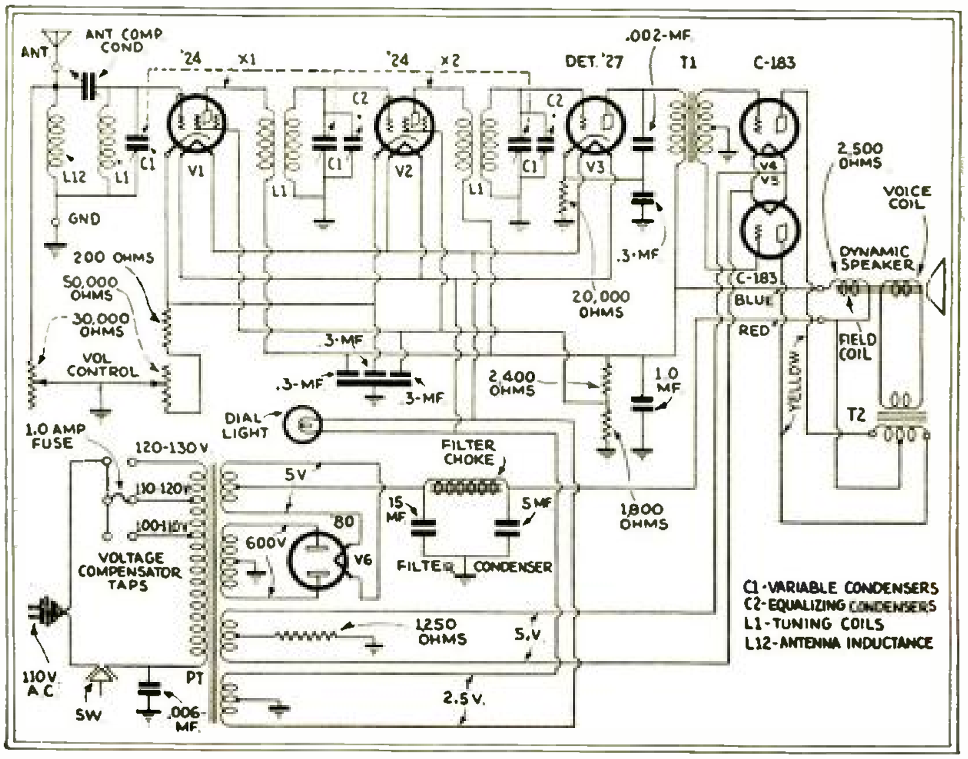


Fig. 2

Schematic diagram of the Sparton "400" receiver. Shielded plate leads X1 and X2 were replaced with heavily insulated, unshielded leads to prevent short-circuits to ground.

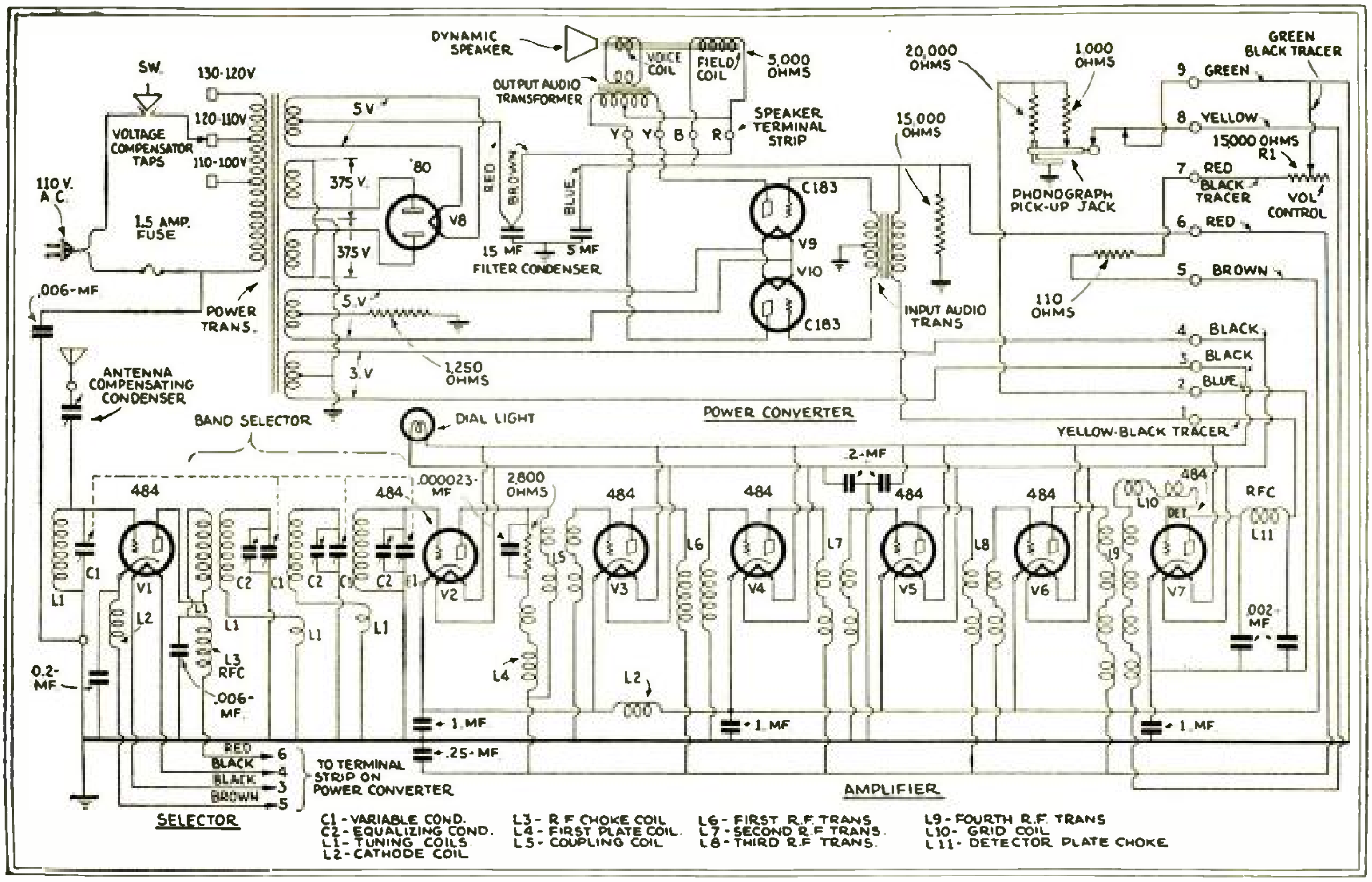


Fig. 1. The Sparton Models "601" "610" and "737" receivers. A common complaint, lack of volume control, may be due to a shorted 0.2-mf.

A large number of Bosch "28" and "29" receivers, lately, have showed up with the common complaint of "noisy reception." Several of these were taken to the repair shop to determine the cause of the trouble. The type '26 tubes were each, in turn, pulled out of the circuit starting with the 1st R.F. stage, but, with the exception of two sets, the noise continued. When the '27 detector tube was removed, about 75% of the noise disappeared in all except one case.

After a new and perfect first A.F. transformer had been installed in place of the one in the set, the noise cleared up in all except three sets. One had a very noisy carbon volume control that made a racket even though the control was not touched! When a new volume control was put in, that set was in perfect shape. The remaining two receivers caused quite a bit of trouble. The grid-leak and grid-condenser were changed with no change in results. Finally, the detector plate 50,000 ohm "glastor" resistor was replaced, and the noisy condition cleared up. Some sets needed both the transformer and the resistor replacements, before the complaint was settled.

For sharp tuning in the first R.F. stage, these same models use a variometer that is often the source of varying volume, or "fading." Reception will be normal for a time and then drop in volume, necessitating a re-adjustment of the volume control. After several minutes, reception will become "normal" once more. Upon examination, a black lead will be disclosed, connected to one side of the stator of the variometer. This lead passes through a hole in the chassis and continues on to the other side. Vibration causes the metal chassis to bite through the insulation of the lead at the hole, for the lead is drawn quite taut, and causes the annoying condition of fading. A heavily insulated lead, additionally protected where it passes through the hole, should be used to replace the old lead.

A great deal has been spoken about the Majestic "60" series superheterodynes. The first batch of these sets that were placed upon the market were wired with some highly absorbent cotton covered leads. The slightest bit of moisture was enough to throw the set out of balance. Several resistors used were affected in the same way. In some sets the tuning meter would become inoperative; in others, very erratic. The main trouble however was a very weak, or even inoperative, receiver. These sets can be rewired according to the extensive, detailed data supplied by Grigsby-Grunow; or sent to the nearest distributor of Majestic receivers, who should make the necessary changes without charge.

THE RADIO FIREMAN

IN the little Dutch village of Jutphaas, near Utrecht, a system of wired radio has been installed in order to transmit calls to members of the local fire brigade. Special radio receivers are linked up with the fire alarms; they are so designed that when the latter are pulled automatic morse signals consisting of five letters are simultaneously transmitted to the home of every fire-fighter. These letter-calls vary according to the district in which the outbreak has taken place.
—*Amateur Wireless.*

UNUSUAL INTERFERENCE SOURCES

By William Murrills

IN A small Western city several interesting cases of radio interference have been discovered. In one instance a set owner complained that at certain times of the day it was impossible to use the radio because of the interference. The power company then traced the interference to the point where the noise was loudest; this led them to a cable entering the local telephone company's office. At the time of the test, none of the electrical machinery of the plant was in operation and the main switch was open so that all lines were dead. It was almost certain, therefore, that the source of interference was not in the building. To make sure, however, a test was made. When the test equipment was placed on top of the generator, only a faint noise was heard; while on the floor right next to the machine no noise whatever was audible. Upon further investigation, it was found that the particular cable in question contained a wire leading to a switch in the office, from which a police light on the main street was operated as a courtesy to the city. When this switch was opened, the noise completely died out. It was evident, then, that some high-frequency current was being picked up and carried along the wire to a point near the aerial leading to the receiving set of the complaining set owner.

The city, upon being told that the police light was causing interference in nearby radios, decided to discontinue the operation of the light rather than go to the trouble and cost of locating the interference source.

(*Continued on page* 303)

Recording Amplifiers

The subject of instantaneous sound recording consequently, our readers

By GEORGE

THE advisability of using high gain audio amplifiers to insure the production of good home records has been repeatedly pointed out in these articles. It is now my purpose to discuss in detail the different types of amplifiers that can be used.

The recording level required for instantaneous or "home" recording is much higher than that required for commercial wax recording; the cutting stylus in the latter case having very little mechanical work to do against the wax disc and, consequently, the required level is only about +3DB. In making instantaneous records, however, the cutting stylus, besides modulating the track, must compress the material of which the record is made. This compression must be effected by weighting the cutting head with a fairly heavy weight, and naturally the modulating action of the stylus is retarded considerably. As a result, the gain of the amplifier feeding the cutting stylus has to be quite high if a loud record is desired.

Aluminum records are made at a level of between +15 to +20DB, and since the output level of a carbon microphone is about —36 DB, the gain of the recording amplifier must be at least +51DB. Ungrooved celluloid records, due to their greater hardness, require a higher recording volume level than aluminum records, or about +25 to +30DB. It is obvious, therefore, that the amplifier gain should be at least +61 DB. The recording level for pre-grooved celluloid or aluminum records is the same.

It is desirable for two reasons that the amplifier have more gain than is really needed. First, high gain affords extreme freedom of position about the microphone: that is, the person or persons being recorded may be located at a greater distance from the microphone than ordinarily, and still obtain a good recording. Secondly, high gain makes it unnecessary that the microphone, in order to increase its sensitivity, be operated at the high current value, which results in strong background noise.

The "direct-coupled" amplifier is considered one of the most faithful from the point of view of frequency response, and it makes an excellent amplifier for use with pre-grooved celluloid or aluminum records. (Diagrams of direct-coupled amplifiers have appeared in past issues of RADIO-CRAFT.)

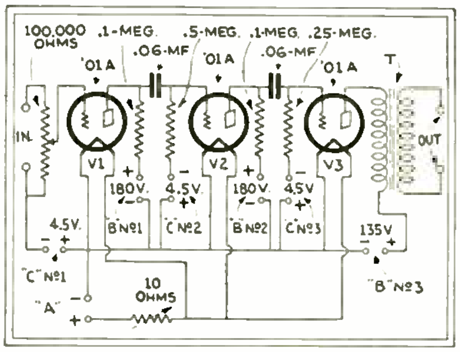


Fig. 1

A resistance-coupled amplifier, having a flat characteristic, which is suitable for recording.

The disadvantage is that the gain with respect to the microphone is comparatively low. There is very little mobility allowed around the microphone, and since the latter thus has to be operated at full current value, to increase its sensitivity, the chances of microphone noise are increased.

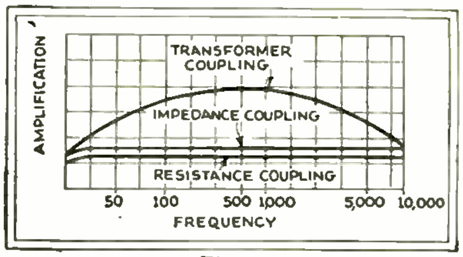


Fig. 3

Frequency versus amplification characteristics of three types of A.F. amplifiers.

An amplifier using resistance coupling has a relatively flatter characteristic than either impedance or transformer coupling, but the gain in this type of amplifier is low, due to the fact that the only amplification is that derived from the "mu" of the tube; at best, only about 75% of the "mu" being obtained.

The circuit of such an amplifier is shown in Fig. 1. It should be noticed that separate "B" and "C" batteries are used in each stage. This is done to minimize inter-stage coupling, reduce external noise, reduce pickup, etc. It must be realized that all extraneous noises will be superimposed on the record. Any precautions that would tend to reduce these extraneous signals should be taken.

A.F. Amplifiers

The principal advantages of resistance coupling are: (A), flat frequency characteristic up to moderately high frequencies; (B), absence of all resonance peaks; (C), lightness and compactness of units, and; (D), low cost of units.

The most important disadvantage of this type of coupling is the high "B" voltage required due to the large voltage drop in the plate resistor.

So called "impedance coupled" amplifiers use an inductance instead of a resistance in the plate circuit. The gain is approximately the same as in resistance coupling, but less "B" voltage is required, due to the lower D.C. resistance of the choke.

The gain can be increased by the use of higher-mu tubes, but more care in design is required to avoid such difficulties as the following: (A), loss in amplification at low frequencies due to the use of too low an impedance choke coil, and: (B); resonant points and excessive amplification, or even circuit oscillation, at frequencies between 100 and 300 cycles, a condition which may be brought about through the combined action of the high effective tube input capacity and the inductive reactance of the coupling impedance.

The "transformer-coupled" amplifier is, in the opinion of the writer, the best type for recording. In the first place, it gives

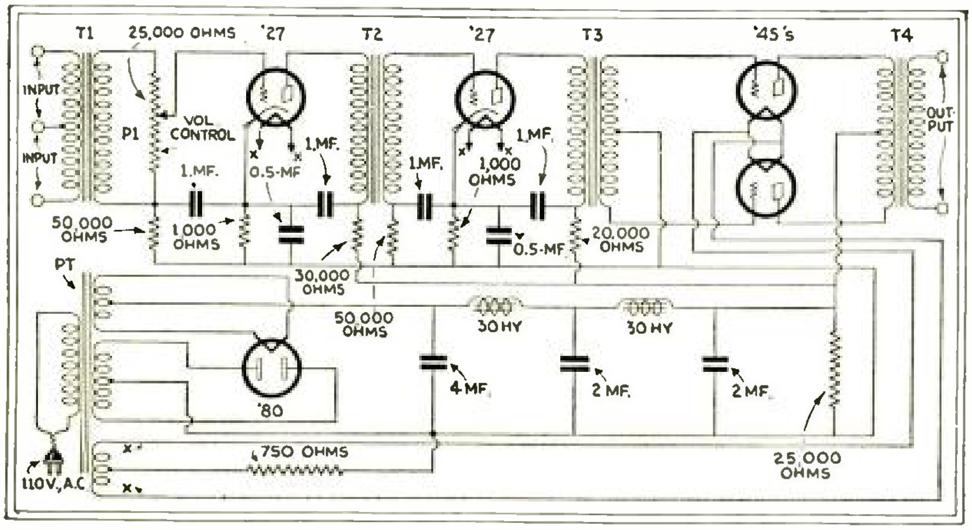


Fig. 2

The final amplifier selected by the author for recording purposes. The very thorough by-passing makes for extreme stability of operation.

and Level Indicators

has created a great deal of interest; will welcome this discussion.

