LATEST SERVICE DATA

RADIO NEWS

APRIL

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Radio Call Book Magazine

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Technical Review

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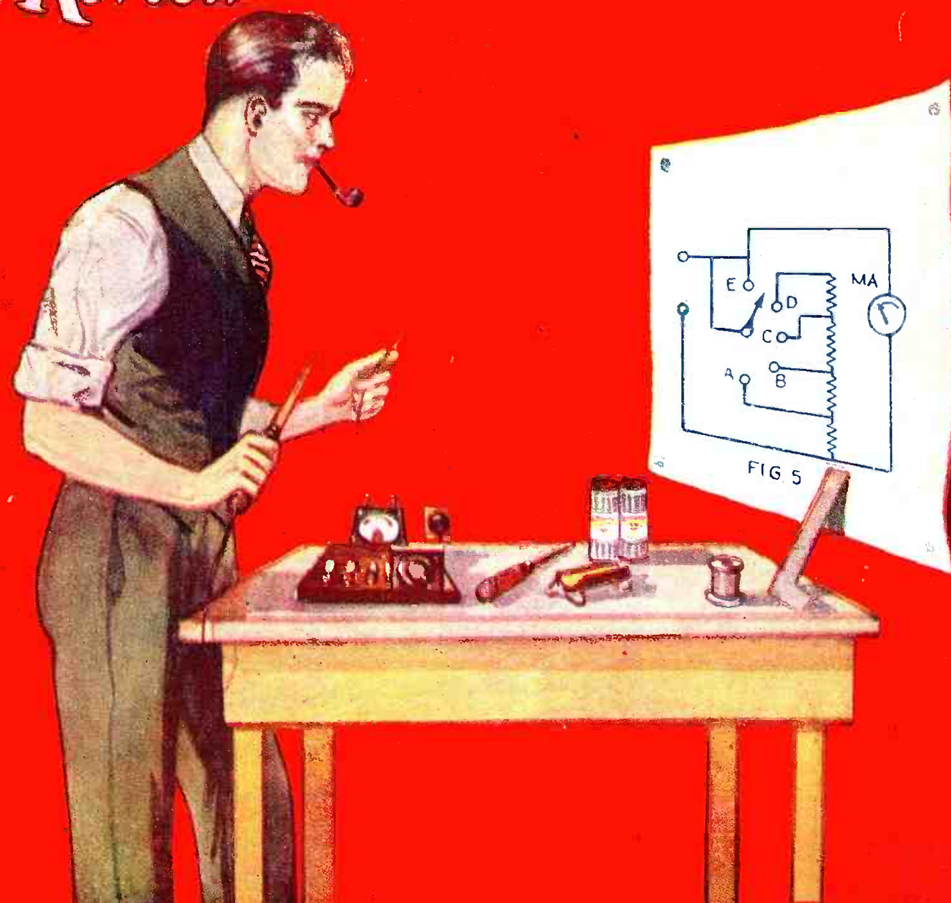
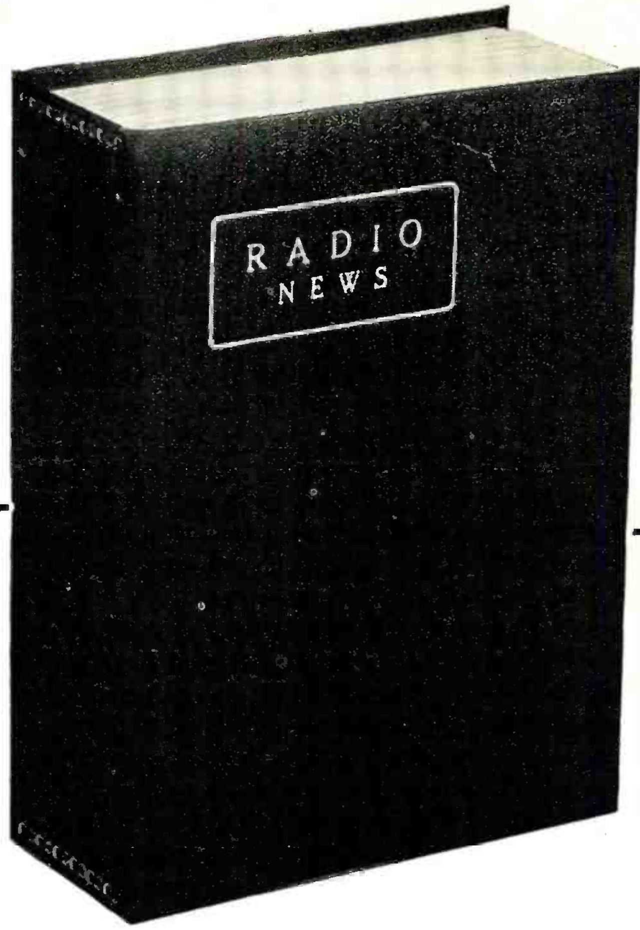


A Publication Devoted to Progress and Development in Radio

Service Work
Engineering
Industrial Application
Experimental Research

Short-Waves
Broadcasting
Television
Electronics

DX Reception
Set Building
Amateur Activity
Electrical Measurement



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MANY times you've probably hunted high and low for important issues of *Radio News*. And, when you finally found the copy you needed, it was torn and barely legible. Or, the copy you wanted so urgently could not be found at all!

No longer need you be inconvenienced by mislaid or torn copies of *Radio News*. No longer must you purchase duplicate copies to replace lost issues. A sturdy, convenient binder is now available to readers of *Radio News*.

In response to many urgent requests from our subscribers, we have obtained a first-class, durable binder constructed to hold twelve copies of *Radio News*, with the front cover stamped in gold.

We know this binder will render satisfactory service because we have tested it thoroughly by using it in our own office for months.

Radio News, Dept. 4-B
222 W. 39th St., New York, N. Y.

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Here's How To Get This Binder *Free!*

Knowing that many of our readers want these binders, we are making this special offer: Subscribe to *Radio News* for 9 months at $2 or 2 years at the money-saving price of $4 and we will send you this serviceable binder, postage prepaid, *absolutely free!* Renewal subscriptions will also be accepted!

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If you need more than one binder—if you do not care to place a subscription at this time—you can obtain these binders at the amazingly low price of $1—postage prepaid!

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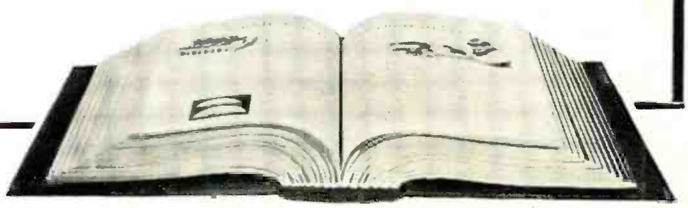

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Edited by Laurence M. Cockaday

VOLUME XIV — April, 1933 — NUMBER 10

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(*Cover Design by Morey*)

RADIO CALL BOOK SECTION

DEPARTMENTS

Published Monthly by **Teck Publications, Inc.,** ***Washington and South Avenues, Dunellen, N. J.***

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222 WEST 39th STREET, NEW YORK CITY, N. Y.

Entered as second class matter at the Post Office at Dunellen, N. J., under the act of March 3, 1879.

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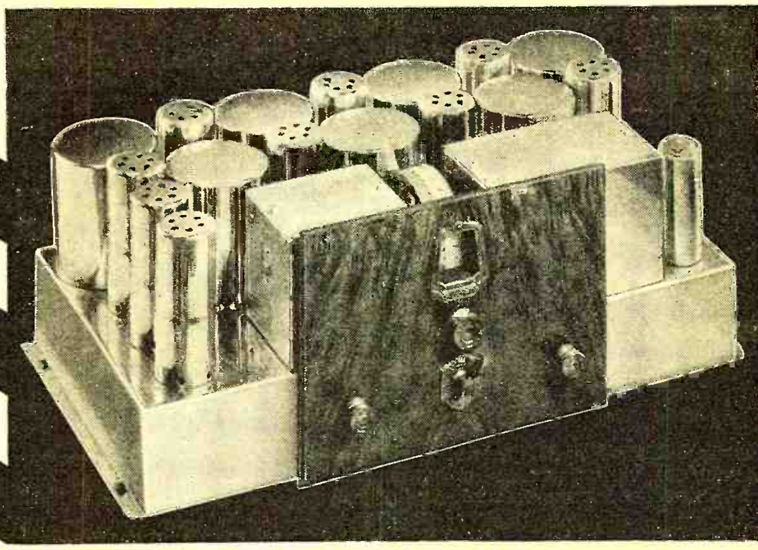
Consistent ~ day in and day out WORLD-WIDE RECEPTION

ENGLAND
FRANCE
GERMANY



AUSTRALIA
ITALY
So. AMERICA

The SCOTT 15-550 METER ALL-WAVE DeLuxe RADIO

There are no "ifs" "buts" "under favorable conditions" or other equivocations in the SCOTT guarantee. It says, simply and clearly, that the set I build for you will receive foreign broadcasts from stations as far as 10,000 miles away, with loud-speaker volume, consistently, at all seasons of the year.

In addition, every part of the set (except tubes) is guaranteed against breakdown or service failure for a five-year period instead of the ordinary 90-day term.

Beside bringing you dependable direct short wave reception of advertising-free foreign programs, this remarkable radio will receive literally everything upon the North American continent on the regular broadcast band. Its rich, natural tone is a revelation—giving you reproduction of voice and music so exact that variation from actuality can be measured only with super-delicate instruments, being undetectable by the human ear.

Such performance comes only from exacting laboratory construction, constantly checked and tested by extensive scientific equipment. Backing it is the SCOTT experience of more than eight years in building world's-record-breaking radio receivers.

Claims are easily made—a *Guarantee* is something different! Which do you want—the *hope* that your receiver can deliver performance, or *positive assurance that it will?*

Then send at once for all particulars about the radio known as "The World's Finest Receiver."

E. H. SCOTT RADIO LABORATORIES, INC.
4450 Ravenswood Ave., Dept. N-43, Chicago, Ill.

Winning Praise Galore • Vindicating All Claims

Here are just a few extracts from hundreds of letters of praise on file in my laboratories, which may be inspected by anyone. "Your claims of 10 kilocycle selectivity 100% correct," SGP, Ala. . . "Regarding tone, nothing could be finer," FW, Calif. . . . "Stations all the way from Berlin to Tokio and Australia," JBT, Conn. . . . "VK3ME, Melbourne, 10,500 miles from here, received each time on the air," CGB, Conn. . . . "European stations as much 'at my finger tips' as ordinary locals," TPB, D. C. . . . "Listen to Madrid every night while eating dinner," WHB, Ind. . . "Seven year old son regularly receiving RW59—VK2ME—VK3ME—EAQ—DJA—2RO—G5SW—Pontoise and many more," CK, Maine. . . . "Madrid on short waves (direct) just as good as WAAB rebroadcasts it," JJO'C, Mass. . . "After so much untruthful advertising it is very gratifying to get a radio set that really does what is claimed for it," CEMcK, Mo. . . "First station tuned in was VK2ME Australia. Boy, what a set!" LGD, N. J. . . "Triumphant vindication of all claims you make for it; performance convinces me you have been extremely conservative in outlining its potentialities," RD, N. Y. . . "Simply too wonderful for words," HCVS, So Africa. . . "Performance really wonderful," MC, Paris, France.

These New Brochures Tell the "SCOTT SECRET"

MAIL THIS COUPON *NOW*

E. H. SCOTT RADIO LABORATORIES, INC.
4450 Ravenswood Ave., Dept. N-43, Chicago, Ill.
Send me complete details about the SCOTT ALL-WAVE DELUXE RADIO, explaining why this set *Guarantees* the performance that others only claim.

Name...
Address..
Town.......................... *State*..............

The Editor—to *You*

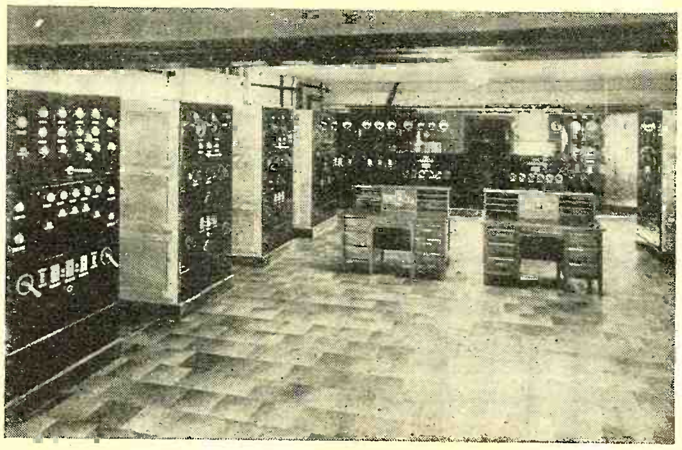
IT is always an encouragement to hear of increasing activities in the radio field. But at this time it gives us great pleasure to announce that in two fields of radio activity great progress is being made. These are, respectively, the service field and the short-wave field. A survey of radio servicemen readers of RADIO NEWS shows that their business has increased 66⅔% this month over the last eight months. This is based upon actual questionnaire replies received over this period time, and covers merchandise bought by the serviceman and resold to his service clients. The items handled range from replacement parts, tubes and accessories, all the way up to complete radio receiving equipment. It is one more indication that the radio serviceman is becoming not only a more efficient agent in his chosen vocation of repairing receivers but also an able salesman with a growing ability in business management and salesmanship. The second field of activity showing an increase is among the users of short-wave receiving equipment. What was only a year ago considered a fad, the reception of long-distance short-wave transmissions from the far corners of the earth, is now taking hold among a much larger group of listeners than heretofore thought possible. Thousands of new recruits have joined the ranks of the short-wave listeners during the last few months in America and they are persons in all walks of life. Some of those with whom the Editor is personally acquainted represent the fields of medicine, banking, art and business. And only recently such people as Guy Lombardo, Harry Reser, Frank Westphal, all well-known in the radio art, have been "bitten by the bug" and have purchased the finest type of equipment they could find for this purpose. This is not surprising, however, as the short-wave field is now established on a firm basis, due to the rapid expansion of high-power short-wave broadcasting stations springing up in great numbers all over the world. With a good short-wave set today it is possible to sit down and pull in stations 3000 to 12,000 miles distant and receive them enjoyably and comfortably. If one knows how to tune, there is certainly more thrill and adventure on the short waves *in a half hour* than on the broadcast waves in many hours' listening.

* * *

THIS brings us to the announcement of a new department in RADIO NEWS of especial interest to the short-wave fan. It is entitled the DX'ERS CORNER and tells you monthly where and when to listen for short-wave stations. The Editors will be glad to hear what our readers think of this new feature.

* * *

COMING back to the serviceman, we hope that our servicemen readers will find many things of helpfulness and value in this issue. There is an article on the installation of remote-control units for radio receivers that should bring them a profit—and their clients a lot of enjoyment. There is an article on using meters in radio and extending their value over many fields. Another article tells how to bring up to date the Set Tester DeLuxe, built and used by so many wide-awake servicemen and described earlier in RADIO NEWS. Another article gives full information on four new and important tubes. There is a description of a push-pull amplifier using the new –79 tube, as well as a complete discussion on the use of tube adapters and their applications. Still another article completes the series of three, on building a complete public-address system. This article describes the building of a seven-tube superheterodyne tuner, to be used for picking up radio programs on the public-address system. There are also four complete articles on the performance of radio receivers for both the short and long waves.



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THE illustration on this page pictures the transmitting room of the new British Empire Broadcasting Service at Daventry, England, built for the purpose of transmitting home programs to all parts of the British Empire. There are eight transmitters, using call letters GSA, GSB, GSC, GSD, GSE, GSG, on various wavelengths. The system employs seventeen directive antennas, used in pairs, for transmitting simultaneously on two wavelengths to India, to the Australasia Continent, to Africa and Canada. All of these transmissions can be heard clearly in the United States, although the best reported are those which transmit to the Canadian zone with the call letters GSC and GSA. Station GSA may be heard in the United States almost as well as a local station, on 49.6 meters, from 8 to 10 p.m., E.S.T. Have you heard it?

* * *

Coming over the editor's desk are a few letters from satisfied readers of the magazine. They are as follows:

* * *

"I HAVE been a reader of your magazine for years and must say that you put out a good magazine for us servicemen. Keep up the good work."—J. W. Myers, Vandalia, Mo.

* * *

"THIS is my first letter to you. Until recently I had a complete file of every issue of RADIO NEWS from the first to the last without a break, until someone decided they needed a few back issues, so I suffered a great loss."—E. W. Maynard, Chicago, Ill.

* * *

"I HAVE read RADIO NEWS for seven years now and I can see that there is nothing like the thrill of reading it. The cost is 1% of its value."—Diago, Havana, Cuba.

* * *

"I HAVE been obtaining RADIO NEWS by 'hook or crook' for several years 1922) and have enjoyed most of the articles from it. The ones that particularly interested me were the following: 'Electrical Filter Design,' 'Using Graphs and Charts,' 'The Radio Physics Course,' 'Mathematics in Radio.'"—Leland Tangen, Grand Forks, N. D.

* * *

MR. ZEH BOUCK asks us to insert the following requests in connection with contributions to The Service Bench:

"It will be appreciated if contributors will give a brief history of their service activities, receivers specialized in, service connections, etc. Manuscripts, when typewritten, should be double-spaced. Photographs are always desirable and in many instances help tell the story. Size of the photograph or illustration is less important than clarity."—The Service Editor.

* * *

THE Editors acknowledge with thanks the hundreds of additional letters that are received each month from readers and appreciate their comments and suggestions.

Laurence M. Cockaday

Radio Servicemen.

THE most important problem that the serviceman faces at present is the necessity of getting more profits out of his radio servicing business.

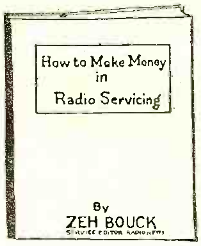
Realizing the need for sound advice and practical suggestions in this field, we offer three important books and an advertising service, with the conviction that they will prove their worth, many times over, during the coming months.

Radio News believes that any serviceman can substantially increase his profits through the medium of these aids, providing he keeps abreast of the ever-changing panorama of radio developments as presented in *Radio News.*

Each month, all the latest facts are presented, new service hints are given, new sets are described and new parts are advertised. And, all *Radio News* readers may obtain free technical service information at all times.

Radio News Presents Four Aids Toward Bigger Profits In The Radio Servicing Field

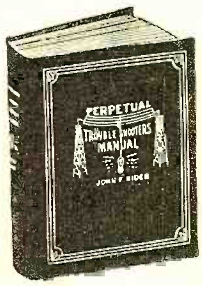
How To Make Money In Radio Servicing



This 130-page book was written by Zeh Bouck especially for *Radio News.* It gives real, practical suggestions for profits in radio servicing and contains information on the following subjects: Equipment; Contacts; Advertising and Publicity; Circularization; Service Procedure; The Service Salesman; Off-Season Business; Service Sidelines; The Business End of Servicing; How to Buy; and Keeping Up-to-Date. For profits—read this book!

"How to Make Money in Radio Servicing" is not for sale at *any* price! But it is given *free* with an eleven-month subscription for *Radio News* at $2. (Canada $2.50—Foreign $3.)

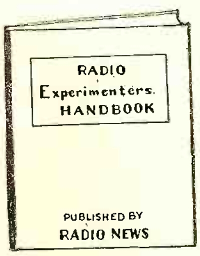
Rider's Perpetual Trouble Shooter's Manuals



Thousands of servicemen use Rider's Manuals. They contain not only wiring diagrams of receivers, but also the chassis layouts, voltage data, electrical values, color coding, socket layouts, alignment condenser data, trimmer condenser locations, etc.—in fact, all the data which the modern serviceman requires.

There are two volumes. With both volumes you will have as complete service information as is available anywhere. Through special arrangements, *Radio News* offers: Either volume of Rider's Manual with Two Years of *Radio News* for $7.50 (Canada $9.50—Foreign $10.50). Both Volumes of Rider's Manual with Two Years of *Radio News* for $12.50 (Canada $15.50—Foreign $16.50).

Experimenter's Hand Book



This new volume of 136 pages is of outstanding importance to every radio serviceman. It has chapters on: Electrical Measurements; Resistance, Inductance and Capacity Measurements; Design of Radio Components; Circuit Design; Short Wave Essentials; Photo-Electric Cell Applications; Shop Notes; Antenna Experiments; Experimental Circuits in Radio and Electronics; and Miscellaneous Radio Experiments. You need this book at your work-bench!

This book is *not for sale!* It will be sent *free* with an eleven-month subscription for *Radio News* at $2.00 (Canada $2.50—Foreign $3.00).

Advertising Mat Service

Servicemen will find this series of nine mats of special value in their newspaper and other advertising campaigns. They are standard single and double-column sizes and include all hand-work, pictures, display lettering, and, in some cases, borders. From these mats your printer can make stereotypes and set up the advertisements. Actual reproductions in miniature appear below.

This service will result in sizable savings in printers' bills. Your printer will be glad to explain the use of mats. The mats also may be used in printing cards, blotters, envelope stuffers or circulars.

The price of the set has now been reduced to 25c. The nine mats will be sent *free* with an eleven-month subscription for *Radio News* at $2.00 (Canada $2.50—Foreign $3.00)—or, if desired, you may purchase them at the new low price.

Radio News, Dept. 4, 222 W. 39th St., New York, N.Y.

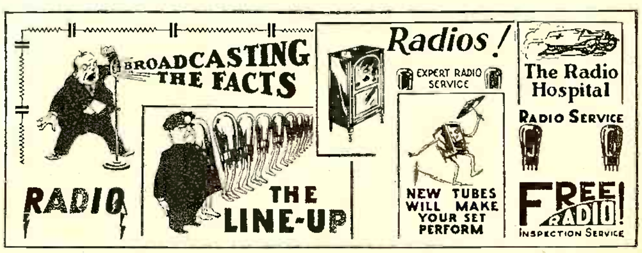
Enclosed find $........... Enter my subscription for RADIO NEWS for .... and send me the following: [If renewal, check ( ).]

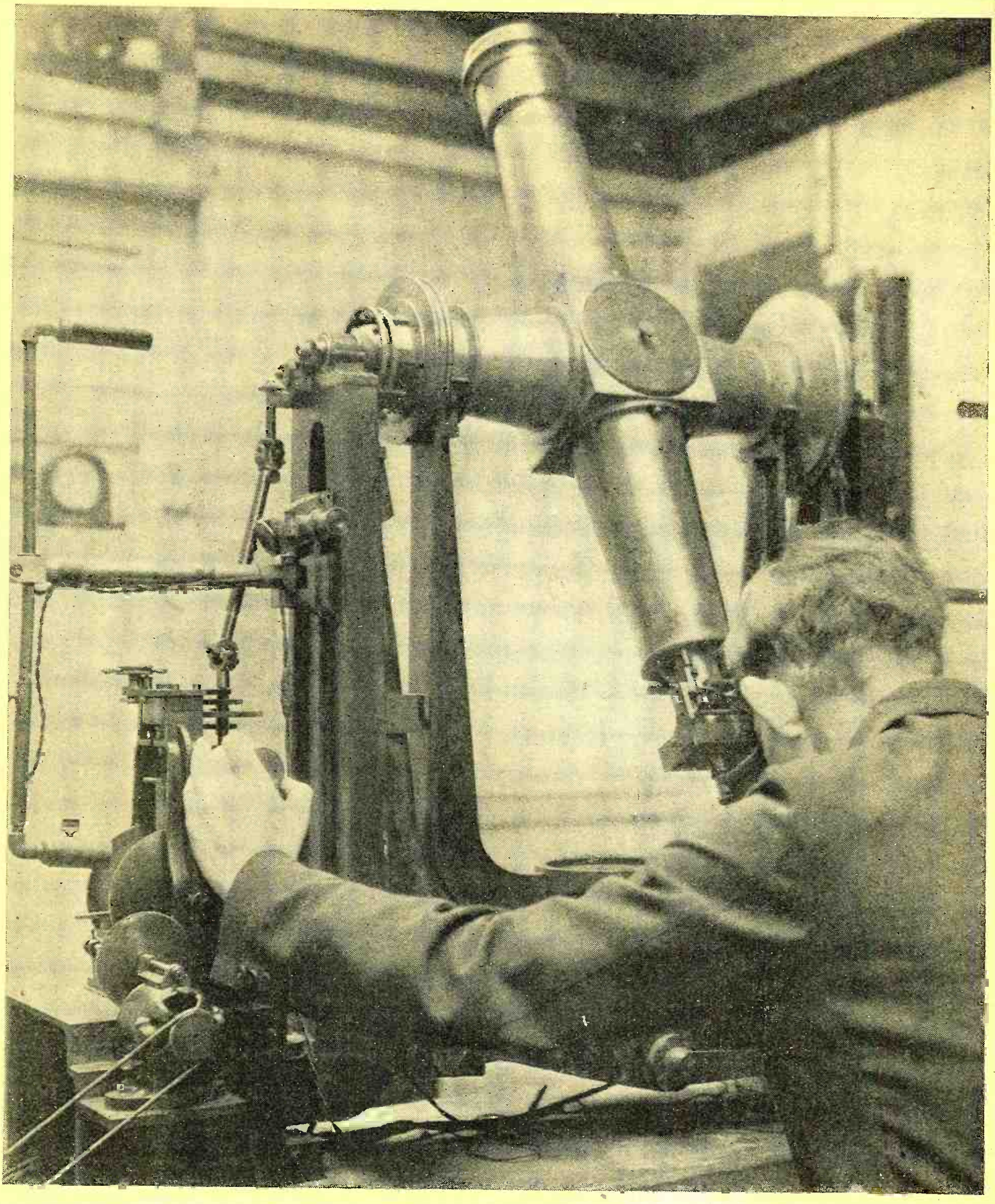
(CHECK YOUR CHOICE)
- ( ) How to Make Money in Radio Servicing
- ( ) Rider's Manual Volume I ( ) Volume II ( )
- ( ) Advertising Mat Service (free with sub.)
- ( ) Advertising Mat Service @ 25c
- ( ) Experimenter's Hand Book

Name..

Address..

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





Where Does Time Come From?

The accepted form of time, 24 hours a day, 60 minutes an hour, 60 seconds a minute, is merely man's method for arbitrarily dividing into understandable sections an existence of consecutive happenings. When a person sets his watch he gives little thought of where time comes from, but, ultimately, our time depends upon the earth's rotation, and the man who sets the world's timepieces is actually an astronomer. Every time the earth revolves, the stars seem to pass over our sky, from horizon to horizon, and of course a certain star would pass the zenith once every 24 hours. The illustration shows Paul Sollenberger, astronomer, U. S. Naval Observatory, operating a transit telescope to check the standard clocks

Radio News

VOLUME XIV April, 1933 NUMBER 10

TELLING TIME BY RADIO

How radio and astronomy have joined hands in giving to citizens of the United States what is probably the world's most accurate system of time. How radio time is made, checked and distributed is told in this interesting article by—

Walter E. Burton

THE housewife who sets her clocks by the radio, the navigator of an ocean liner and the scientist who is measuring earthquake shocks or performing other delicate experiments, all are benefiting from the services of the American time headquarters—the U. S. Naval Observatory at Washington. But it is doubtful if many of the millions of persons who listen in every day to the sharp, measured notes of radio time signals, appreciate the complicated and accurate work that stands behind each note.

In a room at the observatory is a group of instruments employed in sending out radio time signals six times a day. The transmitting clock is a large, pendulum-operated instrument that is mounted on the wall. A solenoid magnet just below the pendulum can be energized to slow down or accelerate, temporarily, the speed of the clock when a correction is necessary. The pendulum, which beats seconds, operates contacts that close a circuit at the beginning of every second, sending out the radio signal. Auxiliary equipment blots out certain seconds, according to a definite identification system.

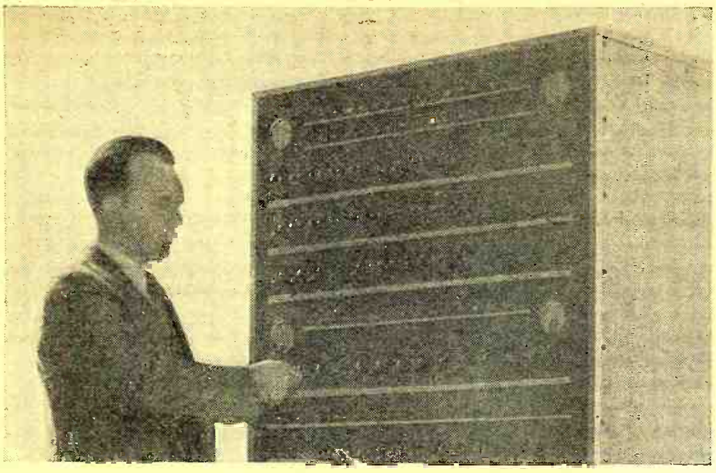
This transmitting clock is not extremely accurate, so that it must be corrected just before each broadcast. On clear nights, such corrections are made by star observations; it is the "apparent" rotation of the stars around the earth by which time is initially determined. However, all nights are not clear, so the observatory maintains a battery of standard clocks that are nursed and guarded with more care than a collection of gold bricks or the heir to a kingdom. These standard clocks are employed to check the transmitting clock, so that errors in the latter can be computed. Recently a new clock vault, buried in the earth of the hill at the edge of Washington where the observatory stands, was completed, and some of the standard clocks were moved into it. Temperature, pressure and moisture conditions are kept constant, and the vault is entered only when it is necessary to make repairs.

THE TRANSMITTING CLOCK

This is the apparatus that sends out the familiar "peep, peep, peep" of the radio time signals

Even the standard clocks are not entirely accurate. Furthermore, they are never reset. It is easier to let them continue keeping wrong time and to make the necessary corrections in time calculations, than to disturb the temperature and other conditions by entering the vault to reset them. When temperature, pressure and moisture values are kept uniform, the rate of change of the clocks remains constant, so that accurate computations can be made from day to day. Above the clock vault is a room in which is located a periscope for reading the clocks. There are concrete pedestals for seven clocks in the vault. At the present time, the clock rates can be predicted to within 1/100 second a day.

But even the standard clocks have to be checked with the stars. In peculiar little buildings, looking somewhat like chicken coops built of shutters, are located the transit telescopes employed for observing the passage of stars. The roofs of the buildings are moved to one side



THE MASTER TIME SWITCHBOARD
Through this switchboard the transmission of U. S. Naval Observatory time signals, operation of all checking equipment, control of clocks and astronomical recordings are controlled

during observations. The telescopes are not large, being about three inches in diameter. They are mounted on a rigid support so that they cannot be moved east or west, but can be swung to the north or south. The observer focuses the telescope on a star that is on a line passing from north to south through the zenith. A motor-driven mechanism keeps the telescope trained on the star, with the help of a hand-operated control that can be used to speed up or slow down the apparent motion of a cross-hair passing through the star image. The speed at which this cross-hair seems to move—it is really the eyepiece that moves—is proportional to the speed of the earth's rotation. The observer operates a micrometer attachment that causes electrical contact to be made as the star image passes other cross-lines in the eyepiece field. These impulses are recorded on paper by a chronograph which, at the same time, makes a record of similar impulses produced by the clocks being checked. The difference between the time when the stars actually pass and the time that the clocks indicate that they will cross constitutes the error in the clock. Observations are made every clear night on several stars. Furthermore, to compensate for errors in the telescope movement, the instrument is reversed, so that two sets of readings are taken on each star. It is exactly like running an airplane speed test in opposite directions in order to compensate for wind effect.

"Check and Double Check"

Even after the transmitting clock, controlled by master clocks which in turn are checked by the stars, has sent out its impulses, errors may creep into the radio time signals. So a battery of receivers at the observatory picks up the signals sent out by the transmitting stations at Arlington, Annapolis and elsewhere, and records them. An instrument developed at the observatory prints, on a roll of paper, side-by-side records of the signals from standard clocks, the transmitting clock and from the radio stations. By checking one against the other, errors can be measured. Occasionally there is a difference of several hundredths of a second between signals sent and received—an error of little consequence to the man who is catching a train, but of tremendous importance to scientists.

Time signals always begin 5 minutes before the hour, and end on the hour with a long dash. Each dot you hear is important only at its beginning, which is exactly at the beginning of the second. The end of the signal is of no importance. For this reason, a radio receiver, particularly if it operates recording equipment, should be operated at a high volume level, so that the beginning of each signal will be received with sufficient strength. The average error of time signals broadcast from Arlington is computed to be slightly more than 2/100 of a second. The Annapolis 17-8-kilocycle signal lags almost 2/100 second behind Arlington, and San Francisco still more. Plans are being made to supply the West Coast with better time signal service, so that greater accuracy will result.

A Service Available to All

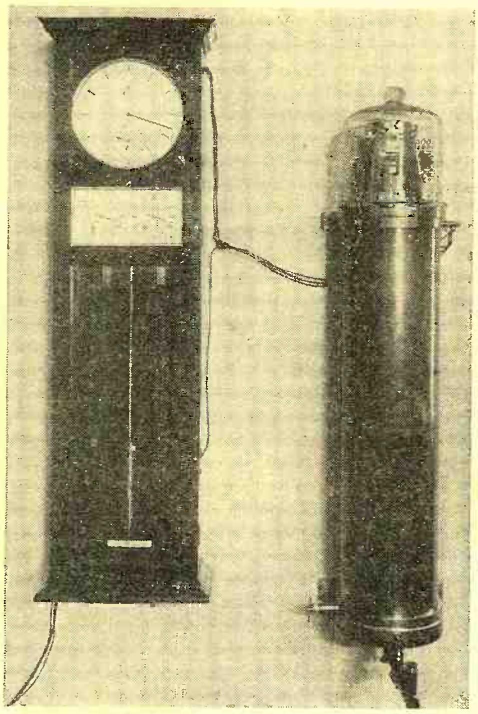
Naval Observatory time signals, first sent out for the benefit of navigators who wanted to set their chronometers with accuracy, since have found numerous uses. They are now the basis of time throughout the United States. The observatory furnishes time signal service free to telegraph companies, radio networks and others who provide wires to the transmitting room.

When oil or minerals are being located with gravity-determining equipment, time is a vital factor; so the signals are picked up with radio receivers and employed in detecting underground fortunes. They are valuable in measuring longitude for precise map making and surveying. The signals are used by radio monitoring stations for checking frequencies of transmitting stations. Earthquake records obtained by means of seismographs are coordinated with the aid of these same time signals. Scientists who are working on other problems involving the element of time frequently employ the familiar radio dots because they are more accurate than other means.

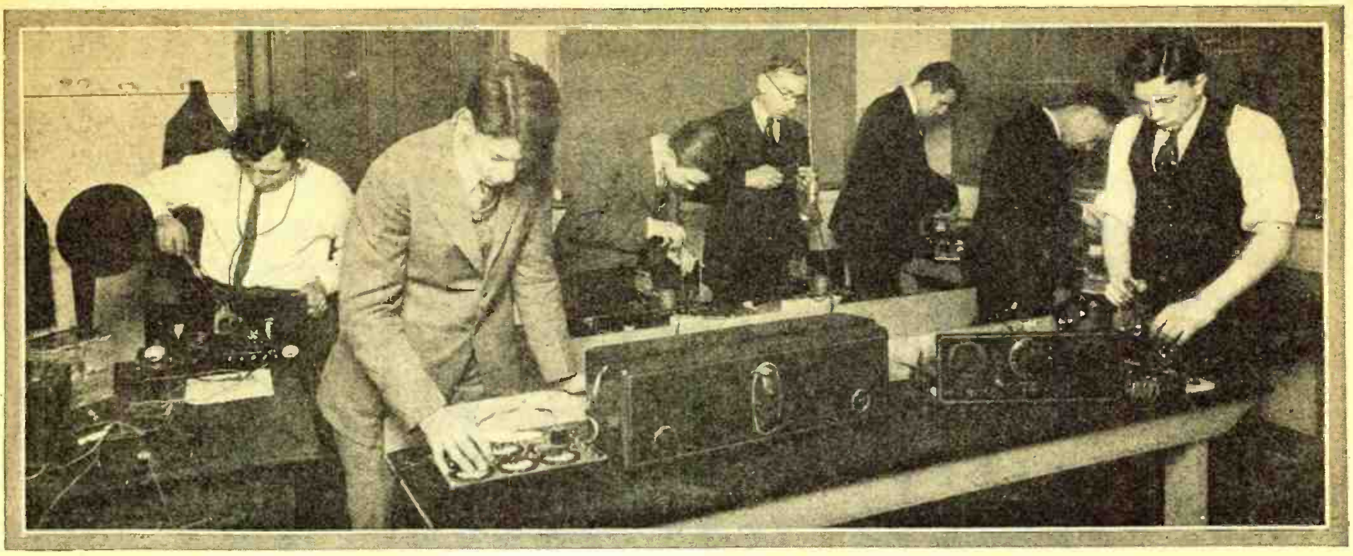
So the next time you listen in on your radio receiver for the long dash that will enable you to set your wrist watch at high noon, think of the romance that lies behind each cold-sounding "peep, peep, peep. . . ." And remember the transmitting clock and its standard-clock watchmen; and the astronomer who, with his three-inch telescope, watches over all of them.

If you have not taken advantage of this government time service you can easily do so, picking up the direct transmission by means of an easily built long-wave receiver.

(*Continued on page* 637)



A MASTER CLOCK
At left is one of the clock systems mounted in the clock vault at Washington, D. C. Below is the recording instrument that prints on a roll of paper a system of time dots indicating the inaccuracies between standard clocks, the transmitting clock and the time signals as received back from radio stations. Lt. James B. Carter is seen examining the record



The Service Bench

Servicing Volume Controls—AVC Circuits—Service Shops—Service Charges—Service Kinks—Bypass Condenser—Sales Ideas—Business Cards—Selling Noise Reduction Antennas—Sales Attractions—Servicing Superette, Jackson-Bell, Ozarka, Zenette, Majestic, RCA-Victor

Conducted by
Zeh Bouck

IT has been estimated that the volume control is the seat of more radio trouble than any other single component in the receiver, and the situation is complicated by the variety of volume-control circuits. However, standardization by the majority of volume-control replacement manufacturers has simplified the serviceman's job by boiling down the required types of controls. It is possible to replace 75% of all volume controls in their original circuits by one of three fundamental variable resistors.

The most useful volume control is the 15,000-ohm reverse taper, potentiometer type (three-terminal)—and several of these should be carried in the service kit. This volume control can be used for direct replacement in better than one-third of all receivers and, in an emergency, the volume-control circuits in any of the remaining two-thirds can be successfully modified to use the 15,000-ohm reverse-taper control. However, the serviceman will be wise to include among his standard replacement parts a 500,000-ohm reverse-taper, which services directly about 20% of existing receivers, and a 75,000-ohm regular taper which takes care of seventeen out of every hundred receivers, without circuit alteration.

Volume-control troubles fall into two general classes—*mechanical-electrical* difficulties associated with a faulty control, and the inability of the control to provide an *adequate degree of attenuation* on local stations. Faulty volume controls show up as noisy in adjustment, sudden jumps, or as having no effect whatever, due to an open circuit or a short-circuit. Inadequate attenuation is usually the fault of circuit design, and not due to any deficiency of the control unit itself. Many receivers provide excellent volume-control action on weak to moderate signal strength stations, but are incapable of cutting down to a desired minimum on powerful locals.

Noisy controls are almost invariably due to wear or corrosion at the points of contact. In the case of unenclosed controls, troubles of this nature are readily cured by cleaning both the resistance element and the arm. Emery boards, sold in drug stores for manicure mechanics, are convenient for this purpose. The arm should be removed and bent in to provide greater pressure and better cleaning action against the resistor. Replacement is the obvious and only remedy when the volume control is of the closed type.

Jumpy controls are usually due to uneven wear and, with the exception of the wire-wound type, replacement is indicated.

Sudden jumps to maximum or to minimum volume indicate an open circuit or a short-circuit, depending on the design of the volume-control circuit.

Insufficient attenuation is amenable to three possible treatments—raising the resistance of the control in the bias type of circuit, shortening the leads in the absorption design, or by changing over the volume-control circuit to a more effective arrangement.

> **Volume Control Bibliography**
>
> VOLUME control circuits have already been analyzed in painstaking detail by the publishers of the various replacement manuals and handbooks, and for categorical data of this nature the serviceman is referred to the following bibliography:
>
> *"Resistor Replacement Handbook"—Electrad.*
> *"Modern Radio Serviceman's Pocket Book"—Modern Radio.*
> *"Clarostat Control Hand Book"—Clarostat.*
> *"Mallory-Yaxley Replacement Catalog"—Mallory-Yaxley.*
> *"Centralab Volume Control Guide"—Centralab.*
> *"Perpetual Trouble Shooters' Manual," by John F. Rider, Volumes I and II—Radio Treatise Co.*

Adequate cut-off can be readily secured by the bias method when using the type -24 tube, but it is more difficult in the case of variable-mu tubes, which require about twice the bias voltage. In such instances it is desirable to pass a small amount of "B" bleeder current through the volume control, to ground, by connecting an additional resistor between a convenient tap on the high-voltage source and the high-potential side of the volume control. This additional current, necessarily, increases the bias at the low-volume point.

Absorption volume-control circuits generally shunt the volume control around either the antenna or first r.f. primary. Unless the leads to the volume control are extremely short, they will have enough reactance to force a portion of a powerful signal through the coil, definitely limiting the low-volume adjustment.

Where the procedures indicated above are ineffective or impractical, it is best to alter the volume-control circuit to a more efficient arrangement, such as that shown in Figure 1. This circuit, which employs the almost universal 15,000-ohm reverse-taper volume control, combines the actions of the bias and absorption control circuits. It is, therefore, highly efficient as a volume control, and can be readily applied to a wide variety of receiver circuits. As the bias resistance is increased, the shunt across the antenna primary is decreased. In other words, tube sensitivity is decreased along with the antenna input, providing adequate control, with much quieter reception as a worthy by-product.

The shunting action across the antenna primary necessarily detunes the associated circuits. The receiver should therefore be lined up on weak signals. On local signals the detuning effect merely provides additional and desirable attenuation.

Volume Control on the Superette

James A. Robinson, proprietor of the Robinson Radio Shop, in Methuen, Mass., con-

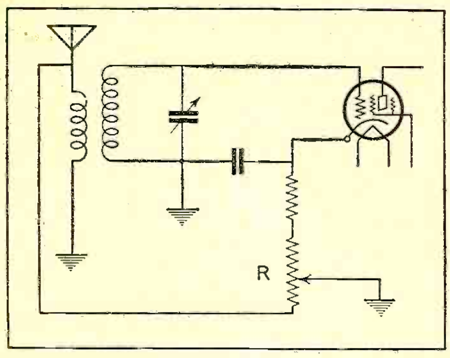


FIGURE 1

tributes the following data on volume-control servicing with the Westinghouse WRIO, WRIOA and the RCA-Victor Superette receivers.

"The customer usually complains that the variation in response is too abrupt from zero to full volume, and desires that the change be made more gradual. Under normal circumstances, and particularly when the receiver is being operated at some distance from a high-powered broadcast transmitter, only a small portion of the volume-control resistance is used.

