RADIO'S LIVEST MAGAZINE

A GERNSBACK PUBLICATION

Radio-Craft

July

25 Cents

HUGO GERNSBACK Editor

Which Audio System? — A Tube-Checker Adapter — New Tube Chart
A Midget "3-Tube" Superheterodyne — The Thermocouple "A" Unit

SPEED

Radio Tubes—Foto-Lectric Tubes—Television Tubes

Economic conditions have given marked impetus to the development of several special-purpose tubes of increased efficiency. Three new SPEED types have been announced —several others are nearing completion in the SPEED laboratories.

TO THE RADIO TRADE: SPEED Radio Tubes will be displayed in Booth 40, Exhibition Hall, and in Demonstration Rooms 718, 719, 720, Stevens Hotel, Chicago; RMA Trade Show, May 23-26, Incl.

NEW TYPES

SPEED Type 256

is an AC General Purpose tube with 5-prong base, similar to SPEED type 227, with improved characteristics. This new fast-heater tube is in a small bulb measuring only 4¼" overall. This efficient tube, with the others in its series illustrated below, will be widely popular in new 1932 receivers.

SPEED Types 257, 258

are designed to replace types 224 and 235 respectively in new equipment. SPEED type 257 is an AC Radio-Frequency Pentode with a 6-prong base; SPEED type 258 is an AC Variable-Mu Radio-Frequency Pentode with a 6-prong base. These fast heater tubes measure only 4⅞" overall.

SPEED Triple-Twin, an exclusive development of the SPEED laboratories. Type 295 AC; type 291 DC; type 293 for automobile use.

CABLE RADIO TUBE CORPORATION,
Brooklyn, N. Y.

Send me current bulletins on items checked:
☐ SPEED Radio Tubes ☐ SPEED Foto-Lectric Tubes
☐ SPEED Television Tubes

Name ....

Address ....

City and State ....

REGULAR TYPES

Receiving Tubes

General AC Series	*General DC Series*	*Automobile Series*	*Sparton Set Series*
224	201A	236	S82B
235	199	237	S83
551	WD11	238	S84
226	WD12	239	S85
227	120		
245	140	Low Wattage Series	Rectifier Series
247	112A		
171AC	171A		
256	200A	230	280
257	222	231	281
258		232	282
	Triple-Twin Series	233	
Special Amplifier Series	291	234	
210	293		
250	295		

Other new important types will shortly be announced.

Foto-Lectric Tubes

Five types with several different basing arrangements. For use with DeForest Phonofilm, Kinoplay, Weber, Platter, Holmes, DeVry, RCA Photophone, Powers, Pacent, Royal, Universal, Gries, Western Electric and many other types of equipment.

Standard gas-filled types, red sensitive, caesium on caesium-oxide, silver-oxide base. Guaranteed against defects.

Television Tubes

One inch plate, Wall Electrode type for operation in plate circuit of type 171A tube and with plate current limitations in circuit of types 245 or 247.

Crater type, in standard diameters of .015", .020", .030", .040". Other sizes available on special order.

Send Coupon for Current Bulletins

CABLE RADIO TUBE CORP.
230-240 NO. NINTH ST. BROOKLYN, N.Y.

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.

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Radio-Craft
FOR THE SERVICE MAN · DEALER · RADIOTRICIAN

HUGO GERNSBACK, Editor-in-Chief
LOUIS MARTIN, Associate Editor
R. D. WASHBURNE, Technical Editor

CONTENTS OF THE JULY, 1932, ISSUE

VOLUME IV   Number 1

IN OUR NEXT FEW ISSUES:

"I EQUALS E OVER R." A modern treatment of a fundamental subject which directly concerns every phase of radio design, construction and repair. A "why" and "how" article.

CONSTRUCTING AN A.C.-D.C. PORTABLE RECEIVER. Complete details for building a compact, light-weight radio set suitable for use on either direct- or alternating-current power lines. The tone quality is remarkably good.

AN OHM- AND OUTPUT-METER. Construction details for a new instrument design for the radio Service Man. Compactness and extreme utility are features of particular appeal to the service technician.

BUILDING AN INTERMEDIATE FREQUENCY OSCILLATOR. Two points of paramount importance to the Service Man building his own service oscillator—construction and calibration—are described by the author.

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

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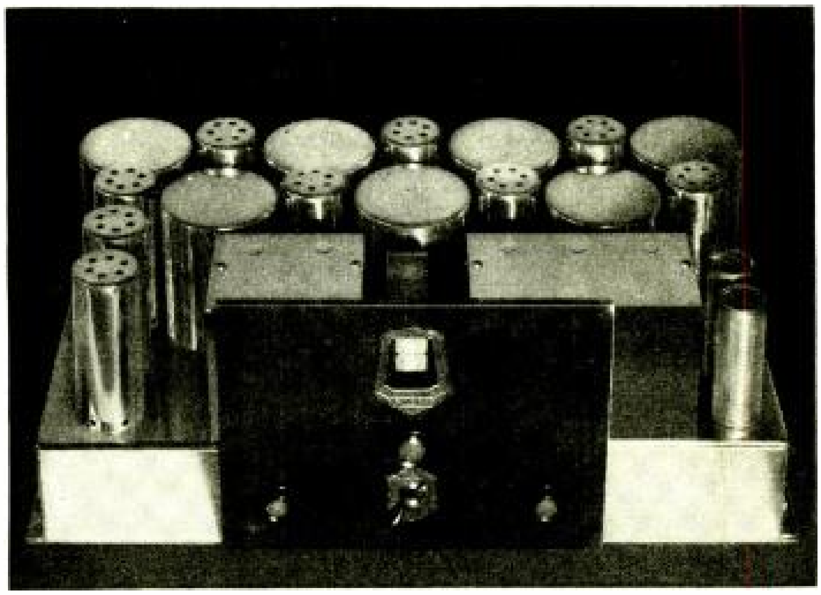
Announcing

THE *de luxe* SCOTT ALL • WAVE



15-550 METERS

no plug in coils

SINGLE DIAL

no trimmers

Proved **by independent laboratory tests and by practical use to be the greatest radio achievement of all time!**

Such a receiver as the *de luxe* Scott All-Wave is still generally considered *impossible*. Yet, here it is! A 15-550 meter receiver *without* plug-in coils that tunes the whole range with absolute precision, on ONE dial—*without* the help of trimmers. But that's not all. The *de luxe* SCOTT ALL-WAVE incorporates far greater *sensitivity*, and obviously better *selectivity* than have ever been considered possible of attainment. And with it all, a tonal output that is guaranteed to be as perfect as the tonal input at the station!

Here IS Sensitivity • • •

*12/1000ths of a microvolt per meter at 1400 K. C. and 6/10ths of a microvolt at 600 K. C. This is an average of several thousand times more sensitivity than engineers have ever considered practical. And this sensitivity would not be practical even in the *de luxe* Scott All-Wave were it not for the unique means by which this receiver lowers the natural noise level of reception. But it IS practical in the *de luxe* SCOTT ALL-WAVE, and the 12/1000ths to 6/10ths microvolt per meter sensitivity brings in stations, *at most any distance,* with local volume. Stations that no other receiver could ever hope to get, come in on the *de luxe* Scott All-Wave, with enough volume to be heard a block away!

Entirely New Selectivity

No receiver in existence today can demonstrate such ideal selectivity as the *de luxe* SCOTT ALL-WAVE. *At 1000 K. C. it gives 4.5 K. C. separation provided the field strength of one station does not exceed the other by more than 10 times. It gives 9 K. C. separation when the field strength of one station exceeds the other 100 times. At 200 times field strength it separates by 10 K. C. At 5000 times field strength, the separation is 20 K. C., and mind you—only ONE dial, and without trimmers of any kind!

Absolute Reproduction!

The over-all response of the *de luxe* SCOTT ALL-WAVE, as determined by the sound pressure curve of the entire receiver including the speaker, proves the Scott All-Wave capable of *absolute* reproduction. This curve is flat within plus or minus 2 deci bells from 30 to 3000 cycles. This means that the human ear cannot detect any difference or loss in frequencies between a selection as it is being played before the microphone and as it comes from the *de luxe* SCOTT ALL-WAVE.

E. H. SCOTT RADIO LABORATORIES, INC.
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Regular 'Round the World Reception Now Even MORE *Enjoyable*

The standard Scott All-Wave of 1931 gave dependable, daily, 'round the world reception. This new *de luxe* SCOTT ALL-WAVE brings in the entire world *with perfect ease and convenience*—one dial—no trimmers—no plug-in coils. From France to Japan—from England to Australia, and from Alaska to the Argentine—they're all on the single dial of the *de luxe* SCOTT ALL-WAVE—waiting to thrill you as you've never been thrilled before. London, Paris, Berlin, Madrid, Sydney, Melbourne, Saigon, Buenos Aires, Bogota, and dozens of others are within easy, daily range of the *de luxe* Scott All-Wave 15-550 meter superheterodyne.

Send the COUPON for Curves and Proof

The story of Scott precision engineering as applied to the development and final attainment of complete perfection in the *de luxe* Scott All-Wave reveals the most outstanding radio facts of the day. The coupon will bring it to you FREE—also unquestionable PROOF that the *de luxe* SCOTT ALL-WAVE Is the ONE receiver that can guarantee easy, enjoyable, dependable, daily, 'round the world reception. Clip the coupon. Send it now.

**Measurements made by Radio Call Book Laboratory*

THE E. H. SCOTT RADIO LABORATORIES, INC.
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Send me full particulars of the *de luxe* SCOTT ALL-WAVE.

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96 PAGES

OF NEW DATA HAVE BEEN ADDED TO THE

OFFICIAL REFRIGERATION SERVICE MANUAL

To bring this useful service manual right up-to-date, Mr. L. K. Wright, the Editor of the OFFICIAL REFRIGERATION SERVICE MANUAL, has added a wealth of entirely new material on electric refrigerators. This new section, which totals 96 pages, has contained therein dozens of new models of recent manufacture which have been placed on the market during the past few months and in addition, information regarding improvements on older models. As usual every refrigerator has been accurately described from the viewpoint of servicing—diagrams to illustrate the essential parts, and simplified so that repairs can easily be made

NO EXTRA COST FOR THIS MATERIAL

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Radio Service Men—Turn Idle Summer Hours into Profit by Servicing Electric Refrigerators with the aid of this New and Complete Service Manual.

THE idea of electricians, radio service men and other mechanically inclined men, servicing refrigeration units is self-evident and the thought has occurred to perhaps untold thousands ever since electric refrigeration started. Yet nothing was done, because the average man knows little or nothing about refrigeration. Compared with servicing a radio set or wiring a home for electricity, the servicing of a refrigerator is absurdly simple, once you get the hang of it.

The OFFICIAL REFRIGERATION SERVICE MANUAL has been edited by L. K. Wright, who is an expert and a leading refrigeration authority. He is a member of the American Society of Mechanical Engineers, American Society of Refrigeration Engineers, The National Association of Practical Engineers, etc.

In this Refrigeration Manual every page is profusely illustrated; every refrigerator part is carefully explained; diagrams are furnished of every known machine; special care is given to the servicing end. The tools needed are illustrated and explained; there are trouble shooting charts, and other service data.

Remember there is big money in the refrigeration servicing business. There are thousands of firms selling refrigerators every day and they need to be cared for often. Eventually there will be more refrigerators than radios. Why not increase your earnings with a full or spare time business by servicing refrigerators.

Here are some of the important chapters:

- Introduction to the Refrigeration Servicing Business
- History of Refrigeration
- Fundamentals of Refrigeration
- Description of All Known Types of Refrigeration.
- Service Tools and Shop Equipment
- Motors
- Trouble Shooting
- Unit Parts, Valves and Automatic Equipment
- Makes and Specifications of Units
- Manufacturers of Cabinets
- Refrigerants and Automatic Equipment

and Many other Important Chapters.

Several thousands of copies of the OFFICIAL REFRIGERATION SERVICE MANUAL have been sold; and there still remains the greatest opportunity for thousands more to learn how to make more money in a short time through openings in this new field.

NOW • •

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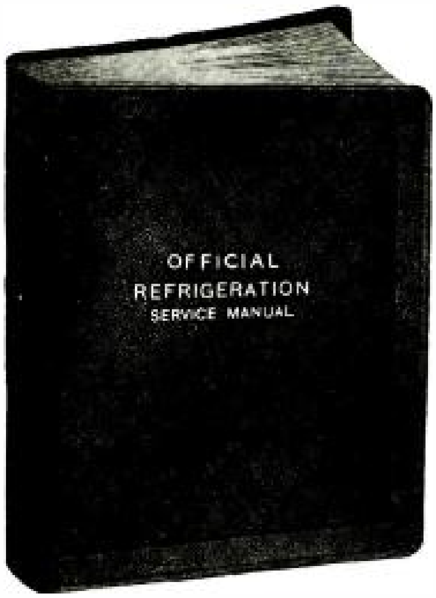

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Radio-Craft

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On this page are listed booklets, catalogs, pamphlets, etc., of Manufacturers, Schools, Institutions, and other organizations, which may be of interest to readers of "Radio-Craft." The list is revised each month, and it will be kept as up-to-date and accurate as possible. In all cases the literature has been selected because of the valuable information which the books contain. If you are interested in subjects not listed on this page, write us and we will try to serve you.

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Fill in and mail the coupon below; make sure that your name and address are included and are plainly written. Order by number only.

46. SOUND PROJECTION CONTROLS

This leaflet shows the correct connections for all Centralab sound projection controls, which are ruggedly built units designed to withstand the hard usage which their particular application demands. It is a useful little piece of literature for the sound projectionist and also for advanced experimenters and Service Men who encounter P.A. and motion-picture amplifiers in their work. *Central Radio Laboratories.*

47. SHALLCROSS RESISTANCE BULLETINS

Bulletins No. 74, 151, and 100 contain much useful and practical information for the Service Man and constructor. No. 74 describes the design and construction of an easily-made Wheatstone Bridge, the basis of which is a kit of highly accurate Akra-Ohm resistors. This bridge has a measuring range from one ohm to ten megohms, which is sufficient for all ordinary purposes. No. 151 tells how a single Weston Model 301 Universal Meter may be used for six voltage and five current ranges, with the aid of suitable multipliers and shunts. No. 100 describes the general line of Akra-Ohm resistors and gives their full technical characteristics. *Shallcross Mfg. Co.*

48. INTERESTING PHOTO CELL EXPERIMENTS

This booklet describes a number of interesting and practical experiments with photo cells and relays. It tells how to use the LuxTron; How to Light an Electric Bulb with a Match; How to Make an Electric Light Turn Itself Out; How to Make Burglar Alarms and Fire Alarms; How to Make an Alarm System for Public Garages; How to Make a Smoke Alarm; How to Make a Turbidity Alarm; How to Construct a Weighing Alarm; Method of Lighting Stores for Police and Watchman's Inspection; A Silencer for Radio Announcers. *LuxTron Mfg. Co., Inc.*

49. SPEED FOTO-LECTRIC AND TELEVISION TUBES

Bulletin B describes the line of Speed photo-electric cells for television and talking motion-picture work. It includes full data on their dimensions and base connections, and also shows their characteristic curves for sensitivity plotted against light, output vs. illumination, and output per lumen vs. anode voltage. Two additional multigraphed bulletins describe the wall electrode and crater type neon tubes for television receiving purposes. *Cable Radio Tube Corp.*

50. TRANSVERSE CURRENT MICROPHONES

The transverse current microphone is so named because an electric current passes transversely across it, parallel to a silken diaphragm. The latter forms the front wall of a receptable filled with carbon granules. The transverse current is modulated by variations in pressure against the granules caused by the vibration of the diaphragm in harmony with sound impulses. The operation of this interesting microphone is described in a six-page folder which every user of microphones will find worth reading. *Amplion Products Corp.*

51. VITROHM LINE VOLTAGE REDUCERS

Line voltage reducers are very profitable items for radio dealers and Service Men. They are easily sold to owners of radio receivers, they take only a few seconds to install, and they perform a real service by protecting power transformers against high line potentials. This bulletin tells how the Ward-Leonard reducers are used, and lists the correct sizes and models for about 150 broadcast receivers. *Ward-Leonard Electric Co.*

52. S-M GENERAL PARTS CATALOG

The well-known line of Silver-Marshall parts and chassis is fully described and illustrated in this large 16-page catalog, which will be useful to every Service Man and constructor for reference purposes. A few of the important developments mentioned in it are: all-wave superheterodyne covering from 200 to 550 meters; all-wave "super" covering from 200 to 2000 meters; vario-mu super-heterodyne tuner; short-wave converter without plug-in coils; pentode automobile receiver, with remote control; 50-watt power amplifier and complete public address systems; and high-grade transformers and replacement parts. *Silver-Marshall, Inc.*

53. THE WUNDERLICH TUBE

The new Wunderlich tube is a special purpose, high-quality detector which combines full-wave rectification with a stage of audio amplification and provides the necessary voltage for automatic volume control, all within one tube structure. This unusual tube is named after its inventor, Norman E. Wunderlich, who, in cooperation with the Arcturus Radio Tube Company, has sponsored the development and commercialization of the tube and circuits for its use. Its theory of operation is discussed clearly and thoroughly in two technical bulletins, one written by the inventor himself and the other by Professor Frederick E. Terman of Stanford University. These are noteworthy contributions to tube literature. *Arcturus Radio Tube Company.*

54. DUBILIER TRANSMITTING CONDENSERS

This is an engineering catalog of transmitting condensers of many sizes and types. The designs and specifications permit a wide choice of application and embody standardization of mechanical details for economy and interchangeability. *Dubilier Condenser Corporation.*

RADIO-CRAFT 46-54
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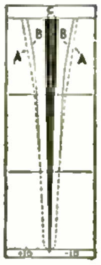


STENODE selectivity curve makes 10KC selectivity, so-called, look like broad tuning.

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.

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.

Made in England

None genuine without the inventor's signature.

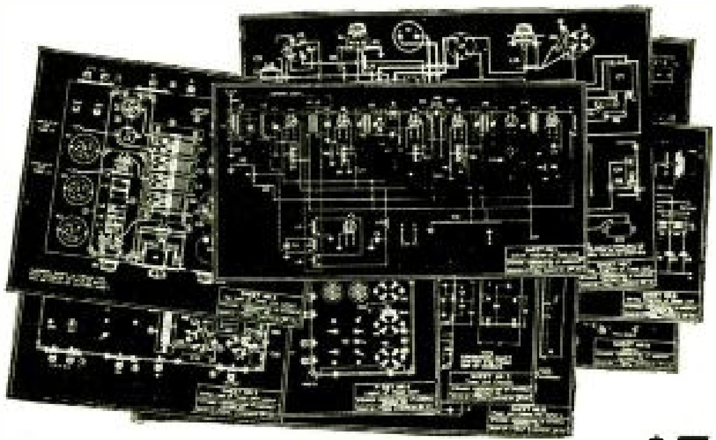
The Receiver That Is NOISE FREE on SHORT WAVES or BROADCAST

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



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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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.

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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.

The schools who have consented to act as an examination board are:

International Correspondence Schools, Scranton, Penna. Mr. D. E. Carpenter, Dean.

RCA Institutes, Inc., New York, N. Y. Mr. D. O. Whelan, President.

East Bay Radio Institute, Oakland, Calif. Mr. T. T. Tonnehill, Director.

Radio Training Association of America, Chicago, Ill. Mr. A. G. Mohaupt, President.

School of Engineering of Milwaukee, Milwaukee, Wis. Mr. W. Werwath, President.

Radio College of Canada, Toronto, Canada. Mr. J. C. Wilson, President.

Radio Division, Coyne Electrical School, Chicago, Ill. Mr. H. C. Lewis, President.

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

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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 Vol. IV, July, 1932, No. 1

THE RADIO TUBE BUSINESS

An Editorial by HUGO GERNSBACK

THAT the recent economic situation has disastrously affected practically every business and industrial organization in the country can hardly be denied.

The radio business is no exception to the rule. Yet, generally speaking, the industry as a whole has not fared so badly as some of the other industries, with the possible exception of the radio tube business.

Radio tube manufacturers have had exceedingly bad times, much worse than they should have had, and if I use strong language in the succeeding paragraphs I do so solely with the hope that the tube industry will see the light and change their present methods of doing business.

I do not believe that there is another industry, anywhere, where manufacturers appear to deliberately go out of their way to make it difficult for the trade and the ultimate consumer to use their merchandise. Seemingly, every conceivable obstacle is put in the way of the trade with a thoroughness that would be admirable if the tube industry had no thought in mind except self-destruction.

Fully ninety percent of the tube manufacturers today seem to have no fixed policy regarding the marketing of their merchandise. They will glibly tell you that sales are made either through the jobber or to the set manufacturer. It is true that the set manufacturers use large quantities of tubes; as to the radio jobber, of course, he does not use tubes, he only buys them to sell to dealers who sell them to the public. But, most of the tube manufacturers, until very recently, have entirely disregarded some 65,000 Service Men who really have the last word in the matter for they are the ones who either make or kill the reputation of a tube. When a Service Man is called in by a set owner, you may rest assured that the owner will buy the tube recommended by the Service Man and NO OTHER TUBE. The majority of tube manufacturers seem to be entirely ignorant of this fact. Even at this time, tube manufacturers do not seem to know that the majority of tubes made in the United States today are sold by these self-same Service Men. This being the case, do the tube manufacturers make any strenuous effort to win the Service Man's good will? Positively not! They go out of their way to make it difficult for him,—(and for that matter the ultimate consumer as well)—to buy their tubes.

With the multiplicity of radio tubes in use today, a tube manufacturer does everything in his power to bewilder and befuddle the Service Man. The majority of the tube manufacturers, with appalling thoughtlessness give no information whatsoever about their product, and seemingly keep the Service Man and ultimate consumer purposely in the dark regarding the functions and adaptability of their tubes. Pick up the average independent tube and you will find printed on the carton the legend "so and so—UX-222," and that is all. *No information slip accompanies the tube containing data as to its function, how the tube should be used, what its voltage requirements are, how much current it draws, and a number of other points of vital importance to the Service Man and to the ultimate user.*

Imagine a photographic film manufacturer putting out a carton of films giving nothing but the name of the manufacturer and the caption—"Monochromatic Film!" How much business would the film manufacturer do if he used such methods?

Of course, the most successful tube manufacturers are not in this class because they supply, with every tube, an instruction sheet giving reasonable data about the tube itself; but these tube manufacturers are the exception rather than the rule. The so-called independent tube manufacturers seem to know nothing at all about this. One or two others print some very meagre data on the carton, but there is not a tube manufacturer today who gives real honest-to-goodness data that every Service Man, every experimenter and every set owner, technically inclined, is trying to get.

There is a tendency to further befuddle the ultimate user by putting out new tubes with weird number and letter designations that mean nothing to the user. No effort is made, even by the foremost tube manufacturers, to tell the consumer that a particular tube might be substituted to advantage for an older type. There are a number of tubes that are interchangeable, but the tube manufacturers keep the secret to themselves for apparently unfathomable reasons. Even with the newer tubes, no information is given on the carton and no information slip is included with the tube. Recently a large tube manufacturer brought out a brand new tube that is supposed to be revolutionary, but one must obtain their catalog and read about it in order to determine what it is all about. The cathode, in this instance, is connected to the cap of the tube—an unusual thing; but the information does not come with the tube, one must send for the firm's catalog to find out about it.

When will tube manufacturers wake up and understand that with such a highly technical article as a tube one cannot give too much information? When will they supply diagrams, packed in with the tubes, that will give ALL the important technical data necessary to an understanding of the functioning of a particular tube?

When will tube manufacturers get together and standardize tube numbers to conform with their characteristics? This was formerly done, but of late, many manufacturers of new tubes have deliberately gone out of their way to create new number and letter designations for their tubes, making it impossible for anyone not having the manufacturer's literature, to secure the necessary information which can only be had by correspondence, and not always then.

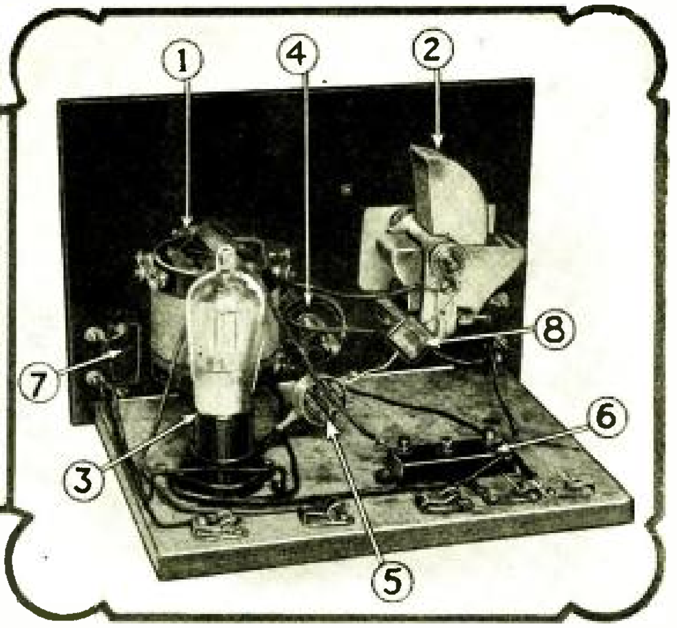
It would also be a simple matter for tube manufacturers to devise an entirely new means of branding their tubes so that the user, even if he loses the slip that might accompany the tube, would still know the characteristics of the tube. For instance, take the UX-222. This means nothing to the ultimate user. He does not even know what voltage the tube is supposed to work on. Would it be so difficult to label the tube or stamp right in the socket the following?

UX-222 F3.3-V.—0.132-A.

Then, six months later, when the tube burns out, the user of the tube would know that F stands for Filament; 3.3 stands for Voltage and 0.132 stands for Amperes.

It is conceivable that, by that time, there will be a new tube supplanting the 222. The user of the tube would then have no difficulty in picking out a suitable replacement tube.

But I have little hope that any of these suggestions will be carried out until such time as the tube manufacturers wake up to the facts or realize the folly of their ways.



At the left, front view and at the right, rear view of the "Megadyne." Despite its utter simplicity, it gives real one-tube loud-speaker reception.

THE "MEGADYNE"

ONE-TUBE PENTODE LOUDSPEAKER SET

IN this article, the author describes the first practical one-tube loudspeaker set using the new tubes. During the past few months, the set has been tested experimentally in a number of locations in the metropolitan New York district by several independent experimenters. In all instances, the performance of this little set was astonishing; not only does the set bring in all locals on the loudspeaker with sufficient volume to fill a large room comfortably, but distant stations have also been received on the loudspeaker.

In New York City, such stations as KDKA Pittsburgh, WTAM Cleveland, WBZ Springfield, WTAC Hartford, Conn., and many others were received with fair loudspeaker strength.

Experimenters and fans who have looked forward to a REAL one tube set now have their wish fulfilled.

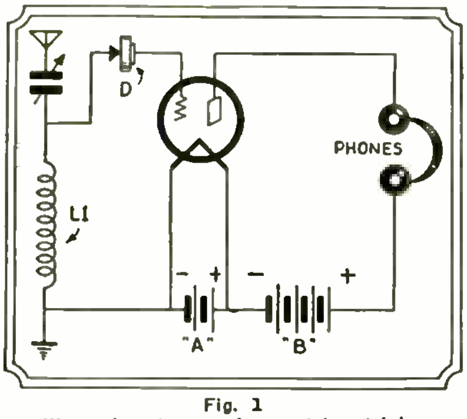


Fig. 1
Illustrating the use of a crystal and tube.

By HUGO GERNSBACK

THE advent of the new and more efficient tubes has made it possible to build radio sets which were not dreamed of five years ago. I have often stated editorially that the radio art is headed in a direction where in a few years, it will be possible to obtain as much volume from a single one-tube set as we formerly obtained with a seven- or ten-tube set.

During the past two years, the trend in this direction has been unmistakable. We now have four-tube sets that outperform the seven- and ten-tube sets of three or four years ago.

Of late, there has arisen an urgent demand for a *good* one-tube set. There still seem to be, not only hundreds, but actually hundreds of thousands of experimenters and fans who wish to experiment with one-tube sets that they are able to construct themselves. The old fascination is still alive, and incidentally, it should not be forgotten that a new crop of radio experimenters comes along every year, all willing and eager for something new to play with. Naturally, for them, the old "one-lungers" hold little interest, they want, and must have—something new and more efficient. The new tubes which have been announced during the past year are an answer to this prayer.

Development of the Megadyne

Several months ago, I started to experiment with the idea of producing a one-tube loudspeaker set that would actually work and could not be classed as "tricky." I thought that the efficiency of the new tubes would make this possible. A few of them were tried in all sorts of circuits, but it was found that no matter how good the usual circuit arrangements were, the volume that could be obtained from a loudspeaker was not sufficient to call it loudspeaker volume.

I then resurrected my old *Interflex* idea, a circuit that I devised in 1925. This circuit was exceedingly popular at the time and several hundred thousand receivers using this circuit were built all over the world. To those who have forgotten the circuit, and to those who were not in radio at the time, I outline the circuit herewith in its fundamentals:

Figure 1 shows how the crystal detector is connected directly into the grid of a tube. The circuit is not of the reflex type, nor is there regeneration in any form. The crystal in the grid circuit acts as the *detector*, while the vacuum tube acts as an *amplifier*. The amplification obtained, depending upon the sensitivity of the crystal, is from 10 to 20, and may be greater in some cases. In other words, by using a crystal detector, the addition of the tube will give real amplification. The circuit is remarkable in that there is no distortion and the reception of the signal is clearer than when the tube is used alone; it being well known by radio engineers that the present vacuum tubes are poor detectors, whereas, due to the perfect rectification possible, there is nothing better than a crystal detector for clarity.

A surprising thing about this circuit is

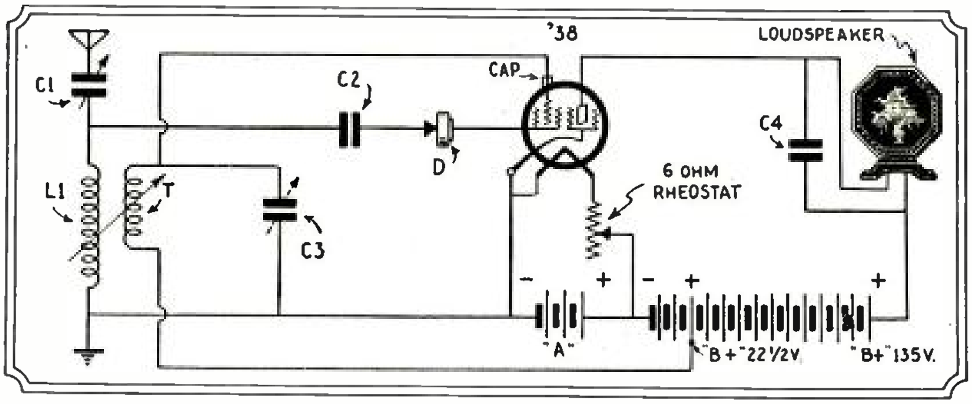


Fig. 2
Complete schematic circuit of the "Megadyne."

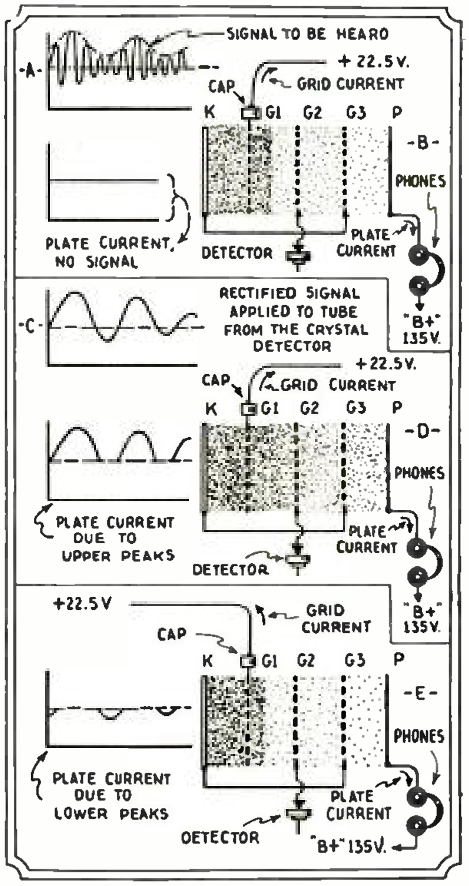


Fig. 3
Drawing illustrating the action of the tube in Megadyne circuit. At A is the signal to be heard which is applied to the tube having a normal distribution of current as indicated at B. During the positive parts of the signal, the current density in the tube increases as shown at D, and during the negative portions the current density decreases as shown at E. Thus the tube amplifies the signal exactly as it comes from the crystal.

that the addition of the crystal, for reasons unknown, immediately makes the circuit one that can be used for DX purposes. The curiosity lies in the fact that the crystal detector, by itself, normally has a range of about 25 miles; a good tube by itself, without regeneration, has a range of not more than 50 miles; *yet the two together, if coupled as shown in Fig. 1, have actually brought in stations as far as 1,100 miles away without regeneration.* Of course, it is not possible to do this when the local stations are on, it must be done after midnight when all locals have gone off the air.

The Interflex system is made use of in the Megadyne (*megas*, the Greek for great; *dyne* from the Greek for power) and the results are astonishing. The final circuit of the one-tube loudspeaker set is illustrated in Fig. 2. It will be seen immediately that an entirely new circuit is used and, as a matter of fact, it will be noted that the tube works "backwards." The positions of the screen-grid and the control-grid have been reversed; the writer found that in practice this combination gave far greater amplification than the straight circuit. The reason for this is probably to be found in the better utilization of the space charge. If we look into the inside of the '38 tube we see that the arrangement of the elements are as shown in Fig. 3. It will be noted that with the writer's connection, a sort of "electronic suction" effect takes place in that more electrons are used and liberated faster, giving rise to greater electronic action which consequently gives rise to greater volume in the loudspeaker.

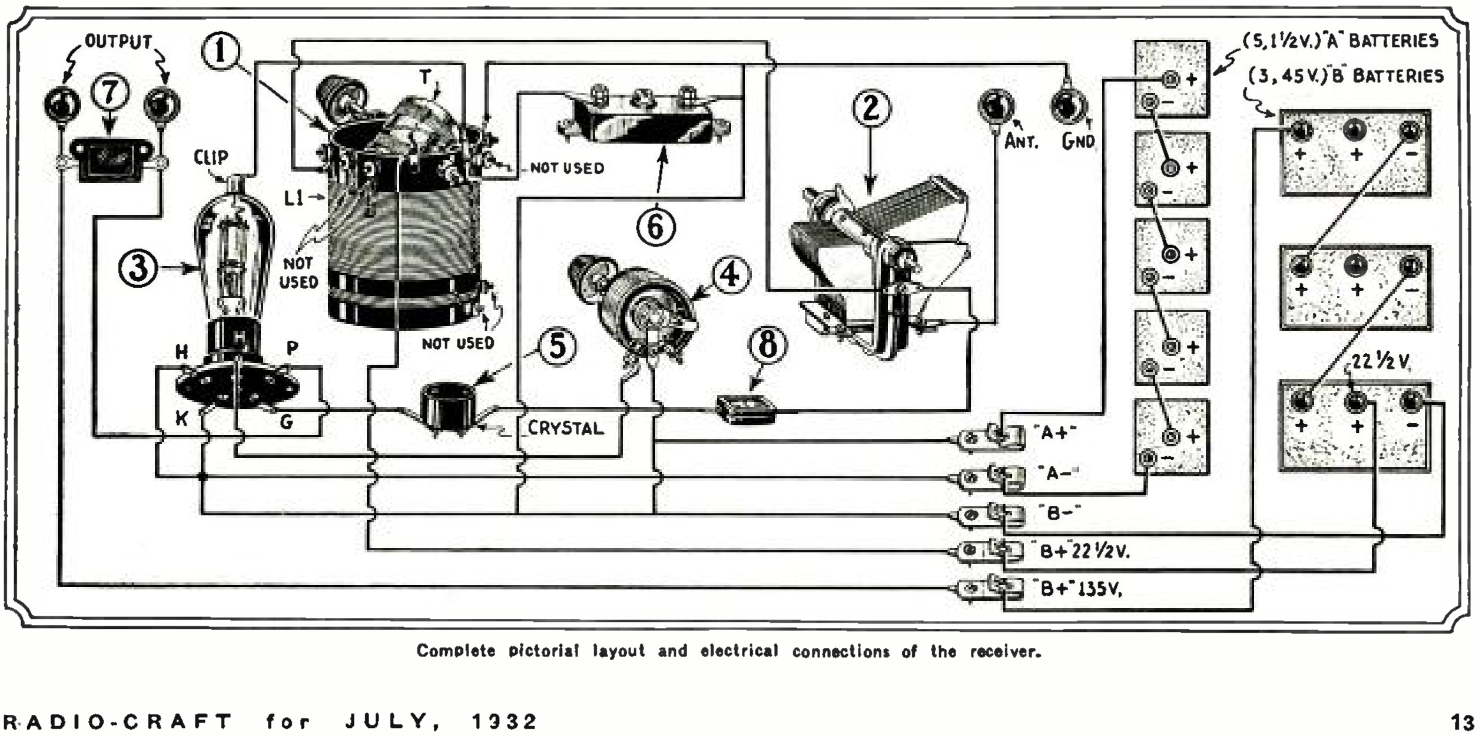
The set I am describing in these pages has purposely been kept simple, and I have gone back to a fashion that was popular years ago, that is, utilizing a wooden board and an insulating panel instead of the present-day metal chassis arrangement.

I chose the simpler form because I felt that it would be easier for the majority of constructors to build the set in this manner. Of course, those who wish to build a more elaborate one may easily do so. The set described here is of the battery type because a *one-tube* loudspeaker set will only function with a battery. In the next issue, however, I will show how to build the same set to work on a 110-volt, A.C. line; it will no longer be a one-tube set because you must have a rectifier tube, and it thus becomes, properly speaking, a two-tube set, although it uses the selfsame tube in the radio end.

When building the Megadyne set, be sure to follow the circuit exactly, and for best results use the parts specified.

Remember, this is a one-tube set, and the first consideration is to *conserve every bit of radio energy,* because you haven't much to start with. You will find, moreover, if you use the usual arrangement of primary and secondary, that you will lose just about 50 percent of the volume. For this reason, I found it necessary to use the arrangement shown in the circuit which compensates for most of the losses that are usually common in other circuits.

(*Continued on page* 43)



Complete pictorial layout and electrical connections of the receiver.

THE LATEST RADIO EQUIPMENT

NEW SERIES OF NA-ALD ADAPTERS

THE Alden Manufacturing Co. announces the new series of adapters, suitable for four- five- and six-prong tubes, illustrated below. Reading from left to right in the upper row there are:

First, the 965DS; for Supreme set testers (new models) that have an extra wire in the cable which is connected to the latch. This five-hole, six-prong adapter is all that is necessary to test six-prong tubes. (The suppressor grid connects to the center post.)

Second, the 964DS adapter; for use with the new 906L analyzer plug. It has a four-prong bottom and a six-hole top with a center stud; suppressor-grid contact is dead.

Third, the 965DS; for use with the new 906L analyzer plug. It has a five-prong bottom and a six-hole top with a center stud; suppressor grid contact is dead.

Fourth, the 965KS; a tube checker adapter. It has a five-prong bottom and a six-hole top; the suppressor-grid contact in the top is connected to the cathode prong of the UY base.

Fifth, the 966; for Hickok and other testers. It has a six-prong bottom and a six-hole top.

On the lower row, reading from left to right, there are:

First, the 982; for testing the new 82 mercury-vapor rectifier. It is equipped with a toggle switch which gives a reading of first one and then the other plate. It is equipped with the proper resistors for satisfactory operation.

Second, the 965DW; built in two sections and used for testing the new 57- and 58-type tubes. This adapter is to be used with plugs not having a latch lock.

Third, the 965DSW; same as the 965DW above, except that it is to be used with plugs having a latch lock.

Fourth, the 966SL; for use with Hickok and Radio Products instruments. It is equipped with a five-prong bottom and a six-hole top; the suppressor grid is brought out to a 6-inch lead terminating in a phone tip.

RCA VICTOR "R-78"

ANNOUNCEMENT of a new receiver incorporating radical advances in circuit design that are hailed as the most important since the advent of socket operated receivers, has been made to the trade by the RCA Victor Company, Inc.

The new receiver which will be known as the RCA Victor R-78 embodies an entirely new circuit utilizing 12 new tubes. Because the unique features of the new circuit have resulted in many major acoustic improvements, the new receiver has been termed the "Bi-Acoustic Radio." According to its sponsors, the new Bi-Acoustic circuit provides twice the power and twice the tone range of ordinary receivers, hence the use of the prefix "Bi." Tone equalization, automatic tone compensation, dual automatic volume control, increased musical range and the application of the new class "B" radio amplification are important factors in this new radio, according to the announcement.

Among the features which stand out as major developments are:

(1) The application of the principle of class B audio amplification which makes it possible to provide within the confines of a comparatively small radio cabinet, and at an economical cost, a system of superior amplification that has an output of over 10 watts.