J. SALIBA, S.B.

the most amplification for a given investment. Using three transformer-coupled stages, Fig. 2, the gain is approximately 70 DB, which is more than enough for good recording.

In this type of amplifier the "B" voltage may be comparatively low; and high-mu tubes are not necessary. The signal voltage besides being amplified in the tube is also stepped up in the transformer. The amplifier is very stable with hardly any chance of oscillation. The frequency characteristic (closely approximated in Fig. 3) is not as flat as that of the resistance- or impedance-

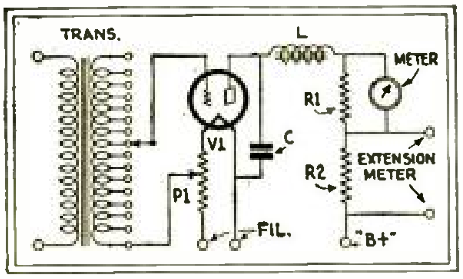


Fig. 4
A diagram of a commercial volume indicator.

coupled amplifier, but it can be improved considerably by connecting a variable resistor of 100,000 ohms, maximum resistance, across the secondary of each transformer, and adjusting them for best results.

The writer has had considerable success with the amplifier shown in Fig. 2, its quality and stability recommending it for police recording in crime detection (described in the July, 1931, issue of RADIO-CRAFT). Using "Sangamo" transformers the gain was such that recording was possible with the subject 15 to 20 feet from the microphone.

Level Indicators

Strange as it may seem, the "level indicator," which is very essential for good recording, is in very little use. It is not hard to build; and, even if purchased, the slight cost is more than offset by the insurance of good records at all times.

Heretofore, it has been the custom to test the level at the cutting stylus by means of a "monitor" speaker; or, if the microphone happened to be in the same room with the machine, by means of feeling the stylus with the finger! At best, either of these methods is a guess.

A level indicator, in reality, is nothing more than an ordinary vacuum-tube or "V.T." voltmeter, which operates on the principle of the vacuum tube detector. In an amplifier, the vacuum tube must be worked on the "straight" portion of its characteristic (point b, Fig. 5) so as to maintain the linear ratio of input voltage to output power, which is required for undistorted power output; while in the V.T. voltmeter the tube is worked on the curved "heel" of the characteristic (point a, Fig. 5) so as to obtain the distorted output shown in the figure.

The circuit of a commercial level indicator is shown in Fig. 4. An A.C. flowing through the primary of the input transformer will cause an alternating voltage drop across it; and by induction, an increased voltage drop will appear on the secondary side. A portion of this secondary voltage is applied between the grid and filament of the tube. This voltage alternately adds to, and subtracts from, the D.C. grid bias.

Since the tube is operated on the curved heel of its characteristic the plate-*current*-change that corresponds to the grid-*voltage*-change will be distorted, and the average plate current drawn by the tube thus applied be higher when an A.C. potential is applied to the grid, than if the grid had only the D.C. bias.

In order to smooth out the fluctuations of current in the meter circuit, but still permit the meter to register most of the current peaks, a condenser C and an inductance L are connected in the circuit as shown in Fig. 4. Damping for the meter is provided by the resistance R1 shunted across it. It is evident, therefore, that the combined damping action of the tube and the plate circuit filter causes the needle of the meter to deflect for *groups* of plate current fluctuations. If the needle was permitted to follow each individual plate current fluctuation it would be extremely difficult to follow the rapid, erratic movements of the needle.

Figure 6 shows the circuit of a level indicator that can be easily built at home, and while not as elaborate as the commercial type it is quite accurate enough for home recording. The meter used is an ordinary D.C. milliammeter with a 0-5 scale; damping is provided by the condenser C shunted across the meter. Since the battery will drop in voltage due to use, the 10,000 ohm potentiometer P2 is provided to afford control over this voltage,—since it is very important that the filament and the plate voltages remain constant. From time to time the battery voltages should be checked.

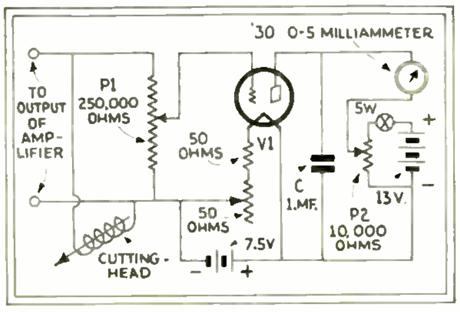


Fig. 6
A volume indicator circuit for the home-constructor.

The level that is necessary for good records of each type of record is best determined by test (of course, this figure was only roughly approximated in the values

(*Continued on page 314*)

A PORTABLE RADIO PROGRAM RECORDER

OWNERS and operators of broadcast stations, who in the past have been violating minor rules and regulations of the Federal Radio Commission, and have been evading the long arm of the law, are now watching station operation very carefully, especially since the installation of a new radio program recorder, Fig. A.

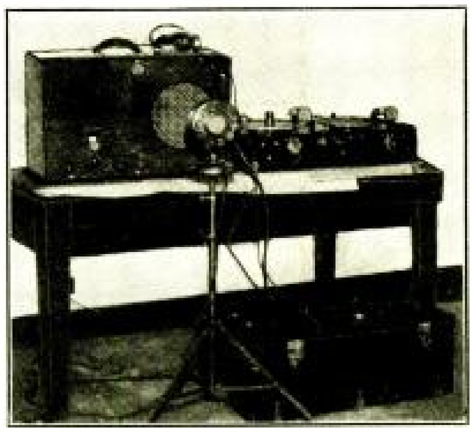


Fig. A
The Federal Radio Commission's "evidence" of broadcast infractions. (Illustration, courtesy RCA-Photophone, Inc.)

The apparatus, recently demonstrated before officials of the Federal Radio Commission, was designed by RCA-Photophone, Inc.; and consists of a recorder containing two motor-driven turntables, a recording amplifier, a microphone, a radio receiver and a loudspeaker. Pre-grooved blank disc records are placed upon each of the twin turntables and when in operation, with sound being recorded as it emanates from the loudspeaker, these records operate continuously, *automatically changing* from one to another.

Heretofore, the commission has been forced to depend almost entirely on stenographic records, which have in the past proved unsatisfactory. With this new device it is possible to have an absolutely perfect record, which, if needs be, can be introduced before the Commission's examiners.

The portability of the apparatus makes it possible to carry it to remote places.

THE "TROPIC

SHORT-WAVE "SUPER

Many short-wave superheterodynes have made their appearance in the radio field, but Tropics. The receiver described by the author has been designed with a view toward and dampness.

By GEORGE

"BUILD me a radio set for use in the Tropics." These few words sounded innocuous enough some months ago when a representative of the U. S. Consular Service in New York addressed them to the writer. Not realizing, however, that this would eventually prove to be an outstanding example of the folly of wisdom, I blithely accepted the job.

After about ten minutes of friendly grilling, I was almost convinced that I had picked a "lemon," but being blessed (?) with a generous portion of Welsh stubbornness it wasn't very long before I began to formulate a plan of attack pointing toward a successful solution of the problem.

However, before we consider the design of the receiver finally used, it will be well to picture radio reception conditions which exist in the torrid belt between the Tropics of Cancer and Capricorn.

If the set constructor will bear with us during this short interview, we promise to divulge some interesting information, the possession of which may indicate to more than one technician just *why* some one of his radio installations, though in a more mild climate, is not working "according to Hoyle."

Tropical Limitations

During the summer months static is a daily, and sometimes all day affair so that for a radio receiver to be really useful, *reception below 50 meters is essential.* Another thing,—the set must possess a reasonable degree of selectivity (which greatly increases the signal-to-static ratio), and a tone control (this latter refinement is necessary, since static is essentially of a high frequency nature, and the cut-off effect of a low-frequency-pass tone control further reduces the interference).

One very great obstacle is the damp, tropical atmosphere (near the coast it is heavily laden with salt) that effects the operation of power transformers available in the United States. Very few of them would operate for more than six months, due not only to the condition of the air, but also to the heat generated in operation at 25 cycles (the almost universal commercial frequency in South America), and the fact that sometimes they are subjected to an external temperature of 115 degrees Fahrenheit.

This temperature is equally disastrous to other components; condensers impregnated with pitch or wax, carbon resistors (unless specially treated), the fine windings of I.F. transformers, and all aluminum parts, fall a victim to this heat and the prevailing dampness. It may be stated in passing that aluminum of 1/12-gauge will crumble to a gray-white powder in three months or less.

As mentioned before, long-wave reception (our broadcast band of 200 to 550 meters, for instance) is out of the question during the greater part of the year, so that short-wave transmission from stations many miles away must be relied upon. Those of us who are familiar with short waves will appreciate the fact that reception from a near, local station is the exception rather than the rule, due to the skip-distance effect; and even the best of the distant stations are received none too regularly.

People in the tropics, although they depend upon short waves for their entertainment, are not short-wave fans, and object to plug-in coils and the critical controls common to the regenerative set. As for headphone reception, well, that's out. The obvious solution to this problem is a superheterodyne; the set and circuit eventually evolved as the best one is shown in Figs. A and 1.

Circuit Design

There is really nothing outstanding in the design. Complications were avoided as far as possible, although considerable care was taken in the design of the power supply, the output of which is well filtered to smooth out the fluctuations of the notoriously bad power lines "down there."

A stage of resistance-coupled audio was used after the second-detector. This, together with push-pull pentodes, assures of loudspeaker reception.

A *tuned* R.F. stage ahead of the detector would have been better, increasing the sensitivity a little bit, but it would have introduced objectionable switching complications; so it was decided to leave this circuit untuned, and to couple it very loosely to the detector.

The set was assembled on a chassis which in its completed form measured 22¼ x 11¹, in. wide. Monelmetal, an alloy of copper and nickel, is ideal for the purpose, since

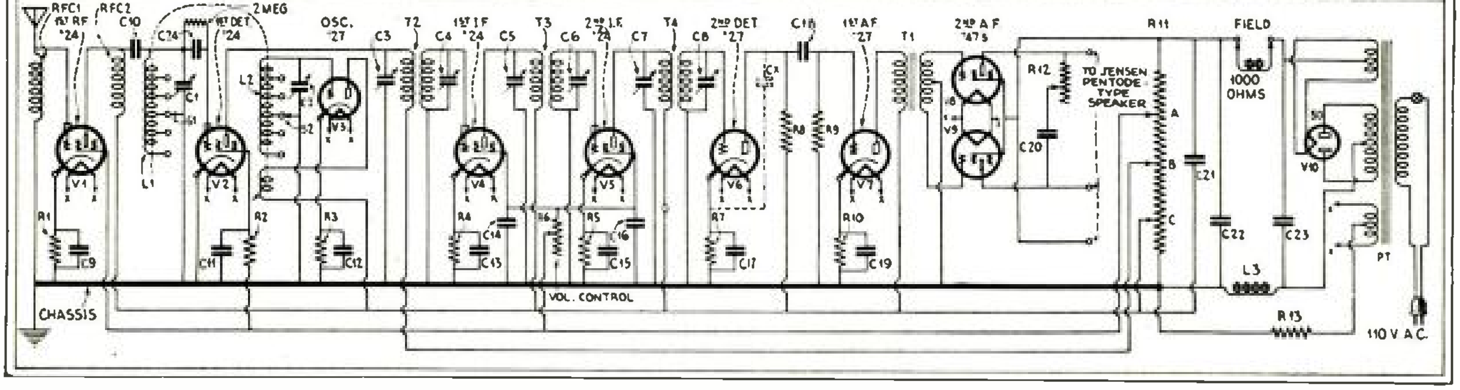


Fig. 1
Schematic circuit of the "Tropic 10" Short-wave Superheterodyne designed by Mr. Brooks. The first-detector and oscillator tap switches are mounted on the same shaft.

10"

-HET"

very few are suitable for use in the reducing static and withstanding the heat

BROOKS

it is both non-corrosive and an efficient shielding medium.

Construction Details

A sheet of this metal measuring 28 x 17 in. is required for the chassis. It is bent 3 in. on the front and back; then 3½ in. at the ends, and turned out ½-in. to form a "foot," as shown in Fig. 2.

While the writer has all the tools necessary to the trade, including a circle cutter for the 1⅛-in. and 1⅜-in. holes, it was decided to use common, ordinary tools as often as possible. First, the ⅜-in. holes were drilled and then reamed out to the required size. Three experimental chasses were made this way, each with 13 holes of this size. Since the writer still is in good health it will be realized that monelmetal is not difficult to "work."

Particular care was taken to prevent pick-up of long-wave signals through the I.F. transformers. For this reason the leads from these units to the respective tubes were made less than 1 in. in length; shielding of these leads eliminating the last possibility of pickup, and at the same time, helping greatly to reduce inter-stage feed-back.

No provision was made for the reception of C.W. (continuous wave) signals. The set is primarily a broadcast receiver, although code stations can be heard if carrier modulation happens to be present on the same wave as the C.W. signal.

Contrary to the experience of others who have operated short-wave superheterodynes, there was no uncanny silence between carrier waves on this set.

On the contrary, there was considerable static, yet when a carrier was tuned in "on the nose," the static mysteriously disappeared, and the station came in clearly (or with a minimum of interference).

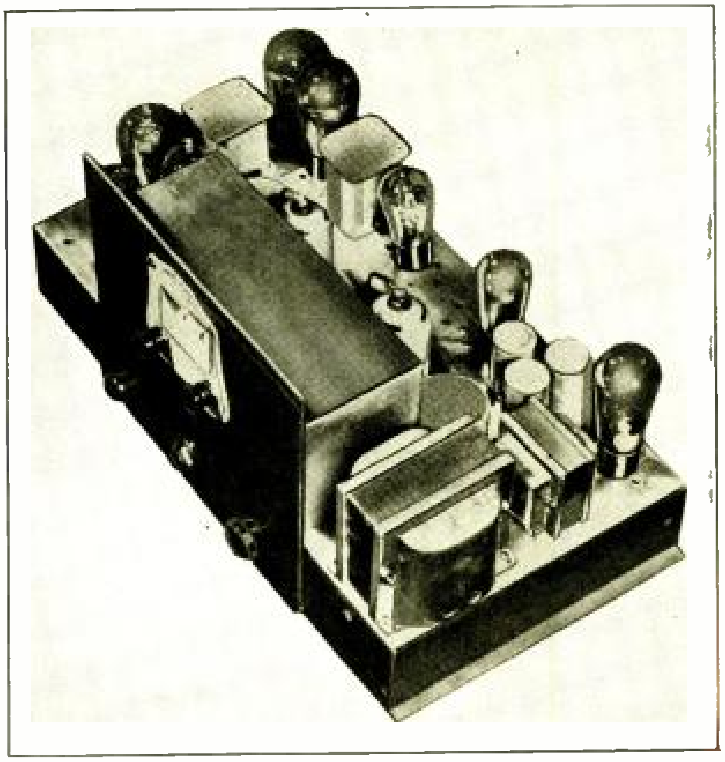


Fig. A
The "Tropic 10" S-W. "Superhet."