"As the volume-control resistor is integral with the voltage-divided system, it required some experimentation before a simple method of obtaining the desired result was discovered. In the circuit diagram of Figure 2, the original volume-control resistor will be found shunted by a fixed 5000-ohm resistor. This, of course, lowers the cut-off, at the same time smoothing the action. Thus, 5000 ohms will not be the optimum value in all locations. However, a short process of cut-and-try will indicate the best value of shunt resistor for individual cases. This resistor is connected from the single soldering lug on the volume-control unit (yellow lead attached) to the metal case."

Jackson-Bell Models 62-3-4

These receivers are next in line for volume-control servicing. Writes Ernest Gray, Manager, Radio Repair Shop, Baltimore, Md.:

"When suspecting the volume control on these receivers, first check the resistance network, comprising the 3000-ohm potentiometer, 250-ohm wire-wound fixed r.f. bias resistor and the 30,000-ohm carbon resistor, connected between the screen-grid terminal on the voltage divider and one side of the potentiometer. The volume is greatest when the potentiometer arm (grounded, of course) is at the right-hand end of the resistor, limiting the bias on the type -24 tube to the IR

FIGURE 5

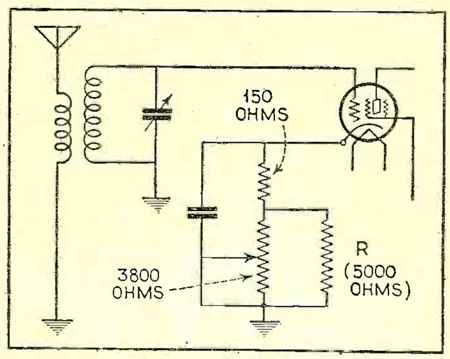


FIGURE 2

drop across the fixed resistor. This bias, however, is slightly less than the optimum value, and I find that control is improved by substituting a 2-watt, 300-ohm resistor for the original 250-ohm value.

Improved Automatic Volume

Albert R. Hodges, E.E., of Ridgewood, N. J., comments on the inadequacy of automatic volume controls (perfect control being a theoretical impossibility in the type considered) and hits upon an improvement which has been incorporated in the new National AGS short-wave superheterodyne.

"Many of the latest radio receivers are using a so-called 'improved type of automatic volume control in which the a.v.c. tube circuit is adjusted to keep the level at the output of the last i.f. stage (or, in some cases, at the input of the detector) constant for all antenna signal strengths, equal to or above, a given value determined by the design of the receiver. Then the manual control is arranged so that the desired amount of this constant output can be used to feed the audio amplifier and hence the loudspeaker. The theory behind this method is that the range of the a.v.c. or its ability to correct for varying signal strengths at the antenna is unaffected by the position of the manual control.

"A careful study of the matter, however, shows that the full advantage of a.v.c. cannot be obtained on a receiver of this design. Suppose a local station is being received and the volume level desired is obtained by having the manual control one-half on. Now suppose a distant station is tuned in. The a.v.c. naturally increases the sensitivity of the receiver as much as possible, in an effort to bring the level, at the detector grid, up to the predetermined constant value. However, if the signal is too weak to be brought up higher than to half of this desired constant level, the volume at the loudspeaker will be only half that desired. Of course, by turning up the manual control, the volume could be brought up to the required level in this case, thus proving that the receiver is inherently capable of giving the desired results, but that it cannot do it automatically. Hence the a.v.c. is not doing all that it should do to add enjoyment to radio reception.

"This difficulty can be corrected by making the initial bias (with no signal at the antenna) of the a.v.c. tube adjustable, by using a potentiometer across part of the voltage divider, connecting the grid return, or cathode of the a.v.c. tube, to the arm. If this control is mounted on the panel, it can be used to replace the former manual control, thus obtaining full a.v.c. without any additional complications. However, if it is used in addition to the regular manual control, it will serve nicely, as a between-carrier noise suppressor, by permitting adjustment of the maximum sensitivity of the receiver. If mounted on the chassis, it will serve to compensate for variations in the a.v.c. tube used, thus insuring best possible results."

THIS MONTH'S SERVICE BENCH

The service bench show in Figure 3 represents a major part of the shop equipment of the Waverite Radio Service, Quincy, Ill. It is a beautiful example of neat layout, adequate room and excellent lighting. Important tools are readily available, and the tubes, as they are removed from the receivers under inspection, are inserted in the rack under the instrument panel rather than trusted to luck on the table top. Attention is particularly directed to the plug-and-jack

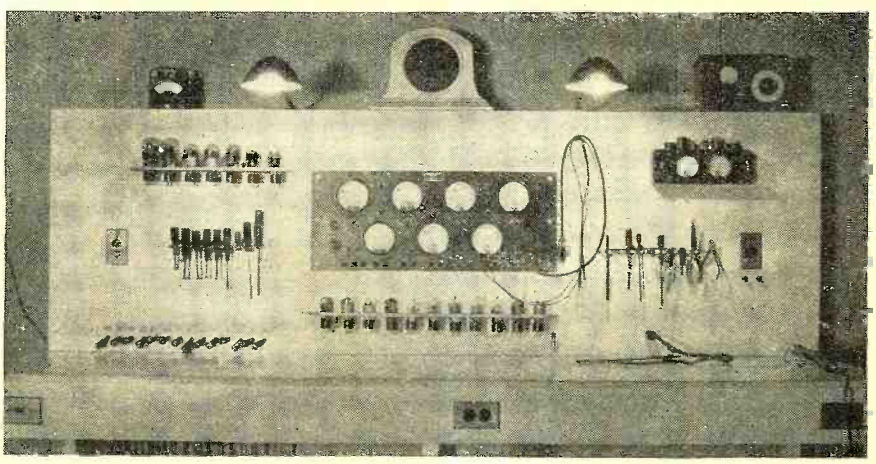


FIGURE 3

arrangement on the left-hand side of the service bench. The test equipment is conventional, and consists of the usual oscillators, output meters and analyzers. The test bench itself is supplemented with two similar benches with shelves and tools, but minus the electrical equipment, and a small machine shop.

Charges by the Waverite Radio Service are based on a rate of $1.50 an hour, plus a call charge of $1.00 in the daytime and $1.50 at night. Dealers receive a 15% discount on parts and service, netting the dealer a reasonable profit with no effort or responsibility on his part.

The Waverite organization *does not sell sets!* Their specialization is consistent, and is indicated in their slogan of "Nothing to sell but service!"

ALL IN THE DAY'S WORK

Frank W. Bentley, Jr., of Missouri Valley, Ia., specializes in service kinks, and sends us the photographs of Figures 4 and 5. Anent Figure 4, he remarks—"Pieces of gummed paper of many sizes and varieties are commonly dated and stuck to some portion of a radio tube as a check on its performance. Such scraps of paper are usually unsightly, do not stick well, making a slovenly job. A satisfactory and handy adjunct to the service kit for this purpose is a box of loose-leaf patches. These are of heavy cloth, take a pencil mark readily and retain it, adhere tenaciously and present a neat appearance. They come in boxes of a hundred and the cost is negligible."

Figure 5 solves the emergency problem of heating a soldering iron in an open fire. "It is impractical to drop the iron directly on the coals due to the quick destruction of the tip. Cut off about four or five inches of three-quarter-inch pipe. Close one end by pounding. This can be buried and packed in the hot coals of almost any kind of fire, and heats rapidly. Dropping a small iron into the pipe, it heats cleanly and with no oxidation."

By-Pass Condensers

James H. Mills, authorized Silver service station in South Haven, Mich., finds some time for other receivers, and passes on the following data on Ozarkas, Majestic and Zenettes:

"In testing an Ozarka, Model 90, don't blame the speaker if you find a voltage reading on the high side of the speaker field, but none on the low side. It is most likely a short-circuit in one of the three sections of the by-pass condenser. Two sections connect to the filament circuit of the type -26 tubes, and the remaining to the low side of the speaker field. If replacements continue to blow, then suspect the speaker, with the probability of a short-circuited field (or leads to the field), placing 300 volts on a 200-volt condenser.

"If a Majestic, Model 52, plays along fine for a while and then the volume drops or cuts out altogether, once more look to the by-pass condensers—especially the capacitor between the cathode of the first detector and the tap on the grid section of the oscillator coil. This is a .04 mfd. condenser."

Mr. Mills also mentions that low volume on a Zenette, Model A, points the finger of suspicion at the resistor which reduces the voltage on the screen of the type -24 detector tube. Probably an open circuit.

Pepping Up the RCA-Victor R-5

"Here is a wrinkle which I used successfully in improving the sensitivity of an RCA-Victor, Model R-5. This is the small, tuned r.f. receiver, and employs a system of constant regeneration, with only slight degree of regeneration control afforded by the volume adjustment. This set was installed where a good antenna system was out of the question, and the serviceman's problem was to get the utmost of sensitivity from the set.

FIGURE 4

"Removing the metal shield from the detector tube increased regeneration to the point where the receiver would just spill over with the volume control advanced to maximum, with definitely improved reception. It is necessary to readjust the trimmer condensers when this change is made."—HOWARD A. WILSON, Merchantville, N. J.

Warming-up Howl

Frank J. Faulkner of Brigham City, Utah, suggests a simple remedy for the familiar warming-up squeal:

"Many receivers using transformers in the audio-frequency amplifier howl badly while warming up. Changing tubes doesn't help, nor does reversing leads check the trouble. Shunting the first a.f. secondary with a suitable resistor will often do the trick. Start with a high value—say 200,000 ohms—and go down until the howl is eliminated."

If too low a resistor value is used, the higher frequencies will suffer. However, this "tone control" also reduces background noise and results in a false mellowness which the average listener likes. Personally, your Service Editor prefers all the highs he can get, and doesn't mind a half-minute's howl, if necessary, to get them! Needless to say, a good set should provide the highs without the howl.

SERVICE SALES PROMOTION

Iver Hansen, of Nunn, Colorado, appreciates the possibilities of rural radio servicing, as shown in his business card reproduced in Figure 6. He is also, as is evident, awake to the possibilities of hearing-aids as a sideline.

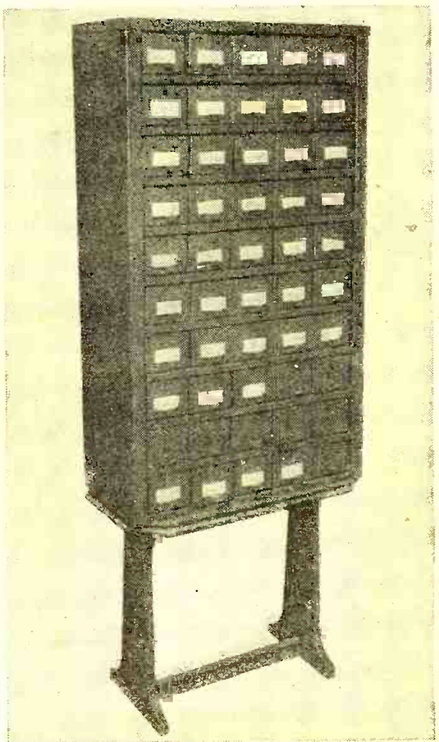


FIGURE 8

Our campaign in favor of noise-reduction lead-ins is slowly producing results, and Harry Carstairs, of Oklahoma City, contributes the circuit of Figure 7 for demonstrating the benefits of such systems. The diagram shows a typical shielded down-lead system in which impedances are matched at both the antenna and receiver terminals.

A switch at the set coupler permits the system to function either as a straight unshielded lead-in or as the balanced transmission line. In the upper position, the shield itself is used as the lead-in, the total effect being that of the conventional system, plus a negligible load between the antenna and lead-in. With different systems, a slight modification of this arrangement will suggest itself to the serviceman. Writes Mr. Carstairs:

"I have a vacuum cleaner permanently located on the floor above the shop, within five feet of the down lead. The cleaner can be switched on and off from the shop. The demonstration is most impressive. The racket from the cleaner is intolerable when the system is operated as a straight lead-in—and altogether inaudible when the shielded transmission line is used!"

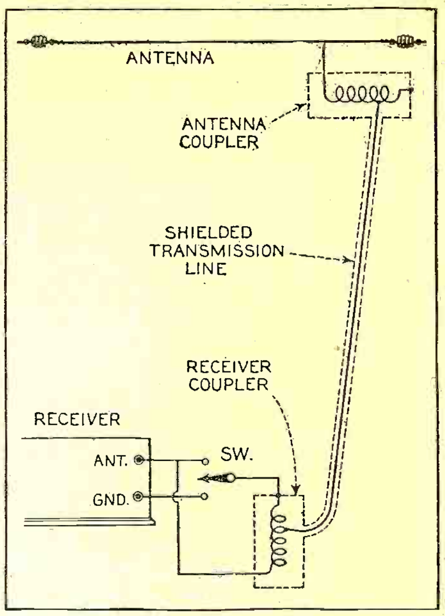


FIGURE 7

The steel resistor cabinet shown in the photograph, Figure 8, will make an attractive addition to the service shop. The implication of system and efficiency constitutes a subtle sales urge. It is being distributed free of charge by the Lynch Manufacturing Company with every order for five hundred resistors. It contains fifty drawers, 8 by 3 by 2½ inches. The overall dimensions of the cabinet are 33 inches high, 18½ inches wide and 8½ inches deep.

SERVICE NEWS OF INTEREST

A new catalog, recently issued by the S. O. S. (Sales On Sound) Corporation at 1600 Broadway, New York City, relates to several highly-profitable service sidelines, employing sound-recording and reproduction systems. New York servicemen will find it worth while to visit the main show rooms of this company where several unusual photo-electric adaptations are on exhibit.

P. A. in Department Stores

Wright-DeCoster suggests several simple rules for the operation of department store public address systems, employed principally for background music.

"Right here, we must warn you that nothing can make a good installation fall down flatter than a poor operator. The music must be played very very softly. The records should be popular or light pieces; preferably all music with no voice. Organ records are very good.

ELECTRICAL HEARING AIDS

IVER HANSEN

RURAL RADIO SERVICE

TUBES AND BATTERIES NUNN, COLO.

FIGURE 6

"If the department store has a record de-

(*Continued on page* 637)

SOME NEW USES FOR VACUUM TUBES IN THE ELECTRONIC ARTS

By **Irving J. Saxl, Ph.D.**

Part Two

USE has been made in this construction of a property of the radio tube not very well known commonly. It was discovered by Mr. Siegmund Strauss. Mr. Strauss is not new in the field of radio. He is known as a collaborator of Robert von Lieben, whose construction of the cathode-ray relays brings about practically the same construction which later was used by Dr. Lee de Forest (German patents Nos. 179,807, 236,716, 249,142, 254,588).

There are a number of other constructions to which the radio sciences and arts are indebted to Strauss. Among other things, in 1912 he invented the tube transmitter based on the back-feeding principle (Austrian patent 71,340); in 1914 he invented the resistance-coupled amplifier (German patent 458,197) and in 1925 he invented the vacuum-tube device for the measurement of very high resistance and small ionization currents (German patent 371,061).

This last invention, with which he determined the highest resistance and the smallest ionization current, tends to become more and more important.

How are ionization currents measured? For detecting the ionization, a number of specially designed chambers have been used. Figure 1 shows an X-ray picture of the Strauss ionization chamber. It is important that the chamber as such does not absorb many X-rays. It will be seen that the sensitive collector chamber, A, appears only as a very faint shadow, showing that X-rays can pass through the chamber practically without absorption.

For very soft X-rays—so-called "Grenz" rays—another type of ionization cell is used, as shown in Figure 2. The sensitive surfaces consist of particularly thin layers of skin, such as is used for beating gold. The electric conductivity of this material has been achieved by covering it with pulverized graphite. The absorption of X-rays, even the softest ones (longest wave-length X-rays) in the walls of this type chamber* is negligible. The fact that these latter cells are very sensitive to mechanical disturbances results in the other cell, which has a more sturdy construction, being used in general work.

FIGURE 1. X-RAY PICTURE OF AN IONIZATION CHAMBER

FIGURE 2. IONIZATION CHAMBER FOR SOFT RAYS

FIGURE 4. A PRECISION HIGH RESISTANCE

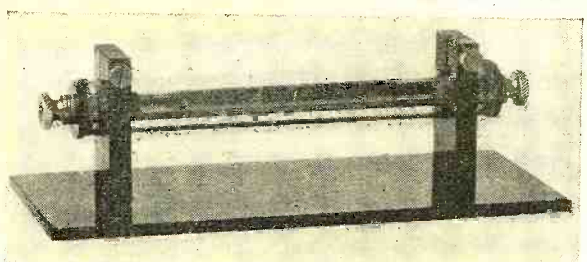
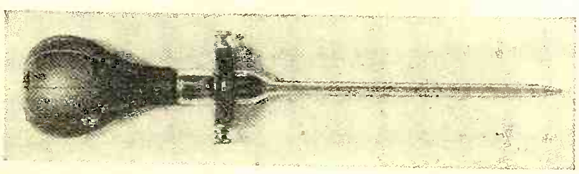


FIGURE 5. PIPETTE FOR FLUID MEASUREMENT



If we charge the grid of a vacuum tube, highly negative, then the negatively charged particles emitted from the filament cannot penetrate through the grid; they are repelled. No current therefore can flow from filament to plate.

In Figure 3 we show the fundamental idea of this construction which Strauss calls "Mekapion." Assuming the fact that the grid has a high negative initial charge and the vacuum tube is highly insulated, no current flows between filament and plate unless this negative charge is permitted to leak off. How can this be done?

The grid is connected through a condenser, X, to the positive side of the B battery. Connected parallel to the condenser is the ionization chamber; for instance, the chamber shown in Figure 1. The grid has an initial negative charge which is held by the capacity, X, and the leads of the ionization chamber. This initial charge can flow off *only* through the ionization of the chamber, C.

If this negative charge has fallen below a certain amount, a considerable electronic current suddenly takes place. This current flows through an electromagnet, M, and returns to B plus of the battery. In this moment something else takes place also. The electromagnet, M, has attracted a lever, and this lever also opens a contact. Connected to this contact is a current supply (storage battery connected to one side of the transformer, PQ). If the current is interrupted in the winding P, the collapsing lines of the electromagnetic force build up a charge on the secondary, Q. This is designed in such a way that if the current is interrupted in P, a highly negative potential is produced on the outlet of Q, which is connected through the chamber to the grid of the tube. The grid therefore immediately receives this negative potential which interrupts the flow of

FIGURE 3. SCHEMATIC DIAGRAM OF THE MEKAPION

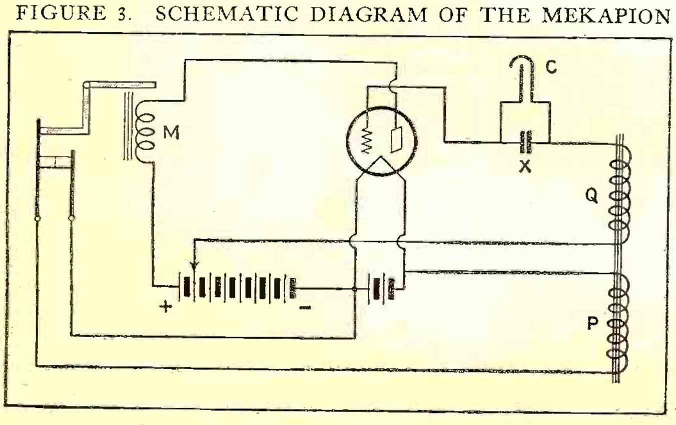
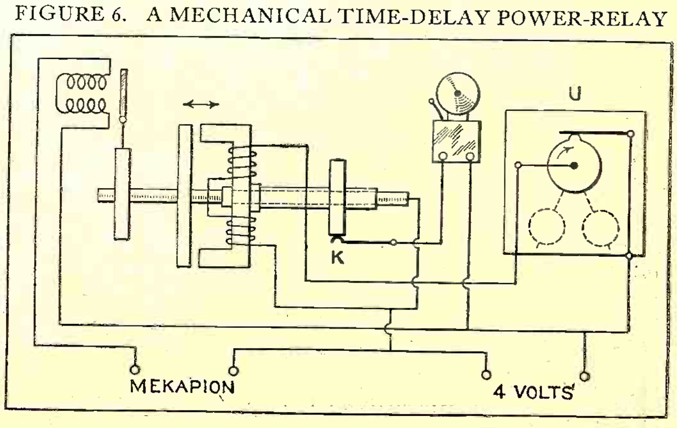


FIGURE 6. A MECHANICAL TIME-DELAY POWER-RELAY



electronic current within the tube. It will remain interrupted until the résistance of C has broken down again far enough so that a current can flow through M, again interrupting P and building up the charge on the secondary, Q.

Introduces Time Element

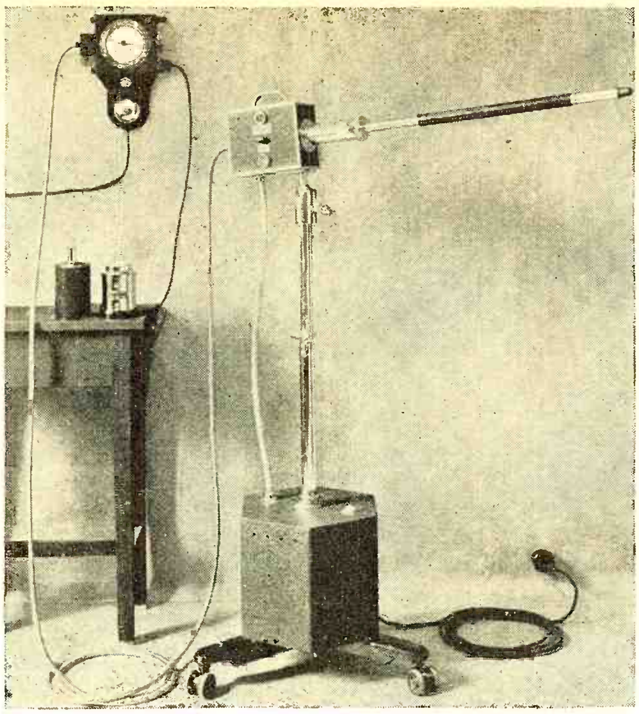
This makes possible the integrated registration of currents by introducing the time element. The stronger the X-rays or the smaller the resistance which can be put in C, the more impulses per unit of time will be allowed to pass through the tube.

Currents which would be too feeble to operate relays can be used if accumulated upon the capacity, X, in this particular circuit, to operate the necessary relays within the plate circuit.

It is possible to calibrate this circuit by known radioactive preparations; for instance, a standard of uranium oxide.

If the standard is connected to the Mekapion, this small current can be used in place of the feeble ionization current produced by the irradiation of the chamber with X-rays. The only difference consists of the fact that this current radiated from the uranium standard remains constant. Provided the right voltages are supplied to the tube elements, the period of discharge of the Mekapion has to remain constant, a fact which can be easily controlled with a stop watch; an electrical measurement has been referred to a comparison with instruments measuring time. As these observations can be extended over a long period, if desired, an almost unlimited degree of exactness can therefore be reached.

Instead of the uranium standard, it also is possible to use a high ohmic resistance, as shown in Figure 4. This resistance consists of an inner cylinder of amber. Around this cylinder are wound spirals of a thin layer of metal, the dimensions of which give the magnitude of the resistance. The resistance is enclosed by a glass tube to protect it from atmospheric influences, such as moisture, dust, etc.



DEVICE FOR COUNTING "X-RAYS"

Figure 8. This is the Mekapion X-ray integrater with the ionization chamber located on one end of the horizontal rod. The power transformer and other accessory apparatus are in the shielded container at the base of the instrument

Resistance Measurements

The possibility of substituting the ionization chamber with various other materials of known or unknown electrical resistance makes possible the application of this type apparatus for a great number of other devices. For instance, a routine test of bakelite bases for vacuum tubes can be made with the same outfit.

This system has been used in the control of the production of bakelite products, making possible the continuous checking of the flow of material during work. It is also possible to measure the resistance of fluids with this method, for instance, for testing the insulation of various oils. A simple outfit for doing this is shown in Figure 5. It consists of a pipette with a rubber balloon on one end. Across the pipette electrodes are inserted in the glass, which holds them a constant distance apart. The oil is sucked in the pipette and the resistance between the two plates is measured by the Mekapion. This is important for the testing of insulating oils in factory tests, for the controlling of insulation of these oils during their operation, etc.

Suitable high-tension transformers and switches rely upon the insulating properties of various oils. The resistance of these oils changes during the work, and it is important to find out whether the resistance of the oil has been broken down before a dangerous discharge takes place within the metallic parts of the device.

Differences in the number of impulses (within one minute) have been found to be of the magnitude of 1 to 40 between excellent insulating oils and oils not suitable for this purpose.

Also, for the construction of electric paper condensers, it is important that the paraffin used in impregnating the paper has the highest possible electric resistance. For this and other applications where the *maintenance of high resistance* is of major importance, this quick and reliable method has proved important.

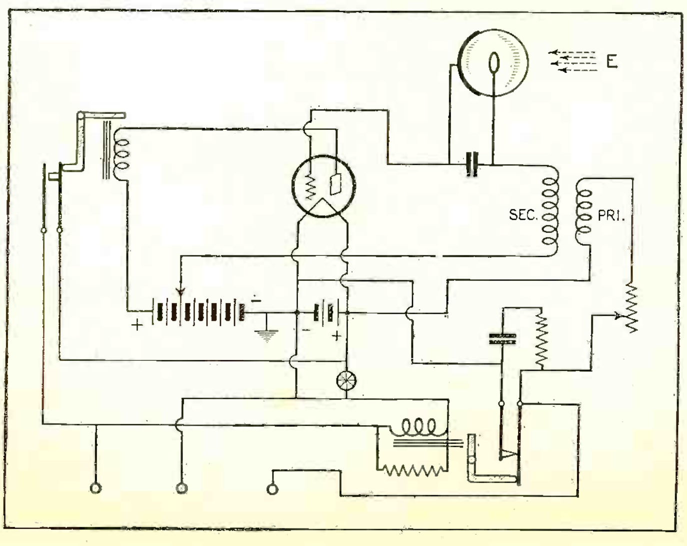
Routine Checking of Insulations

The insulation of materials of many kinds can be tested with such a device quickly and in a more fool-proof way than with any electrometer or galvanometer heretofore used. With this instrument, objects can be tested which in themselves have a high insulation but change this resistance against the flow of electricity under the influence of vapors and gases under different pressures. Making use of this effect, the pressure of air and its humidity can be measured and registered exactly.

By using relay signalling apparatus similar to that shown schematically in Figure 6 in connection with the Mekapion, the humidity within factories can be controlled effectively. Great possibilities are thus opened for apparatus of the Mekapion type, which uses photo-cells instead of resistances.

Figure 7 shows a wiring diagram of this method applied to the measurement of light. The light rays, E, falling upon a photo-cell, produces an electronic current. The more light falling upon the cell, the more electrons are generated; thus the resistance of the space within the photo-cell breaks down.

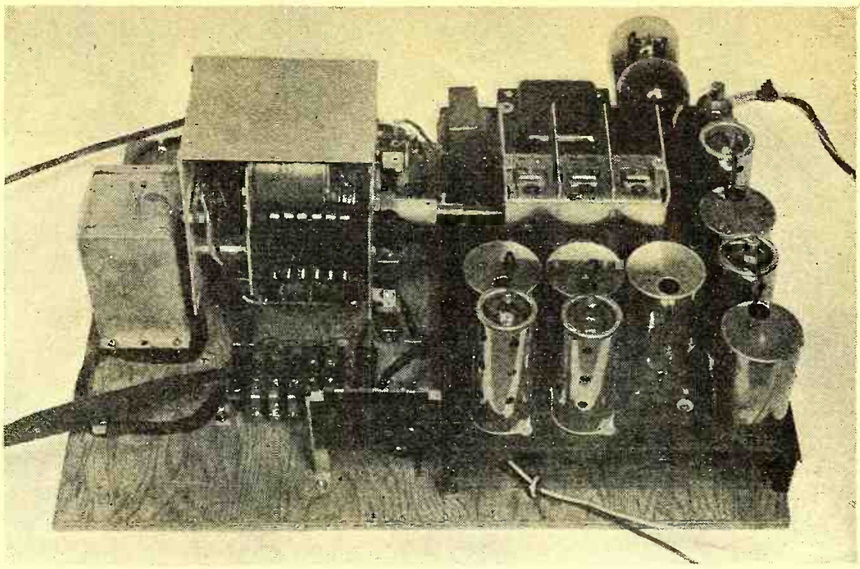
FIGURE 7. CIRCUIT FOR MEASURING LIGHT



By putting the cell across the condenser, it acts as a variable resistance, the changes of which vary in accordance with the intensity and wavelength of the beam of light.

But instead of measuring individual impulses over a short period of time, it is possible to register exactly the total light energy which was received at a certain area within a definite time. This method is of importance for the determining dosage of ultra-violet "baths." Put the patient under the ultra-violet lamp, put this "light-

(*Continued on page* 634)



A COMPLETE SET-UP

The remote control equipment is shown here, installed on Lafayette 7-tube superheterodyne. The remote control motor and drive equipment unit is mounted beside the receiver and direct-coupled to the tuning condenser shaft. The remote control box is connected to the motor by a cable

REMOTE CONTROL

FOR ANY SINGLE DIAL RECEIVER

With the inexpensive unit described here any one-dial receiver can be tuned and completely controlled from a point up to 75 feet distant. Installation is simple and results certain

By Harry Georges

IT is superfluous to state that the serviceman is not in business for his health. Like every other business, servicing *must* show a profit. To make it do so, the serviceman is obliged to take advantage of *trends* in radio, giving the public what it desires and demands.

Many business men fail to appreciate the fact that it is extremely expensive to try to create public demand by a process of education. On the other hand, where such a demand exists, it is very profitable to cater to it.

In radio, we have had many object lessons to illustrate this point. During the past few years there has been a constant trend toward simplification and compactness in radio receivers. When the midget sets first appeared, wide-awake radio men reaped a rich harvest from them. Recently, history repeated inself, with the introduction of the unique portable a.c.-d.c. sets. Because these convenient little receivers followed the trend of demand, their sales appeal has been enormous.

And now, once more we find another radio development which promises great popularity and hence opportunities for profit. The American public has placed a definite stamp of approval on radio "remote control" as a refinement offering greatly increased convenience. Some of the most important radio receiver manufacturers, such as Philco, Stromberg-Carlson, RCA-Victor, etc., have recognized this fact and have announced new models equipped with

ARMATURE IN VOLUME CONTROL POSITION

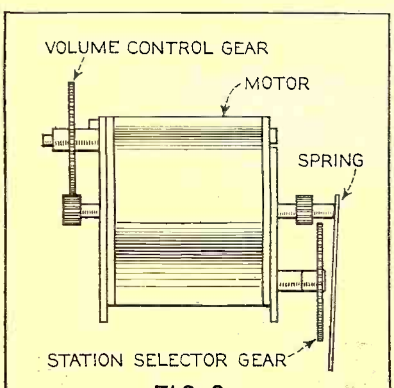
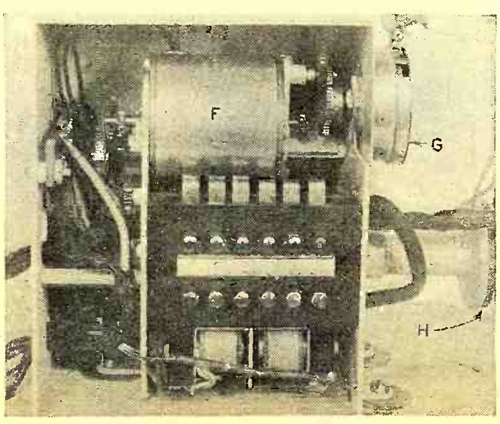


FIG. 2

THE MOTOR DRIVE UNIT

The local station selector control and pre-selector buttons are shown in the foreground, the motor at (F) and volume control at (G). The coupling gear (H) is replaced by suitable direct drive coupling adapter



ARMATURE IN STATION SELECTOR POSITION

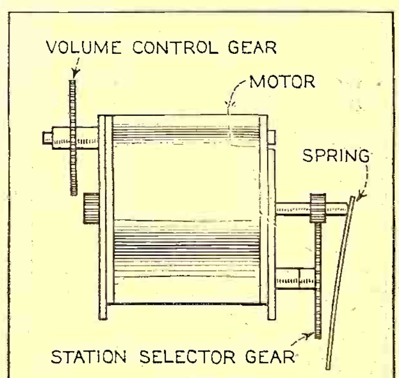


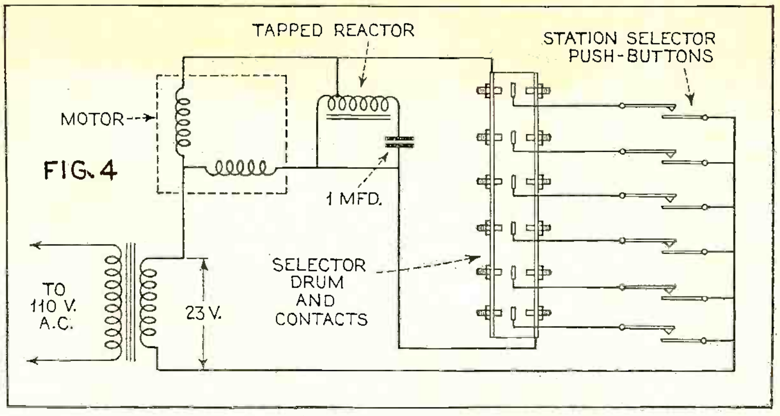
FIG. 3

remote control. There are, however, hundreds of thousands of older model sets, excellent in every other respect, but not fitted with remote control. Owners of these latter sets will want to have them modernized, and the fulfilment of this desire will serve as an unlimited source of profit to progressive servicemen who know opportunity when it knocks.

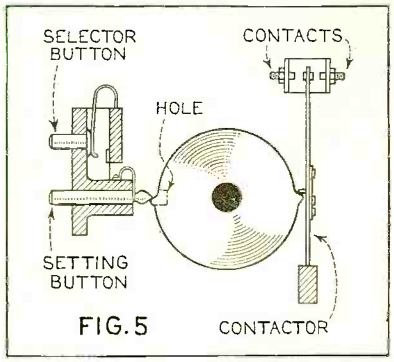
To be salable, the remote control must be well made, reliable, positive acting, noiseless and easy to install. Furthermore, it is essential that its price meets the limitations imposed by present economic conditions. Otherwise it will remain unpurchased, no matter how much it is desired.

The remote control illustrated in Figure 1 and described in this article meets these specifications in every particular. It is highly efficient, can be installed readily on almost any radio receiver and can be purchased complete at such a low price that the serviceman can give his customers a superfine remote-control job, charging the very reasonable sum of $25.00 and still make a respectable profit.

This idea is worth thinking about, and if the thought is followed up by action, remote control will help to remove the word "depression" from the 1933 vocabulary of the radio serviceman.



THE MOTOR CIRCUIT



DETAIL OF SELECTOR DRUM

The conception of controlling and operating a radio set at a distance is by no means new. However, the first attempts to construct such devices were crude and costly. The electrical and mechanical difficulties were gradually ironed out, resulting in the modern control unit described here. This device is shown in the accompanying illustration, in this instance hooked up to a Lafayette seven-tube superheterodyne receiver. Any other single-dial receiver could be used with the remote control in exactly the same way. With this unit the receiver may be tuned and controlled from any desired remote point or points merely by pressing push-buttons. The device turns the set "on" or "off," accurately tunes in any one of the six preselected stations, and increases or decreases volume. Manual tuning, other than necessary for the original setting of the selector buttons, is entirely eliminated.

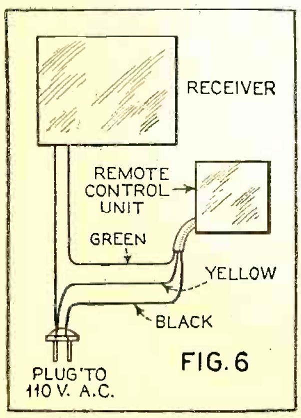
Two push-buttons are provided for the "on" and "off" operation and two for volume control. When one of the volume-control buttons is pressed, volume gradually increases. When the desired volume level is attained, the finger is removed from the button. The other volume-control button simply reverses the process, reducing the volume to the desired level.

Six push-buttons are provided for tuning in different stations. The equipment may be so set that pressing the button at the left starts the tuning condenser rotating in one direction and pressing the button at the right reverses the direction of rotation. The tuning condensers stop instantaneously when the finger is removed from the button. Thus it is possible to use these two extreme buttons for general tuning throughout the entire dial range, using only the four other buttons for tuning in local stations for which they have been set, making tuning of the four locals automatic, the only manual operation required being to press the proper button and hold it down until the pilot light flashes bright. In New York, for instance, these buttons may be adjusted so that pressing one button will bring in WEAF, pressing the second button brings in WJZ, the third WOR and the fourth WABC. If desired, six stations may be pre-selected, using all six push-buttons, and the general tuning still will be possible because the tuning condenser may be stopped at any intermediate points by taking the finger off the push-button when the desired stations other than those pre-selected are heard.

This remote-control outfit is made by the Westinghouse Electric and Mfg. Company. To those who are familiar with the electrical industry, this fact speaks volumes regarding the materials and the construction of the device. Even a casual examination readily reveals the accurate, precise workmanship and the excellence of the materials employed.

The remote control incorporates a specially designed capacitor motor about 2 inches in diameter by 2 inches long. This is coupled to the tuning condensers of the receiver through a series of precision reduction gears. Metal pinions and fiber gears give absolutely noiseless operation. A powerful relay turns the set "on" or "off." A series of drums and contactors start the motor in the right direction for a given station and stop it exactly at the right point. The volume control is also geared to the motor. Push-button control is available at the receiver as well as at the remote control box. Twenty-five feet of flat cable permits the control box to be placed anywhere within this distance from the receiver. It is possible to install any number of additional control units, and the cable may be lengthened to a (*Continued on page 627*)

INTERCONNECTION OF 110-VOLT A.C. CORDS



THE REMOTE CONTROL EQUIPMENT

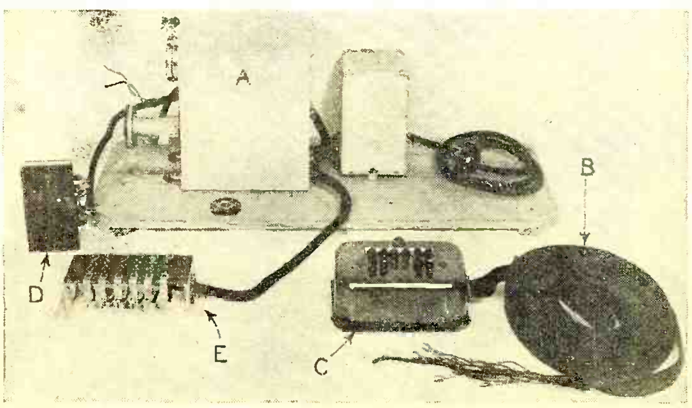
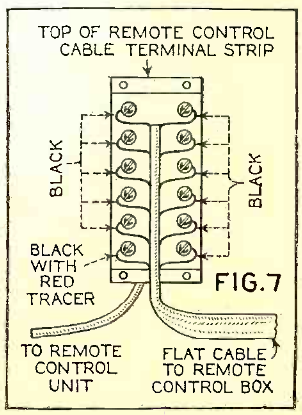


Figure 1. The complete outfit as purchased, ready for installation, is shown here. (A) The motor and drive unit; (B) the connecting cable; (C) the remote control box; (D) the local control; and (E) the cable terminal block

CABLE TERMINAL BLOCK (E) AT THE MOTOR



Extending Meter Ranges

BY MEANS OF MULTIPLIERS AND SHUNTS

Practically every serviceman and experimenter has frequent occasion to use meter shunts and multipliers, but not everyone knows how to figure proper values for a desired range extension. This article tells how—and why

By George A. Eaton

ALL resistances used in conjunction with the various instruments herein described should be of the wire-wound type, as this is the only type that will withstand this sort of service and still maintain its original value over a long period of time. Shunt resistances, such as are used with current meters, are of an especially critical nature, as they are often required to carry 10 to 20 times as much current as the meter itself. In order that these units give the desired results, they must have a low temperature coefficient. If a resistance is to be enclosed in a space where there is a poor circulation of air, it should have a power rating at least twice as great as its normal calculated rating. The best resistors are wound on hollow, perforated tubes of glazed porcelain or some other equally good insulator that has the property of dissipating heat quickly. The wires best suited for resistor windings are such wires as: chromel, nichrome, advance and manganin.

D.C. Voltmeters and Series Resistances

Ohms per volt (Rpv) = total resistance of meter ÷ maximum voltage range of the meter. Hence, $Rpv = Rt \div Et$; and $Rt = Rpv \times Et$.

The current consumption for full-scale deflection is: $I = 1 \div Rpv$ or $Et \div Rt$.

The customary method for multiplying the operating scale of a d.c. voltmeter is by means of a series resistance (Rs.). If Et is the normal range of the meter and Et′ is the maximum range desired, then the Rs required is determined thus: $Rs = Rt\,[(Et' \div Et) - 1]$.

EXAMPLE: Et is 200 volts, Rt = 100,000 ohms and Et′ is 500 volts. What is the Rs required and what is the multiplying factor (M)?

SOLUTION: $Rs = 100{,}000\,[(500 \div 200) - 1] = 150{,}000$ ohms.

$M = (Rt + Rs) \div Rt$. Substituting values: $M = (100{,}000 + 150{,}000) \div 100{,}000 = 2.5$. Therefore, any reading on a meter thus doctored must be multiplied by M = 2.5.

Note: A number of series resistances, properly tapped, can be used to provide a number of voltage ranges (see Figure 1). The taps may be numbered by their multiplying factors to give quicker readings.

Determining the Internal Resistance of D.C. Voltmeters

METHOD 1: By determining current for maximum voltage indication. See Figure 2, in which V is the voltmeter whose resistance is to be measured and MA is a current meter with a range of 5 ma. for high-resistance meters and 20 ma. for low-resistance meters. A single 0-10 milliammeter will suffice if the voltage adjustment is such that the meter will indicate about half-scale deflection.

FORMULA: Resistance of voltmeter = voltage indicated on V ÷ current indicated on MA.

EXAMPLE: The maximum range of V is 300 volts. With a reading on V of 200 volts and a reading of 5 ma. on MA, the total resistance of V is calculated as follows: 200 volts ÷ .005 amps. = 40,000 ohms.

METHOD 2 is the half-scale deflection system. See Figure 3, in which V is the voltmeter whose resistance is to be measured and Rvs is a variable series resistance with known adjustments. A resistance whose adjustments are not known may be used and its resistance measured at the completion of the test.

PROCEDURE: With the switch closed, apply voltage until V indicates full-scale deflection. Then open the switch and vary Rvs. until V indicates exactly half-scale deflection. Now, if the resistance used is a graduated one, all that you need to do is note the amount of resistance used, as this is equal to the resistance of V. In other words, if Rvs is adjusted to 60 ohms, then the resistance of V = 60 ohms.