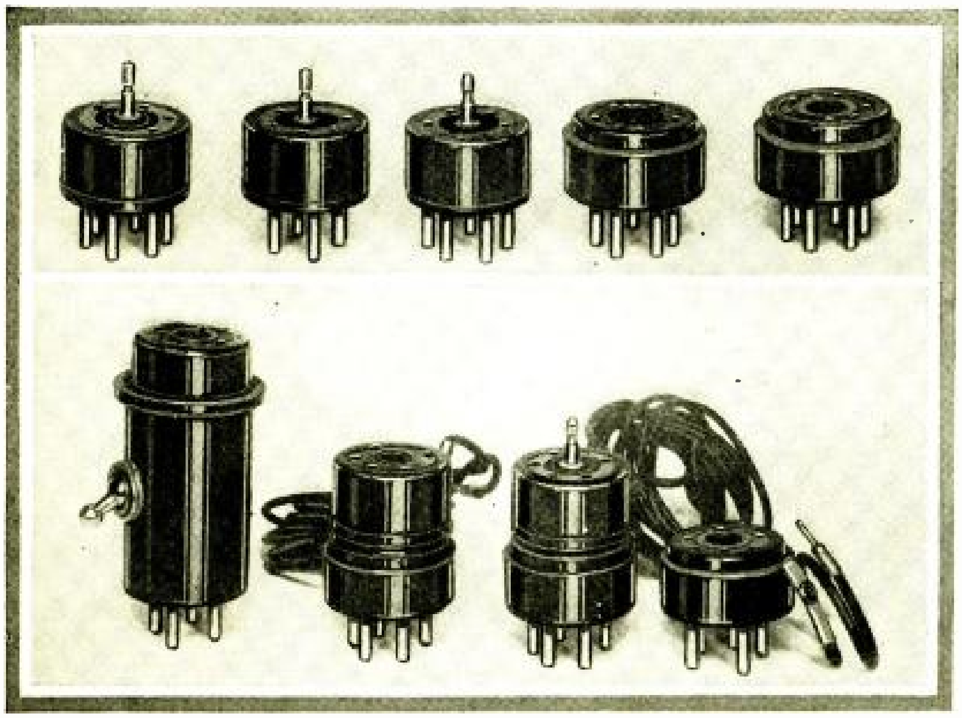
(2) Automatic Tone Compensation, by means of which the reproduction of high and low frequencies are automatically balanced at *every* level of volume.

(3) A new system of cabinet tone stabilizers which eliminates the "boomy bass" and the "shrill highs" to preserve the crystal clearness of the original tones.

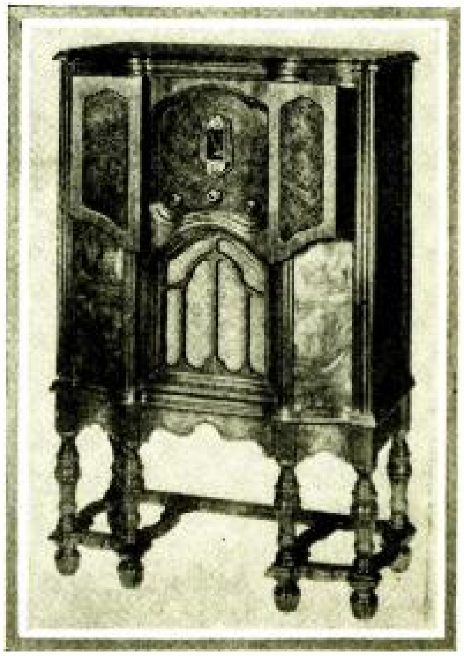
(4) Dual Automatic Volume Control which is instantaneous in its operation and holds the volume at an absolute level over the entire operating range. More important, it effectively suppresses noises between stations.

(5) Extended Tone Range which makes possible the reproduction of an additional octave at each end of the tonal scale.

Perhaps the most important feature of this new receiver is the exclusive use of the new tubes including the "82" rectifier.



New Series of Na-Ald Adapters



RCA Victor R-78

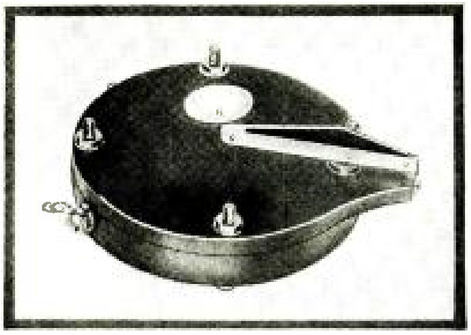
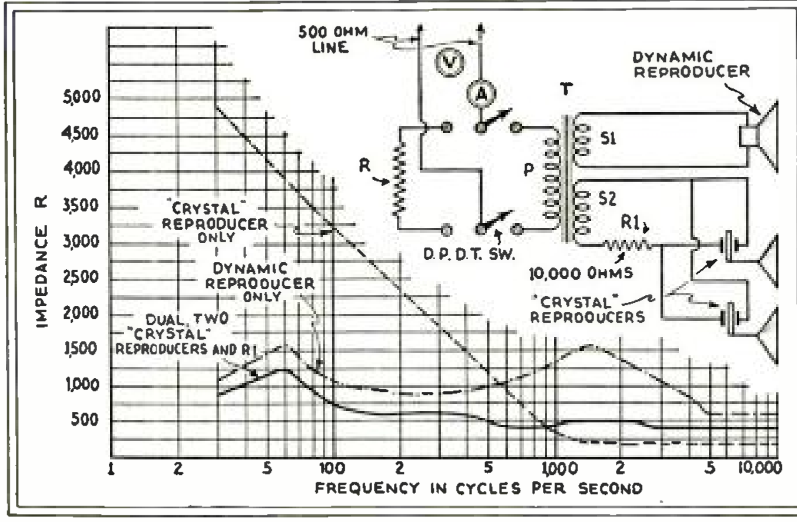


Fig. B
Picture of the new Crystal speaker which is bound to be used in all receivers that require a maximum of sensitivity.

THE ROCHELLE-SALT CRYSTAL REPRODUCER

A revolutionary idea in commercial reproducer design. A Rochelle-Salt Crystal, of improved construction, mechanically coupled to a cone gives remarkable clarity and volume. Consuming no power, it has high efficiency.

By C. B. SCOTT*



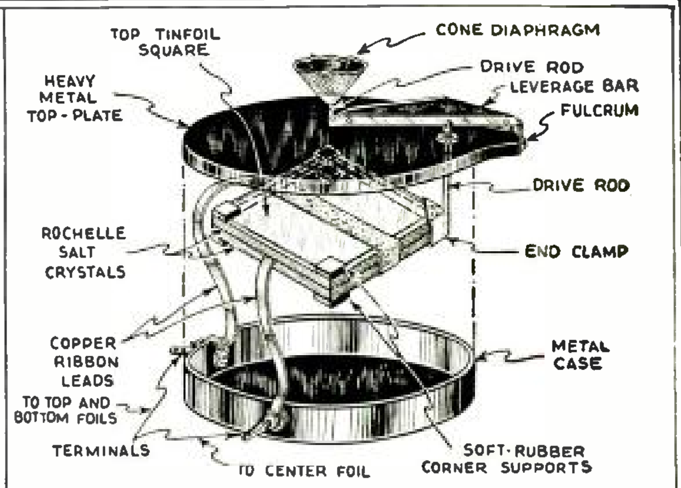


Fig. 1, right. The speaker's crystals.
Fig. 3, left. Impedance variations.

PIEZO electricity, a phenomenon well known to most radio engineers, demonstratable in quartz and other crystals, is present in much greater quantity in Rochelle-salt crystals. Until quite recently, however, it had been impossible to obtain these crystals in size and quantity to make their commercial application practicable. At last, a process has been developed for growing large, homogeneous crystals, and methods have been devised for machining and shaping them into usable sizes and shapes.

Direction of Motion

The Type R-95 "Crystal Reproducer," illustrated in Figs. A and B uses a double or "bimorph" crystal element consisting of two slabs 2½ x 2½ x ⅛-in. thick, metal-foiled on each surface, and cemented together in opposition to each other so that a torsional motion of the combined slabs, illustrated in Fig. 1 results; when three corners of the element are held semi-rigid, the vibration of the fourth corner is in a direction vertical to the flat surfaces. (This action is similar to that in thermostats, where the expansion of one metal and contraction of the other in one [parallel] plane, produces a "wiggling" motion in another. *Technical Editor.*)

This corner is fitted with a metal cap provided with a connecting link which in turn is soldered to a tone arm, providing a mechanical amplification of motion of 2½ to 1.

The end of the tone-arm is then fastened to the center of a conventional paper cone and results in a very light, compact reproducer, suitable for general use, with an outside diameter of 9½ in., a depth overall of 3¾ in.; and a weight of two pounds (as compared with the typical "dynamic" type of reproducer, weighing approximately 5½ pounds).

The "crystal" reproducer has several advantages from the electrical point of view.

It is voltage-operated and the power consumption is very low, as *it requires neither field current nor polarizing voltage.* For this reason it has been recognized as being especially valuable in multiple reproducer work, such as installations in schools, hotels, and hospitals. Due to its very high "sensitivity," several may be operated on the same power required to operate one of the present type of reproducers. Likewise in this type of installation, one of the important factors is that there be a minimum of service and repair work. *"Crystal" reproducers have been operated for a continuous period of four years under a wide variation in temperature and humidity change, with no deterioration in output.*

Frequency Range

The "crystal" reproducer *covers a much wider range of frequencies* than is now covered by the present types of reproducer units. The Rochelle salt crystal itself is responsive from 0 to 500,000

(*Continued on page 54*)

Fig. A
This speaker was tested by RADIO-CRAFT and found to have excellent tone quality and volume.

* Brush Development Co.

TWO NEW TUBES

Two new tubes, a 6-3-volt A.C.-D.C. output pentode and a high - voltage mercury - vapor rectifier, are discussed by the author in this interesting article.

By LOUIS MARTIN

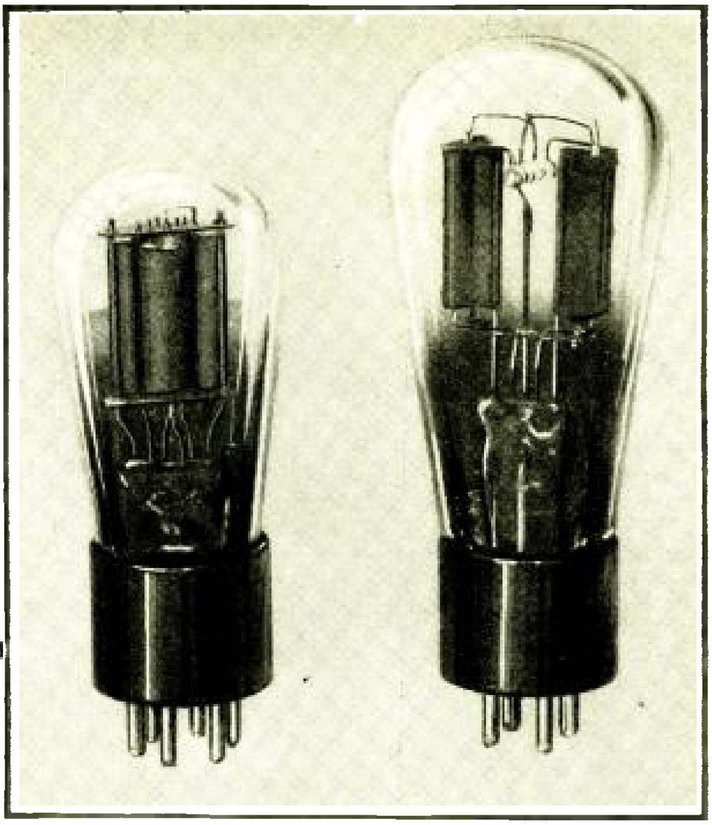


Fig. A   Fig. B

PAST issues of RADIO-CRAFT have contained articles describing the characteristics and uses of all of the new tubes which have been announced. There remain to be described but two more tubes in order to complete the announcement.

The 41 A.C.-D.C. Output Pentode

Figure A illustrates a new A.C.-D.C. Output Pentode, which is capable of delivering 1.2 watts of undistorted power output. As may easily be seen, the tube uses the new six-prong socket which is described elsewhere in this issue, has a black cylindrical plate and is designed mainly for automotive use.

Previous types of automotive tubes, although equipped with heaters, were unsuitable for A.C. operation. This has rather limited their use to receivers employing D.C. for the filament supply, as a consequence, they have not been used extensively. This new tube is certainly a step forward in the right direction; it may be used with either an A.C. or D.C. filament supply insuring at the same time a minimum of hum in the output.

Figure 1 shows a family of plate voltage—plate current curves of this new tube. A load-line of 11,000 ohms is drawn through the operating point as shown in the same figure. This line shows that if a resistance of 11,000 ohms is connected in the plate circuit of the tube, a "B" potential of approximately 360 volts will be required in order to secure the rated voltage of 167.5 on the plate. As in all pentodes, the characteristic dip in these curves are missing due to the action of the suppressor grid.

As stated above, a six-prong base is used; socket connections are shown in Fig. 2. As in other pentodes, the screen-grid is connected directly to the same "B" supply point used for the plate circuit. The characteristics of this tube should make it especially adaptable for short-wave receivers because of its low grid plate capacity—.5-mmf. The characteristics of this tube are as follows: Filament voltage, 6.3 A.C. or D.C.; filament current, .75-ampere; grid-plate capacity, .5-mmf; input capacity, .75-mmf; plate-cathode capacity, 8.6 mmf; grid bias,—12.5 volts; plate potential, 167.5 volts; amplification factor, 215; internal plate impedance, 120,000 ohms; mutual conductance, 1800 micromhos; plate current, 16.5 ma.; screen-grid current, 2.5 ma.; load impedance, 11,000 ohms; maximum undistorted output, 1.2 watts.

An interesting set of curves is shown in Fig. 3. They show the variation between power output and distortion as the load impedance is varied. The dotted set of curves show the above variation with a control-grid bias of -10 and a plate and screen-grid voltage of 125. The solid lines show the same variation with the rated constants applied, that is, control-grid voltage -12.5 and plate and screen-grid voltages 167.5. From this latter set

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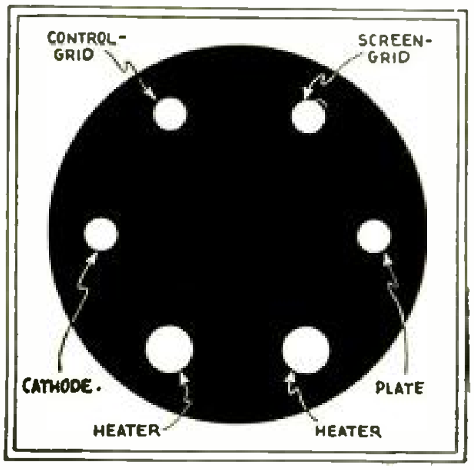
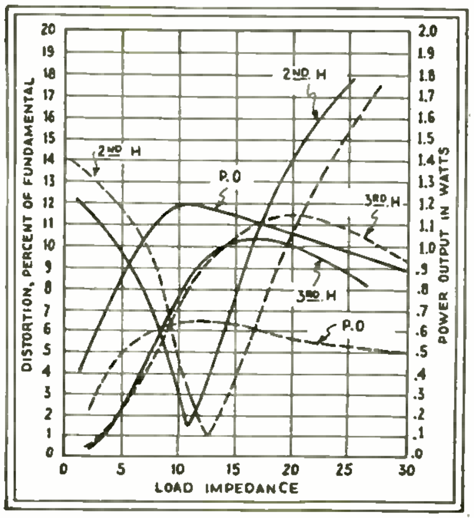




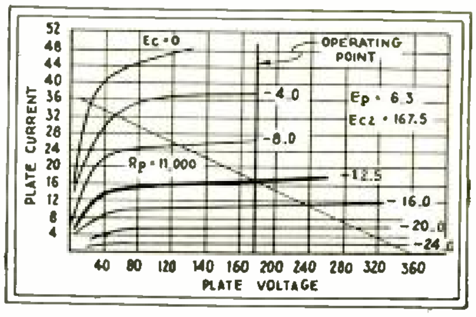


Fig. 1, above. Output curves of the new 41 pentode.

Fig. 2, left. Socket connections of the 41.

Fig. 3, center. The tube's dynamic characteristics.

PENTODE, CLASS B or TRIODE AUDIO SYSTEMS-- --Which?

A comparison of the distortion in each of three available systems.

By McMURDO SILVER*

AS is customary, tube manufacturers have taken sixty days ahead of the trade show as the time to introduce several new tubes, three of them being only improvements on existing '24, '27, and '35 types, and as such not really needful of special attention at the moment. The remaining two, the new '46 class B output tube and the new '82 mercury vapor rectifier tied to the '46 bring up a timely consideration of the available audio channels for home-radio receivers.

Audio power-output stages can today be divided into three general classes: straight, triode push-pull; pentode push-pull, or parallel; and the new class B push-push. The merits and possibilities of these three systems are worthy of special attention, particularly as in consumer and trade advertising of differently equipped radio receivers, at least a little not particularly clear sales ballyhoo is bound to be indulged in. Considering high quality A.C. sets designed for home use, it is possible to classify the three available systems as:

(a) '45's in push-pull (triode);
(b) '47's in push-pull or parallel (pentode);
(c) '46's in push-push (class B).

The snap conclusion that the first classification (a) is Class A audio amplification since the last (c) is Class B, should not be arrived at in considering these three classifications; for no past set has employed what may be properly termed Class A amplification. For instance, Class A audio amplification may be described as the condition where the fixed, negative grid-bias of a tube is so set that signal excursions vary the grid positive and negative between the limits set by the straight portion of the grid voltage-plate current curve. Distinguished from this Class A condition, where a positive grid excursion accompanied by grid current is anticipated and provided for, the type of triode audio amplification utilized in the past has been predicted by setting the fixed grid-bias at a point substantially midway between zero bias (above which grid current will be drawn) and the bend at the negative end of the grid voltage-plate current curve.

*President, Silver Marshall, Inc.

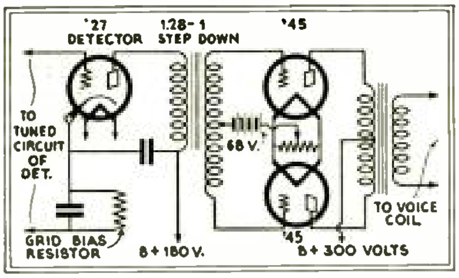


Fig. 2
Schematic illustrating the voltages in the new S.-M. amplifier.

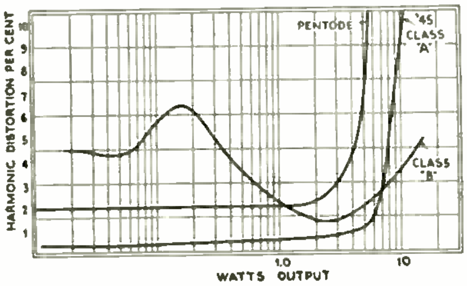


Fig. 1
Curves showing the relative distortion of the three systems.

Class B or push-push audio amplification with previous tubes has involved setting the bias of the tubes practically at the negative cut-off point, so that as the signal excursion runs one grid so negative that it cuts off plate current, the other grid runs progressively positive. In order to utilize the *full length* of the straight portion of the grid voltage—plate current curve, the grids will, of course, run positive.

The new '46 Class B tubes, however, operate at *zero fixed grid-bias*, and as practically all of their operative excursions will, therefore, be positive, quite considerable grid current will be drawn as compared to conventional power tubes used as Class B amplifiers, and consequently input coupling transformer costs will soar, if satisfactory voltage regulation is to be obtained.

The relative merits of the three systems which, it is now seen, can be divided into four groups, can be pretty well grasped by comparing the maximum undistorted power output, the harmonic distortion percentage for generally used power output levels, and power sensitivity.

Harmonic Distortion

Harmonic distortion can be quite annoying, and the I.R.E. has arbitrarily standardized upon the level of 5 percent as the maximum allowable; the maximum undistorted power output rating of all tubes being based on this maximum harmonic distortion figure. Whether this rating is allowable is a very debatable point, but it is the generally accepted allowable maximum. The writer has found, however, that the harmonic distortion allowable without unpleasant ear reaction will vary considerably with note pitch, note combinations and volume levels; in general it being less noticeable at high volume where it is masked by speaker distortion. He has reached the general conclusion that at home entertainment levels for really pleasing quality, 5 percent is too high, 1 to 1½ percent is about all that should be permitted for really high quality reproduction at home volume levels.

Power Sensitivity

Power sensitivity is a means of indicating the ratio of input voltage required for a given power output, and might be termed a means of expressing efficiency in terms of input voltage plotted against power output. Its greatest value is in determining the voltage required to drive the output stage, and deciding whether this can be provided economically and adequately by the available preceding circuit.

The chart below gives a good idea of the relation of these values for the four available systems.

Systems	Maximum undistorted power output watts	Harmonic Distortion for .20-watt output %	Harmonic Distortion for 2.0-watts output %	Power sensitivity
(a) '45 push-pull....	3.2	0.5	1.0	.45*
(b) '47 push-pull....	.5	2.	2.5	1.55
(c) '46 push-pull (class B)	16.	6.2	1.3	.118*
(d) '45 push-pull (class A)........	8.	0.4	0.6	.52*

*Including one suitable driver stage.

(*Continued on page 49*)

A PRACTICAL "3-TUBE" SUPERHETERODYNE

By H. G. BOYLE*

THERE has been an increasing demand, of late, for smaller and simpler receivers of midget construction. The problem is to design a receiver of the greatest efficiency with the least number of parts. As a rule, the very small sets were simplified versions of the larger sets; the same circuits being used without any changes from standard practice.

After a few preliminary attempts were made to build a small receiver along standard lines, it became apparent that some radical steps must be taken in order to obtain satisfactory results. The following outline will cover the system developed which has a far greater efficiency than any other arrangement of a like number of tubes and parts.

The Detector-Output Tube

As the first step toward the solution of the problem it was believed that if the second detector of a superheterodyne were replaced by a combination detector and output tube, a considerable saving would be immediately effected.

If the plate-current characteristic of the type '47 tube (pentode) be examined, it will be found that a "knee" or bend occurs at a convenient operating point. The plate current flowing at this operating point (grid bias) is sufficient to produce the proper bias across a resistor connected in the filament circuit of the pentode. This knee may be used for detection purposes, and the output of the tube fed directly into the output transformer of the receiver. With this arrrangement, it would be possible to develop an output-power about equal to that which would be obtained were the tube used in the conventional amplifier circuit.

Curves were then run to determine the correct value of bias resistor for the best balance between power sensitivity and overload. (Overloading occurs when an increase in signal strength produces a distorted signal in the output.) Fig. 1 shows the relation between grid bias and plate current of a '47 pentode. It is seen that with a bias of 25.52 volts, the plate current is 5.8 ma., and that a 4,400 ohm resistor in the filament circuit of the tube would give the desired bias. (4400 x 5.8/1000 equals 25.52 volts.)

Figure 2 is an interesting curve in that it shows the power output obtainable with increasing signal voltages applied to the grid of the tube. The abscissa (horizontal line) represents the peak value of signal volts; the left-vertical line, the power output in milliwatts. It should be noted that when the peak signal voltages reach 31, grid current starts to flow, and the power output does not increase with signal voltage. The dotted line in the same figure shows the actual voltage actuating the tube with various signal voltages. It is seen that with no signal input, the grid voltage is equal to the bias voltage (25.52 volts); as the signal increases in strength, the actual voltage on the grid of the tube increases accordingly.

The curve in Fig. 3 shows the relation between power output and load impedance. Maximum power is secured with this arrangement with a load of 65,000 ohms; further experimenting, however, indicated that better results would be secured with a load impedance of 55,000 ohms and a grid bias of 20 volts. These slight changes in values are due to the fact that the plate voltage in this arrangement is 385 volts (135 volts higher than usually used) and a screen-grid

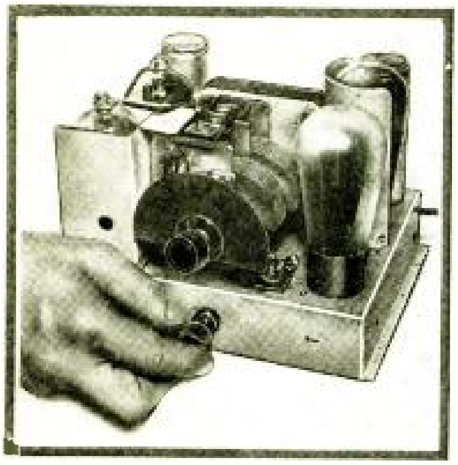


Illustration showing the comparative size of the "Tynamite."

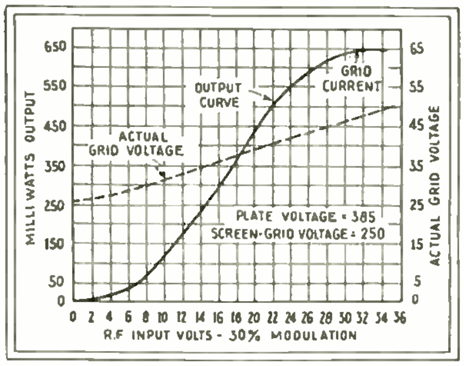


Fig. 2
Curve showing the variation of grid bias with signal input.

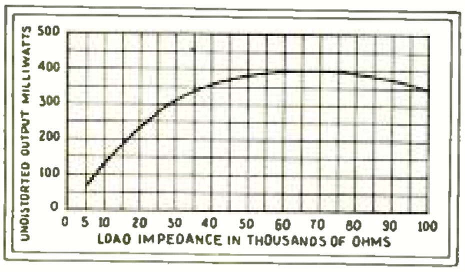


Fig. 3
Relation between power output and load impedance.

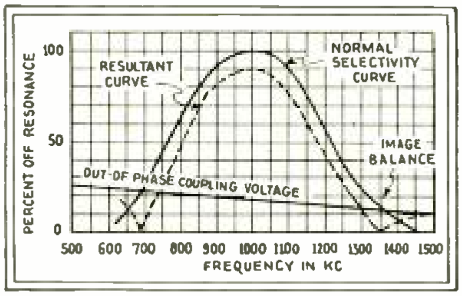


Fig. 5
Curve showing the magnitude of the out-of-phase voltage.

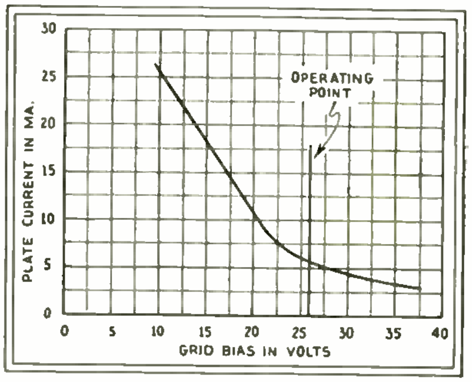
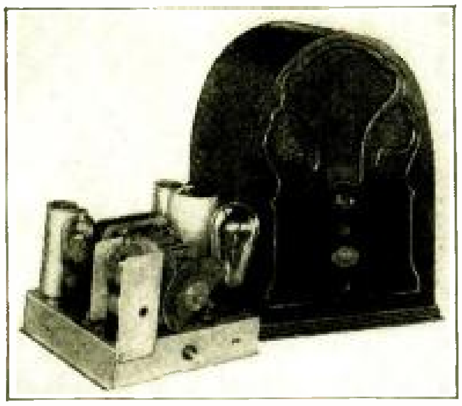


Fig. 1
Grid voltage—plate current curve of the pentode.

*Crosley Radio Corp.



The Crosley "Tynamite" and "Bonniboy" employing the new design.

'A technical discussion of an extremely compact new receiver employing a single second-detector, output tube and an image-frequency bucking device.

voltage of 250 (this value being more or less standard).

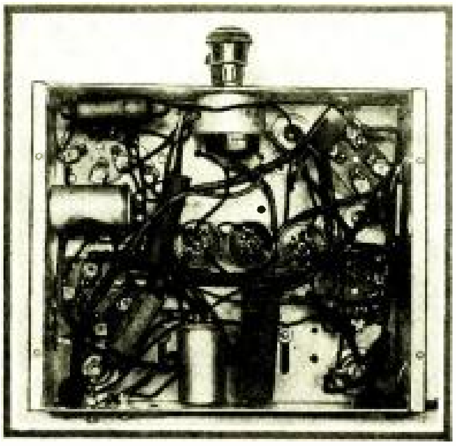
Further experimentation showed that the power-output curve followed the normal fidelity of the pentode tube, giving considerably greater response at the higher frequencies. By using a sufficiently large bypass condenser across the bias resistor to reduce degeneration of low frequencies to an acceptable minimum, this "tilt" was still further accentuated and it was found necessary to bypass the plate circuit heavily enough to attenuate the higher notes in order to obtain pleasing reproduction. As shown in circuit diagram, Fig. 4, this plate circuit filter consists of a .003-mf. condenser connected from plate to ground. This filter was sufficient so that no additional I.F. filter was necessary. This rather large condenser did not affect rectification to a measurable extent, although heterodyne nuisance might have been further reduced by increasing the size of this unit, if "boomy" reception would be tolerated.

Since bias was obtained from a center tapped resistor across the filament circuit, it became common between the detector and I.F. returns, and although of very few ohms, it was found absolutely essential to provide adequate bypassing from the filament to true ground in order to prevent violent overall oscillation. It was found that a 5 mf. electrolytic condenser was sufficient for the purpose.

The sensitivity of this detector-output tube was such that it was necessary to shield it externally from both static and magnetic fields; the latter apparently actually moving the plate to such an extent as to produce hums and roars, and in some instances actual mechanical rattles. A certain amount of coupling still existed between the speaker leads, frame and elements of the tube, and it was necessary to ground the speaker in order to prevent self-oscillation within the detector.

Suppression of Image Frequency Response

It seemed illogical to include a 3-gang condenser in a receiver containing only four tubes, and it was felt that some arrangement might be used whereby a 2-gang condenser would produce sufficient pre-selection.



An under-side view showing the layout of the parts.

(It does seem illogical to include a 3-gang tuning condenser in a midget receiver having but "3" tubes; some manufacturers, however, "think" otherwise.—*Editor.*)

Investigation showed that if the antenna circuit was tuned to some extent, it would prevent cross-talk between adjacent channel station. However, with the normal tuned circuit the "skirt" selectivity (the "skirt" selectivity represents the width of selectivity curve at frequencies far removed from the resonant frequency) is not sufficient to eliminate response at the image frequency (image frequency being the frequency of a station which has a value equal to the resonant frequency plus twice the I.F. frequency). It was found that it was possible to tune the antenna circuit so that it would act as a series resonant circuit at the image frequency, but under such conditions, and with the load of an oscillating detector on the circuit, the best image frequency ratio obtainable was about 100 to 1 (image frequency ratio may be defined as the ratio between the total frequencies included in the broadcast band, from 500 to 1500 kc. to the band of frequencies over which image-frequency response is secured). In practice, this was found unsatisfactory. By very careful adjustment it was possible to increase this ratio

(*Continued on page 50*)

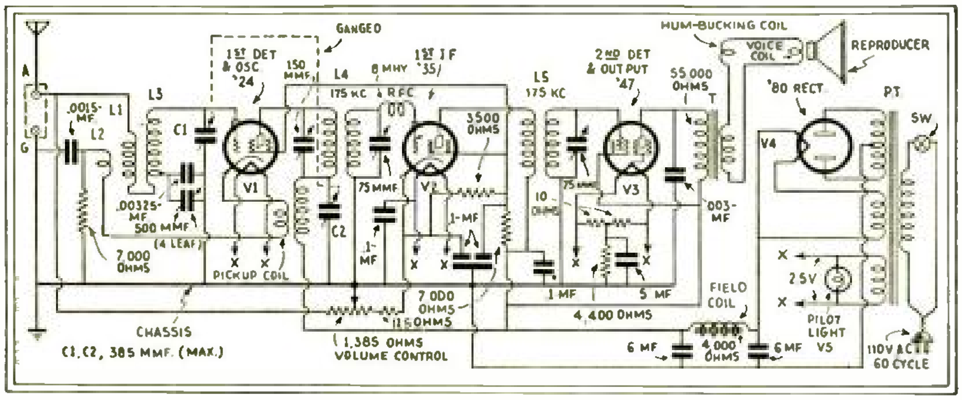
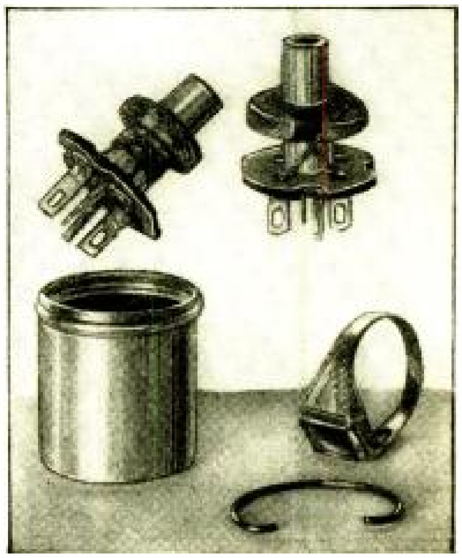


Fig. 4
Schematic circuit of the receiver (chassis No. 131) showing the value of all the parts.



The relative size of the coils are illustrated here.

BUILDING THE VARIABLE-MU SIX

By ARTHUR B. COONEY

HOW would you like to build a high quality, six tube, electric radio at a cost of twenty- to thirty-five dollars and a few hours of fascinating work? This article gives the plans and directions for building such a set.

The circuit consists of three stages of high gain radio-frequency amplification, using type '51 variable-mu tubes, (for elimination of "cross talk" and proper volume control), a power-type detector using a '24 for maximum gain, resistance coupled to a pentode ('47) power tube for audio-frequency amplification. The sixth tube is the '80 rectifier which operates the built-in power supply and furnishes the set with plate voltage. The completed set measures 12¾ x 9½ inches and is only 6¾ inches high. It operates any size 2500-ohm field dynamic speaker with more volume than can be used in the average home.

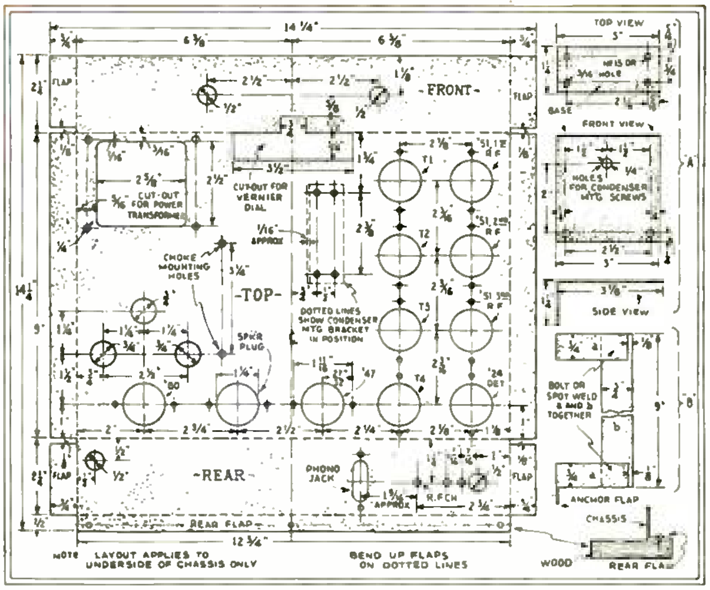


Fig. 1
Chassis layout of the set in which all hole-locations are specified. Detail views are shown to the right.

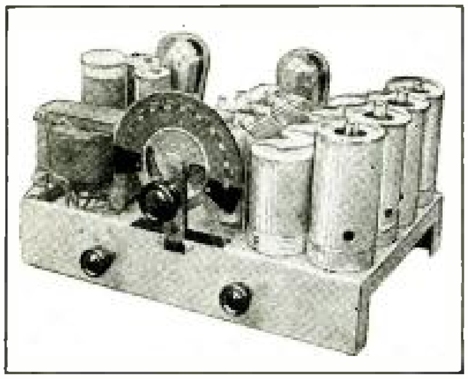


Fig. A
Front view of the Variable-Mu Six.

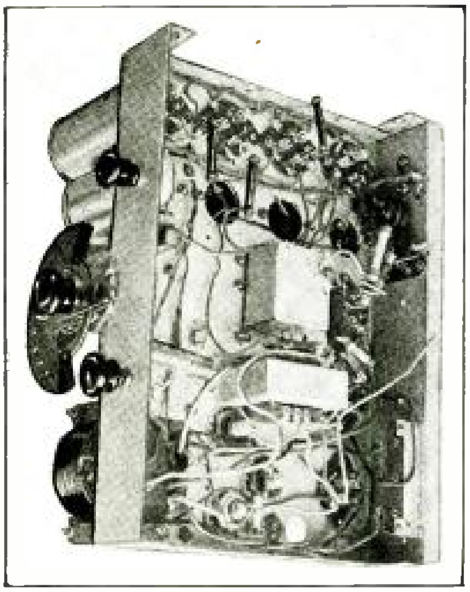


Fig. B
Under-subpanel view of the set.

The volume control action is particularly good. This set is small enough to fit in a midget type cabinet and efficient enough to deserve a place in a good console. The receiver will perform as well as or better than many standard makes of tuned R.F. sets retailing from sixty to eighty dollars and has less hum than many of them. A glance at the circuit diagram (Fig. 3) will show that this efficiency is not due to a freak hookup, trick coils, or special parts; the materials used may be obtained without difficulty. Anyone who has an elementary understanding of radio, who can follow directions, solder, and use common hand tools, can build this set successfully.

Building the Chassis

As the metal chassis is the foundation of the set it is logical to build it first. The drawing (Fig. 1) shows the layout and gives the measurements for the various holes. Before you start cutting, measure the size of your dial, filter choke, and power transformer. As there is considerable variation in the size of these items, you may have to change the layout to fit your own parts. The purpose of the mounting bracket shown in the drawing is to hold the 4-gang, .00035-mf. variable condenser on edge so that the trimmers may be adjusted conveniently. If you are going to use the de-luxe type of condenser that has heavy square shielding between each section, you will not need to make the bracket as the condenser will bolt directly to the top of the chassis. Make sure of all these details before you drill your first hole.

Get a piece of 20-gauge aluminum or galvanized iron 14¼ x 14¼ inches. Aluminum is easy to cut but hard to solder; the iron is cheaper, solders easily but is hard to cut. Put your material on a flat surface and lay out all the holes and cutouts. As the drawing shows the layout as it appears from *underneath*; the flaps must be bent so that the marked side of the material faces down when the job is done. If you get this reversed it puts the volume control on the left, which is not a good idea unless you are a "south-paw." The easiest way to make the big holes is to drill small ones close together around the edge and cut between them with a sharp chisel; then smooth the edges with a file. The large round holes for the sockets and coils will have to be made the same way if you do not have a fly cutter. A sheet-metal shop will sometimes do this type of work very reasonably.

When your holes are finished you are ready to bend the flaps. Keep your layout marks underneath and bend the two ¾-inch flaps at right angles to the rest of the chassis; now bend up the anchor portion of the rear flap; bend the front and rear flaps into position. Make the chassis rigid by soldering or spot-welding the overlap at points A and B on the left and right edges of the chassis.

Winding the R.F. Transformers

Standard screen-grid R.F. transformers will work in this set but those shown in Fig. 2A are easy to make and are very efficient. All the coils are wound on forms of bakelite or fibre tubing 1-inch outside diameter and 1⅞ inches long. They are supported by small mounting brackets of sheet brass as shown in the drawing. The brackets center the coil within the shield and hold it above and perpendicular to the chassis. If the centering is not reasonably accurate or the coils not perpendicular they will be too near the shields and eddy currents will be produced which will cut the R.F. gain and make the set less sensitive. Make the brackets carefully and test the completed forms for position before you start winding. The less you handle the coils after they are finished the more uniform they will be. The coil

A description of a T. R. F. receiver designed for the man who wants a stable set using the latest tubes in a simple arrangement.

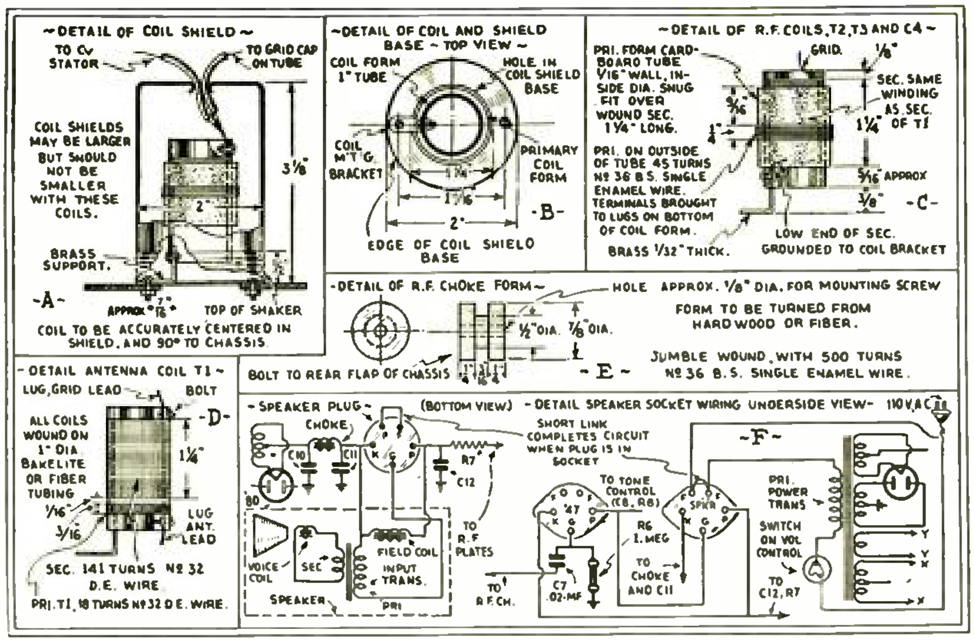


Fig. 2. Detail sketches of the coils, chokes and speaker-socket wiring. Details of the coil mounting bracket are shown at A; of the shield at B; of the R.F. coils at C; of the antenna coil at D; of the R.F. chokes at E; of the speaker wiring at F.

terminals are ½-inch soldering lugs bolted to the forms. One grid terminal is bolted at the top of the form opposite the bracket; the two terminals for the primary leads are bolted on opposite sides of the bottom of the tubing, 90 degrees from the bracket.

