WITH THE EXPERIMENTERS

# RADIO NEWS

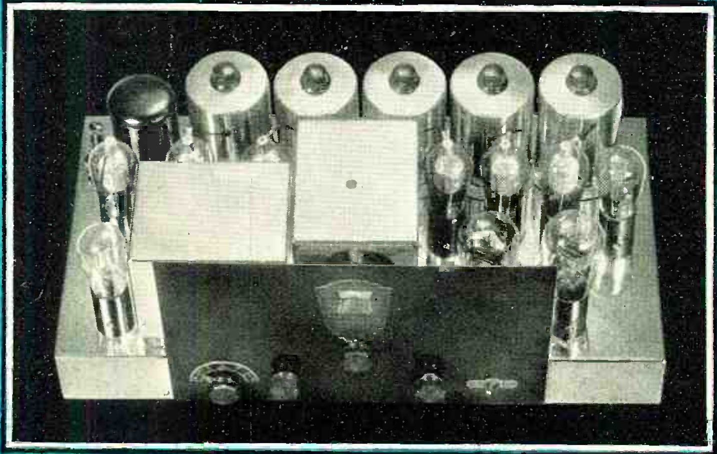
May
25 Cents

Radio-Controlled Sailing "Yacht"

Television lens design
Service oscillator
Making a S. W. Set
Helping the Deaf
Pentode receiver
Interference

www.americanradiohistory.com

# *Super* Power



## Insures *World-Wide Performance*–

## 5 TO 550 METERS–NO PLUG-IN COILS

IF YOU have followed Lincoln's advertising, you will note we have never made statements of performance of our receiver. We have never claimed you can get foreign reception at all times as clear as a bell. As long as the atmosphere is used as a medium—subject to its varied conditions, and as long as radio is limited to local interference and absorption, *ALL RADIO EQUIPMENT* is handicapped.

Yet, in spite of these unavoidable conditions, Lincoln engineers have for years been the recognized leaders, and Lincoln receivers have been used by Arctic explorers, designing engineers of broadcasting equipment, for reception of press matter direct from the war zone of China and other special work where other receivers failed.

Lincoln owners are getting the full benefits of Lincoln's Super Power. Lincoln receivers, the world over, are known for what they actually do—just ask the Lincoln owner.

### SUPER POWER TO AMPLIFY SIGNALS NOT HEARD ON ORDINARY RECEIVERS

If you have not heard a Lincoln, you have no conception of what high amplification will do. Tune in a station on any other receiver, tune in the same station on a Lincoln with equal volume with regulation in low power then snap the high power switch, the tremendous blast of volume will startle you. This is what you must have to get weak signals with local volume.

### EXTRA POWER INVALUABLE STATES TEXAS OWNER

A recent letter received from a man with wide experience in all short-wave receivers states: "The gain is unbelievable to persons who have heard other SW receivers. I usually run any North American SW station I hear on local switch and have all of the reserve power for fishing on SW. Best of all, sensitivity seems absolutely uniform on all frequencies which cannot be said for all receivers, in fact, no other SW I have tried. Believe me, that extra power is invaluable in SW work if one hopes to hear foreign stuff to amount to anything."

This man is telling you just what to expect in Lincoln high-powered receivers. He is verifying what Arctic explorers, broadcast engineers, and hundreds of Lincoln owners have proved without a question of a doubt.

If you are going to spend your money for radio, don't waste your money experimenting—remember, Lincoln's high power is the only answer to satisfactory distant reception.

From the tropical jungles of Colombia, South America, comes the following report: "I take pleasure in writing you that the Lincoln receiver ordered from you last December arrived in excellent order and that no trouble whatever was experienced in installation. It is giving the most wonderful reception and I wish to congratulate you on having produced a masterpiece. It brings in stations from extreme distances, with great volume and clarity, both American and European. Have listened to VK2ME Sydney Australia, on Sundays with excellent volume which is something around 6,000 miles distant from this point. It is without a doubt the finest battery operated receiver to be had and again let me express my appreciation for your prompt and careful attention to my order." This man is in the worst location in the world near the equator where radio reception is ordinarily impossible.