METHOD 3: Substitute a fixed resistance (Rs) of known value for Rvs in Figure 3. Apply a voltage with the switch closed, note the reading on V and call this reading V1. Now open the switch and note the new reading on V and call this reading V2. Then the formula is: $Rt = Rs \div [(V1 \div V2) - 1]$. Formula Rs is the value of the fixed resistance which we substituted for Rvs.

EXAMPLE: Rs = 90 ohms; V1 = 200 volts; V2 = 80 volts. What is the resistance (Rt) of the meter?

SOLUTION: $Rt = 90 \text{ ohms} \div [(200 \text{ volts} \div 80 \text{ volts}) - 1] = 90 \div 1.5 = 60$ ohms.

ABBREVIATIONS USED IN FORMULAS

Rpv = Resistance of meters; in ohms per volt
Rt = Total resistance of meter
Et = Maximum range of meter
I = Current consumption
Rs = Series resistance
Rst = Shunt resistance
Rvt = Variable shunt resistance
M = Multiplying factor
Rvs = Variable series resistance
Rx = Resistance of unknown value

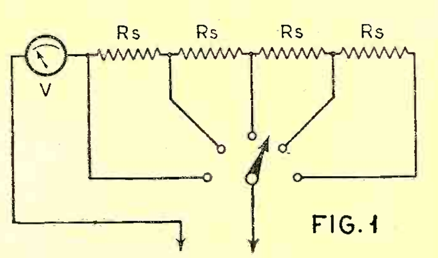


FIG. 1

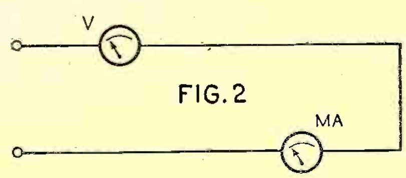


FIG. 2

D.C. Ammeters and Shunts

The range of a current meter is increased by shunting a portion of the total current around the meter. (See Figure 4.) Any value of Rst will increase the range of MA by the ratio: (Rst. + Rt) ÷ Rst. For example, if the internal resistance of MA is 10 ohms and the value of Rst is 100 ohms, the meter range has been multiplied by 100 + 10 ÷ 100 = 1.1, or the new maximum range is normal range times 1.1. Thus, if the normal range was 10 ma., the new range will be 10 times 1.1 or 11 ma.

Suppose we have a meter with a maximum range of 100 ma. (.1 amp.) and an internal resistance (Rt) of 1 ohm. We wish to extend its range to 1000 ma. (1 amp.) or ten times its normal range.

Let A1 represent the normal range

(100 ma.) and let A2 represent the new range desired (1000 ma.). Then the formula for finding the required shunt resistance (Rst) is: Rst = Rt ÷ [(A2 ÷ A1) — 1], or, to actually solve the above problem: Rst = 1 ohm ÷ [(1000 ma. ÷ 100 ma.) — 1] = $^1/_9$ ohm or .111 ohm.

A number of shunts may be connected across a meter and controlled by a switch, as shown in Figure 5. A voltage divider is suitable for this purpose. When the switch is at tap E the meter is direct reading, and as the switch is moved the various parts of the shunt are brought into use. As the switch is rotated from E to A, the range is increased; therefore, at A the range is maximum.

Determining the Internal Resistance of D.C. Ammeters

Arrange the meter whose resistance is to be measured as shown in Figure 6. Rvt is a variable shunt resistance. A calibrated resistance is best, but another resistance may be used and measured at the completion of the test to determine the amount of resistance used.

PROCEDURE: Adjust the current, with switch open, until the indication on MA is maximum. Then close the switch and adjust Rvt until the current indicated on the meter is exactly half of the original value. Then the internal resistance Rt of the meter equals the amount of resistance used in Rvt to produce half-scale deflection.

Using the D.C. Milliammeter as a D.C. Voltmeter

To change the d.c. milliammeter to a d.c. voltmeter we add a series resistance (Rs). For example, let us say that the milliammeter in Figure 7 has a current range of 1 ma. or .001 amp., its internal resistance is 250 ohms. From this we can see that the voltage required to give full-scale deflection on such a meter would be .025 volt. To make a voltmeter that has a range of 250 volts, out of this, we must use a series resistance that will multiply the range 10,000 times. Then, the calculate the size of the series resistance required, we have this formula: Rs = Rt [(V1 ÷ V) — 1], in which V is the normal voltage range and V1 is the voltage range desired. Thus the solution to the above problem is: Rs = 25 ohms [(250 volts ÷ .025 volt) — 1] = 249,975 ohms.

Now, in the case of high voltages it is customary to omit the meter resistance (Rt) and simply use this formula: V1 ÷ (current range of meter in amperes). Or, as in the example cited: Rs = 250 volts ÷ .001 amp. = 250,000 ohms.

As stated before, the error due to omission of the meter resistance is small at high voltages, but increases as we aproach the normal range of meter. Under 10 volts we must consider the meter resistance.

The multiplying factor is determined by this formula: (Rt + Rs) ÷ Rt = M. Or, as in the example cited: M = (25 ohms + 249.975 ohms) ÷ 25 ohms = 10,000.

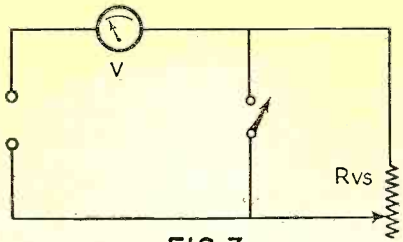


FIG. 3

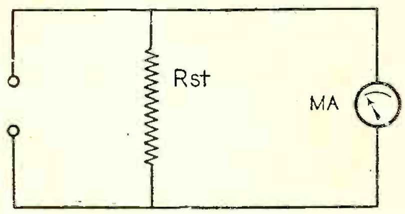


FIG. 4

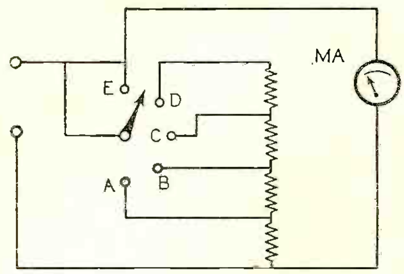


FIG. 5

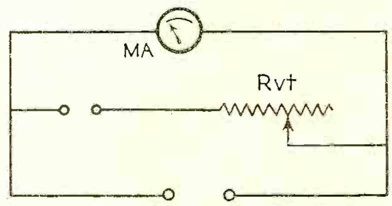


FIG. 6

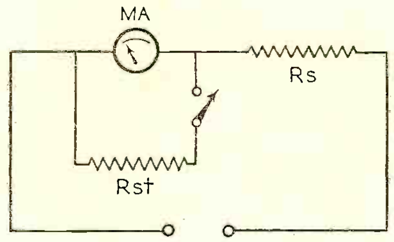


FIG. 7

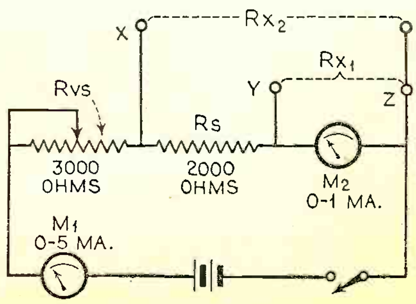


FIG. 8

Consider having the above cited meter with the 250,000 ohms series resistance (Rs). This arrangement, we said, would give us a range of 250 volts. If we should now require a meter of 500 volts range, it can be had by shunting a resistance (Rst) across the meter, as shown in Figure 7. The value of this shunt resistance should be equivalent to the internal resistance of the meter, if, as we said, we wished to double the range. Therefore, in this particular case a resistance of 25 ohms would be required.

If this shunt resistance is connected with a switch, as in Figure 7, the meter can be used either as a 250-volt meter, by leaving the switch open, or as a 500-volt meter by closing the switch. If the shunt resistance is used, the power rating of the series resistance should be such as to allow a passage of .002 amp. (2 ma.) or the sum of the current consumption of the meter and the resistance (Rst).

An Ohmmeter for D.C. Resistance Measuring

A versatile d.c. resistance-measuring unit can be constructed as shown in Figure 8. The potentiometer (Rvs. = 3000 ohms) is used to produce full-scale deflection on meter 2. The terminals Y and Z are used when measuring low resistance and the terminals X and Z are used when measuring high resistance.

PROCEDURE: Close the switch and adjust Rvs until meter 2 indicates full-scale deflection (1 ma.). Then connect the unknown resistance across Y and Z or X and Z, depending on the range required. This will, of course, disturb the resistance in the circuit, so readjust Rs until meter 1 indicates 1 ma. This will give a new indication on meter 2; we will call this indication I1. Now, if the the unknown resistance is connected across Y and Z, it will be known as Rx1. And it will be a low resistance or less than 100 times the internal resistance of meter 2. Then we have this formula for the solution: Rx1 = Rt ÷ [(I — I1) — 1], in which Rt is the internal resistance of meter 2 and I is the total range of this same meter.

Now if the unknown resistance is connected across X and Z, it will be known as Rx2, and it will be a high resistance or more than 100 times the internal resistance of meter 2. When measuring a high resistance (Rx2) it will be seen that it is in shunt with the series combination, Rs and meter 2. Therefore the solution for Rx2 is the same as for Rx1, except that we must add the resistance of Rs to the resistance of meter 2, or, to be more precise, the correct formula for the solution of Rx2 is: Rx2 = (Rt + Rs) ÷ [(I ÷ I1) — 1].

The range of resistance that can be measured by this device is from a fraction of an ohm to approximately 100 times (*Continued on page 634*)

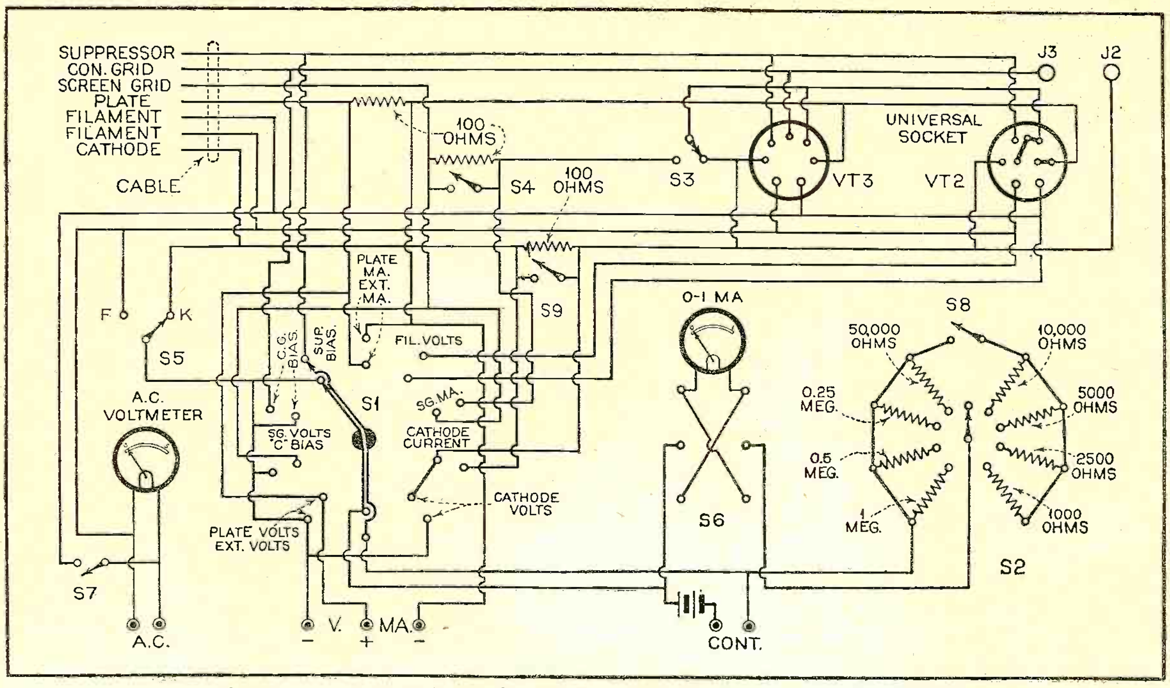


FIGURE 1. CIRCUIT DIAGRAM OF THE IMPROVED SET TESTER

THE SET TESTER DE-LUXE

Brought Up-to-Date

By Bernard J. Montyn

IN response to many requests, we are describing the changes necessary to analyze receivers using the new 6- and 7-prong tubes with the Set Tester de Luxe, previously presented in the October, 1931, issue of RADIO NEWS.

The new circuit is shown in Figure 1. With the changes incorporated, it is now possible to use it on receivers with any of the new tubes now available, including the 7-prong tube, type –59, the –46, the Wunderlich tube, the –55, etc. This is done without using any other adapters than the ones on the analyzer plug. The additional parts needed are but few, making the extra expense very low.

Before we start on rewiring, it would be best to look over the old tester in order to see what will have to be changed. The 6-prong tube has one additional element and we must provide a way to measure its voltage. This means one point more on the selector switch S1. The 7-prong tube has the same number of elements as the 6-prong and we need no additional tests for it. There are, however, cathode tubes and filament tubes which make it necessary to measure voltages with reference to the filament or to the cathode. A special switch is to be provided which changes the reference point. Finally, it is desirable that the cathode-to-filament voltage be measured and that a way be provided to check the cathode current. These tests would become the screen-voltage and screen-current tests on the types –47 and –33. In all there must be three more points available on S1. Since we do not wish to replace S1, there will have to be three other settings eliminated. This is possible, for the screen-grid voltage and C-bias tests are really the same and they can be united, leaving one switch position free. Further, it is possible to connect the external jacks in a different way, which eliminates the points "external volts" and "external ma." This takes care of our requirements. The switch which was indicated by the symbol S5 now can be employed for the change of the reference point.

Since there is not enough room on the unit to add any sockets, the best solution is to employ a "universal" socket" which accommodates, 4-, 5- and 6-prong tubes. Another socket for 7-prong tubes is also provided. There seems to be no good reason for using a second analyzer plug on the cable, and it might as well be connected to the inside of the tester. This leaves open a place for the inevitable 8- or 9-prong socket (yes, they are coming!).

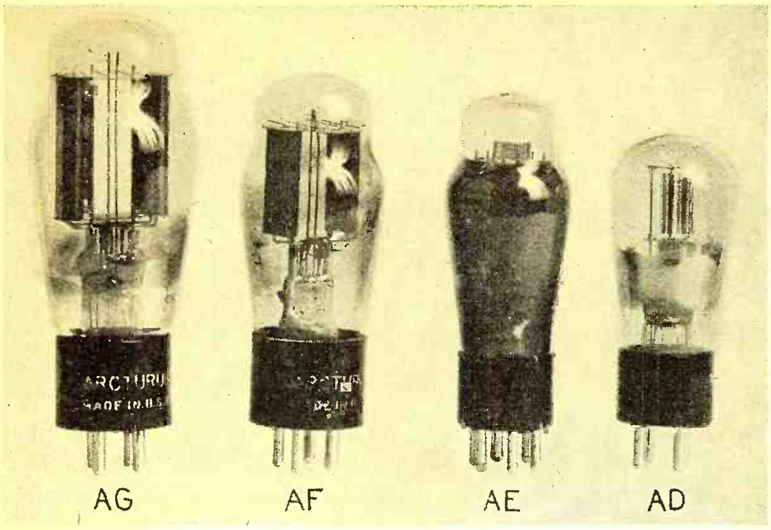
Perhaps some of our readers will prefer to take off all the wiring and do the job over again, thereby avoiding any confusion. It is, however, not necessary to rewire everything; only certain portions have to be changed.

The best way to do it is in the following order: Remove the three sockets and their interconnecting wires. The leads which come from the switch S1 should be loosened, but not removed, for they will be connected to the new sockets. Remove all connections to S5, the jacks for continuity testing, for external measurements and clear the three points on S1, mentioned above.

The two sockets are now mounted and wired in parallel (see Figure 1). A new 7-wire cable is connected directly to the inside of the tester, the wires going directly to the 7-prong socket or through 100-ohm resistors to the socket. All wires which did go from S1 to the socket can be connected again, with the exception of the cathode lead, which now goes to the switch S5. Note that there is now a 100-ohm resistor in the cathode circuit, which serves to measure the current. The short-circuiting switch is one of the new parts required; the resistor, however, is salvaged from the removed parts. There remains the connecting of the suppressor grid and cathode connections to the switch S1 and to the external jacks.

Use of the Tester

Nearly all tests are made in the same way as they were previously, with the exception of external measurements. The switch S1 must be set for plate voltage and plate current to make external measurements. The added resistance in the cathode circuit provides an additional way of changing the grid bias; this is most desirable (*Continued on page* 634)



FOUR NEW TUBES

These four new tubes include several novel features which will prove of interest to servicemen

By J. van Lienden

WHEN a mercury-vapor rectifier tube approaches the end of its emission life, the high inverse peak voltage occasionally causes arcing or "flash-back." The current of this flash-back is limited only by the resistance in series with the tubes and often reaches greater values than the transformer windings or other portions of the circuit can carry without injury.

To remove the danger of injuring radio receivers, the three new Arcturus rectifiers, illustrated above, incorporate a protective fuse in each plate lead.

The type AF tube is recommended in place of the -82 type, regardless of whether the circuit is fused elsewhere or not. The characteristics of this tube are shown in the table appearing on this page. The type AG tube is intended to replace the -83 type, affording the same protection. The characteristics shown in the table are the same as those of the -83 type.

Mercury-vapor type tubes permit a better regulation in the power pack because of the low internal voltage drop. So, for instance, using the circuit in Figure 1, with a transformer secondary voltage of 400 volts per section, the output voltage between A and B was 340 volts, with a current of 10 ma. The voltage between A and B drops to 320 volts when the current is 400 ma., a difference of only 20 volts.

Type AD is an indirectly heated, half-wave rectifier for use in a.c.-d.c. receivers and for automobile B supplies. Heretofore such sets often used ordinary triodes as rectifiers and only recently special mercury-vapor rectifiers have been made available for this purpose. The type AD tube requires a heater potential of 6.3 volts and a heater current of .3 amperes. For the use in a.c.-d.c. receivers this filament can be connected in series with those of all the other tubes A total continuous drain of 50 ma. is the maximum allowable. Therefore this tube is ideal for those small universal receivers that have become so popular recently.

In Figure 2 we are showing the power supply and the output tube for such a receiver. The output tube is the new Arcturus AE type, which we shall describe. The resistor R can be calculated and depends on the total number of tubes employed. Add all the filament voltages and subtract this sum from the line voltage. The remaining voltage is to be dropped in the resistance R, and therefore R equals E ÷ .3, where E represents the voltage across the resistor.

In a receiver with such a low available plate supply one should not use high-resistance chokes, for then too much of the plate voltage will be lost. Assuming a total B drain of 50 ma., there is a loss of 1 volt for every twenty ohms (d.c.) resistance in the choke.

When mercury-vapor rectifiers are used in a receiver, they should be shielded and have a 1 mh. radio-frequency choke in each plate lead. This is found necessary to prevent any noise due to the sudden stopping and starting of the current. The filter used with these tubes should preferably be of the choke-input type.

For the small a.c.-d.c. receiver (*Continued on page 629*)

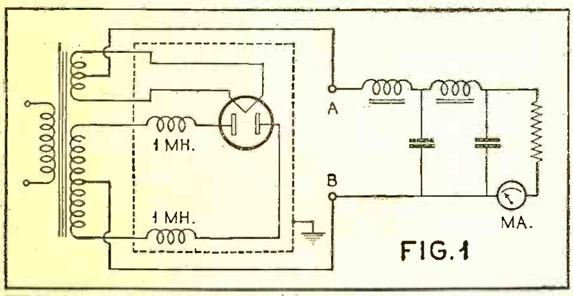


FIG. 1

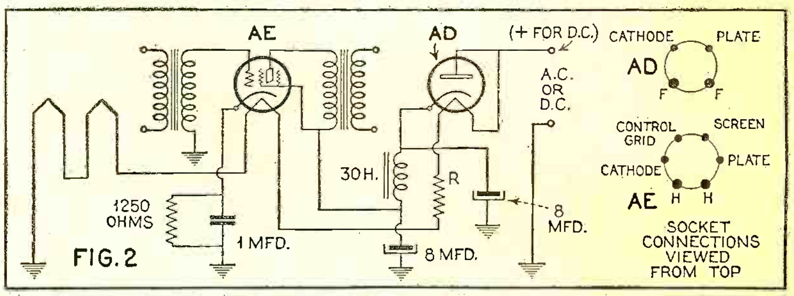


FIG. 2

	AF	AG	AD
FILAMENT VOLTAGE	2.50	5.0	6.3
FILAMENT CURRENT	3.0 AMPS.	3.0 AMPS.	.3 AMP.
MAX. A.C. VOLTS PER PLATE	500 RMS	500 RMS	350 RMS MAX.
MAX. PEAK INVERSE VOLTAGE	1400	1400	500 *
MAX. D.C. OUTPUT, CONTINUOUS	125 MA.	250 MA.	50 MA.
MAX. PEAK PLATE CURRENT	400 MA.	800 MA.	200 MA.
TUBE VOLTAGE DROP	15	15	15
BULB	S-14	ST-16	S-12
BASE	MED. 4 PIN	MED. 4 PIN	SMALL 4 PIN
OVERALL LENGTH	4 7/16" - 4 11/16"	5 1/8" - 5 3/8"	4" - 4 1/2"
MAXIMUM DIAMETER	1 13/16"	2 1/16"	1 9/16"

* MAXIMUM PEAK PLATE VOLTAGE

AE	
HEATER VOLTAGE	12.6
HEATER CURRENT	.3 AMP.
PLATE VOLTAGE	100
SCREEN VOLTAGE	100
CONTROL GRID BIAS	-13.5 V.
PLATE CURRENT	8.5 MA.
SCREEN CURRENT	1.75 MA.
AMP. CONSTANT	20
PLATE RESISTANCE	12,000 OHMS
TRANSCONDUCTANCE	1650 MICROMHOS
LOAD RESISTANCE	13,500 OHMS
POWER OUTPUT	400 MILLIWATTS
OVERALL LENGTH	4 7/32" - 4 15/32"
MAX. BULB DIAMETER	1 9/16"
BULB	ST-12
BASE	SMALL 6 PIN

Design Principles of Long-Distance Receivers *for the Broadcast Band*

The author continues his suggestions on circuit design for real DX reception. He is now at work on a constructional article giving complete details of a receiver, incorporating many of the features suggested here. It is hoped this material will be ready for the May issue

Part Two

By C. H. Long

SOME of the requirements that must be met by a good long-distance receiver have already been mentioned. The strongest possible signal should reach the grid of the first tube, which should preferably be a triode (except in the case of short waves) for better signal-to-noise ratio. The grid circuit of this tube should be tuned to the signal (or be part of a circuit so tuned), as should the aerial-ground circuit, and the coupling between these circuits should be sufficient to insure the practical maximum of energy transfer.

While the importance of a good receiver is under consideration, it is well to sound one precaution. No receiver, however good, can perform at its best without a good energy-collecting system, any and all claims to the contrary notwithstanding. It has already been pointed out that the applied signal must be above the first tube's noise level to be heard. If the design of the receiver does not permit the use of a full-sized antenna because of the resulting lack of selectivity, the receiver should either be redesigned or discarded in favor of a better if one is seeking the best results in the reception of the weak signals from far-distant stations.

To receive feeble signals effectively, the receiver should be sufficiently sensitive to amplify the noise level of the *first* tube, a steady hiss, to moderate volume with antenna and ground disconnected. With proper care in design to minimize noises, this will mean fractional microvolt sensitivity over the entire scale. Further sensitivity obviously cannot be used. It is well, however, to have a certain amount of reserve sensitivity to compensate for aging tubes and the like.

In order to secure the necessary sensitivity, at least three stages (four are better) of amplification at either signal or intermediate frequencies are required. These may be supplemented by some regeneration. Screen-grid tubes are satisfactory for use in all stages after the first. One must be careful to avoid a needless number of amplifying stages, as an increase in the noise at the expense of the signal will result therefrom. The resistance of all tuned circuits should be kept low as a highly important aid in securing the necessary sensitivity. At the same time, the inductance of the tuned circuits should be as high with respect to the capacity as is consistent with selectivity and stability requirements, because the signal voltage drop developed across an inductance is proportional, other things being equal, to that inductance. Since the amplified signal voltage divides proportionally to the impedance, between the a.c. plate resistance of the tube and the tube's external plate impedance, to secure the maximum amplification output the impedance of the plate circuits of the radio-frequency amplifying tubes should be as high as selectivity and stability requirements will permit. Depending on their a.c. plate resistances, different types of tubes have different impedance requirements for satisfactory operation. As is well known, for instance, the screen-grid tube, in order to amplify efficiently, must work into a high impedance, much higher than that required for the three-element tube. The couplings between circuits should be sufficiently tight to insure nearly maximum energy transfer. As mentioned, tubes have a certain "best operating point" with reference to amplification-to-noise ratio. which may be determined experimentally and at which they should be used for DX reception (excepting possibly in the case of the final radio-frequency stage). To attempt to secure more amplification from them by raising the plate voltage is only to increase the noise.

To insure really good results in long-distance reception, particularly on the broadcast waves, it is necessary that the receiver have a high degree of selectivity. There are two chief reasons for this. The first is that it is needed to prevent interference from more powerful and unwanted signals. The second is that static interference of all kinds is considerably reduced thereby, being limited to the band on which reception is taking place. This is of importance, since there is always some static, even when conditions are at their best.

To meet the problem of station interference, the selectivity of the receiver should be at least such that the band width at 1000 times field strength does not exceed 20 kilocycles, for, even though results may be obtained with a lesser selectivity, they will not be nearly as good as they might be. Other things being equal, the better the selectivity, the better the results will be. Selectivity, to be of the greatest assistance in reducing static, must be of a very high order indeed, considerably in excess of that mentioned above—though this degree of selectivity gives a slight reduction in static interference. This matter will be treated more fully later under the problem of static reduction.

The necessary selectivity should be secured primarily by employing a large number of tuned circuits whose resistance is kept low. The band received should narrow down gradually more or less in proportion to the stage-by-stage sensitivity, as the signal proceeds through the receiver. This is necessary for the sake of greater receiver quietness, which will be discussed more at length later, and to prevent any trace of cross modulation. Regeneration, properly and judiciously applied, is an aid to selectivity, but otherwise it may prove a general nuisance.

Noise Level of Receiver

There are several important items yet to be considered. One of these is the reduction of the noise level of the receiver to a minimum. To complicate matters for us, the customary receiver noise is increased by the application of a signal or a little external noise. Hence, due to this phenomenon, if the receiver is noisy, the chances of receiving a weak signal are small. Receiver noises reduce the *usable sensitivity;* may, indeed, reduce it to a point where it is totally inadequate for the needs of difficult long-distance reception. It is, therefore, obvious that it is highly important to hold receiver noise at the absolute minimum.

Receiver noises other than tube noises will also operate to increase tube noise; hence, all such noises should so far as is possible be eliminated. All connections should be firmly made. There should be no "rosin joints" or poor contacts anywhere, and there should be no half-way connections to shielding at any point. Defective parts must be guarded against by the use of high-grade parts and the replacement of any parts that become noisy in service. If a.c. is used, thorough filtering of the line current supplied to the receiver must be employed in order to approach, but unfortunately never quite to equal, battery quietness. However, the receiver is powered, the filtering of the circuits associated with each individual tube should be thorough and complete. To keep the noise down, all amplifying stages should operate in a perfectly stable condition. The receiver is noticeably quieter in operation if the selectivity gained per stage is in the order of the per stage gain in sensitivity. For example, if the per stage gain is 30, the per stage selectivity should in the ideal case reduce the response at 10 kilocycles off resonance to not to exceed 1/30th that at resonance. In practice, a factor of, say, 1/15 will be found satisfactory in this example, but a factor of ½ or ⅓ will cause the receiver to be unnecessarily noisy. By the reduction to a small value of the detector input, the noise of preceding stages may be somewhat reduced in proportion to the signal, due to the non-linear rectification, which will increase the difference between signal and noise that is slightly weaker. Tubes having low noise levels should be used, especially, as already mentioned, in the position of first tube. It is advisable to choose battery tubes and battery operation for the tuner for the sake of greater quietness. For, though a.c. is cheaper and more convenient, and though the circuit design is easier, and the tubes are in general more sensitive than battery tubes, a.c. tubes and other equipment are without exception more noisy than good battery equipment. In spite of the slightly higher sensitivity of the a.c. tube, due to the higher noise level the usable sensitivity, the only sensitivity that counts, of the best a.c. receiver is somewhat less than that of the best battery receiver. However, the audio channel may be a.c. powered, if desired, better tone at reduced cost being thus secured. To minimize tube noise the plate voltages of the tubes in the tuner should be maintained at the best operating point. In the author's personal receiver is incorporated a circuit that has proved useful in still further reducing the bad effects of tube noise. It is the intention to describe this circuit in a future article.

"One should know when to listen for the kind of DX he expects to hear. The time during which reception of any desired transmitter is possible can easily be figured out with the aid of a world map and a world time chart."

Reduction of Static and Electrical Interference

Another highly important item to be considered when receiving feeble signals is the reduction to the minimum of static and stray noise interference. This refers primarily to small static and noise of the same order of strength as that of the signal. Such reduction may permit satisfactory reception of a signal on one receiver, while on another not featuring it, nothing but noise is heard under like conditions.

Keeping the noise level of the receiver at a minimum is an aid in the reduction of this type of interference. When the signal is small, the usual receiver noise rises nearly as the square root of the signal. When a weak signal and static about its equal are being received, the signal handled by the receiver is in effect doubled, and the receiver, unless exceptionally quiet, will become noisy to the degree that little or nothing but noise is heard, regardless of amplification.

Reduction to a small value of the signal supplied to the detector, in order to increase by the detector's square law action the difference between signal and noise, is often an aid. The detector is then followed by one stage of audio for phones, or two for speaker. At other times, with a slightly different type of static, it is advantageous to listen in with phones connected directly in the detector circuit.

It has been mentioned that selectivity aids in the reduction of static. To be of greatest service the selectivity must be of an unusually high order. It is then effective in considerably reducing small static and electrical interference. It has been the author's repeated experience that by this means alone static that almost blots out a signal can be reduced to a point where the signal is received quite clearly and fairly free of interference. The selectivity under consideration must confine reception to a much narrower than 10-kilocycle band. Yet voice from the distant stations must remain clear and distinct, which requires that special precautions be taken, as ordinarily under these circumstances speech would become quite blurred. The customary audio compensation, unfortunately, restores also much of the interference (though there is some gain). It should be possible to readily regulate the width of the band received in order to take care of different degrees and kinds of static interference and also the condition of no interference, when the entire register should be available, preferably in the detector output.

Audio tone filtering, whereby the treble is suppressed, is of some assistance in reducing electrical interference. Although it tends to destroy the intelligibility of speech, nevertheless, employed in the proper way in conjunction with a high degree of selectivity it is a useful aid.

Purely local electrical interference, such as from wiring or electrical equipment within the house, can often be reduced by means of the interference-reducing, shielded antenna lead-in systems now on the market. Usually it is best to ground the shield and to a separate ground well removed from the receiver ground.

Speaker or Phones

Signals can always be received just a little more clearly on the phones than on the speaker. If the receiver is designed according to the recommendations laid down, it will bring the signals from any station receivable to good speaker volume, but by using the phones one can receive more distinctly those stations almost drowned in the interference. Hence, if one is seeking the best results in long-distance reception, the receiver should always be provided with phone outlets.

For best results under all conditions, jacks should be placed in both the detector and the first audio stage, for sometimes one position is preferable and sometimes the other, depending on circumstances. For best results they should never follow the second audio stage, as two audio stages greatly enhance the noise at the expense of the signal.

Miscellaneous Tuning Hints

The possession of the necessary equipment with which to hear the distant stations is the prime essential, but the proper technique of handling this equipment may easily mean the difference between success and failure.

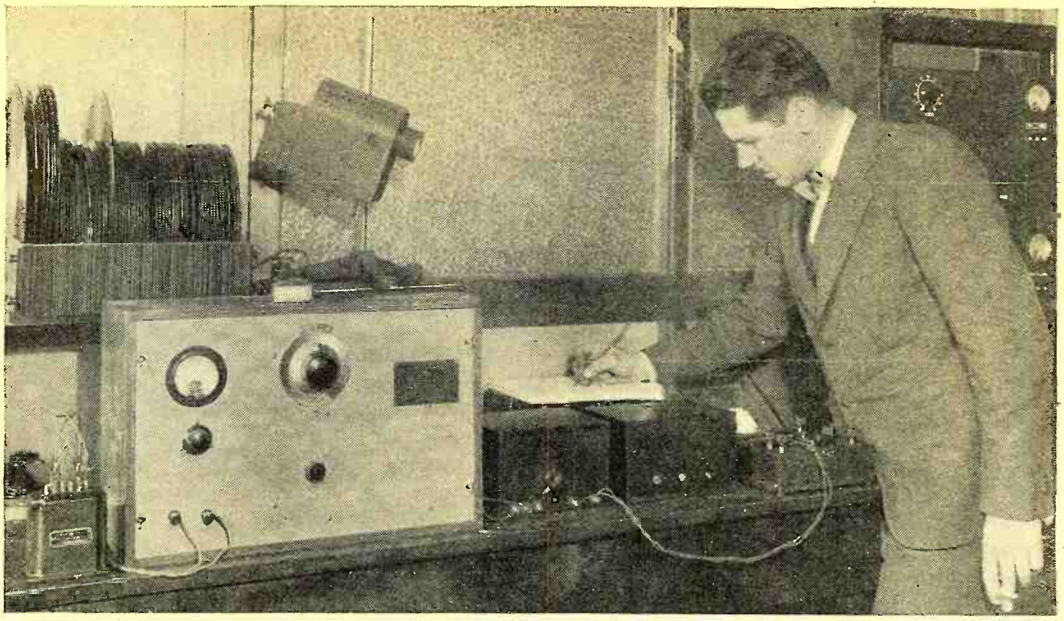
First of all, one should know when to listen for the kind of DX he expects to hear. It is well known, for instance, that in distance reception on the broadcast waves darkness must prevail over the path that the signal follows from transmitter to receiver. Japan is received from about 3 a.m., C.S.T., until daybreak. Again, Hawaii is best received from about 2 to 4 a.m. The times during which the reception of any desired transmitter is possible can easily be figured out with the aid of a map of the world and a time chart. (*Both a handy time chart and special DX map were published in* RADIO NEWS *last month.*—THE EDITOR.)

When DX is being sought, it is quite important to tune carefully and slowly, if one is to avoid passing completely over many signals without ever realizing it. Furthermore, a signal that seems largely noise at first may be cleared up greatly if one has receiving equipment that permits of the various necessary adjustments of selectivity, antenna tuning, and so forth. Regeneration, properly applied, is a great aid in locating weak signals by their carriers.

Up-to-date call lists are a great aid in the reception of distant stations. Often one cannot be sure of the station call, and a good call list will aid in identification. Sometimes in the case of Japanese, Chinese and other stations from which English is spoken but rarely, it is the only means of initial identification. It might be mentioned that Japanese stations make it a practice to give their call in English just before signing off.

Patience is a very useful virtue in connection with the reception of DX. The signal that fades may come back again in five or ten minutes or even less time with sufficient strength for reception. Furthermore, the station that cannot be received at one time may come in fairly well when conditions are better.

The coldest weather is not always the best for reception or even the most static-free, but for best results on the broadcast waves the weather must be, if not (*Continued on page* 631)



CHECKING UP ON THE FREQUENCY CHARACTERISTIC
The amplifier connected to an oscillator and an output meter while a "run" is being taken

USING THE NEW -79 TYPE TUBE IN D. C.

PUSH-PULL AMPLIFIER

By I. A. Mitchell

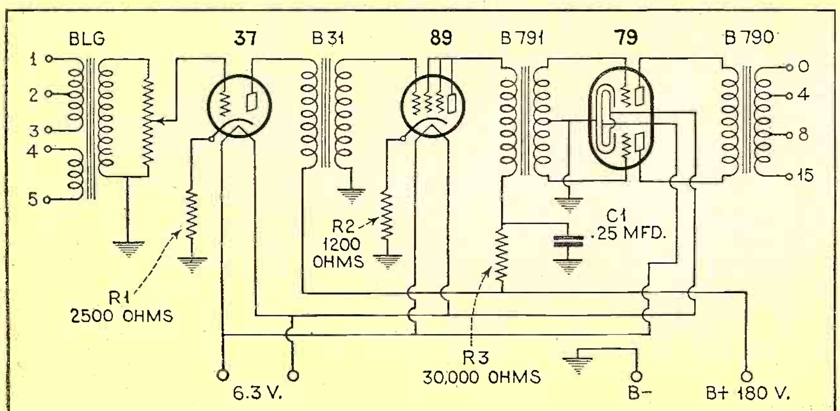
THE theory of Class B operation has been covered in previous issues of this publication and we will therefore touch only briefly upon the theoretical aspect. As stated above, the input impedance of the tube is low, being in hundreds of ohms, and due to the operation of the tube in the positive grid range, grid current of appreciable magnitude is drawn. Upon analyzing the component distortions, we find that the third harmonic is the strongest. If the driver transformer, feeding the Class B tube, is so designed as to develop a small amount of third harmonic distortion, this third harmonic will be in direct opposition to that in the output of the push-push stage and balance out. Two things must be taken into consideration as governing this method of distortion reduction: the fact that the third harmonic contact is not constant over the full power range and that the input transformer has leakage reactance. The first point is covered by choosing an optimum value of input distortion which will cover the full range fairly well. The leakage reactance can be kept low in the transformer design, so that the phase shift between input and output distortion is negligible. It is also important that the output transformer design take into consideration the fact that in Class B only one tube (in the -79 one-half of the tube) is operating at a time. This means that the effective leakage reactance from each half of the primary to the secondary must be low, to minimize the attenuation of the higher frequencies.

As in all Class B systems, for good output, the regulation of the B supply should be good. If used for mobile work, either B batteries or a husky compound-wound motor-generator type B eliminator should be used.

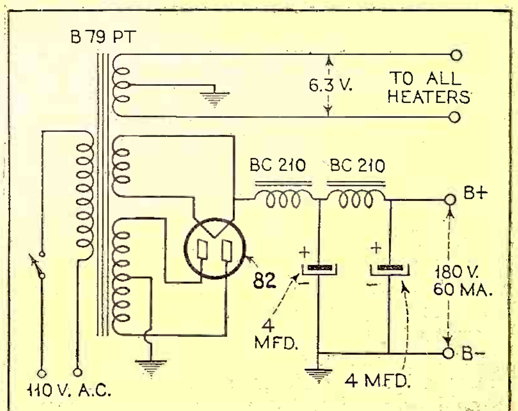
In the design of the amplifier described in this article, full consideration has been given to its universal possibilities of use. The complete amplifier, cased in a sheet-steel box, weighs only 11 pounds and measures 5 inches by 8 inches by 6½ inches. The complete power supply weighs only 12 pounds and measures 5 inches by 8½ inches by 6½ inches.

Either of two input transformers can be used without altering the layout, both including universal features. The first transformer (type BPR) has two primary windings, one for a

SCHEMATIC DIAGRAM OF THE AMPLIFIER
Figure 1. The -89 type tube is connected as a class A triode amplifier. The output tube combines both sides of the "push-pull" circuits in one envelope



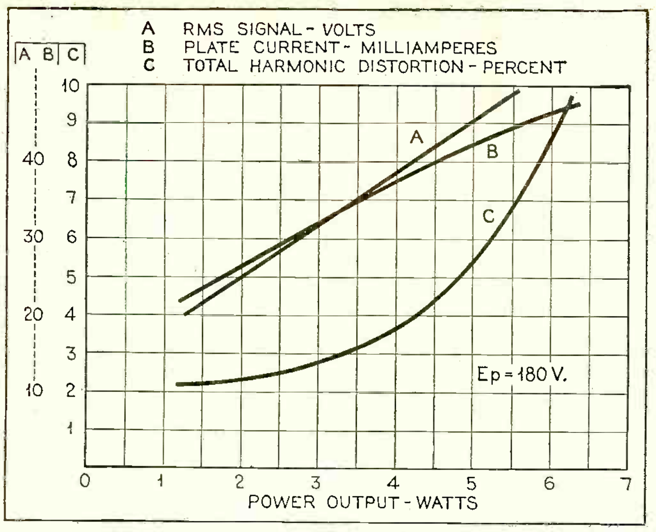
POWER SUPPLY CIRCUIT
Figure 3. A mercury-vapor rectifier tube is used for better regulation of the output voltage



detector plate or high-impedance pick-up, the other for a double-button mike or low-impedance pick-up. The second transformer (type BLG) has facilities for connecting a 50, 200 or 500-ohm line; a single-button microphone, double-button microphone or parallel microphones, three 200-ohm lines used simultaneously, three 500-ohm lines used simultaneously, or one 500-ohm and one 200-ohm line used simultaneously. The output transformer is tapped at 15, 8 and 4 ohms, allowing its use in one to four permanent-magnet or 6-volt dynamics. Two magnetic speakers can be connected in series directly to the output plates.

The amplifier is well suited to any portable work. Applied to public address, it will fill a small arena. As an amplifier for automobile-radio use, its high-power output allows good volume without overloading. It can supply music to a small picnic ground and the many other outdoor amplifier uses where a.c. is not available. There are many rural districts where a.c. power is not available and battery-operated receivers are used. With this amplifier, sufficient power output can be obtained to supply full quality volume for either indoor or outdoor use. Or it may be desired to use the same unit in both the car and home, or for portable work where either a.c. or battery supply is available. This can be accomplished by bringing the terminals to a cable and plug which upon disconnection allows the amplifier to be moved anywhere.

Figure 3 shows a diagram of a power supply which will feed the amplifier from a standard a.c. line. The heater-type filaments on the amplifier tubes make it particularly suitable for a.c. operation. An -82 rectifier is used with choke input in the power supply. Through low resistances and proper circuit design, good regulation is maintained. The output consists of only two filament terminals and two high-voltage terminals which can readily be brought out to a four-prong female plug to which the amplifier plug is joined. Biasing and voltage drop for the -37 tube is taken care of in the amplifier.



CURVES OF THE -79 TYPE TUBE

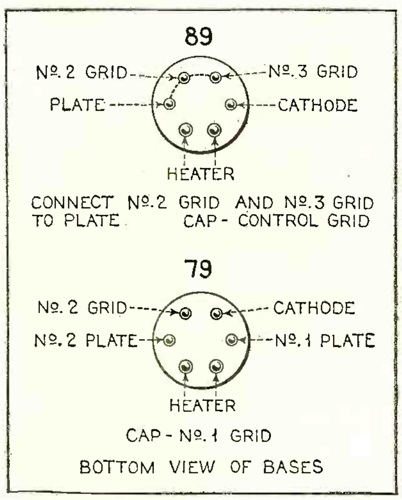
Figure 4. These curves show the signal volts required for a given output, as well as the plate current and the harmonic distortion of the class B tube

The illustrations show the layout of the chassis and box for the power supply. The holes in the side and cover of the box are to provide ventilation for the power-supply components which develop considerable heat. If the power supply is not to be used for portable work, the box can be omitted.