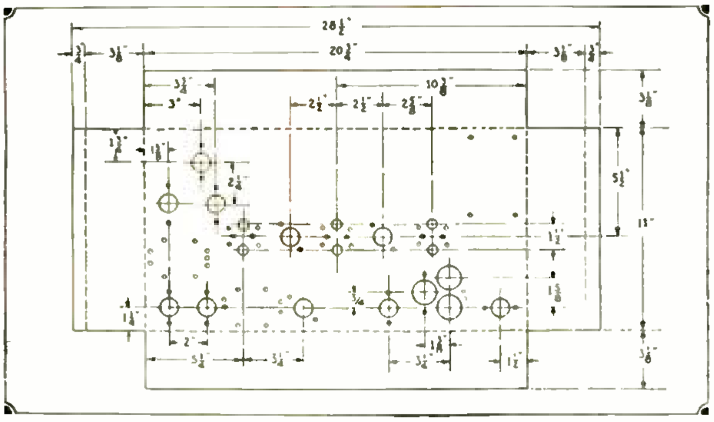


Fig. 2
Location and sizes of the holes in the monelmetal chassis.

In order to cover the ranges from 25 to 100 meters, the detector tuning coil L1 and the oscillator coil L2 were each wound with 103 turns of No. 26 double-silk-covered enameled wire on a bakelite tube 1⅝ in. in diameter and 2⅝ in. long, tapped at 3, 8, 18, 60, and 103 turns, as shown in A and B, Fig. 3.

The tickler coil for the oscillator was wound with 30 turns of No. 26 D.S.C. enameled wire as shown in the figure.

Coupling between the oscillator and detector tuning coils was accomplished by merely spacing them 5 inches on centers as shown in Fig. 3. Both the oscillator and the detector tuning tap switches are ganged together, the type used being given in the parts list below.

In order to secure good spacing of the stations over the condenser dials it was found imperative to use S.L.F. (straight line frequency) condensers.

List of Parts

- 3 Mershon *copper-case* electrolytic condensers, 8 mf. each, C21, C22, C23;
- 1 Lafayette 60 H. filter choke, L3;
- 1 Pilot double drum dial;
- 3 Amsco "450 kc." I.F. transformers, T2, T3, T4;
- 2 Amsco .00015-mf. S.L.F. variable condensers, C1, C2;
- 1 Electrad 15,000 ohm, 50 watt voltage divider, R11;
- 1 25-cycle Lafayette power transformer, PT;
- 1 Best double-pole rotary switch, S1, S2;
- 2 Carter 0.5-meg. variable resistors, R6, R12;
- 10 .01-mf. Dubilier fixed condensers, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19;
- 6 100 mmf. Hammarlund variable condensers, C3, C4, C5, C6, C7, C8;
- 2 60-mhy. R.F. chokes;
- 1 0.5-meg. Lynch resistor, R9;
- 1 "metallized" 80,000 ohm resistor, R8;
- 1 20,000 ohm carbon resistor, R10;
- 6 250 ohm Ward Leonard resistors, R1, R2, R3, R4, R5, R7;

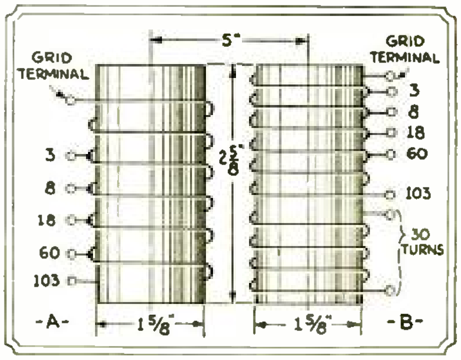


Fig. 3
Coils L1 and L2, wound in the same direction, are separated 5 in.

- 1 2-meg. grid leak;
- 1 .00025-mf. grid condenser, C24;
- 1 Push-pull input audio transformer, T1;
- 9 UY sockets;
- 1 UX socket;
- 1 .002-mf. Dubilier condenser, C20;
- 1 200 ohm Ward Leonard resistor, R13.

RADIO CRAFT KINKS

CONNECTIONS FOR 110 V., D.C.

By Oscar Block

IN those districts where the "Ham" is accursed with D.C. mains and at the same time uses '01A tubes (or other .25-amp. types) either one of two methods of connecting the filaments may be used, as shown in A and B, Fig. 1.

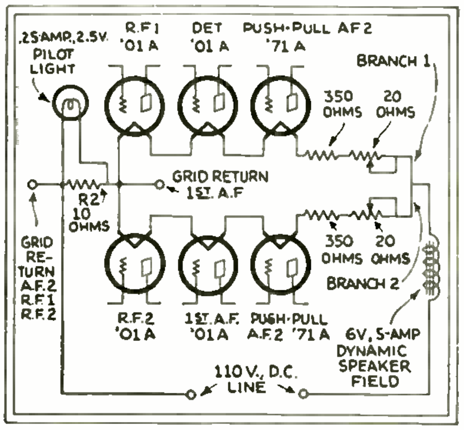


Fig. 2

Final connection of the series-parallel circuit C, Fig. 1. Resistors R1, 350 ohms; R3, 20 ohms.

Circuit A has the advantage of low current consumption, but has the disadvantage that the "B" battery potential on each tube will be low. It is also not adaptable to push-pull circuits since this type of hook-up requires a parallel connection of the filaments in order to use conventional push-pull transformers.

Circuit B illustrates a series-parallel connection of filaments. This mode of connection has none of the disadvantages inherent in the connections of Fig. 1A, although the current drain is greater. It has the distinct disadvantage that if one of the tubes are removed, the increase of current through the tube with which it is in parallel is apt to burn it out. Figure 1C shows a circuit that eliminates this latter difficulty and at the same time retains all of the advantages offered by the connections of Fig. 1B.

In this case, since each branch of the filament circuit and its regulating resistance is independant of the other branch, any fluctuation in one will not manifest itself in the other. A suggested layout for the power unit of a D.C. set is depicted in Fig. 2. This layout is designed for .25-amp. tubes and is intended for those of '71A type. The pilot light should consume .25-ampere at 2.5 V.

If tubes are used with characteristics other than those assumed, then the values of R1, R3, and the grid returns of the various tubes, must be changed. The variable 20 ohm resistor R3 is placed in the circuit to compensate for line voltage irregularities. It is to be adjusted until the voltage across the tubes is at its rated value.

It would be interesting to determine just how the various values of resistances used in this connection are determined.

First, it is known that the line voltage is 110, and, second, that the terminal voltage of each tube is 5.0. The pilot lamp requires 2.5 volts for operation. Each branch of the circuit has three tubes in series, and since each tube requires 5.0 volts, the three tubes must have 15 volts. This voltage, when added to the 2.5 volts of the Pilot lamp, gives a total of 17.5 volts, which, when subtracted from the 110 volts of the supply line, leaves a remainder of 92.5 volts across both R1 and R3.

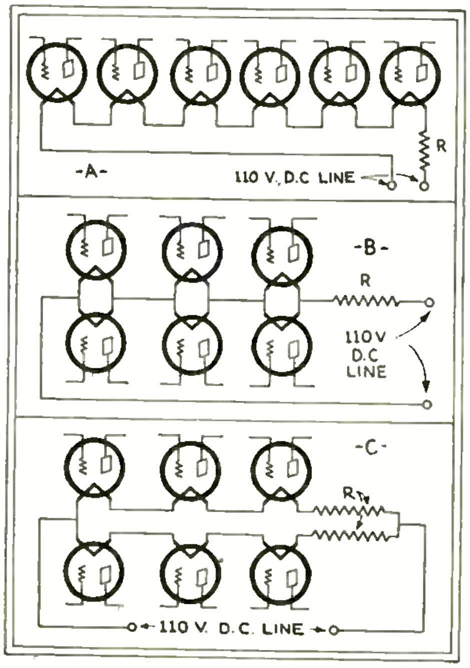


Fig. 1

"DC"-type filament connections. Circuit A consumes little filament current, but "B" potential is low; that of B, results in high "A" current and "B" potential, and; C, a safer arrangement.

Now the current through either branch 1 or 2 is the filament current of the tubes, which in this case is .25-ampere. The resistance of *both* R1 and R3 is then computed from the formula $R = \frac{E}{I} = \frac{92.5}{.25} = 370$ ohms. In order to provide a means of adjusting the filament voltage, 350 of the 370 ohms are made fixed and the remaining 20 ohms variable. The computation is exactly the same for either branch.

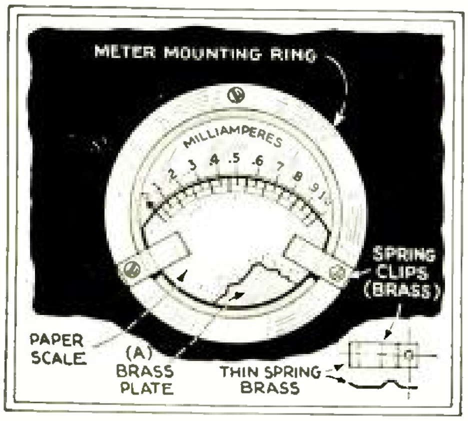


Fig. 3

The desired paper scale is pasted over a removable non-magnetic plate (A).

ADDITIONAL METER SCALES

By J. Christine

THE trend in service equipment, for the man who "rolls his own," is to use one instrument for a multiplicity of purposes. If a single meter is to be used as a voltmeter, ammeter, milliammeter, ohmmeter, capacity meter, etc., the numerous scales that are necessary complicate the reading of the meter to such an extent as to make the instrument impractical. If separate scales are to be used, then we are faced with the problem of removing the glass from the meter every time a change in the scale is to be effected. The novel scheme illustrated in Fig. 3 overcomes this difficulty.

The zero and top mark lines of the meter scale are drawn on the second scale to facilitate lining it up when it is placed on the instrument. The meter is then calibrated and the markings placed on the new scale.

With this arrangement it is possible to use as many extra scales as is desired, without, at the same time, opening the actual instrument itself.

A SIMPLE METHOD FOR MEASURING A.C. RIPPLE IN FILTERS

By Clifford E. Denton

THERE are many times when the experimenter or Service Man wants to know the exact ripple voltage from a high voltage power system or motor-generator.

A simple method which has been used by the author for this purpose employs a rectifier-type A.C. voltmeter, which will measure the average (0.636) value of the A.C. or "ripple" voltage. See Fig. 4.

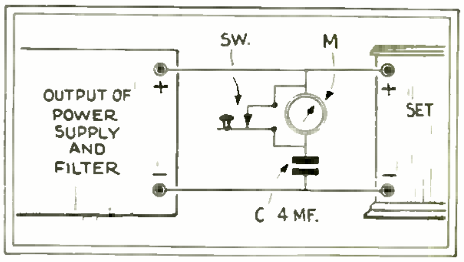


Fig. 4

Measuring "ripple." A.C. Voltmeter M, D.C.-insulated by C, indicates potential when switch Sw. is depressed.

To isolate the meter M from the D.C., but allow the A.C. to pass through it, condenser C is used; a 4-mf. high-voltage type unit will be satisfactory.

It is important that the "working" voltage of the condenser be equal to, or greater than, the power supply's "peak" voltage; which is equal to the "R.M.S." value of the voltage applied to the plate of the rectifier tube, multiplied by 1.41.

The switch Sw. should be of the closed-circuit type, which remains closed except when pressed; this to prevent the initial charging current drawn by the condenser C from passing through the meter. The meter should be connected into the circuit only after the receiver is in operation. This places the actual working load on the filter

(*Continued on page 302*)

The Radio Craftsman's Page

The Bulletin Board for Our Experimental Readers

THE STENODE RADIOSTAT

IN engineering circles, interest in the "Stenode Radiostat" has been at top pitch since the first public announcement that there was in the process of refinement a system of reception which made available a receiver of hitherto unheard of selectivity, combined with exceptionally good tone-quality and a very high signal-to-static ratio.

What is believed to have been the first really extensive analysis of all literature then available on this subject, and its presentation in more readily understandable terms, was the article, "The 'Stenode Radiostat' System," by Clyde J. Fitch, which appeared on page 210 of the October, 1930 issue of RADIO-CRAFT.

It was this article which prompted Mr. Arthur Lynch, then vice-president of the Stenode Corporation of America, to prevail upon Dr. Robinson to prepare for the readers of RADIO-CRAFT a memorandum concerning certain phases of the original story.

This memorandum, dated July 16, 1931, and written in the light of later knowledge, we take pleasure in presenting below. It is preceded by the letter of Mr. Lynch; and is followed by the interesting remarks of Mr. Fitch.—*Editor.*

EUROPEAN DATA ERRONEOUS

Editor, RADIO-CRAFT:

Some time ago an article by Clyde J. Fitch appeared in RADIO-CRAFT, which was intended to be an outline of the fundamental principles on which the Stenode works.

While the article was extremely interesting, there are a number of points about it which are not entirely correct, and I feel sure that some of Mr. Fitch's deductions were the result of published reports on the Stenode made by some of the European investigators who were not sufficiently familiar with Dr. Robinson's work to have all the facts, and who, therefore, drew some erroneous conclusions.

Before Dr. Robinson returned to London last month, I asked him to analyze Mr. Fitch's article and prepare a memorandum for me dealing with the subject. I am inclosing a copy of this memorandum and, since the Stenode is bound to become a matter of increasing importance with your readers, it seems to me that the re-publication of Mr. Fitch's article along with Dr. Robinson's discussion of it would be helpful.

Cordially yours,

ARTHUR H. LYNCH, *Vice-President,*
The Stenode Corp. of America,
Hempstead Gardens,
Long Island, N. Y.

(A recent Stenode release states that the Hempstead laboratories of the company have suspended operations, only its executive offices being retained to take care of the details which concern manufacturing licenses, certain development work for government service, and negotiations concerning use of the system in telegraphic and cable systems. Laboratory work will be continued, however, at the home office in England.—*Tech. Ed.*)

ANNOUNCEMENT

WITH this issue of RADIO-CRAFT, Mr. Louis Martin, formerly an instructor of RCA Institutes, Inc., assumes the position of Associate Editor, succeeding Mr. C. P. Mason, who, after exhibiting exceptional ability, and diversity of knowledge, has been invited to take the position of Associate Editor of Mr. Hugo Gernsback's newest publication, EVERYDAY SCIENCE AND MECHANICS.

Mr. Martin brings to RADIO-CRAFT a wealth of laboratory, theoretical, and practical knowledge; and, through his position as instructor, an appreciation of the troubles and viewpoints of technicians at every stage of advancement, which will be of inestimable value. It will be part of the duties of Mr. Martin to pass upon all the technical queries that are received; and thus it is that every reader will have an opportunity to benefit.

DOCTOR ROBINSON REPLIES

Editor, RADIO-CRAFT:

Mr. Fitch undoubtedly devoted a considerable amount of thought to the new problems in radio which were introduced by the Stenode. The first thing which struck him was that the sideband theory made it absolutely impossible to receive modulated waves on a highly selective receiver such as that provided by the Piezo-electric effect of a quartz crystal.

He does not deny that we receive modulations by such a device, and in fact he gives us the credit for being honest and reporting correctly what we had observed. He thinks that our reasoning was incorrect insofar as the sideband theory appeared to him to prevent our receiving modulations from pure amplitude-modulated waves. He draws the conclusion that every station that we receive must be doubly modulated, i. e., both amplitude- and frequency-modulated. In fact, he concludes quite definitely that it is the frequency modulation effects which account for the reception of the modulations on such a highly selective receiver as the Stenode.

Mr. Fitch must know that a strict watch is kept on all transmitting stations. In any case, this is the condition in Europe. (The new Frequency Monitoring Station at Grand Island, Nebraska, was built solely for this service; although the large number of stations in America necessarily increases the difficulties many fold.—*Tech. Ed.*) Records of the European stations are kept to show the carrier frequency varies over long periods of time, and it is interesting to know that some of the bigger stations in Europe do not deviate from their carrier frequency by more than *one or two cycles.* This does not show that carrier frequency does not vary at a high speed—*within audio range,* in the course of a few hours! Other records are also kept, these being the amount of frequency-modulation which occurs at the various stations, and again it is interesting to note that in some of the best stations the frequency modulation, even for the loudest signals, is well under *one cycle* (quite sufficient to operate Stenode receivers).