### TWO MODELS—LINCOLN DELUXE SW-32 AC
### LINCOLN DELUXE DC-SW-10 (BATTERY MODEL)

*Six screen grid tubes accurately balanced with Lincoln's original tuned impedance transformers.*

*Built and actually tested on the air by competent engineers.*

*Finished in beautiful highly polished silver nickel.*

*You can own a high-powered Lincoln they do not cost as much as you would think.*

Write at once for new prices, for demonstrator, effective for the next thirty days.

*Clip* and Mail NOW!

## LINCOLN DE LUXE–SW-32

## LINCOLN RADIO CORPORATION

Dept. N-3, 329 S. Wood St., CHICAGO, ILL.

Please send descriptive literature to NAME..........................................

ADDRESS.................................... CITY.................................... STATE....................

www.americanradiohistory.com

# 815 Logs *of 48 foreign stations*

## *received in* U.S. again Prove

# SCOTT ALL-WAVE

## *the One 'Round the World Receiver*

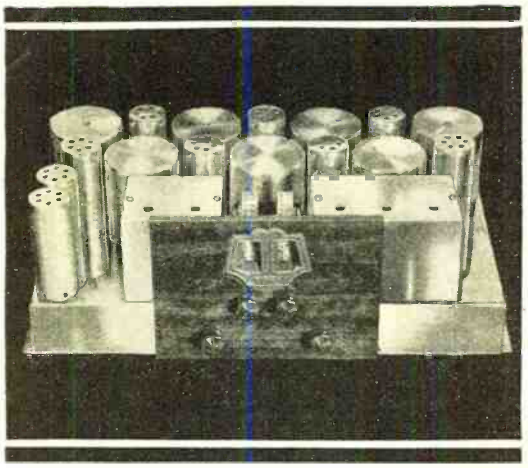
**JANUARY LOGS**
**From Scott Owners**

| *Stations Received* | | *Number of Logs* |
|---|---|---|
| VK3ME | Australia | 122 |
| VK2ME | Australia | 100 |
| HKD | Colombia | 85 |
| I2RO | Italy | 70 |
| FYA | France | 69 |
| HKM | Colombia | 59 |
| HKA | Colombia | 49 |
| G5SW | England | 43 |
| HKO | Colombia | 37 |
| F3ICD | Indo-China | 35 |
| PONTOISE | France | 19 |
| ZEESEN | Germany | 15 |
| LSN | Argentina | 11 |
| GBW | England | 10 |
| HKE | Colombia | 10 |
| GBU | England | 9 |
| GBS | England | 8 |
| HKC | Colombia | 7 |
| PRADO | Ecuador | 7 |
| RABAT | Morrocco | 6 |
| VRT | Bermuda | 6 |
| CMCI | Cuba | 5 |
| HKF | Colombia | 4 |
| CT1AA | Portugal | 3 |
| FTN | France | 3 |
| K6XO | Hawaii | 3 |
| OXY | Denmark | 3 |
| HCIDR | Ecuador | 2 |
| J1AA | Japan | 2 |
| PLV | Java | 2 |
| RV-15 | Russia | 2 |
| YV8BMO | Venezuela | 2 |
| Konigswuster | Haussen | 1 |
| CMK | Cuba | 1 |
| CM2MK | Cuba | 1 |
| DHA | Germany | 1 |
| EAR25 | Spain | 1 |
| EAQ | Spain | 1 |
| FTF | Holland | 1 |
| FTK | France | 1 |
| KKH | Hawaii | 1 |
| LSY | Argentina | 1 |
| LSX-LSG | Argentina | 1 |
| T-14-NRH | Costa Rica | 1 |
| YV4VV | Venezuela | 1 |
| VFW | France | 1 |
| 1ZH | New Zealand | 1 |
| 2YA | New Zealand | 1 |


## *Send* COUPON *for full* PARTICULARS

A radio that does not cover a range of 15-550 meters is completely out of date. But you want more than just a set that "dials" 15-550 meters. Even "promises" of foreign reception won't do. The set you want is the one that can PROVE its world-wide prowess BEFORE you buy it. That ONE receiver is the Scott All-Wave 15-550 Meter Superhetrodyne—a custom-built jewel of advanced design and precision engineering. The coupon will bring you full details — and you'll be happily surprised at the modest price. Clip—fill in—mail the coupon now.