The amplifier itself is shown schematically in Figure 1 and in the illustrations. It consists of two cascade stages of audio using a -37 and -89 tube and then feeding into the -79. The total voltage input to the amplifier is 180 volts. This supplies the -79 tube, which is not biased, with its full rated 180 volts and at the same time puts the rated 160 volts on the type -89 tube, which has a 20-volt bias. Both the -89 and -37 tubes are self-biased, as this is the most dependable method of obtaining proper bias voltage.

The grids of the -79 tube are driven to a point where, at maximum uniform signal, the total plate current is 44 ma. The average plate current is much lower than this. It is important that the -89 tube be properly connected for Class A operation, as otherwise it will not operate efficiently. The socket connections for both -89 and -79 tubes are illustrated in Figure 2. The volume is controlled with a 500,000-ohm potentiometer in the grid circuit of the first tube.

FIGURE 2. SOCKET CONNECTIONS

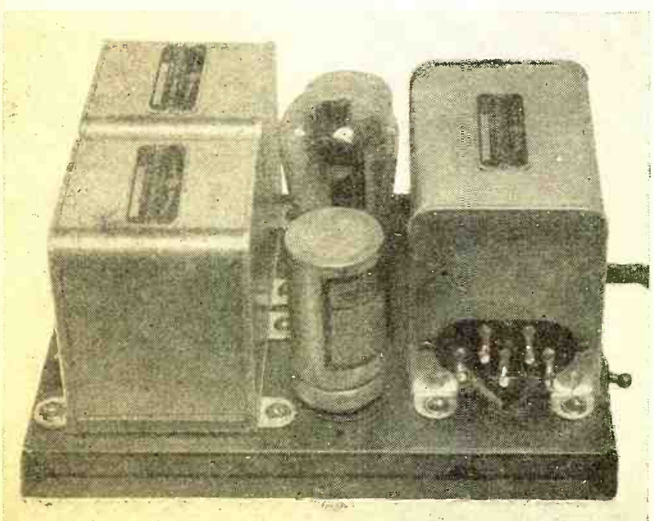


Present Class A tubes have their power and efficiency limitations, though the inherent harmonic distortion is low. Previous Class B tubes were of too large a size to take care of the numerous low-power applications. The inevitable result was the development of a tube such as the -79. It is the writer's belief that this tube will find wide application in the medium power amplification field.

A number of new tubes with specific Class B virtues (*Continued on page* 631)

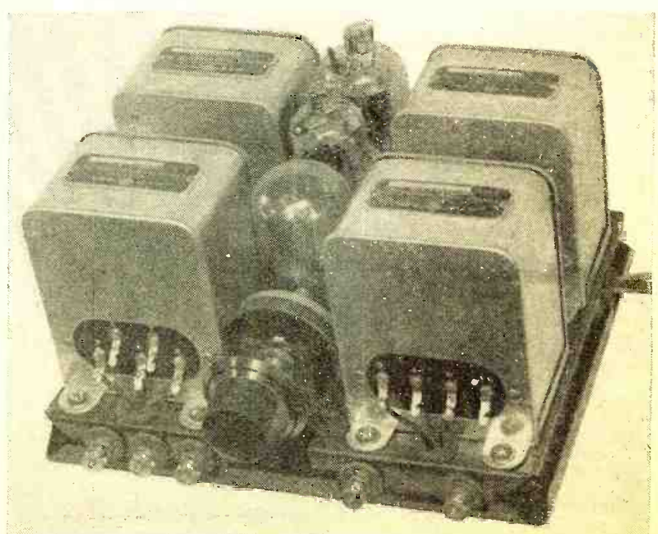
THE POWER PACK

Whenever 110 volts a.c. is available, this unit will provide the necessary power for operation



INSIDE OF THE AMPLIFIER

The construction is simplicity itself. An output of 6 watts can be obtained from this amplifier



TUBE ADAPTERS

AND THEIR APPLICATIONS

Adapters are now available to meet almost every conceivable requirement, and offer a convenient means for modernizing receivers and set analyzers

[*By* H. G. Cisin]

THROUGH the use of special adapters, it is possible to use many of the newest tubes in sets originally designed for older type tubes. By means of these convenient accessories an otherwise obsolete radio receiver can often be modernized with very little expense.

In receivers designed for –35 and –51 tubes, for instance, the new –58 may be substituted without fuss or bother by means of the Na-Ald tube adapter illustrated in Figure 1. It is noted that this adapter has a six-prong receptacle connected to a five-prong plug. The suppressor grid and cathode are connected together within the adapter and brought down to the cathode prong. A special shield is available for use with the –58 tube to take care of the height added by the adapter.

Within the past year the –47 type or PZ pentode has gained great favor at the expense of the –45 power output tube. The pentode adapter shown in Figure 2 makes this substitution possible. In view of the fact that the PZ pentode is four times as sensitive as a –45 tube, making possible greater volume and smoother reception, the value and popularity of the pentode adapter is readily comprehended. When using this adapter, the bias resistor should be changed to 450 ohms for a single tube and about 225 for two pentodes in push-pull. This same adapter may be used when it is desired to substitute a 2-volt –33 type pentode in place of the older style –31 tube. When this substitution is made, the bias resistor should be changed to the proper value for the –33.

Replacing Old Detectors

A number of improved detector tubes are now available. The type –57 tube is designed primarily for use as a biased detector, but its triple grid structure and electrical characteristics also make it useful as a screen-grid amplifier for low signal outputs. The shield arrangement on the dome of the tube is an important development in that it allows a decided reduction in the output capacitance and renders the tube very satisfactory for short-wave operation. The independent prong provided for the suppressor grid permits the adaptation of this tube to a variety of circuit arrangements depending upon the way in which each grid is used. The versatile tube adapter shown in Figure 1 permits this tube to be substituted readily for a –24 detector.

Of course, the screen voltage should be increased to 90 volts and the grid bias should be adjusted to the recommended value if maximum advantage is to be gained.

Another important new detector tube is the Wunderlich tube. This is a special-purpose, high-quality detector which combines full-wave rectification with a perfect stage of audio amplification and provides the necessary voltage for the automatic control of sensitivity—all within one tube structure.

While there are no adapters available at present for substituting the Wunderlich tube directly in place of another type of detector, the Wunderlich tubes may be tested on old type testers and analyzers by using the adapter shown in Figure 3. It will be seen that this adapter is suitable for testing a five-prong Wunderlich "A" tube in a type –27 socket. The two grids of the top socket are connected together and brought down to the grid prong of the bottom plug, thus converting the Wunderlich tube (so far as testing is concerned) into a standard three-element type.

In the field of battery-operated sets, automobile radio receivers are now attracting the most attention. The special 6.3-volt tubes are exceedingly popular for this type of service. Until a short while ago, the –38 type tube was the standard auto-radio power output tube. Recently, however, several new tubes have been announced to supplant this one. These include the –41 and the –42. The –41 tube has an undistorted power output of 1200 milliwatts as compared with 525 for the –38, while the –42 has an undistorted power output of 3500 milliwatts. Through the use of the adapter illustrated in Figure 4, a –41 tube may be inserted in place of a –38, with greatly improved results. This adapter has a six-prong receptacle and a five-prong plug. The grid terminal of the top socket is brought out to a control-grid stud on the side of the adapter. This is connected to the grid clip in the receiver.

Improving the A.F. End

Where the –45 tube is used as a driver tube in a Class A amplifier, it may be replaced by a –46 tube; the adapter, shown schematically in Figure 5, is employed. This adapter has a five-prong socket on top connected to a four-prong base. When the –46 is used as a Class B power amplifier, the two grids are tied together. The adapter shown in Figure 2 may also be utilized where a –46 is to be used in place of the –45. Two of these adapters are employed for push-pull stages.

Even the new –82 full-wave mecury-vapor rectifier may be substituted for the old-style –80 type rectifier by means of an ingenious adapter (see Figure 6) which contains a suitable resistance in series with one of the filament leads, in order to

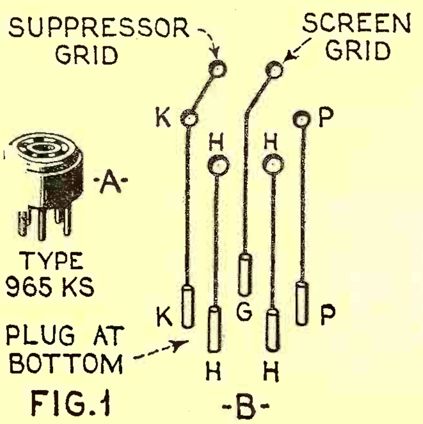


FIG.1

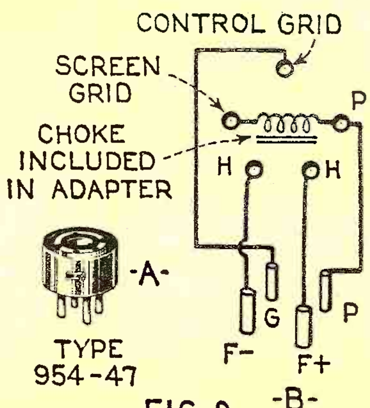


FIG.2

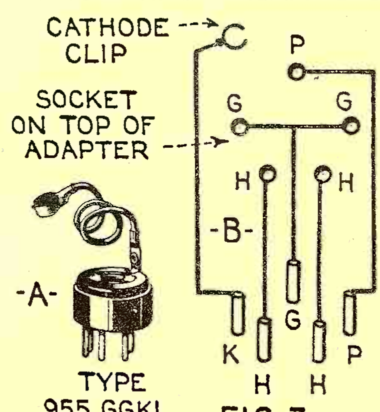


FIG.3

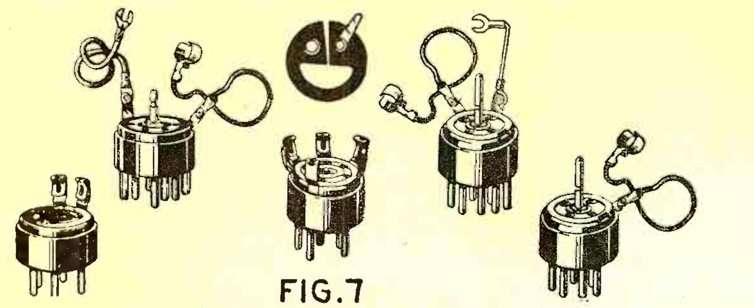


FIG. 7

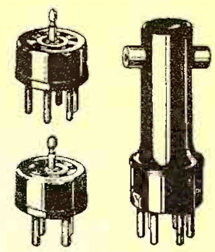


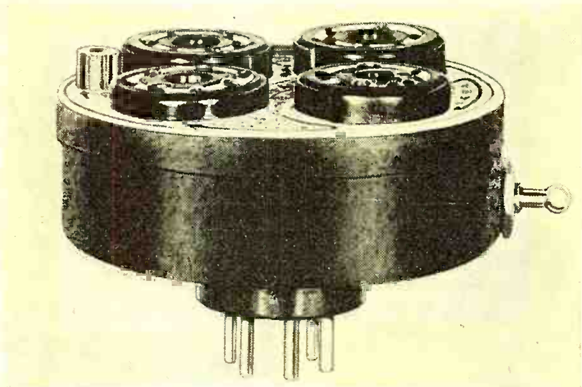
FIG. 8

TYPE 949

FIG. 9

drop the voltage from 5 volts to 2½ volts. The -82 tube is more conservatively rated than the -80 and has a reserve adequate to take care of the over-voltage normally experienced in service. Because of its voltage regulation, it is ideal for use in connection with Class B amplifiers. The voltage drop across this tube remains almost constant as the load is increased, until the total emission of the filament is approached.

Adapters similar to the one shown in Figure 6 are also available for testing the new -82 and G-2 tubes in old testers. These adapters are arranged so that both plates may be tested. They also have limiting resistors and other special features designed or suggested by the engineers of Weston, Jewell, Supreme, Radio Products and also by the engineers of the leading tube companies.



A UNIVERSAL ADAPTER

Figure 10. The type 950XYL adapter for tube checkers permits the testing of a wide variety of new tubes in checkers designed before the advent of these tubes

Adapters have enabled the serviceman to keep his tube testers, analyzers, etc., up to the minute, thus completely solving an otherwise unsurmountable problem. Test adapters are made just as rapidly as the new tubes are announced. They are available in every conceivable form and for practically every purpose. A few of the various types are illustrated in Figure 7. The chief engineer of the Alden Mfg. Company estimates that his concern has made at least three hundred and fifty different kinds of adapters. These include, among others, test adapters for modernizing old set analyzers and tube checkers so as to permit tests of -55, -57, -58, -59, PA, PZH, -41, -42, -43, -46, -48, -82, -83, -85, -89, Duo-Diode, Duplex Diode Triode, and, in fact, *all* the other new tubes. In addition to the adapters, associate analyzer plugs, such as the ones illustrated in Figure 8, are also available.

Modernizing Test Equipment

The Wunderlich test adapter, described above and illustrated in Figure 3, is a typical example of the way in which engineers have enabled servicemen to use old-style instruments in testing new-type tubes. Typical test adapters designed for -41 and -42 type tubes are similar in appearance to the one shown in Figure 4. Using adapters such as these, -41 and -42 type tubes may be tested in set analyzers having five-prong test sockets.

The last word in tube-checking adapters is the Na-Ald "all-purpose" adapter shown in Figure 10. This is a truly universal checking adapter, as it enables one to test all of the following tubes, in any tube checker: -29, -33, -36, -37, -38, -39, -41, -42, -44, -46, -47, -49, -52, -55, -57, -58, -59, -64, -65, -67, -68, -69, -70, -80, -85, -88, -89, Wunderlich "A," Wunderlich "B," GA, PA, PZH, LA, -82, -83, -93, -95, -85, -86, G-2-S and G-4-S. This adapter is very easy to use, as it has only one toggle switch, which is employed only for the last four tubes.

Before commercial adapters were available it was necessary for the servicemen to construct makeshift adapters, using a tube base for the bottom and a socket for the top. These had the disadvantage of being bulky and cumbersome. On the other hand, adapters such as the Na-Ald units illustrated, have the least possible height and diameter required to perform their particular function. When it comes to output and pick-up adapters, the diameter is such that the new shields which are being required by the underwriters will not be interfered with, nor will they cause short-circuits. Even the analyzer plugs are so carefully calculated and so compact in design that they will fit readily into old-style Radiolas. A new small analyzer plug is available having a six-prong small base and designed especially for automobile radio sets.

Thus these adapters can always be used, no matter how limited the space. Adapters which are used on analyzer plugs must be of such size as to clear the close-fitting, shock-preventative shields which are within 1/32 inch of the tube bases in the latest sets and which in many cases are permanently fastened to the chassis.

Adapters are used to perform many (*Continued on page* 631)

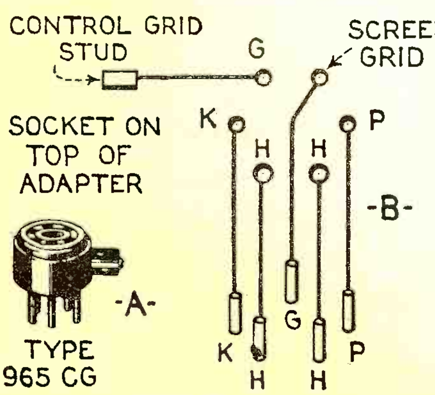


FIG. 4

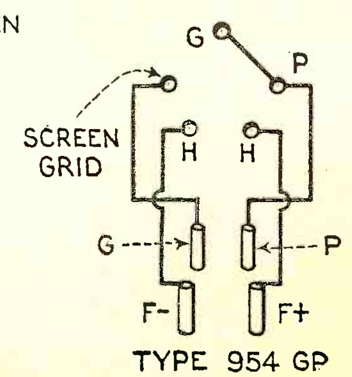


FIG. 5

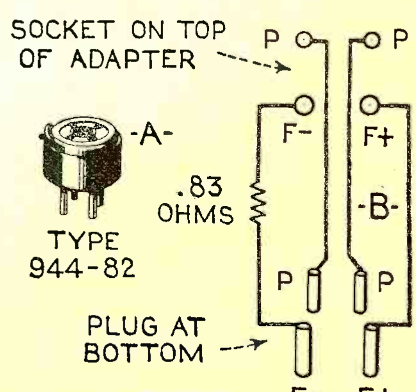


FIG. 6

AN INTRODUCTION TO THE VARIOUS PHYSICAL

Phenomena Underlying Radio

Radio apparatus of today, including television, uses practically all of the physical phenomena capable of being controlled by science. Devices which can be assembled within the space of a few cubic feet involve actions and energy transformations ranging over the whole domain of physics. Sound, heat, light, electro-static and electro-magnetic changes, as well as the dynamics of moving parts, are linked together in a chain of interactions which require study if we are to understand them

By E. B. Kirk

Part Four

WHEN the kinetic theory of heat first gained general acceptance (as recent as 1860), it was thought that the heat of a body was due entirely to the motion of its atoms and molecules. If a body was heated, the motions and therefore the energy was increased; if cooled, energy was taken away and the motions decreased. The pressure of a gas was explained as the force exerted on the containing vessel by the collisions of the atoms. Conduction of heat was thought of simply as the passing along of kinetic energy of agitation by collision.

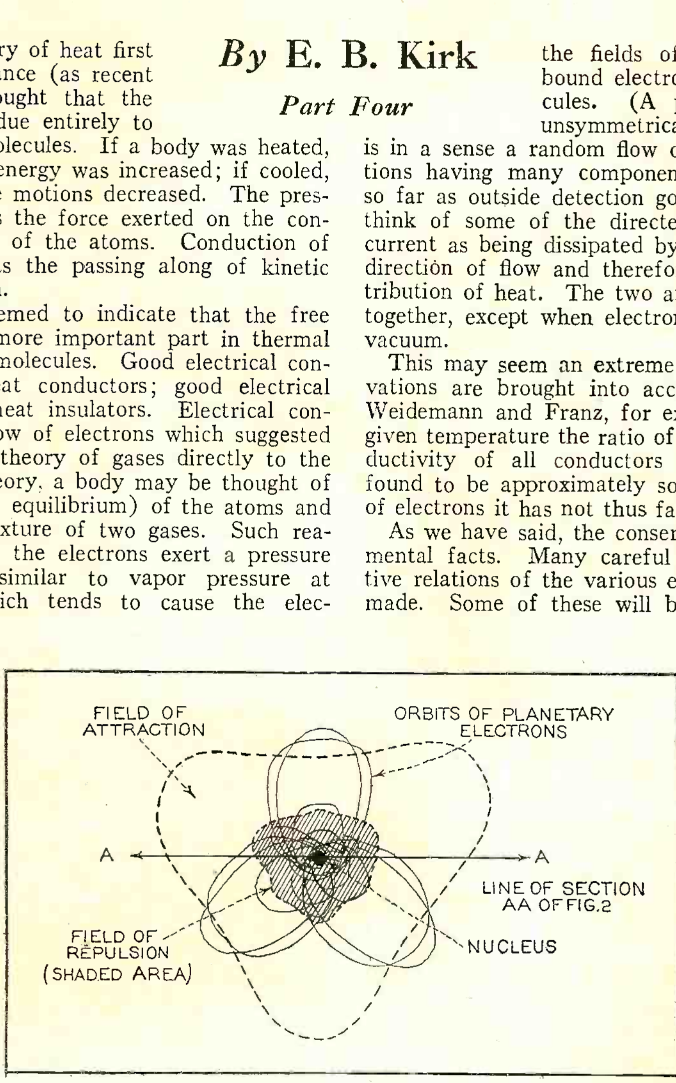
Later, however, evidence seemed to indicate that the free electrons might play an even more important part in thermal processes than the atoms and molecules. Good electrical conductors were usually good heat conductors; good electrical insulators were usually good heat insulators. Electrical conduction was thought of as a flow of electrons which suggested the application of the kinetic theory of gases directly to the electrons. In terms of this theory, a body may be thought of as a uniform mixture (when in equilibrium) of the atoms and free electrons, similar to a mixture of two gases. Such reasoning leads to the belief that the electrons exert a pressure at the surface of a solid similar to vapor pressure at the surface of a liquid, which tends to cause the electrons to evaporate from the surface. This electron pressure is determined by the inter- and intra-atomic forces, involving the nature of the atoms, the temperature, pressure and all their other physical properties. In terms of the potential and kinetic energies of the electrons, this mode of analysis has proven helpful in thermo and thermionic electrical theory.

Similarity of Heat and Electricity

If we consider heat as we have done above, we see that there is no fundamental difference between it and electricity. Heat is a statistical distribution of energy in all directions and among all modes of motion. An electric current is an orientation of part of this energy in one direction. An orientation may constitute a real flow of electrons as in the case of currents through conductors, or else it may be only a displacement or rearrangement of the fields of force, as in the case of the bound electrons of insulators and polar molecules. (A polar molecule is one with an unsymmetrical field of force.) A flow of heat is in a sense a random flow of electricity, a flow in all directions having many components, most of which balance out, so far as outside detection goes. Likewise it is reasonable to think of some of the directed flow of energy of an electric current as being dissipated by collisions at right angles to the direction of flow and therefore appearing as the random distribution of heat. The two are inseparable and always appear together, except when electrons are moving through a perfect vacuum.

This may seem an extreme point of view, still many observations are brought into accord by this theory. The law of Weidemann and Franz, for example. This states that at any given temperature the ratio of the thermal to the electrical conductivity of all conductors is a constant. This has been found to be approximately so, and without the kinetic theory of electrons it has not thus far been explained.

As we have said, the conservation of energy rests on experimental facts. Many careful determinations of the quantitative relations of the various energy transformations have been made. Some of these will be useful later and are therefore given at this point.



THE FORCE FIELDS OF AN ATOM

Figure 1 is a diagrammatic representation of the force fields of an atom or molecule. All atoms have two characteristics in common. They have about them a field of attraction either electrical or gravitational in origin. Although this field is intense near the atom and fades off as does the gravitational field of the earth at great distances, it has been represented by the outer dotted line in the diagram. However, surrounding the nucleus there seems to be another field of influence, one of repulsion. It also has no sharp boundary, but has been indicated by the shaded area. The figure represents only one plane section, but in reality the fields surround the atoms in various asymmetrical patterns determined by the distribution of the charges of the nucleus and the planetary electrons. Each element has its own individual fields of force

Mechanical Equivalent of Heat

Joule was the first to determine directly the relation between work and heat. He used a machine whereby a known amount of mechanical work was converted into heat by the stirring of water. From the rise in temperature of the water he was able to calculate, simply, the mechanical equivalent of heat. Since his time many more accurate methods have been devised, and the value now accepted is:

1 Gram-calorie = 41,820,000 ergs (Laby)

(The erg is a unit of work and is equal to the force of one dyne acting through a distance of one centimeter. A dyne is the unit of force in the centimeter-gram-second system. A college physics text will explain these units.)

If a current is sent through a conductor, it is found that there is always a drop in potential from one point to another. This means that some of the energy which enters the wire has been converted into some other form. Chemical actions or mechanical motion might be caused by the flow of current, but if care is taken that these actions cannot take place, it is found that the energy that is lost is appearing as heat, which is usually called the I^2R losses.

The relation which connects mechanical work with electrical energy is:

$$W = I^2R = I E$$

If I, the current (quantity of electricity per second measured in coulombs), is measured in amperes, and E, the voltage drop, is measured in volts, W is the power in watts. One watt of power is equal to 10,000,000 ergs per second. The important thing to remember is that the potential difference, E, represents the amount of work necessary to move a unit charge through that potential difference, and as $I = \frac{Q}{t}$, the total quantity moved per second, the total work is $I \times E$.

One gram-calorie equals 41,820,000 ergs; therefore it follows that—

One watt = gram-calories per second/4.182, or the heat produced by a flow of current is—

Heat in gram-calories per second = watts/4.182.

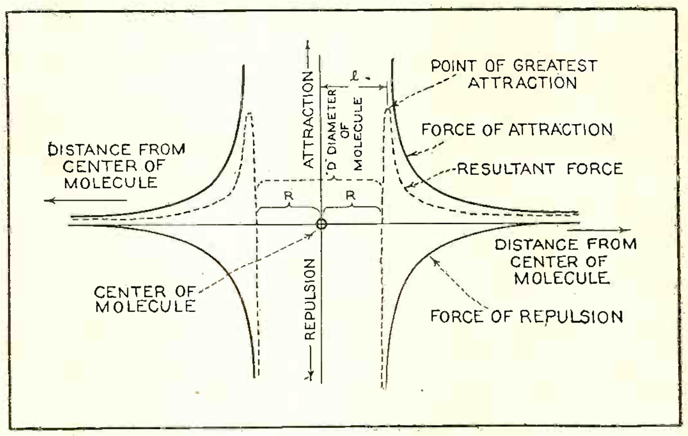
Practical Examples of Energy Relations

It may be interesting to look at a few quantitative examples of energy transformations. Let us assume that an amplifier supplies 2 watts to a loudspeaker and that the speaker is of the average inefficient type, converting, say 4% of the input energy into sound. This gives .08 watt of energy per second to be converted into the kinetic energy of the moving air molecules which constitute the compressions and rarefactions of sound waves. Eight hundredths of a watt at the diaphragm of the speaker gives 800,000 ergs of work per second being done. But of course the sound waves spread out from the speaker in approximately spherical form. If we are seated three meters (approximately 10 feet) away, the energy which reaches the ear is calculated to be approximately .7 ergs per second per square centimeter of area, assuming that the walls of the room do not reflect appreciably. This is a very small amount, but it is 35,000 times the amount of energy per second which the ear is just able to detect. The least perceptible sound is one with a power of .00002 erg per second per square centimeter. In the above example the gain over minimum audibility would be approximately 45 db. (The decibel is explained in the November issue of RADIO NEWS.)

If we suppose a fairly strong signal to deliver to the antenna .02 erg per second, this incoming energy per second, although 1000 times the least energy detectable by the ear, is of no value until transformed into sound. Working backward from the minimum audible energy, .00002 erg per second, and assuming that an amplification of 100,000 is used (a gain of 50 db.), it follows that as little as 2/10,000,000,000 erg per second in the antenna could be detected. It is interesting to note that if the inverse square law held for radiation, the above value would be the power per square centimeter received at a distance of 12,500 miles if 100 watts were radiated. Further, if we assume 30 watts are being expended in the tubes, transformers and speaker of the set, the output of .08 watt as sound gives an efficiency of only .27%. The efficiency per person (2 ears) listening is .0000005%.

The amount, 2/10,000,000,000 erg, also happens to be approximately the kinetic energy of an electron falling through a potential difference of 100 volts. It would require 10,000 of these electrons impinging every second in order to have power delivered equal to the least detectable sound.

The eye is sensitive to 2/10,000,000,000 erg per second under the best conditions; this then is of the same order of magnitude as the energy of one of the above electrons.



SECTION A-A THROUGH THE FORCE FIELDS

Figure 2. The forces surrounding an atom may be indicated as in the accompanying diagram. An approaching atom would at first experience attraction, if its approach continues it comes within a much more intense attraction, greatest at some distance, l in the figure. Further approach diminishes the attraction until at the distance R repulsion becomes effective. At any distance less than R an increasingly great repulsive force has to be overcome. This hypothesis helps to explain the apparent elastic qualities of atoms and also the extreme difficulty experienced when attempts are made to disrupt the nucleus of these atoms

Suggested Reading

Fundamental Concepts and Definitions—Kimball, College Physics. Any good physics text will explain the meaning of mass, force, potential energy, kinetic energy, work power, electric potential, heat temperature and so forth, and the units which are used for the measurements of these quantities, such as the dyne, erg, joule, volt, watt and so on.

Heat—Maxwell, J. Clerk. Theory of Heat. In particular, Chapters I, II, III, IV, XVI and XXII.

The Kinetic Theory of Gases—Bloch, E. Kinetic Theory of Gases. This is a very good elementary exposition. Loeb, L. B. The Nature of a Gas. An excellent book; the first half deals with the fundamentals of all matter. Very readable. Loeb, L. B. The Kinetic Theory of Gases. This is a comprehensive treatment of the subject. The first few pages are recommended as a historical introduction to the subject.

Kinetic Theory of Electrons—Crowther, J. A. Ions, Electrons and Ionizing Radiation. The kinetic theory of electrons is briefly discussed on pages 341 to 348.

Chronology of Frictional Electricity

600 B. C.—Thales produced static electricity by rubbing amber.

1501-1576—Cardano first to make the distinction between electric and magnetic attraction in a working theory.

1600—Gilbert noted that other substances in addition to amber could be electrified.

1672—Otto Von Guericke made the first friction machine, which consisted of a revolving ball of sulphur rubbed by the hand or with a cloth.

1675—Picard first noticed production of light by electricity. The friction of the mercury within a barometer caused a glow.

1703—Dutch travelers first noticed pyro-electric effect while traveling in Ceylon. Tourmaline crystals attracted hot ashes.

1705—Hauksbee gave true explanation of glow observed by Picard in 1675.

1708—Wall first published allusion to possible connection of electricity and lightning.

1709—Hauksbee and Winckler used a revolving glass globe in place of the sulphur globe of earlier machines. Gordon substituted glass cylinder for globe.

1730—Gray studied the difference between conductors and insulators.

1733—DuFay discovered that there were two kinds of charges. First used terms "vitreous" and "resinous." Made first attempt at formulating an electrical theory—two-fluid theory.

1733-1744—Many electric machines were made in Germany. Boze first to use a prime conductor on a machine. Winkler used a friction cushion of leather.

1744—Ludolf ignited sulphuric ether by an electric spark. This aroused much interest, because it was spectacular, and considerable money became available for research.

1746—Kliest, Muschenbroek and Cuneus discovered the Leyden jar. (*Continued on page* 639)

How to Build A RACK *and* PANEL PUBLIC ADDRESS SYSTEM

By William C. Dorf

Part Three

THE preceding two articles (February and March issues) on this rack-and-panel, public-address system treated, with considerable detail, the construction and assembly of the rack; installation of a powerful 6-tube Class B amplifier; the layout and installation of the phonograph turntable with pick-up and the construction, installation and operation of an effective mixing panel.

This is the final article of the series and it will be devoted to the construction and installation of a highly selective and sensitive 7-tube superheterodyne tuner. Besides the circuit diagram, the illustrations include top and bottom views of the receiver and dimensional drawings of the panel and the chassis. The constructor will also note the drawings with coded letters on the band-pass and the detector-oscillator coils, outlining the proper connecting posts of these inductances. It will be evident to the sound engineer, serviceman and radio experimenter assembling this rack-and-panel sound system that, with all this constructional information, the building details of the tuner have been thoroughly covered and simplified.

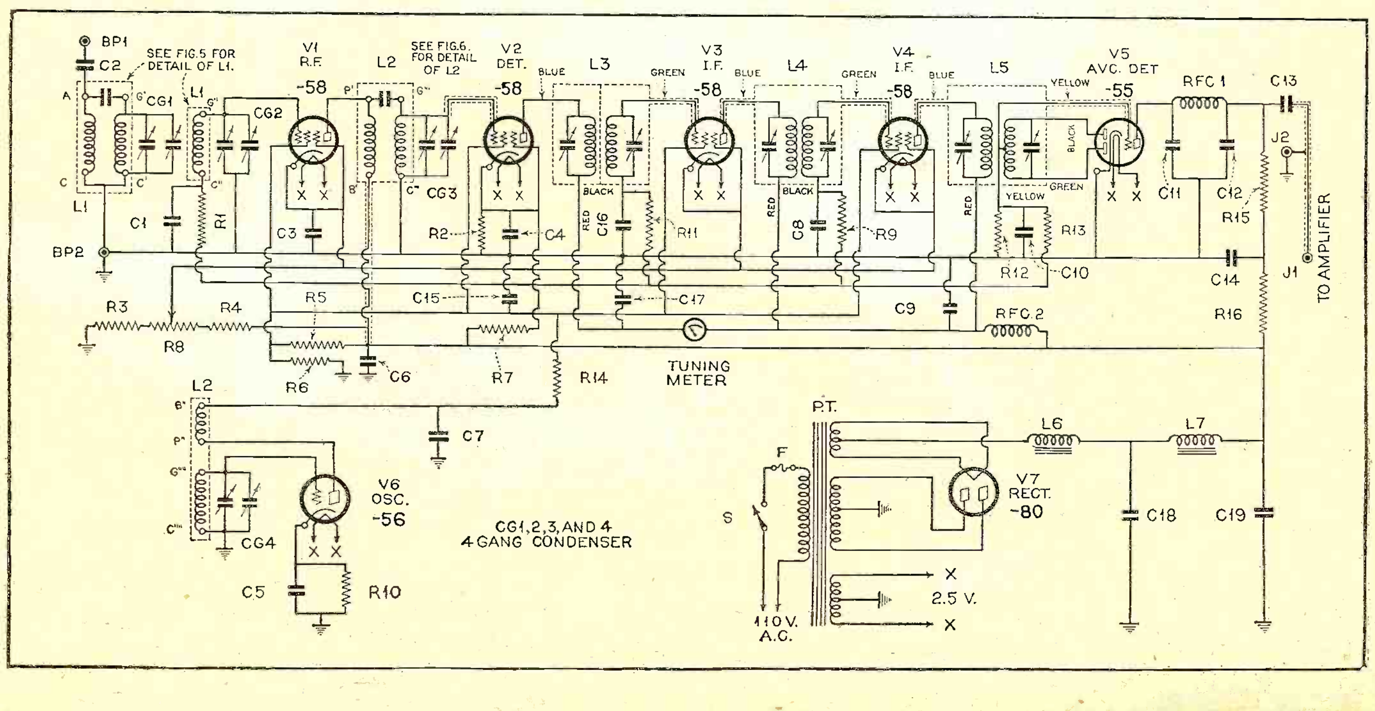
A modern superheterodyne tuner of this type using the new –50 type tubes need not be limited to a rack-and-panel, public-address system. It is a safe bet that this circuit will answer many a radio experimenter's requirements for a compact set to be used with a pet audio amplifying system.

A few words at this point would not be out of order, to explain that it was the purpose of this series of articles to meet a long-felt requirement of the serviceman and radio dealer, for a complete commercially designed public-address system, that he could rent out to public meetings or permanently install for all classes of public-address work.

The receiver is fully shielded, it is single-dial controlled and features visual meter tuning and automatic volume control, using the new –55 duo-diode-triode type tube for full-wave detection. The circuit also takes advantage of –56 and the –58 types of tubes.

The coupling coils, L3, L4 and L5, are all pre-aligned for 175 kilocycles, which is the intermediate frequency of the tuner. This means the constructor does not require an oscillator, output meter or any costly equipment to accurately peak these transformers. This is all done beforehand by the manufacturer.

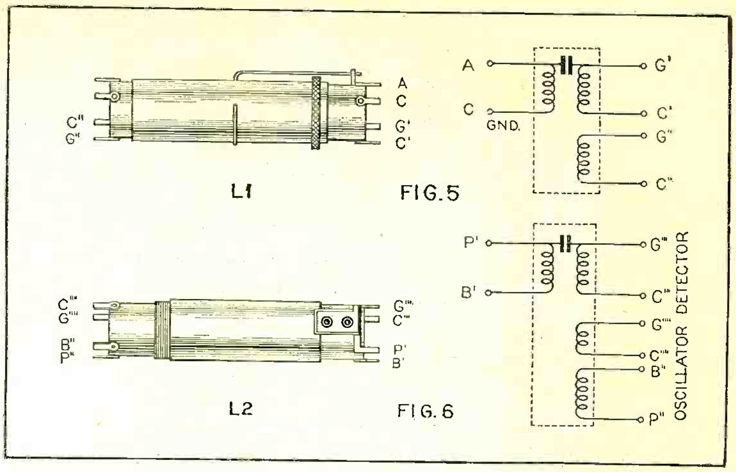
THE SCHEMATIC WIRING DIAGRAM



The visual-tuning-meter arrangement not only provides an exact tuning adjustment for the best quality of reproduction, but it also makes possible the "silent" tuning feature. As the audio amplifier and the mixing panel have a separate volume control which can be set to the zero position and with the control R8 on the receiver (actually a sensitivity control set to full-on position), stations can be brought in as desired and tuned to exact resonance as indicated by the visual tuning meter.

Still another feature of this receiver design is reducing in-between station noise. The resistance R8 varies the bias to the r.f. and the two i.f. tubes, therefore regulating the sensitivity of the set and controlling the amount of noise picked up. In any noisy location, this control can be set about one-quarter "on" or just below the noise level. Then the station can be tuned in without annoying background noises.

It was pointed out in the first article that this rack-and-panel sound system should find wide application for sound truck installation. The design of this circuit requiring only a few feet of wire for the antenna and the complete shielding of the set minimizing auto-ignition pick-up, also readily lends itself to motor-car use.



COIL CONNECTIONS

The circuit diagram and the detail drawings on the band-pass and the detector-oscillator inductances show the exact connection terminals for these coils

The tuner uses seven tubes in all. The band-pass r.f. antenna stage employs a –58 variable-mu type tube; it is double tuned and has a high impedance plate load, which makes it possible to realize the full gain of this tube. The signal from this stage passes through a small coupling condenser mounted directly on the coil L2, to the first detecter, a –58 type tube.

The oscillator circuit employs a type –56 tube and is so designed, in conjunction with the special tracking oscillator tuning section of the four-gang condenser, so as to accurately maintain the 175-kilocycle difference of the pre-selector and detector circuits throughout the whole waveband. This type of coil design (with the tracking condenser) eliminates extra cost and extra installation of padding resistors and condensers heretofore required in a single-dial control superheterodyne receiver. The oscillator circuit is inductively coupled to the detector stage.

The first detector stage is followed by a two-stage, double-tuned intermediate-frequency amplifier, using the –58 type tube. Each i.f. transformer is enclosed in a shield can and the mica condensers for tuning the coils are constructed of Isolantite and mounted directly underneath the top of the can. There are small openings at the top of the shield so the condensers can be easily reached with a screw driver for any adjustments necessary.

There is a copper disc between the primary and secondary windings of the first i.f. transformer, L3, to reduce the coupling and provide the high degree of selectivity required in this stage. The transformers L4 and L5 are precisely coupled to provide a flat-top response curve. The coupling unit between the second i.f. tube and the second detector is also double tuned, and this stage is shown with both ends of the secondary coil connected to the diode plates of the –55 tube, with a center-tapped connection for full-wave detection.

The –55 duo-diode-triode tube is employed in this circuit as an amplifier, for automatic control of volume and for push-pull detection. The automatic volume control action is made possible by a voltage set-up across the resistor R12 and the condenser C10. The a.c. component of this voltage is prevented from being impressed on the r.f. and the i.f. tubes by the resistance-capacity filter, comprising the resistors R13, R9, R11, R1 and the condensers C8, C16 and C1, while the d.c. component changes the effective bias of the tubes.

The visual tuning meter is connected in the plate lead to the first detector tube, and the volume control, R8, is a potentiometer of 4000 ohms connected to the cathode circuits of the r.f. and i.f. tubes.

The power supply employs the conventional –80 type rectifier which feds into a 2-stage filter.

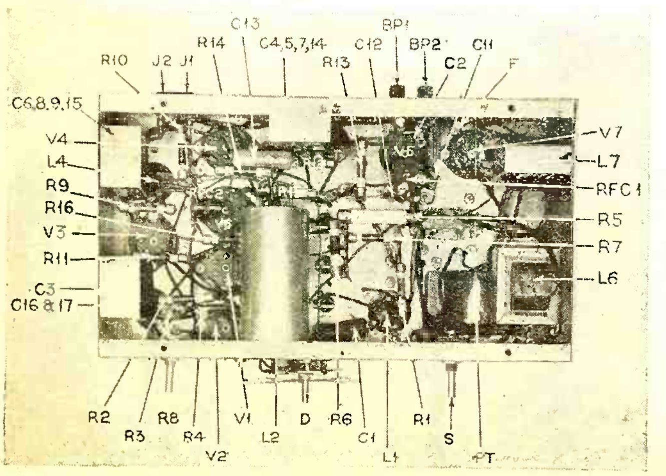
Assembly and Operation

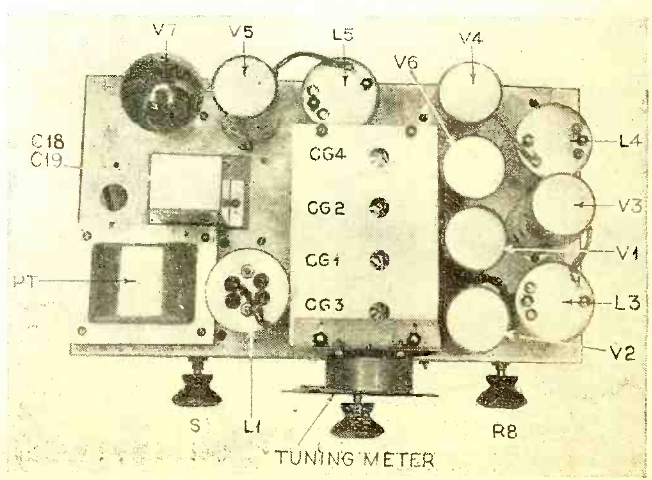
In reference to the assembly and the wiring of the receiver, the constructor can refer to the dimensional drawings, illustrations and the schematic circuit. In mounting the parts, the following procedure is suggested. First mount the power transformer, PT, then the seven tube sockets, V1 to V7, inclusive, to be followed with the tube-shield bases. Next mount the coils, L1, L3, L4 and L5 and, completing the assembly on top of the chassis, mount the four-gang condenser and the filter condensers, C18 and C19. In mounting the parts beneath the chassis, begin with the filter chokes, L6 and L7, the three and four-section condensers, the binding posts, BP1 and BP2, and the twin jacks, J1 and J2. These parts can be followed with the various resistors, tubular condensers, r.f. chokes, single by-pass condensers, the power switch and the volume control, R8.