The antenna coil (T1) differs from the other R.F. transformers in that the primary and secondary are both wound on the one tube, one below the other. Solder one end of the No. 32 double enameled wire to the grid terminal. Wind the first turn of the secondary parallel to the top of the coil but 3/16 inch below it. The secondary is finished when you have wound 141½ turns. You get the half-turn by bringing the wire from the grid terminal side of the form over to the bracket so it will be grounded when the coil is bolted to the chassis. Drill a hole through the tubing just below the lowest turn of the secondary, bring a loop of the wire inside the form and solder it to the mounting bracket. Wind the first turn of the primary. When you have finished the 18th turn solder the end to one of the lugs at the bottom of the form. The antenna goes to this terminal.

The other coils, (T2, T3, T4,) have different primaries than the antenna coil has. Wind the secondaries on the other three forms just as you did when you made T1. As shown in the drawing (Fig. 2C) the primary is wound on the outside of a piece of cardboard tubing that fits over the secondary. You will need three 1¼ inch lengths of 1/16 inch cardboard tubing that will fit snugly over the wound secondary. You may have to make this tubing by winding gummed paper, 1¼ inches wide, over the secondary to the required thickness. The first turn of the primary is parallel to the top of the cardboard tube and 9/16-inch below it. Wind on 45 turns of 36 S. E. wire. Fasten both leads of the primary to the tube with gummed paper or adhesive tape. Slide the finished primary over the secondary till the top of the cardboard tube is 3/32-inch below the top turn of the secondary. Solder the leads to the lugs at the bottom of the coil form. The terminal connected with the top turn of the primary goes to the plate of the tube. The other terminal is connected to the power supply. Make two more coils like the one you have just finished. When you have done this, smear a little Duco cement or aeroplane dope over the top and lower turns of each winding to prevent the turns shifting when the coil is handled. Then test all windings by putting them in series with a dry cell and pair of headphones to make sure current flows through them.

The R.F. choke (R.F.C.) is easy to make. Turn a piece of wood or fibre to the measurements shown in Fig. 2E. Jumble wind 500 turns of the same wire used on the primaries of the R.F. transformers. For terminals, drive two short brads into the side of the form and solder the leads to them. Test for continuity with a dry cell and a pair of headphones.

The proper shields for the R.F. coils are aluminum with screw bases 2 inches wide and 3⅛ inches high. The screw bases are cut out to match the hole in the chassis and allow the wiring to reach the coil terminals. These shields are a standard article and should be easy to buy. It is also easy to make your own from the proper size aluminum salt shakers which may be obtained from any "dime" store. Just cut off the handles and drill the holes in the top to make it into a screw base. Mount upside down.

Assembling the Set

The bases of the tube shields and the sockets are held to the chassis with the same bolts. The three '51 sockets are below the chassis in the first three, large holes on the right of the chassis facing the front flap. The '24 socket goes in the fourth hole in the same row. Each socket has a tube shield base above it on the top of the chassis and all have filament prongs

(Continued on page 48)

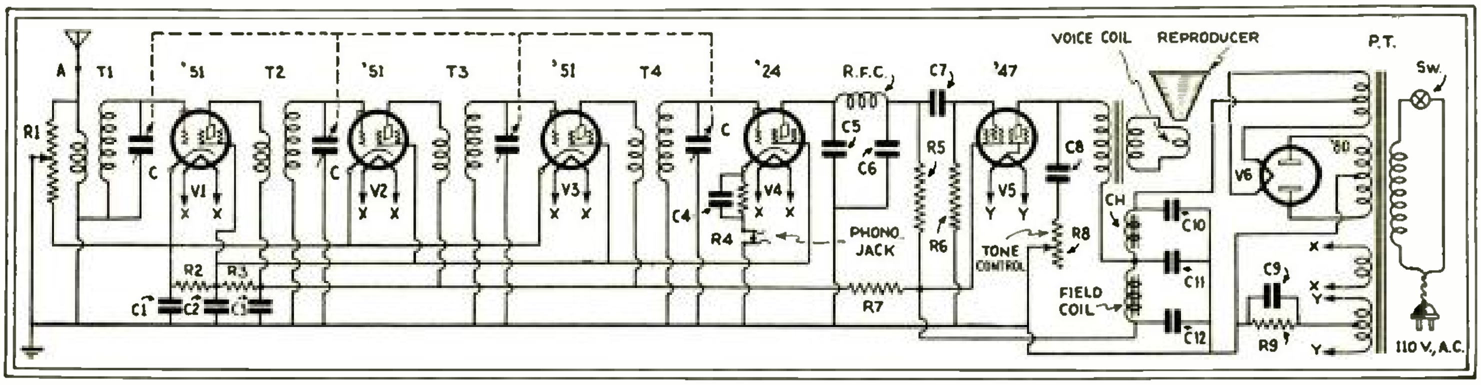


Fig. 3. Complete schematic circuit of the set. See the text for operating voltages.

A UNIVERSAL-RANGE OHMMETER

By BERTRAM M. FREED
and N. ARNOLD GOULD

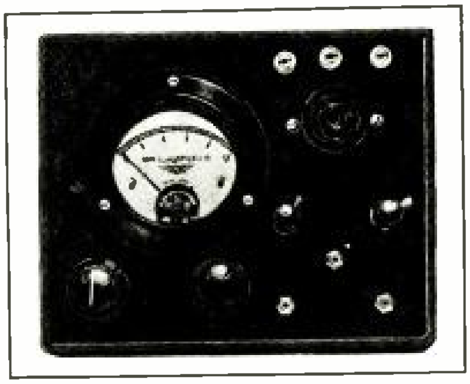


Fig. A
Panel view of the tester.

SINCE the advent of the more recent radio receivers, the lot of the Service Man has become more difficult. When the first electric sets made their appearance very few resistors were used in their construction. The power pack usually had a voltage divider composed of three or more sections, whose combined resistance seldom exceeded 50,000 ohms, and a small number of carbon and wire-wound resistors in various parts of the circuit. To check the values of these units, a voltmeter and battery combination was usually sufficient. However, when higher resistances were encountered, no accurate check was available.

As receiver design became more complex, service equipment had to be developed in order to meet the new requirements. More versatile set analyzers and ohmmeters came into being. Now, with receivers using higher voltages, automatic volume control, bi-resonator circuits, and resistance-coupled amplification, it is necessary to employ very high resistors, far beyond the range of the ohmmeter at the disposal of the Service Man, for regular service work.

With this in mind, the construction of an ohmmeter, that would accurately measure almost any resistance encountered in radio servicing, was planned. The completed unit far exceeded the low and high limits originally contemplated; it was possible to measure resistances as high as 15 megohms and as low as ½ ohm with a fair degree of accuracy. In this manner, resistances in automatic volume control circuits, grid-leaks in resistance coupled circuits, and bi-resonator circuits may be checked. In addition, R.F. coil primaries and secondaries, voice coils and power transformer windings may be tested for shorts; even for partial shorts.

The Ohmmeter

The essentials of the ohmmeter are parts readily obtainable, as no special switches or resistances are required. Refer to the diagram, Fig. 1.

An 0-1 ma. milliammeter is used; S1 and S2 are D.P.D.T. switches for changing the circuit from "series" to "shunt" testing; S3 is a S.P.S.T. switch for turning the battery current on and off; R1 is a resistance of 2000 ohms; R2 is a 3000 ohm variable resistor; B is a small 4½ volt "C" battery. R2 is variable for zero adjustment of the meter.

R4 is a carbon resistor from 500,000 to 750,000 ohms depending on the voltage supplied by the power transformer, P.T.—this resistance limits the current flow into the meter, thereby preventing accidental burn-out; R3 is a variable resistor of 250,000 ohms and is used as a zero adjustment for the high voltage; C1 is a fixed condenser of .1-mf. or more—the value is not critical as it is used to provide a smoother current flow in-so-far-as it absorbs each current pulsation, in taking a charge from the rectifier output. Only a condenser of high quality should be used as a breakdown might be disastrous to the power transformer.

A 5-volt ¼-ampere tube was chosen for the rectifier, because of its low current requirements, and also because either a '01A, '12A or 171A tube is usually included in the kit of the Service Man.

In order to keep the completed unit as compact and light as possible, it was necessary to select as the power transformer, one that was very small and light. To this end, various audio transformers were tried. Bearing in mind that a high voltage was necessary to secure a very high-resistance range, a good quality 10-1 ratio audio transformer was selected. Due to the construction of the transformer, about 120 turns of B.&S. gauge No. 22 enameled wire was wound over the regular transformer secondary to obtain the required filament voltage for the rectifier. A layer of fish paper was wrapped around the winding and the laminations were re-assembled.

At this point it may be expedient to mention that care should be exercised in choosing a transformer with sufficient iron. Lack of sufficient iron in the transformer will cause the core to become saturated and overheat, which would result in a rapid drop in voltage.

A flush receptacle was placed in the rear of the ohmmeter compartment to facilitate easy connection to the power line and to eliminate hanging wires when not in use.

Low Resistance Measurements

For low resistance measurements, terminals C and L (Fig. 1) are used. The battery switch S3 is closed and the D.P.D.T. switch, composed of switches S1 and S2 as shown in the diagram, is moved to the "shunt" position (positions D and A respectively). This causes a current flow through R1 and R2 through the meter. With R2 adjusted to show a full

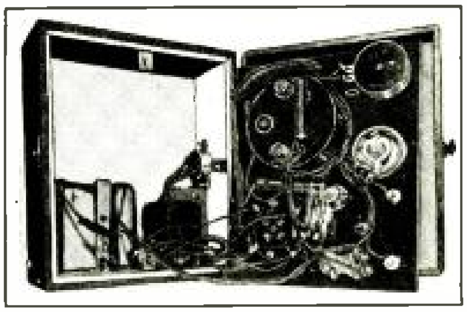


Fig. B
Internal view of the tester.

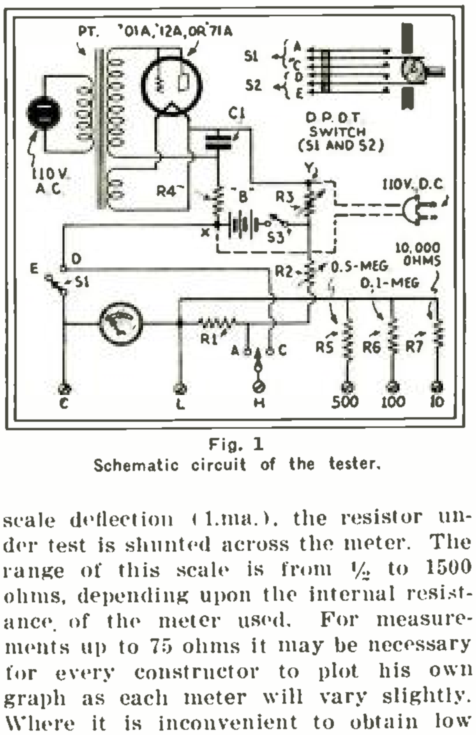


Fig. 1
Schematic circuit of the tester.

scale deflection (1.ma.), the resistor under test is shunted across the meter. The range of this scale is from ½ to 1500 ohms, depending upon the internal resistance of the meter used. For measurements up to 75 ohms it may be necessary for every constructor to plot his own graph as each meter will vary slightly. Where it is inconvenient to obtain low value resistors for plotting a curve, the following formula may be used for the low range.

$$R = \frac{Rm}{\frac{I1}{I} - 1}$$

Where

R is the unknown resistance;

Rm is the internal resistance of the meter;

I is the current range of the meter, in this case 1 ma.;

I1 is the reading obtained.

(*Continued on page 57*)

Fig. A

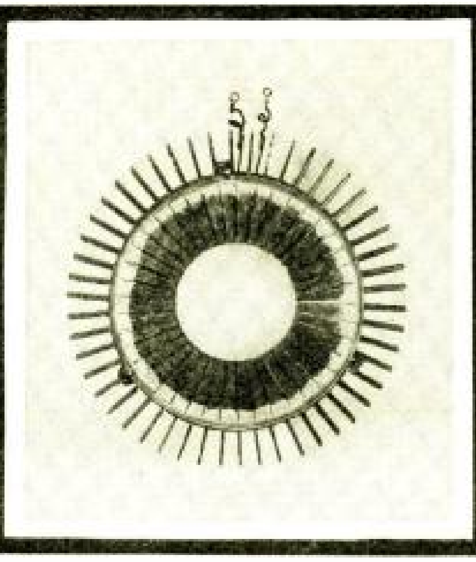


Fig. B

Fig. C

A THERMOCOUPLE "A" UNIT

By DR. OTTO HERMAN

WITH the addition of the relatively new 2-volt tubes, a number of receivers using these tubes have been constructed. Such receivers are usually designed to operate from an air-cell battery which, it is claimed, has a useful life of about 1,000 hours. Some people who use the air-cell battery far out in the country have stated that the air cells gave service for about 400 hours; in another district, some people claimed a life of 600 hours. It has been assumed that the extremely moist air in some parts of the country is the cause of the short life of the air-cell.

The possibility of producing a device that would depend for its operation upon heating effects was begun by the writer some time ago. The result is the "Thermotron," a thermo-electrically operated generator. The Thermotron uses gasoline as a fuel and consequently is especially intended for use in farm districts where electric power is unavailable. Gasoline and kerosene heated devices constitute an essential part of the environment of a farm home. Anything in this category is suitable to the farmer. It inspires confidence because such fuels have been and are a part of their environment.

In Fig. A is shown a thermo-electric generator which is based on the phenomenon of thermo-electricity discovered many years ago. This generator, which was given the name *Thermotron* has been specifically designed for use in rural homes as a source of filament current for modern battery-operated radio receivers using 2-volt tubes.

In Fig. B is illustrated the current producing section of the Thermotron. This section forms a unit-body consisting essentially of a plurality of thermocouples connected in series and a radiator ring carrying fins which project radially outward. The radiator or spider ring enclosing the thermocouples is electrically insulated from the same but in thermal contact therewith.

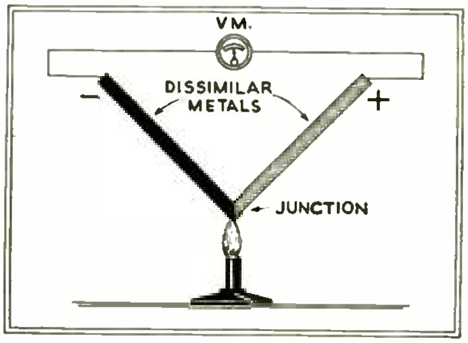


Fig. 1
Sketch illustrating the principle of the thermocouple.

An interesting description of a thermo - operated generator which is capable of supplying "A" power for air-cell receivers.

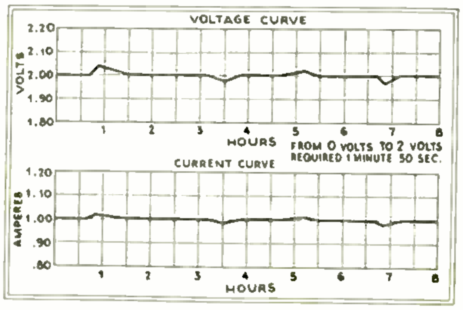


Fig. 2
Voltage and current curves of the "Thermotron."

By itself, the thermocouple section resembles a disc having a hole in the center and being divided into a number of equal sectors, each of which forms a negative thermo-element. Between the negative elements, and electrically insulated therefrom, are the positive Z-shaped elements prepared from a strip of ribbon and organically united at their extremities with the negative elements to secure permanent junctions with no extra ohmic resistance.

Obviously, each positive element (excepting the first one) is organically united with a negative element sector to form a cold junction and with the other adjacent negative element to form a hot junction. In other words, the elements forming the thermocouples alternate with each other, so that the first positive element and the last negative element, both of which being connected to terminals, come necessarily next to one another in the ring-like structure, as indicated in Fig. B.

The Elements

The positive element, which is formed from a strip of ribbon, consists of an alloy composed of nickel, copper and silver. The silver component in the alloy does not exceed one percent by weight; its melting point is 1275° C.

The negative element alloy is composed of antimony, vanadium and zinc. The vanadium content in the alloy is of the commercial kind and does not exceed five percent by weight. It makes the alloy more negative against the positive element and also serves the purpose of preventing its oxidation up to about 415° C. Moreover, the vanadium content also raises the fusing point of the alloy up to about 675° C., and imparts to the alloy the strength required for practical purposes.

The current in a thermocouple formed from these two electrodes flows from the nickel-copper-silver alloy over the hot junction to the antimony-vanadium-zinc alloy. I have termed that electrode—from which the current flows over the hot

(*Continued on page* 51)

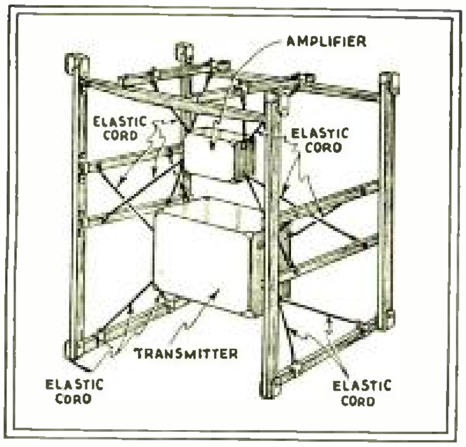


Fig. 1
An early type of receiver mount.

SERVICING AVIATION SETS

In this first of a series of articles the author discusses the power equipment used in airplane radio installations.

By MYRON EDDY

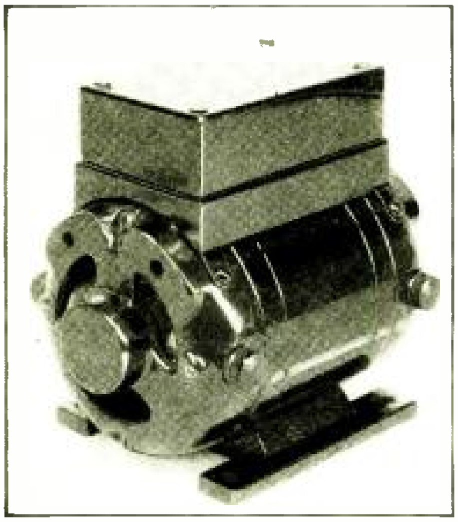


Fig. F
A dynamotor used in airplane work.

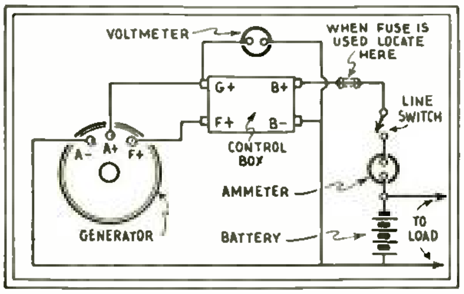


Fig. 2
The Eclipse engine-driven generator.

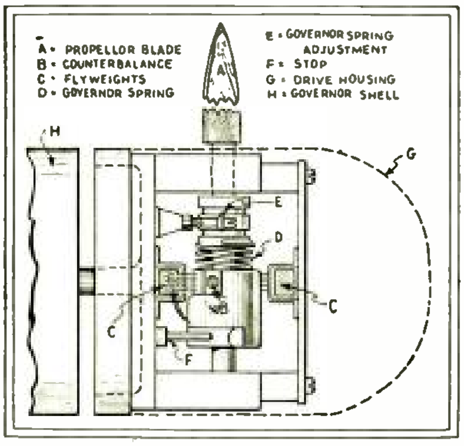


Fig. 4
Arrangement of parts in the Deslauriers propeller and governing action.

IN aviation, there are plenty of radio sets to be serviced. You will find these receivers at every airport (the law requires an A-1 airport to be able to communicate with all radio-equipped flyers); and you will find them on every transport 'plane. Being radio-equipped, such planes earn more money from mail contracts. Some airline companies use radiotelephone and some use radiotelegraph. The government uses both; in addition, it maintains radio-beacon stations from one end of the country to the other.

These sets which safeguard the air traveler are certainly most important; *they cost a great deal and should receive the best of servicing*, especially because they are not very well protected while on the plane. The airplane pilot may be able to operate a radio set, and the airplane mechanic can probably keep it clean and replace batteries, but you radiomen are going to have to do the real service work.

Transport companies employ radio Service Men, but the itinerant flyer must depend on local talent wherever he is forced down and whenever he lands to call on his Aunt Sue or get gas. It may be that our young and inexperienced pilot, Mr. Elmer Zilch, merely needs a "B" battery. Or maybe he will tell you that "this here needle pointed 'way past the red mark for a long while, and then that tube got all blue." These things happen in the best families. That's why Service Men at every cow pasture airport and crossroads hamlet should know how to shoot trouble on airplane sets.

This is true whether or not the radio trouble developed in the air is serious, or the repairs expensive, because *the plane ordinarily must land approximately when and where the trouble occurs;* which means that if the leading village radio expert in Podunk gets a hurry-up call to the municipal airport to fix the set on the 'plane of a big butter-and-egg man headed east and can't handle the job, Podunk gets a black eye, and the man called in as a radio expert gets nothing.

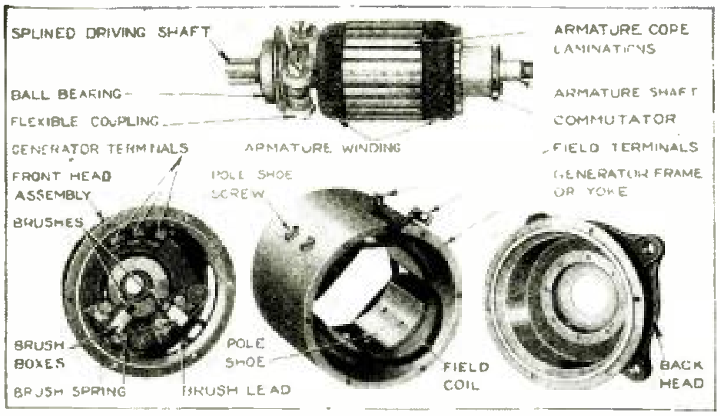
But mark this,—if the trouble is in the receiver, the local Service Man can fix it,—*then charge plenty.* (And what a pleasure that is in these days of fifty-cent service calls: "no fix, no charge"; since the problems encountered in servicing aviation radio receivers are essentially the same as those associated with broadcast receivers.

Aboard the 'plane the receiver is slung in a cradle (an early type, using rubber rope, is illustrated in Fig. 1), but when the pilot sets his 'plane down hot, bounces and then guns the motor, the radioman must either hang onto his receiver or his chair. He usually lets the receiver "ride," because he doesn't like to eat standing up. On the take-off, he can brace himself with his legs and *try* to steady the set with his hand, but I think he'll find drinking coffee on a roller coaster an easier thing to do! In fact, the entire set as installed on a plane operates under adverse conditions as to vibration, dirt, inclement weather, etc.

Flying along in fair weather, all is fine. But when the 'plane flies over the mountain, the operator and his set both get bumped a bit. The air is fine but frisky. Going over the "hump" of the Rockies you will find not only Big Papa hump, but a very large family of little humps. The receiver beats a tattoo on your fingers when you put your hand behind it to stop its shimmy. Your hands get cold and so does your set; and there is many a job for the Service Man at the end of a mountain run because the heater-unit of the set wasn't generous enough with its calories while the 'plane was flying above the line of vegetation.

Another thing that Old Man Weather does to complicate the job of servicing aviation receivers occurs in the tropics. That is the undue heating of parts. Moisture is absorbed by coils and condensers. Old Sol comes along and does the rest; the set is steamed and baked until you finally have one well-cooked radio goulash, *but not a dependable set. The only thing a Service Man can do to combat this process is to anticipate nature's cooking by a little premeditated baking of his own.* If he will house the set between flights in a little radio garage containing dry warm air and nothing else but, okay!—otherwise, stand by for blue smoke and fireworks.

Pan-American Airways, Inc., fly airways south out of the United States totalling nearly 15,000 miles. They have one of the most efficient aviation communication systems in the world. The Chief Communication Engineer of this company



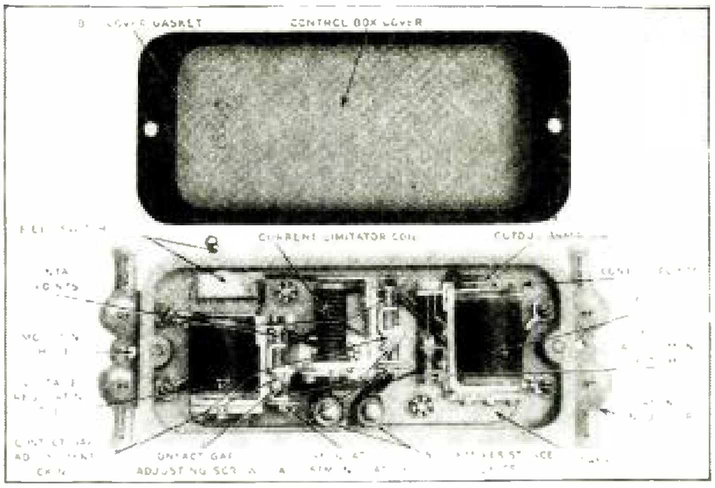


Fig. B, above. Parts of the Eclipse generator.
Fig. C, right. Control Box used with the Generator of Fig. B.

says that heat, cold, and moisture are the great enemies of the men who service these sets. This organization has developed its own radiotelegraph sets, radiotelephony not being used; and, naturally, must develop its own service crews. These are recruited mostly in the United States, the radio operators holding commercial licenses. The fattest operators handle ground stations and service 'plane sets, only men weighing 'ess than 150 pounds being assigned flight duty. (Old-time Service Men who like their groceries, take note.)

But servicing receivers is only a small part of the total radio service work to be done in aviation; nevertheless, in every case this work must be done by highly competent workmen.

Aeroplane Generators

To properly service aviation radio equipment it is absolutely essential that you understand the "power pack" used. The original source of supply may be a generator, or it may be a dynamotor and battery. If a generator is used, it may be either an engine-driven or a wind-driven type. If wind driven, it is undoubtedly equipped with a Deslauriers propeller. I will tell you first about both generators so that you can service either one; then, dynamotor servicing will be discussed.

The Eclipse, one well-known type of airplane-engine-driven generator, is in very general use on radio-equipped transport planes. Figure A shows this generator and its control box; Fig. 2, the manner in which they are wired, and; Fig. B, the component parts.

This instrument is a D.C. shunt-wound, self-excited, 4-pole machine and is secured to the engine by bolts, being driven from the airplane engine through a splined driving shaft.

Usually, a flexible spring coupling is connected between the drive shaft and the armature to absorb any tortional vibration from the engine crank-shaft. When this coupling is correctly assembled and the armature is held securely, the splined member of the coupling can be turned either way approximately 13 degrees without the springs becoming loose. If it becomes necessary to take apart the flexible coupling, the exact position of the spring adjusting nuts should be first carefully noted. In reassembling, if the nuts are set up to their original position, the correct spring tension in the coupling is then assured. (The adjusting nuts should be locked with a tie-wire to prevent their coming off.)

In servicing this generator, the following points should be carefully borne in mind. The commutator should be clean and smooth. The brushes should be clean, and free to move in the brush box, while making good contact with the commutator over the entire area of the brush section. *Bearings should be kept correctly lubricated.* If it is found that oil has leaked into the interior of the generator from the engine, look to the various oil sealing washers and replace any that are damaged or worn. Also clamp up tightly on the bearing plates.

An old generator will often be found more or less filled with carbon dust, mixed with oil. Always clean this out with gasoline and a brush then make certain that the generator is dried out well. The commutator may be cleaned with a cloth and a little gasoline if necessary.

Most Service Men know enough not to use emery cloth on a commutator; No. 000 sandpaper, or even finer, is recommended. Of course, if the commutator has been severely pitted, the armature will have to be removed, and placed in a lathe so that a slight cut can be taken across its face. In this case the mica will also have to be undercut and the commutator *carefully polished.*

New brushes may be quickly seated by placing a thin strip of fine sandpaper under the brush with the sanded side of the paper in contact with the brush. Then, by drawing the sandpaper from under the brush repeatedly, in the direction of rotation of the armature, the brushes will be made to conform to the general shape of the commutator. It is not necessary or desirable that any tension in addition to that furnished by the brush spring be applied during this process. Sometimes the brush followers are binding. These should be adjusted to give free up and down movement.

(*Continued on page* 55)

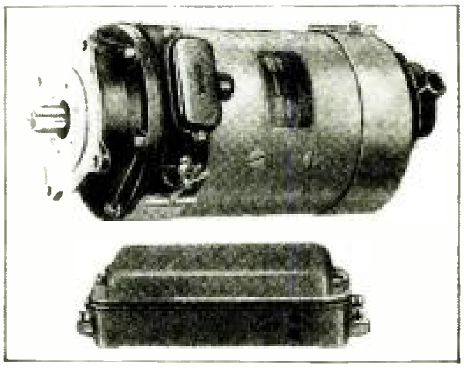


Fig. A
The Eclipse engine-driven generator.

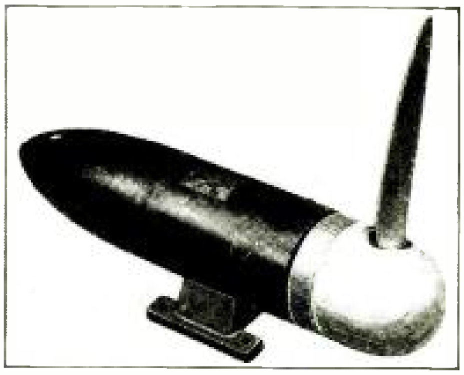


Fig. D.
A single-blade Deslauriers wind generator.

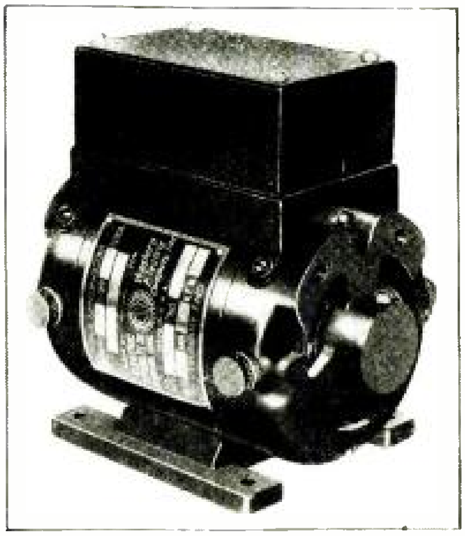
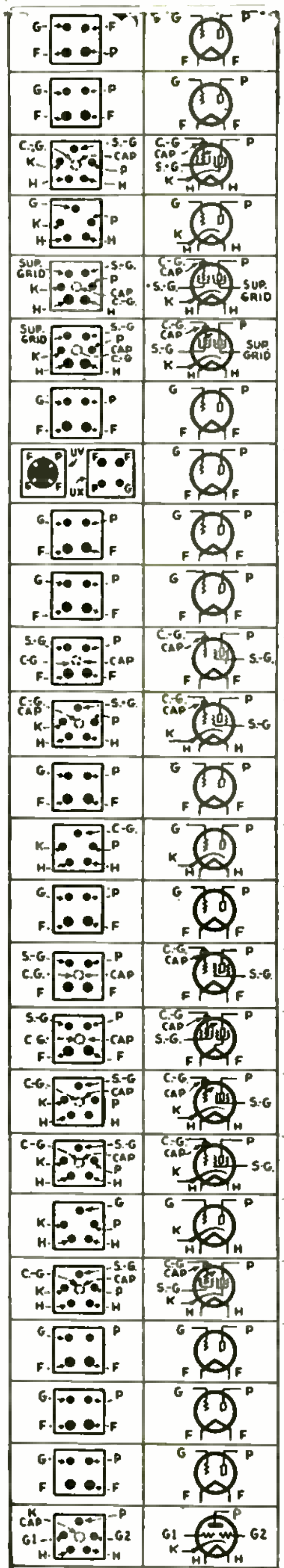


Fig. E
One type of airplane dynamotor.

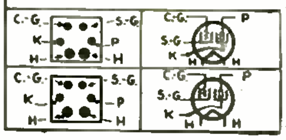
RADIO CRAFT'S TUBE TABLE

DETECTORS AND AMPLIFIERS



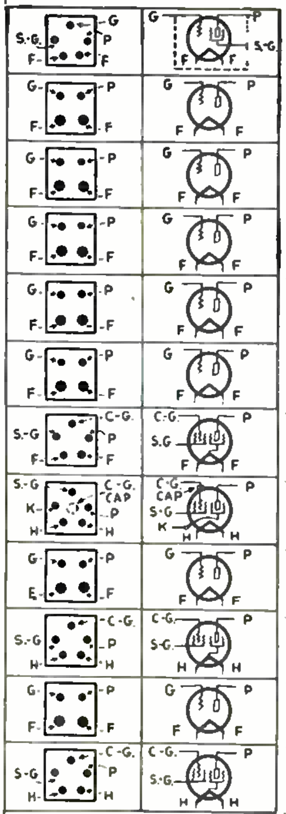
Socket Connections	Symbol	Type	Purpose	Rating of Filament or Heater: Volts	Amps.	Supp.	Plate Volts	Bias Volts: D.C. Fil.	A.C. Fil.	Screen Volts	Plate Current in Ma.	A.C. Plate Res.	Mut. Cond. Mmhos.	Amp. Factor	Ohms Load	Power Output in Mw.
		WD-11	Detector or Amplifier	1.1	.25	D.C.	90 135	− 4.5 − 10.0			2.5 3.0	15500 15000	425 440	6.6 6.6	15500 18000	7 35
		WX-12	Detector or Amplifier	1.1	.25	D.C.	90 135	− 4.5 − 10.5			2.5 3.0	15500 15000	425 440	6.6 6.6	15500 18000	7 35
		44	R.F.-I.F. Amplifier	6.3	.3	D.C. A.C.	135 180 250	variable −3 to −50	variable −3 to −50	90 90 90	6.25 6.4 6.5	250000 410000 600000	1030 1040 1050	257 426 630		
		56	Detector Amplifier Oscillator	2.5	1.0	D.C. A.C.	250 250 90	− 20 − 13.5 0.0	− 20 − 13.5 0.0		2.0 5.0	9500 9500	1450 1450	13.8 13.8		
		57	Biased Detector Amplifier	2.5	1.0	D.C. A.C.	250 250	− 6.0 − 3.0	− 6.0 − 3.0	100 100	.1 2.0	greater than 1.5 Meg.	1225	1500	250000	
		58	R.F.-I.F. Amplifier 1st Detector	2.5	1.0	D.C. A.C.	250 250	− 3.0 Min. − 10	− 3.0 Min. − 10	100 100	8.2	800000	1600	1280		
		112A	Detector or Amplifier	5.0	.25	D.C.	90 135	− 4.5 − 9.0			5.2 6.2	5600 5300	1500 1600	8.5 8.5	5600 8700	30 115
		199	Detector or Amplifier	3.3	.06	D.C.	90	− 4.5			2.5	15500	425	6.6	15500	7
		200A	Detector	5.0	.25	D.C.	45	Grid Return to −	Fil.		1.5	3000	666	20		
		201A	Detector or Amplifier	5.0	.25	D.C.	90 135	− 4.5 − 9.0			2.3 3.0	11000 10000	725 800	8 8	11000 20000	15 55
		222	R.F. Amp. A.F. Amp.	3.3	.132	D.C.	135 135 180	− 1.5 − 1.5 − 1.5		45 67.5 22.5	1.5 3.3 .3	850000 600000 2 Meg.	350 480 175	300 290 350	.25 Meg.	
		224 224A	R.F. Amp. Detector A.F. Amp.	2.5	1.75	A.C. D.C.	180 275 250	− 1.5 − 5.0 − 1.0	− 1.5 − 5.0 − 1.0	75 30 25	4.0 .1 .5	400000 2 Meg.	1050 500	420 1000		
		226	Amplifier	1.5	1.05	A.C. D.C.	90 135 180	− 5.0 − 8.0 − 12.5	− 6.0 − 9.0 − 13.5		3.8 6.3 7.4	8600 7200 7000	955 1135 1170	8.2 8.2 8.2	9800 8800 10500	30 80 180
		227	Detector Amplifier	2.5	1.75	A.C. D.C.	90 180 250	− 6.0 − 13.5 − 21.0	− 6.0 − 13.5 − 21.0		2.7 5.0 5.2	11000 9000 9250	820 1000 975	9.0 9.0 9.0	14000 18700 34000	30 165 300
		230	Detector or Amplifier	2.0	.06	D.C.	90	− 4.5			1.8	13000	700	9.3	15000	16
		232	R.F. Amp. Detector	2.0	.06	D.C.	135 175	− 3.0 − 6.0		67.5 67.5	1.4 .2	1.15Meg	505	580		
		234	R.F.-I.F. Amplifier 1st Detector	2.0	.06	D.C.	67.5 90.0 135.0	−3 Volts Mini	mum	67.5 67.5 67.5	2.7 2.7 2.8	400000 500000 600000	560 580 600	224 290 360		
		235	R.F. Amplifier	2.5	1.75	A.C. D.C.	180 250	− 1.5 − 3.0	− 1.5 − 3.0	75 90	5.8 6.5	350000 350000	1100 1050	385 370		
		236	R.F. Amplifier	6.3	.3	D.C.	90 135	− 1.5 − 1.5		55 67.5	1.8 3.0	200000 300000	850 1050	170 315		
		237	Detector or Amplifier	6.3	.3	D.C.	90 135	− 6.0 − 9.0			2.6 4.3	11500 10000	780 900	9.0 9.0	17500 14000	30 80
		239	R.F.-I.F. Amplifier	6.3	.3	D.C.	90 135 180	−3 Volts Mini	mum	90 90 90	4.4 4.4 4.5	375000 540000 750000	960 980 1000	360 530 750		
		240	Voltage Amplifier	5.0	.25	D.C.	135 180	− 1.5 − 3.0			.2 .2	150000 150000	200 200	30 30	.25 Meg. .25 Meg.	
		841	Voltage Amplifier	7.5	1.25	A.C. D.C.	425 1000	− 6 − 9	− 6 − 9		.7 2.2	63000 40000	450 750	30 30	.25 Meg. .25 Meg.	
		864	Detector or Amplifier or Oscillator	1.1	.25	D.C.	90	− 4.5			2.9	13500	610	8.2		
		Wunderlich	Detector	2.5	1.0	A.C. D.C.	250	Grid	Leak		2–5	12000	1200	12.0	1 Meg.	

OUTPUT POWER TUBES



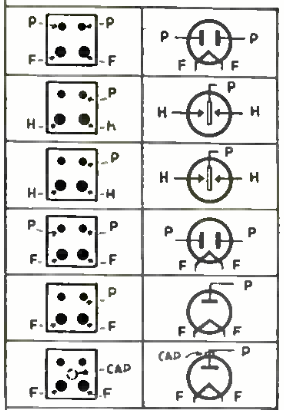
Socket Connections	Symbol	Type	Purpose	Volts	Amps.	Supp.	Plate Volts	Bias D.C. Fil.	Bias A.C. Fil.	Screen Volts	Plate Current in Ma.	A.C. Plate Res.	Mut. Cond. Mmhos.	Amp. Factor	Ohms Load	Power Output in Mw.
		41	Power Pentode	6.3	.65	A.C. D.C.	125 167.5	− 10 − 12.5	− 10 − 12.5	125 167.5	11.0 16.5	150000 120000	1400 1800	210 215	13000 11000	650 1200
		42	Power Pentode	6.3	.65	A.C. D.C.	250	− 16.5	− 16.5	250	34	100000	2200	220	9000	3000

THE ADVENT OF THE NEW TUBES HAS MADE A COMPLETE, UP-TO-DATE TUBE CHART AN ABSOLUTE NECESSITY. RADIO-CRAFT THEREFORE PRESENTS THE MOST COMPLETE TUBE CHART, WITH SOCKET CONNECTIONS AND SYMBOLS, AVAILABLE TO THE PUBLIC.