**The E. H. SCOTT RADIO LABORATORIES, Inc.**
*(Formerly Scott Transformer Co.)*
4450 Ravenswood Avenue
Dept. N52, Chicago, Illinois



FROM NEW YORK AND SAN FRANCISCO—from Canada and the Gulf Coast—from everywhere in the United States—verified logs of foreign reception have poured in—815 in all—during the month of January. The most distant station was 10,500 miles away from the receiver! And most of the logs that came in were of stations over 6,000 miles distant.

These logs—this reception of foreign stations was accomplished with Scott All-Wave Receivers operating under all possible conditions. The results obtained are, therefore, AVERAGE—and represent the results YOU will get when YOU buy a Scott All-Wave for yourself. They constitute actual PROOF of the SCOTT ALL-WAVE'S ability to give daily 'round the world performance. Not just once in a while — but daily, summer and winter. And by reception, we mean loud, clear, reproduction—ample volume—clear, undistorted tone—thoroughly satisfactory in every way.

# SCOTT
## ALL·WAVE
## 15·550 METER
## *Superhetrodyne*

**The E. H. Scott Radio Laboratories, Inc.**
**4450 Ravenswood Ave., Dept. N52, Chicago, Ill.**

Send me full particulars of the Scott All-Wave, 15-550 meter Superhetrodyne.

☐ DXER ☐ SET BUILDER ☐ DEALER

*Name* ........................................

*Street* ........................................

*Town* ........................ *State* ............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*Technical Editor*

William C. Dorf
*Associate Editor*

# RADIO NEWS

*Edited by* Laurence M. Cockaday

Howard S. Pearse
*Associate Editor*

Jos. F. Odenbach
*Art Editor*

VOLUME XIII — May, 1932 — NUMBER 11

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(*Cover Design by Morey*)



## DEPARTMENTS



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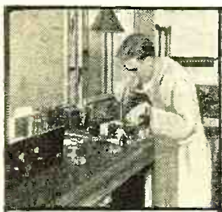
J. E. Smith, President, National Radio Institute, the man who has directed the Home-Study training of more men for the Radio Industry than any other man in America.

# BE A RADIO EXPERT

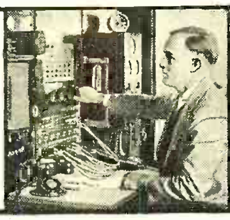
## Many Make $50 to $100 a Week

## I'll Train You at Home in Your Spare Time for RADIO · TELEVISION · TALKING MOVIES



**Set Servicing**

Spare-time set servicing pays many N. R. I. men $200 to $1,000 a year. Full-time men make as much as $65, $75 and $100 a week.



**Broadcasting Stations**

Employ trained men continually for jobs paying up to $5,000 a year.

**Ship Operating**

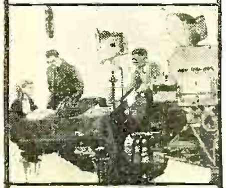
Radio operators on ships see the world free and get good pay plus expenses.

**Aircraft Radio**

Aviation is needing more and more trained Radio men. Operators employed through Civil Service Commission earn $1,620 to $2,800 a year.

**Talking Movies**

An invention made possible by Radio. Offers many fine jobs to well-trained Radio men, paying $75 to $200 a week.



**Television**

The coming field of many great opportunities is covered by my course.

If you are dissatisfied with your present job, if you are struggling along in a rut with little or no prospects of anything better than a skinny pay envelope—clip the coupon NOW. Get my big FREE book on the opportunities in Radio. Read how quickly you can learn at home in your spare time to be a Radio Expert—what good jobs my graduates have been getting—real jobs with real futures.

**Many Radio Experts Make $50 to $100 a Week**

In about ten years the Radio Industry has grown from $2,000,000 to hundreds of millions of dollars. Over 300,000 jobs have been created by this growth, and thousands more will be created by its continued development. Many men and young men with the right training—the kind of training I give you in the N. R. I. course—have stepped into Radio at two and three times their former salaries.

**Get Ready Now for Jobs Like These**

Broadcasting stations use engineers, operators, station managers, and pay up to $5,000 a year. Manufacturers continually employ testers, inspectors, foremen, engineers, service men, buyers, for jobs paying up to $6,000 a year. Radio Operators on ships enjoy life, see the world, with board and lodging free, and get good pay besides. Dealers and jobbers employ service men, salesmen, buyers, managers, and pay up to $100 a week. My book tells you about these and many other kinds of interesting radio jobs.