When the set is completely assembled and wired, insert the seven tubes in their respective sockets (*Continued on page 632*)

TOP AND BOTTOM VIEW OF RECEIVER

These illustrations, lettered in accordance with the parts list and text, can be followed, for the placement of parts





Radio Call Book Section

Conducted by **S. Gordon Taylor** *and* **John M. Borst**

Broadcast Stations of the World

Africa, Asia, Oceania, South and Central America

By Call, Location, Frequency and Power

AFRICA

ALGERIA

Call	Location	K.C.	K.W.
——	Algiers	824	2.4

CANARY ISLANDS

Call	Location	K.C.	K.W.
EAR5	Las Palmas	1071	.5

EGYPT

Call	Location	K.C.	K.W.
——	Cairo	710	.5
——	Cairo	780	.3
——	Alexandria	780	.2
——	Alexandria	1080	.5
——	Alexandria	1080	.5

KENYA

Call	Location	K.C.	K.W.
VQ7LO	Nairobi	750	1

MOROCCO

Call	Location	K.C.	K.W.
——	Rabat	724	2
CNO	Casablanca	983	.025

TUNISIA

Call	Location	K.C.	K.W.
TUA	Tunis	235	.5

UNION OF SOUTH AFRICA

Call	Location	K.C.	K.W.
——	Bloemfontein	588	.75
ZTJ	Johannesburg	667	15
ZTD	Durban	731	1
ZTC	Cape Town	810	1
——	Pretoria	1000	.05

ASIA

BRITISH MALAYA

Call	Location	K.C.	K.W.
——	Kuala Lumpur	——	——

CEYLON

Call	Location	K.C.	K.W.
——	Colombo	600	1.75

CHINA

Call	Location	K.C.	K.W.
XOL	Tientsin	625	.5
COHB	Harbin	674	1
XGOA	Nanking	680	75
COMK	Mukden	731	2
XGX	Shanghai	812	.05
XOPP	Peking	910	.1
XGAN	Shanghai	930	.1
XGY	Hangchow	977	.75
XGNE	Shanghai	1070	.05
XGZ	Nanking	1071	.25
XGT	Shanghai	1150	.1
XGKW	Shanghai	1162	.015
XCBL	Shanghai	1180	.25
RUOK	Shanghai	1440	.25

FRENCH INDO CHINA

Call	Location	K.C.	K.W.
F31CD	Saigon (Chi Hoa)	840	12

HONG KONG

Call	Location	K.C.	K.W.
ZBW	Victoria Peak	845	1.5

INDIA

Call	Location	K.C.	K.W.
VUM	Madras	770	.2
VUC	Calcutta	810	3
VUB	Bombay	840	1.5
VUL	Lahore	882	.1

JAPANESE EMPIRE

Call	Location	K.C.	K.W.
JOAK	Tokyo	590	10
JOTK	Matsue	625	.5
JONK	Nagano	635	.5
JOUK	Akita	645	.3
JQAK	Dairen, Manchuria	645	.5
JFAK	Taihoko, Formosa	670	10
JOLK	Fukuoka	680	.5
JOVK	Hakodate	680	.5
JODK	Keijo, Chosen	690	1
JOKK	Okayama	700	.5
JOJK	Kanazawa	710	.3
JORK	Kochi	720	.5
JOSK	Kokura	741	1
JOBK	Osaka	750	10
JOHK	Sendai	770	10
JOPK	Taihoku, Formosa	778	.5
JOGK	Kumanoto	790	10
JOCK	Nagoya	810	10
JOIK	Sapporo	830	10
JOFK	Hiroshima	850	10
JOAK	Tokyo	870	10
JOQK	Nugata	920	.5
JOOK	Kyoto	960	.3
JFBK	Tainan	1111	1

SIAM

Call	Location	K.C.	K.W.
HS7PJ	Bangkok	810	——
HSP1	Bangkok	887	2.5
HS7PJ	Bangkok	923	——
HSP3	Bangkok	938	——

OCEANIA

AUSTRALIA

Call	Location	K.C.	K.W.
VK2CO	Corowa NSW	560	7.5
VK7ZL	Hobart, Tasmania	580	3
VK3AR	Melbourne, Victoria	610	5
VK5CK	Crystral Brook, S. Aus.	635	7.5
VK2FC	Sydney, NSW	665	5
VK6WF	Perth, W. Aus	690	5
VK5CL	Adelaide, S. Aus	730	5
VK4QG	Brisbane, Queensland	760	5
VK3LO	Melbourne, Vict	800	5
VK2BL	Sydney, NSW	855	5
VK6PR	Perth, W. Aus	880	.5
VK7HO	Hobart, Tasm	890	.05
VK4RK	Rockhampton, Queensl	910	2
VK3UZ	Melbourne, Vict	930	.3
VK2GB	Sydney, NSW	950	3
VK5DN	Adelaide, S. Aus	960	.3
VK3BO	Sydney, NSW	970	.2
VK4GR	Brisbane, Queensl	1000	.05
VK3HA	Hamilton, Vict	1010	.2
VK2UE	Sydney, NSW	1025	1
VK5PI	Port Pirie	1040	05
VK2CA	Kingston, Canberra	1050	.05
VK4MB	Brisbane, Queensl	1060	.05
VK2KY	Sydney, NSW	1070	1.5
VK3SH	Swan Hill, Vict	1080	.05
VK7LA	Launceston, Tasm	1100	.2
VK2HD	Newcastle, NSW	1110	.2
VK2UW	Sydney, NSW	1125	1.5
VK6ML	Perth, W. Aus	1135	.3
VK4BC	Brisbane, Queensl	1145	.6
VK3YB	Melbourne, Vict	1145	.025
VK2WG	Wagga, NSW	1155	.05
VK4TO	Townsville, Queensl	1170	.2
VK3DB	Melbourne, Vict	1180	.3
VK4MK	Mackay, Queensl	1190	.1
VK5KA	Adelaide, Queensl	1200	1
VK2CH	Sydney, NSW	1210	1
VK6KG	Kalgoorlie W. Aus	1220	.1
VK2NC	Newcastle, NSW	1245	2
VK3WR	Wangotta, Vict	1260	.05
VK2SM	Sydney, NSW	1270	1
VK3TR	Trafalgar, Vict	1280	.05
VK4BK	Brisbane, Queensl	1290	.2
VK3BA	Ballarat, Vict	1300	.05
VK5AD	Adelaide, S. Aus	1310	.3
VK2MO	Gunnedah, NSW	1320	.05
VK4RO	Rockhampton, Queensl	1330	.25
VK2XN	Lismore, NSW	1340	.05
VK3KZ	Melbourne, Vict	1350	.3
VK4BH	Brisbane, Queensl	1380	.6
VK2GN	Goulburn, NSW	1390	.1
VK3GL	Geelong, Vict	1400	.05
VK2KO	Newcastle, NSW	1415	.2
VK3AW	Melbourne, Vict	1425	.3
VK2WL	Wollongong, NSW	1435	.05
VK7UV	Ulverston, Tasm	1460	.2
VK2AY	Albury, NSW	1480	.05
VK3AK	Melbourne, Vict	1500	.05

NEW ZEALAND

Call	Location	K.C.	K.W.
ZL2ZK	Wanganui	600	.5
ZL2ZR	Wellington	600	.15
ZL1ZH	Hamilton	630	.05
ZL4YA	Dunedin	648	.5
ZL2YA	Wellington	720	5
ZL3ZR	Greymouth	820	.02
ZL2ZP	Wairoa	820	.004
ZL1YA	Auckland	910	.5
ZL3YA	Christchurch	980	.5
ZL2ZF	Palmerston North	1050	.15
ZL4ZM	Dunedin	1080	.045
ZL4ZO	Dunedin	1080	.03
ZL4ZB	Dunedin	1080	.02
ZL1ZB	Auckland	1090	.018
ZL1ZR	Auckland	1090	.04
ZL2ZU	Dannevirke	1100	.00 5
ZL2ZO	Palmerston North	1120	.01
ZL2ZW	Wellington	1120	.01
ZL2ZM	Gisborne	1147	[illegible]
ZL2ZJ	Gisborne	1150	.02
ZL4ZI	Invercargill	1160	.008
ZL4ZP	N. Invercargill	1160	.016
ZL2ZD	Masterton	1180	.0025
ZL1ZQ	Auckland	1190	.013
ZL3ZC	Christchurch	1200	.25
ZL2ZE	Ekatehuana	1210	.005
ZL4ZL	Dunedin	1220	.18
ZL2YB	New Plymouth	1230	.1
ZL2ZH	Napier	1260	.015
ZL2ZR	Wellington	1280	.15
ZL2ZM	Manurewa	1310	.01
ZL1ZJ	Auckland	1320	.026
ZL2ZI	Hastings	1330	.015
ZL2ZL	Hastings	1330	.015

SAMOA

Call	Location	K.C.	K.W.
5ZA	Apia	940	.005

CENTRAL AMERICA

COSTA RICA

Call	Location	K.C.	K.W.
TISO	San Jose	600	——
TIGP	San Jose	666	——
TIFB	San Jose	714	——
TIC	San Jose	882	.015
TICR	San Jose	911	.075
TI4NRH	Heredia	952	.075
TITV	San Jose	999	——
TITR	San Jose	1350	——

DOMINICAN REPUBLIC

Call	Location	K.C.	K.W.
HIX	Santo Domingo	625	1
HIJK	Santo Domingo	1180	15

EL SALVADOR

Call	Location	K.C.	K.W.
——	San Salvador	664	.5

GUATEMALA

Call	Location	K.C.	K.W.
TGW	Guatemala City	1320	.25

HAITI

Call	Location	K.C.	K.W.
HHK	Port au Prince	920	1

HONDURAS

Call	Location	K.C.	K.W.
JRL	San Pedro Sula	1350	.0075
HRB	Tegucigalpa	1370	2.3

SOUTH AMERICA

ARGENTINA

Call	Location	K.C.	K.W.
LP6	Buenos Aires	590	1.5
LV3	Cordoba	620	.35
LU3	Buenos Aires	630	4.5
LP4	Buenos Aires	670	1
LS1	Buenos Aires	710	5
LV1	San Juan	730	1.5
LR7	Buenos Aires	750	1
LT4	Mendoza	760	.17
LT1	Rosario	780	4.5
LR1	Buenos Aires	790	.5
LU2	Bahia Blanca	800	.5
LV7	Tucuman	820	.2
LR5	Buenos Aires	830	1.6
LT8	Rosario	840	.35
LV10	Las Heras	860	.35
LR6	Buenos Aires	870	2.1
LV9	Rosario	900	.5
LR2	Buenos Aires	910	5.5
LV2	Cordoba	920	.5
LR3	Buenos Aires	950	7.5
LR4	Buenos Aires	990	10
LR9	Buenos Aires	1030	5
LT9	Rosario	1060	.1
LT3	Rosario	1080	.25

(Continued next month)

The DX Corner

HERE is presented, in new form, *The DX Corner,* especially for the benefit of short-wave DX listeners. RADIO NEWS has recently equipped a *Short-Wave Listening Post* in Westchester County, New York, with the last word in long-distance short-wave receiver equipment, as pictured above. With this equipment a log of *Short-Wave Best Bets,* as printed below, will be made monthly from actually received programs. The RADIO NEWS staff offers this material as the most efficient form of log that can be presented, although, after reading some short-wave lists, the information may seem meagre. Actually, however, it is our belief that long lists are an incumbrance when the possibilities of satisfactory reception are limited to a relatively small number of stations. To use the log, simply determine the hour, by your watch, write it into the space left for this purpose in the proper schedule, and start listening for the stations listed under that schedule. The log gives Eastern Standard Time and a space has been left for the dial settings on your own particular set.

Short-Wave "Best Bets"

Wavelengths in Meters	*Call Letters*	*Dial Settings*
5 A.M.	**Eastern Standard Time....Local Time**	
31.2+	VK2ME	....
31.5	VK3ME	....
6 A.M.	**Eastern Standard Time....Local Time**	
31.2+	VK2ME	....
31.5	VK3ME	....
49.5	W8XAL	....
7 A.M.	**Eastern Standard Time....Local Time**	
49.5	W8XAL	....
8 A.M.	**Eastern Standard Time....Local Time**	
16.8	W3XAL	....
19.6	Pontoise	....
19.7	DJB	....
23.3	Rabat	....
65.+	WCAU	....
9 A.M.	**Eastern Standard Time....Local Time**	
16.8	W3XAL	....
19.6	Pontoise	....
19.7	DJB	....
25.3	GSE	....
25.6	VE9JR	....
10 A.M.	**Eastern Standard Time....Local Time**	
16.8	W3XAL	....
19.7	W8XK	....
25.3	GSE	....
25.6	VE9JR	....
49.9	VE9DR	....
11 A.M.	**Eastern Standard Time....Local Time**	
25.2	Pontoise	....
25.2	W8XK	....
25.4+	I2RO	....
49.9	VE9DR	....
12 NOON	**Eastern Standard Time....Local Time**	
25.2	Pontoise	....
25.4	I2RO	....
49.9	VE9DR	....
1 P.M.	**Eastern Standard Time....Local Time**	
19.7	W8XK	....
25.2	Pontoise	....
31.3	GSC	....
49.6	GSA	....
49.6	W3XAU	....
49.6	W1XAL	....
49.6	W4XB	....
49.9	VE9DR	....
50.+	HVJ	....
2 P.M.	**Eastern Standard Time....Local Time**	
25.4	I2RO	....
30.4	EAQ (code)	....
31.3	GSC	....
31.3	HBL (code)	....
31.3+	W1XAZ	....
49.6	GSA	....
49.6	W4XB	....
49.9	VE9DR	....
51.	W3XAU	....
3 P.M.	**Eastern Standard Time....Local Time**	
25.4	I2RO	....
25.6	Pontoise	....
30.4	EAQ (code)	....
31.5	OXY	....
32.3	Rabat	....
49.6	GSA	....
49.9	VE9DR	....
51.	W3XAU	....
4 P.M.	**Eastern Standard Time....Local Time**	
25.2	W8XK	....
25.6	Pontoise	....
30.4	EAQ	....
31.3+	W1XAZ	....
31.4	W2XAF	....
32.3	Rabat	....
48.8	W8XK	....
49.1	YV1BC	....
49.1+	W9XF	....
49.3	W9XAA	....
49.6	GSA	....
49.6	W4XB	....
49.9	VE9DR	....
5 P.M.	**Eastern Standard Time....Local Time**	
25.2	W8XK	....
25.4	I2RO	....
25.5	GSD	....
25.6	Pontoise	....
30.4	EAQ	....
31.3	HBL	....
31.3+	DJA	....
38.4+	HBP	....
41.6	EAR58	....
48.8	W8XK	....
49.1	YV1BC	....
49.1+	W9XF	....
49.9	VE9DR	....
51.	W3XAU	....
6 P.M.	**Eastern Standard Time....Local Time**	
25.2	W8XK	....
25.6	Pontoise	....
30.4	EAQ	....
31.3+	W1XAJ	....
31.4+	W2XAF	....
48.8	W8XK	....
49.3	W9XAA	....
49.9	VE9DR	....
51.	W3XAU	....
7 P.M.	**Eastern Standard Time....Local Time**	
25.2	W8XK	....
30.4	EAQ	....
31.3+	W1XAZ	....
31.4+	W2XAF	....
48.8	W8XK	....
49.1	YV1BC	....
49.5	W3XAL	....
49.6	W4XB	....
8 P.M.	**Eastern Standard Time....Local Time**	
25.2	W8XK	....
31.3	GSC	....
31.3+	W1XAZ	....
31.4+	W2XAF	....
45.+	W4XB	....
48.8	W8XK	....
49.1	YV1BC	....
49.3	W9XAA	....
49.6	GSA	....
50.	HKD	....
51.	HJ2ABA	....
9 P.M.	**Eastern Standard Time....Local Time**	
31.3	GSC	....
31.4+	W2XAF	....
45.3	PRADO	....
45.+	WIOD-W4XB	....
48	CKPR	....
48.8	W8XK	....
49.1	YV1BC	....
49.1+	W9XF	....
49.3	W9XAA	....
49.6	GSA	....
49.6	W4XB	....
51.	HJ2ABA	....
10 P.M.	**Eastern Standard Time....Local Time**	
31.4+	W2XAF	....
45.3	PRADO	....
45.+	WIOD	....
48.8	W8XK	....
49.1+	W9XF	....
11 P.M.	**Eastern Standard Time....Local Time**	
45 +	WIOD	....
48.8	W8XK	....
49.1+	W9XF	....

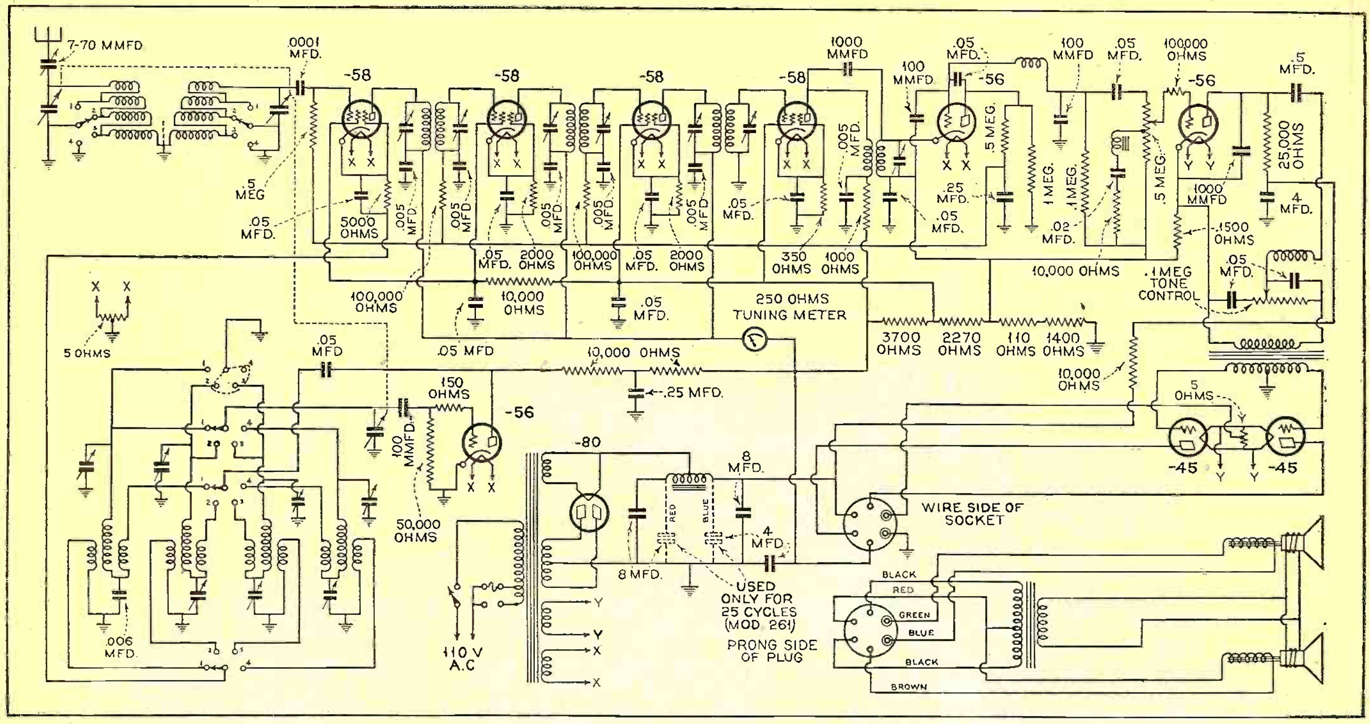
Station Locations

Wavelengths in Meters	*Call Letters*	*City Country*
16.8	W3XAL	Bound Brook, N. J.
19.6	FYA	Pontoise, France
19.7	W8XK	Pittsburgh, Pa.
19.7	DJB	Zeesen, Germany
23.3		Rabat, Morocco
25.2	FYA	Pontoise, France
25.2	W8XK	Pittsburgh, Pa.
25.3	GSE	Daventry, England
25.4	I2RO	Rome, Italy
25.5	GSD	Daventry, England
25.6	FYA	Pontoise, France
25.6	VE9JR	Winnipeg, Canada
30.4	EAQ	Madrid, Spain
31.2+	VK2ME	Sydney, Australia
31.3	GSC	Daventry, England
31.3	HBL	Geneva, Switzerland
31.3+	WIXAZ	Springfield, Mass.
31.3+	DJA	Zeesen, Germany
31.4+	W2XAF	Schenectady, N. Y.
31.5	VK3ME	Melbourne, Australia
31.5	GSB	Daventry, England
31.5	OXY	Skamleback, Denmark
32.3		Rabat, Morocco
38.4+	HBP	Geneva, Switzerland
41.6	EAR58	Teneriffe, C. I.
45.3	PRADO	Riobamba, Ecuador
45.+	W4XB	Miami, Fla.
48.	CKPR	Fort Williams, Ont.
48.8	W8XK	Pittsburgh, Pa.
49.1	YV1BC	Caracas, Venezuela
49.1+	W9XF	Chicago, Ill.
49.3	W9XAA	Chicago, Ill.
49.5	W8XAL	Cincinnati, O.
49.6	GSA	Daventry, England
49.6	W4XB	Miami, Fla.
49.6	W1XAL	Boston, Mass.
49.6	W3XAU	Philadelphia, Pa.
49.9	VE9DR	Montreal, Canada
50.	HKD	Barranquilla, Colombia
50.+	HVJ	Vatican City
51.	W4XB	Miami, Fla.
51.	W3XAU	Philadelphia, Pa.
51.	HJ2ABA	Tunja, Colombia
65.+	WCAU	Philadelphia, Pa.

Where Is VE9GW?

It has been reported by a number of lis-

(*Continued on page* 639)



TECHNICAL AND OPERATING DATA ON MODERN

Receiver Performance

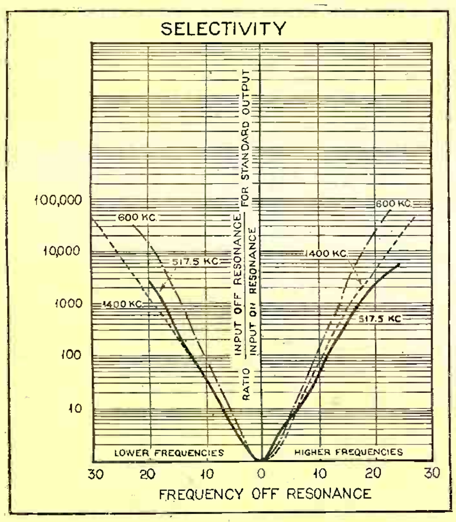
The American Bosch Model 260 "Super"

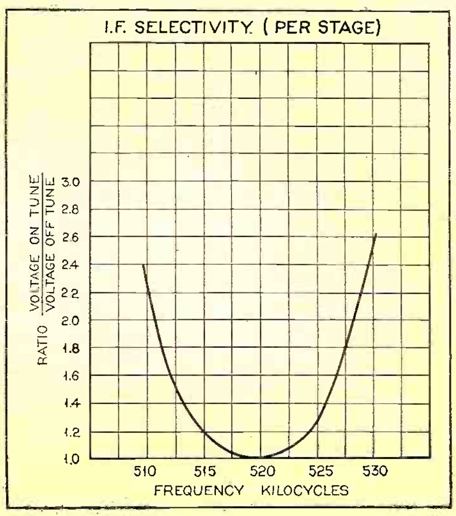
By the
Technical Staff

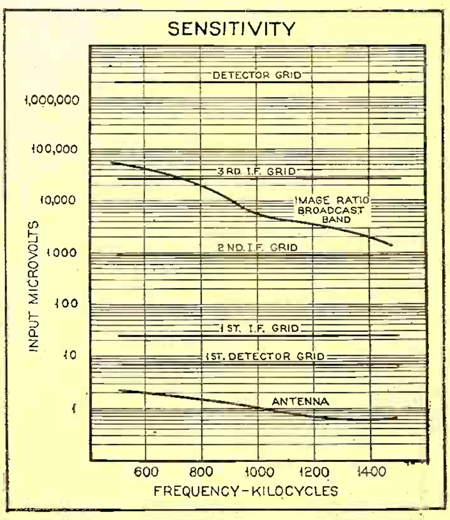
THIS model incorporates numerous modern refinements in broadcast receiver design and in addition includes complete coverage of the short-wave bands from 200 meters to 15 meters. A special feature of the design is found in the directly tuned antenna circuit, not alone on the broadcast band, but throughout the entire range of the receiver. In the days of one and two-tube receivers, the advantage of a tuned antenna was appreciated, but in later years, with the development of multi-tube sets, the tendency has been toward a certain amount of sacrifice in efficiency, to be compensated for by the addition of more tubes. The designers of the receiver under discussion have evidently sought for high efficiency, in addition to the use of 10 tubes of the most modern types.

The tuned antenna system offers a two-fold advantage. First, and most obvious, is the increased signal pick-up and more efficient transfer of the signal to the tube circuits. Less obvious, but equally important is the improved signal-to-noise ratio which results. This noise reduction has two explanations. In the first place, a tuned antenna provides a higher signal input to the receiver than does an untuned antenna circuit, yet external noise is approximately the same for both. The signal-to-external-noise voltage ratio is therefore directly improved. Secondly, with tube noise (the most important of which originates in the first tube) more or less constant for all signals, the higher the signal placed on the grid of the first tube, the lower the tube noise will be in proportion.

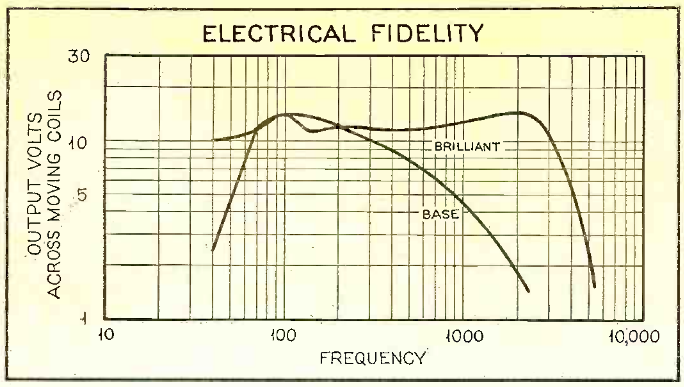
Antenna tuning is, of course, rather broad and, unless precautions are taken, will result in a reduction of adjacent channel selectivity. One such precaution may be found in providing relatively loose coupling between the antenna and first







tube. This retains the advantage of external noise reduction, but loses the advantage of reduced tube noise ratio. Another means is to provide high selectivity in the intermediate-frequency amplifier. In the Model 260 it will be noted that, including the oscillator, there are 8 tuned circuits between the first and second detectors—adequate to provide a high degree of i.f. selectivity.



Manufacturer's Model: American Bosch Model 260, superheterodyne.

Tuning Range: 15 meters-555 meters, divided into four bands as follows: 15-35 meters, 33-85 meters, 79-200 meters and 200-555 meters.

Tubes: 3 type –56, 4 type –58, 2 type –45 and 1 type –80.

Power Source: 110-120 a.c., 25-60 cycles.

Loudspeaker Equipment: Dual type dynamics.

Manual Controls: Four front-panel controls which include band selector switch, station selector dial, volume control (with on-off switch integral) and tone control.

Features: Automatic volume control, meter tuning, manual noise suppressor to eliminate noise between stations while tuning, antenna balancing control at rear of chassis to adapt receiver to antennas of different size.

Operating Characteristics

The schematic circuit diagram is shown herewith, together with five curves showing the operating characteristics.

Sensitivity: Sensitivity curves are based on an output of 100 milliwatts. The lower curve, marked "antenna," represents the overall sensitivity. The balance of the curves show the sensitivity at various positions throughout the receiver and, incidentally, the gain of each stage. The image-frequency selectivity ratio varies from approximately 1:2333 at 1480 kc. to 1:22,000 at 540 kc.

Selectivity: Curve self-explanatory.

Intermediate-Frequency Selectivity (per stage): This curve depicts the effect of the individual tuned i.f. stage in its contribution to the stage gain and indirectly the overall gain of the receiver.

Electrical Fidelity: The two curves represent electrical fidelity at the extreme settings of the manual volume control. These measurements are made from antenna to voice coil.

Receiver Performance Data

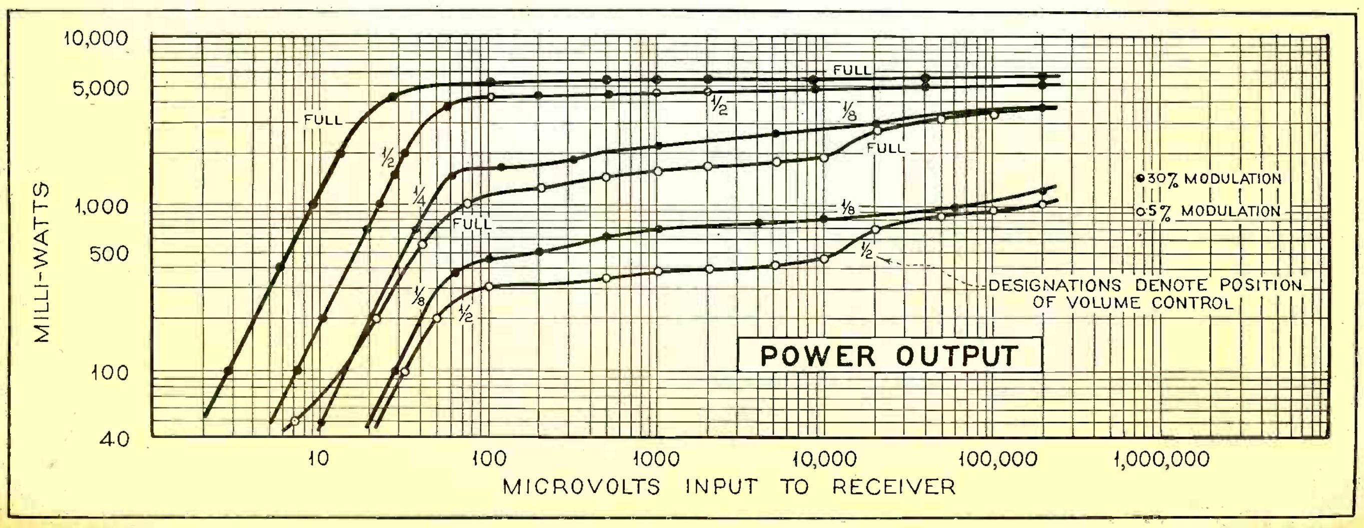
THE information given in this article covers the performance characteristics and circuit designs of modern radio receivers. It is felt that this data should be of particular interest to servicemen and dealers, and their comments on the material presented here will be appreciated. Subsequent articles will cover other popular receiver models. So far as possible, the receivers discussed will be selected on the basis of preference expressed by readers.

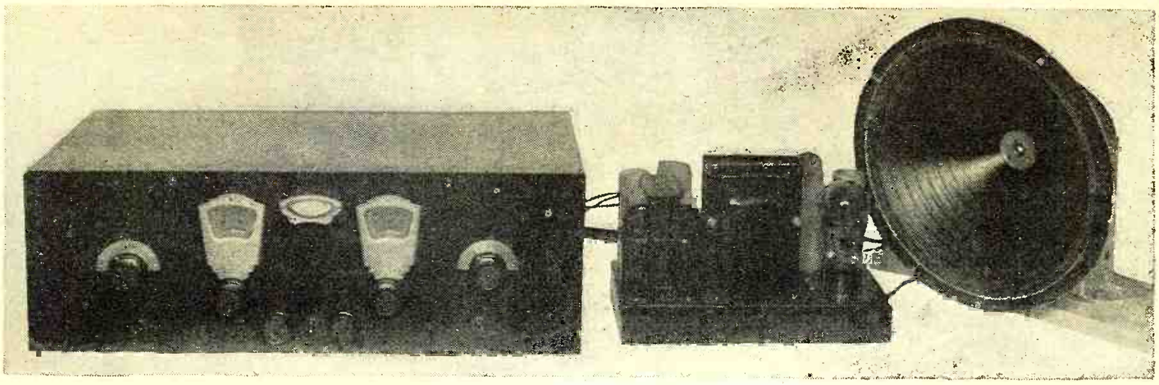
Power Output: Curves show power output for 5% modulation and 30% modulation at various settings of the manual volume control. In analyzing these curves it is well to bear in mind that the power output curve normally shown for receivers which incorporate automatic volume control show only a single curve similar to the top curve of this group. Such a single curve does not begin to tell the story of a.v.c., for the simple reason that it shows the output with the volume control turned up full, whereas, in a normal operation, such a setting of the volume control is practically never employed. Such a curve does not, therefore, represent the output characteristic which one can expect in normal home operation. In home operation, for instance, it is a recognized fact that all stations are not reproduced with the same volume for a given setting of the volume control, and the curves shown here are particularly interesting inasmuch as they do show the automatic volume-control action and the resulting output characteristics for different settings of the manual volume control. The effect of different degrees of modulation is also clearly demonstrated in this group of curves. Four of the curves are made from a signal modulated 30%, while the other two, which are broken by crosses, are made with a signal modulated 5%.

Circuit Design Features

A design feature of particular interest is found in the provision for both automatic and manual tone control.

Automatic tone control is provided to maintain an equally high degree of tone quality (to the ear), regardless of the setting of the manual volume control. In a receiver not so equipped the apparent fidelity varies considerably at different settings of the volume control, the lows and highs apparently falling off materially in proportion to the middle range as volume is decreased, due to the characteristics of the human ear. The series-tuned circuit consisting of the choke, condenser and resistance, connected across part of the volume-control potentiometer, constitutes the automatic tone control circuit and is broadly resonant over the middle frequency range. The effect of this arrangement is to attenuate the middle frequencies proportionately more than the extreme frequencies as volume is reduced.





Design Features of New
Commercial Type S-W Super

This new commercial type short-wave receiver, while designed primarily for professional service, offers numerous advantages which also recommend it for the earnest consideration of both "ham" and the short-wave broadcast fan

Part One

AS a general thing, the radio enthusiast who is interested in both broadcast-band and short-wave reception has owned an all-wave receiver rather than equipment consisting of separate receivers. However, there are circumstances which may have an important bearing on this choice. It is sometimes the case, for instance, that only the man of the house is interested in what the short waves can produce, while the rest of the family demand an uninterrupted fare of broadcast programs. Even in the best-regulated families such diverse requirements are likely to cause a certain amount of friction if both factions must depend on the same all-wave receiver for their enjoyment.

Then, too, there are some radio hobbyists and professionals who require certain features not always found in all-wave receivers. Such, for instance, as a separate beat oscillator, to permit reception of c.w. code signals, or band-spread tuning, to simplify the selection of stations in the crowded ranges of the dials. Many readers will find their own reasons for not wanting to depend on the radio in the living room for their own particular brand of radio amusement. The important factor is that there are often conditions under which a separate short-wave receiver is almost a necessity—and this need, whatever the reason behind it, is met by the new Lincoln R-9 commercial type short-wave receiver which has recently undergone preliminary tests by the RADIO NEWS staff.

This new receiver, as its name implies, was designed for commercial services such as airports, news syndicates, relay work and commercial telegraph and telephone stations. In meeting the requirements of these varied services, it likewise meets every conceivable requirement of the amateur transmitting station operator and the short-wave broadcast fan. It is strictly businesslike in appearance—and businesslike in operation. There is nothing superfluous in its make-up; every part and control serves a real practical purpose. It is a laboratory-built job, designed with the one purpose of bringing in short-wave signals in the best possible manner, and in appearance, results and operation should suit the real DX fan or the professional user right down to the ground. At least this is the conclusion arrived at by the members of the RADIO NEWS test staff upon completion of the preliminary tests, which were carried on first in a test station in the city and then at a suburban test station in Westchester County.

In an article next month a detailed description of the operating tests and the results obtained with this receiver will be given. For the time being it is sufficient to say that during the short preliminary tests stations were tuned in from numerous points in Europe, Africa, South America and North America on all wavelengths from 14 meters up. Between 8:30 and 9:45 one evening 12 separate stations were tuned in on the 49-50 meter broadcast band. For the location in which the receiver was operated at the time, this is quite a remarkable record—in fact, it is one which would be difficult to beat in the very best of locations. It is of interest to know that six of these stations were Spanish-speaking. Time would not permit waiting for announcements on all of them. Three of these were, however, identified as South American stations. It is suspected that one of them was Cuban, while the location of the other two is not known.

A hasty run through the amateur band brought them forth in droves, both on 'phone and c.w. The commercials were spotted at numerous points throughout all wavelength ranges, both on 'phone and the code.

THIS report on results obtained with this new receiver is based on tests made by the RADIO NEWS staff, under the direct supervision of Laurence M. Cockaday and S. Gordon Taylor.

As shown in one of the accompanying photographs, the R-9 consists of the receiver chassis, a separate power pack which supplies all voltages for the receiver, and a heavy-duty auditorium-type dynamic speaker. The chassis employs ten of the newest tubes in a superheterodyne circuit, the diagram of which appears in Figure 1. The chassis foundation is of heavy-gauge metal, with an aluminum front panel finished in black leatherette crackle. A metal case fits over the chassis, serving as both an overall shield and as a dust cover.

The power pack employs a type –80 rectifier and includes a heavy-duty filter which insures substantially infinite life for the filter condensers by using two condensers in series in each leg of the filter network, shunted by protective resistors. The speaker draws its field current from the power pack, its field coil serving as one of the two chokes. The adequacy of this filter is indicated by the fact that in actual operation with headphones there is no perceptible hum.

The auditorium dynamic speaker is the same type employed with the Lincoln DeLuxe All-Wave receiver, and to anyone who has heard that receiver in operation nothing more need be said. For others, it will suffice to say that this loudspeaker is one of the new high-efficiency type which someone has remarked "makes a 5-watt input sound like 10 watts." Its achievement in efficiency is only matched by its quality of reproduction.

The receiver covers from slightly over 200 meters down to a bit below 9 meters, which means that it is one of the few available receivers that cover the amateur 10-meter band as well as all the short-wave broadcast bands and higher amateur bands.

No Plug-in Coils

This range is covered without the use of plug-in coils. A band selector switch is provided on the front panel and permits instantaneous selection of any of the five bands which, measured during the tests, proved to be as follows: 8.8-16.8 meters, 14.6-27.7 meters, 27.4-51.6 meters, 48.2-99.0 meters and 86.2-216.0 meters. It will be noted that the individual band ranges are somewhat smaller than is usual in a short-wave receiver, which means that stations are spread further apart on the main dial and tuning is therefore made easier.

THE CONTROL PANEL

Two-control station selection for general tuning, single control for fine tuning, and auxiliary controls regulating volume and sensitivity. The a.v.c. system and c.w. oscillator may be cut in or out by means of switches

Band Spreading on All Bands

To further facilitate tuning, a band-spread condenser is provided on the panel. This band-spread arrangement takes the form of a three-plate midget condenser. Stations which fall one degree apart on the main tuning dial are spread over an average of 10 degrees on the band-spread dial. The advantage of this scheme lies in the band-spreading being effective over the entire range of the receiver. For instance, the short-wave listener, if he wants to tune around on the 49-meter broadcast band, can set the main tuning dial for a station at the lower end of this band and then do all the tuning within that band with the band-spread dial. During the preliminary operating tests of the receiver, using this tuning method, Caracas and W9XF (Chicago) were separated by a full three degrees on the band-spread dial, whereas in receiving these two stations on many short-wave receivers they are separated by a small fraction of one degree. GSA (London), instead of being about one degree above Caracas, is 15 degrees above on this receiver, and so on.

For operation in the police, aviation and amateur bands, this tuning feature is of inestimable value. The 'phone portion of the amateur 75-meter band, for instance, is spread over approximately one-quarter of the band-spread dial. With this band confined to from 2 to 4 degrees on the average short-wave receiver which does not employ band-spreading, all tuning is necessarily a hair-trigger process, but with the effective arrangement incorporated in this receiver the tuning, even in the extremely crowded bands, is as simple as that of a broadcast receiver.

C.W. Reception

Another aid in tuning is the heterodyne beat-oscillator. This tube is shown just below, and coupled to, the second detector in Figure 1. Its circuit is tuned to the same frequency as the intermediate amplifier, and when its switch is thrown to the "on" position it permits the reception of c.w. signals. Likewise it may be used to locate broadcast and 'phone stations by means of heterodyne "birdies." When the oscillator switch is thrown to the "off" side, the filament remains lighted but the plate voltage is cut off, leaving the tube dead but at the same time keeping it warm and ready for instant operation when wanted.

Automatic Volume Control

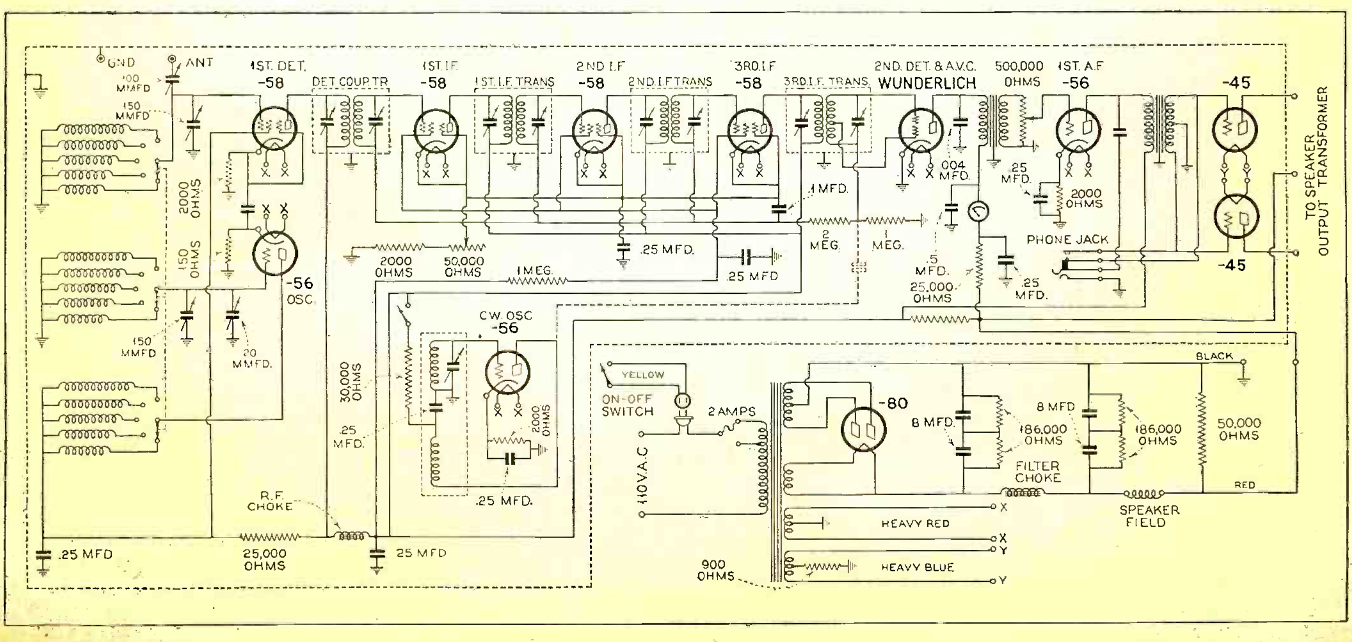
Automatic volume control is an excellent feature in most short-wave reception, particularly of the broadcast variety, and a highly effective system of a.v.c. has therefore been incorporated in the R-9 receiver. For certain purposes, however, especially in some of the commercial services, this feature is not at all times desired. A switch has therefore been placed on the panel so that the a.v.c. action can be used or not, as occasion demands. This is just another example of the universal adaptability of this new receiver.