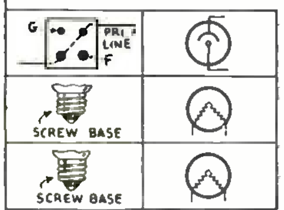
Socket Connections	Symbol	Type	Purpose	Rating of Filament or Heater: Volts	Amps.	Supp.	Plate Volts	Bias Volts: D.C. Fil.	A.C. Fil.	Screen Volts	Plate Current in Ma.	A.C. Plate Res.	Mut. Cond. Mhos.	Amp. Factor	Ohms Load	Power Output in Mw.
		46	Power Amplifier	2.5	1.75	A.C. D.C.	300 400	0.0 0.0	0.0 0.0	Tied to Control Grid	4.0 6.0				1300 1450	8000 8000
		112A	Power Amplifier	5.0	.25	A.C. D.C.	135 180	− 9.0 − 13.5	− 11.0 − 16.0		6.2 7.6	5300 5000	1600 1700	8.5 8.5	8700 10800	115 260
		120	Power Amplifier	3.3	.132	D.C.	90 135	− 16.5 − 22.5			3.0 6.5	8000 6300	415 525	3.3 3.3	9600 6500	45 110
		171A	Power Amplifier	5.0	.25	A.C. D.C.	90 135 180	− 16.5 − 27.0 − 40.5	− 19.0 − 29.5 − 43.0		12.0 17.5 20.0	2250 1960 1850	1330 1520 1620	3.0 3.0 3.0	3200 3500 5350	125 370 700
		210	Power Amplifier-Oscillator	7.5	1.25	A.C. D.C.	250 350 425	− 18.0 − 27.0 − 35.0	− 22.0 − 31.0 − 39.0		10.0 16.0 18.0	6000 5150 5000	1330 1550 1600	8.0 8.0 8.0	13000 11000 10200	400 900 1600
		231	Power Amplifier	2.0	.130	D.C.	135	− 22.5			6.8	4950	760	3.8	9000	150
		233	Power Amplifier	2.0	.26	D.C.	135	− 13.5		135	14.0	50000	1500	75	7000	700
		238	Power Amplifier	6.3	.3	D.C.	135	− 13.5		135	9.0	102000	975	100	13500	525
		245	Power Amplifier	2.5	1.5	A.C. D.C.	180 250 275	− 33.0 − 48.5 − 54.5	− 34.5 − 50.0 − 56.0		27.0 34.0 36.0	1900 1750 1670	1850 2000 2100	3.5 3.5 3.5	3500 3900 4600	780 1600 2000
		247	Power Amplifier	2.5	1.75	A.C. D.C.	250	− 16	− 16.5	250	32.0	35000	2500	90	7000	2500
		250	Power Amplifier	7.5	1.25	A.C. D.C.	250 450	− 41 − 80	− 45 − 84		28.0 55.0	2100 1800	1800 2100	3.8 3.8	4300 4350	1000 4600
		LA	Power Amplifier	6.3	.3	D.C.	135 165	− 9.0 − 11.0		135 165	12.0 17.0	52700 50000	1900 2100	100 100	9500 8000	700 1200

RECTIFIERS



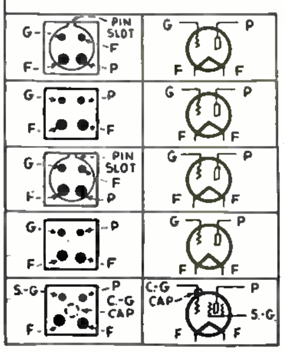
Socket Connections	Symbol	Type	Purpose	Volts	Amps.	Supp.	Ratings
		82	Full-Wave Rectifier	2.5	3.0	A.C. D.C.	Maximum A. C. Volts (R. M. S.) 500 Volts Maximum D. C. Output Current .125 Milliamperes Tube Voltage Drop........ 15 Volts
		BA	Full-Wave Rectifier	Has	No Fil	ament	Maximum A. C. Volts (R. M. S.) ......350 Volts (per plate) Maximum D. C. Output Current ......350 Milliamperes Maximum D. C. Output Voltage ......300 Volts
		BH	Full-Wave Rectifier	Has	No Fil	ament	Maximum A. C. Volts (R. M. S.) ......350 Volts (per plate) Maximum D. C. Output Current ......125 Milliamperes Maximum D. C. Output Voltage ......300 Volts
		280	Full-Wave Rectifier	5.0	2.0	A.C. D.C.	Maximum A. C. Volts (R. M. S.)......350 Volts Maximum D. C. Output Current......125 Milliamperes
		281	Half-Wave Rectifier	7.5	1.25	A.C. D.C.	Maximum A. C. Volts (R. M. S.)......700 Volts Maximum D. C. Output Current...... 85 Milliamperes
		866	Half-Wave Rectifier	2.5	5.0		Maximum Peak Inverse Voltage.......7500 Volts Maximum Peak Plate Current......... 600 Milliamperes

VOLTAGE REGULATORS



Socket Connections	Symbol	Type	Purpose	Ratings
		874	Voltage Regulator	Operating Voltage........ 90 Volts Starting Voltage..........125 Volts Operating Current........10-50 Milliamperes
		876	Current Regulator (Ballast Tube)	Operating Current........1.7 Amperes Voltage Range............40-60 Volts
		886	Current Regulator (Ballast Tube)	Operating Current........2.5 Amperes Voltage Range.......... 10-60 Volts

TUBES FOR TRANSMITTING AMATEURS



Socket Connections	Symbol	Type	Purpose	Volts	Amps.	Supp.	Plate Volts	D.C. Fil.	A.C. Fil.	Screen Volts	Plate Current in Ma.	A.C. Plate Res.	Mut. Cond. Mhos.	Amp. Factor	Ohms Load	Power Output
		211	General Purpose	10.0	3.25	A.C. D.C.	1000	− 55	− 55		72	3400	3530	12		75 watts nom.
		841	Oscillator	7.5	1.25	A.C. D.C.	350 450	− 5.0 − 8.0	− 5.0 − 8.0		43 36	21500	1400	30		Peak 16 watts
		845	A. F. Amplifier or Modulator	10.0	3.25	A.C. D.C.	1000	−150	−150		75	2100	2380	5		Peak 100 watts
		852	Oscillator or R. F. Power Amplifier	10.0	3.25	A.C. D.C.	2000	−150 −250	−150 −250		85 100			12		120 100 watts
		865	Oscillator or R. F. Power Amplifier	7.5	2.0	A.C. D.C.	500	− 40 − 75	− 40 − 75	125 125	30 60			150		7.5 7.5 watts

HOW TO USE A SET ANALYZER

A discussion of analyzer theory and operation which starts from the very depths of receiver-voltage measurements and shows the reader the "how" and "why" of analyzer operation.

By F. L. SPRAYBERRY

THE purpose of this article is to inform the Service Man of the correct procedure in the use of a modern set analyzer; and how to interpret its meter readings in the terms of normal or abnormal receiver operation. Provided these simple instructions are followed, anyone with a fundamental knowledge of vacuum tube circuits can intelligently service the modern broadcast receiver with a minimum amount of time and labor.

Type of Instruments Required

First we shall describe the two meters around which is built the Jewell Model 444 set analyzer that has been selected as an example of good instrument design.

The meter on the left, Fig. A, is of the A.C. type, having scales for both current and voltage. The range in amperes is 0-4 and 0-8, the milliampere range being 0-20 and 0-100. The A.C. voltage scale is 0-4, 0-8, 0-160 and 0-800. The instrument on the right is a combination volt and milliammeter for D.C. voltages and currents and in addition has three calibrated ohmmeter scales, with ranges of 0-1,000, 0-10,000 and 0-100,000 ohms. A 4.5 V. flashlight battery provides voltage for the ohmmeter and for tube testing. Every instrument scale is available at the indented jacks along the rear edge of the panel.

Many Service Men make measurements with a set analyzer *but do not know what these measurements mean*, or how the instruments are connected to the circuits under test, and therefore cannot visualize the conditions in the circuits.

The successful interpretation of set analyzer readings depends upon a knowledge of the fundamental connections shown in Figs. 1A to F. It makes no difference how the tester is *mechanically* arranged,—if it is correctly designed it will always *electrically* connect instruments to a circuit as shown in these figures.

Rule Number One

The common reference point for all the voltages (except cathode and filament) *in a vacuum tube circuit* (measured at the tube socket) *is its filament or cathode.* That is, if the tube is of the "*indirect heater*" type, such as the '24, '27, '35, or '51, *the cathode* is the high-voltage negative; and if it is of the "*direct* heater" type, such as the '01A, '12A, '71A, '45, '47, or '50, the negative side of the filament is the high-voltage negative.

Therefore, high-voltage negative of a particular tube is always taken as a reference point with respect to any other part of the circuit of that tube. Consequently, if we say a certain tube has a plate potential of 250 volts, a control-grid potential of 16.5 volts, or a screen-grid potential of 250 volts, we really mean with respect to its cathode or filament.

(Note that the terms "'B' negative" and "'B' positive" should not be applied to the current *source*—ordinarily, a power pack—but only in connection with the plate-circuit return [for minus, and the plate, for positive] connection of a tube. Such careless use of the term "'B' negative" and "'B' positive" has resulted in much misunderstanding. The *power pack* terminals are correctly designated *only* as positive or negative; that is, without any mention of the letter "B." Battery manufacturers, through battery markings, have contributed their share to the confusion. *Technical Editor.*)

The cathode potential is a figure obtainable only in tubes of the indirect-heater type, and is the voltage measured between

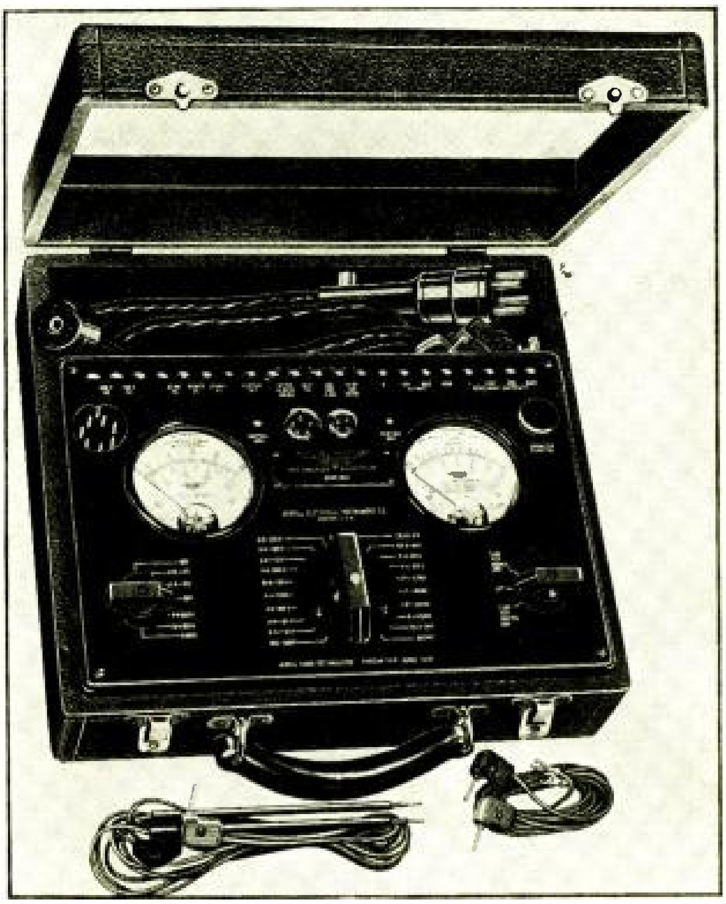


Fig. A
A Jewell analyzer employing the principles discussed in this article.

the cathode (emitter) and its heater-filament. The cathode may be positive in polarity and the filament negative, or vice versa, depending upon the circuit arrangement.

The filament voltage is not measured with respect to the high-voltage negative, but is simply the voltage drop across the filament. The filament current *source* may be a battery or, (in the case of an A.C. receiver), the secondary of a step-down transformer.

From a consideration of these fundamentals we may conclude that if the negative end of the high-voltage circuit becomes open, shorted or incorrectly grounded, the measurements obtained will be inaccurate; but of this, more anon.

Filament Voltage

Consider Fig. 1A which represents a set analyzer voltmeter connection for the measurement of filament voltage. What conditions could exist if "low," or "no voltage," is indicated on the meter, V? (We assume voltage is applied to the primary of the transformer, which is not shown.)

If there is no secondary voltage, the transformer filament winding is almost invariably open; a continuity test will give an immediate check on this. If the voltage is low, the complete circuit may be shorted or grounded, (the ground may be to the core of the transformer, or to the chassis of the receiver); a continuity test between filament and core or chassis will establish where the ground exists.

If the filament voltage is high, the secondary winding may be shorted to another secondary or to the primary, or the

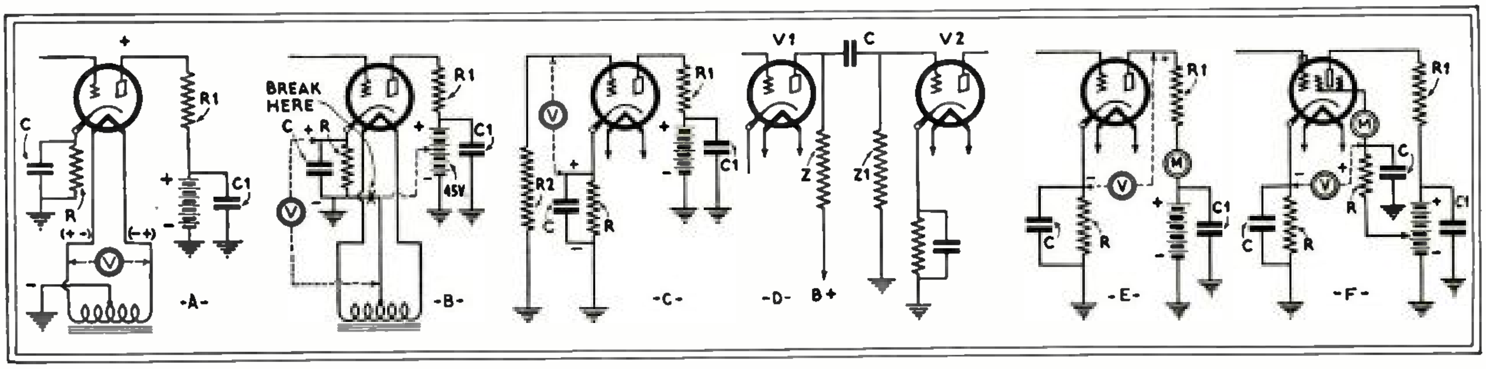


Fig. 1. The points between which the terminals of a Voltmeter should be connected for measurement work is shown in the above sketches. The connection of the milliammeter for plate and screen-grid current readings are shown in E and F respectively.

line voltage may be high make a continuity test for shorts or grounds, and use the A.C. voltmeter to check the line voltage. Watch out for shorted primary turns, which also will cause a high filament secondary voltage.

Cathode Voltage

In Fig. 1B we have the connection for the measurement of "cathode" voltage; that is, the cathode-to-filament potential as indicated on meter V. In this circuit, what condition could cause a low, high, or no-voltage reading on meter V?

Consider low voltage first. Since the cathode voltage in this instance depends on the plate current flowing through the tube, a low cathode voltage will be indicated if the plate current is low (due perhaps to low plate voltage, or a weak tube).

An indication of "no voltage" between cathode and filament (which in this example is shown grounded at the center-tap of the filament voltage secondary winding) will be obtained if the condenser C is shorted, since the bias resistor R is then shorted out of the circuit, which results in no voltage drop across R and therefore no cathode voltage.

High cathode voltage, positive in polarity, may be caused by a short to the "B+" circuit, or to one of the tube elements; either will result in a high plate current and, in turn, a large voltage drop across R. Lack of cathode voltage may be caused by an absence of plate voltage, open plate circuit, shorted condenser "C," or open cathode circuit.

The dotted lines in Fig. 1B show how a positive voltage might be placed on the heater to cause the cathode to be negative. Should this be the case the center-tap of the heater, as indicated by X, will not be grounded.

It is interesting to note that the control-grid and cathode voltages *ordinarily* are the same unless, as in the instance illustrated in Fig. 1B, the cathode is given a negative (or positive) voltage by placing a positive (or negative) charge on the heater. Also, if a positive charge of greater value than the voltage drop across R is placed on the heater, then the cathode voltage will be negative, the exact value being the difference between the voltage drop across R and the voltage applied to the heater. Few sets, however, employ a negative cathode voltage and in most cases the applied cathode voltage will be equal to the effective grid voltage.

In Figs. 1A to 1F, you will note that resistors R1 and R2 are placed in the plate and grid circuits, respectively, to represent the load. Actually these may be coils, transformers, chokes or any other form of impedance; in any case, the same principles apply. The battery represents the high-voltage supply while the plate bypass condenser C1 may represent either the filter condenser system in the power pack, or one of the regular plate-circuit bypass condensers.

Control-Grid Voltage

Now refer to Fig. 1C which shows the voltmeter connection for determining control-grid voltage. In this measurement, the polarity of the voltmeter is reversed within the set analyzer so that the plus end of the meter is connected to the cathode, and the negative end to the grid. What conditions in this circuit will cause abnormal measurements provided we have plate current?

Suppose the circuit were normal and the resistance R2 in the control-grid circuit was a 500,000 ohm grid leak in a resistance-coupled amplifier. Would our voltmeter at V indicate exact control-grid voltage? *No, not at all*, since in the grid circuit, there is a 500,000 ohm resistance (R2) which is in series with the voltmeter.

Now, in order to get a voltage indication on a voltmeter, current must flow in the circuit; and when the voltmeter is connected between the control-grid and cathode, the only current flowing in the circuit is that taken by the instrument. The voltage drop across the bias resistor is never high enough to drive through the circuit a current of sufficient magnitude to move the moving element, and thus the needle of the voltmeter. Therefore, due to this high resistance in the circuit, the *indicated* voltage (on the voltmeter) will be much lower than the true or *effective* voltage.

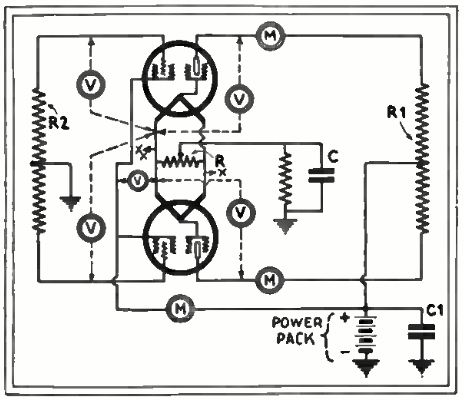


Fig. 2
Measurements in a push-pull stage.

The correct way to get the *effective control-grid voltage* would be to short the grid load resistor; or to make a measurement of the cathode voltage (which in most cases equals the control-grid voltage). If the bias resistor R becomes open and a control-grid voltage measurement is attempted with the set analyzer, a high control-grid voltage will cause a correspondingly low plate current. The reason for this is that the instrument itself takes the place of the bias resistor, the high voltage drop occurring across the instrument due to its high resistance. When this condition is noted with a set analyzer always check the bias resistor with the continuity tester; since a condition of high plate current and no grid bias usually indicates a shorted bias resistor bypass condenser C.

If the control-grid circuit becomes open at any point, control-grid voltage will not be indicated on the voltmeter. Likewise, if the primary of the coupling unit in the preceding stage becomes shorted to the secondary or control-grid circuit, a *positive* bias will be placed on the control-grid of the tube. This will show on the set analyzer as a high plate current; also, the normal control-grid voltage reading will not be evident but the meter will be reading in the reverse direction. This condition is sometimes found in resistance or impedance-coupled stages, due to a leaky or shorted coupling condenser.

Consider Fig. 1D, which represents a stage of resistance coupling (a form found in many makes of early screen-grid sets, particularly the Atwater Kent; impedance coupling is utilized in the R.F. stages). If condenser C, which couples the plate and control-grid circuits, breaks down under voltage, the control-grid of the following tube, V2, becomes positive and if Z1 is a

(*Continued on page* 55)

SHORT CUTS IN RADIO SERVICE

Fig. 1
With this new kink, it's a pleasure to measure.

PRIZE AWARD

SERVICE JOBS IN BEAUTY SHOPS
By C. O. Nixon

EVERY town and city of 2,000 population and over has its beauty shops, each with its permanent waving machines.

Most of these are without voltage meters which are essential in order that the operator may note the voltage fluctuations while "baking" a head of hair, and increase the time to compensate for low voltage—which is usually caused by putting onto the line a hair dryer, etc., while baking.

Live Service Men in small towns and cities can "cash in" by attaching to these permanent waving machines for a nominal sum, an A.C. line voltage meter as illustrated in Fig. 1. In the case of the Gabrieleen machine it is only necessary to twist the prongs of a Beede or Readrite A.C. 150-volt meter so that they may be inserted into a spare heater socket (Fig. 1).

The Fredericks and other makes will require slightly different application, but should not be difficult for any Service Man who knows his "stuff."

This meter installation is easily sold and made, as similar voltage indicators built into the machines cost $65.00 and more.

These Beauty Shops are potential buyers of interference filters to be applied to their hair drying equipment, especially such shops as have radio receivers.

$10 FOR PRIZE SERVICE WRINKLES

Previous experience has indicated that many Service Men, during their daily work, have run across some very excellent Wrinkles, which would be of great interest to their fellow Service Men.

As an incentive toward obtaining information of this type, RADIO-CRAFT will pay $10.00 to the Service Man submitting the best all-around Radio Service Wrinkle each month. All checks are mailed upon publication.

The judges are the editors of RADIO-CRAFT, and their decisions are final. No unused manuscripts can be returned.

Follow these simple rules: Write, or preferably type, on one side of the sheet, giving a clear description of the best Radio Service Wrinkle you know of. Simple sketches in free-hand are satisfactory, as long as they explain the idea. You may send in as many Wrinkles as you please. Everyone is eligible for the prize except employees of RADIO-CRAFT and their families.

The contest closes the 15th of every month, by which time all the Wrinkles must be received for the next month.

Send all contributions to the Editor, Service Wrinkles, c/o RADIO-CRAFT, 98 Park Place, New York City.

IMPROVING THE A. K. 35
By Theodore R. Sayre

OLD battery receivers are characterized by a deplorable lack of good tone quality. To correct this state of affairs, the writer worked up the audio amplifier illustrated in Fig. 2. An excellent "modernizing" job can be done by applying this circuit to Atwater Kent No. 35 receivers with greatly improved quality and volume resulting therefrom.

Incidentally, the sensitivity will be increased to a considerable extent. In addition, this unit makes an excellent D.C. phonograph amplifier since the type '22 tube gives considerable voltage gain.

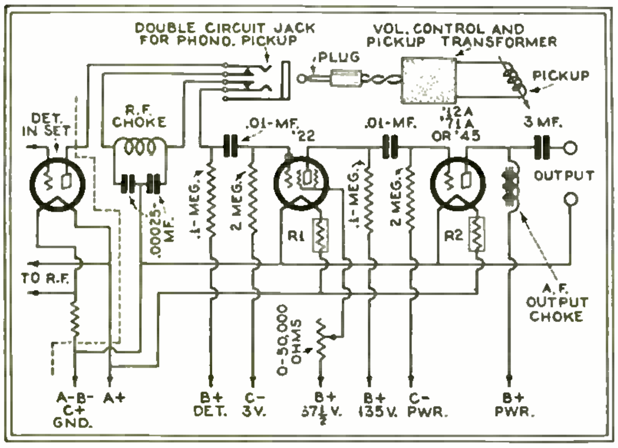


Fig. 2. Circuit of the revised A.K. "35".

THE "B" UNIT'S FIELD SUPPLY
By A. Israel

QUITE a few people have bought 110-volt D.C. dynamic speakers but have failed to get good results because the field-coil did not receive enough current when connected to their radio receiver as one of the filter choke-coils; also, there are many 110-volt A.C. dynamic reproducers collecting cobwebs simply because something is wrong with the rectifier system.

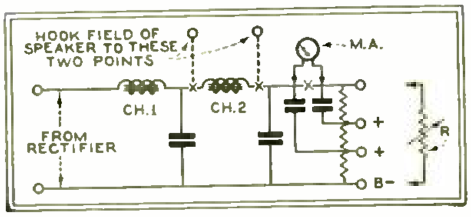


Fig. 3
Mr. Israel's "field supply."

However, by connecting a standard "B" eliminator, as shown in Fig. 3, considerable direct current will be available for operating field coils.

The reproducer field-coil is to be connected, as shown by the dotted lines, in place of choke CH2. The current through the coil may be regulated by connecting a variable resistor from "B" plus to "B" minus. This unit is indicated as R, its value being variable between the limits of about 0 and 25,000 ohms. This resistor is preferably of the compression type, so that its current carrying capacity will increase as its resistance is lowered.

To prevent the current drain exceeding the rated output of the tube used as a rectifier, it is advisable to connect a milliammeter in series with the circuit, as indicated at M.A.

A.C. RADIOLAS ON D.C.
By Robert C. Barton

MANY Service Men seem reticent about attempting to convert 110-V. A.C. receivers to operation on D.C. supply lines of practically the same potential. While, in general, it is not advisable to attempt to rewire most sets, many models are readily adaptable to such changes, the modified receiver giving very satisfactory performance, even though the maximum value of the high-voltage supply cannot exceed the line potential which, ordinarily, is about 120 volts.

Past issues of RADIO-CRAFT magazine have contained detailed data concerning

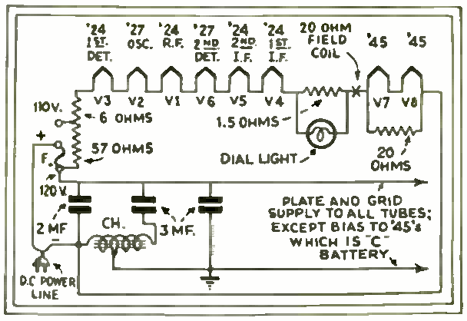


Fig. 5. Detail of the filament connections.

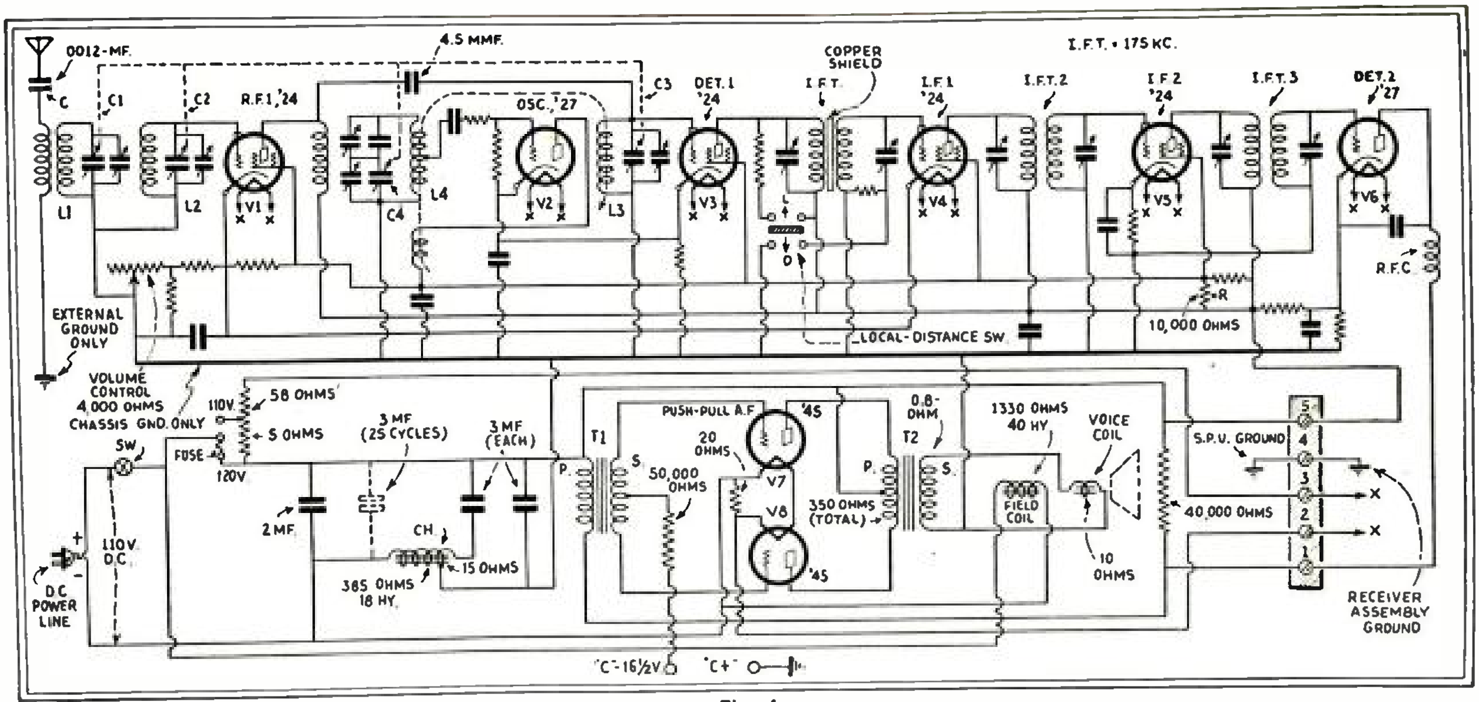


Fig. 4.
Modified diagram of an RCA 9-tube superheterodyne, now capable of operating with but 8 tubes from a D.C. line.

the change-over of relatively simple sets such as the Freshman "Masterpiece," certain Atwater Kent models, and one or two other makes of similar type; however, there has been no attempt to describe the changes to be made in, for example, a complicated receiver such as the RCA-Victor "80" Superheterodyne chassis. (See Data Sheet No. 29, in the November, 1930 issue of RADIO-CRAFT; see also Data Sheet No. 44 in the June issue. *Technical Editor.*)

Of course, such sets may be operated from a D.C. line supply by means of a rotary converter, motor-generator, rotary interrupter and transformer, or a vibrating type of interrupter and transformer, (the transformer in the latter two arrangements takes care of the reduction in voltage incident to the use of circuit-interrupters; this point has been discussed in past issues of this magazine).

However, where space or cost are important factors, the solution is to convert the circuit. In Fig. 4 is shown the diagram of the RCA-Victor (etc.) 9-tube superheterodyne modified as an 8-tube set for operation directly from the D.C. light lines. Note the convenience with which the cathode-heater type tubes in the original receiver lend themselves to this circuit change; as shown in more detail in Fig. 5, the filaments are to be connected in series.

All grounds are to the chassis *only*. A ground connection for the set is automatically obtained through connection to one side of the light line. Particular attention should be given to antenna condenser C, since this unit may be called upon to function as a protective device against "burn-out" of the primary coil L1, in the event that the antenna should accidentally become grounded.

In Fig. 6 are shown the changes necessary to convert the Radiola Model R7 for 110 V., D.C. operation. This is their "Superhette" design; at the same time, this chassis will be found in other makes of receivers, for instance Graybar, Westinghouse, and General Electric, as described in the descriptive sheet which covers this circuit, Data Sheet No. 47, in the August, 1931 issue of RADIO-CRAFT.

The circuit shown in Fig. 6 particularly concerns the power-pack, while the method of connecting the remainder of the set will be apparent by reference to the previous circuit dealing with the "80"; and the comments concerning that set will apply in connection with the "R7."

Particular attention should be paid to

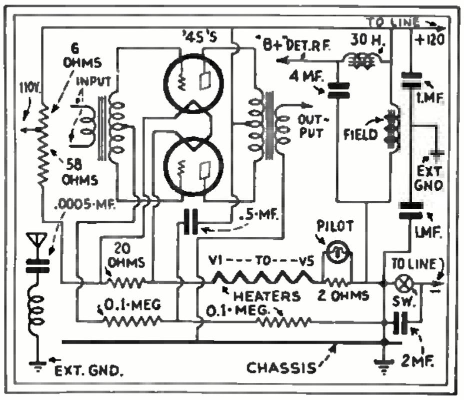


Fig. 6.
Conversion of the R7 receiver.

the selection of resistor of correct ohmage, and sufficient current carrying capacity for the particular position in which each one is intended to be operated.

Note that in Fig. 4 resistor R has been added to the circuit. In Fig. 5 at X, is indicated an optional position for the field-coil of the dynamic reproducer; the result is greatly improved quality of reproduction. If this circuit is used it will be necessary to rewind the field coil to a resistance of 20 ohms, with a wire sufficiently heavy to pass about 1¾ ampere. The main limiting resistor must then be reduced from 57 to 37 ohms.

TESTING PENTODES ON THE READRITE "245 A"

By Alphonso Moody

SERVICE MEN, who use a Readrite model "245 A" set tester, need not worry about the testing of the new '47 pentode tube, as all necessary tests can be made in the following manner:

Remove the tube from the socket of the set and place it in the five-hole socket of tester. Place the plug end of the cable in the vacant socket. Read the filament voltage on the 10-volt scale of the A.C. meter and the plate current on the 0-100 scale of the milliammeter.

To read plate voltage, place one end of the black test lead in the B-jack of the tester, and one end of red test lead in the "300" jack. Touch the free end of the red test lead to the positive milliammeter jack and the free end of the black test lead to the + jack. Read on the 0-300 scale of the D.C. voltmeter.

Control-grid voltage may be read with the red test lead in the "68" jack and the free end touched to the + jack instead of to the K jack; the free end of the black lead going from the B-jack to the grid jack.

Prospective Customer. "What will you allow me for my old Whatzis Sloppyheterodyne?"

A METERLESS TUBE-CHECKER ADAPTER

By VINTON K. ULRICH

THE Service Man who has a good analyzer with several meters does not desire to buy or build a tube checker unless he can make use of these meters. Of course, if he has a large business the cost of extra meters does not matter, but many Service Men find it hard to scrape up a few dollars!

The adapter which is illustrated in Figs. A and B makes use of any of the ordinary set analyzers—plugs into the socket of the adapter as would be done when taking readings from a radio receiver.

The diagram Fig. 1, is practically self-explanatory. A transformer PT of special design supplies the various filament voltages along with—3V. for grid-bias change (to obtain a shift in plate reading), 10 V. for the fifth element of the R.F. pentode, 70 V. for the screen of screen-grid tubes, and 125 volts for plate supply.

The writer's transformer consists of a shell-type core with a cross-section area of approximately one square inch; the 90 volt primary is wound with No. 24 enamel-covered wire; the high-potential secondary, No. 26 enamel; and the filament secondary, No. 18 D.C.C. The number of turns of wire per volt is five. The constructor who wishes more complete information on transformer design is referred to the article, "The Design of Power Transformers," by C. W. Palmer, in the September, 1931 issue of RADIO-CRAFT.

The large switch is a 10-point tap switch either single or double pole; the latter, with sections connected in parallel is preferable as it can more easily carry the high filament currents. Switch SW1 is used to give a shift of three volts in bias; a method which seems to be better than the use of a series "drop" resistor. Whether switch SW2 is necessary depends upon the provisions made in the analyzer for the screen-grid type tubes. Its purpose in the S.G. position is merely to put a bias of +70 V. on the G terminal of the tube, and to connect the control-grid cap of the tube to Switch SW1; in the Normal position, the regular grid connection to the grid terminal of the tube is obtained. The constructor can easily determine whether his analyzer has provisions for performing this duty and thus can adapt or omit SW2 accordingly.

Switch SW3 in the Normal position connects the cathode to the center-tap of the filament secondary through resistor R,

Fig. A

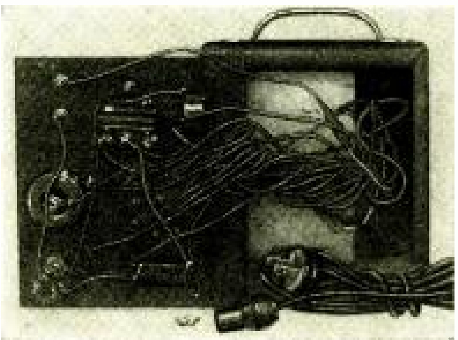


Fig. B

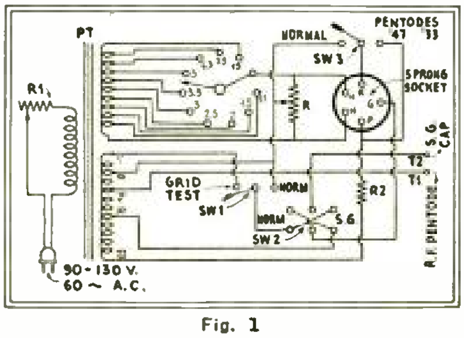


Fig. 1
Schematic circuit of the adapter.

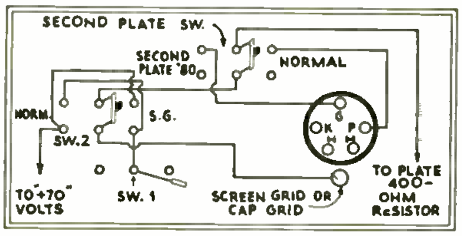


Fig. 2
Switching system for testing '80 tubes.

and also to the zero-potential tap of the transformer. The pentode position puts a bias of +125 V. on the cathode when testing '47 and '33 type pentodes. *If this switch is in the pentode position with a heater-type tube in the socket, the tube will be ruined, for its cathode is not insulated for 125 V.*

Resistor R1 adjusts the line potential to 90 V. for the primary of the transformer; since this may be the line voltage in some places. Read the filament voltage from the analyzer meter; if it does not correspond with the adjustment of the voltage selector switch, adjust R1.

Resistor R2 protects the plate milliammeter in case of shorted elements.

To use this adapter proceed the same as though you were analyzing a radio set. Take the plate reading with SW1 at Normal and then at Grid Test position; then subtract the readings to get the "change" (indication of mutual conductance). The meter readings may be calibrated from tubes known to be good.

Outside of the '80, all types of tubes commonly used can be tested without adapters.

The make of parts and their method of mounting are left to the constructor, as individual problems will arise.

The author built his unit as shown in Fig. A, without a 15 V. filament tap (because he did not have a 10 point switch; nor any immediate need for this voltage).

Resistor R1 must have *at least* 25-watts rating, wire wound, and with a resistance range of zero to several thousand ohms. (In spite of the fact that the writer used a compression-type unit as illustrated in Fig. B.)

Switches of the push-button type, because of their factor of safety, are recommended.

To test a "6.3 V." pentode throw SW2 to the S.G. position; which puts a potential of +70 V. on the suppressor grid and 125 V. on the plate.

If the analyzer with which this adapter is to be used indicates current in the grid lead, it is possible to test the second plate of an '80 by incorporating a D.P.D.T. switch to put the plate potential on the grid prong instead of the plate; this will be made clear by reference to Fig. 2.

This diminutive device requires a panel measuring only about 4 ins. square.

(*Continued on page 60*)

THE ANALYSIS OF RADIO RECEIVER SYMPTOMS

OPERATING NOTES

By BERTRAM M. FREED

A GROUP of some twenty Service Men seriously attempted the determination of exactly what information was most necessary and vital in the servicing of commercially manufactured receivers. After some discussion and debate, and a number of actual tests, it was unanimously decided that *with the schematic diagram and a socket voltage analysis chart, any receiver could be efficently serviced by the average radio Service Man*, discounting any encounter with unusual problems.

Previous "Operating Notes" by this writer have dealt with these unusual problems that from time to time confront the repairman, retarding his work and yet, producing much satisfaction, when solved. The following is an account of several "tough" assignments.

Radiola 67

Recently, a Radiola 67 radio-phono combination was the source of much annoyance and discouragement. The complaint was, "fading." After the set had been operating for some time, reception would slowly die out. When the automatic volume control (type '27) tube was removed, reception was obtained, although without the automatic volume feature. This peculiar condition would occur at different intervals. The chassis was removed from the cabinet, along with the visual tuning meter, phono-radio transfer switch, and manual volume control. For over four hours, the fading did not take place, with the A.V.C. tube in the circuit. The chassis was re-installed in the cabinet *and the fading condition again started!*

The entire outfit, pack, speaker and all, was carted back to the repair shop, where it was on life-test for several days without a single flaw in its operation. *When back in the cabinet, again the fading!*

A thorough socket analysis was then made. This time, grid voltages on the R.F. and I.F. type '27 tubes were measured and it was found that after the receiver had faded, and with the A.V.C. tube in the circuit, the grid voltage on the I.F. amplifiers had, instead of the normal potential of 9 volts, about 90 volts; at last, some real symptoms had been discovered. The schematic for the receiver was carefully studied and it was found that the grid return leads of the I.F. transformers (I.F. stages) were in the A.V.C. circuits. (The complete diagram appears on page 258 of the Official Radio Service Manual, Vol. 1.)

An effort was made to determine the conditions under which the A.V.C. tube would deliver such a high bias. It was reasoned that such a condition would result if the grid of the A.V.C. tube was not receiving grid voltage. The 1. megohm carbon resistor was checked with a high-range ohmmeter and found to be in good shape. This circuit was checked back with the same instrument through the colored cable to the transfer switch. Close examination of this unit disclosed that upon the slightest pressure on the switch, the blade to which the grid-return lead of the A.V.C. tube was connected failed to make contact to the blade connected to the manual volume control. The weight of the heavy cable connected to the switch was enough to open this circuit, resulting in all the trouble. Fig. 1 gives a skeleton illustration of connections and voltage distribution.