**Many N. R. I. Men Have Made $200 to $1,000 in Spare Time While Learning**

The day you enroll with me I send you material which you should master quickly for doing 28 jobs, common in most every neighborhood, for spare-time money. Throughout your course I send you information on servicing popular makes of sets; I give you the plans and ideas that have made $200 to $1,000 for N. R. I. students in their spare time while studying. My course is famous as the course that pays for itself.

**Talking Movies, Television, Aircraft Radio Included**

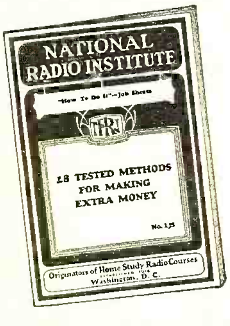
Special training in Talking Movies, Television and home Television experiments, Radio's use in Aviation, Servicing and Merchandising Sets, Broadcasting, Commercial and Ship Stations are included. I am so sure that N. R. I. can train you satisfactorily that I will agree in writing to refund every penny of your tuition if you are not satisfied with my Lessons and Instruction Service upon completion.

**64-Page Book of Information FREE**

Get your copy today. It tells you where Radio's good jobs are, what they pay, tells you about my course, what others who have taken it are doing and making. Find out what Radio offers you without the slightest obligation. ACT NOW!

J. E. SMITH, President
National Radio Institute
Dept. 2ER
Washington, D. C.


## Special Free Offer




*"28 Tested Methods for Making Extra Money"*

In addition to my big free book, "Rich Rewards in Radio," I'll send you my valuable manual "28 Tested Methods for Making Extra Money." Never before available except to students. Now, for a limited time, it is free to readers of this magazine. How to make a good baffle for cone speakers, how to reduce hum in externally fed dynamic speakers, how to operate 25 cycle apparatus on 60 cycle current, how to operate 110 v. A. C. receivers on D. C., how to shield sets from local interference are five of the subjects covered. There are 23 others. Get this valuable book by mailing the coupon now.

**THIS COUPON IS GOOD for One FREE COPY OF MY BOOK** — mail it now

J. E. SMITH, President
National Radio Institute, Dept. 2ER
Washington, D. C.

Dear Mr. Smith:
I want to take advantage of your Special Offer. Send me your two books "28 Tested Methods in Making Extra Money" and "Rich Rewards in Radio." I understand this does not obligate me and that no salesman will call.

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

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

City........................................State.................... J

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# The Editor—to *You*

IT has often been said, "Vacuum tubes are the heart of a radio set." In my opinion a better analogy would be, "Vacuum tubes are the digestive system of a radio receiver." High-frequency "food" is fed to them in a raw state and the vacuum tubes prepare it by mixing, by assimilation, and by selection, discarding the unwanted energy and feeding the loudspeaker the proper electrical materials for building up the "bones" and "muscles" of the audible program being received. But like the digestive system of many individuals, vacuum tubes are often neglected and allowed to become run down and worn out, so that many receiving sets are expected to function properly when in this condition—which they cannot possibly do. Again—to continue the analogy—the digestive systems of various living animals, with wide variations in diet, differ greatly. It takes a different kind of stomach to assimilate different kinds of food, and similarly vacuum tubes are designed for performing specific functions in assimilating various kinds of electrical foods and different kinds of tubes must be chosen for the specific use for which they are required.

* * *

To many laymen, a vacuum tube is just a vacuum tube, but to the well-informed technician vacuum tubes vary greatly in electrical characteristics suitable for the performance of many different tasks. It is therefore necessary that the designer and the experimenter be kept fully acquainted with the characteristics and functioning of the various types of vacuum tubes as they are developed and placed upon the market. It is also important that the characteristics of all known makes of tubes be kept available for the radio technician.

* * *

RADIO NEWS, therefore, is presenting serially a well-prepared group of articles dealing with the characteristics of old and new vacuum tubes, which should be extremely helpful, as a reference, to all radio men. The present instalment deals with the types of vacuum tubes generally used for power-output tubes in audio-frequency amplifiers. The first article of the series appeared on page 850 of the April, 1932, issue. It will be followed in further issues and will include data on tubes used for radio-frequency work, as oscillators, as detectors, and as generators of high-frequency electrical energy, as well as complete data on tubes to be used as rectifiers.