On the other hand, there are some stations whose frequency varies considerably from hour to hour, and farther than this, which have very pronounced frequency-modulation. One such station in Europe is Toulouse, and Mr. Fitch will be interested to know that with this station, very poor results are obtained with the Stenode as regards quality. This fact has been witnessed by some of the best known radio engineers of today, and has had a profound influence wherever engineers may have had the opinion that frequency-modulation contributed to the results.

Perhaps Mr. Fitch has now had an opportunity of studying the theory of the Stenode which I gave in my last paper before the Radio Club of America last November. It was made very obvious there that we can receive modulations from pure amplitude-modulated transmitters, and a formula was given which is now called the "Stenode Formula," to show precisely how modulated waves are received by very highly selective receivers. This formula shows that a very selective receiver cuts down the "percentage modulation" of incoming waves, and the various factors which control this are included in the formula.

It will be noted from the preceding that I am aware of other scientists than Mr. Fitch, who in the middle of 1930 had the same opinions as are expressed in this RADIO-CRAFT article. Mr. Fitch was, therefore, not alone in his reasoning, but in fact shared these opinions with some other scientists. I feel sure that when he has studied my paper, which was referred to above, and when he has had experience with actual Stenode receivers, he will be convinced that the effects of the Stenode are obtained quite independently of any frequency modulation.

There is one other feature of the article which is illuminating, and this is that my original publication of the results of the Stenode led certain engineers to conclude that sidebands did not exist. Mr. Fitch avoids any definite statements attributing these views to myself. I have never said there are no sidebands, but I have always looked on the sideband theory in what I consider to be its correct form, which is that any modulated wave can be treated mathematically so that the same result will be obtained if we had a number of continuous waves of correct frequency amplitude and phase. Starting out from this point, I showed that the results of the Stenode can be explained by completing the sideband

(*Continued on page 314*)

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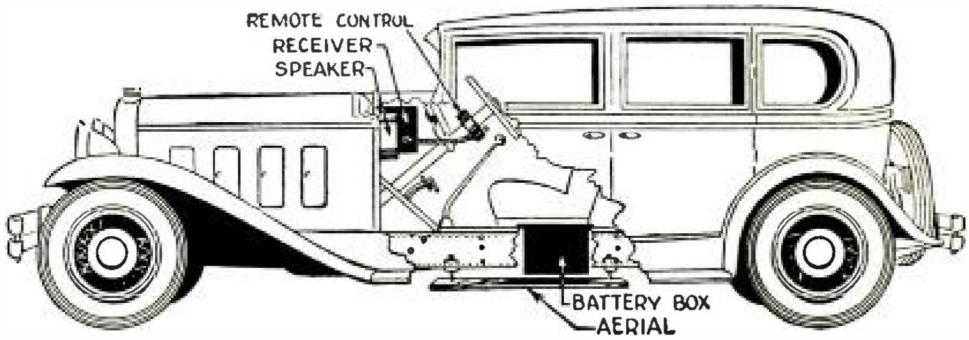

Remote Control

Remote Tuning Control clamps on steering column as illustrated above. Provides positive control without back-lash. A volume control and lock type "off and on" switch, complete the assembly.

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Radio-Craft's Information Bureau

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

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

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

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

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

PENTODE PORTABLE

(136) Mr. R. W. Miller, Edina, Mo.

(Q.) I have built the "Pentode Portable" described in the August issue of RADIO-CRAFT. It sure is a knockout. When using a good aerial, at night I can bring in stations up to about a thousand miles, with plenty of volume for loud speaker!

I have some trouble making the set regenerate. Sometimes it works fine; and the next time it will not work at all. I have tried different tubes, but it doesn't seem to help. Can you give me any suggestions to make it regenerate?

(A.) As reference to the circuit of this interesting two-tube receiver will indicate, regeneration is controlled by the motion of a rotor inductance or variable tickler, L2; just as in the earlier and familiar "Ambassador" sets. Consequently, the considerations for obtaining regeneration and oscillation are almost identical.

It would appear that there is a loose connection in the receiver; since Mr. Miller reports that at times regeneration control is perfect (stations a thousand miles away being received with good loud-speaker volume). It will be well, also, to check the condition of the aerial; a corroded joint, or rubbing contact to ground, might cause the effect. Try another grid leak. Check the condition of the batteries. The tuning condenser may be defective; it may short- or open-circuit in some positions of the rotor. If the receiver lacks sufficient regeneration at one end of the tuning band, the number of turns in L2 should be increased or decreased, until the regeneration control passes inspection. Make sure all battery connections and leads are perfect. If the tubes are good, and making solid electrical contact, a thorough check-up along the lines suggested should isolate the fault.

MULTI-RANGE OSCILLATOR

(137) Mr. Guy H. Allen, South Bend, Ind.

(Q.) I have an inductor of 85 turns of No. 26 C.S.C. wire, which is tapped at the 40th turn. I use this in an A.C. oscillator, for balancing purposes, in a unit which covers the broadcast band from 550 to 1500 kc. I now find I am able to use this contraption on the 20-, 40-, and 80-meter amateur bands without the change of coils; thus giving me a range from at least 17,300 kc. (W2XK), 17.34 meters, to 560 kc. (WIBO), 535.4 meters.

Would you kindly explain this phenomenon; and could its calibration be relied upon if such is obtained?

(A.) Our inquirer has discovered the phenomenon of harmonic frequency production, so often discussed in RADIO-CRAFT. The statement may be recalled that, in an oscillatory circuit including an ordinary vacuum tube, there is produced not only the *fundamental* frequency of that circuit (due to the values of its inductance and capacity—see Table I, page 55, July 1931 issue), but also numerous other frequencies which are multiples of the fundamental. These "harmonic" frequencies are rated in their numerical sequence; the first multiple being the "second harmonic" or double the fundamental frequency; the second multiple is the third harmonic, or three times the fundamental; and so on.

We fear our correspondent did not read this July 1931 RADIO-CRAFT; wherein, on page 10, is described an "All-Wave Oscillator for Modern Servicing" which commercializes the phenomenon of harmonic-frequency production.

The practicability of calibration, obviously, is evident at least, for the 200- to 1500-kc. band specified. Further, this method is used in amateur radio transmitting work to calibrate accurately short-wave wavemeters; the signals of crystal-controlled stations are used for the fundamental; to which may be tuned (by zero-beat) a vacuum-tube oscillator, whose harmonics may be logged on graph paper for further reference.

Constancy and accuracy of calibration are largely a matter of obtaining constant current supply and uniform tube characteristics. In general, quite close work may be done.

AMPLIFIER GAIN

Edward G. Kertz & Associates, Kenosha, Wis.

(Q.) We would like to know how much gain it takes to make a good recording, and we would also like to know the impedance of pickups suitable for recordings.

(A.) For recording on aluminum, the level at the cutting head should be about +20 decibels. If a carbon microphone is used, the pickup volume level is down about —36 db. It is obvious, therefore, that an amplifier having a gain of at least 56 db. is necessary.

If celluloid is to be used, the required recording level is near +36 db. and, consequently, an amplifier having a gain of at least 72 db. is necessary. A good three-stage transformer-coupled job will serve the purpose very nicely.

The impedance of the cutting head does not make any difference, so long as it is properly matched to the output of the amplifier. The use of a high-impedance cutter of the order of 4000 ohms is common practice.

RECORDING VOLUME

Mr. C. L. Wentworth, Minneapolis, Minn.

(Q.) We are using a special celluloid for recording and find it difficult to get the grooves deep enough to give us sufficient volume. We have seen "electrical transcription" records, from some California recording studios, that seem to be made on this same material; and we wonder how it is possible to overcome this lack of volume.

(A.) Your lack of volume is not due to the shallow groove. A shallow groove might make it difficult for the reproducing needle to track, but the lack of volume is due to the modulations being too small. This can be caused by several things: either the amplifier's gain is not high enough; there is improper impedance matching between cutting head and amplifier; or the material might be too resistant for good recording. The transcription records are processed records—that is, a metal stamper is used to impress the sound track. In that case the hardness of the material is reduced considerably, by heating, so that it will take an impression. Try using celluloid that contains no pigment (coloring).

PICKUP CONNECTION

Mr. Thomas M. Graves, Oskaloosa, Iowa.

(Q.) I have an Apex "Model B-31" radio receiver and a good Pacent pickup. I would like to know where to tap in on the loud speaker to make records.

(A.) Your cutting head's leads should be connected to the plates of the output tubes. The simplest way is to use adapters which make contact to the plate prongs, in the manner illustrated in the September, 1931 issue of RADIO-CRAFT.

FREQUENCY RANGE

Mr. Hans Behrsin, South Braintree, Mass.

(Q.) Will you tell me if a frequency range of 35 to 6000 cycles will record the highest and lowest frequencies?

(A.) A frequency range of 35-6000 cycles is very suitable for good recording. As a matter of fact, the maximum reproduced frequency in talking pictures is never more than 6000 cycles; while broadcasters limit themselves to about 5000 cycles.

COMMERCIAL RECORDS

Mr. R. J. Dwyer, Rochester, N. Y.

(Q.) In commercial recording, the wax "master" is electro-plated. Test records are stamped from this; then a metal "mother" is made from this original negative (by electroplating once again); and from the metal mother is made the production negative "stamper" (or stampers) from which the composition records for commercial use are finally made. Inasmuch as, in instantaneous recording with aluminum discs, we have the equivalent of the metal mother (the first step, or the original, and the first negative from this, being eliminated) cannot a metal negative be obtained from this, by electroplating; whereby the home recordist might have records stamped on regular record composition or celluloid and thus be able to obtain additional records from the original which, duplicated, might be played in the ordinary way on the regular phonograph using the regulation steel needles?

(A.) You are right in assuming that the aluminum disc is the equivalent of the metal mother. Stampers have been made from these aluminum discs by the plating process, and the results have been fairly good. The only objection is that the groove in the stamped record is as shallow as the aluminum record; and that is not as deep as the groove on the commercial record.

A better method of making copies of the original would be to "dub" (re-record) the original on a wax disc, and then obtain the stampers in the conventional manner.

PRE-GROOVED RECORDS

Mr. A. B. Anderson, Gulfport, Miss.

(Q.) If aluminum records were pre-grooved, would this lessen the resistance to the recording stylus and give better recording?

(A.) Pre-grooving aluminum records will not materially lessen the resistance to the recording stylus or give better recording. The only purpose in pre-grooving records is to do away with the feed-screw, and thus simplify the recording apparatus. Aluminum pre-grooved records are now on the market, and very good results are obtained with them.

COMPUTATION OF DECIBELS

The *decibel*, so often used in the work of audio amplification, transmission and reproduction, is simply the ratio between the strengths of any two signals, or the ratio of change in the energy of a signal when it is amplified or attenuated.

Ten decibels "up" on a signal means that the power has been increased tenfold; ten decibels down, that it has been divided by ten. The steps are unequal, but the peculiarities of this method of rating are based on physiological and engineering reasons. The decibel, as a mathematician would instantly see from the table given here, is a *logarithmic* unit (the number of decibels is represented by ten times the "common" logarithm of the ratio of change.)

Since the sound energy of the reproducer should be, approximately, in proportion to the electrical output power; and since electric power is measured by "voltage times current," the power varies as the *square* of the voltage (or current). Therefore, the ratio of energy change corresponding to ten decibels is as much as the ratio of voltage (or current) change, corresponding to twenty decibels.

Any signal strength may be taken as the base (or zero) in computing relative intensities. However, for voice-transmission measurements, six milli-watts (1.73 volts across a 500-ohm line) is a standard used by engineers.

The ratio of change in power, and in voltage (or current) corresponding to any number of decibels, may be quickly found from the following table. Multiply the signal strength, or voltage, which is taken as the base, by the factor given in the proper column, opposite the appropriate number of decibels.

"UP" Energy	"UP" Voltage	DECIBELS Number	"DOWN" Energy	"DOWN" Voltage
1.26	1.12	1	0.794	0.891
1.69	1.26	2	.631	.794
2.00	1.41	3	.501	.708
2.61	1.59	4	.398	.631
3.16	1.79	5	.316	.562
3.98	2.00	6	0.251	0.501
5.01	2.24	7	.199	.447
6.31	2.51	8	.158	.398
7.94	2.82	9	.126	.355
10.00	3.16	10	.100	.316
12.59	3.55	11	.079	0.282
15.85	3.98	12	.063	.251
19.98	4.47	13	.050	.224
25.12	5.01	14	.040	.200
31.62	5.62	15	.032	.178
39.81	6.31	16	.025	0.158
50.12	7.08	17	.020	.141
63.10	7.94	18	.016	.126
79.43	8.91	19	.013	.112
100.00	10.00	20	.010	.100
125.9	11.22	22	.0079	.089
158.5	12.59	22	.0063	.079
199.6	14.13	23	.0050	.071
251.2	15.85	24	.0040	.063
316.2	17.78	25	.0032	.056
398.1	19.96	26	.0023	.050
501.2	22.39	27	.0020	.047
631.0	25.12	28	.0016	.040
794.3	28.16	29	.0013	.035
1,000.0	31.62	30	.0010	.032
1,259	35.48	31	.0008	.028
1,585	39.81	32	.0006	.025
1,998	44.67	33	.0005	.022
2,512	50.12	34	.0004	.020
3,162	56.23	35	.00032	.018
3,981	63.10	36	.00025	.016
5.012	70.80	37	.00020	.014
6,310	79.43	38	.00016	.013
7,943	89.13	39	.00013	.011
10.000	100.00	40	.00010	.010
12.590	112.2	41	.00008	.0089
15.850	125.9	42	.00006	.0079
19,960	141.3	43	.00005	.0071
25.120	158.5	44	.00004	.0063
31,620	177.8	45	.000032	.0056
39,810	199.6	46	.000025	.0050
50,120	223.9	47	.000020	.0045
63,100	251.2	48	.000016	.0040
79.430	282.0	49	.000013	.0036
100,000	316.0	50	.000010	.0032
1,000,000	1.000	60	.000001	.001
10,000,000	3,162	70	.0000001	.0003
100,000,000	10.000	80	.00000001	.00001
1,000,000,000	31,620	90	.000000001	.00003
10,000,000,000	100,000	100	.0000000001	.00001

A DISTORTIONLESS DETECTOR CIRCUIT

By C. H. W. Nason

OVERLOADED detector tubes are responsible for the major proportion of the distortion acquired by the broadcast signal, in its path from microphone to speaker. Recent attempts by the writer, to receive test signals at a point directly under the station antenna, resulted in the development of a detector based on the involved principle of the balanced-modulator circuits employed in multiplex telephone work.

The balanced modulator, Fig. 1, is operated in this case with the grid circuits of two tubes in push-pull, but with the plate circuits in parallel; under normal conditions the distortion in such a circuit is so slight as to be negligible. The tubes can be

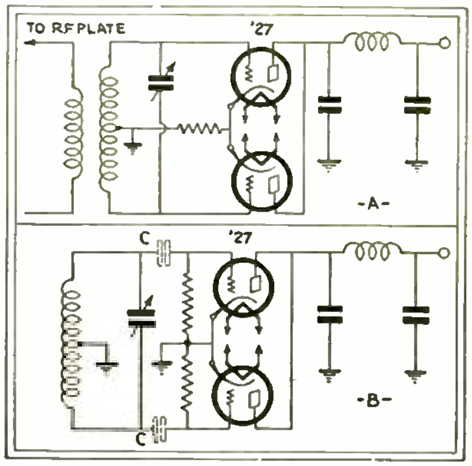


Fig. 1

Power detectors. At A, "bias"; B, "grid."

arranged either as "bias" or as "grid-circuit" detectors; in the latter case, the grid condensers are theoretically not needed, and the circuit arrangement has been shown without them. In the case of grid circuit detection (as shown for '27 type tubes) the plate current will be quite high. Negative biases for '27 tubes, when employed as plate-circuit detectors, should be as follows:

Plate Voltage	Grid-Bias
45	— 5 Volts
90	—10 "
135	—15 "
180	—20 "

With the grid-leak detector the two resistors shown should be 100,000 ohms each. After the point at which the plates of the two tubes are joined together, circuit arrangements for the balanced detector do not differ materially from those employed with ordinary detectors. The current drawn by the grid-leak type of detector, which is operated at zero grid volts, is rather high; but should offer no abnormal problems in the design of electric receivers to employ it.