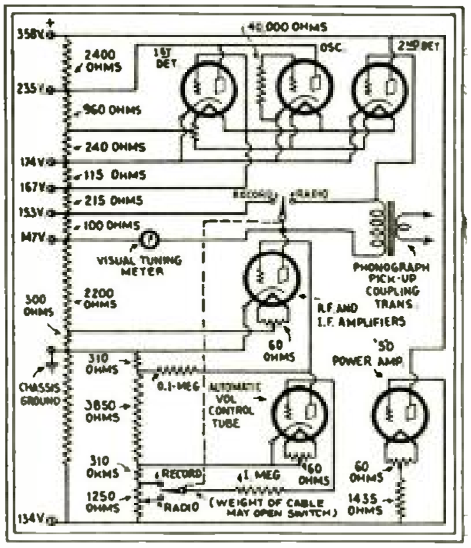


Fig. 1
Detail of Radiola 67 power unit.

Brunswick 17's and 24's

The Brunswick 17, 24, and 25, superheterodyne furnished interesting material on two occasions. The trouble in one instance was lack of volume control. Although this complaint is not uncommon with this receiver (cathode-heater leakage in R.F. and I.F. tubes, and the speaker terminal shield shorting to one or more terminals, causing the same condition in other receivers of this model), much time was spent in its elimination.

All the resistors and bypass condensers in the grid-return circuits of the R.F. and I.F. stages were checked and found perfect. The condensers, namely the .02-mf., in the R.F. and first-detector return circuits were given a most careful check, for on a previous call, leakage was found present in the first-detector condenser,

(Continued on page 46)

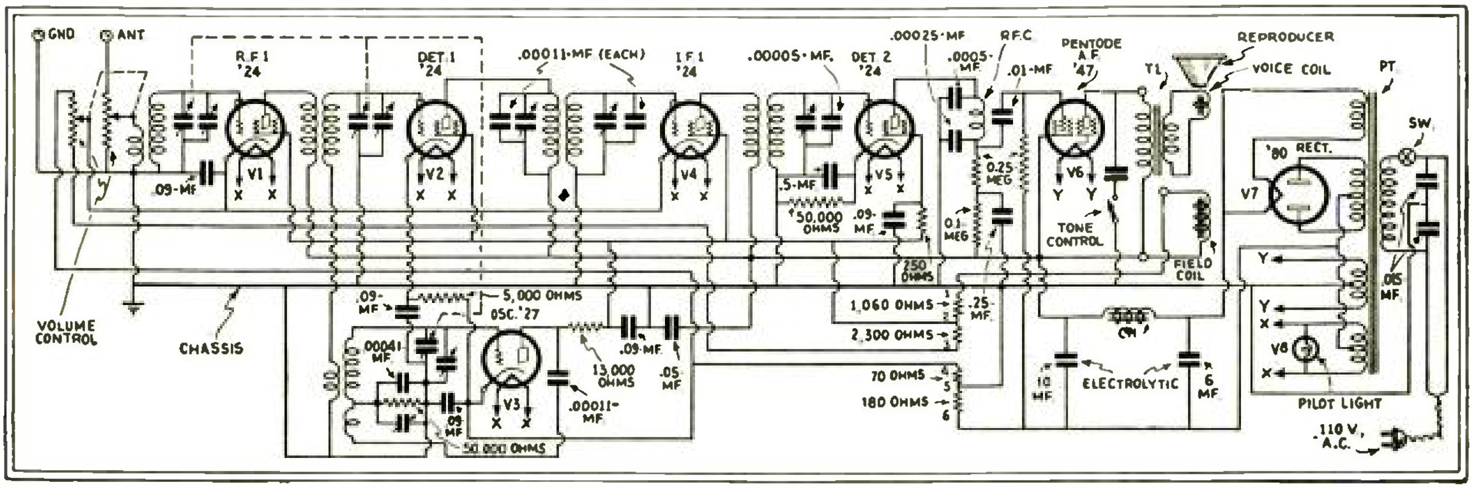


Fig. 2
Complete schematic circuit of the Philco Model 70 receiver. Values of the parts are shown on the diagram.

THE SERVICE MAN'S FORUM

Where His Findings May Benefit Other Radio Technicians

REVERSED AERIAL CONNECTION

Editor, RADIO-CRAFT:

We all have noticed, at certain times, an increase in signal strength when the antenna and ground wires were connected to a radio in a reversed manner, as suggested in a letter by "Radio Louie" from Needles, Calif., published in RADIO-CRAFT for May.

In some of the smaller towns, especially where the power plant is small, the transformers, which step the voltage from 2200 down to 110 volts, are few and far between. In larger towns it is different; there are one or more transformers to a block. In the former instance, all homes fed from the transformers, will pick up more signal from the lines (they really *are* an aerial), due to the lines being longer.

There is enough capacity between the primary and secondary windings of the power transformer in the radio set to bypass this signal to ground.

When the radio is connected as in "B" of Fig. 1 (this being the correct way), the signal from the line is bypassed directly to ground, but it must pass through the primary of input R.F. transformer to get to ground.

In some sets when the antenna and ground are reversed, the different circuits are not grounded directly, causing an unbalanced condition, bringing the set nearer the oscillating point, or perhaps causing it to oscillate which also gives us the effect of a greater signal pickup.

Your backyard antenna has not a very good pickup when compared to the A.C. lines, which sometimes cover an area of ¼ mile or more, in some of the smaller towns.

Line disturbances are picked up more readily when the radio is connected up in the way suggested. Battery sets do not experience this trouble, because they have no connection to the line in any way.

C. A. GODITUS,
Wilkes Barre, Pa.

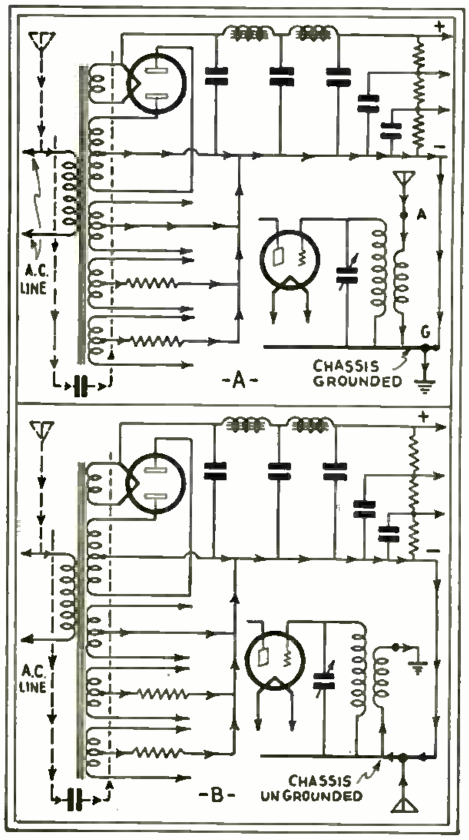


Fig. 1
At A, the signal flows directly to ground; at B, the signal (induced from the power line flows through the primary of the R.F. transformer to ground. If the power line is a better aerial than the regular aerial, then louder results will be obtained with reversed antenna connections.

ONE ON US

Editor, RADIO-CRAFT:

I note in a current issue of RADIO-CRAFT—that is, May, 1932—that a Mr. Hryzink has been awarded a $10.00 prize for a Short Cut in Radio Service involving the use of a separate '27 tube as an automatic volume control in a screen-grid receiver.

Will you kindly refer to my article on automatic volume controls in the November, 1930 issue of RADIO-CRAFT. In Fig. 3 you will find information on such a unit identical with that given by Mr. Hryzink. How come?—and if so—What of it?

I take pride in the fact that some of the information in my articles may have been helpful to the Service Man in his daily routine—but think that he is laying it on a bit strong when he uses the same stuff for contest purposes. Admittedly the subject matter in my story does not conform with that of Mr. Hryzink—yet you will note that I was attempting to generalize on A.V.C. systems without specializing on one particular unit. Also it is possible—I am certain today—that the material was not original with me. I think that Mr. Hryzink should at the very least donate a substantial portion of his prize to the relief of indigent and broken-down Service Men — particularly those who have not had the advantage of a collection of back numbers of RADIO-CRAFT.

C. H. W. NASON,
New York City.

WHO KILLED COCK ROBIN?

Editor, RADIO-CRAFT:

In the May issue of RADIO-CRAFT an article headed "An Automatic Volume Control for Screen-Grid Tubes," by Wm. Hryzink, drew first prize of $10.00, it being considered the best service wrinkle for the month.

I make a motion to have Mr. Hryzink forward that prize check to A. A. Ghirardi, who should be credited for the article; 98% of it was copied word for word from pages 561 and 562 of his RADIO PHYSICS COURSE, 2nd edition.

C. A. GODITUS,
Wilkes Barre, Pa.

MORE OF A. K.

Editor, RADIO-CRAFT:

Having read many of the arguments regarding cooperation given the professional Service Man by some of the big manufacturers of sets, and having had a wealth of experience along these lines myself, I beg to get this off my chest:

Having read with interest the perfectly lovely letter of Mr. L. A. Charbonnier, Service Manager of the Atwater Kent outfit, in February RADIO-CRAFT, (and it read something like Mr. Stimson's notes) I said, "just to see I'll give it a trial"; like the old man who bought the dead horse, I did not look for much. After writing Atwater Kent Mfg. Co. stating that I had several years experience and three or four years servicing their set for their dealers, I meekly and humbly asked might I be favored with one of their "Holy(?) Bibles." In the course of human events I was the recipient of a very nice letter explaining their policy of handling such requests; namely, transmitting them to their distributor, who in turn would investigate my qualifications, and ask the local dealer could I have one of the treasure books. The distributor in this case knew me personally, knew I had serviced sets for their dealer, and in a

(*Continued on page 54*)

THE Official Radio Service Mens Association, sponsored by RADIO-CRAFT, *invites all Service Men who are not members of the Organization to write for an application blank. It is the official service organization of this magazine and is maintained solely for the interests of Service Men. Membership cards are issued upon passing a written examination which is forwarded by mail. Write for yours today, The O.R.S.M.A., 98 Park Place, N. Y.*

OFFICIAL RADIO SERVICE MEN'S ASSOCIATION

HOW TO MAKE AND CALIBRATE
A SIMPLE SERVICE OSCILLATOR

By C. H. W. NASON

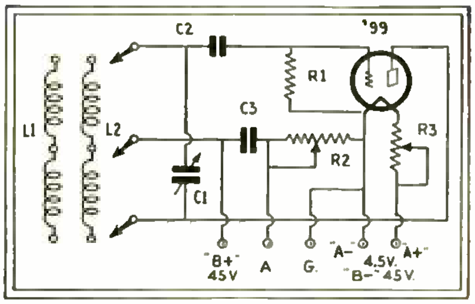


Fig. 1
Schematic circuit of the oscillator.

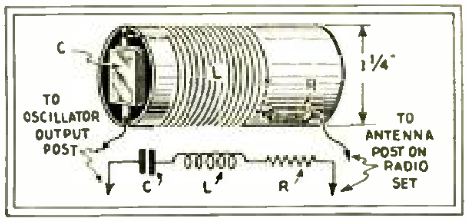


Fig. 2
Details of the dummy antenna.

A GLANCE through preceding issues of RADIO-CRAFT will show that, for the correct alignment of the superheterodyne receiver circuits, it is essential that we have modulated test oscillators to cover the intermediate frequency range from 100 to 200 kc. as well as to cover the broadcast band.

I say "modulated oscillators" advisedly, because of the fact that the modulated oscillator will work with any type of output meter and will give an indication of the over-all sensitivity of a receiver from antenna to loudspeaker, whereas with an unmodulated signal we are limited to the use of a resonance indicator in the plate circuit of the detector tube such as has been previously described in these columns.

Calibrating by Zero Beat

An oscillator such as is shown in Fig. 1 and operating in the broadcast band may easily be calibrated by allowing it to interfere with an incoming broadcast signal of known frequency. This is done by the so-called "zero beat" method. Tune in a broadcaster of the highest rank, one whose frequency is beyond suspicion of inaccuracy, then slowly move the oscillator dial (the oscillator being loosely coupled to the antenna) until a heterodyne whistle is heard. As the frequency of the oscillator approaches that of the incoming signal, the pitch of the whistle will be reduced until it disappears; this is the zero-beat point and the frequency of the signal and that of the oscillator are *identical* when this condition obtains. You may prepare a graph of the oscillator dial-settings for various frequencies connecting the points observed with a line which will permit your reading directly from the curve the frequency of any intermediate dial setting.

Harmonic Production

The oscillator is now calibrated over the *broadcast* band with a fair degree of accuracy; but we have no such check with which to calibrate the *intermediate* range.

Any generator operating in a non-linear fashion generates harmonics of its natural frequency, that is to say that the ouput will contain spurious signals which are exact multiples in frequency of the fundamental. To show this, it is only necessary to consider a 1000-cycle source F1, rich in harmonics F2, F3, F4, F5, which will have frequencies as follows:

F1	F2	F3	F4	F 5
1000 cy.	2000 cy.	3000 cy.	4000 cy.	5000 cy.
1500 cy.	3000 cy.	4500 cy.	6000 cy.	7500 cy.

With the procedure thus clarified, it is easy to see that the harmonics are separated one from the other by a frequency equal to the fundamental. Consequently, taking several of the frequencies lying in the range of the intermediate frequency oscillator, and working backward, we find that a tabulation as above will give us a clue as to a means of calibration.

F1	F2	F3	F4	F5	F6
(Fun.)	(2nd H.)	(3rd H.)	(4th H.)	(5th H.)	(6th H.)
100 kc.	200 kc.	300 kc.	400 kc.	500 kc.	600 kc.
120 kc.	240 kc.	360 kc.	480 kc.	600 kc.	720 kc.
150 kc.	300 kc.	450 kc.	600 kc.	750 kc.	900 kc.
175 kc.	350 kc.	525 kc.	700 kc.	875 kc.	1050 kc.
200 kc.	400 kc.	600 kc.	800 kc.	1000 kc.	1200 kc.

It is readily seen that certain fundamental frequencies have harmonics lying in the broadcast band.

If the oscillator is coupled to the antenna of a calibrated receiver, the calibration of which has been checked against broadcast signals of known frequencies, it should be a simple matter to pickup on the receiver and identify the various harmonics of the frequency to which the oscillator is tuned.

It is not sufficient to identify a single harmonic, as it will be seen from the tabulated data that 600 kc. (for example) may be either the 6th harmonic of 100 kc. the 5th harmonic of 120 kc., the 4th harmonic of 150 kc. or the 3rd harmonic of 200 kc. Thus it may be seen that at least two harmonics must be received and identified before we may reach a logical conclusion as to the frequency of the fundamental.

(For this reason, the entire broadcast band should be scanned for signals and those received logged before any attempt is made to guess the frequency of the fundamental.)

Suppose that with the oscillator condenser nearly closed (near 100 kc.) we find that harmonics are picked up at 575, 690, 805, 920, 1035 and 1150 kc.; we may conclude, since these readings are separated one from the other by 115 kc., that the fundamental frequency is 115 kc. and that we have received the 5th, 6th, 7th, 8th, 9th and 10th harmonics. (It should be remembered that the higher order harmonics are likely to be very weak and it is only possible to receive them with the receiver at full sensitivity,—that is, with the output of the oscillator at a maximum and the volume control turned full on.)

The remaining points on the oscillator dial necessary to a complete calibration of the instrument over the desired band may be obtained in the same manner.

The use of a straight-line-frequency tuning condenser will help matters in this respect as it will be found that the points observed lie in a substantially straight line over the greater portion of the range and very few points will be necessary to a complete calibration.

Construction Details

It will be seen that the oscillator (which, with its batteries, should be totally shielded) employs the familiar Hartley circuit using a single tapped coil which simplifies the procedure in changing ranges. The coil employed for the low-frequency range is a standard Pacent duo-lateral coil having a few turns removed to adjust its inductance to the correct value. For the purpose of shifting the frequency range of the device a simple three-pole double-throw switch is provided. This switch may be of any type but is preferably one having but slight capacitance between its elements.

(*Continued on page 60*)

CLARION "REPLACEMENT" CHASSIS, MODEL AC-160 A.V.C. SUPERHETERODYNE

(Push-Pull Pentodes, Variable-Mu Tubes, Tone Control and A.V.C.)

Of the estimated 17 million radio sets now in use in the United States, the chassis of approximately 11 million are now obsolete, due to the rapid advance in receiver design. At the same time, the cabinets in which these chasses are housed are just as much in vogue as the day they were bought; and they still represent a considerable portion of the cost of the ensemble.

To offset this discrepancy, a western manufacturer has brought out a 10-tube superheterodyne receiver chassis, complete in every respect, and modern in design, which is to be used as "replacement" for the older set models. The diagram of this receiver, the model AC-160, is shown. The chassis is available without tubes.

The electrical values of the components are as follows: Resistor R1, volume control, 1,150 ohms; R2, tone control, 0.1-meg.; R3, 8,000 ohms; R4, 0.1-meg.; R5, 2,000 ohms; R6, 400 ohms; R7, 0.5-meg.; R8, 40,000 ohms; R9, R12, 10,000 ohms; R10, 30,000 ohms; R11, 0.2-meg.; R13, 300 ohms; R14, 700 ohms; R15, 175 ohms; R16, 2,000 ohms; R17, 4,300 ohms; R18, 3,800 ohms; R19, R20, 1,000 ohms.

Condensers C1, C2, C3, are tuning units; C4, C18, .0008-mf.; C5, C7, .02-mf.; C6, C12, C14, C21, C25, 0.1-mf.; C8, 0.7-mf.; C9, C10, C22, .05-mf.; C11, .00005-mf.; C13, .01-mf.; C16, C23, 8 mf.; C19, C20, 0.35-mf.; C24, 1. mf.

Operating voltage and current characteristics are taken with the volume control set "full on," and the "supersensitive" switch turned "to right."

Filament potential, V1, V2, V4, V9, 2.2 volts; V3, V5, V6, 2.1 volts; V7, V8, 2.3 volts; V10, 4.9 volts. Plate potential, V1, V4, 151 volts; V2, 140 volts; V3, 115 volts; V5, 192 volts; V6, 230 volts; V7, V8, 250 volts; V9, 15 volts; V10, zero. Control-grid potential, V1, V4, 0.2-volt; V2, 5.7 volts; V3, V5, V10, zero; V6, 8 volts; V7, V8, 16.5 volts; V9, 20 volts. Cathode potential, V1, V4, 3 volts; V2, 9 volts; V3, V5, V7, V8, V10, zero; V6, 15 volts; V9, 45 volts. Screen-grid potential, V1, V4, 75 volts; V2, 70 volts; V3, V5, V6, V9, V10, zero; V7, V8, 255 volts. Plate current, V1, 3 ma.; V2, 1.2 ma.; V3, 9.5 ma.; V4, 2.5 ma.; V5, 0.5-ma.; V6, 5.5 ma.; V7, V8, 27 ma.; V9, zero; V10, 47 ma.

plete in its action, even on very strong sig-

Do not connect the ground wire to the "Ant." post unless a fixed condenser is connected in series, to prevent a burnout of the antenna coil in the event that a ground may have occurred in the power transformer.

A good ground is *important* to satisfactory operation; selectivity and circuit stability depend upon this consideration. The ground connection is conveniently tested by grounding one side of a 110-volt lamp, noting the brilliancy when each side of the light-line is connected to the remaining lead of the lamp; a dim light indicates a poor radio ground. An entire absence of light in this test usually indicates a lack of ground at the main power transformer; in this case the local power company should be notified.

Switch SW.2 should not be thrown to the "Phono." position unless a pickup is in the circuit; otherwise, noise and fluttering will result.

Poor sensitivity *may* be due to mis-alignment of the tuning condensers, but *the trimmers of these units should not be adjusted except as a last resort.*

Since this receiver has automatic volume control, poor tone quality will result if the set is adjusted slightly off-tune. Therefore, it is recommended that the volume first be reduced to low audibility, the set tuned for a point mid-way between the two extreme dial points of reception, and then the volume brought up to normal.

Another method of checking tone quality at this point is to substitute for the regular antenna, a very short piece of wire, so that the volume control must be adjusted to the "full on" position, when the A.V.C. feature no longer holds, tuning being "peaked," as in the ordinary types of sets.

A poor type '27 tube used as the second-detector V5, or A.V.C. V9, will result in poor operation. Note that tubes unsuited to use in these positions may test "okay" on a tube checker.

In "noisy" localities it may be well to shunt the power line by a filter system of the usual type—two 0.1-mf. fixed condensers, connected in series, the two free ends connecting to the two line-leads, and the center-tap being grounded.

Due to the high audio gain of this receiver, special precautions in the design were taken to eliminate hum beyond the normal, slight degree existing in practically all sets. Consequently, should a complaint of hum arise, after eliminating the usual possible causes check the position of A.F. transformer T1. The angle of its mounting bracket has been carefully calculated to eliminate hum and if for any reason T1 must be replaced, be sure to retain the bracket and see that it is not accidentally twisted out of its original angle.

The tuning condenser nearest the front-panel is C1, followed by C2, and C3, (in this order); the trimmer for each of these circuits is located on top of the respective tuning unit. Padding condenser C4A is located on the front skirt of the chassis, alongside unit R1- SW.2. Trimmers of the I.F. circuits are located on the left-hand side of the respective I.F. transformers, the top adjusting screw of the two being the grid-circuit tuning control; I.F. transformer I.F.T. 1 is the one nearest the front-panel.

Connect the 175 kc. service oscillator to the control-grid cap of V2, and to ground. Do not remove any of the tubes from the sockets; also, it is unnecessary to disconnect the control-grid cap connection from V2.

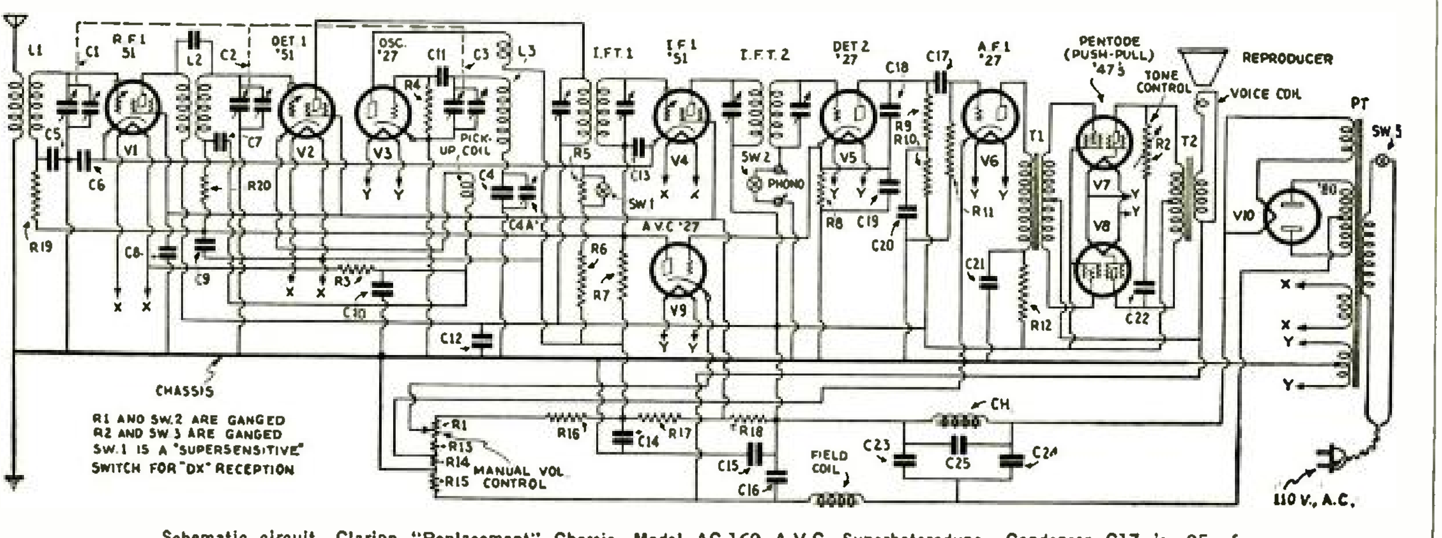
After adjusting the I.F. circuit, connect a broadcast-frequency service oscillator to the input posts of the radio set, and tune in its signal at 1400 kc. Now adjust the trimmers of C1 and C2, respectively, for maximum output.

To check the calibration of the receiver, whether it is high or low, the trimmer in shunt to C3 should be adjusted until a crystal-controlled station of known high frequency is brought in, *at the correct dial marking*, with peaked tuning and maximum volume. If the broadcast-frequency service oscillator is accurately calibrated, it might be used in place of the broadcast station's signal which, however, is held within about 50 cycles by reason of the crystal-control. In this adjustment a test frequency of 1400 kc. should be used. Note that at this frequency the setting of the trimmer of C3 will be exceedingly critical.

Now comes the problem of balancing the oscillator to the R.F. and detector circuits so that perfect tracking will be obtained over the entire tuning range.

Tune the external broadcast-frequency test oscillator and the receiver both to 600 kc., then slowly increase or decrease the capacity of C4A, at the same time continuously tuning back and forth across the signal with the receiver tuning condenser gang. The output meter needle will now be swinging up and down in step with the variation in tuning. Watch the peak of this swinging closely and readjust C4A until the swinging needle reaches its highest peak.

Retune the receiver and broadcast-frequency service oscillator to 1400 kc. and re-check the trimmer of C3 to make sure that the adjustment of C4A has not thrown the receiver out of calibration. Should this have occurred, readjust the trimmer of C3 until the calibration is correct, and then check on the trimmers of C2 and C1 to make sure that the adjustment of C4A has not reduced the sensitivity.



Schematic circuit, Clarion "Replacement" Chassis, Model AC-160 A.V.C. Superheterodyne. Condenser C17 is .05-mf.

SPARTON MODEL 40 6-TUBE T.R.F. AUTOMOTIVE RECEIVER

(Lafoy-type Automatic Volume Control; Remote Tuning Control; Electro-Dynamic Reproducer)

To maintain constant signal output, regardless of the intensity of the incoming signal (within practical limits), to overcome the reduction in signal intensity which will occur in a given locality (due to metallic structures, ore deposits, etc.) it is necessary to incorporate some form of volume control which will operate to vary the gain in the amplification of the receiver in proportion to the loss in carrier signal strength. Most automatic volume controls or A.V.C. circuits operate to vary the control-grid of the amplifier tubes, in accordance with *the A.F. modulation* of the station's carrier; the "Lafoy" system, however, varies the control-grid bias more nearly in accord with the intensity variations of the station's carrier itself, the A.V.C. tube V6 in the diagram, functioning more nearly as an R.F. amplifier than as a detector.

High amplification in this set is obtained through the use of a three-stage R.F. amplifier incorporating screen-grid tubes of the "automotive" type, the output of this section feeding a screen-grid detector. The audio circuit comprises a single pentode, which is impedance- and resistance-capacity-coupled to the detector.

The values of the components are as follows: Condensers C1, C2, C3, C4, tuning units; C5, antenna compensator; C6, C8, C10, C12, 0.2-mf.; C7A, 0.3-mf.; B, 0.2-mf. C, 0.3-mf.; C9A, 0.3-mf., B, 0.2-mf., C, 0.3-mf.; C11A, 0.3-mf., C, 0.3-mf.; C13, C14, .00025-mf.; C15A, 0.3-mf., B, 0.2-mf.; C16, coupling condenser, .01-mf.; C17, .0005-mf.; C18, .006-mf.; C19, 1. mf.; C20, 0.1-mf.

Resistors R1, R2, R5, R7, 20,000 ohms; R3, R4, R6, 5,000 ohms; R8, 30,000 ohms; R9, manual volume control, ¼-meg.; R10, ¼-meg.; R11, 160 ohms; R12, 350 ohms.

Correct methods for installing and servicing antennas and interference suppressors have been described in past issues of RADIO-CRAFT. However, a little additional data is available.

For the aerial in collapsible type tops, we recommend that the "false top" type be employed. This type of aerial is constructed in the following manner:

Fashion two pieces of drill cloth that are the same color as the top material, as long as, and approximately six inches narrower than the roof. On one section, lay a piece of light weight felt of the same dimensions, and then lay on top of the felt a piece of 16-mesh copper screen wire the same size. On top of this wire, lay another piece of light weight felt and over this the second section of drill cloth, then sew the edges of the combination together.

The top deck is removed from the roof bows and the aerial is placed on top of them. The top decking is then placed back over the aerial.

Where it is desired to let the top down, it is advisable to connect the aerial lead-in wire to the aerial at the rear, and let the shielding on this wire, extend only for a distance of about three feet from the receiver end. In such cases, the lead-in wire is run through the floor boards back of the seat underneath the car, up to the receiver.

Note that in this receiver there are two fuses; one of them is of ⅛-A. rating, and is connected in the "B" battery jumper wire, while the other is a 5 A unit located in the receiving unit near the ground binding post.

Interference may be distinguished by the sound: Generator noises (eliminated by bypassing the commutator) are tone frequencies quite different from the staccato tapping sound of high-tension spark interference; high-tension interference is a sharp, raspy sound and can be eliminated practically 100 percent by means of spark suppressors (on the distributor and spark plugs); low-tension breaker point noise is not readily distinguished from high-tension interference, but will be the sound remaining after spark suppressors have been installed. Low-tension breaker interference is difficult to eliminate. Try reversing the two primary leads to the coil; install a bypass condenser connected from the engine to the ammeter and switch lead.

The operating voltage and current characteristics of this set are to be measured with a set analyzer equipped with a voltmeter of the 1,000-ohms-per-volt type; the manual volume control must be turned to the full on position, and with no signal reception.

The filament potential of all tubes is 6 volts. Plate potential, V1, V2, V3, V5, 135 volts; V4, 132 volts; V6, zero. Control-grid, V1, V2, V3, 1.5 volts; V4, 10 volts; V5, V6, 18 volts. Screen-grid potential, V1, V2, V3, V4, 67.5 volts; V5, 135 volts; V6, zero. Plate current, V1, V2, V3, 3 ma.; V4, 0.1-ma.; V5, 8 ma.; V6, zero.

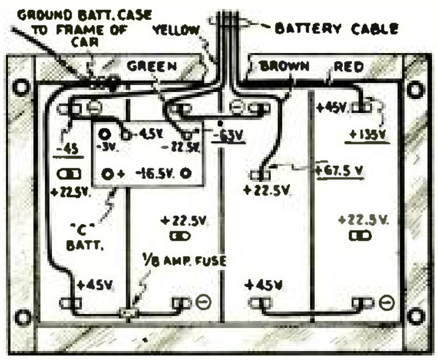
The antenna compensating condenser C5 is to be adjusted at the time the receiver is installed. Tune in a weak station between 1200 and 1400 kc., turn the volume control full on, and then, using an insulated screwdriver, adjust C5 for maximum receiver output. Never adjust either the C5, or the remaining trimmers, with the cover removed.

Circuit oscillation can be caused either by tubes or the receiver itself. Check the contact surfaces between the partitions and the rotor shaft, making sure that a good ground is obtained. *Do not under any conditions* oil the shaft under the contacts. Make sure that the receiver chassis is well grounded.

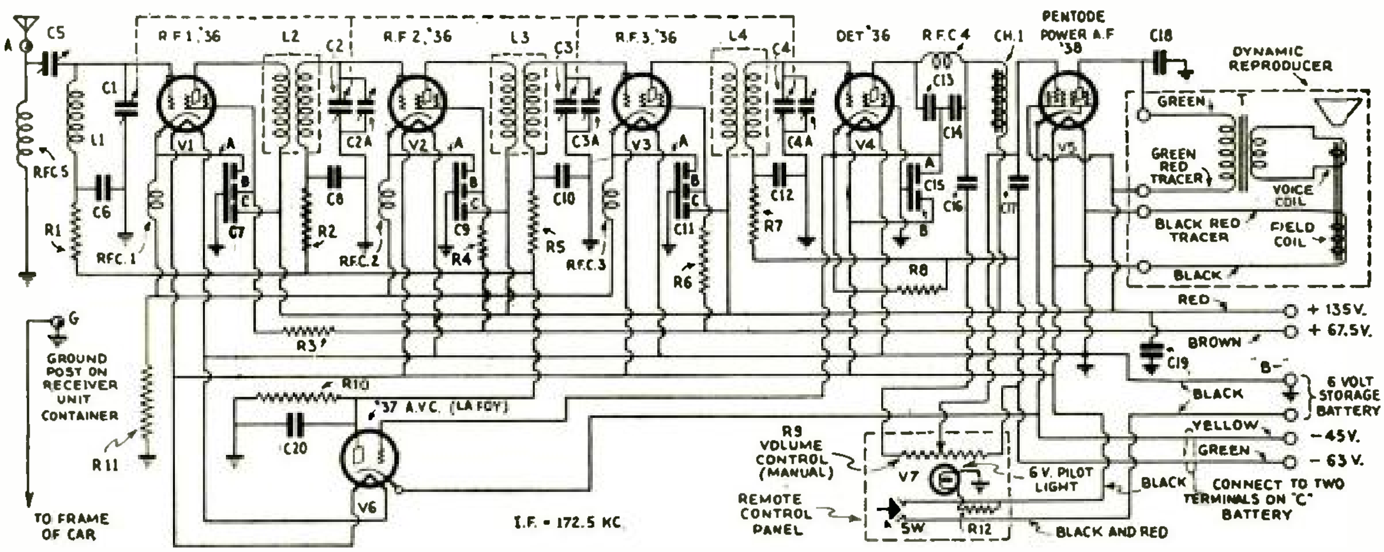
For best results it is essential that the receiver unit be located so that the remote control flexible-shaft runs direct (that is, without sharp bends).

The battery circuit for this receiver is unusual, as indicated in the diagram; an additional figure illustrates the connections.

The "A" battery consumption of this set is about 2½ A.; the "B" requirements, about 20 ma.



Sketch of the battery box showing the location of the cable and the battery.



Complete schematic circuit of the Sparton model 40 receiver using the new Lafoy system of automatic volume control.

THE RADIO CRAFTSMAN'S PAGE

The Bulletin Board for Our Experimental Readers

A DX CLUB

Editor, RADIO-CRAFT:

Due to the fact that I'm one of the great "army" I let my subscription expire. However, through some sort of good luck I always manage to get hold of each issue of RADIO-CRAFT and enjoy them greatly. I'm interested more or less in the DX side of radio and in four years have logged close to 900 stations on the broadcast channels. Sixteen countries are represented in my log. There are many other DX'ers who have bigger and better logs than mine, but for four years "pleasure" I feel well satisfied.

If there are any of your readers interested in DX, I'd like to hear from them; more so if they feel like joining a good DX club! Full details of the above club will be sent to all inquirers.

JOSEPH STOKES,
7318 *Woodlawn Ave.,*
Swissvale Station,
Pittsburgh, Pa.

BIGGER AND BETTER COMPLAINTS

Editor, RADIO-CRAFT:

I wish to voice my opinion regarding two articles which have appeared in recent issues of RADIO-CRAFT: The first is regarding the electrolytic condenser rectifier experiment described by Mr. P. M. Jarowey in the December, 1931 issue of RADIO-CRAFT. It seems strange that the method of connection used by Mr. Jarowey is that which all electrolytic condenser manufacturers advise against. I would appreciate comments from Mr. Jarowey on this point.

The second complaint that I have is with regard to the "B" eliminator on page 677 of the May, 1932 issue of RADIO-CRAFT. In my estimation, no bell-ringing transformer that I know of will light an '80 and besides present prices of power transformers make such a scheme ridiculous. I would also appreciate hearing from Mr. Schuldt, author of the above mentioned article, on this point.

E. ARNOLD,
42 *W. Fordham Rd.,*
Bronx, N. Y.

(Below, we print first the comment of Mr. Jarowey, and then we hear from Mr. Schuldt, on the above mentioned points.—*Editor.*)

IMPORTANT NOTICE

In the interest of those readers who do not like to mutilate this magazine, we have asked our advertisers not to place coupons in their advertisements.

Instead of the usual coupons, you will find a number of convenient post cards inserted between the last page and the back cover of this magazine.

This new service will save you time and work. No need to cut coupons, fill in your name nor hunt for and address envelopes. Moreover, the space for your name on a coupon is usually so small that the advertiser is often not able to make out your writing and then you wonder why you do not get the literature sent for.

Then, last but not least—the postage for a postal card is only 1c whereas a letter costs 2c and will soon perhaps cost 3c if Congress raises the first-class postal rate.

Read the advertisements and then turn to the page containing the special postal cards. Detach, fill out and mail the card of the advertiser whose literature or offers you want to have sent to you.

Mail your card today! Show the advertisers that you appreciate their cooperation and thoughtfulness.

MR. JAROWEY'S ANSWER

Editor, RADIO-CRAFT:

I have at hand your letter with Mr. Arnold's objections, and wish to thank you for bringing it to my attention.

Since the readers of RADIO-CRAFT have shown such interest in the article from last December's issue I have answered a number of letters personally.

I have conducted a number of tests for actual operation of the device and the result is as follows:

I picked first, a Silver-Marshall separately excited dynamic speaker that was designed for an '80 tube and a paper condenser for rectifier and filter respectively. Under actual load, the voltmeter showed 90 volts at the terminals with the rectifier tube and condenser: the final ripple (120-cycle hum) was 18 volts A.C., so there it is, a drop in voltage from 150 volts D.C. at no load to 90 volts and 46 ma. at full load, and considerable ripple voltage with it.

I then took the same base and transformer (with 250 ohms secondary resistance) and applied both plate terminals to the electrolytic condenser positive electrodes, and, as shown in original diagram, the result was as follows: No load volts, 128; with dynamic speaker-field as load, 99 volts was obtained and the final ripple as 3.15 volts A.C., (50 ma. flowing). The resultant hum was barely perceptible to the ear. A pair of conventional condensers (electrolytic) were used.

I have also wound a special transformer for 165 volts on both sides of the center tap, and made a plate supply unit for a Freed-Eisemann model NR9 using 5-'01A and 1-'71A tubes, with a pair of 4 mf. electrolytic condensers, and as good reception was obtained as with any eliminator of that voltage.

If it is necessary, I can make a photograph of the speaker excitation with all meters connected and under actual operation at a few days notice. I do not intend to argue with manufacturers, for that is outside my interests but the fundamental principle has been scrutinized from every possible angle for errors and given every chance to prove itself, and that is what I am trying to defend. So there it is, this is not an empty pipe dream, but an actual reality.

Thanking you once more, I will remain

P. M. JAROWEY,
815 *Merchant St.,*
Ambridge, Pa.

FROM MR. SCHULDT

Editor, RADIO-CRAFT:

Answering Mr. Arnold's opinion of my suggestion for an emergency "B" eliminator in the May issue of RADIO-CRAFT, he evidently overlooked the word "emergency."

I happened to need some D.C. voltage to adjust a 150 V. D.C. meter, and did not have it available, neither did I have a power transformer, as he suggests. Here in Florida, we cannot stick our head out of the window and get anything we need. When we want something in radio parts, we wait until we can send for them, improvise what we have, or go without them.

He states he does not know of a bell-ringing transformer that will light an '80. I have one, a fifty watt unit, which will light one, and then some! But he rightly assumed that I meant the ordinary 25-watt transformer which can be bought for around sixty cents.

CHAS. A. SCHULDT,
206 *So. Franklin St.,*
Tampa, Fla.

RADIO-CRAFT KINKS

Practical Hints From Experimenters Private Laboratories

PRIZE AWARD:

CONVERTING THE ATWATER KENT 35 RECEIVER FOR AUTO USE

By William V. Slatery

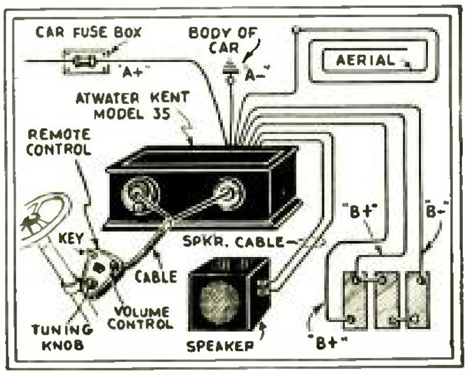


Fig. 1
Receiver connections after the change.

WHAT to do with the old trade-in sets is a problem that worries all radio dealers. I have found that by a little work almost any type of battery set may be converted into an auto set that works very well on local and other strong stations. The "Freshman Masterpiece A," Crosley Bandbox Model 601," Atwater Kent 20 Compact," and "Atwater Kent Model 35" sets, all work very well but the "Atwater Kent Model 35" gives the best all-around performance.

The method for converting an "Atwater Kent Model 35" is very simple. This set is one of the most compact receivers that has ever been offered by any company. Three stages of R.F. are used all being controlled by one dial. Its cabinet, which is only 17½ x 8 x 5½ inches, is made of a pressed metal which completely shields the set. As this set has a very high "gain" it makes a good auto receiver as it may be used with an aerial of any length without affecting the tuning in the least. Five type '01-A, and one '12A or '17A tubes are used. The weight of the set is 16 pounds.

First let us make a list of the extra parts that we will need.

One remote control unit with keylock switch, two controls and a flexible shaft and coupling. Mounting for steering post;

One aerial kit consisting of 50 feet of aerial tape, insulating fabric, extra copper wire, top dressing for water-proofing, solder, and brush;

Six spark plug suppressors;

One distributor suppressor;

Ten feet shielded battery cable;

One "B" battery metal case (for three);

Three 45-volt "B" batteries;

One small cabinet-type magnetic cone speaker;

Several angle irons and various sizes of nuts and bolts.