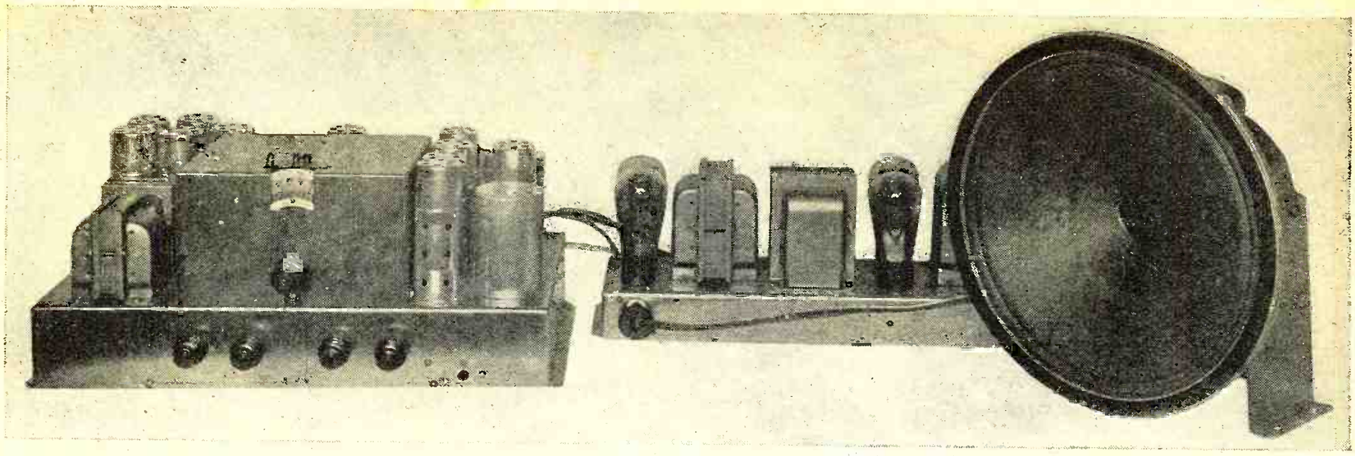
Signal Indicator Meter

Visual tuning is incorporated in the form of a tuning meter mounted on the panel. It is so used that deflection is obtained even on very weak signals, and a good wide swing is obtained on even the moderately good signals. On strong signals deflection approaches full scale. The result is that the meter serves as a real aid in quick and precise tuning.

The R-9 is designed for either loudspeaker or headphone operation. Referring to the circuit diagram, it will be noted that a headphone jack is incorporated in the plate circuit of the first a.f. tube and is isolated from the d.c. voltage of this tube by means of a blocking condenser. (*Continued on page 632*)

FIGURE 1. THE SCHEMATIC CIRCUIT DIAGRAM





THE COMPLETE RECEIVER

This is the receiver as set up in the test locations to check its operating characteristics under actual receiving conditions. It proved to be highly effective both on the broadcast band and on short waves

Operating Tests on a Fifteen Tube

ALL-WAVE "SUPER"

A technical description of this receiver was presented in the February issue. The present article covers results obtained with it in operating tests conducted around New York City

By **S. Gordon Taylor** *and* **John M. Borst**

WHEN a brand-new all-wave receiver arrives, a dyed-in-the-wool short-wave fan will not rest before he has unpacked the equipment and tried it out. Likewise, when McMurdo Silver's "Masterpiece" arrived at the RADIO NEWS Laboratory, the staff lost no time in getting the outfit set up. A technical description by the designer and manufacturer was given in the February issue. For convenience of readers who might have missed this story, the most important points are listed herewith: The receiver is a 16-tube, all-wave superheterodyne receiver, covering the wavelengths from 15 to 550 meters, in four bands. There are no plug-in coils; changing bands is accomplished by a switch. This switch indicates the band it is set for by a colored dot on the knob, the color agreeing with the calibrated strips on the "rainbow" dial. The dial is calibrated in megacycles on all short-wave bands.

The receiver includes automatic volume control, visual tuning, and a noise-suppressor system which keeps the speaker silent until a station of a certain minimum strength has been tuned in. It operates by means of an extra tube (see diagram) which increases the bias on the first a.f. stage to about 65 volts, until a signal comes in, when the bias automatically decreases to normal. This "squelch" circuit can be cut out if one wishes to listen for weak stations. The output stage comprises a pair of push-pull -45 type tubes in the famous Class A prime circuit. These tubes drive the Jensen auditorium speaker.

As soon as the receiver was set up in the laboratory, broadcast stations were tuned in. The working of the automatic volume control, the meter and the squelch circuit as well as the dial calibrations were then checked.

In the laboratory, which is in the heart of the city, entirely surrounded by skyscraper and factory buildings, reception of broadcast stations was accomplished with a short antenna of about ten feet. In fact, stations came in when only the hand was brought within one foot of the antenna post. Excellent quality was obtained on many out-of-town stations, such as WFI, Philadelphia; WHAM, Rochester; WGY, Schenectady, etc., all in the daytime and through difficult inductive interference.

On the front panel there are four knobs, besides the single station selector dial. From left to right, these are: volume control, tone control, squelch circuit cut-out switch and wave-band switch. On the back of the chassis one finds a switch to cut in the beat oscillator and also the phonograph radio switch.

The laboratory, being in a noisy location, offered a good opportunity to check the noise suppressor. There is no noise heard between stations and when an incoming carrier releases the a.f. stage, the automatic volume control decreases the sensitivity of the set, which makes the listener think there isn't any interference in the building. If the squelch circuit is cut out, a terrible racket is heard between stations! The tuning meter works normally on the broadcast band when the squelch circuit is cut out. When the noise suppressor system is used, one finds that the meter shows a slight dip at exact resonance on powerful stations. One should then tune for this dip.

After being convinced that the equipment was in good working condition, the receiver was removed to the RADIO NEWS short-wave testing station in Westchester County, approximately 12 miles radio distance from downtown New York.

The receiver was set up and connected to a long antenna (approximately 150 feet) in accordance with the recommendations of the designer. Then, knowing that EAQ, Madrid, was on the air, that station was tuned for to begin with. EAQ transmits on 30.4 meters, 9860 kilocycles or 9.86 megacycles. Tuning near 10 mc. on the orange (lowest wavelength) band, it was no trick at all to find Madrid. Finding short-wave stations is greatly facilitated by the beat oscillator. Just tune until you hear a beat, then turn the oscillator off and there is your station! After having listened to EAQ long enough to identify it exactly, the beat oscillator was switched on again until another 'phone station was heard just below. This proved to be a local commercial 'phone station, WOB, Lawrenceville. Switching to the next waveband, going up in wavelength, a place on the dial was found where four stations came in close together. These proved to be W2XAF, Schenectady, on 31.48 meters; W1XAZ, Springfield, on 31.35 meters, 9570 kc., and GSC, on 31.3 meters, 9585 kc. The fourth could not easily be identified, because it was too close to GSC. (The next day it was found that this was DJA, Zeesen, Germany). By this time there was occasion to switch the aerial to another standard test receiver and back and forth for comparison on distant signals. It was discovered that England would come in when the aerial binding post was touched with the finger. Later, a short aerial was employed of about 30 feet long (by opening a switch in the long aerial), and this also produced good results.

It was now becoming late in the afternoon and a try was made around 50 meters. This is found on the same (yellow) band. Of course, no one could fail to get Caracas on 49.97 meters (6 mc.). Bowmanville, VE9GW, comes in like a local on 6.095 mc., 49.22 meters. Just above this, on 49.96 meters, HKD, Baranquilla, Colombia, was heard. Another Colombia station, HKS, Cali, comes in on approximately 47 meters.

One of the outstanding features of the receiver, it was found, is its quietness in operation. This was the first time in our experience that the sensitivity control could be turned up all the way without having everyone in the neighborhood go deaf.

Twilight Reception on Broadcast Band

It was near twilight when it was decided to try the broadcast band. In the hour from 5 to 6 p.m. the entire dial was tuned through, stopping at every degree to see if a station could be picked up. Of course, some evidence of a station could be found on every degree, but some are too weak and on some channels two or three stations may be heard at once. From 540 to 1200 kc., 43 stations were heard clear enough for identification. This does *not* include the locals, 9 in number, which brings the total up to 52. On other channels, the reception was not clear owing to daylight. Remember, this while it was still daytime over the greater part of the United States. As soon as WPCH signed off at 6 p.m., WCCO, Minneapolis (on the same channel), could be heard clearly. Right next to it (on 800 kc.) WFAA was found. This is a hard station to get in this location, and to receive it at 6 p.m. is not a bad accomplishment. These same stations were received again on other days at the same hour. During these tests on the broadcast band, a rather short aerial was used—not more than 20 feet in length.

After twilight, going back to the short waves around 50 meters, the dial was now found to be crowded with stations. It might interest the reader that code stations from all over the world were copied during the tests. Argentina, France, Germany were as easy to get as the ship's operator gets WCC or KPH.

During the evening the same 50-meter stations came in, with the addition of VE9DR, Montreal, on 49.96 meters. There were, of course, a whole collection of American stations, rebroadcasting programs from WJZ, KDKA and WCAU. A good way to help identify them was by switching over to the broadcast band to find the same program. After this there was silence—even the testing staff must eat.

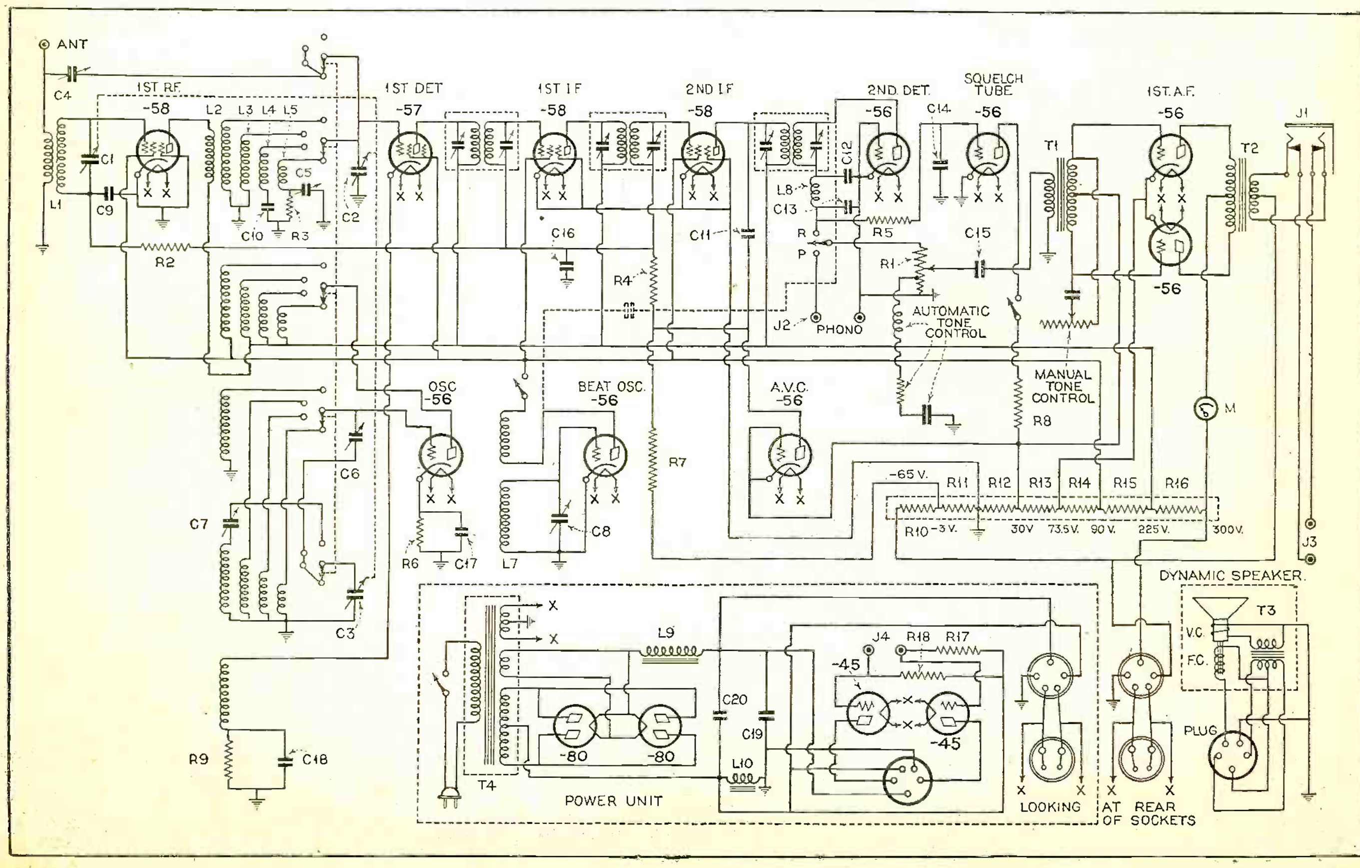
At 7:45 p.m. GSA, England, came on the air on 49.6 meters. He gives a tuning signal for at least 15 minutes. Then the chimes came in, followed by Big Ben. The sound of the large bell nearly rocked the house. Certainly, with such a powerful signal and so many identifying signals, even the rankest novice cannot fail to find that station. This program comes over as well as the average U. S. stations; it can really be enjoyed, and one forgets all about the fact that this is short-wave reception because of the absence of noise. The Colombian stations, HKD and HKA, both at Baranquilla, could at this hour be tuned in more easily on 49.96 and 48 meters, respectively.

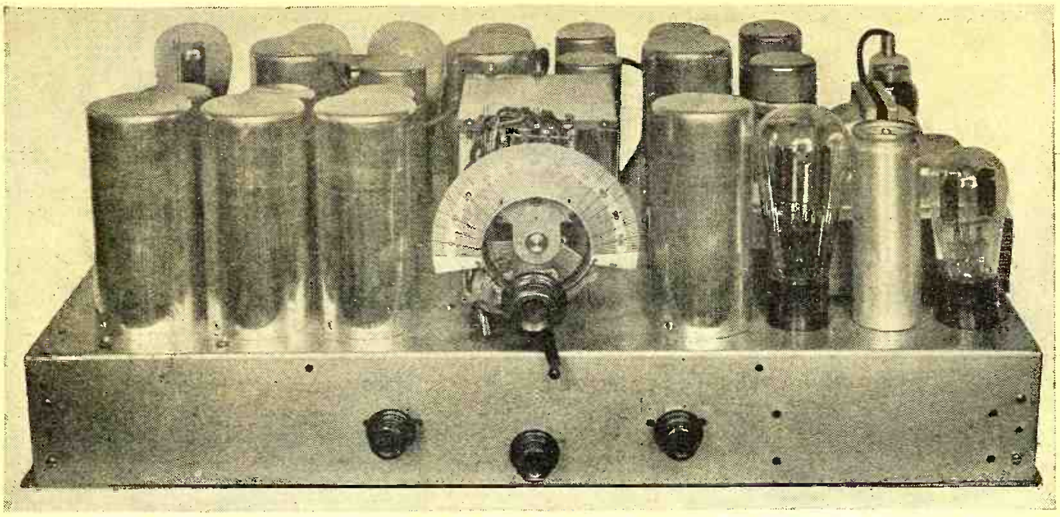
Just a word about the calibrated dials. It is obviously very difficult to calibrate any short-wave receiver by a dial which is produced in quantities. It is surprising how close the calibration checks. But since stations tune so sharply, it is practically impossible to set your dial exactly right by the calibration alone. The wanted station will usually be found within about ⅛ inch of its correct place on the dial. In the case of EAQ it was much closer.

All-Wave Dial Calibration

When the receiver is tested in the factory, the dial setting of two or three distinct stations are marked with pencil lines. On the test receiver sent us, we found three pencil marks near 25 meters. Two of these were found to be the settings for FYA, France, I2RO, Rome; the third one was apparently not on the air. These two stations, by the way, were among the stations received the next morning. Unusually good results were obtained that day with DAN, Norddeich; HBL, Geneva, and GSC coming in clear and loud so that the German, French, etc., could easily be understood. Station HBL, Geneva, was transmitting a program to the Columbia Broadcasting System. The same program was also transmitted by an English station, Rugby, and comments about the modulation were received from the U. S. on other nearby wavelengths. The whole arrangement could easily be followed. At the same time, a program was transmitted from Rome—a (*Continued on page* 634)

THE SCHEMATIC CIRCUIT DIAGRAM





CLOSE-UP OF THE CHASSIS

Sixteen tubes with all the trimmings, including complete shielding, all-wave coverage, automatic volume control and between-station noise suppression

OPERATING TESTS ON AN ALL-WAVE

LOW-COST "SUPER"

This receiver, which was described in considerable detail last month, came through the operating tests with flying colors, easily qualifying for a top-notch rating on a "performance per dollar" basis—or a good rating on any other basis

Part Two

By **S. Gordon Taylor** *and* **William C. Dorf**

THIS article will be devoted entirely to broadcast and short-wave reception results on the new Midwest low-cost sixteen-tube all-wave superheterodyne receiver. The previous article, which appeared in the March issue, gave a technical description of the receiver and discussed at length the developments incorporated in it.

In the first article, a preliminary reception report was given. Since this first test there has been plenty of time to put the set through its paces in operating tests conducted in five different locations, under different operating and weather conditions. To say that these tests bore out the promising preliminary findings on a set of such a low price range is to put it mildly. The tests were started in an apartment house in New York City, situated about six miles from the heart of the metropolitan district. The tests were made in the evening and were started rather late—to be exact, 10:30 p.m. The weather was clear and cold and the night free from static. The antenna used was an indoor installation of approximately 20 feet in length. The ground lead to the set measured about 10 feet.

By running through the tuning dial, on the broadcast band, a carrier signal was found on almost every degree on the dial. However, it would be practically impossible to have the time or the patience to obtain all station announcements, and after logging the dial settings for the principal New York City local stations such as WEAF, WJZ, etc., the announcements were heard on DX stations WTMJ, Milwaukee, operating on 620 kilocycles; WFAA, Dallas, 800 kc.; WHAS, Louisville, 820 kc.; CKOC, Hamilton, Ontario, Canada, 635 kc.; WSM, Nashville, 650 kc., and KOA, Denver, 830 kc.

Due to the late hour in starting these initial tests, no attempt was made for foreign short-wave broadcasts, although a few minutes were spent listening to police calls on the tuning range of 75 to 200 meters, indicated by a red dial light, from such cities as Detroit, Buffalo, Chicago, Los Angeles, etc.

The broadcast operating tests were resumed another evening in the same general location but in a different apartment house. The tests got under way about 8:30 p.m., and the indoor aerial used was about 30 feet in length, with a ground lead of 10 feet. The receiver was first tuned to 650 kc., and the way WSM, Nashville, was coming in, indicated a good night for DX reception, an indication later borne out by the following results.

From WSM, Nashville, the dial was turned to WABC, our powerful New York local station, and a test was made to receive the distant stations that operate adjacent to this local. WWL, New Orleans, on 850 kc., was received, but WABC was heard in the background. However, WENR, Chicago, 870 kc., one channel the other side of WABC, was received without interference from this local station. The Canadian station at Toronto, Canada, 840 kc., was tuned in at low noise level and with enough volume to be classed with a local. For the next channel, 830 kc., KOA, Denver, was heard with their call, and the station announcements were clearly heard from WHAS, Louisville, 820 kc.; WCCO, Minneapolis, 810 kc.; WBAP, Fort Worth, 800 kc.; and WGY, Schenectady, 790 kc. The above results obtained in this location, on the broadcast band, indicate the sensitivity and selectivity of this receiver. Other stations whose call letters were heard the same evening were: WLW, Cincinnati, 700 kc.; WBZ, Boston, 990 kc.; KDKA, Pittsburgh, 980 kc.; XEAW, Hidalgo, Texas, 965 kc.; WCFL, Chicago, 970 kc., and a Mexican station at 910 kc.

The third test was made in Bayonne, N. J., a small city located about ten miles from New York City. This test was made in a private dwelling quite clear from any large buildings. The antenna was approximately 100 feet in length, with a ground lead of 5 feet to a cold-water pipe. This spot proved about the same on the broadcast band as the previous test locations and attention here concentrated mostly on the short waves. It was a cold day, with indication of a snowstorm, which later materialized, but had no (*Continued on page* 630)

Technical Review

RADIO SCIENCE ABSTRACTS

Radio engineers, laboratory and research workers will find this department helpful in reviewing important current radio literature, books, Institute and Club proceedings and free technical booklets

Conducted by
Joseph Calcaterra

The Radio Engineering Handbook, by Keith Henney. McGraw-Hill Book Co., 1933. No doubt many engineers and experimenters have long been waiting for just such a book as this. Other engineering branches have always had their handbooks, but radio communication has been sadly neglected. This was due, probably to the fast growing of the art. The new handbook describes the best practices now employed in the design and operation of radio equipment. It is divided into 23 sections, 22 of which have been written by recognized authorities. The remaining section contains mathematical and electrical tables.

Here, for the first time, the reader finds the most important practices and design procedures within the covers of a single volume. The chapters are full of practical information, tables, diagrams and descriptions of equipment the reader is liable to encounter. The beginning of the book is devoted to chapters on the electrical and magnetic circuits, resistances, inductance, capacity. These chapters cover the design of inductors, condensers and resistors. Section 6, on "Combined circuits of L, C and R contains the theory of tuned circuits, coupled circuits, transmission lines and wave filters. Then follow measuring instruments, vacuum tubes and oscillating circuits. Later sections deal with the design of complete receiving and transmission systems for both long and short waves, for telephony, telegraphy, and television. Special sections are devoted to aircraft radio, photo-cells and talking movies. The authors have done exceedingly well in the short space allotted them.

Educational Broadcasting, a bibliography by Robert Lingel; The University of Chicago Press, 1932. This book contains a complete bibliography of American literature on educational broadcasting, by a member of the staff of the New York Public Library. An appendix lists all publications on radio law.

Radio and Education, edited by Levering Tyson. The University of Chicago Press, 1932. The sub-title of this volume is: "Proceedings of the Second Annual Assembly of the National Advisory Council on Radio in Education, Inc." The organization held their annual meeting in Chicago on the 18th, 19th and 20th of May, 1932. This book contains the lectures given in the seven sessions during three days. Reports are given on educational broadcasts during the past year and the experience gained. It seems that education by radio is totally unlike education in the classroom and an entirely new technique has to be developed. Besides several lectures on education, there also are some on advertising, from the standpoint of the broadcaster, the public, the advertising agency and the client. The book should be of interest to anyone interested in radio as well as to the general reader who wishes to keep abreast of the times.

The Broadcaster Trade Annual, 1933. This British yearbook contains much useful information, especially for those who are interested in radio conditions in Great Britain. The contents includes a report of the different radio organizations, a technical section, a commercial section, a legal and license section and a directory section. The directory section contains a list of British manufacturers, of trade names, parts supply houses, wholesale dealers and Who's Who in Radio. In the technical section one finds a list of the supply voltages in cities and towns in Great Britain. Further, it gives much miscellaneous information on servicing, formulas, tables, etc.

Rundfunk-Jahrbuch, 1933; Reichs-Rundfunk-Gesellschaft, Berlin. The German yearbook resembles last year's edition in its printing, binding and illustrations. It is full of drawings and half-tones, all printed on coated paper. The contents consist of reports giving the experiences and progress of the different broadcasting companies in Germany. Other chapters sketch the technical progress in various branches of the industry and give to the layman a glimpse of life in the studios. Several tables of statistics complete the volume.

Review of Articles in the January, 1933, Issue of the Proceedings of the Institute of Radio Engineers

Measurement of the Frequency of Ultra-Radio Waves, by J. Barton Hoag. This paper describes the evolution of an equation which permits the measurement of ultra-radio frequencies to three significant figures. The method used is independent of end effects and has been applied to a determination of the velocity of propagation along iron wires.

Frequency Doubling in a Triode Vacuum-Tube Circuit, by Carl E. Smith. A quantitative analysis of the operating performance of a triode vacuum tube as a frequency doubler, which can be adapted, with slight changes, tripling, quadrupling, etc. The investigation has been designed to bring out the conditions that will give the maximum plate efficiency and most desirable operating conditions.

Modulation Frequencies in Visual Transmission, by Edwin Lee White. This paper describes a method of computing the maximum frequencies produced in television transmisison, based on the consideration of the degree of edge definition produced. The fact that these frequencies are independent of the amount of detail in transmitted pictures is shown.

An Improvement in Vacuum-Tube Voltmeters, by R. M. Somers. This paper describes a vacuum-tube voltmeter for the measurement of audio frequencies, which depends for its operation almost entirely upon the amplification factor of the tube. It combines the marked advantages of a single voltage source for filament, grid and plate supply, with the absence of zero-adjustment requirements on the indicator, and has the further advantage that it can usually be made direct reading, in volts, on an 0-2 milliampere thermocouple type of indicating instrument.

Transoceanic Reception of High-Frequency Telephone Signals, by R. M. Morris and W. A. R. Brown. This paper treats the application of high-frequency telephone transmission to international rebroadcasting and gives brief descriptions of the method used in rating the suitability of reception for rebroadcasting, the effects of magnetic disturbances upon transmission, the correlation of magnetic activity with transmission and the forecasting of magnetic disturbances and resultant transmission conditions.

Review of a Paper in the Nov.-Dec., 1933, Proceedings of the Radio Club of America

Short-Wave Transoceanic Telephone Receiving Equipment, by F. A. Polkinghorn. A general discussion of the receiving equipment used on the short-wave transatlantic telephone channels, to England, and some of the methods of analysis used in attacking the problems encountered in the design of the receiving equipment. Data is given on the field strengths obtained, the use of directive antennas, transmission lines and receiver characteristics.

Review of Contemporary Literature

Evaluating Hearing Aids, by Harvey Fletcher. Bell Laboratories Record, January, 1933. A method is discussed of rating different types of hearing aids and degrees of deafness so that recommendations for the best type suitable to a given person's hearing deficiencies can be made without requiring such persons to try different types of aids to determine which is satisfactory for them.

A Heterodyne Oscillator of Wide Frequency Range, by J. G. Kreer, Jr. Bell Laboratories Record, January, 1933. This article contains a description of the design characteristics of a heterodyne oscillator which can be rapidly and easily passed through a wide range of frequencies from 200 to 35,000 cycles.

Measuring Microphonic Noise in Vacuum Tubes, by H. A. Pidgeon. Bell Laboratories Record, January, 1933. A testing unit which gives a steady reading of the microphonic noise in a tube under test in terms of an arbitrarily selected level is described in this article, together with its design characteristics, method of use and results obtainable.

The Stroboscope. General Radio Experimenter, December, 1932. A general discussion of the principles of operation of the stroboscope by means of which the motion of rapidly moving objects or mechanisms can be stopped for observation. A list of the interesting and useful applications of this device are given and a description of the features of the Edgerton Stroboscope.

Tubes with Cold Cathodes, by Dr. August Hund. Electronics, January, 1933. This article gives a description of the characteristics and applications of filamentless tubes. One of these types of tubes depends upon the conduction of negative ions and the other operates on the negative resistance principle similar to the Poulsen arc.

Auto-Radio an Expanding Market in 1933. Electronics, January, 1933. An analysis of the increasing market for radio installations in automobiles and the design and marketing problems involved.

Control of Sound Quality in Picture Recording, by Carl Dreher. Electronics, January, 1933. The methods used to check up on equipment employed in RCA variable-area recording to produce the desired sound quality are described in this article. Special emphasis is given to the problems of noise reduction.

Circuits for Amplified Automatic Volume Control. Electronics, January, 1933. A description of an interesting circuit development by means of which a sensitive and level a.v.c. system is obtained. The circuit makes use of the possibilities of the –55 tube.

Combining the Frequency Meter and Monitor, by Clyde J. Houldson. QST, January, 1933. This article gives complete details, including circuit diagrams and construction data on a stable frequency-meter monitor combination that is useful in checking the adjustment of a transmitter or a receiver to a desired frequency.

Tunable Hum, by F. S. Dellenbaugh. QST, January, 1933. This article describes the causes, effects and elimination of tunable hum which often results from the use of Tungar and mercury-vapor type rectifiers.

A Note on the Theory and Practice of Tone Correction, by F. M. Colebrook. The Wireless Engineer and Experimental Wireless, January, 1933. This paper describes briefly the nature of the side-band attenuation which occurs in practice in low-decrement circuits, the corresponding audio-frequency amplification required, and shows by theory and experiment how much amplification can be conveniently realized.

Recording Field Strength, by C. H. Smith. The Wireless Engineer and Experimental Wireless, January, 1933. This article gives a circuit diagram and complete data on the equipment used by the British Broadcasting Corp. for making automatic field-strength measurements. The equipment used is selective, easy to operate, simple to calibrate and stable in operation.

Design of Radio-Frequency Coils, by S. W. Place, Radio Engineering, January, 1933. A discussion of the important factors of gain, attenuation, size, resistance, losses, etc., which affect the design of efficient radio-frequency coils.

Noise Elimination in Auto-Radio Installations, by C. G. Seright. Radio Retailing, January, 1933. This article gives information on the sources of radio noise in automobile radio installations, and the means which can be used to overcome such noises.

How to Get Copies of Articles Abstracted in This Department

The abstracts of articles featured in this department are intended to serve as a guide to the most interesting and instructive material appearing in contemporary magazines and reports. These publications may be consulted at most of the larger public libraries, or copies may be ordered direct from the publishers of the magazines mentioned. RADIO NEWS *cannot undertake to supply copies of these articles. They are NOT included in the* RADIO NEWS *Free Technical Booklet Service.*

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THROUGH the courtesy of a group of manufacturers, RADIO NEWS offers to its readers this Free Technical Booklet Service. By means of this service, readers of RADIO NEWS are able to obtain quickly and absolutely free of charge many interesting, instructive and valuable booklets and other literature which formerly required considerable time, effort and postage to collect. To obtain any of the booklets listed in the following section, simply write the numbers of the books you desire on the coupon appearing at the end of this department. Be sure to print your name and address plainly, in pencil, and mail the coupon to the RADIO NEWS Free Technical Booklet Service. Stocks of these booklets are kept on hand and will be sent to you promptly as long as the supply lasts. To avoid delay, please use the coupon provided for the purpose and inclose it in an envelope, by itself, or paste it on the back of a penny postcard. The use of a letter asking for other information will delay the filling of your request for booklets and catalogs.

Review of Technical Booklets Available

1. *Parts and Sets 1933 Spring and Summer Catalog No. 54.* A complete catalog of over 130 pages, issued by the Wholesale Radio Service Co., one of the oldest and largest mail-order houses. The catalog contains illustrations, descriptions, specifications, list and net prices of a variety of radio parts, tools, replacement items, receiver chassis, complete sets, public-address systems and electrical merchandise required by dealers, servicemen, set builders, amateur and commercial operators, experimenters and engineers.

2. *1933 R.F. Parts Catalog.* An 8-page folder containing complete specifications on the entire line of Hammarlund variable and adjustable condensers, r.f. transformers, sockets, shields and miscellaneous parts for combination broadcast and short-wave receivers, short-wave receivers and transmitting variable condensers.

4. *A 15 to 200-Meter Comet "Pro" Superheterodyne.* A description of the outstanding features of the Hammarlund-Roberts high-frequency superheterodyne designed especially for commercial operators for laboratory, newspaper, police, airport and steamship use.

5. *A 1933 Volume Control, Fixed and Variable Resistor Catalog.* This 12-page catalog, issued by Electrad, Inc., gives complete data on standard and special replacement volume controls, Truvolt adjustable resistors, vitreous wire-wound fixed resistors, voltage dividers and other resistor specialties and public-address amplifiers (using new tubes). Many revisions and additions to the 1932 line are included.

6. *Line-Voltage Control.* Complete characteristics and uses of a real voltage regulator and complete chart showing the correct Amperite recommended by set manufacturers for their receivers. Also tells how to improve your customers' sets and make a profit besides.

8. *Trouble Shooting in A.C., D.C. and Battery Sets.* This is as sample lesson of the National Radio Institute Course. It contains valuable information on how to overcome hum and noises of all kinds, fading signals, broad tuning, howls and oscillations, poor distance reception, distorted or muffled signals, etc. It is available only to RADIO NEWS readers who are over 16 years of age and who are residents of the United States or Canada.

9. *Catalog of Fixed, Metallized and Precision Resistors.* This 16-page catalog gives complete specifications of the International Resistance Co. 1933 line of metallized, wire-wound and precision wire-wound resistors,

(*Continued on page* 636)

With the Experimenters

D.C. Milliammeter Converted for Use as an Output Meter, How to Make a Multi-cable Plug, Mounting Stand for a Lapel Microphone, Two Kinks in Making Plug-in Coils

Conducted by

S. Gordon Taylor

How to Make an Output Meter

Since the amount of current available for the operation of an output meter is often very small, it is advantageous to use a rectifier type of instrument. If a low-range d.c. milliammeter of the D'Arsonval type is available, it can readily be converted into a rectifier type output meter by connecting it (as shown in Figure 2) to an old rectifier unit taken from a trickle charger such as the National or Elkon. These chargers have three units, although one is sufficient for our purposes. The connections and schematic circuit of the rectifier are shown in Figure 1.

The meter could, of course, be calibrated by comparison with an a.c. meter, but for use as an output meter this is not necessary. If an 0-1 or 0-1.5 milliampere meter is used, it will be necessary to use resistors as shown to cut down the sensitivity. When used across the coil of a dynamic speaker, post 1 may be used. When used across the input transformer to the speaker it will be found necessary to use one of the other scales.

The author constructed the meter shown in a small box having connections for the 0-1 milliammeter so that it could be easily removed, hence the low-range meter was available for other purposes when not used in the output meter.

Two common posts, O1 and O2, are used, so that the meter may be available with a 1 mfd. condenser in series for use directly from plate to ground.

C. BRADNER BROWN,
Kansas City, Mo.

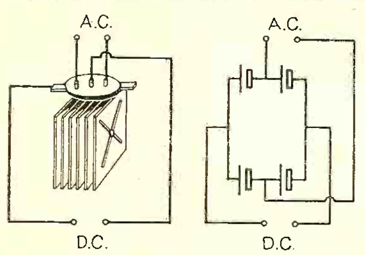


FIG. 1

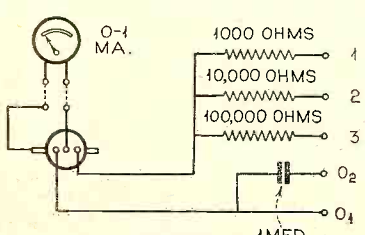


FIG. 2

Home-made Cable Connector

The cable connector described here is neat, durable and can be made in four, five or six wire types for a cost of not more than twenty cents invested in two soft rubber electric plugs from a five and ten-cent store, however it is essential that they be the type illustrated in Figure 1. They are the cheaper kind, and can be obtained for five cents apiece; a socket of the type shown in Figure 3 can be obtained for ten cents or less, and the tube base can be found in almost any radio man's junk box.

The bottom of the tube base should be cut out to a diameter of $1\frac{3}{32}''$ and bakelite disk $1\frac{7}{32}''$ in diameter and $\frac{3}{32}''$ thick bolted to it, center to center, as shown in Figure 2 (b, c). Holes should be drilled in the bakelite disc for the wires at each prong.

The socket should be cut out on the dotted line as in Figure 3, and the lugs bent up. There are other types of wafer sockets but the type shown is necessary.

The plugs should be taken apart by stretch-

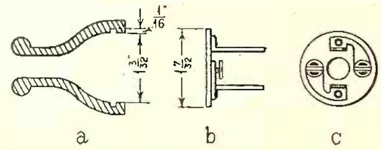


FIG. 1

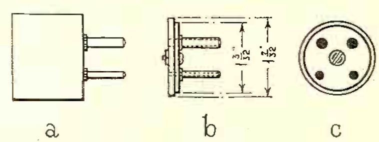


FIG. 2

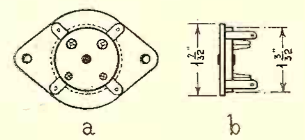


FIG. 3

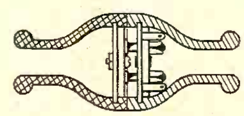


FIG. 4

ing the soft rubber and taking out the fiber disk with the metal prongs which fit in the groove "S" in the soft rubber insulator. The wires of the cables should be soldered to the socket lugs and put through the holes in the base pins and soldered at the tip. Then the parts are forced into the groove from which the electric plug was taken.

Figure 4 is a cross section view of the completed connector.

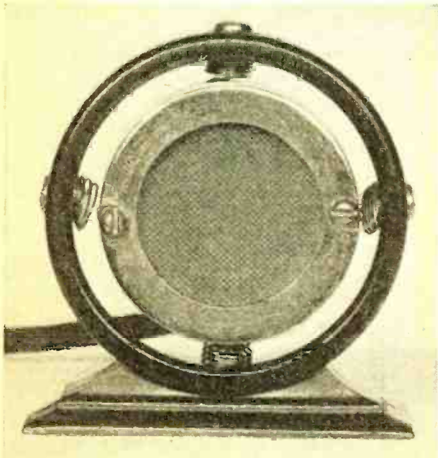
It is advisable to tape or wrap the cable so as to hold it in the neck of the insulator to prevent strain on the soldered connections.

If the tube base does not come flush with the end of the rubber it should be shimmed up with insulating material until it does. There are many uses for these parts. They can be used on an extension cord for dynamic speakers, power pack, etc., or the parts can be used separately by using a socket or base fastened to the power pack, set, speaker or whatever has to be connected to the cable, and using the opposite type on the cable.

HARRY KENYON,
Berlin Heights, Ohio.

Stand for the Lapel Microphone

The bakelite case of a discarded Westclox Tiny Tim clock provides a simple and attractive mounting for the little lapel mikes. Simply drill four ⅛-inch holes through the bakelite ring of the clock case. Next fit



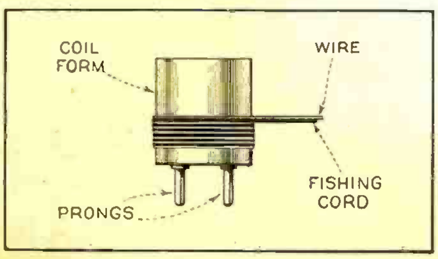
each hole with a ¼-inch long 6/32 screw and 6/32 nut. Then suspend the microphone with four short light springs, by fastening ends of springs under corresponding screws in mounting ring and microphone. The result is a snappy little desk mike.

LOUIS P. MAIGRET,
Port Arthur, Texas.

Two Short-Wave Coil Kinks

Here are two "kinks" that will be appreciated by the experimenter who winds his own short-wave plug-in coils. Before winding the coil, place the spool of wire in the oven. Remove from the oven and wind the coil while the wire is hot. The heat causes

(*Continued on page* 637)



Radio Physics Course

LESSON SIXTEEN—MAGNETS AND MAGNETIC FIELDS

By Alfred A. Ghirardi*

MAGNETIC fields, permanent magnets and electromagnets perform important functions in radio and television transmitting and receiving apparatus. Radio and audio transformers, magnetic types of loudspeakers, phonograph pick-ups, B eliminators and power packs, battery chargers, etc., all depend for their operation on the proper use of magnetism and magnets. In fact, the transmission of radio signals themselves is partly due to the action of the electromagnetic fields sent out through space by the transmitting antennas of the broadcasting stations.

The proper use of magnetism also plays an important part in our everyday lives. There could be no dynamos for generating e.m.f. commercially on a large scale, and no electric motors to turn the wheels of industry, if it were not for the action of magnets. The telegraph, telephone and thousands of other common necessities of life depend upon magnetic action. Like electricity, we cannot actually see magnetism, but that does not prevent us from learning a great deal about it by studying its many effects which can be seen and measured.

Natural Magnets

We probably first come in contact with magnetism during our childhood days when we "discover" that the common small steel horseshoe magnet (painted bright red) will pick up nails, needles and other iron objects. Some of us also find that a straight bar magnet consisting of a magnetized piece of hard steel will point north and south when suspended in a horizontal plane by a piece of thread.

Magnetism first became known to our world many years ago (probably independently in different places and at different times), when it was discovered the lumps of a certain kind of iron ore found in the ground would always point approximately to the north star (direction of the north pole) when suspended so that they could move freely. This ore was used as a compass by the early Norse navigators and for land navigation by the Chinese as early as 218 A. D. This ore (iron oxide, Fe_2O_3) was called *lodestone* or *leading stone*. It is now called *magnetite*. Not all magnetite is found already magnetized. The name magnet comes from a town, Magnesia, in Asia Minor, where the mineral was originally found mostly, and from where a knowledge of these stones reached Greece as early as 585 B. C. Magnets of lodestone are called *natural magnets*, because they are found in the earth already magnetized.

Artificial Magnets

If a piece of hard steel be stroked continuously in the same direction with a piece of lodestone it will be found that the steel also becomes magnetized. If it is suspended by a piece of thread it will always point in a north and south direction. If it is dipped into a quantity of iron filings, small iron tacks or nails, and withdrawn, the filings or nails will adhere to it, particularly at two well-defined points as shown in (A) of Figure 1. These points are called the *poles* of the magnet. They are the places on the magnet where lines of magnetic force either enter or leave it. The pole which always points to the north magnetic pole of the earth when the magnet is suspended freely is called the *north seeking*, or simply the *north* (N) pole of the magnet. The other is called the *south* pole (S).

The earth itself is a great big magnet, with its magnetic poles lying within short distances of the true north and south geographical poles of the earth.

This property of attracting iron and steel is called *magnetism*, and the body possessing it is called a magnet. Natural magnets are not used commercially now, because many alloys of iron have been developed which make stronger and more satisfactory magnets than these. Also, artificial magnets are no longer magnetized by stroking them with lodestone, but, as we shall see later, they are now magnetized very powerfully by inserting them in coils of insulated wire through which electric currents are sent.

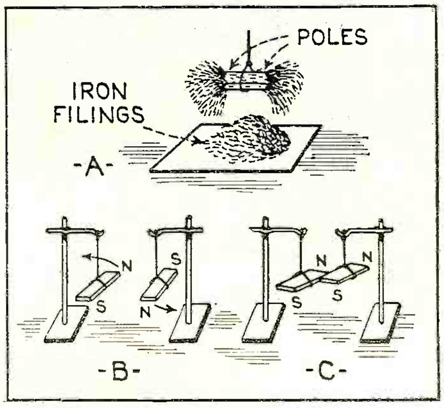


FIGURE 1

Laws of Attraction and Repulsion

If two bar magnets made of hard steel are freely suspended by a string, one at a time, their north and south poles can be determined by noticing which end points toward the north pole of the earth in each case. These poles can then be marked on the magnets. Now if the north pole of one magnet is brought near the north pole of the other, as shown in B of Figure 1, they will be found to exert a force of repulsion between each other. If the south pole of one is brought near the south pole of the other, repulsion will take place again. If the south pole of one is brought near the north pole of the other, a force of attraction will draw them together as shown in C of Figure 1. The same action will take place if the north pole of the first is brought near the south pole of the other. These results may be summed up in the first two laws of magnetic attraction and repulsion:

(1) *Unlike magnetic poles attract each other.*
(2) *Like magnetic poles repel each other.*

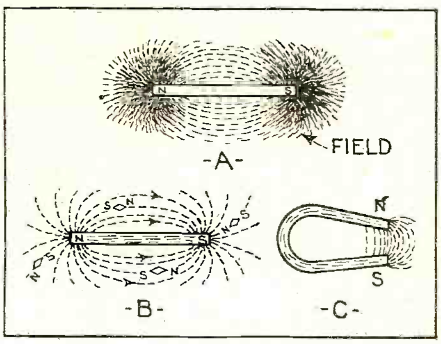


FIGURE 2

Since it has become common practice to call that pole of a magnet which is attracted toward the earth's north geographical pole, the *north* magnetic pole, it is evident that since unlike poles attract, the earth's north geographical pole must really be a *south* magnetic pole. Likewise, the earth's south geographical pole is really a *north* magnetic pole.