Permeability Tuning

(*Continued from page 271*)

or the variometer, illustrated at E, which depends for its operation upon the variation in the mutual-inductance of two rotable coils connected in series; nor the old 3-circuit tuner, shown at F, which exhibited a *detuning* action when the natural period of the tuned circuits S-C3 was disturbed by the coupling variation of two inductances (S. T. as the rotating tickler T was varied for regeneration control).

Then we should consider still another type of tuning variation—as, for instance, the vernier change of inductance which was obtained as shown at G by the variation of the self-inductance (and distributed-capacity) of the secondary L6, as the iron *peridyne* plate P was adjusted, in one type of shielded R.F. transformer developed some time ago by Mr. H. Gernsback.

Then there is the *lowering* of inductance which results when we place over a coil, a copper, aluminum or brass (non-magnetic material) shield A1, and drop it into position A2, as shown at H; the vernier change of inductance when a "damper" plate is rotated within the center of an R.F. coil, I; and the *increase* in inductance which is obtained when an iron (magnetic material) core A1 is inserted in a coil, position A2, as illustrated at J.

Thus we arrive at the conclusion that the use of a magnetic material enables us to *increase the inductance* of a coil, enabling us to tune in stations of higher wavelength without winding on more wire (A), without tapping the coil (B), using variable condensers (C), changing the spacing of the turns of wire (D), varying the coupling of two coils in series (E), varying the coupling of two isolated coils (F), introducing a peridyne plate (G), rotating a damper plate (H), or removing a coil shield (I); the whole problem of tuning from 200 to 550 meters, using system J, resolving almost solely into the selection of the right grade of iron for the core.

Selecting the Iron

Whereas in the past, we have found ready at hand a core material, or so-called "radio frequency" iron, for inclusion in radio frequency transformer design, all previous calculations had only to deal with a primary and secondary of fixed construction; and with a response graph (to an input potential of varying frequency) taking somewhat the curve shown in Fig. 2. (Later designs show an improved response figure, as shown dotted.)

These lines indicate that the circuit is *broadly resonant,* (the design striving for the dot-dash response), and therefore there always must be associated with such units a *sharply resonant* selector circuit (a coil and condenser) for the purpose of obtaining the desired selectivity at any given point along the broadcast tuning spectrum, as at A1, Fig. 3; the most desirable shape is that obtainable from a band selector as at A.

It will be observed that here (solid line) cut-off is extremely sharp, and that the degree of frequency-acceptance is limited to 10 kc., as necessitated by present transmitter design; but that, as we change to a lower or higher frequency, B and C, respectively, the degree of selection becomes

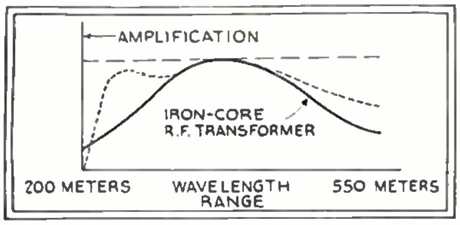


Fig. 2

Response curves of "fixed-tune" R.F. transformer. Solid line, early average; dotted, late average; dash, desired shape.

perhaps 30 kc. broad in the former instance, and 5 kc. in the latter.

From these observations it may be judged that uniform response hinges considerably on the "radio frequency" iron; and further remarks will disclose that therein lies almost the entire secret of a *self-tuning* radio frequency transformer.

Permeability

The ratio of the magnetic flux that passes through a substance, to the flux that would exist in air if the magnetomotive force (ampere turns) and flux path remained unchanged, is the definition of permeability. Therefore, *permeance* may be defined as that property of a magnetic circuit which allows the flow of magnetic flux; and the facility with which it permits this flux flow is an indication of its *permeability.*

Inductance, on the other hand, is defined as that property which has the effect of storing up energy in the form of a magnetic field. With a given number of turns (and a given shape), the inductance increases as the strength of the magnetic field increases (while maintaining the current constant).

Consequently, anything we can do to increase the strength of the field without changing the current, will increase the inductance of the coil.

Substitute iron for air, for instance, and, the former being more "conductive" to a magnetic field (that is, having greater *permeance,* or less resistance) than air, the

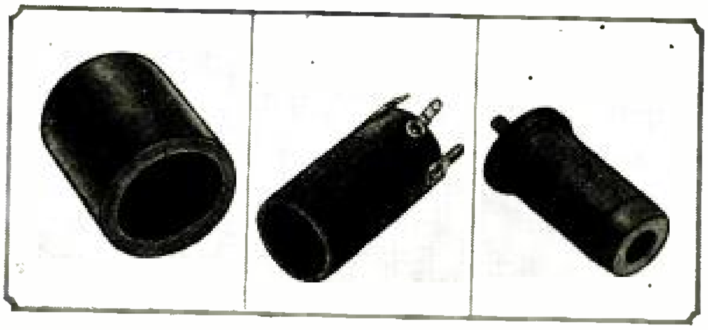


Fig. B

A disassembled permeability tuner. Left, the "R.F. iron" case; center, tuning coil: and right, "R.F. iron" plug.

magnetic field is more readily built up to a high value, and thus the inductance is increased; and thus the "natural wavelength" of the coil becomes greater.

Polydoroff "R.F." Iron

The formula for the resonant frequency (f) of a tuned circuit ordinarily considers the permeability equal to that of air, or 1; consequently, it reads:

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

However, should there be substituted for air a magnetic material, for instance, the Polydoroff iron-dust molded core and case, then this factor must be allowed for, and the formula then reads:

$$f = \frac{1}{2\pi\sqrt{LC\mu}}$$

The permeability figure at the extreme right is about 8, for this new iron.

This metal, which seems to play such a vital part in the scheme of things, is worthy of an entire book concerning its characteristics; space, however, prevents more than passing comment on its structure and use.

The fact that eddy-current losses in iron laminations only 1 mil. thick still are excessively high, precludes its use at frequencies above 200 kc.; and shielding effects from the use of this grade of iron greatly reduce the inductance—sometimes to zero. Ordinary iron exhibits, too, high hysteretic losses, due to the atomic structure of the iron.

Hysteretic losses therefore may be greatly reduced by changing the atomic structure of the iron, a condition which is obtained by making it in the form of powder. (Two methods are available: one, condensation of iron carbonyl vapors; and the other, the reduction of iron in hydrogen.) Particles of 1 *micron* may thus be obtained; but this size is too fluffy to compress well, and therefore 10-micron (.0004-in.) particles are used.

Next in line for solution is the problem of eddy-current loss, which is due to the conductivity which exists between each particle of the iron (resulting in an absorption loss occasioned by the shorted-turn effect of the connecting, conductive particles). The answer is found in insulating *each particle* of the iron with a very thin varnish.

To make this resulting insulated-iron-powder workable, it is mixed with phenol resin and compressed under extreme pressure and heat; the result is a bakelite compound which looks and machines like gray iron; by weight it is 90% pure iron.

We now have available the means to produce a marvellous transformer which will have the even amplification shown dot-dash in Fig. 2; and contain within itself some means of tuning *with 10 kc. selectivity at all points* (using multiple-stage circuits) over the entire broadcast spectrum.

That these specifications are not absurd, is proven by reference to Fig. B; this is a view of a disassembled "Permeability Tuner." It comprises a "radio frequency" iron case (left), a little litz-wound coil (center), and a "radio frequency" iron plug (right). (The case is approximately 1⅝ in. in diameter and 2¾ in. long; the coil consists of 52 turns of No. 10 x 38 litz., on a form only 1 in. in diameter; the plug diameter is approximately ⅞ in. at one end and 1⅛ in. at the other, and the length is about 1⅞ in., to which must be added the length of a molded-in screw, which protrudes ½ in. The total weight is 9 oz.

In Fig. 4 the completed R.F. transformer, with shields, is shown in cross-section; either the coil and its shield, or the iron plug, case and its iron shield, may be moved in relation to the remaining (fixed) component. The device connects into a circuit in the same manner as an ordinary *fixed-tune* R.F. transformer.

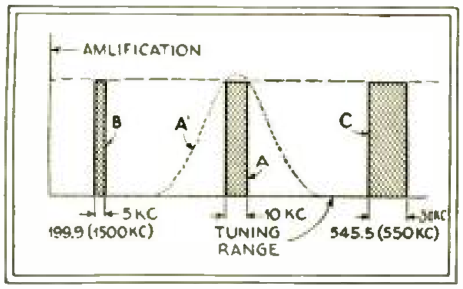


Fig. 3

The width of the response curve varies with frequency as shown at A, B and C above.

A number of these units may be "ganged" with perfectly satisfactory results, since the characteristics of one unit are readily reproducible in another. The stage-gain of a permeability-tuned R.F. amplifier is between 50 and 60 (even better than can be obtained in ordinary capacity-tuned circuits). An experimental "permeability-tuned radio receiver is shown in Fig. C.

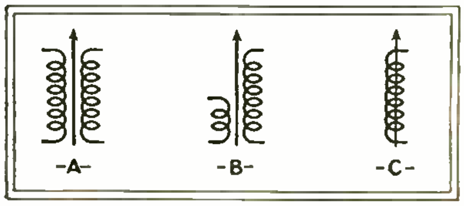


Fig. 5

Proposed symbols for permeability tuning. At A, inter-stage coil; B, antenna coil; C, a single inductance.

A symbol proposed by RADIO-CRAFT for the "permeability tuner" is shown in Fig. 5. In addition to the single line which ordinarily is used to indicate "radio frequency" iron (and therefore, an iron-core R.F. transformer), there is added an arrowhead to indicate variability (the tuning which is accomplished by variation of the inductance of the coil).

All the possibilities of this new and astonishing instrument have not as yet been plumbed; and it remains for the ingenious experimenter to put his fertile imagination to work finding new applications of this device which, it is expected, will be available the early part of 1932.

WORLD'S RADIO MARKET

THERE are a billion people within the range of broadcast stations now established. On the basis of five listeners to every set, it would require 200,000,000 sets to provide facilities for all of them to "tune in" on the programs available.—Dr. Julius Klein, Assistant Secretary of Commerce.

Novel ...mic Microphone

(Continued from page 270)

...ng R which is designed to reduce to ...mum the cavity in front of the diaphragm.

... magnetic field density of 11,000 max-...lls is established in the air gap, in which is placed the moving coil, by means of the permanent magnet. This is constructed of steel containing about 35% cobalt; which results in a magnet of much smaller size than ordinarily encountered in this work, and one that does not readily yield to demagnetization.

Frequency Equalization

In order to increase the low frequency response of the microphone, a tube T is inserted. The effect of this tube is to equalize the air pressure between the front and back of the microphone, and thus alter the mechanical impedance of the diaphragm so as to substantially affect the low frequency response. This equalization of pressure has also the effect of making the response independent of changes in barometric pressure.

Laboratory tests to determine the sensitivity of the microphone to background noise, revealed that the noise output is 6 DB lower than that of the Western Electric Type 394 condenser microphone. To find this value, wind velocities of from 20 to 30 miles per hour were directed against both the condenser and moving-coil type instruments, and the output measured (with the resultant figure given above).

The response of this instrument is substantially independent of temperature. Measurements, conducted at temperatures ranging from 50 degrees below zero (Fahrenheit), to 130 above, showed only a 1.5 DB variation in output.

A pre-amplifier connected to this type of instrument will require a matching transformer T, Fig. 2, with a low-impedance secondary.

Figure 3 is a response graph of the microphone as taken at different incident angles of the sound waves. Below about 900 cycles, the response is independent of the direction of the sound. Above this frequency the response varies with both the frequency and the angle of incidence of the sound, the maximum variation being only about 5 DB.

In order to determine the effect of humidity on the electrical characteristics of the microphone, a sample was placed for 5 days in a room having a constant humidity of 90%. The results indicated no deviation from normal.

A perforated metal grid G, Fig. 1, which is covered with silk, protects the diaphragm from injury. The grid and metal housing form a shield which may be grounded through one of the three jack contacts provided on the rear of the housing; the other two are connections for the external amplifier. (A cam arrangement mounted close to the jack presses the blades close to the plug, assuring positive contact at all times.)

Summary

In order that the merits of this new microphone, which, without a stand, measures 3 x 3¼ in. in diameter, and weighs 2½ lbs., may be more readily grasped, they are listed as follows:

It may be placed at a considerable distance from the pre-amplifier;

Is adapted to use in localities indoors or out, where there exists wind or other extraneous noises;

Simple and rugged in design;

Frequency response graph practically uniform;

Unaffected by atmospheric conditions;

Conveniently located and mounted, and does not require spring mountings;

High sensitivity, occasionally precluding the need of a pre-amplifier;

Does not require an exciter battery;

Is insensitive to ordinary vibration.

The Visigraph

(Continued from page 268)

(such as p, q and y) which come below the bottom of the capitals. The letters are composed of dots and of short or long dashes.

The machine is so arranged, that, without regard to the height of the letters, whether large or small, it produces them of the same size. The sheet of aluminum foil may be preserved, or passed between rollers and smoothed out, ready for use again.

This method, it may be pointed out, makes it possible to transcribe any language, or line drawings, automatically, and put them in raised form; thus extending enormously the opportunities for reading, education and usefulness open to the blind. The cost of such apparatus is dependent upon the effective demand. The principle is, of course, applicable to a greater range of purposes than that shown here; but the humanitarian character of the work shown is of unusual interest.

Latest in Radio

(Continued from page 272)

Referring again to Fig. 4, the action of the A.V.C. will cause the voltage drop across the resistance R to decrease as the signal is tuned in. The voltage between the terminals of the V.I. will then increase, the amount, depending upon the strength of the signal, which in turn depends upon how "close" the station is tuned in. The *height* of the discharge will be a maximum when the station is tuned to exact resonance.

This figure shows the cathode of the tune-a-lite connected to a variable arm on the bleeder resistance. This arm is for the purpose of adjusting the no-signal voltage applied to the tube until it is just equal to the ignition voltage.

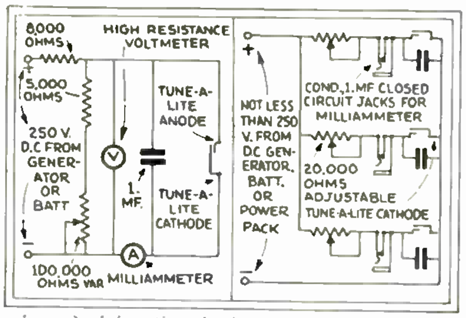


Fig. 2, left. Circuit for determining ignition and extinction voltages.
Fig. 3, right. Determining tube life.

Figure 5 indicates another method of connecting the V.I. This method has the advantage of allowing better regulating action by the tune-a-lite. The diagram of Fig. 6 depicts still another method of connection which is especially suitable for small A.V.C. sets using the hum-bucking type of dynamic speaker, and resistance filtering.

Commercial Adaptation

Certain receivers have recently appeared on the market using a "diode" or two-element type of detector; an example of one is the Fada model "48". The tune-a-lite method of indicating resonance is used, but under the name "Flashograph." This receiver is illustrated and discussed in the first item on page 273.