Bore four small holes in the rear of the metal cabinet of the set and four corresponding holes in the engine dashboard, as near as possible to the steering wheel post. Bore one more hole in the dash at the point where the battery cables run from the rear of the set. Remove the dials, push the battery cable from the set through the battery cable hole cut in the dash, and bolt the set securely upon the dash, using lock-washers to hold the nuts in place. Bore four holes in the cabinet of the magnetic speaker and bore five holes in the car dash at some place where the loudspeaker will be out of the way. connect leads to the set cable.

Place the remote control unit on the steering post and connect one of the controls to the variable (tuning) condenser and the other control shaft to the volume control on set.

Place the aerial tape on the roof of the car and cement it down firmly with insulating fabric and top-dressing. Run the aerial lead-in through the roof, so as to come out in the car corner next to the steering wheel, down through the dashboard and connect it to the aerial cable of the set. (Note—A spring aerial may be suspended inside the car or underneath if it is not desirable to go to the trouble of placing the aerial on the roof.)

Fasten the metal "B" battery case with the three 45-volt "B" batteries underneath the car as close as possible to the steering wheel and connect the leads with the shielded wire from the battery posts to the cable from the set.

$5 for a Practical Radio Kink

As an incentive toward obtaining radio hints and experimental short-cuts, "Radio-Craft" will pay $5.00 for the best one submitted each month. Checks will be mailed upon publication of the article.

The judges are the editors of "Radio-Craft" and their decisions are final. No unused manuscripts are returned.

Follow these simple rules: Write, or preferably type, on one side of the sheet, giving a clear description of the best radio "kink" you know of. Simple sketches in free-hand are satisfactory, as long as they explain the idea. You can send in as many kinks as you wish. Everyone is eligible for the prize except employees of "Radio-Craft" and their families.

This contest closes on the 15th of every month, by which time all the Kinks must be received for the next month.

Send all contributions to Editor, Kinks Department, c-o "Radio-Craft," 98 Park Place, New York City.

THE VACUUM TUBE AS A POLARITY INDICATOR

By Louis B. Sklar

THE device illustrated in Fig. 2B was conceived and developed by the writer and used as a polarity indicator in testing the windings of medium-size transformers.

Radio and electrical engineers may find uses for this device in other fields, due to its novel feature as an A.C. "polarity" indicator.

Its operation is as follows: Fig. 2B shows schematically an A.C. vacuum tube voltmeter. Its function is identical with the D.C. type voltmeter shown in 2A. On that half of the cycle when the plate is plus with respect to the filament, current will flow in the milliammeter. The grid of the tube is not connected; the vacuum tube will therefore act as a two element half-wave rectifier. When the test clips P and A are connected to P1 and A1 and test clips S and B are connected to S1 and B1 there will always be a positive bias on the grid. When the plate is positive, a greater current will flow in the plate milliammeter and this will indicate that the right terminals of the transformer were picked. Should test clips S and B be connected to the wrong secondary terminals as shown on Fig. 2C, a smaller current will flow in the plate circuit on account of the negative bias on the grid at the instant when the plate is positive.

A variable resistor R is placed in the primary circuit of transformer T, thereby reducing the positive bias on the grid and also limiting the current in the primary winding, so that transformers having very fine wires and whose current capacity is small, can be tested.

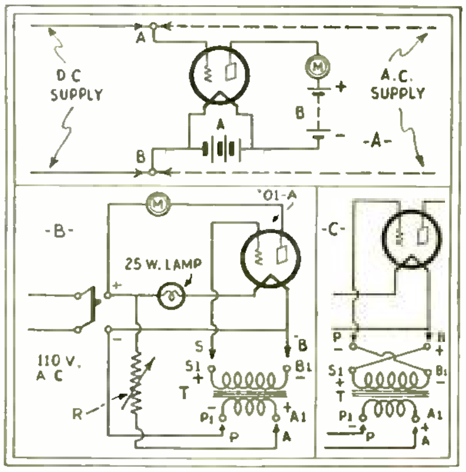


Fig. 2
The final circuit of the "polarity" indicator is shown at B.

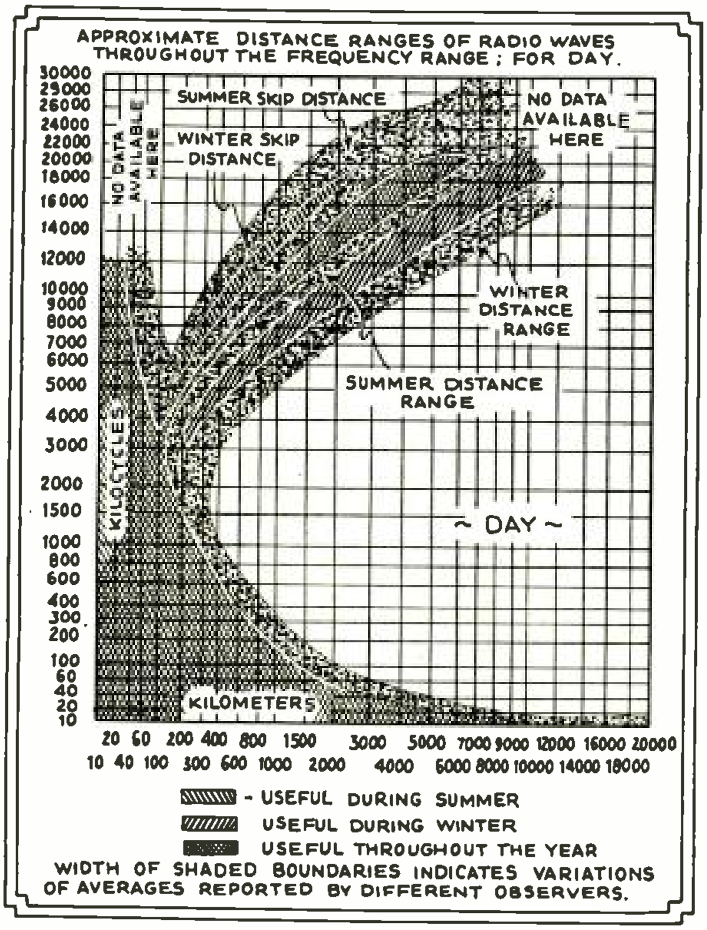


Chart showing the variation of short-wave reception at night.

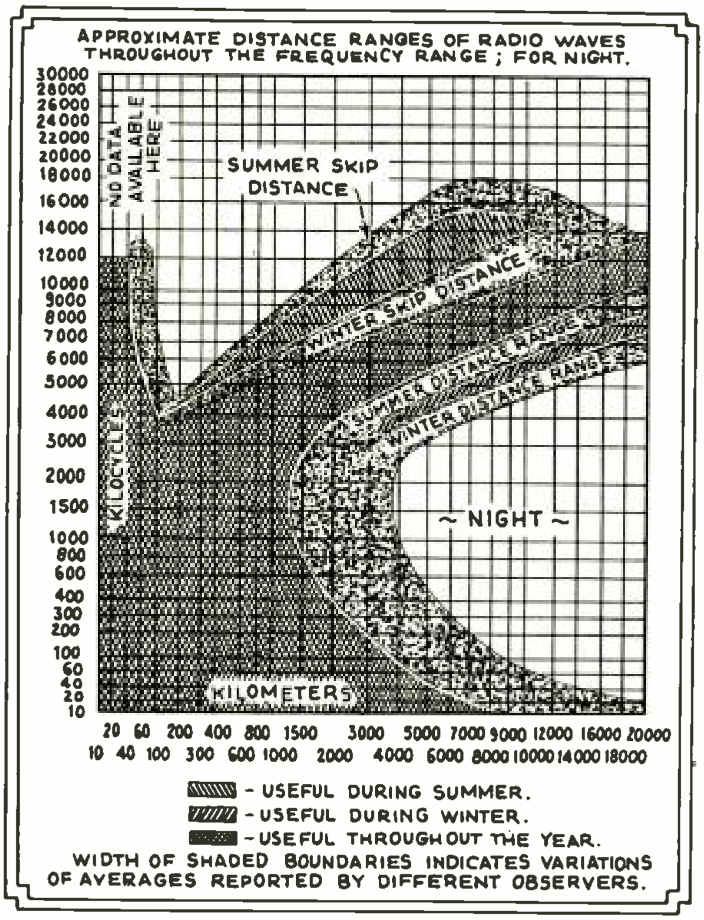


Chart showing variation of short-wave reception during the day.

A comprehensive discussion of the factors which influence short-wave reception during both day and night.

SUMMER SHORT-WAVE RECEPTION

RADIO wave transmission takes place by the propagation of a "ground wave" along the ground, or a "sky wave" reflected or refracted from the Kennelly-Heaviside layer, or by both means. The waves are subject to absorption, both in the ground and in the ionized upper atmosphere. The ground-wave absorption, in general, increases with frequency and is reasonably constant, with time, over a given path at a given frequency; it varies for earth of different conductivities and dielectric constants. The sky-wave absorption is not a constant with time, frequency, or path; it appears to be a maximum in the broadcast band (550-1500 kc.), decreasing with change of frequency in either direction. In the daytime this absorption of the sky wave is so great that there is practically no sky wave, from frequencies somewhat below to somewhat above the broadcast band, the specific limits varying with the season. Hence sky-wave propagation in the daytime is only appreciable in the lower and higher frequency ranges. During the night, however, sky-wave propagation takes place on all except extremely high frequencies. Sky-wave propagation is subject to material variations, dependent upon conditions and changes in the ionization of the Kennelly-Heaviside layer.

Besides daily variation of daylight and darkness, factors such as latitude, season, magnetic storms, and solar disturbances, have been found to have effects upon this ionization. These changes in ionization result in wide variations in the transmission of sky waves from hour to hour, day to day, and year to year. At the higher frequencies, received field intensities for a given season and frequency may vary as much as 1 to 10 from one year to another.

At the higher frequencies, reception at great distances is due entirely to the sky wave. Above a certain frequency, however, which may be as low as 4000 kc. (see attached graphs), no appreciable portion of the sky-wave radiation is reflected back to earth from the Kennelly-Heaviside layer in a certain zone surrounding the transmitter. In the area bounded by the inner edge of this skipped zone, the received wave may be composed of both ground wave and sky wave (the sky wave being appreciable on frequencies up to about 6000 kc. in the summer and 12,000 kc. in the winter); the sky wave intensity in this area is ordinarily much less at night than in the day.

The outer boundary of the skipped zone is often called the skip distance. The skip distance increases with frequency, and varies diurnally and seasonally. Beyond the skip distance, the sky-wave radiation is received with useful intensity.

With present knowledge of propagation conditions it is impossible to postulate any formulas or make any tables or charts which could be used to determine distance range over any given path accurately. The attached graphs give average distance ranges as observed by a number of experimenters to occur most frequently over a number of transmission paths. Through certain frequency ranges, available data were so incomplete as to require extrapolation which may be considerably in error. Wide variations of distance range and skip distance must be accepted as normal.

(*Continued on page* 59)

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.

MODERN PORTABLE RADIO SET

(161) Mr. Clarence DeNise, Easton, Pa.

(Q.) I understand that RCA is now putting out a portable radio receiver which supercedes the old "812" superheterodyne, although batteries are retained to light tube filaments. Are the circuit data concerning this set available?

(A.) Our inquirer undoubtedly refers to RCA Victor Portable Radiola Model P-31, the schematic circuit of which is reproduced in Fig. Q.161. The front view of this set appears on page 721 of the June, 1932 issue of RADIO-CRAFT. As partly indicated in the diagram of connections, a circuit of exceptional design is incorporated in this receiver.

Following are the operating constants for the tubes: Filament potential, all tubes, 2 volts. Plate potential, V1, V2, V4, V7, V8, 150 volts; V3, 45 volts; V5, 1.5 V, negative; V6, 145 volts. Control-grid potential, V1, 0.2-volt; V2, V4, 0.5-volt; V3, V6, 1, volt; V5, 2 volts; V7, V8, 14 volts. Screen-grid potential, V1, V2, V4, 65 volts; V3, V6, V7, V8, none; V5, 150 volts. Plate current, V1, V3, V4, 3 ma.; V2, 0.2-ma.; V5, zero; V6, 2.5 ma.; V7, V8, 1.5 ma. Screen-grid current, V1, V4, 1, ma.; V2, 0.1-ma.; V3, V6, V7, V8, none; V5, 4 ma.

Condenser C1 reduces the detuning effect of the antenna. Pentode V5 has a triple use, functioning as an A.V.C. tube, a diode second-detector, and a triode A.F. amplifier. The action is as follows:

The I.F. signal voltage is applied to the filament and plate of the second-detector V2, and is then rectified by straight diode action. The audio output is then applied to the control-grid and filament of the same tube by means of coupling condenser C2. Tube V5 then acts as an A.F. amplifier, *the screen-grid acting as the plate;* resistors R1 and R2 in combination act as the grid-leak across which is developed the A.F. potential. Since the I.F. signal must pass through resistors R3 and R4, a potential for automatic volume control is thus conveniently obtained; the drop across R3 furnishes the control-grid bias for V4, and the drop across R3-R4, bias for V1. A small initial bias of 1.5 volts is present on these tubes as the drop across resistor R5. The control-grid bias for V5 is obtained as the drop across resistors R2-R6. The audio output of V5 is transferred, by means of the A.F. choke, coupling condenser C3, and potentiometer R7.

The R.F., oscillator, and I.F. adjustments of the Model P-31 portable set are similar to those of the Model M-30 automotive receiver described in detail in Data Sheet No. 64, in the April, 1932 issue of RADIO-CRAFT.

Due to the fact that second-detector V5 functions also as the A.V.C. tube, it must remain in its socket during alignment adjustments; consequently, this procedure is described below:

Set the volume control of the receiver at maximum. Then, reduce the output of the external service oscillator, or its coupling to the receiver, until a definite reduction in output meter reading is obtained. *At this low input the A.V.C. action is not sufficiently flat to interfere with the correct alignment of the various circuits.*

PILOT "WASP" CIRCUIT

(162) Mr. N. Genota, Dubuque, Iowa.

(Q.) What is the schematic circuit of the original "Wasp" receiver manufactured by Pilot Radio & Tube Co.? I have seen all the other "Wasp" circuits, but never the original one. Back issues of RADIO-CRAFT do not seem to carry this diagram.

(A.) Factory diagrams of this set are now out of print. The circuit is shown in Fig. Q. 162. It has not previously appeared in RADIO-CRAFT.

MICROPHONE POSITION

(163) Mr. L. O. Fischer, Bronx, N. Y.

(Q.) Is there any advantage to be gained by placing a microphone at a distance from a speaker or orchestra?

(A.) Modern practice is to use a microphone having low noise-level, such as the condenser, or the more recent dynamic type—compensating the reduced sensitivity by increased gain in the voltage amplifier. Thus, singers may be placed 6 to 12 feet, and the piano 35 feet away, as compared with the former "close pickup" at 6 to 12 inches for the singer and 5 or 6 feet for the piano. Increasing the distance between band and mike increases the apparent size of the former; also, the relative sound value of its component instruments.

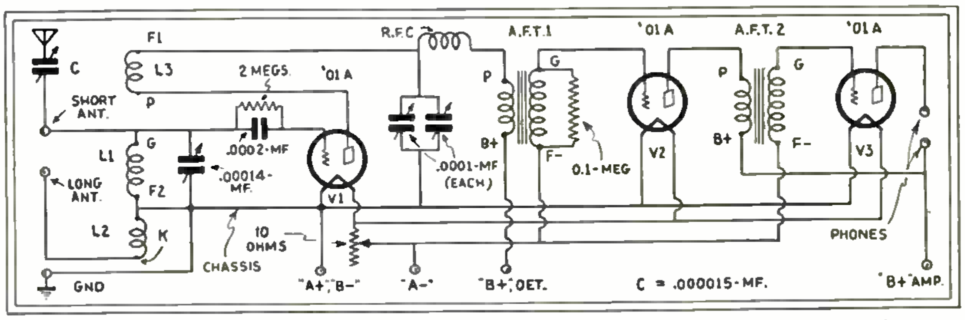


Fig. Q. 162. The circuit of connections in the old, original Pilot "Wasp" short-wave receiver.

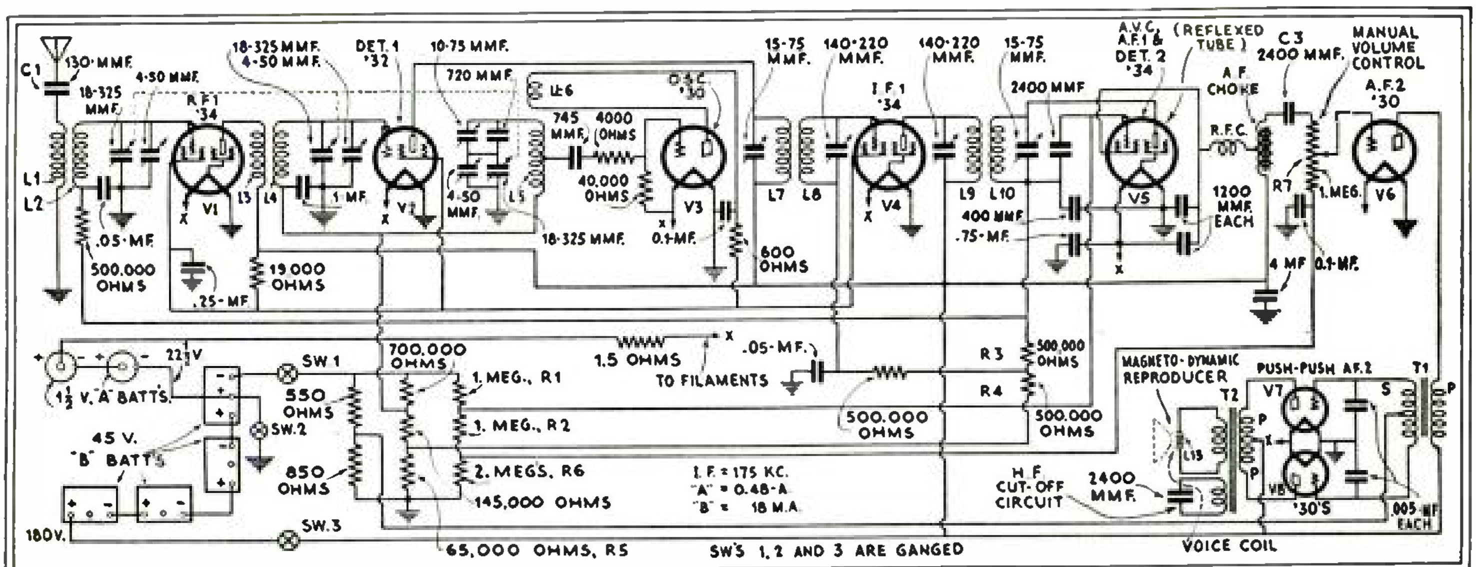


Fig. Q. 161
Schematic circuit of the RCA Victor Portable Radiola Model P-31. A reflexed pentode, V5, makes this circuit particularly interesting.

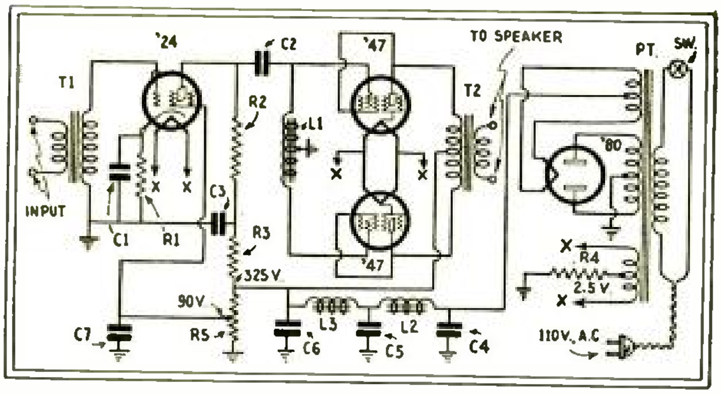


Fig. 2
Circuit showing the method of coupling a '24 into two '47s, in push pull. The pentodes are used as triodes.

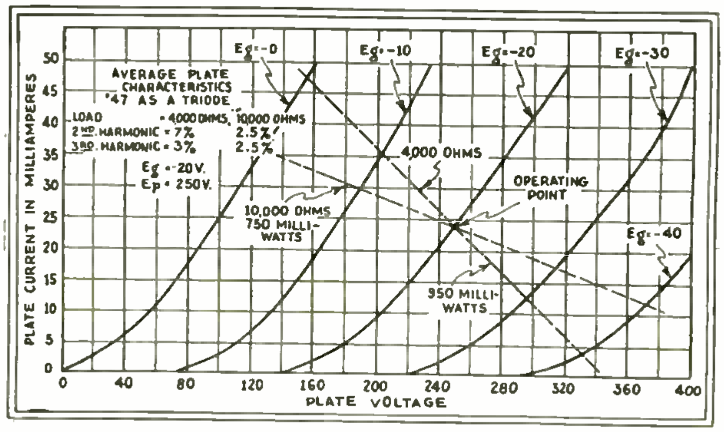


Fig. 1
Plate characteristics of the '47 as a triode.

THE PENTODE—A TRIODE

By C. H. W. NASON

RECENTLY some attention has been paid to the operation of the pentode tube as a triode. That is to say—with the screen-grid tied directly to the plate side of the output impedance (instead of the usual connection, the "B" plus side of this impedance), so that the potentials of these two elements are identical as regards both static and dynamic values. The curves given in Fig. 1 show the totalized current for various values of grid and plate voltage. (This graph is available through the courtesy of the Cable Radio and Tube Corp.)

Upon these curves there have been drawn the load-lines for load impedances of 4,000 and 10,000 ohms, respectively; these being the loads possible with apparatus originally devised for use with '45s or '10s. Computation of the harmonic content at these two values of load impedance, and with the maximum allowable grid swing or signal input based upon data obtainable directly from the curves and calculation of the power output obtainable under the same conditions, show that *the '47 operated in this manner has not only an entirely different aspect but that it is a tube superior in many ways to either the '47 in its normal connection, the '45 or the '10.*

Based upon these calculations let us see what the relative merits of the possible arrangements may be:

Tube	Plate Volts	Grid Volts	Plate Milli-amps.	Power Output Watts	Load Ohms
'45	250	-50	34	1.6	3900
'47	250	-16.5	32	2.5	7000
'10	250	-22	10	.4	13000
'47 (triode)	250	-20	24	.75	10000
'47 (triode)	250	-20	24	.95	4000

The power input to the plate circuits under the above conditions would be (obtaining the bias by means of a resistance between cathode and ground).

Tube	Plate Watts
'45	10.2
'47	8.5—about 10 watts counting the screen-grid current.
'10	2.72
'47 (triode)	6.5

The actual power efficiency may be seen to vary but slightly except in the case of the '47 as normally operated. By operating the '47 pentode as a *triode*, with a plate voltage of 300 and a negative grid potential of 25 volts, it is possible to obtain approximately the same power output as with the '45 tube with a power input from the supply circuit of but 8.1 watts (plate current 27 ma.) The total potential required is 325 volts as compared with a total of 300 volts for the '45.

With a load impedance of 10,000 ohms the harmonic content is sufficiently low to permit the use of a single tube; however, the power output is rather low compared to that obtainable with a load impedance of 4,000 ohms. Under this last condition the second-harmonic content is sufficiently high to require the use of a push-pull system so as to cancel the even harmonics.

The grid swing required for the full power output obtainable is but half that required for the '45 and not much more than is required by the '47 in its normal connection. The distortion is much less however than in the case of straight pentode operation; and the tendency toward frequency discrimination due to variation in the load impedance with frequency is much less pronounced than in the case of the pentode proper.

It is rather obvious, then, that in the '47 as used in a triode connection we have a new tube of highly desirable characteristics,—a tube, furthermore, that may be employed with existing apparatus (since the transformers normally required for use with the '45 or '10 may be employed). The power sensitivity resulting from this connection is much higher than that of the '45; and the power output obtainable in the push-pull connection (about 4.25 watts) is sufficiently high for nearly all purposes other than in the case of auditorium use.

In order that the amateur and technician may readily achieve an amplifier of this type, for actual service in the home or field, the writer submits herewith the data covering an amplifier suitable for use either from a phonograph pickup or microphone. Two variations of the design are given, dependent upon the gain required of the amplifier and the service. They are shown in Figs. 2 and 3.

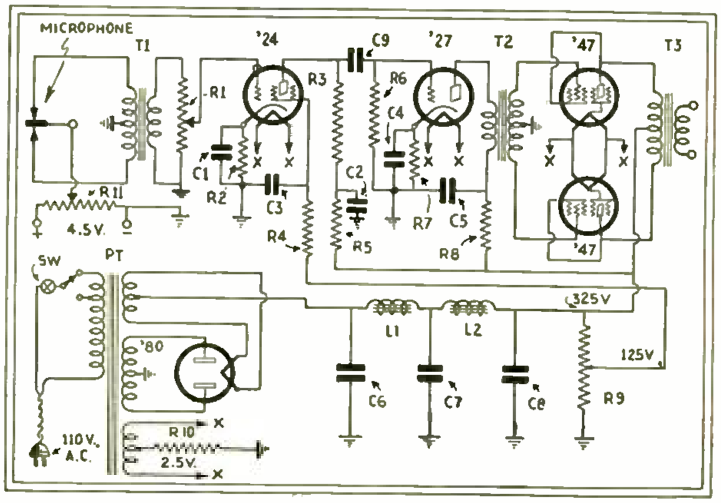


Fig. 3
Schematic of a microphone amplifier using the new arrangement.

THE "MEGADYNE"

(*Continued from page 13*)

To do this it is necessary to tune the antenna, which may not be the best arrangement for regular sets, but is THE best arrangement for this set.

Referring again to the circuit, we first have condenser C1, which is used to tune the antenna. Its capacity is .0005-mf. C2 is a small molded bypass condenser, .00025-mf. It is a new addition to the *Interflex* idea, and is quite necessary in this circuit. It will be found that the circuit does not operate well without the condenser at this point. Remember that all connections between C1 and the control grid of the tube should be just as short as possible. They cannot be too short.

As to the crystal detector, in the *Interflex* circuit, I recommended the use of a Carborundum detector. It is still perhaps the best detector for this purpose, but unfortunately it is no longer manufactured. I therefore substituted a fixed crystal detector which is of the iron-pyrites variety and which works very well in this particular circuit. I do not recommend a galena detector as it is not stable enough. Next to carborundum, iron pyrites is the best.

Note that, in this circuit, the detector works best in only one direction. Try reversing its connections, and you will quickly find out which is best. It is not possible to do this on locals as the circuit will be found to work even without the crystal for strong locals. It is only on distant stations when the necessity and superiority of the crystal detector becomes apparent. When trying to ascertain which is the best position for the crystal, tune in a DX or weak station and then find out which way it works best. Then leave it in this position. It will be found also, that some crystals are better than others. I therefore recommend that you obtain several and find out which gives loudest signals. Once tightened into place, the crystal needs no further attention, and it is not likely to be burned out unless, of course, lightning should hit your aerial; under normal conditions the crystal will last for years.

Regarding the tube, the circuit will be found to work well with such tubes as the 222, 224, 247, 232 and 238. I found, however, after having tried all the newer tubes, that the best results are obtained with a 238 tube.

Condenser C4 may be .00025-mf. to .0005-mf. The best one is ascertained by experiment. Condenser C3 is of the variable compression type, obtainable on the market, the value being from .0003-mf to .001-mf. *This condenser, while adjustable, is not used as a variable, and once adjusted remains in that position.*

It will be seen that the cathode of the tube is connected to ground. The use of a resistance in the cathode circuit brings no advantage in this circuit so it is omitted.

As to the loudspeaker, remember, we have not any too much volume, and for that reason only a *good* magnetic loudspeaker will perform well. I have used successfully the better magnetic types which are available now, such as the RCA 103, Amplion Adjustable and also Baldwin loudspeaker units, which are very low priced and which, with the addition of a good horn, perform remarkably well.

Regarding batteries, the '38 tube uses 6.3 volts; the current consumption is low, i.e., .3-ampere. You can either use a 6-volt storage battery, or otherwise five new dry cells. If the set is used over a length of time, another dry cell can be added. You can tell by the dull incandescence of the tube's heater if the tube is operating at the right voltage. It should be dull red. If it gets too brilliant it is a sign that you are using too much "A" voltage. This tube being constructed for automobile work where the voltage of the automobile battery varies from 7½ volts when freshly charged down to 5 volts when run down; it will be found that the set will operate well on five dry cells over a long period of time, unless, of course, the set is used continuously.

"B" Voltage: I recommend the use of 135 volts, though the set will be found to work well with only 90 volts.

The novelty of operation lies in the fact that the so-called screen-grid voltage connects to the control grid—the cap of the tube.

And here is where some caution is necessary. If you use 135 volts, take a tap of 22½ volts *figured from the negative end of the "B" battery.* This tap goes to one side of the tickler, as shown.

The three circuit tuner as used in this circuit may be any good type as long as it follows specifications. The secondary, wound on a bakelite or ordinary cardboard tube 2½ inches high. The tube is wound full 1⅜ inches with No. 30 D.C.C. wire. There are 68 turns altogether. The tickler measures 1½ inches in diameter and about 1¼ inches wide. It is wound with the same size and kind of wire as the secondary, and there are 32 turns altogether. The three circuit tuner specified has the usual primary. In this set it is not used and no connections are made to it.

Additional Notes

CAUTION. When making your tickler connection to the "B" battery, after everything is connected, and the tube lights, place the set in operation. The tap on the "B" battery should not be more than 22½ volts, counting from the —B side. Considerably louder signals may be obtained by increasing this voltage to 45½ volts, *and here is where you have to be careful.* Certain types of tubes if used with a voltage higher than 22½ will "cherry" the grid, that is — due to the extra current flowing—the grid becomes overtaxed. If you find that the grid gets red hot, disconnect the excess voltage immediately and go back to 22½ volts, as otherwise you will blow out the tube; but this does not apply to all tubes. Certain tubes as, for instance RCA, or Cunningham 338 are not affected in this manner, and they will take as high as 67½ volts on the control grid without cherrying. Therefore, always be sure to watch the grid and see that it is not overloaded. I may add that I have not found any tubes that give better results (louder signals) when a voltage higher than 45 is used on the control grid.

Adding extra voltage on the control grid does one thing, it gives stronger regeneration and makes for louder signals, but it is also more difficult to control the regeneration, particularly on distant stations when it will be found that 22½ volts is really better.

Condenser C3 is important because it adds to the volume of the signal. It is critical and should be adjusted to the lower waveband (higher frequencies). Select a station between 200 and 250 meters. The signal should not be too loud. Then with a screwdriver, which should be insulated, begin *slowly* to adjust the adjustable condenser. You will find that adjusting this condenser also affects the tuning somewhat. It will, therefore, also be necessary to adjust the tuning condenser C1 slightly until you reach a point in your adjustment of C3 where the signal comes in loudest. Some tubes have a tendency to "motorboat"—a sort of clucking, puttering noise is heard in the loudspeaker; condenser C3 corrects this condition to a great extent. When the best adjustment has been found for the lower waveband, leave the condenser and do not touch it thereafter. Do not try and use too much regeneration on the tickler because you will then get distortion, although the signal will be louder. Best results will be obtained when the set oscillates slightly, or just below the oscillating (whistling) point.

If, in rare instances, you find you cannot get the set to oscillate, try increasing the capacity of condenser C4. A larger condenser here sometimes helps. If the set still refuses to oscillate, it will then be necessary to use a higher voltage on the control grid. Try 45 volts with a series resistance so as to keep the grid from getting red.

Sometimes reversing the polarity of the tube heater or tickler leads helps.

Outside of this, the set will probably not be found to be tricky. It should perform normally in all instances.

Of course, the set may also be used with headphones substituted for the loudspeaker, and in this manner we will be able to get more stations because naturally stations several thousand miles away are not received on the loudspeaker except under unusual conditions. The set is really remarkable for DX work.

(*Continued on page* 58)

THE INSTALLATION OF ANTENNA LEAD-INS

By HERNDON GREEN

FORMERLY, practically all radio sets were installed by bringing in the aerial and ground wires under the window or through a small opening in the floor, the reason for such a makeshift being that no simple and practical fitting was then available. Window wires have the habit of shorting or breaking from the opening and closing of the window, while wires through the floor are frequently pulled out in shifting the radio or cleaning around it.

The Woodruff "Super-Thru," which derives its name from the fact that it is designed for use THROUGH the wall, was developed to meet the need for a lead-in fitting that would be attractive both in appearance and price, and which could be installed through a single round opening the size of a nickel coin in any thickness wall, and without a metal wall box. The device, of course, was constructed to meet the rigid requirements of the Underwriters' Laboratories.

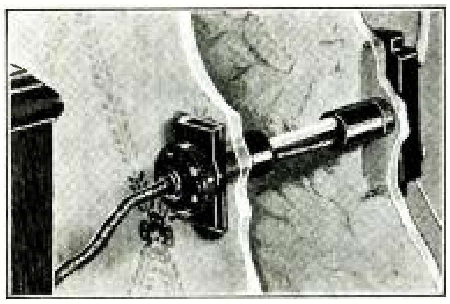


Illustration showing how the "Super-Thru" looks when installed properly.

The inside plate is very small. The attachment plug is polarized and will not fit a regular electric socket. On the rear face of the plate there are two small, sharp pins which enter the wall to prevent the plate from being turned out of line after installation. The outside plate is also very small and neat in appearance. It carries heavy terminal posts and has a built-in resistance-type lightning arrester. The plates and plug are molded of dark brown bakelite. The lead-wires are about 18 inches long and are attached to the inside plate ready to be installed. This device is equally adaptable to installation through papered, plastered or wood walls.

The Super-Thru is easily installed. A 13/16 in. diameter hole is made at the point of entry. Then, as shown in 1 in the accompanying drawing, the inside plate is inserted from the inside of the house, and the insulation stripped from the leads on the extended part. The outside arrester block is placed in position at 2, with the leads through the openings provided. The wires are bent and fastened under their respective posts at 3, and the excess length cut off. At 4, the aerial-ground leads are attached and the two small tension screws tightened, which serves to draw the entire assembly tightly against the wall. A cord from the plug to the set finishes the job.

In most brick or stone houses it will be possible to install the Super-Thru through the lower edge of the wood window frame. In such cases it is usually best to make the opening half-way through from the inside of the house, then line up the bit and make the opening from the outside of the house to meet it, otherwise the bit may run out too low or too high on the window frame. It takes about 10 minutes with a ¾-inch "star" drill to make an opening through a brick wall. Don't waste time and effort with a cold chisel.

In cases where the radio is not against the outside wall of the house, bring the leads in in the usual way under the floor, place a strip of wood across the floor sills at the point of installation to represent the outside wall, and install the Super-Thru *vertically* through the floor, taking care that the inside plate fits up against the wall correctly.

Past installations made it impractical for the radio to be moved. But, by providing several outlets in the home, you will be able to get much more use of the radio. During hot weather the political speeches and other programs may be received more comfortably in a cooler part of the house than they would be where the set was located during the winter months. An outlet in the guest-room enables the host to connect the set for the pleasure of the visiting friends, while one in the bed room will prove convenient, indeed, in times of sickness.

By connecting all the outlets on one side of the house to one aerial, a complete job will not be expensive, yet it will afford a nice profit to the Service Man.

In order to meet with the requirements of the National Electric Code, as adopted by most towns and cities, the lead-in wires must enter the building through non-combustible, non-absorptive, insulating bushings slanting upward from the outside, or through other approved equipment designed to give adequate insulation and protection.

The Super-Thru has the approval of the Underwriters' Laboratories, and will meet the requirements of any electric inspector.

The aerial and ground wires are outside the building and the customer does not see them at close range, but the lead-in is very conspicuous, for it is close to the radio, which is usually in a prominent part of the home. The Super-Thru puts a finishing touch to the aerial installation that lifts the entire job out of the class of amateur work. Even if the present aerial is satisfactory, the radio owner is interested in a workmanlike appearance for the lead-in. Many dealers and Service Men are making a sale on almost every repair job they have, just by showing this new product to the radio owner, particularly to the lady of the house.

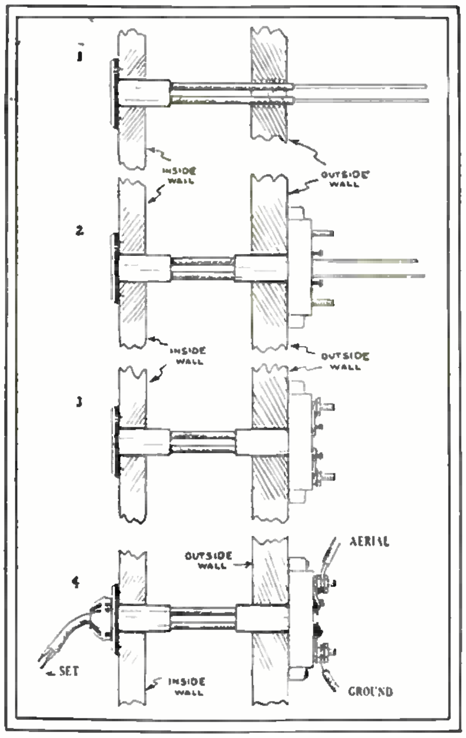


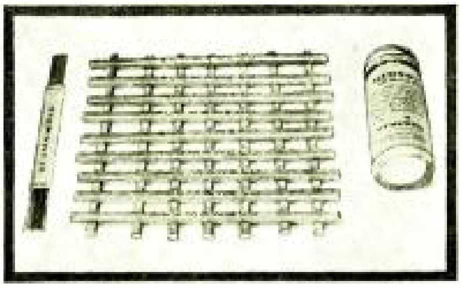
Fig. 1

The procedure used in installing the "Super-Thru." In (1) the inside plate is installed from the inside of the house; in (2) the lightning arrester is placed on the outside of the building and the leads pulled through the wall as shown. The leads are cut to their respective length as at (3) and the antenna and ground leads attached as indicated at (4). All "messy" and unsafe wiring are thus done away with.

HOW TO SOLDER ALUMINUM

By HARRY L. WHITE

THE failure of aluminum to respond to ordinary methods of soldering has always puzzled radio men, as well as other users of this versatile metal. The reason is simple, but not generally understood. Aluminum has a natural coating or film of aluminum oxide over its entire surface, and this is not removed by any of the soldering fluxes in common use. So strong and tenacious is this oxide film that it resists the dissolving action of the strongest paste, liquid or powder fluxes, and it causes the hot, molten solder to roll like water off the back of the well-known duck.



Photograph of the kit necessary to successfully solder aluminum.

In view of these past difficulties, the development of a really successful aluminum solder is news of considerable interest. The new material is known as "Alumaweld," and is supplied in the form of 10-inch bars that outwardly look just like the ordinary solder. It must be used with a special powdered flux, which is applied to the work like powdered rosin. This flux is furnished in a small, handy bottle.

A stock sample of Alumaweld, received for test by RADIO-CRAFT, was tried on two typical jobs such as the radio constructor, experimenter or Service Man is likely to encounter in his everyday work. First two pieces of aluminum were soldered together, to form a joint that could be used in making shield cans, etc.; then a copper wire was soldered to a sheet of aluminum, to form a "ground." The resulting joints proved to be tight and strong, and could not be pulled apart by two men, each holding an end of the work with a pair of pliers. In fact, the copper wire broke off without the joint itself showing any sign of weakness.

The requisites for the successful use of Alumaweld are an extremely hot iron and spotlessly clean metal surfaces. For most jobs the use of a gas flame is recommended, but a medium size radio iron seems to be satisfactory for light work. A stiff, sharp wire brush is supplied with the solder, and the user is told to use it vigorously. The flux, when heated preliminary to the application of the solder, smokes up considerably and produces a pungent odor, but this is no more objectionable than the action of other fluxes.

This new solder is useful for a wide variety of purposes, and for other metals besides aluminum. According to the claims of its manufacturers, it is several times as strong as common solder, and can be machined, polished and plated. It will expand and contract with the metal to which it has been applied to the extent that it will not crack because of normal changes in temperature such as occur in cylinder blocks, crank cases, water jackets, radiators, etc. It will not crystallize excessively or give way when subjected to extreme vibration.

Alumaweld is used very much like ordinary solder, but since it requires a powdered flux rather than a paste, it must be handled a little differently. The work to be soldered must be supported in a horizontal position, so that the flux will stay in place. If two pieces of aluminum are to be soldered together, each is "tinned" separately, and the tinned surfaces are then placed in contact and the heat applied. If there are no parts in the immediate vicinity of the joint, a clean gas flame should be used, so that the solder melts in thoroughly. Otherwise, a very hot iron will do the trick.

The accompanying drawings show the correct method of performing a representative soldering job: the placement of an aluminum shield or partition on an aluminum base or sub-panel. After the lip has been bent, the sheet is clamped upright in a vise, and the top surface of the lip scraped off with the wire brush until it is bright and shiny. A thin layer of the powdered flux is then distributed over it, and the Alumaweld and the hot iron applied together. See Fig. 1.