The force of magnetic attraction and repulsion between two magnets decreases rapidly as the distance between them is increased, and of course increases greatly as they are brought nearer together. This can be proven experimentally by placing the unlike poles of two bar magnets about one-half inch apart and noticing the strength of the attraction, and then placing them about four times as far apart and again noticing the attraction. If a delicate spring balance were used to measure the force in each case, it would be found that when the distance is *increased four times*, the force of attraction or repulsion is only $\frac{1}{16}$ as much. That is:

(3) *The force of attraction or repulsion between two magnetic poles is inversely proportional to the square of the distance between them.*

Representing the pole strengths by m and m^1 respectively and the distance between them by d, the force F is found from the equation:

$$F = \frac{m\,m^1}{d^2}$$

This relation is an important one to remember. We shall see later that the distances between the stationary magnet poles and the poles on the moving parts of loudspeakers are kept as short as is practical, in order to develop strong forces to move the loudspeaker cone or diaphragm. If the air gap is made large, the speaker will sound weak. The reader will note the similarity between the laws of attraction and repulsion between magnets and the laws of attraction and repulsion between electric charges already stated in Lesson Four.

When a magnetic substance is stroked by a magnet the induced pole is opposite to the inducing pole. That is, if an N pole is used, it will induce an S pole at the end of the magnetic substance it strokes.

Magnetic Classification of Substances

Any substance capable of being magnetized or attracted by a magnet is commonly termed a *magnetic substance*. Those that are not noticeably attracted are usually called *non-magnetic*. In recent years it has been found that some substances also become weakly magnetized in a direction opposite to that of the magnetizing field. Therefore a more detailed classification of magnetic substances than the above has been formulated.

When certain substances such as bismuth, antimony, copper, silver, zinc, sulphur, mercury, gold, water and quartz are placed in an intense magnetic field, they become weakly magnetized in a direction *opposite* to that of the magnetizing field. They are called *diamagnetic substances*.

When certain substances such as air, oxygen, manganese, chromium, platinum, alu-

* Radio Technical Pub. Co. Publishers' Radio Physics Course.

minum, etc., are placed in an intense magnetic field they become weakly magnetized in the same direction as the magnetizing field. They are called *paramagnetic substances.*

When iron, steel, nickel or cobalt are placed in a magnetic field they become strongly magnetized in the same direction as the field. These substances are characterized by the fact that a weak field produces a strong magnetism in them. They are called *ferromagnetic substances.*

The paramagnetic and the diamagnetic substances become so weakly magnetized under the action of even comparatively strong fields that for practical purposes they are considered as being non-magnetic. In practical work, the *magnetic substances* are considered to be steel, iron, nickel and cobalt, soft iron being the best magnetic substance of the four and cobalt the weakest.

In the practical applications of magnetism, steel and iron are used mostly as the magnetic substances. Small percentages of nickel, chromium, cobalt or tungsten are added to steel for making commercial permanent magnets having great magnetic strength as certain other desirable properties as we shall see later. All other substances, such as air, brass, copper, aluminum, zinc, glass, etc., are practically non-magnetic. These substances allow magnetism to go through them, however, without themselves becoming magnetized to any noticeable extent.

Magnetic Lines of Force

When we dipped the magnet in iron filings (A of Figure 1) we saw that the attractive force of the magnet was greatest in the vicinity of the places we call the *poles*. As will be shown presently, magnetic effects are noticeable for a considerable distance in the space surrounding a magnet. This space around a magnet in which a magnetic substance would be subject to mechanical forces of attraction or repulsion if placed in it, is called the *magnetic field*. It is convenient to speak of the *direction* along which the magnetic force is acting at any point in the magnetic field, as a *line of force*. The student should not fall into the habit of looking upon magnetic lines of force as actual lines having physical existence, for this idea will be found misleading. There are no lines around a magnet. What we call lines of force are merely the imaginary lines along which the magnetic forces act. The total number of lines of magnetic force crossing a given space or field is called the *magnetic flux*.

If fine iron filings are sprinkled over a piece of thin paper placed on a magnet, they will arrange themselves in definite lines around the magnet as shown in (A) of Figure 2. These lines mark out the general direction of the magnetic force around the magnet. If a short magnetic compass needle is moved around in the field of the magnet, it will set itself in the direction of the magnetic force acting at any point in the field at which it is placed, as shown at (B) of Figure 2. Thus the complete field around a magnet may be plotted either by means of iron filings or a short compass needle, even though the magnetic forces are themselves invisible. The magnetic maps or figures obtained in this way are often of great service in showing the actual distribution of the magnetic field in a magnetic device. Thus the intensity and directions of the fields around power transformers and choke coils in electric radio receivers may be easily studied by these methods. The strength of the magnetic field at any point is expressed in terms of lines of force per square inch at the point considered. This is called the *flux density*.

For the convenient description of some electrical facts it has become common to as-

(*Continued on page 635*)

Personal interviews with broadcast artists and executives

THE NEW PONTIAC

Backstage in

By Samuel

MESSRS. F. Chase Taylor and Wilbur Budd Hulick, better known on the air as Colonel Stoopnagle and Budd, are the stars of a new revue type CBS program heard Thursday nights. The Pontiac program, in addition to Taylor and Hulick, also features Jeannie Lang and William O'Neal, vocalists; a large orchestra directed by André Kostelanetz and a vocal ensemble. In addition to their funny skits, the Colonel and Budd act as joint masters-of-ceremonies for the programs and handle all special announcements. Miss Lang has been seen and heard in several talkies and stage productions. O'Neal, too, is a product of the stage. He sang leading rôles in many Broadway musical productions. Kostelanetz, staff CBS conductor and arranger, is musical director of several current presentations on that chain. The new series had the distinction of launching the CBS auditorium-size studio in the Carnegie Hall building in New York. The new studio was leased by the chain in order to accommodate large groups of onlookers.

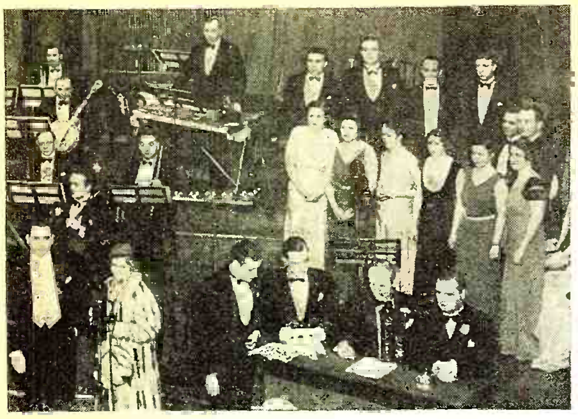
WHEN the Woodbury Program recently switched to NBC from CBS it did an unusual thing in hiring two singers of a single type as co-stars of the series. Morton Downey and Donald Novis are the featured artists, and they are both tenors. To Downey, his new contract is a continuation of his tie-up with the same sponsors on the CBS. To Novis, the new series means his first real break on a commercial series—an opportunity he has long been waiting for. In many respects, the careers of Downey and Novis parallel each other. Both have sung in the concert field and in talking pictures, but it was radio that earned them their greatest popularity. Downey was born in Wallington, Connecticut. After singing at club meetings and social gatherings he became a soloist with Paul Whiteman's band. A long series of personal appearances here and abroad and a few talking picture engagements preceded his broadcasting ventures. His best known radio berth was on the old Camel Quarter Hour on CBS. Novis, a native of England, was brought to America

Our "Uncle

The NBC is expected to take much less space in Radio City than was originally planned. . . . Network officials arranged for Mrs. Franklin D. Roosevelt to leave the studio before the end of the Pond programs in order to sidestep autograph hunters. . . . NBC announcers did a very bad job in describing the opening of the two R-K-O theatres in Radio City, using too many flowery adjectives and making the entire broadcasts sound like long-drawn-out commercial announcements. . . . There is an overabundance of female vocal trios. . . . Kate Smith's popularity is waning and it is hoped that her talkie venture will bolster her status with fans. . . . When the radio talkie, "The Big Broadcast," opened in London, British radio and music favorites turned en masse for the premiere. . . . Bernhard Levitow, conductor long heard on NBC, is now musical director of WINS, New York. . . . Wilson Angel, boy winner of the 1932 Atwater Kent Audition Award, must have been surprised to find that news photographs showed him wearing an adjustable tuxedo bow with the clasp showing. . . . Stoopnagle and Budd have gone talkie in a big way and will

ALICE JOY

CLARK BREWER VICTOR HALL WILLIAM SCHOLTZ JAMES DAVIES



RADIO ENSEMBLE

Chatty bits of news on what is happening before the microphone

Broadcasting

Kaufman

when very young and is a Californian by adoption. While attaining recognition as an exceptionally talented young vocalist in California, Novis leaped to fame by winning the finals in an Atwater Kent audition. He returned to California and secured many talkie and radio engagements before coming to New York for a lucrative NBC contract. Leon Belasco's orchestra accompanies Downey and Novis on the tenors' Wednesday night offerings.

Sam" Says

soon be seen in a full-length film. . . . Don Bestor, NBC dance conductor, keeps his fingers crossed during broadcasts. . . . Ward Wilson, a star in his own right, is frequently an "extra" on the Eddie Cantor programs. . . . WOR's recent rule forbidding the use of assumed names on its programs was undoubtedly applied to make best publicity use of well-known chain personalities who appeared on WOR under pseudonyms. . . . Radio station officials are all guessing as to what the new administration will do about radio legislation. . . . Bill Schudt, CBS television director, thinks the time is already ripe for commercial television programs. . . . After the NBC went through the trouble and expense of putting on the Metropolitan Opera broadcasts this season, it foolishly economized by limiting Milton Cross's time for descriptive narration to a minimum. . . . Which reminds us that Cross has not been given the all-around breaks he deserves. . . . Song plugging on the air continues to be one of broadcasting's curses. . . . Admission tickets to network studios are getting more and more difficult to obtain on account of the tremendous demand.

NETWORKS have been showing added interest in sustaining programs and of late there has been considerable care and planning put into the creation of sustaining hours. An example of this trend to sustaining program build-up is the combination of three well-known NBC features into a single broadcast unit. The new period includes Alice Joy, the Rollickers Quartet and Hugo Mariani's orchestra. Alice Joy gained wide popularity as the "Dream Girl" on the old Prince Albert programs. The Rollickers Quartet, a veteran radio troupe, is well known for appearances on a long list of commercial hours during the past few seasons. The Rollickers consist of Clark Brewer, first tenor; William Scholtz, baritone; Victor Hall, second tenor, and James Davies, basso. Clifford Lang, the Rollickers' pianist and arranger, also participates in their broadcasts. Hugo Mariani, staff NBC conductor, achieved much popularity for many network offerings over a long period. The Rollickers, since launching their new sustaining schedule, have been added to the cast of Paul Whiteman's Buick Program on Mondav nights.

MARY EASTMAN, coloratura soprano who has been featured in joint recitals with outstanding vocalists, has been signed as a CBS artist and is regularly featured on the program known as "André Kostelanetz Presents—." The young singer, for whom CBS executives have high hopes in broadcasting, is a native of Kansas City. She studied there and in Chicago before coming

(*Continued on page 635*)

DONALD NOVIS

MORTON DOWNEY

MARY EASTMAN

GEORGE OLSEN

What's New in Radio

A department devoted to the description of the latest developments in radio equipment. Radio servicemen, experimenters, dealers and set builders will find these items of service in conducting their work

By The Technical Staff

Remanufactured Measuring Equipment

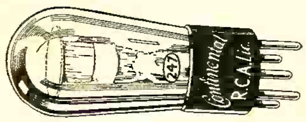
Description—As a boon to the thousands of owners of old set testers, a re-manufactured plan of noteworthy importance has been worked out by this manufacturer whereby old testing equipment can be brought up to date with improved resistance,

voltage and current measuring facilities, and for analyzing receivers employing the new 6 and 7-prong type tubes. This re-manufacturing plan, at the present time, applies to the Supreme testers, models Nos. 99A, 400A and 400B, the Jewell testers, models Nos. 199, 198, 408 and 409, the Weston testers, models Nos. 537, 547, 565 and 566. If desired, the new equipment can be obtained in single units or in combinations of equipment as shown by the illustration. This shows the basic unit, model 400C, in the center compartment. This includes the original d.c. and a.c. voltmeters, with all the old ranges of both meters and the added ranges of the d.c. meter made available at pin-jack terminals. The panel to the right comprises the model 77 universal analyzer converter, and the model 60 oscillator is mounted in the left-hand compartment.

Maker—Supreme Instruments Corp., Greenwood, Miss.

Vacuum Tubes

Description—This manufacturer offers a complete line of radio vacuum tubes made under R.C.A. license. This line is to be sold to dealers and servicemen direct, eliminating



multiple discounts and thereby making these tubes both economical and profitable to handle. Some of the various types included in this line are the –01A battery type, the dry-cell two-volt series and the six-volt automobile series. Also the –46 Class B amplifier tube and the new popular –50 series type tubes. Improved automatic equipment is used in the construction of the tubes. Instead of using magnesium for the tube getter as is generally employed, they use barium magnesia to create a higher vacuum, which means a more efficient vacuum tube. The illustration covers a –47 pentode type tube.

Maker—Continental Tube Corp., 1601 S. Michigan Ave., Chicago, Ill.

Vibrator for Auto B Eliminator

Description—A new type of double-contact vibrator for use in automobile "B" eliminators employing full-wave transformers. This unit is designed to operate over a wide range of battery voltages, works independently of transformer primary impedances and there are no adjustments of any kind. It is compact, rugged in construction and is said to be entirely free from sticking contacts. The vibrator unit is mounted in a metal container lined with sponge rubber and it is

fitted with a five-prong plug so that the entire assembly may be replaced as easily as a vacuum tube. The complete assembly measures 4½ inches by 2¾ inches by 2 inches.

Maker—American Television and Radio Co., 1916 University Ave., St. Paul, Minn.

Midget Receiver

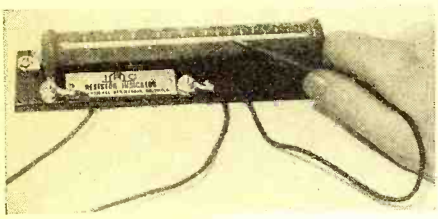
Description—The Goldentone model 5T is a five-tube tuned-radio-frequency receiver using the following vacuum tubes: two type

–58, one –57, one –47 and one –80 type rectifier. It is equipped with tone control and a large-size dynamic speaker of new design. In addition to the regular broadcast band, the set covers the police calls on 1700 kilocycles. The receiver chassis and speaker are enclosed in a two-tone walnut cabinet measuring 16 inches high by 14 inches wide by 9 inches deep.

Maker—Fordson Radio Mfg. Corp., 11702 Livernois Ave., Detroit, Mich.

Resistor Indicator

Description—This resistor indicator is a calibrated 100,000-ohm variable wire-wound resistor and when connected to the resistor

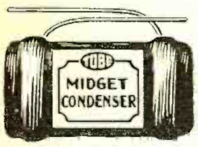


circuit under test will tell instantly the value of the burnt-out or faulty resistor. Another important application of this indicator is its use as a calibrated voltage divider for tapping off fixed voltages from a supply. It is vest-pocket size, measuring 7¾ inches long by 1¾ inches wide. Complete instructions for its use accompany each unit.

Maker—International Resistance Co., 2006 Chestnut St., Philadelphia, Pa.

Condensers

Description—The photograph below illustrates the new line of compact by-pass condensers which are available in capacity values from .001 to 0.1 mfd. These condensers are rated at 600 volts d.c. and have a high safety factor. They are designed for use in receiver by-pass circuits. The second illustration covers a new line of small-size uncased condensers especially adapted to



the repair of radio power units. These condensers are available in capacities from 0.1 to 2.0 mfd. and have a working voltage rating of 400 volts d.c. The dimensions of the 0.1 mfd. capacity unit are 1 1/7 inches

by 1 inch by ¼ inch and the 2.0 mfd. condenser measures 3¼ inches by 2¼ inches by ¾ inch.

Maker—Tobe Deutschmann Corp., Canton, Mass.

A Complete Photo-Electric Cell with Relay

Description—The new model 800 light-sensitive unit with relay utilizes a ceasium type photo-cell and a -12A type tube as an amplifier. It operates directly from either a.c. or d.c. lighting supply lines and is designed to either make or break a circuit. The manufacturer advises that it can respond to a light intensity of 1/10 lumen or higher. The photo-cell with amplifier tube and relay are housed in a cylindrical aluminum case which is finished in black crystallized lacquer.

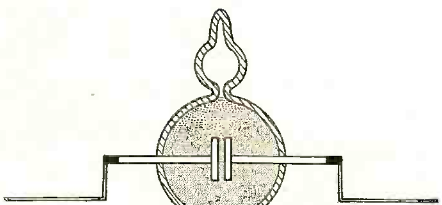
Maker—Wireless Egert Engineering, Inc., 179 Varick St., New York City.

Latest Radio Patents

A description of the outstanding patented inventions on radio, television, acoustics and electronics as they are granted by the United States Patent Office. This information will be found a handy radio reference for inventors, engineers, set designers and production men in establishing the dates of record, as well as describing the important radio inventions

By Ben J. Chromy*

1,861,738. CELL CAPABLE OF SHOWING THE KERR EFFECT. THEODORE WILLARD CASE, Auburn, N. Y., assignor to Case Research Laboratory Incorporated, Auburn, N. Y., a Corporation of New York. Filed Mar. 26, 1928. Serial No. 264,622. 6 Claims.

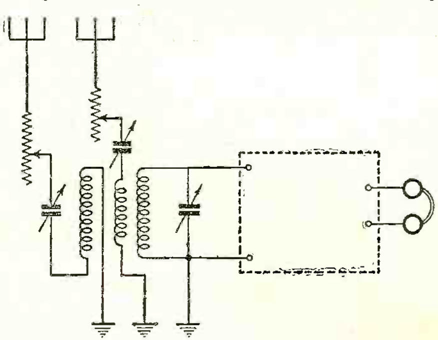


1. In a cell of the Kerr effect type, an electrode member comprising an insulating tube having an enlarged flattened end, a wire sealed in the tube and exposed at the enlarged flattened end, and a thin layer of conductive material secured to the forward flattened end of the tube.

1,870,803. CONDENSER. JOSEPH A. FRIED, Flushing N. Y., assignor to Dubilier Condenser Corporation, New York, N. Y., a Corporation of Delaware. Filed Aug. 7, 1926. Serial No. 127,906. Renewed July 6, 1931. 3 Claims.

1. A condenser comprising sheets of conductive material separated by insulation wound up and worked into the required shape, a wrapping of insulating material forming a casing for said condenser and clips secured to the ends of said casing, said clips being connected to the opposite terminals of the condenser.

1,872,487. RADIO RECEIVING SYSTEM. JOHN M. MILLER, Philadelphia, Pa., assignor to Atwater Kent Manufacturing



Company, Philadelphia, Pa., a Corporation of Pennsylvania. Filed Aug. 8, 1931. Serial No. 555,877. 10 Claims.

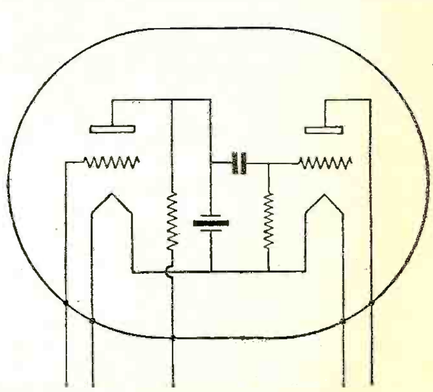
1. In a radio system differentially coupled to two antenna systems including series condensers, the method of reducing noises due to local disturbances which comprises adjusting the relative values of said condensers until both an increase and decrease in value of one of them effects an increase in the noise.

1,874,222. CONSTANT FREQUENCY CIRCUITS. CONSTANTIN D. BARBULESCO, Dayton, Ohio, assignor to Paul S. Edwards, Dayton, Ohio. Filed Sept. 13, 1928, Serial No. 305,753. Renewed Dec. 3, 1931. 18 Claims.

14. A constant frequency oscillator comprising grid and plate circuits, a tank circuit having a small inductance and large capacity connected between the grid and plate circuits, the characteristics of the tank circuit being so chosen as to render stray capacities in the associated circuits substantially negligible.

1,875,059. TUNED RECEIVER TUBE. SIEGMUND LOEWE, Berlin-Friedenau, Germany, assignor to Radio Corporation of America, a Corporation of Delaware. Filed Oct. 25, 1926, Serial No. 143,889, and in Germany Nov. 4, 1925. 7 Claims.

1. A vacuum tube having three electrodes and a piezo-electric control element mounted



therein, said element being coupled to two of said electrodes and being responsive to only a predetermined frequency.

1,874,234. LOCAL-DISTANT RADIO RECEIVER. RENE A. BRADEN, Merchantville, N. J., assignor to Radio Corporation of America, a Corporation of Delaware. Filed Apr. 30, 1930. Serial No. 448,509. 8 Claims.

1. In a receiver of signal modulated radio frequency energy, means for collecting signal modulated energy at a predetermined frequency, a detector means for the collected energy provided with a space discharge device having a normally biased control electrode, means for amplifying the detected signals, and means variably coupling the detector means and signal amplifier means, said coupling including means to vary the characteristic of the detector means to follow a linear law or a square law when the amplitude of signal energy impressed upon the detector input is varied between predetermined values.

* Patent Attorney, Washington, D. C.

Remote Control

(*Continued from page 591*)

total maximum of seventy-five feet. Additional units are connected in parallel to the remote-control terminal strip at the motor.

In the metal-cased box alongside of the motor assembly there is a 110-volt to 23-volt step-down transformer and a tapped reactor and condenser for changing the phase angle of the applied current. The transformer supplies the correct motor voltage, while the reactor and condenser permit operation of the motor in either direction. The motor operates at 23 volts for the station selector and at 18 volts for the volume control.

Referring to Figure 2, we see the normal position of the motor armature. It will be noted that a spring holds the armature so that the gear at one end is meshed with the volume-control gears. At 18 volts, the voltage used for volume-control operation, the gears remain in this position and the operation of the volume control is secured. When the speed of the motor is increased, by operating it at 23 volts, this voltage being used when the selector buttons are pressed, the end thrust of the armature causes it to move laterally, thereby disengaging the gear at the volume-control end and engaging the gear at the station-selector end. This is shown in Figure 3. The spring at the end of the armature always causes it to return to the volume-control position when the current is "off" at the motor. As this action takes place with the motor operating in either direction, controlling the voltage at which the motor is operated determines its function. A 60-ohm resistor is placed in each motor circuit controlling the volume, to reduce the voltage from 23 to 18 volts.

The proper direction of operation and the stopping of the motor for selection of a desired station is controlled by a series of drums and contactors. Figure 4 shows a schematic diagram of the motor and its adjacent circuits. The drums hold the contactors in the proper position so that when a particular selector button is depressed the motor will turn in the right direction. When the contactor is at the point of the drum where it is half-way between each contact, the motor stops. This is 180 degrees from the hole that is used to set the drum for a particular station.

The setting of the drums is made by the pins on the front panel. These are designated as "setting buttons." The selector button is pressed and the drum is moved by the motor until the corresponding contactor is midway between the contacts. The setting pin will now fall into the hole in the drum, if the setting button is depressed. (See Figure 5.) Holding the pin firmly in the hole, the desired station is then accurately tuned in by means of the manual station selector knob; or simply by manually rotating the ganged tuning condensers by firmly grasping the rotor plates. When the desired station is thus tuned in, the pin is released. Thereafter, pressing the corresponding selector button will always bring the drum back to the position for which it was set.

A common lead is used for the pilot lamp and the selector buttons in the remote-control box. In this way, when a selector button in the box is pressed, the current through the common lead is increased and hence the voltage drop in the lead is increased. The result is that while the motor is running, the pilot light becomes very dim. As soon as the motor stops, the lamp flashes bright, thus indicating that the desired station is tuned in. If the station is then not heard, it is simply necessary to press the "plus"

(*Continued on page 637*)

?QRD?

A column devoted to the commercial operator and his activities

Conducted by GY

AT last radio gadgets are to be in on the ground floor of a new idea. By the suggestion of one of our learned scientists, we should go off the Gold Standard and go on the Electron Standard. Electrons are to be used as units of purchasing power. Gentlemen, how many kilowatts would it take to move a Ford? And how many electrons are there in a kilowatt? It might be a good idea to save up your electrons, now, in a nice, new and shiny tube.

Questionnaires have been sent to Radio Inspectors in the various ports from the FRC asking their opinions for a proposed eight-hour day for radio operators. Some inspectors are known to be in favor of this proposed plan and we hope that the lawmakers will be guided by their opinion. A bit of "hurrah" sent into this column or to your Congressman will do much toward pushing the law through with an OK.

On the top of Mt. Washington standeth a swaying hut in which are marooned three hardy souls who are experimenting with ultra-short waves, under unusual conditions. The snow comes falling down by the footfuls and the gales keep blowing 'round by the bagfuls, but still W1FEX keeps contacting with the outer world every morning at 0730 on a frequency of 3573 kc. Brrrrrr! Even our attic seems warm after that, eh?

The American delegation, headed by Judge Eugene O. Sykes, Vice-Chairman of the FRC, when returning from the International Radio Conference, held in Madrid, had very little to say as to the outcome of the subjects discussed there. One problem—that of the proposed widening of the broadcast band so as to relieve the congestion which now prevails—has been left to the consideration of the regional authorities. We are sorry that we cannot give you more dope on that conference at the present time, but—"Wuz you dere, Sharlie?" We weren't, but the bloodhounds are hot on the trail, so more anon.

Although Jack Berman of Boston played with fire-water instead of the proverbial Fire, he still got burned as notice his license revocation by the FRC, who state that he is "an improper person" to operate any amateur station. Jackie had pleaded guilty to violating the tariff and prohibition acts.

And speaking of licenses we have here the case of the "furriner" who went up to renew his license, but due to his not being able to fulfill the citizenship requirements it was refused him. Of course, he had to let go of his assignment, and in all due sympathy we can say that an American in a foreign country would not have been able to secure a license in the first place.

The American Radiotelegraphists' Ass'n. is sponsoring 'An act to promote the safety of life at sea by requiring equipment and an efficient radio service on sea-going vessels." Briefly, it intends to make any vessel which leaves the ports of the United States, except those which do not travel a greater distance than 200 miles between ports on either coast or more than 20 miles off either coast, keep an efficient service manned by an efficient radio force. Vessels of 1600 to 5500 tons must carry at least one operator of first-class rating. And vessels of 5500 tons or over must carry at least two ops, one of whom must be a first-class licensed man. Ships in the first division (1600 to 5500 tons) must maintain an eight-hour watch and those in the second division must maintain a sixteen-hour watch. Also, vessels licensed to carry twelve or more pasengers must maintain a sixteen-hour service, and this type of ship must carry three operators, one of whom must be of first-class license.

This act, if it goes through, will be the means of giving billets to most of the ops now on the beach, so get together, brass-pounders, and ship in your endorsements. The more the merrier!

SOS, SOS, calling John L. Daniels, who signs himself "Chief Operator of stations CPA to CPZ." Stop playing hide and seek with your mother, as she is getting kind of tired looking for you and is liable to pass out of the picture. Her letter, which was sent to the RMCA office, states that she would like to see you again and that your letters from Port Arthur, New Orleans, "Bound for Halifax" have all been received. Take time out to send her a message. It isn't asking for much, huh?

That harum-scarum, Lew De Stacy, is now holding down the "Xmtr" at WMCA and he's rather surprised to learn that the old *Algonquin* is still able to leave port without him aboard. After trying its best to make Lew comfortable, he leaves her flat for a broadcast studio! Ain't that gratitude! But Lew says it was all due to her temperamental nature and he with a bad heart and high blood pressure. Well, the first time anything happened (a small thing like catching on fire while at sea) Lew decided to give her a break and stuck around. Then she almost went aground off Jupiter, Florida, while he was getting compass bearings from the naval radio station there. And when she miscued a kiss of goodbye to the Ambrose Lightship and smacked straight into the *S.S. Fort Victoria*, causing all hands to take to the boats, Lew determined that she was playing too rough. Now, he reminisces.

In his year-end message, Mr. David Sarnoff, Pres. RCA, said, amongst other things, "In communications, radio has extended its service by the addition of new telegraphic circuits from New York to Mexico, Geneva and Haiti and from Manila, P. I., to Switzerland and Formosa, and the addition of new facsimile circuits from New York to Berlin and Buenos Aires. Important experimental work has been carried on looking toward the utilization of new radio channels in the ultra-short-wave band, and toward multiple-message transmission on a single radio channel. Marine radio telegraphy has been improved through the extended use, on shipboard, of new equipment, combining short, long and intermediate-wave operation. Valuable experiments have been made in facsimile transmission of weather maps and other data to ships at sea."

Facsimile transmission of weather maps have been accomplished with the co-operation of the U. S. Weather Bureau and the *S.S. President Harding* of the United States Lines. RCA engineers have been experimenting with this for some time past in the hope that, instead of the inadequate data which the Bureau transmits to the ships at sea referring to weather, the skippers of vessels will be able to have before them a complete map of weather conditions over the whole ocean and be able to plot out their course to steer clear of oncoming trouble, if any.

The new equipment will employ the diversity method of reception, which means the antennas fore and aft, as signal collectors for two separate "superhet" receivers, the output of which is combined in a single common amplifier. This method, CA engineers state, helps in eliminating fading to a marked degree, as it has been found that when a short-wave signal is weak at one point, it will nearly always be strong at another point only a few hundred feet away. There will also be used the new RCA carbon-recorder method of transcribing the facsimile radio signals into a visible image. In this, a metal stylus moves over a sheet of carbon paper and makes the image visible on a sheet of paper. The recorder is fed from continuous rolls of paper and carbon tissue, which permits the quickest preparation possible for the reception of a picture.

Transmission will be from Rocky Point, L. I., with 20 kw. power.

From the RCA-Victor lab, Jack Austin sends 73's to the Utah gang (his old alma mater) and LR Riley writes in to say Hello and tells this one on the Navy. A bug on the *Aroostook* had a buddy on the *Gannet* and, as they were both quite breezy by nature, they resented the regulations about "unnecessary transmission." So they worked out their own set of "Z" signals and Riley sez they were still going strong when he left them. . . . Dick DeFord tells us there is a small war in progress every time RADIO NEWS comes in the mail. Well, Dickie, the best way I can iron that out is to advise you guys to get a few more of them and then each of you will be able to save them for future reference. Catch on? . . . And Jerry G. sends greetings to Jack Schauffler and craves the new address of your Airways station. . . . Joe Gately is now looking over the railing of the *Empire Arrow* of Socony and looks back to wave Hello to the gang on the beach. . . . Met up with Will Bliss, who sez he is still on the *Martinique*, but believes she'll be tying up soon.

Well, gang, the watch is about over and the hay looks inviting, so "Here's looking at you," and whilst doing that same, the remark for the day is, "Where are the hard ones?" Shoot in your requests, advice and suggestions and, "speed" being a byword here, you can rest assured of prompt attention, so 73's and be good. . . .GY.

Four New Tubes

(*Continued from page* 595)

described above, it is hard to find a suitable output tube that will give a rather large output with a low plate voltage and still have a low plate current. The output tetrode, type AE, is especially designed for that purpose. It will give an output of 400 milliwatts with a plate current of but 8.5 ma. and a screen current of 1.75 ma.

AE Tube Not a Pentode

The AE type tube is not a pentode, but a screen-grid tube, with a plate of special design so as to minimize the tendency of secondary electrons reaching the screen. The tube therefore operates as a pentode. Tentative ratings and characteristics are shown in the table. (At the time of going to press, curves for this tube were not yet available.)

The tube can be used with an impedance-coupled input or a transformer-coupled input. The grid leak should not exceed 1 megohm, and if a grid leak is used, the bias should be obtained by means of a resistor in the cathode lead (so-called full automatic bias).

Low-Cost Super

(*Continued from page* 614)

apparent harmful effect on reception. Shortly after the noon hour, Germany, on 31.38 meters, was received with good strength, followed by Pontoise, France, on 25.20 meters. I2RO, Rome, on 25.40 meters, was received with sufficient volume for the announcement to be heard at least 40 feet from the receiver. A man spoke for about five minutes on this station and then was followed by a program of symphonic concert music. The quality of music from this foreign short-wave station proved to be satisfactory. The signal from France, while good, did not have the volume of Rome.

At other times during this test United States short-wave broadcast stations were tuned in, such as W8XK, W9XF, W1XAZ, W2ZAF and W3XAU. Numerous police and airplane calls were received, also several international 'phone stations, television signals and amateur code and 'phone signals.

Suburban Tests

The next operating tests took place at City Island, New York, again using a 100-foot antenna. This is a small island situated on the outskirts of the city. On arrival at this location, the wave-band switch was turned to the lowest wavelength range, which is indicated by an amber light. On this band, France and Italy were picked up. Both were received with good volume, but again I2RO, Rome, Italy, led France with the better signal. The broadcast station of Caracas, Venezuela, on 49.60 meters, and code signals from Madrid and Paris were also received in this location.

The last operating tests were held in the RADIO NEWS suburban test station recently established at Pelham, New York, a town in the Westchester suburbs about twelve miles airline from the heart of New York City. The tests on the broadcast band got under way about 4:30 p.m. and were made with a 30-foot antenna. The dial was rotated from zero to 100 degrees on the dial and signals were indicated on about 70 percent of the broadcast channels. It was quickly decided to make a check of daylight reception, and from this time until 5:35 p.m., which was the first period of darkness and the end of the day, station calls were heard from WPTF, Raleigh; WSM, Nashville; WRVA, Richmond; WGY, Schenectady; WHAS, Louisville; CKGW, Canada; WBZ, Boston, and WCFL, Chicago. An effort was made to obtain station calls on channels above 1000 kc., but two and sometimes three stations were heard broadcasting in many of these channels and the not-unlimited store of patience gave out.

The short-wave tests in the Pelham location, using an antenna 150 feet long, brought in the English Empire station at Daventry on both 31.30 and 49.6 meters, with their calls of GSC and GSA. The best signal from this station was heard in the evening from GSA, transmitting on 49.6 meters. The station EAQ, Madrid, transmitting on 30.3 meters, was easily tuned in several times, from 2:00 p.m. to 3:00 p.m. that afternoon.

YV1BC at Caracas, Venezuela, was easily tuned in on 49.60 meters. Many short-wave fans have been approached regarding this station, and most of them reported its strength unusual for the eastern part of the United States, so no undue credit was taken for this station. However, the next day, which was a Sunday, HBL, Geneva, Switzerland, a German station and Daventry (GSE, 25.3 meters) were received, further increasing the log of European stations. Pontoise, France and Rome were also received, but not with the high level of signal obtained at the Bayonne and City Island testing grounds.

Using Tube Adapters

(*Continued from page* 601)

functions, aside from the modernizing of radio sets, set testers and tube checkers. For example, adapters are very useful for connecting phonograph pick-ups, microphones and amplifiers. Pick-ups have been connected in many different ways, such as connecting them to two elements of a tube in a receiver or inserting them into the plate, grid or cathode circuits. For the older sets, an adapter is available (see Figure 9) which connects to the filament (or heater) and the grid of either a UX or a UY tube. For the heater type of tubes, the most popular adapter has been one that opens the cathode circuit. Other adapters open the plate circuit, still others the grid. These adapters may be obtained with or without switches.

Microphones, particularly those used for home broadcasting, are often connected to the plate circuit of detector tubes and thus do not require any outside source of power to energize the "mike." The writer employed an adapter in this way back in 1927 at the time he invented the home broadcaster, which he at that time called a Homcaster.

Neutralizing adapters for either UX or UY sockets have been produced for use in balancing neutralizing condensers in superheterodyne or neutrodyne sets. Special output adapters are used to bring out the plate current for the connections to output meters, or for the operation of magnetic speakers, 'phones for the deaf, tone controls and for voice recording, etc. Adapters are also available which automatically turn off the loudspeaker when used for connecting headphones to a set.

An interesting type of adapter permits point-to-point testing as well as the combination of point-to-point testing and measuring of plate current. Still other adapters are designed for making a detector of any stage. Handy adapters are available for bringing out current for operating short-wave converters or pre-amplifiers.

While an attempt has been made in this article to describe the scope and application of the various adapters now available for radio use, it is impossible to make such an article all-inclusive, due to the fact that new adapters are being produced just as rapidly as the new tubes. Even now, radio engineers are experimenting with adapters to permit the use of the forthcoming 7-prong tubes in the older radio sets and testers. It is evident that as new tubes are brought out, adapters will always be at hand to take care of them.

Long-Distance Sets

(*Continued from page* 597)

cold, at least cool at both transmitter and receiver. (Of the two, the conditions at the receiving end are the more important.) Thus, the best time for reception of Japanese stations is midwinter and of the Australian stations, spring and fall. The short waves have received so much publicity lately that it is hardly necessary to note their peculiarities. Best reception is usually obtained when the weather is settled and there are no violent storms between receiver and transmitter. Freak reception sometimes occurs wherein the conditions between transmitter and receiver become so uncommonly favorable that the distant station comes in with amazing strength. The author recalls having once had such reception from 2BL, when the signals reaching Texas were as strong as those from the most strongly received Pacific Coast station, KFI.

One cannot, however, wait on freak conditions, which come but rarely. If one has as much as a moderately favorable location, good receiving equipment embodying the principles that have been laid down in this article, plus careful and intelligent management of the same, he will be rewarded with the thrill of real DX on the broadcast waves quite as well as on the short waves, not once but many times, not under freak conditions merely but under any average good conditions.

Begin on Strong Signals

The enthusiast without previous experience in listening to the overseas 200 to 545-meter broadcasters will do well to begin with the strongest and most easily received: KGMB, 4QG, 2YA and JOAK. The frequency, powers and broadcasting schedules (at such times as reception in this country is possible) of these stations taken from their latest letters of verification are as follows: KGMB, Honolulu, 1320 kc., 500 watts, 10:00 p.m. to 1:30 a.m., C.S.T., daily except Saturday, when they are on until 4:00 a.m., C.S.T.; 4QG, Brisbane, 760 kc., 7500 watts, week days 2:00 to 7:00 a.m., C.S.T., Sundays 2:00 to 6:00 a.m., C.S.T.; 2YA, Wellington, 720 kc., 5000 watts, times not given, commonly on week days until 5:00 or 5:30 a.m., C.S.T., except Wednesday, silent day; JOAK, Tokyo, 870 kc. (now operates also on 590 kc.—*The Editors*), 10,000 watts, daily 2:45 to 6:45 a.m., C.S.T.

Push-Pull Amplifier

(*Continued from page* 599)

have been developed, most of them with universal features, and some even capable of pentode operation. The type –79 tube is the latest release and is designed specifically for Class B operation. It consists of two triodes of low input impedance in one envelope—the filament of the heater type operating on 6.3 volts. The inherent distortion of the tube is comparatively low and the efficiency is higher than any previously released tube. The elements are brought out to a 6-prong base and a grid cap. One of these tubes can deliver as much as 6.25 watts output and yet the total B supply drain of the output stage is less than 30 ma., average.

Parts Required for the Amplifier

1 Kenyon BLG or BPR input transformer.
1 Kenyon B-31 interstage transformer
1 Kenyon B-791 Class B input transformer
1 Kenyon B-790 Class B output transformer
2 Eby 1½-inch center sockets, 5-prong
1 Eby 1½-inch center socket, 6-prong
1 Centralab 500,000-ohm potentiometer
1 each Aerovox No. 1094 1-watt resistors—2500 ohms, 1200 ohms, 30,000 ohms
1 cut-out chassis and box
1 each –37, –89, –79 tubes.
1 Aerovox No. 281. 25 mfd. 200-volt by-pass condenser
Miscellaneous hardware and wire

Parts Required for the Power Supply

1 Kenyon B-79 PT power transformer
2 Kenyon BC-210 filter chokes
2 Aerovox E5D-4 electrolytic condensers
1 Eby 1½-inch center 4-prong socket
1 cut-out chassis and box
1 –82 type tube
Miscellaneous hardware and wire

Commercial Type S. W. Super

(*Continued from page* 611)

The headphone jack is of the two-circuit type and automatically cuts off the loudspeaker when the headphones are inserted by short-circuiting the secondary of the transformer feeding the grids of the push-pull –45 tube. Headphone operation is, of course, demanded in certain professional applications of this receiver and also by most amateur station operators. Even in the cases of short-wave broadcast listeners, headphones are often a convenience and sometimes an absolute necessity.

Tuning and Operation

Reference to the photographs of the receiver panel discloses six control knobs and three switches. The control knob at the extreme left is the band-selector switch and is surmounted by a plate on which are embossed the wavelength range covered by each of the five settings. To the right of this is the main oscillator tuning knob and calibrated scale. This is the most critical and sharpest of the tuning control. In the upper center of the panel may be seen the tuning meter and to the right of the tuning meter is the band-spread tuning knob and calibrated dial scale. The knob to the extreme right tunes the input circuit. The setting of this control is somewhat broader than that of the oscillator tuning, and for that reason it is not equipped with calibrated dial scales as are the other two controls. Instead it is surmounted by an embossed plate which is calibrated in degrees from 0-100. At first glance it may seem that the incorporation of three station-selector controls represents a reversion to the practice of a year or two ago. Actually, however, this plan has been employed in line with the effort to provide absolutely maximum results. As explained before, the band-spread dial is simply an added feature not found in most other receivers, so that while this constitutes an extra control it is at the same time an extra feature, and if the reader is too fussy about the number of controls, he can refrain from using this. An important consideration, however, is that when the left-hand and right-hand tuning controls have been set for a given wavelength, the band-spread dial really constitutes a single control while working within a narrow wavelength range above or below that for which main controls are set. When working any one of the amateur bands, for instance, once the band has been located, all tuning within it is accomplished with the band-spread dial. The right-hand knob or input tuning control is sufficient, as mentioned above, so that readjustment within the narrow band of wavelengths covered by the band-spread dial is not essential except where one demands the absolute maximum of sensitivity.

The two knobs at the lower edge of the panel are for sensitivity and volume adjustment. As shown in the circuit diagram, the sensitivity control takes the form of a rheostat which regulates the grid bias by varying the cathode voltage on the three i.f. tubes. The automatic volume control also varies the grid bias on these three tubes, but does so by regulating the voltage applied to the grid rather than at the cathode. The result of this is that the sensitivity control is useful whether or not the automatic volume control is in the circuit. In general, this sensitivity control is set at or near maximum and under certain conditions is really not necessary. However, under other conditions, as where the local noise level is high, for instance, the overall sensitivity of the receiver may be reduced accordingly by means of this sensitivity control and it therefore serves a decidedly useful purpose in adapting the receiver to local receiving conditions.

The right-hand lower knob regulates volume in the a.f. end through the medium of a potentiometer shunted across the secondary of the first audio transformer.

The switch at the lower left cuts the automatic volume control "in" or "out" as desired. In actual operation this switch is absolutely independent of tuning. This means that if one is listening to a given station, the automatic volume control can be cut "in" or "out" without in any way affecting the setting of the tuning controls. If one is copying c.w., for instance, and not using the automatic volume control, should fading become pronounced it is only necessary to cut the a.v.c. into the circuit by means of this switch and turn the sensitivity control higher. This results in the a.v.c. action smoothing out the fading effect.