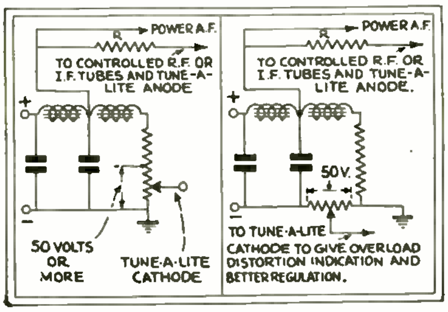


Fig. 4, left. Fundamental connections of the neon tube.
Fig. 5, right. A circuit for improved regulation.

In receivers using '45 output, the novel scheme of connections of Fig. 7 allows the tune-a-lite to act not only as a volume indicator, but also as a distortion indicator. When distortion occurs in an amplifier, the plate current kicks above its normal value, which manifests itself by a flickering of the tune-a-lite. For those receivers employing an A.V.C. tube, the circuit of Fig. 8 is suggested as a means of utilizing this latest contribution to radio.

Ripple Voltage

(*Continued from page 292*)

system and reduces the chances of ruining the meter.

If we have a power supply which delivers, say, 500 volts under load, and the meter range is 50 volts, then a full-scale reading would indicate that the ripple is 10% of the applied voltage.

This method requires a minimum of parts; and satisfactory approximations of the ripple voltages can be obtained.

NEED FOR EDUCATION

ANOTHER reason that the newspapers do not have to fear the radio as a rival," says "F. P. A.," in the New York *Herald Tribune*, "is that most of us know many a home in which at least two newspapers are taken, or, as they say in England, taken in. We know some families that take two *Herald Tribunes*. But there won't be homes with two radio sets, at any rate not going synchronously."

Referred to the Committee for the Enlightenment of Columnists. There are now homes with two radio receivers, two motor cars, and two toothbrushes. Perhaps some public-spirited Service Man can sell Mr. Adams a volume-control attachment—for his neighbors.

The Antenaplex

(*Continued from page 275*)

At this point, a connection should be provided to the 110-V., 60 cycle supply, through a suitable fused switch; between the power supply line and the "antensifier," or group of "antensifiers," a line filter should be inserted, to insure freedom from power line noises in the Antenaplex system. The output of each "antensifier" is distributed through the building to the various "Radio (antenna and ground) Outlets," Fig. B, through the little lead covered "Cabloy" cable, in diameter, (as previously described).

If the building is of the usual tall, narrow construction to be found in the large city, "risers," or vertical wire cables, should be laid out, starting at the central point in the pent house, and spreading across (under the roof) to points directly above the locations of the radio outlets. Thence these lines should be dropped down through the walls so that each line will pass through one outlet on each floor; or, if possible, two outlets placed back-to-back, or nearly so. As many as 50 outlets may be connected to each line, spaced at any convenient intervals—but in no case may branch lines be run, except where an additional "antensifier" is used to connect the branch line into the main line.

If, let us say, only 20 outlets have been employed on one of these vertical lines between roof and basement, the line may be run across the building at the lowest floor reached, and looped up into another riser, to accommodate another group of outlets, and so on at the top of the building, across and down again, until the maximum number

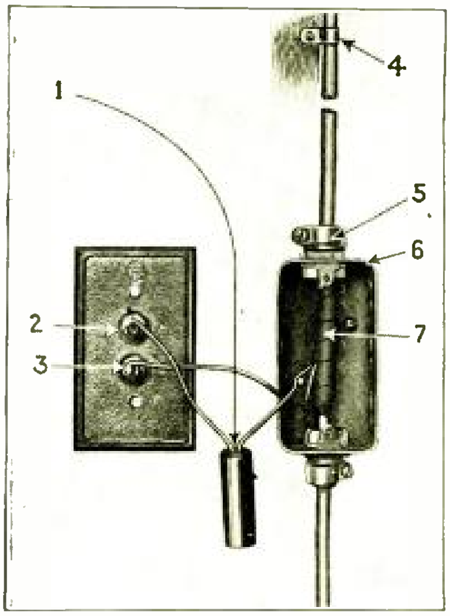


Fig. E

Radio outlet box. Rear view of cover, and front view of box; showing the "taplet" 1, and the antenna and ground connections.

of 50 outlets has been connected. However, in addition to the ground connection employed at each "antensifier," and at each line's outer end, a ground connection should be made at the lowest point on each loop, when lines are looped up and down as described above.

The ground connection should be made of No. 14 copper wire, soldered to the lead sheath and the copper ribbon directly under the sheath of the Cabloy, and should be run to the nearest cold water supply line, where an approved ground clamp should be employed in the manner recommended by the Underwriters.

For buildings of the low, spreading type, the above procedure may be employed, only in a horizontal plane instead of vertical.

Conduit and Outlets

In most new construction work, ¾-in. metal conduit should be employed, as this

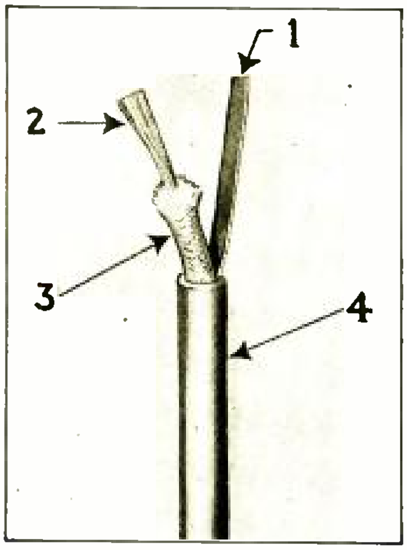


Fig. H

The "Cabloy." At 1, the copper ribbon or ground conductor; 2, cable proper; 3, cotton insulation; and 4, lead sheath.

makes for ready access to lines, ease of pulling lines, and costs approximately the same as the ½-in. metal conduit. Where only short, comparatively straight runs are employed, ½-in. conduit is satisfactory, but for long runs, and especially where bends are encountered, the ¾-in. size will be much more satisfactory.

If desired, ¾-in. Greenfield (flexible conduit) may be employed, or even ½-in. Greenfield for short, comparatively straight runs.

For surface runs, as in the case of old or existing structures, "Wiremold" or other surface metal duct may be employed. (This will be referred to later.)

For all ordinary "Radio Outlets," Fig. E, using a flush plate of the same size usually employed for a single device, any single box 1⅜-in. deep may be used, but for the convenience of those whose duty it is to actually make the taps and splices in the cable, and to arrange the devices in place, an over-size box with a reduction cover will be found a great convenience. For this reason, a standard 4 11/16-in. square box, Fig. F, is recommended, with an aperture cover to take a single plate. The box and cover may be installed so as to mount the radio outlet plate vertically, or horizontally. It is customary, if the plate is to be located down near, or on, the base board, to mount it horizontally; whereas, plates mounted at, or near, switch-height should be installed vertically.

Terminal Devices

In many cases, it is desirable to combine the radio outlet device on the same plate with a current tap, so that 110-volt power for the radio set will be available at the same point.

In this case, a two-gang plate, Fig. G, should be provided for, with a box correspondingly large. However, care should be taken to keep the two devices isolated from each other (in the box), in accordance with the Underwriters' requirements. The power circuits (110-volt) and the signal circuits (radio) must not cross over from one side of the box to the other; and the two circuits and their devices must be separated by a metal barrier within the box. Moreover, the separable plugs which fit into these outlets must be "polarized" so that it will be impossible to confuse them, or make the mistake of inserting the wrong plug into the receptacle.

In each radio outlet, a black cartridge-like device known as a "taplet" is employed, and is connected between the center conductor of the Cabloy and the antenna terminal on the outlet plate. The "taplet" is covered entirely with insulating material, and may be conveniently "stuffed" into any available space in the box.

In the last outlet on every line, a device known as a "terminet" is also employed, and is connected directly across the end of the line from center conductor to sheath (and ground ribbon), Fig. H. It also resembles the "taplet," (but may be distinguished by its red color) and may be placed in any convenient corner of the box.

Splicing and Connecting

In opening up the "Cabloy" for connection or splices, care should be taken to keep it free from moisture.

First, the lead sheath is carefully cut away, for a distance of about 2½-in. being careful not to break or injure the copper ribbon or the center conductor. Then the cotton braid insulation is cut away for a space of about 1 in., using a pair of small scissors or snips. Next, the splice is made to the center conductor, after which the splice to the copper ribbon is made,—in both cases avoiding the use of any kind of acid flux whatever. Only rosin or rosin core solder should be employed.

As soon as the soldering is finished, the splice should be well insulated with rubber tape, running it well up over the ends of the lead sheath so as to keep moisture out of the opening. Then friction tape should be applied to keep the rubber tape in place.

All loose ends of the Cabloy should be sealed up in like manner during the installation process, so as to keep moisture out of the product at all times.

Interference Sources

(Continued from page 287)

This means of radiation is known as "copper coupling" and exists when a high-frequency current is set up in a copper circuit and carried directly by the copper to a point near the receiving antenna. It is particularly hard to locate; since the point at which the maximum of noise is picked up by the test is not necessarily the actual source of the interference.

The Design of Large Installations

(Continued from page 277)

figures. (Actual figures are tabulated on page 297, of this issue.—*Tech Ed.*) The most important use of the decibel is when it is desired to change from power in "watts" to "decibels." Most measurements are made as per so many "DB up" or so many "DB down." In other words, a certain volume level is taken as a reference or zero level and all measurements made are in relation to this position.

For the sake of simplicity, suppose that we regulate the volume of a radio set to that position that gives us the most pleasing response to our individual ears. Then we can call this volume our reference or zero level, and if we advance the position of the volume control, then we go so many DB up, or if we retard the volume control so as to cut the volume, then we go so many DB down from our fixed zero level position. We have changed the volume by either adding or subtracting resistance through the volume control. Now if we take our reference or zero level and find the power required to give us this value in milliwatts, then we can easily derive a ratio between our reference value and any new value that we may care to set up by either advancing or retarding our volume level. However, we have been dealing only with ratios of power in watts. To change our watt ratio to decibels, it is only necessary to multiply the common logarithm of the watt ratio by 10, and our result will be directly in decibels.

The "V.I.", or volume indicator meter, is usually designed so that the zero position of the meter is in the exact center. When a signal is put through the instrument it will designate zero level when the needle is on this zero mark. If the volume is increased or decreased, the amount in DB is readily ascertained by reading the position of the needle and adding this figure algebraically to the value indicated on an

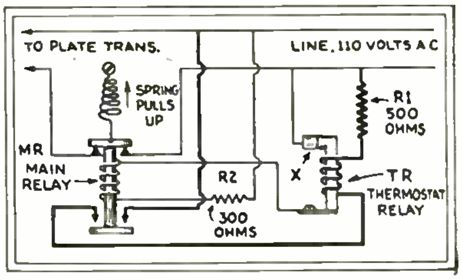


Fig. 3
Diagram of the thermostatic "time-delay" relay.

attenuator connected to the input posts of the V. I.

One great difficulty that now seems to be disappearing, is in deciding at just what value the reference or "zero level" should be taken. It would be best, of course, to chose a figure that would be acceptable to all radio and electrical engineers.

The Stromberg-Carlson Company, up to a very recent date used 10 milliwatts as their value for voice transmission. Another large corporation used 12 milliwatts, and still another, 6 milliwatts. In order to bring about a general standardization, the Stromberg-Carlson Company reduced their value to 6 milliwatts, a value now generally accepted as standard. (Note 3 will show the manner in which the DB calculations for this installation are made.)

To return to our guest room reception, it follows, that to accurately gauge the volume in these rooms, the use of some type of level indicating device is imperative.

In general there are two methods of measuring the sound "level." One makes use of the well-known vacuum tube voltmeter principle, and the other uses a D.C. meter operating in conjunction with a "copper-oxide rectifier." In both cases, the devices are connected directly across the lines through which the level is to be measured. The copper-oxide rectifier rectifies the applied A.C. input which is then applied to the D.C. meter, and the "level" is then read.

The disadvantages of this type of indicating device are that the current passing through the rectifier introduces a slight error that is greatest at the -10 decibel mark, where it may be as large as 1 decibel. Also, an instrument of this type is usually calibrated for a definite line impedance. If used across any other value of line impedance the readings must be corrected. Another objection is that it draws an appreciable current where it is used across a circuit in which it is desired that the current drawn be negligible. As the use of this instrument is primarily designed for line level checking and not for precision laboratory work, the latter can usually be neglected.

The advantages of such a device are that the unit is extremely flexible and portable so that it may be carried around and used anywhere. No batteries or tubes are required. This reason in itself is sufficient to justify the almost universal use of the oxide-rectifier type of level indicator.

The Vacuum-Tube "V.I."

The second type of indicator, or "vacuum tube voltmeter" instrument, is, however, the ideal for level measurements, in that it does not add any appreciable load to the network; and is also quite accurate. In Fig. 4 is shown the schematic circuit of the vacuum tube voltmeter type of "V.I". It will be noted that the input to the grid of the tube is obtained through a transformer. Naturally, therefore, a system of this kind will draw current from the line. However, where it is desired that no current be drawn, the input (grid) can be connected directly to the line without the use of a coupling transformer.

The V. I. is usually so arranged in standard volume indicators, that three ranges of operation are available. This is accomplished by means of a three-way key-switch which, when placed in the lower position, can be used for levels up to about 5DB; in the middle position, up to 15 DB, and; in the top position, it is designed for operation on levels up to approximately 30 DB.

It is desirable to use a tube with a high mu or amplification factor, because of the greater output change possible. For this purpose, therefore, the Western Electric Company uses their type "102D" tube, which is about equivalent to the standard "UX-240." (In the New Yorker, the UX 240 is used exclusively.)

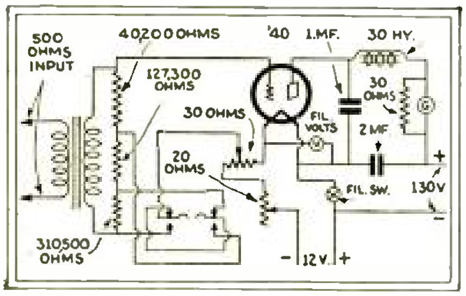


Fig. 4

A schematic diagram of a volume-level indicator based on the vacuum-tube voltmeter principle.

The tube instead of being operated "on the straight portion of its static characteristic" (to give undistorted output) is operated on the "lower bend" or "knee." This results in a non-linear ratio of input-to-output power which is, of course, to be desired in a device of this type. It will be noted that in the plate circuit of the "V. I" tube, there is a filter arrangement, for the purpose of smoothing out the current fluctuations in the plate circuit. The pointer of the meter does not follow all variations, but follows quite nicely most of the current peaks. It would be undesirable to have the pointer follow all fluctuations for it would then be quite impossible to follow it. To dampen or slow down the pointer action still further, the galvanometer is shunted by a 30 ohm resistor.

In practice the volume indicator becomes an indispensible piece of apparatus. It is used for a great many purposes. In the New Yorker, aside from functioning as a level indicator for radio signals going to guest rooms, the V. I. is also used for keeping the line level constant at .006-watt on programs originating in the hotel and either going out to the N. B. C., or going through the hotel amplifying system with an ultimate termination in the guest rooms or other public rooms. Also, the V. I. may be calibrated to read A.C. voltages, and in this manner may be utilized to read a variety of voltages.