The heat must be applied much longer than in the case of ordinary soldering. The flux must be boiled out thoroughly, to give it a chance to destroy the troublesome film of aluminum oxide. The iron should be moved back and forth slowly along the metal until the solder assumes a clear, limpid consistency.

This operation is repeated with the sub-panel. A little more time may be required with this piece, because the metal on both sides of the joint will tend to conduct away the heat. See Fig. 1B. To complete the job, the two tinned surfaces are simply brought together, as shown in Fig. 1C, and the hot iron applied once more. It is advisable to hold the pieces together with a small C clamp, to insure accurate alignment.

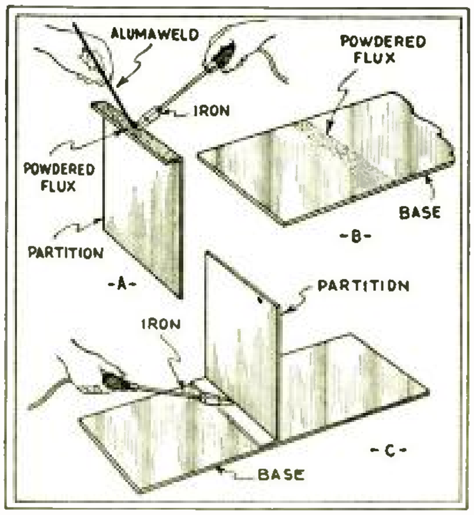


Fig. 1
The correct method of soldering aluminum.

OPERATING NOTES

(Continued from page 33)

which resulted in this same complaint.

After some time spent in attempting to locate the cause, it was noticed that the can of one of the three electrolytic condensers, (the 4.5 mf. unit, Part No. 927 in the schematic circuit which appears on page 207 of the OFFICIAL RADIO SERVICE MANUAL, Vol. II), was insulated from the chassis by means of "fish-paper."

Recalling one trouble found in a Peerless "Kylectron" receiver due to leakage across the same kind of insulation, this strip was checked with a high-range ohmmeter (15 megohms) and found to be the cause of all the trouble; when the condenser was disconnected from the chassis the trouble cleared up. Pieces of fibre washers were then used to insulate the can of the condenser (which is nearest the power transformer) from the chassis which completed the receiver repair.

The other Brunswick 17 had the complaint of bursting into tremendous volume and fading back to normal at regular intervals. This receiver was taken back to the repair shop to be placed on life-test in an effort to locate the trouble. *The set was operating almost a week before the defect was found.* It turned out to be the same strip of fish-paper described in the preceding paragraph. Improving the insulation completed the job.

Measuring Resistances by the Deflection Method

THE conventional instrument for the measurement of resistance is the Wheatstone bridge, which is a costly piece of apparatus. However, there are two methods which provide a fair degree of accuracy (depending on the quality and accuracy of the apparatus employed), the least expensive being the deflection method.

This article has been prepared especially to assist users of "Super Akrohm" (wire-wound) resistors to employ the deflection method, using popular-priced milliammeters that are easily procured.

The low-range milliammeters that are so readily converted into multi-range volt-ammeters are also admirably adapted for conversion into multi-range volt-ohmmeters. The 0-1.5 D.C. milliammeter is probably the most desirable instrument for the purpose due to the fact that a dry battery has a normal potential of 1.5 volts or some multiple of this voltage, depending upon the number of cells connected in series which go to make up the total battery. Other popular instruments can readily be used for this purpose, depending upon the range of resistances to be measured and the source of current available.

The method of connecting the component parts of the circuit in the deflection method is schematically shown in Fig. 1A. In this diagram A is the D.C. milliammeter, having an effective resistance Rm; C is the dry cell or battery; Rc is the calibrating resistance which limits the amount of current passing through the milliammeter; and Rx is the resistance to be measured.

For example:

When A is a D.C. milliammeter having a full scale of 1.5 ma. and C is a source of potential of 1.5 volts and Rc + Rm have a total resistance of 1000 ohms and the X terminals are shorted, the milliammeter should read full scale, or, in other words, the resistance at X is zero. However, if Rx is a resistance of 1000 ohms the instrument should then show one-half scale deflection or .75 ma. This is proven by Ohms' Law which states that $R = \frac{E}{I}$

In this case R is the total resistance of the circuit which includes Rx, the resistance being measured; Rc, the calibrating resistance; Rm, the resistance of the meter; E is the voltage of the dry cell or battery and I is the current indicated by the deflection of the meter; therefore

$$Rx + Rc + Rm = \frac{E}{I}$$

transposing

$$Rx = \frac{E}{I} - (Rc + Rm)$$

So much for the explanation of the deflection method.

In order to avoid the computation of each resistance to be measured, we refer you to a table of calibrating resistances and ohmmeter scales 1 and 2. This information permits a rapid decision as to just what ranges of resistance can be measured with the instruments available and provides a means of calibrating a scale directly into ohms. The table is to assist in determining the proper calibrating resistance according to the range of resistance

TABLE OF CALIBRATING RESISTANCES

1	2	3	4	5
(A)	(B)	(Rc + Rm)	(Rx)	
Milli-amperes full scale	Voltage	Total resistance required for calibration	Scale	Multiply by
1 1 1	Low 1.5 Med. 4.5 High 22.5	1,500 ohms 4,500 ohms 22,500 ohms	1 1 1	1 3 15
1.5 1.5 1.5	Low 1.5 Med. 4.5 High 22.5	1,000 ohms 3,000 ohms 15,000 ohms	2 2 2	1 3 15
5 10	1.5 1.5	300 ohms 150 ohms	1 1	.2 .1

desired and voltage employed or instrument available.

Column 1 of the table refers to the 0-1, 0-1.5, 0-5, and 0-10 D.C. milliammeters. Column 3 refers to the total calibrating resistance (Rc + Rm) necessary to obtain full scale deflection with the X terminals shorted when employing corresponding voltages as shown in column 2. In order to determine accurately the actual resistance of calibrating resistor Rc, or where the resistance of the instrument Rm employed is a considerable portion of the total resistance (Rc + Rm), the internal resistance of the meter employed (Rm) should be subtracted from the resistance (Rc + Rm) of column 3. As the resistance (Rm) of most instruments available for this purpose rarely exceeds 30 ohms, Rm can be neglected except where extreme accuracy is desired.

Scale 1 referred to in column 4 of the calibrating table is an 0-1 D.C. milliammeter scale which has been calibrated directly into ohms where the battery employed is 1.5 volts and the corresponding calibrating resistance (1500 ohms) shown in column 3 is used.

Scale 2 is an 0-15 D.C. milliammeter calibrated directly in ohms where the battery employed is 1.5 volts and the corresponding calibrating resistance (1000 ohms) is used.

The range of resistances measured by the deflection method is increased in direct ratio with the increase of voltage applied. Therefore, as the voltage is increased it is necessary to multiply the resistance indicated in the scales by the corresponding multiplier in column 5.

Occasionally it may be desirable to lower the range of resistances shown on scales 1 and 2 without changing the calibrating resistance or meter. In the case of the 0-1 D.C. milliammeter using 1.5 volts, the resistance shown on scale 1 can be divided by four when a resistance (Rd) of 500 ohms is connected across the meter and calibrating resistance, as shown in Fig. 1B. Using the 1.5 D.C. milliammeter the resistance of scale 2 can be divided by five when the resistance (Rd) of 250 ohms is connected in the same manner.—*from Bulletin No. 73 of the Shallcross Mfg. Co.*

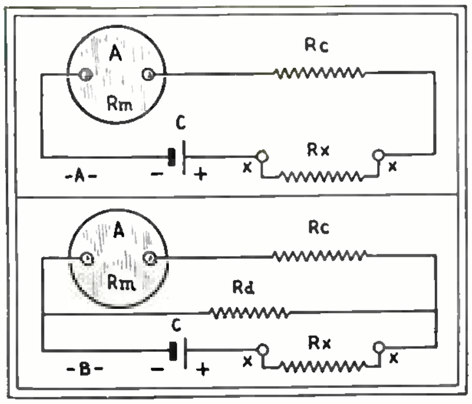
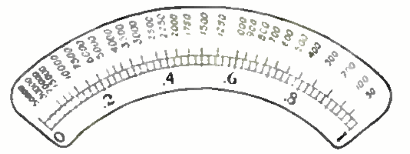
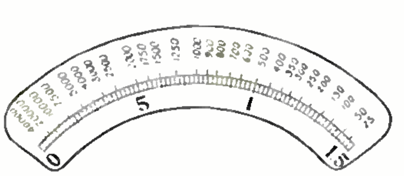


Fig. 1



Scale 1



Scale 2

VARIABLE-MU "6"

(*Continued from page 21*)

facing right hand flap. The R.F. coils and shields are mounted in the row to the left of the sockets. The '47 socket goes below the third hole from the right facing the rear flap of the chassis; the one marked "speaker" goes in the hole to the right and the '80 socket in the last hole. All have filament prongs facing the rear.

Turn the chassis upside down and mount the electrolytic condensers, C_9, C_{10} and C_{11}, the volume control and switch, R_1, tone control resistance R_6, the antenna-ground binding posts, the radio frequency choke, and the phono jack. (if you are using one). The power transformer is bolted to the top of the chassis over the large opening so that the leads face the underside. Mount resistance R_7 on the filter choke Ch_1 opposite the choke terminals and bolt the choke underneath the chassis. If you decide to bypass this set with a nest of .1-mf. condensers mounted in a tin box, (see parts list), bolt your capacity unit underneath the chassis near the coils. Mount the vernier dial and pilot-light on the front of the variable condenser.

If the wiring has been done correctly, and the apparatus is perfect, the set should be ready to operate. Insert the speaker plug and tubes in their proper sockets, connect the antenna and ground, plug the lamp-cord into the light socket and turn on the set. After the tubes have had a few seconds to warm up, rotate the volume control about three-quarters of a turn and tune in stations.

Socket Voltages and Currents

Plates of R.F. tubes to ground, 200 volts; R.F. and detector screen-grids to ground, 85 to 90 volts; R.F. cathodes to ground, 0 to 22 volts, depending upon the setting of the volume control. This is not a true reading as the 1000-ohms-per-volt meter is not sensitive enough to measure this accurately; detector plate to ground, 75 volts.

The following are the voltages to be measured in the power unit: Anode of C10 to ground, 415 volts; Anode of C11 to ground; 400 volts; anode of C12 to ground, 300 volts.

The voltages to be measured in the power tube are as follows: Plate of pentode to ground, 260 to 275 volts; drop across R9, 15 to 18 volts; suppressor grid of pentode to ground, 270 to 280 volts.

The total current measured between the center tap of the secondary of the high-voltage winding on the power transformer and ground is 55 ma.; the plate current in each of the R.F. plate circuits is 2 to 3 ma.; the plate current in the pentode circuit is 33 to 37 ma.

Parts List

One Frost 0-5,000 ohm variable resistor, R1;
One 20,000 ohm resistor, R2;
Two 30,000 ohm resistors, R3, R4;
One 500,000 ohm resistor, R5;
One 1. megohm resistor R6;
One 10,000 ohm resistor, R7;
One 0-25,000 ohm potentiometer, R8;
One 450 ohm resistor, R9;
Four .1-mf., 400-volt paper condensers, C1, C2, C3, C8;
One .25-mf. condenser, C4;
Two .00025-mf. molded midget bypass condensers, C5, C6;
One .05-mf., mica coupling condenser, C7;
One 8 mf. low voltage dry electrolytic condenser, C9;
Two 400-volt, dry electrolytic condensers, C10, C11;
One 2 mf. condenser, C12;
One four-gang .00035-mf. condenser with trimmers and split-rotor end plates, Cv;
One Gardner center-tapped, 900-volt, 60 to 80 ma. transformer, P.T. (This transformer must also supply 5 volts at 2 amperes, and have two 2½-volt filament windings).
Four tube shields;
Four coil shields;
One phono-jack with shorting link;
Five Eby 5-prong sockets;
One Eby 4-prong socket;
One 5-prong speaker plug;
Four screen-grid caps.

WHICH AUDIO SYSTEM?

(Continued from page 17)

The pair of '46 tubes in push-push (class B) is the best in terms of maximum power output, although the difference between their output of 16 watts compared to the next best ('45s in push-pull as "Class A") is only 3 decibels, or only a little over the minimum variation in volume perceptible to the human ear! As against this, their harmonic distortion is seen to be much worse in the volume range of 200 milliwatts or armchair level, up to 2 watts, or about all that will ever be required even for bass notes in the home—except for dancing, when four to six watts may be needed.

The pentodes ('47s) in push-pull (or parallel, they offering no *tonal* advantages in push-pull) show only 2 to 2.5 percent harmonic distortion in the ordinarily used power output range, but they have still from four to five times as much harmonic distortion as the '45s Class A, and one very serious disadvantage—as their output is pushed up, as it easily can and most certainly will be with any sensitive receivers today, their harmonic distortion will be very annoying indeed—rising to 20 percent at a little over 6 watts output as they are normally used. This explains why overloaded pentodes sound so much worse than over-loaded '45s, even though the latter may only approximate Class A.

Looking at power sensitivity, the '46 Class B combination is very poor—so poor, in fact, that though the figure of .118 given is the overall power sensitivity for two '46s driven by the recommended '45 driver stage, still another audio stage is really needed to drive them to full output if detector overloading is to be avoided. The pentodes are easiest to drive, and the output of a good '27 power detector will drive them quite nicely. The push-pull '45s (a) are next easiest to drive, a '27 power detector doing the job fairly well.

There was a story current in Chicago when '47 pentodes were first introduced in 1931, about the chief engineer of a well known Chicago radio manufacturer, to whom the sales engineers of a large tube maker were explaining the then new pentode. As the story goes, when they were all through, the set engineer picked up a sample pentode, held it up to the light, looked carefully through it, and finally, apparently deeply impressed, exclaimed, "wonderful, absolutely wonderful—here we have 30 percent distortion in a bottle!" Of course, this was an exaggeration, the harmonic distortion percentage of a good pentode audio system being below the supposedly permissable 5 percent at home volume levels. But this engineer had sensed immediately the point made above—that in present-day radio sets it would be a certainty that though the full output of pentodes would not be utilized for home entertainment, a very unfavorable reaction would be had by users as sets were tuned to local stations where the output would momentarily rise to levels where 20 and 30 percent harmonic distortion would be apparent.

The harmonic distortion percentages are variable and too high for really good quality for '46 class B push-push, as an examination of Fig. 1 will show, but not so high for pentodes as to be prohibitive, while the '45s are best by far. In stating that harmonic distortion for '46s is "too high," the writer bases this statement on a careful analysis of the reaction of a large number of people to demonstrations of the three systems simultaneously and in small groups at different times. For instance, as they listened to push-pull pentodes at 2.0 watts output, the quality seemed acceptable, as did that of '46 in Class B, though most remarked that it was not as "clear" or "clean" as they would really desire. But as soon as they heard the Class A push-pull '45s, they definitely condemned the pentodes and '46s! Such, then, was the reaction of a wide range of listeners to, for example, the difference between .4 to .6 percent harmonic distortion for the '45s Class A as compared to only 2.0 to 2.5 percent distortion for the pentodes. It is upon these reactions that the conclusion was arrived at that over 1.0 to 1.5 percent harmonic distortion was too much for really high quality reproduction, particularly as there appears to be a psychic reaction almost akin to pain during prolonged listening to programs having harmonic distortion in excess of 1 percent at home volume.

The final conclusion after one year's use and trial of pentodes, which are even better in this respect than '46 class B amplification, was that neither of these systems could be tolerated in high-quality receivers, and that only '45s or equivalent triodes could possibly be acceptable.

Considered from a cost angle, pentodes are as cheap as '45s in terms of receiver cost, since they require the same essential equipment and power availability, whereas '46 class B systems are far more expensive, even though they give markedly inferior results to the ear. This is because, the '46s' draw grid currents ranging up to 60 and 70 ma., they must be driven by a power audio stage ahead of them coupled through an excessively expensive coupling transformer which must have extremely good regulation, since considerable power is required from it by the '46s. It must, therefore, have very low resistance windings and large core area, and will be quite expensive compared to the coupling transformer required for '45s or '47s.

Likewise, the output transformer will be excessively expensive since it must have a high inductance compared to triode output coils. Further, plate supply regulation must be far better than is economically practical because signals do not vary plate current about an average value as in other systems, but cause it to rise to many, many times its normal "no signal" value as a signal is applied. And all of this neglects the necessity of a third audio stage to precede the '45 driven stage for class B '46s, needed because of their low power sensitivity to prevent audio detector overloading, and introducing, as it does, additional filtration problems and costs.

Another angle of the problem of amplifier overload with its consequent harmonic distortion is that dynamic loudspeaker units as used in home receivers distort rather badly at high power, so that when more than about five watts are applied to conventional types, they themselves begin to introduce harmonic distortion, and as ten to twelve watts are applied to them their quality is pretty completely shot to pieces. This is one reason why amplifier overload alone in small degrees is not in itself awfully serious in the range of, say, eight watts and up—at that point the speaker distortion is so bad as to often mask the amplifier distortion, and in addition, distortion is not quite as immediately noticeable at high volume levels anyway.

But from a home entertainment standpoint, there is no earthly use for the sixteen watts output of '46s class B, even if economical speakers did not go all to pieces at such levels and the amplifier cost was not excessive—entirely exclusive of the poor home volume quality they provide.

From this and other considerations involved, it appears that the best possible audio system for home use would employ '45s in push-pull, but would have the disadvantage of only 3 to 3.2 watts power output at 5 percent harmonic distortion. Investigation along this line indicated, however, that this system could be improved upon both in lowering harmonic distortion and increasing power output. Work along this line has been going on in the Silver-Marshall laboratories, and it is now possible to announce a new and economical audio amplifier using '45 tubes that will turn out eight watts at 5 percent harmonic distortion, and up to five watts at 1 percent—a Class A system that appears ideal for home reception where only the finest possible reproduction will be tolerated—and nothing finer can today be provided.

The New Amplifier Circuit

The circuit of this amplifier is the conventional push-pull arrangement, the constants, and not the circuit itself being the secret of its remarkable performance. It being perfectly safe to operate '45 tubes at 300 volts on the plate if the plate dissipation is kept down; the first step is to raise the plate voltage to 300 volts, and then to bias the grid's 68-volts negative. This gives a Class A am-

(Continued on page 58)

A PRACTICAL "3-TUBE" SUPER

(Continued from page 19)

to several hundred to one over a very narrow band of frequencies without noticeable improvement over the remainder of the broadcast range.

The use of a bridge circuit, so arranged that a part of the R.F. energy fed into the tube from the antenna circuit was fed back to the circuit, showed that by effecting a proper balance, an image ratio of well over a thousand to one could be obtained.

Figure 5 shows the selectivity curve of the tuned antenna circuit. This curve is somewhat normal, although its sides are more nearly symmetrical than most curves due to a combination of inductive and capacitative coupling which eliminates the normal high frequency "trails."

As the circuit is tuned from high to low frequencies, its selectivity-curve narrows in the conventional manner, although its gain is not changed by an appreciable percentage. Due to this characteristic, out-of-phase voltage produced in the tuned circuit at an image-frequency whose amplitude would increase uniformly with frequency, would balance out an image induced in the circuit. See Fig. 6.

This balancing out of the image-frequency response may be accomplished by the use of a small coupler with a relatively large inductance in series with the antenna and a few turns of wire coupled to this inductance and connected in series with the cathode of the oscillating tube. This is indicated in the schematic circuit of the receiver, Fig. 4. Coil L1 is the antenna coil of high inductance while Coil L2 is the one connected in series with the cathode as mentioned before. If the inductance in series with the antenna and the capacity-coupling condenser is wound with resistance wire, its normal response is altered so that it has no affect other than that of a constantly increasing impedance across the frequency band. In other words, we now have an impedance connected in series with the antenna, the value of this impedance increasing directly as the frequency increases. A few turns of wire tightly coupled to this Coil L1 and connected in series with the cathode of the tube will introduce in that tube every frequency picked up by the antenna; the higher frequencies being about two and one half times the amplitude of the lower frequencies. These small voltages induced in this small coil are nearly 180 degrees out of phase with the voltage induced in the tuned circuit, and are about one twentieth of this latter voltage at resonance. This out-of-phase voltage is shown in Fig. 5 by the straight, slanting line. Since this voltage must be subtracted from that induced in the tuned circuit, the final selectivity curve of the system is shown by the dotted line.

The only really critical factor in the operation of the system was the coupling between the two coils of the antenna system. By exercise of reasonable care, production limits could be easily maintained in a fixed coil and some adjustment used for a final balance of effects produced by other parts in the receiver. The final arrangement had fixed inductive coupling and a semi-variable capacity-coupling condenser which raised or lowered the gain of the input transformer, widening or narrowing the response curve off resonance until it just balanced the fixed out-of-phase coupling voltage. In other words, the selectivity curve of the antenna system is made variable so that the voltage induced in the tuned circuit would just equal that induced in the small coupling coil, and since both voltages are 180 degrees out of phase, the image-frequency voltage would be considerably reduced. This semi-variable unit should only be manipulated when image-frequency interference is obtained.

Both of the coils mentioned, as well as the coils used in the oscillatory portion of the circuit are quite different from those ordinarily used. As one of the requirements of the receiver was that it be small, normal coils appeared quite out of proportion to the job they had to perform. Those included in the design are less then an inch in diameter and less than an inch in length, this being the size of their shield cans, as indicated in one of the accompanying photographs. The coils themselves are of the universal-wound type, inverted in their respective shields and held in place by a cup in the bottom of the can and a small ring which springs into a bead spun in the can.

Referring to circuit diagram, it will be found that one side of the volume control is connected to the antenna lead. This does not produce the usual volume control action. If an attempt were made to control from this point it would be found that the volume would decrease to a certain point and suddenly begin to increase again as the volume control knob is continuously rotated. This occurs because of the effect of the out-of-phase coupler which would assist in obtaining a null point which accounts for the sudden decrease in volume. After this point had been reached, practically all of the coupling to the grid of the tube would be through this out-of-phase coil itself, and consequently the volume would again increase.

This rather unusual effect is overcome by grounding the arm of the potentiometer, which in effect, grounds the screen-grid bleeder circuit, and running the bias of this tube and the antenna volume control in such a manner that the null point in the volume control action occurs at exactly the same time that the first I.F. tube ceases to function because of the small signal. Incidentally, it may be stated that the volume control also serves to close the grid circuit of the oscillating detector.

By making the first tube oscillate strongly enough to give a low gain, and having the I.F. stage regenerate so that the major portion of the gain of the receiver is in this I.F. tube, it is possible to maintain a very satisfactory adjacent channel selectivity. This combination gives a band width of approximately 50 kilocycles at 10,000 times resonance input, and the overall sensitivity between 400 and 800 microvolts for 50 milliwatts output.

At 30 percent modulation the maximum output obtainable is about 750 milliwatts, increasing regularly to over two watts at 100 percent modulation. Primary overload occurs at approximately a thousand microvolts input.

Compared to any other commercially practicable arrangement containing only four tubes, this arrangement will show better sensitivity, better stability, better selectivity, better image ratio and better fidelity than its competitors. It might also be added that its price would be less than that of a tuned R.F. receiver of only one-half the efficiency of this circuit.

(Continued on page 53)

AN "A" UNIT

(*Continued from page 23*)

junction to the negative element—the positive element.

The thermocouple junctions, facing the center of the ring-like structure, are heated by a gas or gasoline burner which is shown, together with a gasoline tank to which the burner is connected, in Fig. C. The opposite or outside junctions are cooled by radiation of the spider ring with which these junctions are in thermal contact. The spider ring, being composed of aluminum (which is a good conductor of heat) readily dissipates the heat which is carried off by conduction through the elements of the thermocouples—from the hot to the cold junctions. It was found, by the use of the spider ring, that a higher difference of temperature is effected between the hot and the cold junctions of the thermocouples with the consequent result that the Thermotron is capable of producing also a higher voltage than it would produce without the radiators.

The thermocouple section, both on the bottom and on the top, is enclosed by metal covers. A heat insulator ring conforming in shape to the thermocouple section and consisting of a composition of magnesium oxide and asbestos is placed between the thermocouples and the metal covers. Thus, the whole of that portion of the heat absorbed at the hot junctions which is not converted into useful electrical energy is carried off by conduction to the cold junctions and thence to the spider ring where it is dissipated by the radiation.

As seen in Fig. A, the generator section is held in the proper position with relation to the burner by means of vertical supports fastened to the tank. In the center of the completed generator section is a perforated cap that can easily be removed to light the burner for the operation of the device. The starting of the burner is similar to that of a gasoline lamp. Two binding posts, positive (+) and negative (—), are connected to the terminals of the generator. The load resistance consisting of the filament circuit of the radio set is connected to these binding posts.

The completed Thermotron weighs approximately 10 pounds. Its current producing section inclusive of the spider ring, measures 8½ inches in diameter from tip to tip and is slightly in excess of 1½ inches in thickness. The tank on its base has a diameter of 8 inches and is 4 inches in height. The overall diameter of the burner is 2-5/16 inches.

Electrical Characteristics

The device described above produces an electromotive force of 4 volts and, because its internal ohmic resistance at operating temperature is about 2 ohms, it sustains a flow of current of 2 amperes with a load resistance in the circuit approaching zero; therefore, maximum power output and efficiency of the Thermotron is obtained when its load resistance is equal to its internal resistance. Under this condition a useful current flow of 1 ampere is available which is more than needed for any of the 2-volt sets now in use or on the market. Very few of these require more than .65-ampere and some of them draw even less.

With a load resistance in the circuit equal to 2 ohms, the Thermotron has been generating current every day during an entire year except on Sundays and holidays over a period of 8 hours. During this time (about 2500 hours) it consumed a little over 20 gallons of lamp and stove gasoline used in most farm homes. Thus an estimate of its operating expense may be based on the fact that it produces current at a constant rate during a period of time in excess of a hundred hours on one gallon of gasoline.

To determine the extent of fluctuation in voltage and current flow due to one cause or another, the volt and ampere readings were taken every 10 minutes during an eight hour period for the preparation of the curve shown in Fig. 2. At no time did a rise in the voltage show more than .01 or a drop of more than .03 volts. The current flow during the eight hour period was just as constant.

At this point the electromotive force of the device, after it had produced current for 2500 hours, decreased from 4 volts at the beginning to 3.91 volts at the end of the test period, and increased its internal resistance from 2 ohms to 2.10 ohms, so that current flow was reduced from 2 amperes to about 1.86 amperes, as indicated by the instrument connected to the binding posts of the Thermotron by low-resistance copper ribbon. The difference of temperature between the thermocouple junctions was the same at the end of the test period as it was at the beginning.

Theoretical Considerations

Many attempts have been made in the past to turn the phenomena of thermo-electricity into useful account; to produce enough voltage and current by means of a number of thermocouples connected in series and combined into a thermo-electric generator. These attempts, however, have not succeeded because the thermoelectric properties of the metals then employed were almost entirely unsuitable for thermo-elements.

Irrespective of any theory of electricity, the character of a metal alone determines its usefulness as a thermo-element. It must either be highly positive or negative, in a thermo-electric sense, against another metal. The two elements forming the couple, besides producing a relatively high thermo-electromotive force per degree difference of temperature, must have a thermal conductance which should not rise much above their electric conductance. In other words, the ratio of electrical to thermal conductance in each of the two elements should not drop much below unity.

Since the ratio of the two conductivities, electrical and thermal, of the positive as well as of the negative element is not equal to unity, the electrical conductance in both elements that consist of metal alloys being smaller than their thermal conductance, the difference in their size with respect to their cross sectional area cannot simply be made equal to the ratio of their electrical conductance. The cross sectional area of the two elements must bear a quantitative relation to one another based on both electrical and thermal conductance. Therefore, other conditions being equal, the maximum efficiency of a thermocouple is obtained when the ratio of the cross sectional area of the two kinds of metal forming the thermocouple equals

$$\frac{(s\,l)^{1/2}}{(s'l')}\,.$$

where s and l denote the two conductivities of one element and s' and l' of the other element.

It has been experimentally substantiated that when the size of the elements with relation to their cross-sectional areas are determined and formed in accordance with this ratio, the electrical conductance of the thermocouple and the flow of current in the same approaches a maximum, while the heat carried off by conduction from the hot to the cold junctions is at a minimum.

Thermocouple elements can only be useful when they effectively resist oxidation at the temperature to which they are subjected, so that their useful life will extend over a long period of time. In every other respect, the metals used for the elements of the thermocouples in a thermoelectric generator must be adapted to produce a larger quantity of electrical energy for a given quantity of heat absorbed at the hot junctions of the thermocouples than is usually the case with this method of generating electric current.

All sources of electric current invariably convert some other form of energy into the electric form. No form of energy can be produced without expending for it at least an equal quantity of another form of energy. The law of the conservation of energy sustains this conclusion.

With the Thermotron we convert heat into electricity. No machine or device, however, can be constructed by means of which 100 percent of the heat energy consumed can be converted into some other form of energy. There is always a large portion of the total heat consumed dissipated which cannot be converted into some other form of energy because the conversion of heat energy into mechanical, electrical, or any other form of energy is subject to a law of nature, called the second law of thermodynamics. Besides this loss of heat, there are other losses. In the Thermotron, for instance, the heat which is carried off by conduction through the elements forming the thermocouples, from the hot to the cold junctions, is not available for conversion into current.

The efficiency of the very best thermocouple is therefore low. Even with the Thermotron, where thermo-electric elements are employed, consisting of metals having thermo-electric properties of the most pronounced degree, the useful electrical energy produced in heat units compared with the heat consumed is small. However, it is large enough from an economic point of view to make the application of the thermo-electric generator possible for all such purposes where small quantities of electrical energy at a low voltage are required and simplicity and convenience of operation are deciding factors. There are two distinct causes physically inherent in all thermocouples effecting an efficiency smaller than that of an engine converting heat into mechanical power. One of these causes arises from the reconversion of current into heat in the internal resistance of the thermocouples, and the other from the heat carried off by conduction from their hot to their cold junctions.

A "3-TUBE" SUPER

(*Continued from page 50*)

It might well be added for the benefit of experimenters that previous to this work, several adaptations of super-regenerative and grid-leak detectors were tried, as well as combinations of small power detectors with amplifier output system, but under no circumstances were the simplicity and stability of operation of this system even challenged.

(Undoubtedly, the trend in modern receiver design will be toward a decreasing number of audio stages of amplification, since this results in a decreasing number of parts that may cause distortion. If this is true, then this receiver has approached the ideal.—*Editor.*)

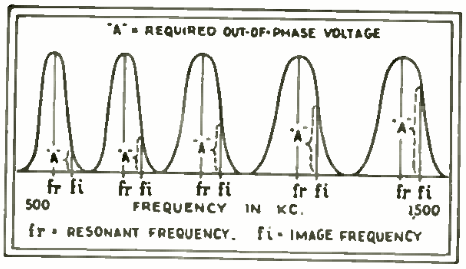


Fig. 6
Out-of-phase voltage required at different frequencies.

NEW TUBES

(*Continued from page 16*)

of curves it can be seen that maximum power output is secured when the second harmonic distortion is a minimum.

For those who require A.C.-D.C. receivers, this tube should be of invaluable assistance in solving some of the problems which arise in connection with the design and construction in such receivers.

New Large Mercury Vapor Rectifier

For those engaged in the construction and installation of public address equipment, the problem of securing a rectifier tube capable of delivering the required power output has been met by the simple expedient of using at least two type '81 tubes, especially when over 300 volts D.C. is required.

To those engaged in this field of endeavor, the tube that is now being announced will prove a "godsend" for we now have available for use a full-wave rectifier capable of supplying 750 volts at 250 ma. The connections and uses of this tube are similar to any full wave rectifier and consequently will not be repeated here; but it will merely suffice to outline its characteristics which in turn may easily be applied to current power units.

Filament voltage, 5 volts; filament current, 3 amperes; D.C. output current, 250 ma., maximum; plate voltage (R.M.S.), 750 volts, maximum. It may be well to state that this new mercury vapor rectifier should be used in conjunction with a choke- and condenser-input filter system. The condenser capacity should not exceed 4 mf.

I received your book, "How to Build and Operate Short Wave Receivers." I am very pleased with it, as I believe it is the best book that has been printed on short wave work. It is invaluable to builders of Short Wave receivers. Worth many times the price, my candid opinion.

E. H. BLADES,
Radcliff, Alberta, Canada.

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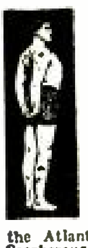

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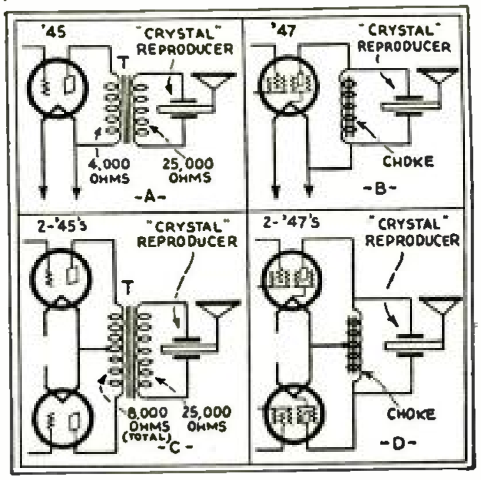
CRYSTAL SPEAKER

(Continued from page 15)

cycles and when built into a reproducer the only limiting factor is the method by which the crystal is made to reproduce through an associated tone-arm, cone, etc., and the frequencies which are brought to it as a result of broadcast station equipment and radio receiving sets.

The reproducer is considered to have a "negative impedance" (condenser effect) of about 25,000 ohms at 1,000 cycles, and characteristics similar to those of a .03-mf. condenser.

It operates extremely satisfactorily when connected directly across an output choke in the plate circuit of a type '47 pentode tube. It also has an astonishing volume when connected across the output inductance in the plate circuit of a pair of type '30 tubes connected in push pull, and is especially good for battery-operated sets when operated by a pair of these tubes in "push-push" or class B amplifier connection. The diagrams shown below indicate the possible hookups with pentode and '45 tubes either singly or in push-pull.



RESISTOR-REPLACEMENT HANDBOOK

Loose-leaf, the Resistor Replacement Handbook just put out by Electrad, Incorporated, makes conveniently available to the radio Service Man a wealth of information on the electrical values of radio receiver replacement parts.

This 72-page book, to which from time to time will be added numerous other pages, measures 5 x 7½ ins.; it is almost ½-in. thick. The black cover material is leather-grained; the lettering, gold.

Incorporating a unique and copyright idea, the pages of the Handbook are so planned that any resistor in any part of the more than 1,000 receiver circuits represented may be located without reference to the service diagram, only certain "key" circuits being used to determine the replacement value of any resistor unit in the set.

Still another and valuable idea incorporated in this first edition is found in the department, "Voltage Dividers," in which operating voltages for the various circuits are conveniently tabulated.

This perpetual Guide carries an annual charge of one dollar which includes not only the volume illustrated, but also replacement leaves over a period of one year.

SERVICE FORUM

(Continued from page 34)

few days I received a nice (baloney) letter from him, saying that due to the fact that they happened to have an extra copy of Service Manual on hand they were instructing their salesman to deliver it to me. Fine! and again but! it never was delivered to me. Therefore I am forced to believe (as I did at the start) that baloney can be had far away from butcher or delicatessen shops.

GEO. G. MITCHELL, JR.
Hackettstown, N. J.

SERVICING AVIATION SETS

(Continued from page 25)

Each Eclipse generator is furnished with a control box containing three distinct elements: the reverse current cutout, the load limit controller and the voltage regulator element. (See Fig. B and Fig. C.) Sometimes dirt in the interior of this control box may cause trouble, especially if it gets between the contacts on a unit. This dirt can usually be removed by inserting a piece of clean paper between contacts, pressing them together and then pulling out the paper. If the contacts are pitted, their faces should be smoothed with a fine file made for the purpose, or sandpaper.

Wind-Driven Generators

The electrical characteristics of the Deslauriers wind-driven generators, Fig. D, are precisely the same as the Eclipse engine-driven generator. The method of maintaining constant speed, which directly influences the voltage generated, however, becomes an important item.

Figure 4 shows the general mechanical arrangement of the Deslauriers propeller and its governing mechanism as mounted in the head of the generator; one type of Deslauriers generator is designed to be separately excited from an outside D.C. source of from 10 to 14 volts.

Dynamotors

It is considered very desirable to be able to generate a suitable source of D.C. without having any power available due to the movement of the 'plane in flight, or any due to the running of the airplane engine either. For this reason dynamotors are used and should be understood by the Service Man.

A dynamotor consists essentially of a rotating armature having double windings and pole pieces. These armature coils are wound in the same manner as in the case of a double-voltage generator. There are two commutators on the shaft, one at each end of the armature. One commutator is connected to what are called the motor armature coils, or the primary end; the other commutator is connected to the generator coils, or the secondary end. Such a dynamotor is shown in Fig. E; another view is Fig. F; the circuit arrangement is very usual.

Any type of rotating electrical machinery using brushes produces radio frequency noise when operating, because of sparking between the brushes and the commutator. In order to suppress this interference at the source, this dynamotor is equipped with a filter which consists of two 1. mf. condensers, one of which is connected across each set of brushes.

USING AN ANALYZER

(Continued from page 29)

resistor. It will probably change resistance value or burn out, as it is normally a grid-leak type of unit with negligible current-carrying capacity. Accordingly it is often necessary not only to replace C but also, in a good many cases, unit Z1.

Plate Voltage and Current

Fig. 1E shows the analyzer meter connections for plate voltage and plate current measurements. Always make plate *voltage* measurements *first*, to prevent shorted tube elements, and the resulting high plate current, causing an overload of the milliammeter.

If a low plate voltage (not in a resistance-coupled stage) is to be measured, remove the tube from the tester. If the plate voltage now rises, the tube has shorted elements and a new tube should be used. Note that the milliammeter MA (and its shunt resistances) is in series with the circuit and the current that flows through the circuit must also flow through it; therefore, do not switch to the milliammeter until plate voltage has been measured.

Whenever you have occasion to measure *current*, always use the highest range of the milliammeter as an added protection to the instrument. Then, if relatively normal current is indicated, use its next lowest range.

Screen-Grid Voltage

The same routine circuit tests described in connection with the plate circuit are followed to determine screen-grid voltage. Fig. 1F shows how in the Jewell 444 a voltmeter and milliammeter are connected to a screen-grid circuit. Screen-grid current usually is low, although what has been said about the voltage and current measurements of the plate circuit applies also to the screen-grid circuit. A grounded or shorted screen-grid circuit always results in a high current; normally, the screen-grid current does not exceed 1/3 of the plate current.

Control-Grid and Pentode Circuits

Figure 2 represents the connections in a push-pull stage using pentode tubes. We have placed meters in all of the circuits just as the Jewell 444 would connect them. Note that one element of the tubes, the suppressor grid, is connected *within the tubes* to the center of each filament; consequently, we can make no measurements on this element.

You will remember that we pointed out just how the screen-grid voltage affected the measurements in other circuits. Likewise, if there is no cathode voltage there will in all probability be no control-grid or plate voltage.

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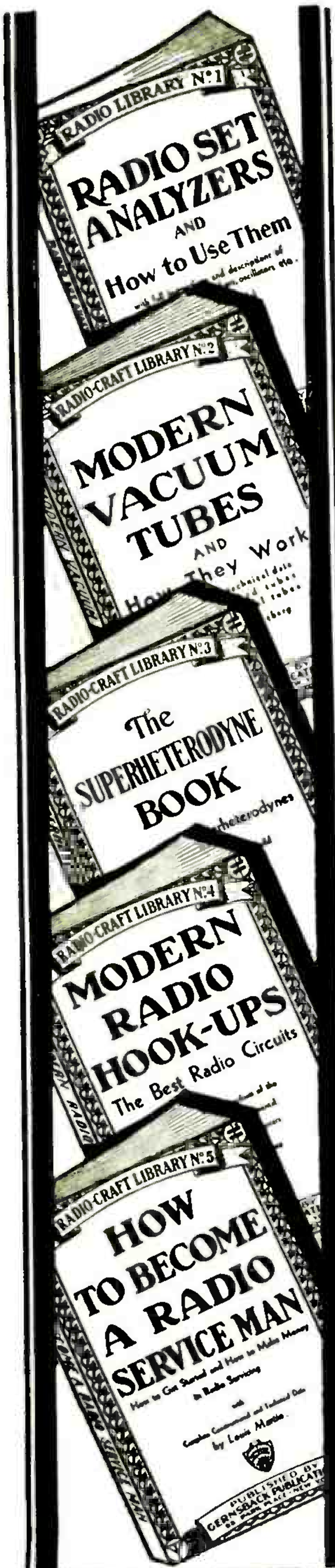

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With Full Instructions and Descriptions of Set Analyzers, Tube Checkers, Oscillators, Etc.

By L. VAN DER MEL

This book explains thoroughly the operation of set analyzers, tube checkers, oscillators and other testing equipment. For every radio man this book is extremely helpful. It covers every phase of testing and gives you valuable short cuts; completely illustrated with photographs and diagrams to facilitate the use of modern testers.

The following chapters briefly outline the contents. INTRODUCTION; THE ANALYZER; Fundamentals, Switches, A.C. and D.C. Voltmeters, Calibration and Design; TROUBLE SHOOTING WITH THE ANALYZER; Classification of Trouble, Analysis of Troubles, Uses of Various Analyzers, Care and Maintenance; CONCLUSION.