The 110-volt supply switch is the one located at the lower edge of the panel in the center. At the extreme right is the superheterodyne beat-oscillator switch, the purpose and use of which has already been mentioned. The beat-oscillator frequency, incidentally, may be varied within an adequate range to permit regulation of the pitch of the superheterodyne note. This is accomplished by means of a small variable condenser, mounted on the oscillator can and adjustable by means of a screw driver.

Referring for a moment to the circuit diagram, Figure 1, a brief discussion will be presented. At the left are the coils for the five bands, together with the three-section band-selector switch. The input tuned circuit consists of a single coil (for each band) tuned by a 150 mmfd. midget variable condenser. This is the right-hand control knob on the front panel. An antenna series condenser is used to couple the antenna directly to the grid circuit of the tube. The two lower sets of coils are the oscillator grid and plate coils. These are tuned by the 150 mmfd. condenser which constitutes the main tuning control on the front panel, and this is shunted by the 20 mmfd. band-spread condenser.

Three i.f. stages are provided, employing type –58 tubes. Dual-tuned transformer coupling is used in the i.f. stages, making a total of eight tuned i.f. circuits which provide the required high degree of selectivity.

Following the third i.f. stage is the Wunderlich tube, employed as a double-diode tube and automatic volume control. The heterodyne-beat oscillator is capacity-coupled to this circuit, as indicated by the broken line extending from the oscillator plate to the grid return of the Wunderlich tube. The tuning meter is connected in the plate circuit of this detector. From this point on the circuit diagram shows the usual features, except perhaps in the peculiar arrangement of the filter condensers in the power pack, but this is a point which has already been taken up.

P.A. System

(*Continued from page* 605)

and connect the plate lead from jack, J1, to the binding post, BP3, on the mixing panel and bring a connection from the jack, J2, to the ground binding post, BP4, on the mixing panel. Now connect the antenna and ground leads to their respective binding posts on the tuner, place the supply plug into a 110-volt socket, turn on the receiver power switch, advance the volume control and rotate the tuning condenser until a signal is heard.

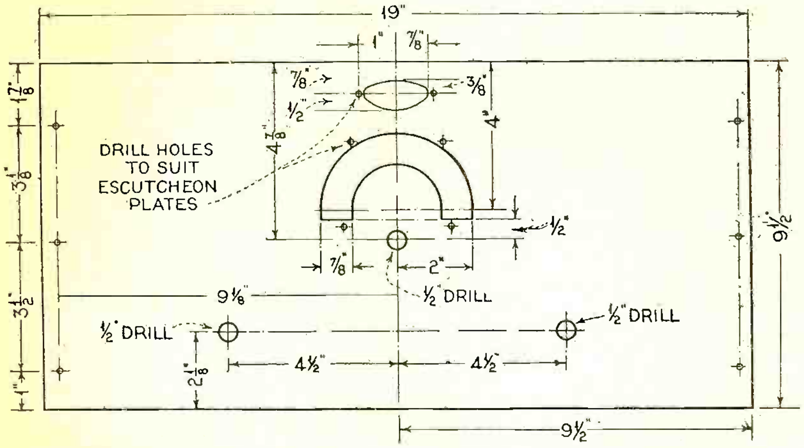
The constructor who has finished this complete rack-and-panel public-address system has the means of supplying either phonograph, microphone or radio reproduction with tremendous volume and good tone quality.

List of Parts Required to Build the Set

BP1, B2—Eby "antenna-ground" twin posts
D—Crowe tuning dial, type 52, with traveling ghost light
F—Littlefuse 1 ampere fuse, with mounting
J1, J2—Eby output twin jack
S—Hart and Hegeman 110-volt on-off switch
VTM—Readrite type TM103, visual tuning meter
6 Alcoa tube shields
Miscellaneous, wire and hardware to include 6 multi-pigtail resistor mounting brackets

Coast to Coast Components

CG1, CG2, CG3, CG4—Type 3449, superheterodyne 4-gang tracking condenser with shield, .00036 mfd., for r.f and detector sections and .00031 mfd. for oscillator section
C1—Type 6706 A tubular .1 mfd. condenser, 200 volts
C2—Type E593A mica .006 mfd. condenser
C3, C16, C17—Type 6061A, 3-section, .25 mfd. condensers, 300 volts
C4, C5, C7, C14—Type 6061, 4-section, .25 mfd. condensers, 300 volts
C6, C8, C9, C15—Type 6061, 4-section, .25 mfd. condensers, 300 volts
C10—Type E593B mica, .0005 mfd. condenser
C11, C12—Type E593C mica, .00075 mfd. condensers
C13—Type 6713A tubular, .02 mfd. condenser, 400 volts
C18, C19—Type 5324, 2-section, 4 mfd. electrolytic condensers, 500 volts
L1—Type 5576A, r.f. band-pass coils with shield
L2—Type 5579A, detector and oscillator coils with shield
L3—Type 2299, 175 kc. intermediate-fre-



ALL HOLES NOT OTHERWISE MARKED ARE 5/32" DIAMETER

FIG. 7 PANEL LAYOUT

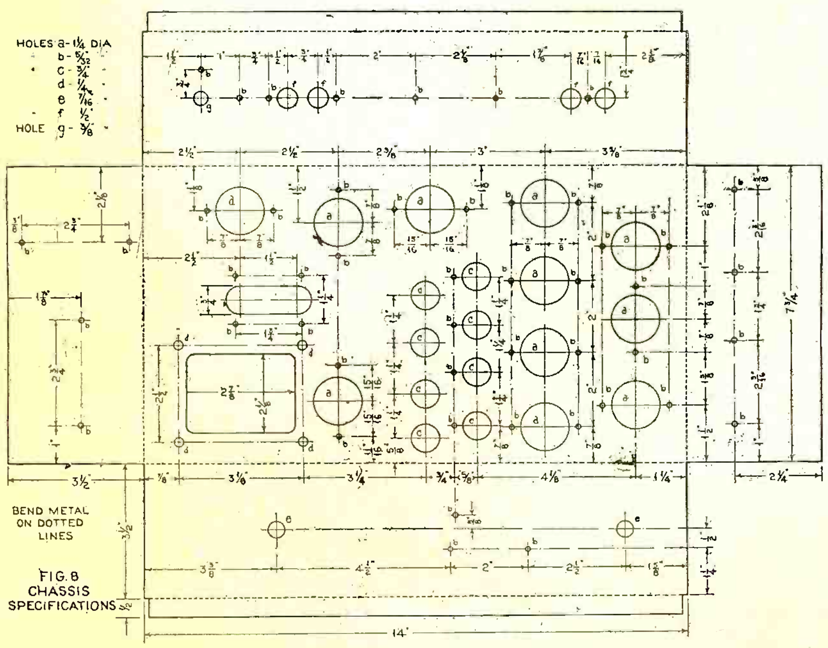


FIG. 8 CHASSIS SPECIFICATIONS

quency coil with shield
L4—Type 2300, 175 kc. intermediate-frequency coil with shield
L5—Type 6091, 175 kc. intermediate-frequency coil with shield
L6, L7—Type 6167A, filter chokes, 30 henry, 550 ohms, 50 ma.
PT—Type 5532A, power transformer
R8—Type RI277A, wire-wound potentiometer, 4000 ohms
RFC1—Type 3404 r.f. choke, 8.8 millihenries
RFC2—Type 3405 r.f. choke, 22. millihenries
1 type T47CH cadmium-plated chassis, drilled, 14 inches long by 7¾ inches wide by 3½ inches high
1 type T47P, No. 18 gauge steel panel, 9½ inches high by 19 inches long

Lynch Resistors Required

R1—Type LF-4, 60,000 ohms, 1 watt
R2—Type LF-4, 1000 ohms, 1 watt
R3—Type LF-4, 500 ohms, 1 watt
R4—Type LR-4, 50,000 ohms, 2 watts
R5—Type LM-3, 7500 ohms, 3 watts
R6—Type LR-4, 7500 ohms, 2 watts
R7—Type LF-4, 100,000 ohms, 1 watt
R9—Type LF-4, 40,000 ohms, 1 watt
R10—Type LF-4, 2000 ohms, 1 watt
R11, R16—Type LF-4, 50,000 ohms, 1 watt
R12—Type LF-4, 500,000 ohms, 1 watt
R13—Type LF-4, 250,000 ohms, 1 watt
R14—Type LF-4, 5000 ohms, 1 watt
R15—Type LF-4, 250,000 ohms, 1 watt

Cinch Components Required

V1, V2, V3, V4, V5—6-prong wafer sockets
V6—5-prong wafer socket
V7—4-prong wafer socket

Meter Ranges

(Continued from page 593)

the sum of the total resistance of Rs and the internal resistance of meter 2.

To figure the power rating in watts for resistances used as multipliers, use this formula: Normal voltage range of meter ÷ resistance of meter in ohms = I (amps. current consumption). Then I squared × resistance of multiplier = power rating in watts.

Information Pertaining to Current to Use in Tests

In all tests pertaining to the measurement of internal resistance of meters we must use a source of current that is consistently accurate. As we notice that most of the tests are made by the full and half-scale deflection systems, we can see why a uniform flow of current is necessary to obtain accurate results. When measuring high-resistance meters, B batteries are a fairly good source of current, as a high-resistance meter will not drain so much current from a battery. The measurement of resistance in low-resistance meters should be made with a more consistent current supply, such as a generator or, if you have alternating current in your home, a B eliminator may be used. We know that if we connect a low-resistance meter across a battery it will very quickly destroy the battery. Therefore, if we used a battery in these tests the current would be continually used up, and, as there is nothing to keep the supply regular, the battery would wear down. Therefore, when we adjust the current for full-scale deflection it would not remain that way, and so by the time we adjusted our resistance in the test arrangement we would not have the same value at source as we started with.

It is quite necessary to have a good rheostat in one lead of the current supply to enable you to adjust the current for the half and full-scale deflection systems.

Electronic Arts

(Continued from page 589)

mekapion" (which for this purpose uses a cadmium photo-cell) on his side and pre-set a point upon the dial which is the dosage the patient should get. Then, automatically, when this dosage is reached, a bell rings and the current is switched off.

A similar equipment can also be used for sun baths, the patient being requested to move in the shadow if the bell rings. If clouds go over the face of the sun, a longer period will elapse until the total dosage is reached. If the sky is clear and the sun is powerful, the period will be shorter. But independently of any climatological changes, this little apparatus will register *directly and continuously* the total dosage of light applied to the body, independent of changes in the light intensity of the sun or variations of the ultra-violet output of a lamp.

Figure 8 shows a picture of the Mekapion for the measurement of X-rays as it actually appears in practice. The current supply is delivered from the base of the instrument. It stands on three roller casters and can be rolled to the bed of the patient. The top of the instrument is movable upon a universal joint. The ionization chamber mentioned before is attached at the end of the long rod. The sensitive parts are all built into the cabinet on top of the instrument.

And there are many more applications of these electronic principles possible in science and industry. They all go back to the fact that the radio sciences have made it possible to measure exactly impulses which are much too feeble to be counted by any other methods. An important new field of endeavor has thus been opened for humanity and civilization.

* For other chambers of little absorption—so-called air chambers—see Braun & Kuestner, Ionization Chambers, Strahlentherapie 32, 550, 1929.

All-Wave Super

(Continued from page 613)

man speaking in English about Rome—which came over well. The French station at Pontoise, too, was easily understandable. It was a grand opportunity to brush up on foreign languages. VK2ME, Sydney, Australia, could be heard, weakly, on 9590 kc., 31.28 meters.

Now a word about broadcast reception late at night. Here the channels which were not clear earlier in the evening came through in fine style. KFI could be separated from Hamilton, Ontario, and his announcement definitely obtained.

In our attempt to describe our long-distance tests of reception, domestic stations may have seemed neglected. The ham bands, for instance, were so teeming with life that one could not begin to list the stations received. Also, airplane and police stations give many interesting announcements.

Set Tester

(Continued from page 594)

for cathode type power tubes. The opening of switch S9 will increase the bias on *both* grids of the Wunderlich tube, while the switch S4 takes all bias away from *one* grid. For the reading of normal plate current, S9 should be closed. When testing the pentode types -47 and -33, screen-grid voltage is read by setting S1 for cathode voltage and screen

(Continued on page 635)

Radio Physics Course

(*Continued from page 621*)

sign direction as well as position to lines of force. By agreement, lines of force are said to come out of the N pole of a magnet and enter the S pole. They then continue through the magnet to the N pole, always forming closed curves or loops as shown in (B) of Figure 2. The lines of force really show the paths a tiny north pole would take if it were placed in the magnetic field and were free to move under the influence of the magnetic field. It would be repelled out by the north pole and be attracted around to the south pole.

Examination of (A) of Figure 2 shows that the lines of force of a bar magnet must traverse quite a long path through the surrounding air—which is a very poor magnetic material. If the bar magnet is bent around in the form of a horseshoe, as shown in (C) of Figure 2, the path of the lines of force is mostly through iron, which is a good magnetic material, and there is only a short path through the air between the poles. In this form most of the magnetic force would be concentrated in the short space between the poles, making it a much stronger magnet than the bar magnet. Permanent magnets used in practice are usually of the horseshoe shape. In radio equipment, horseshoe permanent magnets are used in earphones, magnetic type loudspeakers and electric phonograph pick-up units. The pieces of steel are first bent into shape and any holes required are drilled while they are soft. Then they are hardened by heating to a red heat and quickly dipping into water or oil. They are then magnetized by powerful horseshoe electromagnets. Special alloys of steel are used for permanent magnets, because soft iron would not retain its magnetism. While soft iron possesses a greater attractive force than hard steel while the magnetizing force is present, the steel possesses far superior attractive properties to the iron, after the magnetizing force is removed.

Temporary and Permanent Magnets

If a strong horseshoe magnet is dipped in soft iron filings or soft iron nails, they will be attracted to it and themselves become magnetized and attract each other. If they are removed from the magnet they lose their magnetism entirely. Their magnetism is only *temporary;* that is, they are *temporary magnets.* The horseshoe magnet used retained the greater part of its magnetism after it was magnetized. Therefore it is a *permanent* magnet. Most magnetic substances, such as wrought iron, soft steel, nickel, etc., will lose practically all of their magnetism as soon as the magnetizing force is removed. Hardened steel and its alloys retain the magnetic property for a long time. The permanent magnets used in electrical measuring instruments, earphones, loudspeakers, phonograph pick-ups, etc., are made of hardened steel alloys.

The power of a specimen to retain its magnetism when the magnetizing force is removed is known as the *retentivity.* Steels used for good permanent magnets have great retentivity. The harder the substance, the greater its retentivity. Soft iron has little retentivity. The magnetism which a piece of iron or steel retains after it has been subjected to a magnetizing force of some kind is called the residue or *"residual"* magnetism.

Business Education Important

The forward strides in radio service work have made it imperative that the serviceman not only know his radio technique but that he understands and practices the fundamentals of business in his activities. Radio News is now offering to its readers in this field a series of bulletins on home study courses given by Columbia University. The titles of the bulletins are:

1. Mathematics, Drafting and Industrial Engineering
2. Home Study Course in the Principles of Salesmanship
3. Home Study Course in Business
4. Home Study Course in English
5. General Bulletin on Home Study Courses.

All that is necessary to obtain one or more of these bulletins is to write your name and address on your letterhead requesting the bulletin or bulletins you desire, by number, as listed above. They will be sent to you promptly.

All of the bulletins contain valuable information regarding these fields with a detailed description of the courses, registration instructions and the regulations under which the courses are conducted. All of the courses have been prepared by members of the University staff especially for students at home.

Backstage

(*Continued from page 623*)

to New York, where she was tutored by Frank La Forge. While studying with La Forge she appeared as an assistant artist with Ernestine Schumann-Heink, Richard Crooks and other famed concert stars. She gave several concerts in her own right as well. Miss Eastman has many appearances on both NBC and CBS to her credit. She has already appeared on the Broadway legitimate stage.

THE happy combination of George Olsen and his orchestra, Ethel Shutta, Fran Frey and Richard ("Hot-cha") Gardner, which scored a big hit on the old Canada Dry series, is back on the NBC as a Saturday night commercial feature. Together with Gus Van, the Olsen combine is featured on the Oldsmobile Program. George Hicks, also a highlight on the old Canada Dry series, has an important rôle in the new Oldsmobile series. The Shutta-Frey-Gardner vocalizing has done much to popularize Olsen's orchestra. Gus Van gained fame as a member of the Van and Schenck song team. Since the death of his partner, Van has appeared on the air as a solo artist. On the new series he is continuing the comedy and character songs which were identified with the Van and Schenck stage partnership of twenty years.

Set Tester

(*Continued from page 634*)

current by setting S1 for cathode current.

List of Parts

1 "universal" socket
1 7-prong socket, sub-panel type
5 feet of 7-wire analyzer cable.
1 Na-Ald 6-prong analyzer plug, No. 906WL
1 6-to-5 adapter, No. 965DS
1 6-to-4 adapter, No. 964DS
1 6-to-7 adapter, No. 967SS
1 s.p.s.t toggle switch

Technical Review

(*Continued from page* 616)

motor-radio suppressors, handy servicemen's kits, valuable technical data and list of free bulletins available on the building of servicemen's test equipment.

10. *Information on the Suppression of Motor-Radio Noises.* This interesting and useful folder of the International Resistance Co. gives complete information on how to overcome motor-generator, ignition-coil, interrupter and spark-plug noises in automobile-radio installations.

16. *RMA Standard Resistor Color-Code Chart.* A handy postcard-size color-code chart designed by the Lynch Mfg. Co. to simplify the job of identifying the values of resistors used in most of the standard receivers. It also contains a list of the commonly used values of resistors with their corresponding color designations. A complete catalog of products is included.

18. *Volume Controls, Fixed Resistors, Motor-Radio Spark Suppressors and Power Rheostats.* A 1933 catalog containing descriptions, specifications and prices of a complete line of Centralab standard, special and replacement volume controls for receivers, amplifiers, public-address systems and talkie installations, fixed resistors, motor-radio spark suppressors, wire-wound rheostats and potentiometers. Details are given on how to obtain, without charge, a copy of the 64-page Centralab Volume Control Guide for Servicemen.

25. *Transposition Noise-Reducing Antenna System.* A detailed description, with technical data, on a new antenna system, perfected by the Lynch Mfg. Co., which is effective in eliminating the majority of electrical noise interference on broadcast, shortwave and amateur reception. It is especially suited for application on all-wave receivers which sometimes give unsatisfactory results because of objectionable interference on the shorter waves.

29. *Practical Radio Engineering.* A 28-page book which gives a detailed description of the home-study course in practical radio engineering offered by the Capitol Engineering Institute. The first part of the course is intended to provide the student with the fundamental knowledge and training required to thoroughly understand the second part which is an advanced course in radio engineering. The course prepares the student for actual radio engineering work in the industry. Stress is laid on the practical application of radio principles.

30. *Shielded "Noise-Reducing" Antenna System for Broadcast Waves.* A description of a new Lynch low-cost, impedance-matching system of unique design—including impedance-matching transformers for the antenna and for each receiver—which now makes possible the use of a shielded transmission line of any length, without loss of signal strength. This system is designed for the elimination of "man-made" electrical interference on the broadcast frequencies. It is easy to install and provides for using several receivers on a single antenna. It offers many opportunities for profitable jobs to dealers and servicemen.

34. *Serviceman's Replacement Volume-Control Chart.* A revised list, in alphabetical order, of all old and new receivers showing model number, value of control in ohms and a recommended Electrad control for replacement purposes. Contains specifications for

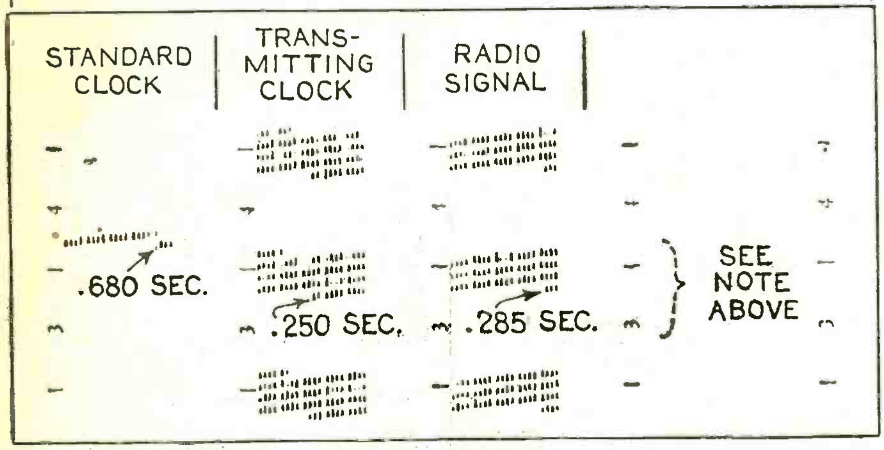
(*Continued on page* 638)

Telling Time by Radio

(*Continued from page* 584)

How Time Records Are Kept

BELOW is a section of the record made by the signal-checking device shown in one of the photographs. There are 200 dots per second, each dot therefore representing an elapse of 5/100 second. The dot at the beginning of each record—that is, the first dot in the lower line of each group—is the one that tells the story, for it marks the instant that each respective signal begins. Example: In the second group, the standard clock signal starts when .680 of the second has elapsed; the transmitting clock, at .250 second, and the radio signal, as received back from the transmitting station, at .285 second. Therefore, the difference between the standard clock and transmitting clock is .430 second, the transmitting clock being that much faster. The radio signal lags .035 second behind the transmitting clock and is .395 second ahead of the standard clock. This seems involved, but the observatory men can read the record like so much type. The machine can print several time records side by side.



The Service Bench

(*Continued from page* 587)

partment, a small attractive sign may be hung on each horn, stating, "This record may be secured in our record department," and the location of the record department should be given.

"Between each record an announcement of some special sale should be made and the exact place where this sale may be located should be given. The announcements should be given in a low pitched pleasing voice.

"Paging customers may also be easily accomplished. This must not be under-estimated as a real service which the department store can give to its patrons. This service should appear in the department store's advertising.

"Every town of any size has department stores. Every wide-awake department store is eventually going to install sound.

With the Experimenters

(*Continued from page* 619)

the wire to expand or "stretch," and when the finished coil cools, the wire contracts, holding the turns in place as if they were glued. I have a set of coils that I wound three years ago, and they show no signs of loosening.

An easy method of spacing the turns on tube base or other unthreaded coil form is to wind alternate turns of fishing cord and wire, and then remove the cord after the coil is finished. This method is illustrated in Figure 1. Wire may be substituted for the cord if desired.

HARRY D. HOOTON,
Beech Hill, West Virginia.

Remote Control

(*Continued from page* 627)

volume control button, releasing it when the desired output level is obtained.

The contactor drum shaft is coupled directly to the shaft of the ganged tuning condenser of the receiver. Although it is feasible to use the fiber gear (H) with a small pinion attached to the condenser shaft, this may be dispensed with in order to simplify the procedure. In this case, the gear is removed from the drum shaft by knocking out the small tapered pin which holds it to the shaft. A standard metallic coupling adapter, furnished with the control, is then fastened on the drum shaft, and the shaft of the condenser is secured to the other end of this coupling.

If the radio receiver uses a volume control of approximately 3000 to 5000 ohms resistance, disconnect the leads from the set volume control, lengthen them if necessary and solder them to the volume control (G) furnished with the remote control. The small brown resistor, also furnished with the remote control, has a resistance of approximately 5000 ohms and this may be connected in series as an additional external fixed resistor, if required.

However, if the receiver volume control has a much higher or a much lower resistance than the one supplied with the remote control, or if it is deemed preferable to retain the receiver control, this may be done by removing the volume control furnished with the remote control unit, forcing out the tapered pin which holds its shaft to the collar. The set volume control is removed and is substituted in place of the one just removed from the remote control. It is put into place and the hole in the collar is used as a template for drilling a hole through the volume-control shaft. The pin is replaced,

(*Continued on page* 639)

Technical Review

(*Continued from page* 636)

over 2000 different receiver models.

36. *Broadcast Transmission, Public-Address and Manufacturers' Type Audio Components.* An exceptionally complete 16-page transformer catalog giving specifications on the Kenyon laboratory, standard and all-purpose amplifier transformer line designed to meet the exacting requirements of broadcast stations, audio research laboratories and professional public-address engineers. A special section is devoted to highly filtered rectifier systems, automatic voltage regulators and special types of test equipment. Also contains manufacturers' type audio transformers and replacement transformers with universal mounting features. Five pages are devoted to detailed schematic diagrams for pre-amplifiers, mixer controls, "Class A" amplifiers of from 2 to 50 watts output and "Class B" amplifiers up to 25 watts output.

37. *Servicemen's and Dealers' 1933 Testing and Trouble-Shooting Instruments.* A 16-page handbook and catalog giving complete details on diagnometers, set analyzers, tube testers, oscillators, ohmmeters and other testing instruments and accessories made by the Supreme Instruments Corp. It also contains details of a series of blue-prints and kits by means of which any serviceman can build any of the above instruments at a saving, and details of a self-payment plan which enables responsible servicemen to pay for these instruments while using them.

39. *Radio Servicing and Radio Physics.* A 4-page folder which gives descriptions and tables of contents of two of the most complete, easily understood and inexpensive books on every phase of radio. The books are written by A. A. Ghirardi and Bertram M. Freed and should be in the libraries of every radio student, experimenter and serviceman. The fact that they are used as standard texts by many radio schools and that chapters have been reprinted in RADIO NEWS MAGAZINE is an indication of their value.

April, 1933
RADIO NEWS Free Technical Booklet Service
222 West 39th Street
New York, N. Y.

Gentlemen: Please send me, without charge, the booklets or folders I have filled in below:

Numbers..............................
....

☐ Serviceman in Business for Myself
☐ Serviceman Employed by: ☐ Manufacturer, ☐ Jobber, ☐ Dealer, ☐ Service Organization
☐ Radio Engineer
☐ Experimenter
☐ Laboratory Technician
☐ Dealer
☐ Jobber
☐ Professional or Amateur Set Builder
☐ Licensed Amateur
☐ Station Operator
☐ ....
☐ ....

I am a ☐ subscriber ☐ newsstand reader.

I buy approximately $.......... of radio material a month.

Name..............................

Address..............................

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

PLEASE USE PENCIL AND PRINT, IN FILLING IN COUPON

INDEX TO ADVERTISERS

Remote Control

(*Continued from page 637*)

thus fastening the set volume control securely to the collar and the metal gear. The volume-control leads are extended from the set and resoldered to the volume control at its new position.

The third and last operation consists in removing the special three-prong plug from the three-wire a.c. cable. One of the wires is also removed from the two-prong 110-volt plug used for supplying current to the set. This wire is connected to the green wire of the remote-control cable. The black wire from the remote-control cable is put into the two-prong plug in place of the wire which was removed. The yellow wire is then connected to the other side of the two-prong plug—that is, to the same side also connected to the set. The diagram shown in Figure 6 makes this quite clear.

Reviewing the procedure outlined above, it will be seen that this resolves itself into three simple operations, regardless of the make or type of radio receiver to be equipped with this remote control. First, a simple mechanical connection between the drum shaft of the remote control and the condenser shaft of the single-dial control set. Second, the substitution of the set volume control for the one on the device and the resoldering of a few wires. Third, removal of a three-prong plug and substitution of a standard two-prong plug. The only other connections to be made are the 12 wires from the 25-foot flat cable to the remote-control cable terminal strip. These 12 wires terminate in lugs which are held tightly in place on the terminal strip by means of brass screws. By referring to Figure 7, it is impossible to make an error in the connections.

From the above, it is apparent that the entire installation can be completed in a short time and without previous experience, including the setting of the pre-selector for any desired group of stations.

Remote control is easy to sell because it possesses logical and compelling sales features. It is a convenient and useful development in radio and it appeals to the universal desire to be up-to-date. It may be used to eliminate old-style, unsightly cabinets, since the set equipped with remote control may be installed in a closet, in the attic, or in any other out-of-the-way place.

Even where a new receiver is to be installed, the serviceman can save money for the customer and increase his own profits by eliminating the expensive cabinet and supplying a modern, inexpensive remote-control unit.

From the listeners' standpoint, remote control adds immeasurably to the utility of the radio set. The receiver in the living room may be operated from the bedroom, by means of a control box alongside the bed. A control box placed near the easy chair permits one to change from one program to another merely by pressing a button. Even distance fans can utilize the pre-selector feature of the remote control, to enable them to bring in a distant station night after night, once it has been located so that the selector tunes to it.

Radio Phenomena

(*Continued from page 603*)

1747—Franklin first to put forward one fluid theory of electricity, using positive and negative. Kite experiment demonstrated electrical nature of lightning. Invented the lightning rod in 1760. Symmer elaborated DuFay's two-fluid theory in opposition to Franklin.

1753-1759—Canton, Wilke and Aepinus studied phenomenon of electrostatic induction.

1760—Planta and Ramsden constructed the first plate machines.

1773—Volta invented the electrophorus.

1773—Cavendish completed his experiments on electrostatics. His work anticipated that of Coulomb, but was unnoticed until published by Clerk Maxwell in 1879.

1776—Bergmann showed that temperature difference is important in pyro-electric action.

1782—Volta invented the condenser.

1785—Coulomb determined by the use of the torsion balance the quantitative relation of force, size of charges and distance of separation.

1812—Poisson developed the mathematical theory of electrostatics.

1837—Faraday's laws of electrolysis gave the first intimation of the discrete nature of electricity.

1888—Hertz discovered that the discharge of a Leyden jar produced the electromagnetic waves predicted by Maxwell in 1873.

1891—Stoney used the term electron for the unit charge involved in electrolysis.

1897—J. J. Thomson's investigation of the discharges through gases led to the discovery of the electron.

The DX Corner

(*Continued from page 607*)

teners that the Bowmanville, Canadian station VE9GW has not been on the air recently. VE9GW was a very popular station on 49.22 meters and, although using low power, came in over most of the United States with a good strong signal. We hope that they will soon be back again on the air.

The British Empire Broadcasts

Stations GSC on 31.3 meters and GSA on 49.6 meters are reported coming in exceptionally strong from 8 to 10 p.m. E.S.T. They are probably one of the "top-notchers" for American listeners during this two-hour transmission which is scheduled primarily for listeners in the Canadian zone. They have been coming in, lately, like locals.

Caracas Easy to Get

The station YV1BC is reported throughout the United States as being a standby for

April, 1933

Technical Information Coupon
Radio News Laboratory
222 W. 39th Street
New York, N. Y.

Gentlemen:

Kindly supply me with complete information on the attached question:

☐ I am a regular subscriber to Radio News, and I understand this information will be sent me free of charge.

☐ I am not yet a subscriber to Radio News.

☐ I wish to become a subscriber to Radio News, and enclose $2.50 to receive the magazine regularly for one year, and to receive this valuable technical information service free of charge.

Name.............................

Address..........................

listeners who like South American music. This station at Caracas, Venezuela, is readily found on 49.1 meters, sandwiched in between W8XK and W9XF.

Australian Early Birds

The two Australian stations, VK2ME and VK3ME, require rising early if one wants to hear them nowadays. They can be heard best between 5 and 7 a.m., E.S.T., although they are not on every morning. Their signal strength is steadily increasing and by early Spring they should be coming in very much louder.

Morocco on Sundays

The station RABAT, Morocco, is coming in now in fine style and can be heard on Sundays from 3 to 5 p.m., E.S.T.

What Happened to HKA?

The famous South American station HKA is not heard nowadays. We wonder if it has been dismantled.

Pontoise Shifts Waves

The great transmitter at Pontoise, near Paris, with the call letters FYA (very seldom given over the air) can be heard practically all day long in America, starting in the early morning at 8 a.m. on 19.6 meters. They shift their wavelength at 12 noon to 25.2 meters and then at 3 p.m. to 25.6 meters, on which wavelength they may be heard until 7 p.m., E.S.T.

DJA with a Wallop

The German station DJA is coming in very strong recently on 31.3 meters. They are reported by many listeners as being one of the strongest Continental transmitters heard in the United States.

Madrid a Favorite

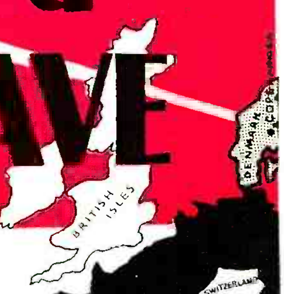
Station EAQ at Madrid is reported as being a favorite for homecomers from business at about 6 to 7 p.m., E.S.T. Many listeners tell us that the first thing they do when they get home from the office is to sit down, set the dials and sit back to enjoy the Spanish program, which contains announcements in English at this time.

Short-Wave DX Listeners, Attention!

This department is inserted this month as an experiment! Do you like it? If so, just drop a card or letter to the DX Editor, care of RADIO NEWS, *giving your suggestions and comments about it. If the response from readers is sufficient to warrant its being continued, it will be enlarged and made more complete as time goes on.*

You also can help to make it more perfect and useful to all by mentioning, in your letters to the DX Editor, stations you receive most favorably on the short waves, giving, wherever possible, the call letters, location, wavelength or frequency and the time when you hear the stations best. Mention only those stations that you hear regularly. Also, it would be advisable if you care to help, to mention any peculiarities of transmission that might help to identify a foreign station, such as their method of signing on or off, language used, any station signals like ringing bells or notes on a piano or the ticking of a metronome, etc. Of course, if you keep a log of foreign station reception, it would be of invaluable aid to us in preparing this information for you. Later on RADIO NEWS *is to select a number of official* RADIO NEWS *listening posts from among its readers who respond to this request and who show their ability in keeping an accurate log of stations. If our readers co-operate with the DX CORNER in this way we can have the finest DX department possible and one that should be of inestimable service to DX short-wave fans at large.*

The World Is Yours with a MIDWEST 16 TUBE ALL-WAVE



Midwest Owner in Newfoundland Hears Trotsky in Copenhagen, Lord Lyttleton at Geneva and Picks up French, German and Italian Stations with Ease! Midwest 16-Tube Set Accomplishes What Nine Other Radios Could Not Do.

. . . and Mr. Hampton's experience is being duplicated daily by thousands of Midwest owners all over the world. Send for additional proof! The superlative performance of this powerful set has established entirely new records of radio reception. Clearness, selectivity, faithful reproduction of tone, tremendous volume under perfect control . . . a thousand new delights await the radio enthusiast who has never enjoyed the untold thrills of one hour with a Midwest 16-tube ALL-WAVE set.

With this masterpiece of radio engineering you can reach out to the far corners of the earth for the new, different and unique in broadcasting . . . or you can enjoy the programs of your favorite stations anywhere in the U. S., Canada or Mexico. Then when you've had your fill of jazz, classical music, daily news items, dialogs or the latest radio headliners, you can tune in police stations, airplanes in flight, ships at sea, amateurs, etc. A flip of a switch gives you your choice of the whole world of radio. Four distinct wave bands with a tuning range of 15 to 550 meters give you long or short wave broadcasts at home and from abroad . . . everything worth while that goes over the air.

Only $39.95

Completely Assembled with Large Dual Speakers

15 to 550 Meters

Read This Letter

Bishop Falls, Nfld., Dec. 2, 1932

Midwest Radio Corp.
Cincinnati, Ohio

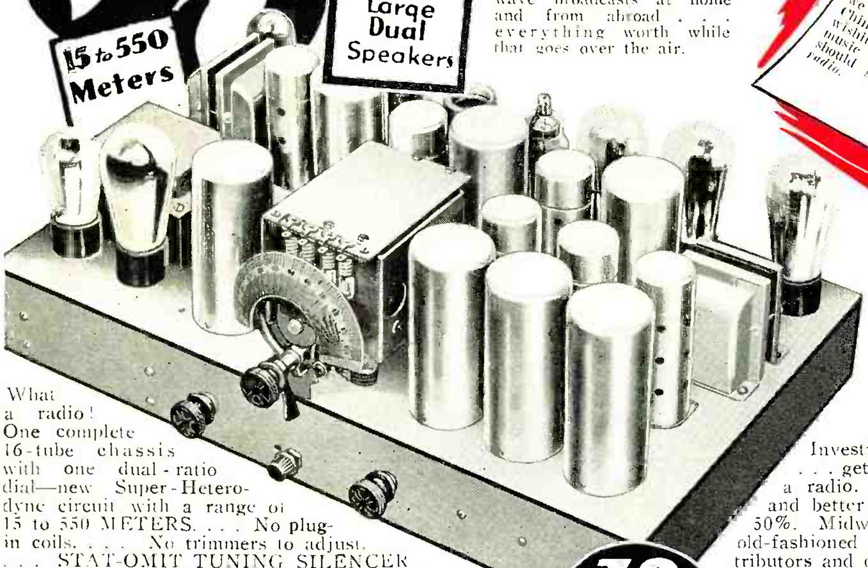
Dear Sirs:

Yesterday and today we have had Springfield on long wave since 3:00 P.M. Newfoundland time, or 1:30 U. S. A. time—something I have never been able to do before, although *I have had nine other radios before getting this Midwest 16-tube.*

Any time after 3:00 P.M. Newfoundland time, we can get French, German and Italian stations on long wave, loud and clear. Sunday, November 20th, on short wave we heard Trotsky speaking on the Russian Revolution from Copenhagen, Denmark. If his English had been good we would have understood every word he said.

Sunday, November 13th, on short wave we heard Lord Lyttleton speaking on the China-Japan affair from Geneva. Anyone wishing to get far away stations and hear music without any hissing or frying *should get a Midwest and enjoy perfect radio.*

Yours truly,
J. C. HAMPTON



What a radio! One complete 16-tube chassis with one dual-ratio dial—new Super-Heterodyne circuit with a range of 15 to 550 METERS. . . . No plug-in coils. . . . No trimmers to adjust. . . . STAT-OMIT TUNING SILENCER gives in-between-station silence . . . no tuning meter or Neon light required. . . . Large acoustically matched Dual Speakers. . . . New CLASS "B" PUSH-PUSH Super-Power Amplifier with six times the power of ordinary amplifiers. . . . Full band Automatic Volume Control. . . . Color-Lite Multi-Wave Band Selector. . . . FULL FLOATING VARIABLE CONDENSER. . . . Complete Scientific Shielding . . . Absolute tone fidelity. . . Image Frequency Suppressor. . . . Fractional Microvolt Sensitivity. . . Latest TYPE TUBES, Super-Triodes, Dual and Triple Grids. Two Full Wave Rectifiers. DUAL POWERED—two separate power transformers. A bigger, better, more powerful, more selective, finer toned radio than you've ever seen before . . . offered at an amazingly low price direct from the big Midwest factory.

Be convinced—TRY IT 30 DAYS before you decide to keep it. Don't send a penny. Mail coupon right now for amazing FREE trial offer and complete details. You'll be surprised.

30 DAYS FREE TRIAL

DEAL DIRECT WITH FACTORY

SAVE UP TO 50%

Investigate . . . mail the coupon . . . get all the facts before you buy a radio. Learn how to get a bigger and better set at a saving of 30% to 50%. Midwest sweeps aside the costly old-fashioned way of selling through distributors and dealers. You buy direct from the Midwest factory. You save all of the middlemen's profits. Mail the coupon now. Get the Midwest catalog. Learn about our sensationally low factory prices, easy payment plan and positive guarantee of satisfaction or money back. Mail the coupon, or write us a postal NOW!

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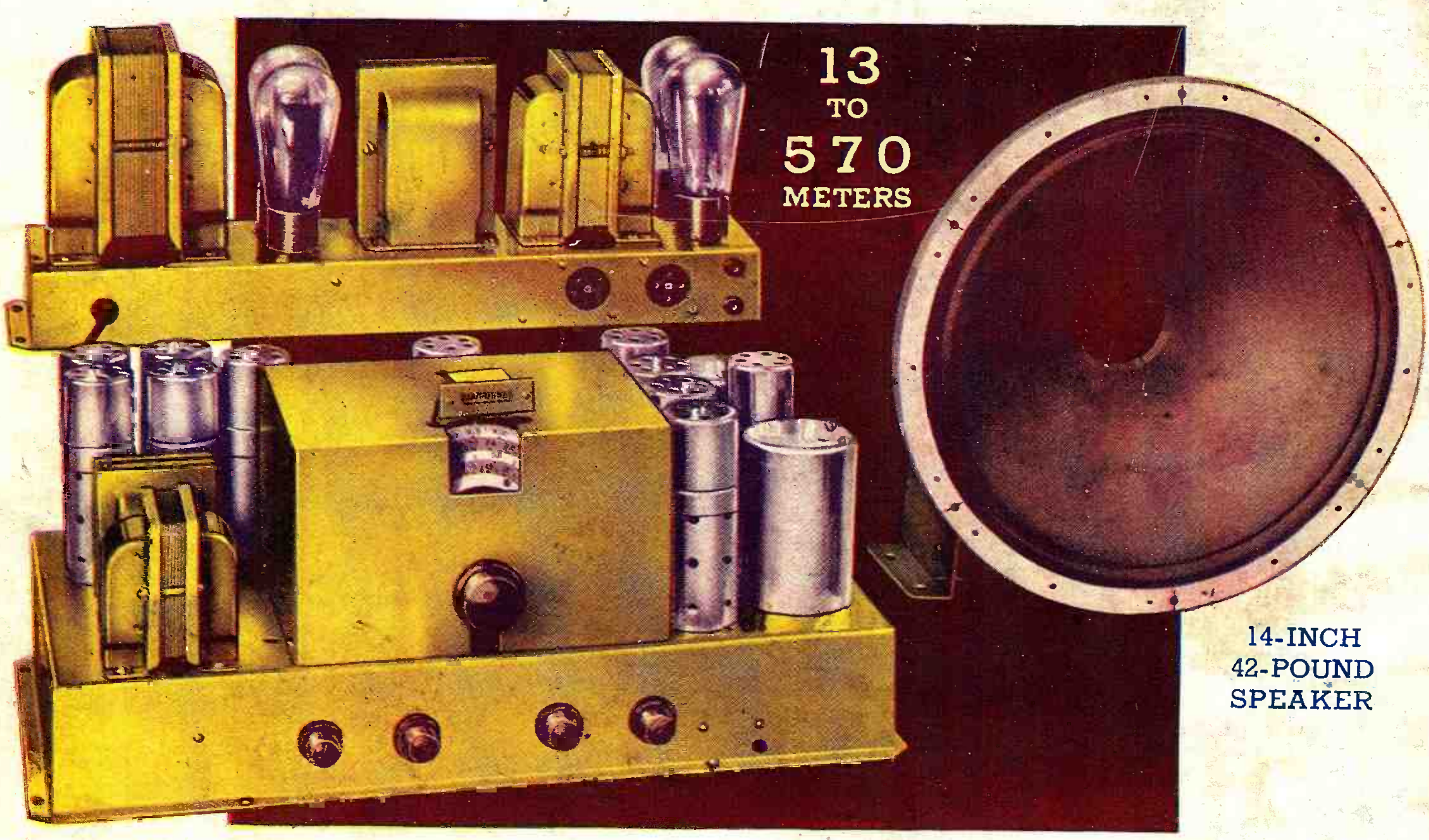

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