NOTES

1. Manufactured by Stanley & Patterson, New York City.
2. Manufactured by Struthers & Dunn., Philadelphia, Pa.
3. The formula for DB is:

$$DB = 10 \log_{10}\left(\frac{\text{PWR. IN WATTS}}{\text{REFERENCE VALUE OR "ZERO LEVEL"}}\right)$$

Assuming that we use 10 milliwatts as our reference value, for it was this figure that was used by the Stromberg-Carlson Company in the original design of the Hotel New Yorker, then, as each speaker is designed to draw 50 milliwatts, our guest room decibel figure is:

$$DB = 10 \log_{10}\left(\frac{.050}{.010}\right) = 10 \log 5.0$$

The Log. of 5.0 is (0.698), thus, our DB=10 X .698=6.98 or approximately 7 DB as the "guest room level," using 10 milliwatts as our "zero level." Supposing the DB value of a standard W.E. "43A" amplifier is desired, the output of which is rated at 12 watts (undistorted). Let us use the now generally accepted value of 6 milliwatts as our reference figure. Then,

$$DB = 10 \log_{10}\left(\frac{12.}{.006}\right) = 10 \log 2{,}000.$$

The characteristic of 2000.00 is 3. The Mantissa=.30103 or the Log of 2000=3.30. Our DB value therefore is: DB=(10)(3.30)=33.0.

If, however, we desired to add another W.E. "43A" Amplifier in parallel with the first, then our output wattage would now be doubled, or 24 watts, but the DB value would only be:

$$DB = 10 \log_{10}\left(\frac{24.}{.006}\right) = 10 \log 4{,}000.$$

The Log 4000=3.6020. Therefore, DB=10 X 3.6=36 DB or an increase of only 3 DB.

THE PENTODE PORTABLE STEPS OUT

Editor, RADIO-CRAFT:

Having just completed the AC portable, described in the September, 1931 issue of RADIO-CRAFT, I wish to express my opinion on this mighty little receiver, not having expected half the results which this mite has shown.

I just couldn't keep the amazement to myself. Everyone I spoke to about the volume and simplicity of this set has doubted me till they actually saw and heard for themselves; but that isn't all.

Last night as I was about to "turn in" I listened to a snappy program and when it ended I was surprised to hear the call letters WOWO, Forty Wayne, Ind; a station which cannot be received under the best condition with my big set using 4 R.F. stages! Well sir, that fired my curiosity for what else it could do; and WTAM, WPG, WRVA, WIP, and a few more just rolled in.

JOHN A. NYIRE,
71 Randolph Ave., Jersey City, N. J.

Magic in Meters

(*Continued from page 280*)

when it is heated. The wire A-B is connected to the source of radio frequency current, the heat of which expands the resistance wire. Spring S, through thread T, exerts a pulling action on this slackened wire, the resultant motion causing the needle N to move over the scale. The degree of movement depends upon the amount of current flowing in the wire, A-B, as shown at A, Fig. 7.

Any instrument which will measure electricity in small quantities may be called a galvanometer, but the general definition is that it is a magnetic device used merely to indicate the *presence* of electricity in a circuit.

The Tangent Galvanometer

A simple type of galvanometer is shown in Fig. 8 and is known as a "tangent" galvanometer. (The genesis of this term lies in the fact that *the current strength is proportionate to the tangent* of the needle's deflection.—*Tech. Ed.*) Briefly, it consists of a magnetic compass laid horizontally within a form on which is wound a coil of fine wire.

When the coil is not connected to a battery, the magnetic needle of the compass will point North and South, drawn by the attraction of the earth's magnetic poles.

If the coil is placed in a vertical position, as shown in Fig. 8, and a current passed through the coil, the degree of deflection will be a function of the intensity of the current flowing in the circuit.

The device is quite accurate and may be calibrated by passing through it known quantities of electricity, and noting the respective positions of the magnetic needle on the scale. Ninety degrees on the scale, in either direction, left or right, is the limit of usefulness of this device. If, for instance, the passage of 2 amperes through the coil causes the needle to deflect 80 degrees, then a deflection of 45 degrees represents some lower value of current.

The reversal of the applied potential will cause a change in direction of the needle's movement. Thus, the device can be used to indicate "polarity."

For those interested in experimenting, the coil can be made up in several sections having leads so that the section can be brought out to binding posts, in order that the coils may be used singly, in series, or in parallel, as desired.

D'Arsonval Movements

Today, galvanometers are made with a large "permanent" magnet (so called) of horseshoe shape, with the coil of wire mechanically supported on "jewelled" bearings so that it is free to turn between the pole faces of the magnet.

When the current passes through the coil, the magnetic lines of force formed around the coil cause it to turn, with a tendency to enclose as many of the lines of force as possible. This construction is known as the "D'Arsonval" type, and forms the basis for our standard types of D.C. voltmeters and ammeters. Figures 9 and 10 show the mechanical design and the electrical circuit; and A, a photograph of this most important contribution to the meter art.

It is interesting to note in this type of instrument the results obtained when its two magnetic fields are combined; such as the circular field produced by an electric current flowing through a wire, and a parallel field produced by two permanent magnets. Fig. 11. Here it will be seen that the lines of force are crowded together on the upper side of the wire and tend to force it down. (This principle underlies the operation of the electric motor, as well as measuring instruments.)

The permanent magnet type of D'Arsonval movement (illustrated in Fig. 12, with the poles marked N and S), is of the common or horse-shoe shape. The coil A-B (Fig. 12) is held to the structure in such way that it can freely revolve.

The current which is to be measured is led into the coil via the springs in such a

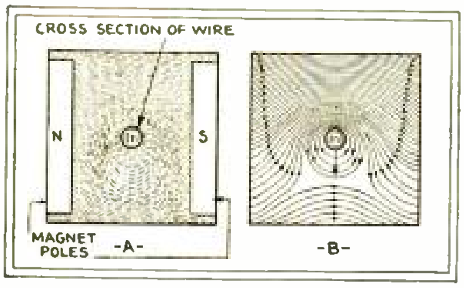


Fig. 11

Magnetic field between the two poles of a permanent magnet at A; and at B, the distorted magnetic field when the wire IN is carrying current.

way that it goes in at B and out at A. The field set up around wire B strengthens the field of the permanent magnet N-S *above* the wire B, and weakens it *below*, thereby forcing the wire B downward. At the same time, wire A sets up a field which strengthens the field of the permanent magnet N-S *below* A, and weakens it *above*, thereby forcing wire A *upward*. This action rotates the coil so that the needle (rigidly attached to the coil) swings across the scale.

It should be noted that the coil and the pointer are mounted at right angles to one another. This is done so that, as the pointer swings over the 0 to 100 scale, the moving coil (swinging through the same angle) always distorts the field of the permanent magnet to the same extent. This results in equal increases in deflection for equal increases in current throughout the entire scale.

Calibration

The "arc," or portion of the circle through which the pointer swings, in this type of instrument depends on the strength of the magnetic field set up in wires A and B—which, in turn, depends upon the current flowing in the coil.

For instance, if the scale were to be calibrated in units of current, let us say *milliamperes* (thousandths of an ampere), we would have a *milliammeter. It is possible that the scale could be calibrated in volts and the meter used as a voltmeter*, for the resistance of the wire A-B is constant, and the current through the coil would be proportional to the voltage across the terminals A-B.

Thus, by winding the coils with any one of various sizes of high-resistance wire, a definite value of resistance can be obtained for the coil, and meters for measuring small or large quantities of electricity will result.

In commercial instruments, resistance, R1, in Fig. 9, is placed in series with the moving coil, and is called a "calibrating" resistor.

This furnishes a means for compensating any inaccuracy in winding the coil, and permits quick and accurate calibration; otherwise, it would be necessary to undertake the laborious job of removing or adding turns of wire to the moving-coil (as in the very first instruments) in order to obtain correct scale indications.

Future Articles

So far, we have only skimmed the high spots in the development of the modern electric meter. Many methods of interest to the laboratorian are being omitted for lack of space, and the fact that they play but a small role in the steady progress of radio meter design.

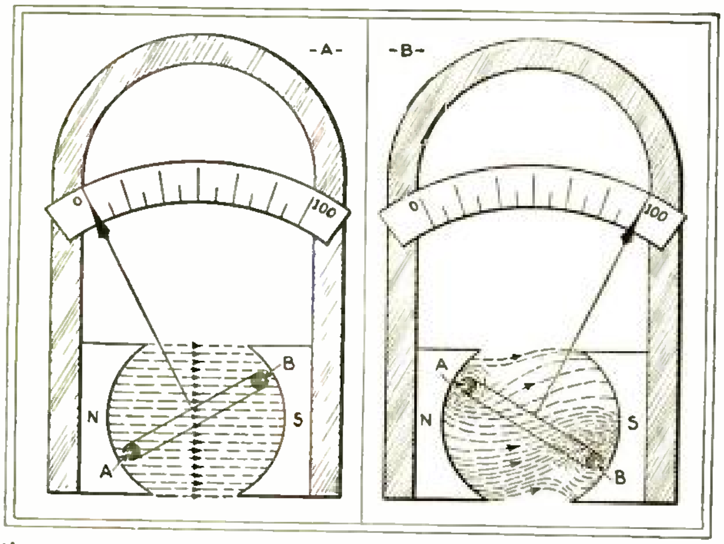


Fig. 12

At A, left, the field distribution in a D'Arsonval movement when the moving coil is not carrying current; at B, right, the field distribution when the moving coil is carrying current.

Looking at a modern commercial meter we cannot conceive the labors of those men who spent their lives to conquer the measurement of that force, "Electricity."

In articles to come, the modern test instruments of all types will be described as to the theory of operation, their use, and short sketches as to how they were developed.

The Service Forum

(*Continued from page 281*)

What the constructor needs to help to revive interest is a real "Roll Your Own." I think a set with the following features would make an ideal receiver: One stage of R.F. ahead of the detector; first detector; oscillator; three stages of I.F., tuned to 175 kc.; second detector, using "C" battery. The audio end could be left to the discretion of the builder.

As a receiver using two dials is more efficient than one with single control, a double-drum dial would be used; the R.F. stage and first detector on one side, and the oscillator on the other.

By using three I.F. stages, it becomes a simple matter to reduce the amplification, when desired, by simply removing the control-grid lead from the cap of the first tube, and placing it on the second.

For the "A" voltage, it would be advisable to use one cell of a storage battery, as almost everyone has one of these lying around. The connectors could be cut, the three cells connected in parallel and, in this way, the battery would give long service before recharging.

Everyone is talking superhets now, so I think the new tubes are going to help the situation. Let us hope you will consider publishing an article on the construction of a receiver, such as I have suggested.

A. E. Ellison,
P. O. Box 130, Ilwaco, Wash.

(The superheterodyne Mr. Ellison has in mind seems to be rather one for the experimenter's own use than for sale to a broadcast fan. How many of our readers would like to see an article on a set of this nature?

The suggestion on the conversion of a 6-volt storage battery for use with 2-volt tubes will interest many readers. However, the two-volt tubes were made for dry-cell or air-cell operation; and the constructor who has current at hand to keep his battery charged up may do better to use the more efficient and powerful '24s, '35s, '27s and '47s.—*Editor.*)

Resistor Guide

(*Continued from page 275*)

to each and every job. To overcome this difficulty, the International Resistor Company has compiled a very compact booklet which lists the different model receivers (using resistors) of over 35 set manufacturers and describes the correct replacement resistors.

This booklet lists ten fundamental circuits in which resistors may be used; and most of the formulas that are directly connected with resistance calculations. Following this, there are tabulated (for each manufacturer) the troubles that may be due to poor resistors; the purpose of each resistor and its points of connections; and the resistor's color code, its value in ohms, and the recommended replacement value.

Due to the small size of the book, it should be found in the pocket of every Service Man. For further information, write to the International Resistance Company, 2006 Chestnut Street, Philadelphia, Pa.

A Service Bench

(*Continued from page 283*)

glow tube, one 10 watt incandescent lamp, and two 300 watt incandescent lamps in parallel. This condenser test set uses 3-point Hubbell plugs for external connections—which are located at the front of the bench. On the small, black board, which rises above the bench, there are various controls built up in two-gang switch plates, which control the dynamic speaker, the magnetic speaker and the output meter. Under the bench is a complete Westinghouse radio receiver chassis and power pack. The connections from this receiver are brought into the back of the bench via Yaxley connectors. This arrangement facilitates the testing of either a chassis or a power pack, without

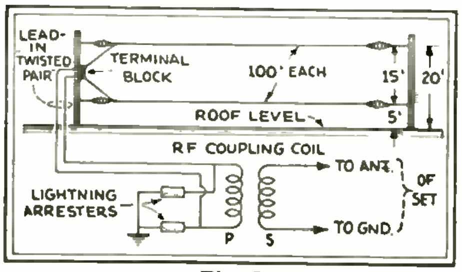


Fig. 2

The antenna-and-counterpoise construction recommended.

the necessity of having the Service Man return both parts.

The entire bench is supplied with both 110 and 140 volts A.C. through a line control-box which is located on the wall at the left-hand end of the bench. This control-box contains a 125 watt, 20 to 40 volt transformer, which is connected as an auto-transformer in order to increase the line voltage. The change in voltage is accomplished by means of a three-pole switch.

Among the other pieces of service apparatus are a pre-heater and field supply built into a steel cabinet; a complete phonograph turntable, pickup and amplifier; an RCA Model 106 loud speaker and an RCA Model 100 loud speaker. All of these are controlled by the switches located on the back panel. A battery-operated short-circuit tester for tubes is also included as part of the equipment.

A very novel antenna arrangement is used that has been found to be very efficient in this location. The diagram is shown in Fig. 2 and is self explanatory.

SYNCHRONIZING ALL SYSTEMS

THE Bureau of Standards, announcing a prospective extension of its service of standard-frequency transmissions, hopes that ultimately standard frequencies will be transmitted twenty-four hours every day; when, it is anticipated, stations may be directly controlled by the received standard-frequency signals, in effect putting all of the stations of the country on a single control. This, it is said, will be more practicable than synchronization of broadcasting stations.

Consideration is being given to placing a sixty-cycle modulation on the transmissions, with a view to aiding electric power systems to accurate synchronization; in order to advance the interconnection of electric power supply systems in various parts of the country and also to improve the accuracy of electric clocks.

A "Speed Tester" for Radio Service

An entirely new thought in radio service instrument design; and one which will interest many.

By R. DOUGLAS CLERK

REALIZING that many Service Men are anxious to have details of my "Speed Tester," which has made it possible for me to make an average of over 20 calls per 8 hour day, I am now submitting detailed directions for duplicating this extraordinary piece of apparatus.

It all came about from figuring the large amount of time wasted in locating trouble in multi-tube sets even when using the most up-to-date analyzers.

Every radio Service Man knows all about it; remove a tube, put the analyzer plug in its socket, place the tube in the tester, push "umpteen" buttons or twist a multi-switch, and read at least one meter for each setting. Then compare this reading with a chart, or more than likely trust to memory, remove the tube, remove the plug, replace the tube in the set, and then proceed to the next tube which you treat in similar fashion.

We all do it—just like the blind leading the blind, and what a waste of valuable time! Anyone able to run a complete test on *one* tube and its attendant circuits in less than one minute is a veritable whirlwind! No, we must branch out for ourselves and forget the precedent; we must design a piece of apparatus which will indicate the defective tube or circuit in a much shorter time than is possible with present day analyzers. Ninety-nine times out of a hundred there is only one fault in a radio, which, if corrected, will put it in perfect shape.

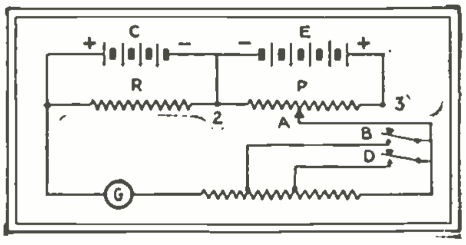


Fig. 1

The fundamental circuit of the "Speed Tester." Position 1, is at the left connection to R.

Here then is our problem. At what point in the circuit can we connect our tester so as to indicate any defect in the set from this one point? Well, there is one place in every radio set where all the "juice" that really matters is concentrated—the "B" supply.

If a tube or circuit is defective in any way, then the current flow from the "B" supply will not be normal; now, if we have instruments sensitive enough to indicate any divergence from normal, then we have located the defective tube or circuit.