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By ROBERT HERTZBERG

MODERN VACUUM TUBES describes the fundamental electron theory which is the basis of all vacuum tube operation, and goes progressively from the simplest two-element tubes right up to the latest pentodes and thyratrons. It is written in clear, simple language and is devoid of the mathematics which is usually so confusing. Valuable reference charts and characteristic curves of standard and special tubes are to be found, also diagrams of sockets and pin connections.

Here are some of the chapters: The Edison Effect and The Electron Theory; Electron Emitters and the Ionization Effect; The Three-Electrode Tube; Vacuum Tube Characteristics; Four- and Five-Element Tubes; Light Sensitive Cells and Other Special Tubes.

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The following is a short list of contents: Basic Principles of the Superheterodyne; The Oscillator; First Detector; Single Dial Tuning Systems; Intermediate Amplifier; Second Detector, Audio Amplifier and Power Supply; Commercial Superheterodyne Receivers; Servicing Superheterodynes.

Book No. 4

MODERN RADIO HOOK-UPS

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A Complete Compendium of the Most Important Experimental and Custom-built Receivers

By R. D. WASHBURNE

It is fascinating to the experimenter, or even to the up-to-date Service Man, to take a commercial set and to change it into one using a famous hookup that is not found in any manufactured set. Many excellent circuits have never been commercialized, but limited only to home-set builders. Thousands of these popular circuits have been requested from time to time, and in this book we have included over 150 circuits, which include the famous Peridyne, Cash-Box A.C.-D.C. Set and others.

The circuits cover the following: Broadcast Receivers, All-Wave Receivers, Short-Wave Receivers, Converters and Adapters, Television Receivers, Home Recording Apparatus, Automobile Receivers, Audio and Power Amplifiers, Power Units and Miscellaneous Equipment.

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How To Get Started and How To Make Money in Radio Servicing

By LOUIS MARTIN

The ambition of many men in radio today is to become a first-grade Service Man. It is not as difficult as one might believe, but it cannot be done in a few short months. Following very carefully the advice of Mr. Martin, who has dealt with the problems of thousands of Service Men, this book deals very carefully with the essential stages in the preparation for qualifying as a Service Man.

Here are the chapters: The Small Independent Service Man; Advanced Commercial Aspects; The Radio Set; Semi-Technical Considerations; Advanced Service Data. Each chapter is again subdivided to bring out in minute detail every point of importance.

Book No. 6

BRINGING ELECTRIC SETS UP TO DATE

With Pentodes, Multi-Mus, Dynamic Speakers—Complete Information How to Modernize A.C., D.C. and Battery Operated Receivers

By CLIFFORD E. DENTON

In this country there are over ten million electrically operated receivers that could be modernized by placing in them new type tubes, new speaker equipment and other modern improvements. This business of improving old sets can go to the experimenters and Service Men if they will quickly jump into action.

Read in this book by Mr. Denton, how easily you can modernize any obsolete set, and with little additional costs.

Here are the high lights of this book: Tubes Available for Replacements; Electrifying Battery Receivers; Use of the New 2- and 6-Volt Tubes; Operating Sets with Single Control; Conversion of A.C. Sets into D.C. and D.C. into A.C.; Replacing Output Tubes with Higher Output Tubes; Improving Old Supers; Loftin-White Amplifiers; Adapters and Their Use.

Book No. 7

RADIO KINKS AND WRINKLES

For Service Men and Experimenters

A Complete Compendium on the Latest Radio Short-Cuts and Money-Savers

By C. W. PALMER

It often becomes necessary for experimenters and Service Men to call upon their memory for some short cut or radio wrinkle that will solve a problem quickly. In business, "short cuts" mean time and money saved, and to the Service Man "time saved" means money earned.

This book is a compilation of important radio kinks and wrinkles and discusses only such items as are constantly used today.

Here are some of the more important chapters: Introduction; Servicing Short-Cuts; Testing Equipment and Meters; Vacuum Tubes and Circuits; Volume-control Methods; Amplifiers and Phonograph Reproducers; Power Supply Equipment; Coils and Tuning Circuits; Short Waves; Loud Speakers; Tools and Accessories.

Book No. 8

RADIO QUESTIONS AND ANSWERS

A Selection of the Most Important of 5,000 Questions Submitted by Radio Men During the Course of One Year

By R. D. WASHBURNE

There has been collected a wide variety of questions which have come into our editorial offices during the past two years, and only those whose answers would benefit the majority of men engaged in radio have been incorporated in this amazing question and answer book.

The tremendously long list of topics better explains the subjects which are treated. Here are the titles:

Radio Servicing; Receiver Design; Home Recording; Television; Sound Equipment; Short Waves; Antennas; Operating Notes; Test Equipment; Tubes; Ultra-Short-Waves; Police Radio; Reproducers; Superheterodynes; Automotive Sets; Power Packs; Automatic and Remote Control Devices; Aligning Procedure; Photo-electricity; Adapters; Measuring Apparatus; Band-Selectors; Converters; Public Address Equipment; Midget Sets; Oscillators; Phonograph Pickups.

Book No. 9

AUTOMOBILE RADIO AND SERVICING

A Complete Treatise on the Subject Covering All Phases from Installing to Servicing and Maintenance

BY LOUIS MARTIN

Automobile radios are up and coming, and someone has to service them properly. It therefore behooves you to read this immensely important new book on the art of Automobile Radio. The book is concise, and full of illustrations, photographs, diagrams and hookups.

Here are only a few of some of the really interesting chapters: Introduction; Automotive Radio Installations; Complete Descriptions of Commercial Automotive Receivers; Servicing Automotive Receivers; The Ignition System; General Service Considerations; Effects of Temperature on Power Supply; Conclusion.

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Book No. 10

HOME RECORDING AND ALL ABOUT IT

A Complete Treatise on Instantaneous Recordings, Microphones, Recorders, Amplifiers, Commercial Machines, Servicing, etc.

By GEORGE J. SALIBA

If there is one subject that is fascinating to every radio man, it is that of Home Recording. Of course, this volume is not all on "Home" recording, but the information contained therein is important to commercial radio men, studio operators, engineers and others interested in this phase of radio.

The art of recording and reproducing broadcast selections is becoming more important every day to radio men, experimenters and Service Men. Equipping dance halls, auditoriums, churches, restaurants and homes with public address and amplifiers brings many extra dollars and often an excellent income.

In this book are found such topics as: Short History of the Art; Microphones; Recording Amplifiers; Cutting Heads; Types of Records; Commercial Machines; Adding Recorders to Receivers; Studio Layouts; Mechanical Filters for Turntables.

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UNIVERSAL OHMMETER

(Continued from page 22)

Suppose the meter reads .16-ma, when the unknown resistor is being measured, then

$$R = \frac{30}{\frac{1}{.16} - 1} = \text{approximately 5 ohms.}$$

For the convenience of Service Men, the following quantities have been measured.

.02 ma.	.6 ohms
.16 ma.	5 ohms
.22 ma.	6.6 ohms
.28 ma.	10 ohms
.44 ma.	20 ohms
.62 ma.	40 ohms
.72 ma.	60 ohms
.76 ma.	80 ohms

The High Range

With the ohmmeter, battery-operated, the high range may be secured by either the series or shunt method. The test leads should be inserted in pin-jacks C and H, switch S3 remaining closed. The position of the D.P.D.T. switch (S1 and S2) depends upon which method is used. The authors suggest that the series method be used until such time as the battery falls below 3½ volts. When this occurs the effective high range of the meter is impaired and the shunt method must be resorted to by setting the D.P.D.T. switch to shunt position. In this way the meter will give accurate readings even after the battery voltage has fallen to 2 volts because of the fact that only the value of R1 and the resistance of the meter is taken into consideration for the measurement of resistors by the shunt method.

The following is a table of meter readings obtained with various resistors under test, using the series method, battery-operated. (Switches S1 and S2 in positions E and C respectively.)

.985 ma.	150 ohms
.970 ma.	300 ohms
.86 ma.	750 ohms
.76 ma.	1500 ohms
.60 ma.	3000 ohms
.56 ma.	3300 ohms
.52 ma.	3600 ohms
.43 ma.	6000 ohms
.33 ma.	9000 ohms
.23 ma.	15000 ohms
.13 ma.	30000 ohms
.07 ma.	60000 ohms
.05 ma.	90000 ohms
.03 ma.	150000 ohms

The accuracy of the high range in the shunt position, battery operated, varies with the accuracy of R1, and for this reason no table or curve is being furnished. A table should be made by using several comparison resistors.

When it is necessary to measure very high resistances the transformer should be connected to the A.C. line, and a '01A, '12A or '71A tube inserted in the socket of the power supply. With switch S3 open, and the D.P.D.T. switch in series position, the variable resistance R3 should be adjusted for full scale deflection of the meter, when the test prods, which are connected to C and H, are shorted. The scale for this range will vary with the amount of voltage delivered by the power supply. In the ohmmeter shown, the voltage available was approximately 850 volts. D. C., and the following tabulation was made:

250,000 ohms	.86 ma.
500,000 ohms	.68 ma.
1 megohm	.64 ma.
1½ megohms	.56 ma.
3½ megohms	.38 ma.
4 megohms	.30 ma.
5½ megohms	.20 ma.
9 megohms	.14 ma.
10 megohms	.12 ma.
11 megohms	.10 ma.
12 megohms	.08 ma.
13 megohms	.06 ma.
14 megohms	.04 ma.
15 megohms	.02 ma.

In some localities, alternating current may not be available, but the ohmmeter may be employed on direct current without the A.C. power supply. The 110-volt line should be connected across points X and Y shown on

(Continued on page 60)

Read about our new plan for buying the 1931 and 1932 OFFICIAL RADIO SERVICE MANUALS. Full details concerning this will be found on page 4. Turn to it NOW.

THE "MEGADYNE"

(Continued from page 44)

One word as to aerial and ground. By using a series condenser the specifications given here pre-suppose an aerial about 125 feet long including lead-in. On shorter or longer aerials, changes should be made in the secondary winding of the coil, although it may be corrected to some extent by using a small series condenser in series with the antenna or ground. This, however, is not recommended because you sacrifice some volume in doing so.

Do not try and operate this set on a short aerial of about 50 feet, or indoor aerials because the results will not be so good. As to the ground, needless to say, the better the ground the better the set will operate. Use only a cold water pipe; gas pipe or radiator pipes should not be used.

I will be pleased to hear from those who have built the set as to the results they have achieved.

In our next issue will be described the same set electrified. It is a remarkably low priced power pack which you can build for a very small sum. No changes whatsoever are made on the battery model here described. The same tube is used, the power pack is entirely independent and is simply added to the present Megadyne set.

List of Parts

One BMS fixed crystal detector;
One Carter 6-ohm rheostat;
One Radio Trading Co. 3-circuit tuner (for .0005-mf. tuning condenser);
One Na-ald No. 425 5-prong type socket;
One Hammarlund type ML-23, 23-plate variable condenser (with shield-plate);
Four Eby binding posts;
One Aerovox .00025-mf. type W fixed condenser;
One XL-Variodenser, .0003- to .001-mf., type G10 variable condenser;
One Polymet .00025- (or, .0005-) mf., mica-insulated fixed condenser;
Five Fahnestock clips;
One roll hookup wire;
Two Kurz-Kasch, 1½ in. knobs;
One Kurz-Kasch vernier dial (scale 0-100, reading clockwise);
One Type '38 pentode tube;
One bakelite panel, size 7 x 10 x 3/16-in.;
One baseboard, 5-ply size 7 x 9 x ½-in.

WHICH AUDIO SYSTEM?

(Continued from page 49)

plifier, which, however, will require greater grid excursions than can be supplied by a '27 power detector; particularly as, since small grid currents will be drawn at maximum output, a coupling transformer of low secondary resistance and actually *step-down* ratio (1.28:1) will have to be used to feed the '45s. Consequently, one audio stage using the new '56 tube (replacing the present '27) is used between the detector and '45 output stage. This is a voltage amplifier, working, however, through a coupling transformer of step down ratio and secondary resistance reduced to a point where a small amount of power can be drawn from it to take care of the .25 ma. average grid current drawn. This, however, only occurs when the whole system is turning out eight watts. The circuit is shown in Fig. 2.

From a cost angle, there is a negligible increase for the components of the first audio stage, and as the power supply filtration of S-M receivers is excessive anyhow, no additional cost is involved here. From a quality standpoint, the system is superb, and is, it is believed, far superior to anything previously available. There is simply no comparison in clarity, brilliance and a certain smoothness due to the elimination of the psychic annoyance of excessive harmonic distortion found in other systems. Side by side with a push-pull or parallel pentode system, the latter, at any output from zero audibility to eight and even ten watts, sounds like an old battery set and horn speaker of 1921 or 1922—it is just ten years out.

The comparison with '46 class B is even more unfavorable to the latter, but this is saying little, since '46 tubes for home use are a decided step backward, apparently justified only by the fear of the tube makers of the loss of *the negative grid-bias patents and the need (for patent trading purposes) of a system that would work with zero bias.*

The '46 tubes, being merely a commercial necessity and an engineering retrogression, will give a black eye to class B amplification, which, sensibly utilized, has much merit; particularly for battery sets, where a pair of normally low-power tubes are enabled to turn out one watt of audio power at harmonic distortion rising from practically nothing to a maximum of 5 percent, and all on so little battery power as almost to make one believe in perpetual motion.

But for A.C. sets, where power consumption at most is only a cent or two an hour, class B amplification has no place, and definitely not when tied up with such abortions in the way of tubes as the '46s when used class B. And as for pentodes—well, a year is enough of them when compared with '45s in true class A.

Conclusion

This year when looking at any audio system advertised as a "high quality" system, if it doesn't use '45s or '50s in a PA system, it will be well to remember what the Chicago engineer said—"30 percent distortion in a bottle." And there will be enough good sets out anyway using '45s, even if at the moment it looks as though there would be only one manufacturer using '45s Class A—but the trade show or a month or two thereafter may change all that, so Labor Day may see not one, but myriads of sets using '45s as they should be used for good quality—in class A audio amplification.

SHORT WAVES

(Continued from page 40)

The Graphs

The scales of abscissas and ordinates are cubical, (i.e., numbers shown are proportional to the *cube root* of the numbers shown). This scale was chosen because it spaces the data satisfactorily. A linear scale would crowd the low values too much and a logarithmic scale would crowd the high values too much.

The graphs show the limits of distance over which practical communication is possible. They are based on the lowest field intensity which permits practical reception in the presence of actual background noise. For the broadcasting frequencies this does not mean satisfactory program reception. The limiting field intensity is taken to be 10 microvolts per meter for frequencies up to 2000 kc. decreasing from this value at 2000 kc. to about 1 microvolt per meter at 20,000 kc. When atmospherics or other sources of interference are great, e.g., in the tropics, much larger received field intensities are required and the distance ranges are less. The graphs assume the use of about 5 kilowatts radiated power, and non-directional antennas. For transmission over a given path, received field intensity is proportional to the square root of radiated power, but there is no simple relation between distance range and either radiated power or received field intensity.

Separate graph sheets are given for day and for night transmission. Above about 3000 kc. as shown, the distance ranges (and in most cases also the skip distances) are greater in the winter than in the summer. The distance ranges in spring and autumn are intermediate between the limits shown for summer and winter. In general, the distance ranges for paths which lie partly in day and partly in night portions of the globe are intermediate between those shown in the day and the night graphs. For such paths, the distance ranges are greater than would be expected from inspection of the day graph, as the waves under these conditions travel over greater distances in the illuminated portion of the earth's surface; for this reason it is possible to use a lower frequency for a part day, part night path than is indicated for the day portion of the path on the day graph.

The distance ranges given in the graphs are the distances for reliable reception; they are not the limits of distance at which interference may be caused. A field intensity sufficient to cause troublesome interference may be produced at a much greater distance than the maximum distance of reliable reception.

UNIVERSAL OHMMETER

(Continued from page 57)

the schematic. Where it is desired, the instrument may be made more versatile by bringing out two additional leads so that the ohmmeter may be used either on A.C. or D.C. without any added switches. However, when a D.C. line is used as the voltage source, the effective high range will be reduced to about $2\frac{1}{2}$ megohms.

It will be noted that three resistors and three tip jacks have been incorporated so that the outfit may also be used as a voltmeter. The values of these resistors depends upon the desired voltage ranges: R5, 500,000 ohms; R6, 100,000 ohms; and R7, 10,000 ohm. Voltage ranges of 500, 100, and 10 volts were obtained respectively.

TUBE CHECKER

(Continued from page 32)

List of Parts

R, 50 ohm C.T. resistor;
R1, 25 watt variable resistor;
SW, 10 point switch (with break between contacts);
SW1, S.P.D.T. push-button switch;
SW2, D.P.D.T. lock-type push-button switch;
SW3, S.P.D.T. push-button switch;
T1, T2, pin tip jacks;
V, 5 prong socket;
R2, 400 ohm protective resistor.

SERVICE OSCILLATOR

(Continued from page 35)

The oscillator is self-modulating by virtue of its grid-leak and condenser, the values of which are so chosen that the charge of the condenser is permitted to build up and block the grid before discharging through the resistance. The frequency of modulation should be quite low so as not to affect the sharpness of the tuned circuits; this frequency is adjustable by varying the grid-leak value. The tone produced in the output of a receiver should be observed while adjusting the value of the grid-leak; the frequency of C above middle-C on the piano (256 cycles), should be about right.—512 cycles.

The output is taken across a 200-ohm variable resistance, the moving arm of the potentiometer being connected to a binding post which will supply the antenna post of the receiver under test through a coupling coil or a "dummy antenna." (The oscillator should be grounded while tests are being made.)

Making a "Dummy Antenna"

In order that receivers under test should behave in a manner similar to their behavior under normal circumstances, the input from the oscillator should be through a circuit which simulates the characteristics of the average broadcast receiving antenna.

Such a "dummy antenna" is quite simple in construction, being nothing more than a small coil, a resistance, and a fixed condenser. A dummy antenna operating in the broadcast band may consist of .0002-mf. mica condenser, 30 turns of No. 32 enameled wire on a 1¼-in. form, and a 25-ohm resistance of the flexible type—all connected in series. The circuit arrangement is shown graphically in Fig. 2. This device is inserted in series with the lead connecting the oscillator with the antenna binding post of the receiver. Its use in connection with all tests where the oscillator feeds the receiver through the antenna input is essential to correct results.

Parts List

One coil for 550—1500 kc. range. 93 turns No. 32 enamel on 1¼-in. form, center-tapped, L1;
One coil, 100—200 kc. range. 400-turn Pacent Duolateral Coil with about 20 turns removed. Tapped at approximate center, L2;
One .00035-mf. Hammarlund SFL 17 condenser, C1;
One .00025-mf. grid condenser, C2;
One .5-mf. bypass condenser, C3;
One .5- to 9-megohm leak, R1;
One Electrad 200-ohm potentiometer, R2;
One Electrad 30-ohm rheostat, R3.

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A.C.—D.8 Dry Rectifier **$14.95**

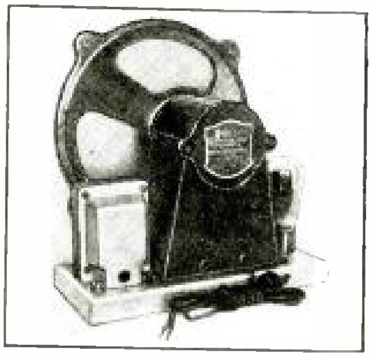
A.C.—D.7 Jr. Audit Tube Rect. ... **$10.95**

A.C.—D.15 Concert Jr. Tube Rect.... **$7.95**

D.9—2500 OHM D.C. Field ... **$7.50**

D.7—2500 OHM D.C. Field **$7.95**

D.15—Midget 2500 OHMS ... **$4.75**



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Model K. Midget A.C. using 280 Rect. ... **$8.50**

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2500 ohm P.P. Output Trans.
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2500 ohm Single Pentode.
2500 ohm Push Pull 238.
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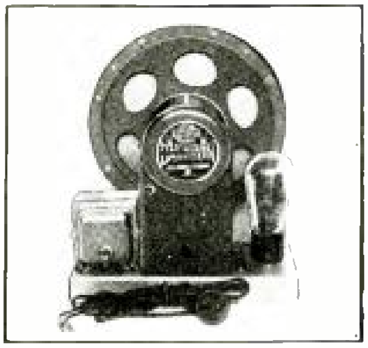

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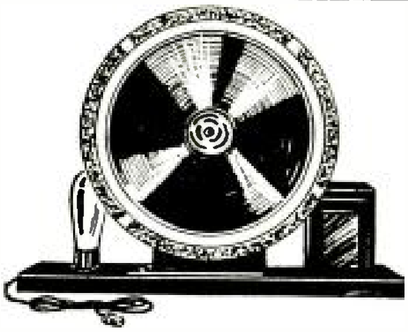

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A sturdy, powerful compact heavy duty induction type phonograph motor. Absolutely free from commutator brushes. It will not set up any disturbances. Equipped with large bearing surfaces to provide adequate support and insure long life.

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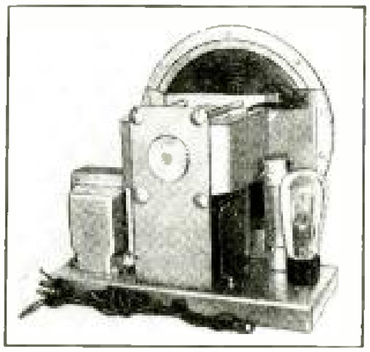

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This microphone is furnished with the latest model Radiola 86 Home recording Super-Heterodyne Receiver and amplifier. Do not confuse this microphone with the "toy" type as it can be used for many professional and commercial uses. It is a single button "mike" with a gun metal finish. It's total length is 6½" and has as standard equipment a four foot cord.

YOUR PRICE

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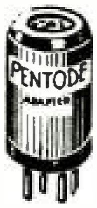

This Pentode Adapter permits the insertion of a type 247 Pentode Power Tube in place of the type 245 tube. Simply remove 245 tube, and insert the Adapter, and plug in the 247.

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9" **$5.95**

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Hotel Directory of the Radio Trade

The Hotels on this page are Patronized by the Radio Trade. Make them your Headquarters.

Important Announcement!

On pages 56 and 57 of this issue will be found a very important announcement telling of the RADIO-CRAFT LIBRARY. Be sure to turn to these pages NOW and learn of the ten new and interesting books which are being published.

JULY SPECIALS!!

EVERY month we list on this page certain *STAR* ★ items, which are NOT LISTED IN OUR CATALOG. These are all specials of which the quantities on hand are not sufficient to catalog them. *Once sold out, no more can be had.* First come, first served. Save yourself disappointment by ordering NOW.

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MOST POPULAR LOW-PRICED ANALYZER ON MARKET

This new Readrite precision instrument embodies features which have always been desired in any instrument built for service work: (1) low cost; (2) simplicity of design; (3) accuracy of measurements; (4) ruggedness of the complete unit. It is needless to add that the kit is capable of testing anything from old battery models to the latest screen-grid, pentode, and multi-mu receivers.

EIGHT METER SCALES AVAILABLE

The "Model 700" is an extremely compact device. The outside dimensions of the carrying case are only 10¾ by 7¾ by 3¾ inches. The analyzer contains a D.C. voltmeter, an A.C. voltmeter and a milliammeter. The D.C. voltmeter has three ranges: 0 to 60; 0 to 200; and 0 to 600 volts. The A.C. voltmeter has also three ranges: 0 to 10, 0 to 140; and 0 to 700 volts. The milliammeter has two ranges; one for 20-milli. reading and the other for 100-milli. **This variety of ranges makes it possible to test every conceivable radio circuit; high voltage** secondaries of power transformers, current drain of all radio tubes, including the high power 250 and 210 tubes, etc.

CONVENIENT SELECTOR SWITCH

The instrument is equipped with a six-position bi-polar selector switch; by means of which readings may be obtained of "C" volts, "C" volts reversed, "K" volts, "K" volts reversed, plate voltage, and screen-grid voltage. A 4½-volt battery is supplied with the analyzer, to provide "C" bias, for grid tests, continuity tests, etc.

TESTS PENTODES —"MULTI-MUS"— & '80 RECTIFIERS

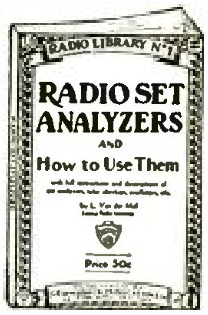
There are two sockets on the panel of the analyzer, one for four-prong tubes and the other for five-prong tubes. There is a "grid-test" push-button. Pin jacks are available for the individual use of all meters, externally, in every range. There is a screen-grid pin jack, and there are two pin jacks for connecting the external battery. A two-way toggle switch controls the testing circuit for either regular or pentode tubes. Both plates of the '80-type rectifier may be tested by use of a special adapter furnished. Charts are provided for measuring resistances and capacities.

IN LEATHERETTE CASE—REMOVABLE COVER

The Model 700 now comes in a handsome black leatherette case, substantially constructed and equipped with nickel plated corners and trimmings. **By a novel hinge arrangement the cover of the case may be swung back and removed, thus affording a completely unobstructed** view of the testing apparatus.

FREE with each Analyzer

We take pleasure in offering with the purchase of each analyzer—**ABSOLUTELY FREE OF CHARGE**—the latest radio publication to come off the press. **THE BOOK IS INTENDED FOR SERVICEMEN OF ALL CLASSES**, whether junior grade or expert. **NOTHING HAS BEEN LEFT TO YOUR OWN INGENUITY: EVERYTHING IS COMPLETE.** Contains detailed descriptions, photographs and circuit diagrams of all commercial set analyzers and testers. **A real book. Contains information on every analyzer on the market. 64 big pages. Heavy cover. Profusely illustrated throughout.**



The Analyzer is furnished complete with test leads, connecting cables, Burgess 4½ volt battery, several battery leads, UY to UX adapter, '80 rectifier adapter and resistance and capacity charts. Shipping weight, 8 lbs.

Model 700 Analyzer. List Price $35.00. YOUR PRICE $14.70

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A.C. SHORT WAVE CONVERTER KIT

Contains all parts and instructions to build a three-tube S. W. converter. Range 10 to 200 meters. Includes filament transformer for 110 volts, 60 cycles, A.C. Complete with set of 3 plug-in coils. Ship. wt. 8 lbs.

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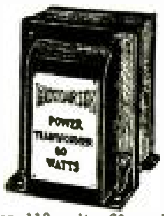

For 110 volts 60 cycle A.C. operation. 5 v. @ 2 a., 2½ v. @ 3 a. Ct., 2½ v. at 10½ a., 2½ v. at 3a. Ct., 340 V-340 V Ct.

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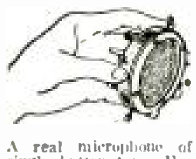

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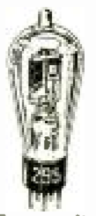

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A 110-VOLT A.C.-D.C. SHORT-WAVE CONVERTER

By W. E. SMITH

MANY short-wave converters have been described in past issues of RADIO-CRAFT but they have operated from either A.C., or D.C., or batteries. No one will dispute the convenience of possessing a short-wave converter whose source of supply is independent of the type of receiver employed, and which may be operated from either A.C. or D.C. with but the use of relays, complicated switching, etc.

The Oscillator and Detector

Of the many types of oscillators in use, the one illustrated in Fig. 1 has been found the most desirable; it is of the typical feed-back variety, the strength of the oscillations being controlled by the size of L2.

Coupling to the first detector is made through the coil L4, the size of which determines the value of the voltage supplied to the first-detector.

Construction

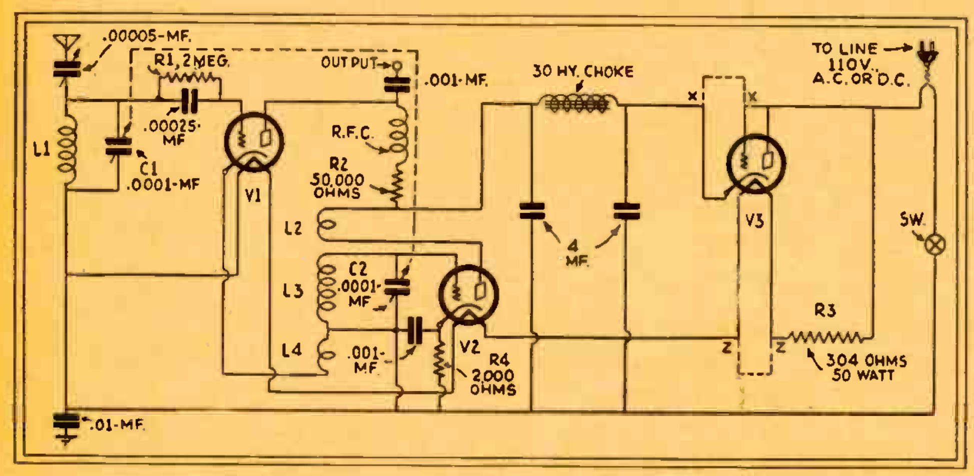
All values of condensers and resistors are marked on the diagram. The values of the coils depend upon the frequency band to be covered. Below is a table giving the number of turns on each coil, using the values of tuning condensers shown in the diagram. For higher wavelengths, additional coils may be used if desired.

Wavelength (in meters)	L1	L2	L3	L4
30-60	14	3	12½	8
16-30	6	2	6	4
55-100	30	4	26	11

The details of construction of the coils are illustrated in Figs. 2A and 2B. Two forms are necessary; one for L1, and the other for L2, L3, L4; their shape is the same as those manufactured by Silver-Marshall, and catalogued as Type "T-130." A standard 5-prong socket is used as a base for the plug-in coils.

When operated on A.C., tube V3 acts as a half-wave rectifier because its grid and plate are connected together. If operation on 126 volts D.C. is desired, all that need be done is to remove V3 and connect points X½ and Z½ together. This simple change of connection may be easily made with a D.P. S.T. switch, but has not been shown for the sake of clarity, and because it is believed that the change from A.C. to D.C. operation will not be sufficiently frequent to warrant its use.

No difficulty should be experienced in constructing and operating this receiver, as the oscillator beats the signal frequency to 1500 kc., which may be readily tuned in with most broadcast receivers. Once a short-wave station is tuned in, it is a good policy to re-adjust the tuning condensers in the broadcast receiver for maximum signal strength.



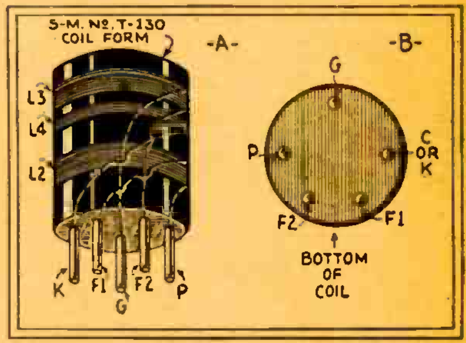


Fig. 2, above. The connections of the plug-in coils of the Universal converter.

Fig. 1, left. Schematic circuit of the 110-Volt A.C.-D.C. Short-Wave Converter.

A RADIO-DISPLAY CAR

THE new automobile shown in Fig. A has been designed and built by R. E. Tongue & Bros., Inc., and is used to demonstrate Crosley and Amrad radio sets to the public, and also to stimulate dealer interest in these sets.

The amplifier is a "Pam" Model 25-D, which operates from a 12-volt storage battery; the "B" potential of 425 volts and the "C" bias of 75 volts are obtained from batteries. Another "Pam" amplifier, Model 5-D, is employed which utilizes only three type '21A tubes, and operates from a 6-volt storage battery; the "B" potential of 157.5 volts, and the 10.5 volts of "C" bias are also obtained from batteries.

A single microphone employing two type '12A tubes operated from a 6-volt storage battery, 90 volts of "B," and 4.5 volts of "C" are used for announcing and public address work.

Five Wright-DeCoster dynamic speakers (with 6-volt fields), one at the front, two at the rear, and one at either side of the truck, complete the loud-speaking arrangements. The speakers on the front and rear are equipped with heavy baffle plates and flare horns; those on the sides, as may be seen from the illustration, are used with baffle plates only. A double phonograph turntable operated by a Radak and a Pacent pickup complete the phonograph equipment.

Preliminary tests with the car seem to have proven its value to the public. The enormous volume output enables the car to attract attention from great distances. Tie-ups have been made with the fairs in the district to have the car entertain the crowds and at the same time display the receivers.

BIASING THE PENTODE

IN the majority of modern circuits the power tubes obtain their negative grid bias through the use of a resistance between the filament and ground through which the plate current of the tube or tubes flows. This resistance is in series with the plate resistance (Rp) of the vacuum tube and the plate voltage is divided across the two. It is thus necessary that the total voltage between the plate of the tube and the ground be augmented by the required grid bias. Not only is the D.C. voltage across both the biasing resistor and the plate resistance of the tube but the signal also appears across both.

Let us consider a circuit such as that shown in Fig. 1A. To the plate voltage, it appears as in 1B, but when bypassed by a condenser as shown, the effective circuit, as far as signal voltages are concerned, is as in C. A. voltage across the biasing resistance and the condenser, which is opposite in phase to that in the grid circuit and which will neutralize the signal if the bypass condenser is not large enough to effectively short-circuit the biasing resistance to all signals of the lowest frequency which it is desired to amplify. The magnitude of this out-of-phase voltage is dependent upon the amplification factor of the tube and in the case of the pentode can become of large proportions.

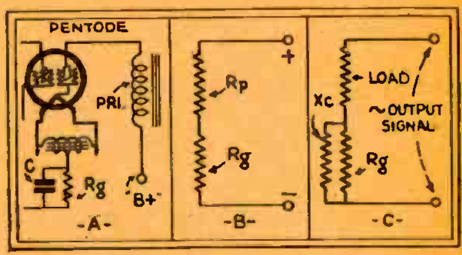
In order to suitably bypass the resistance in the case of the pentode output tube, it would be necessary to employ a condenser of from 15 to 30 microfarads. This is decidedly uneconomical and it is apparent that the use of this system in the case of the pentode will result either in the loss of the low frequencies or in the necessity for the use of a tremendous bypass condenser.

There is a way out which entirely avoids the necessity for a large condenser in this position. That is to use a circuit in which the filament is at ground potential and in which the bias is obtained from some point on the voltage divider negative with respect to ground by the required amount.

Such a circuit arrangement is shown in Fig. 2. No circuit flows in the grid circuit and there will be no voltage drop through the filtering resistance R shown, under any circumstances. The filter may therefore employ a resistance of 100,000 ohms together with a condenser of about .2-mf. to keep the signal voltages out of the power supply system.

When an analyzer is used to measure the control-grid voltage, a reading will be obtained that is lower than the *actual* grid voltage. This is due to the current drawn by the meter in the analyzer, causing a drop in voltage through resistor R. This drop in voltage should be taken into account when measuring this voltage, or else the resistor (R) should be short-circuited.

(Extensive information on the practical aspects of pentode operation is contained in the article, "Pentodes and Their Use." by C. E. Denton, which appeared in the August, September and October 1931 issue of RADIO-CRAFT.—*Tech. Ed.*)



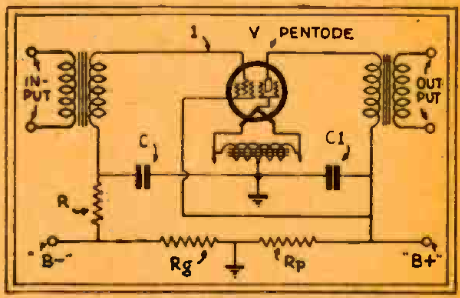


Fig. 1 above; Fig. 2 below.

Rawls

Televisor

Most efficient televisor produced for home use. Equipped with Duraluminum lens disc 16" diameter. Each of its 60 lenses accurately adjusted focally to produce clear, definite images on screen. Disc driven by heavy duty synchronous motor, with switch and framing device operated from front panel.

Short Wave

The Rawls Short Wave Unit in connection with the broadcast receiver has been especially designed for long distance short wave reception from 15 to 200 meters, Super Heterodyne Circuit incorporating 9 tubes in the combination. The use of the new multi mu and pentode tubes give exceptional tone and power. To switch from one short wave band to another, it is unnecessary to change coils—just the click of the panel switch and the change is made automatically.

Broadcast

A six-tube receiver, designed to give the ultimate in tone, selectivity and power. Uses the following tubes: two 235 Multi Mu, one 224A Detector, one 227 and one 247 Pentode output with 280 rectifier. The tone quality of the set is due to the accurate matching of all parts. Its eight-inch Dynamic speaker handles, without distortion, the tremendous output of the pentode tube. Designed especially for reception of the synchronized voice with television image.

Television

The television receiver is the most important receiver of the combination. Eight tubes T.R.F. circuit, using two 235 Multi Mu in RF circuit, one 224A Detector, one 224A, one 227 and two 245's in audio circuit, also with the 280 rectifier. Very careful attention has been given the audio amplifier and its frequency response is flat from 15 to 75,000 cycles, which is necessary to give clear, definite television images. Its two 245 tubes are so connected to supply the undistorted output and current necessary for proper operation of the Rawls crater point lamp.

To give the public the very latest in television our engineers have produced the "Ultimate in Television and Radio."—*Model TV85. . . .*

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Pioneering in the television field they were quick to grasp the need of a set *capable of producing a picture large enough for a group to sit by and enjoy.*

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RYB233	2-Volt Pentode	2.75
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RYB236	6.3-Volt Screen Grid	2.75
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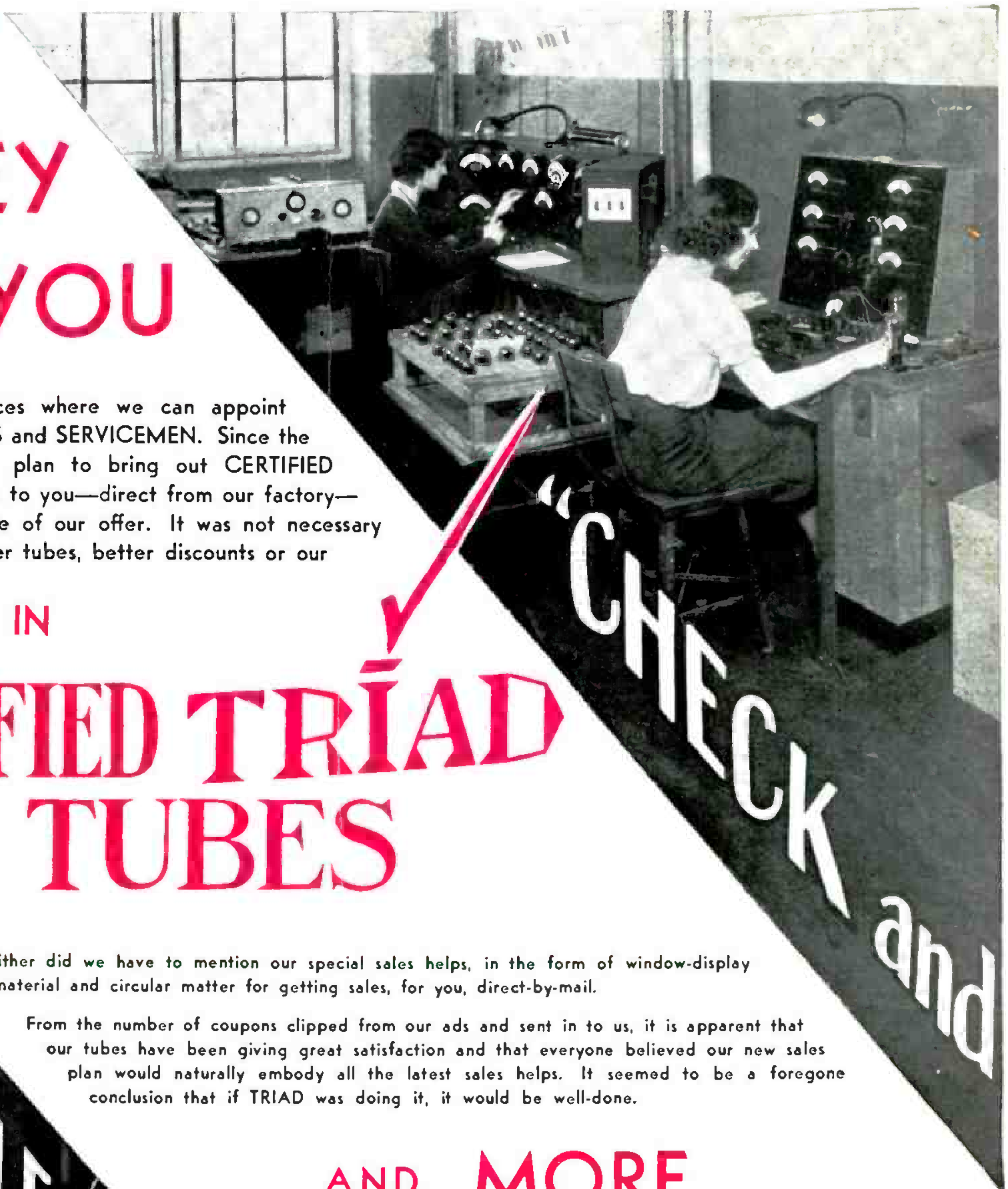

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