Suppose, for instance, that due to some defect we haven't the proper bias on a tube, then the plate current drain of that tube will be greater or less than its normal amount. A weak tube will draw less than it should, and a burnt out tube will not draw any (unless it is shorted, in which case it will draw more than it normally should).

To measure the current flow to each tube is easy; open one lead from the '80 tube rectifier (which supplies the full high voltage) between the '80 tube and the filter. Connect in a meter and measure the current flowing. Now remove any tube in the receiver and the meter will give a new reading, due to the decrease in the load current.

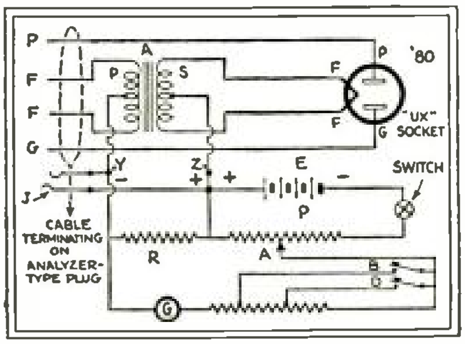


Fig. 3

Schematic diagram of the completed tester.

We can open this lead very easily by using the accursed analyzer plug, which is now in the form of a blessing since we are going to use it *only once*. The plate current supplied by one side of the '80 tube can now be read, but any difference (in current) due to the removal of a tube from the set, which is going to mean so much to us, is too small to be clearly indicated with the meter used—we must make our instrument far more sensitive; we must be able to read differences of a small fraction of a mil. It almost sounds as though we would have to use very expensive laboratory instruments. This, however, is not the case.

Figure 1 indicates where we now stand. Here we have a battery C of any convenient voltage across which is connected a resistor R; another battery E (of higher voltage than C) has a potentiometer P connected across it. These two batteries are so connected that they oppose each other. A meter G, and the necessary "multipliers" in series with it, are shunted across the two resistors P and R, which constitute a potentiometer, with terminals 1 and the arm A.

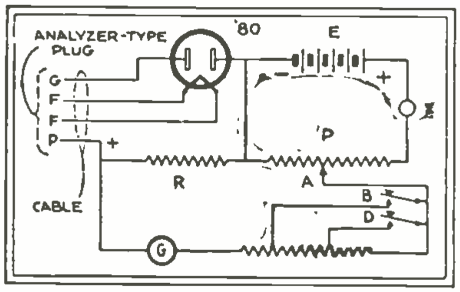


Fig. 2

The potential of C in Fig. 1, here is obtained by the voltage drop across one side of the '80.

If we place the slider of P at the "zero" position (point 2) the meter will read the full voltage of C, and as we increase the adjustment of P toward point 3 the meter will read the difference between C and E (since the batteries oppose each other) until the voltage across the resistor R equals the voltage between points 2 and A, when the difference will be zero, and the meter

G will not read. Now, if we short out a portion of the multiplier of G, we will still get zero for a reading, since the voltage between points 1 and A is still zero; but any change in voltage C will show up as a big deflection on our meter, due to the decreased resistance in series with the meter. We have made a wonderful increase in sensitivity, which will become greater if we remove more of the multiplier, and can be made still more sensitive if we use a micro-ammeter or galvanometer in place of G.

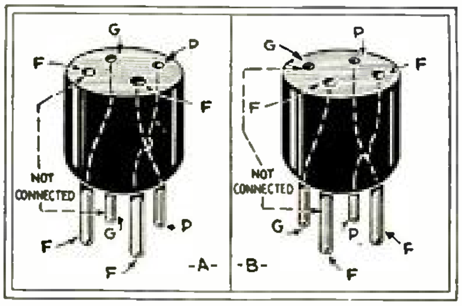


Fig. 5

At A, the adapter for the plug when testing Raytheons; at B, the adapter for the socket of the "Speed Tester."

Now in Fig. 2 we have replaced C by connecting R in the plate circuit of a tester plugged into the '80 socket of a set under test. A voltage is developed across R due to the rectifier current flowing through it, and all the above remarks and conditions are the same as in Fig. 1. If we now balance out the effect of the voltage drop in R, by sliding arm A between points 2 and 3 and then remove any tube from the set under test, we will have a good reading on our meter G, which may be made larger by cutting out more multiplier resistance.

Now we could use the circuit as it stands, but we would get a more accurate picture of conditions if we could include the current from the other plate of the '80. We must not forget that as it now stands we are passing *half-wave* unfiltered current through both R and G. Not so good. In order to read the total current from both plates of the 80, the resistor R must be connected in the *filament* circuit. Figure 3 gives the final circuit making use of full wave rectification by isolating through the use of a transformer (which preferably is centre-tapped) the filament circuit of the '80. This is much better for our instrument, but it is still unfiltered; an electrolytic 8-mf. condenser across R helps a lot, but the use of a "thermo-galvanometer" for G is ideal.

Construction Details

As we are going to use a 4.5 volt "C" battery for E, we must design R so that the drop across it is not more than 4 volts. The maximum current supplied by the '80 is rarely more than 100 mils; therefore, R equals $\frac{E}{I}$ equals $\frac{4}{0.1}$ equals 40 ohms. Let us be on the safe side and call it 35 ohms. The potentiometer can be of any high value—10,000 ohms, or more. The multiplier resistor values are determined by the meter used; and as we are wanting comparative readings only, need not be extremely accurate. It should be such that it will give full-scale deflection when 4.5 volts is applied. Calculate it from R equals $\frac{E}{I}$. Suppose it to be a 1 mil. meter, then R1 equals $\frac{4.5}{.001}$ equals 4,500 ohms, for the total resistance of the multiplier, using a 1000-ohms-per-volt meter. The button D will short out 3,000 ohms, making the meter act as a 1.5-v. meter, increasing the sensitivity 3 times. Button B shorts out all but 500 ohms, giving a further increase of sensitivity.

The transformer, if used, can be constructed on the core of an "AK 37" filter choke (See Fig. 4), and is wound with 90 turns of No. 18 DCC wire for both primary and secondary (each winding is centre-tapped).

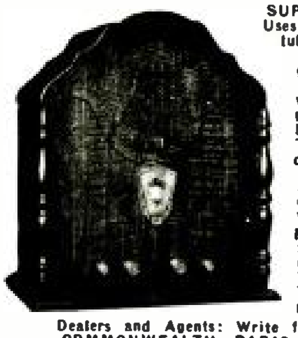
Assemble the core in *transformer* fashion as indicated at A; and not as a *choke* B. This is to eliminate the air gap required for good operation as a choke coil.

A 4-hole socket, a switch, 2 push buttons, and a four-prong plug, with cable, complete the assembly—which can be mounted on any convenient panel.

If a centre-reading galvanometer (100-0-100) is used, then the polarity of C does not matter; but if a milliammeter is used, then it is necessary to make sure that the E.M.F. across R is connected so that the meter reads *backwards* when the battery C is *not* in circuit, and is balanced to zero by the potentiometer P when the switch S is closed. This completes your "Speed Tester."

Operation

To operate the instrument, place the '80 tube in the tester socket; place the plug in the '80 socket with the set turned on. If using a galvanometer, note the reading of G, which will indicate the normal current drain if all is well. (If using a milliammeter, close switch S and adjust P until the milliammeter reads zero.) Now, either



switch off the set or remove the '80 and read the meter. This reading, which is made before any balancing adjustments are performed, is to be recorded.

With the set switch on and the meter *then* balanced at zero, press button D to increase the sensitivity and make any further adjustments of P necessary to get a zero reading; remove any tube from the set and compare the reading with a chart; if all is well with this tube and its associated circuit, we will obtain a similar reading every time we test the same stage in a similar set. This reading is the "normal" one to be used in making up our chart for this particular set. However, if the bias or plate supply to this tube is not right, then the reading will differ from normal, thus indicating a defective circuit or tube.

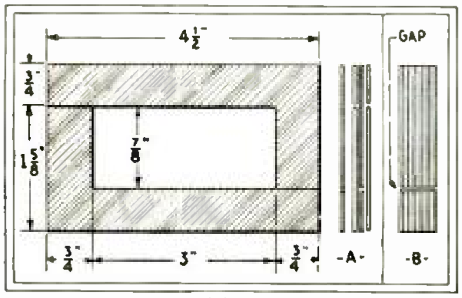


Fig. 4

The laminations should be so arranged (A) that no air-gap exists in the core.

Now remove each tube in turn, and make a comparison with the chart for that particular type of set. Disregard all normal readings and concentrate on those which are abnormal. Use an ordinary analyzer on the defective circuit, substituting good tubes if necessary, and the work is done almost before it is started.

Each model of every make requires a one-line chart showing normal current flow *before* bucking out the current with potentiometer P, and one value for each tube in the set. I suggest that as no two testers will be alike, that each tester have its own set of charts made by the constructor; using the vertical column to the left, on charts ordinarily supplied with every commercial analyzer. This chart can only be made by taking readings on a perfect set of each model, and recording the normal values.

To service battery-type sets, open the "B—" to the set and connect the 'Speed Tester" into the circuit via jack J, Fig. 3, and proceed as in servicing A.C. sets. Receivers using '81's can also be tested with this instrument, but sets using gaseous rectifiers (Raytheons) require one adapter for the plug and another for the socket, the construction for which is shown in Fig. 5.

As further refinements are made in this interesting tester, they will be published.

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Correspondence

(*Continued from page 294*)

theory in such a way that it includes every process in the whole chain of wireless events, from the microphone at the transmitter, to the loud speaker at the receiver.

The principal features which must be considered in conjunction with the sideband theory, and which had not been considered up to the time of the publication of my paper, are, firstly, the damping of the receiver, and secondly, the rectifier.

DR. JAMES ROBINSON.

Editor, RADIO-CRAFT:

Doctor Robinson is correct in the above statements. At the time I prepared the Stenode article for RADIO-CRAFT little was known about the system in this country and I gathered as much data as I could from foreign sources; and while much of this was contradictory and incomplete, I connected the information together in a form that apparently explained the complete system in the only logical manner possible.

It is not a question of whether or not sidebands exist. Dr. Robinson never said that they did not exist. They exist in the same manner that various components of forces exist in a parallelogram of forces, although the net result acts in one direction. The main question centers on the width of the frequency-response band of the quartz crystal, which is as yet, I believe, not definitely known. The crystal reacts so strongly on the associated circuits that an exact measurement is very difficult to make. (See note below.)

The crystal acts as a filter. If it was 100% perfect, it would filter out all modulations and would pass only an undamped wave of the frequency of the carrier. But it is not a perfect filter; therefore it passes modulations, the amount depending upon the frequency of the modulations. The higher the modulation frequency, the less it passes, and vice versa. This is the same as saying that the higher the sideband frequency, the more it is "cut," by the selective circuit. And the resultant audio quality would be poor; the high notes would be considerably weakened, and the tone would sound deep and drummy.

For this reason it was assumed, since Dr. Robinson claimed to obtain excellent tone quality, that *frequency modulation* existed to a slight extent in all amplitude modulated waves. A test indicating that the frequency of some broadcast stations do not vary by more than two cycles in the course of a few hours would not affect the deduction, because the frequency modulation considered would be that which varied at a rate up to 5000 per second, and would be present only when the carrier was modulated in the usual way. I was not aware that any tests had been made to measure the amount of frequency modulation, if any, present in the ordinary broadcast wave; but it would only have to be very slight to affect the highly selective crystal circuit in the Stenode. I would like to see a test made with a Stenode receiver tuned to a transmitter which was only frequency modulated.

There is one point about the Stenode which I believe needs further explanation. In the Stenode, the audio quality at the detector output is very poor; the sidebands are cut so much that the high notes are reduced far below normal, the volume tapering off considerably as the frequency increases. To compensate for this, the audio amplifier is designed to give the opposite effect; that is, amplify more efficiently as the frequency increases, so that the net result is a practically straight line characteristic giving true tone quality. Now, since the audio amplifier offsets the highly selective characteristic of the crystal circuit, why isn't the net result the same as that obtained from an ordinary set of normal 10 kc. selectivity?

However, the proof of the pudding is in the eating thereof. I have recently had the pleasure of having the Stenode completely demonstrated to me, and as far as results are concerned, it certainly does all that is claimed for it. By direct comparison with one of the better class superheterodyne sets of the usual variety, the Stenode was actually superior in tone quality, and gave even better response on the higher audio frequencies. And as to selectivity, stations that could be heard over a few degrees on the dial of the ordinary set could be tuned completely in and out on the Stenode on a motion of the dial so slight that the eye could hardly perceive it.

CLYDE J. FITCH.

(Note.) Graphs of the response of quartz plates for extensional modes (involving areal dilatation) and that mode termed by him "longitudinal oscillation" which involves displacements which are directed principally parallel to the thickness; and also corresponding values of decrement, are given by A. Meissner in the Proc. I.R.E., Vol. 15, 1927, pp. 281 to 296.

Although the latest results of the experiments of K. S. Van Dyke, which are being conducted at Wesleyan University, Middletown, Conn., have not as yet been published, formulas he derived for the analogous constants of quartz plates (from which at least indications of the probable decrement may be gained), have appeared in the Proc. I.R.E., Vol. 16, 1928, pp. 742 to 764.

Sound Recording

(*Continued from page 289*)

previously stated); that is, by making a record as the pointer fluctuates about a certain point in the scale. If the record is too loud, the gain must be cut down and the test made over again.

The 250,000 ohm potentiometer P1 in the grid circuit of V1 is used for varying the voltage of the input signal to the tube, thus determining the maximum (three-quarter) swing of the needle of meter M.

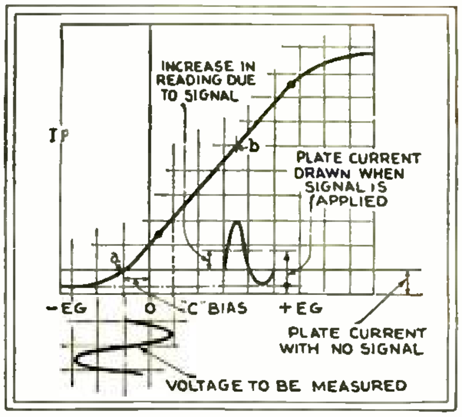

Fig. 5

Due to the non-linearity of the grid-voltage plate-current curve, the average plate current is greater with a signal than without one.

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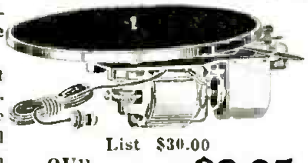

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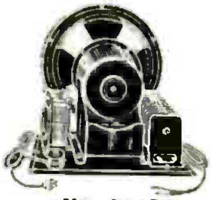

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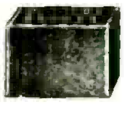

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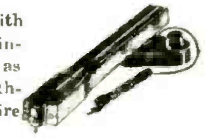

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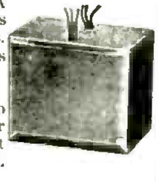

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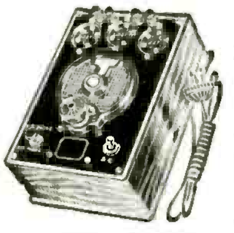

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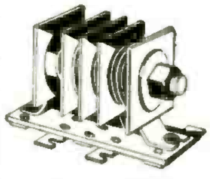

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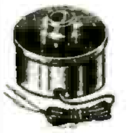

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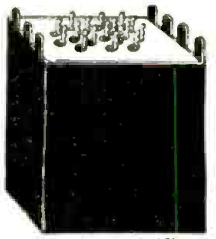

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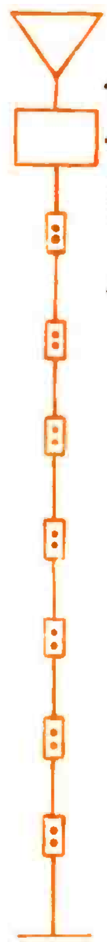

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