* * *

AUGMENTING this series will be occasional articles describing new tubes as soon as they are developed and placed on the market. We believe that no radio man can afford to be without this information as contained in every future issue.

* * *

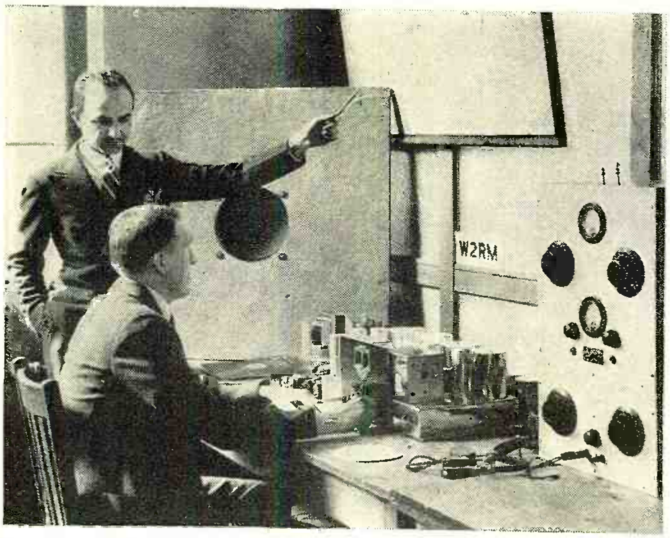
ONE of the newest uses of tubes lies in their application to the transmission and reception of ultra short-wave signals. The photograph on this page was taken in a corner of the RADIO NEWS Laboratory during experiments on a special Scott receiver for this short-wave work. In the next issue, which will be our Trade Show number, will be described some new data, as well as experiments our readers can make, in this field of rapidly growing importance. You will find this information in no other publication.

* * *

OUR Export Service department, the purpose of which is to contact American manufacturers, for our foreign trade in 76 countries outside of the United States, is now going full swing. It has already been of service to many thousands of dealers and importers in these countries in obtaining for them agencies and working agreements for handling American equipment. It has also been of service to thousands of private individuals who wish to obtain American radio sets and parts for their own use. There follows an excerpt from a representative letter in which a dealer in India states his appreciation of services rendered by this department:

* * *

"YOUR new Export Service department is the best feature I have seen in American radio magazines for many a long day. I am a wireless dealer in this town and often write to the United States for information on the trade that is seldom received, in consequence of which I have had, previously, small dealings with American radio concerns. The new department fills a much needed gap for overseas readers of your journal and I appreciate your good offices. Enclosed please find list of those manufacturers from which I require trade and price information." J. M. Johnstone, Moulmein, Burma, India.




OTHER letters of appreciation that come to the Editor's desk are as follows:

"THE first thing I turn to when I receive my RADIO NEWS each month is the Service Bench column. I have received many useful hints from your fine department and am sure many other radio servicemen have also found this column to be of great value. I consider this department as one of the most vital and important and never should it be discontinued." Roger H. Hertel, Clay Center, Nebraska.

* * *

"BY all means do not discontinue the Service Bench or With the Experimenters departments, as they are of great value to me." William Hojohn, Amsterdam, N. Y.

* * *

"I ENJOY reading RADIO NEWS and especially the department With the Experimenters." Walter Rhea, Salem, Arkansas.

* * *

"I COUNT RADIO NEWS as my best source of technical information in radio and public address matters." Homer J. Dana, Assistant Director, College of Mechanic Arts and Engineering, The State College of Washington, Pullman, Washington.

* * *

"IT gives me great pleasure to write this letter to you. I have been a constant reader of RADIO NEWS for over two years. It costs me 2/6, but it is worth 20/–. As you know, there are thousands of American receivers in operation here, and as to servicemen—well, you never hear of any here. Should the sets need attention, they have to be sent to workshops in Sydney. Gaining a fair knowledge of imported radio sets from your RADIO NEWS, I have been able to be of considerable service to owners of these receivers." N. Bladon, Newcastle, Australia.

* * *

"I AM getting my NEWS 'okay.' Am filing some and following the good instructions and knowledge therein. I think RADIO NEWS a full-value magazine for students who will study and follow its contents." J. H. Allison, Norfolk, Va.

* * *

THE EDITORS are always glad to hear from readers. Do not hesitate to write to us telling us what articles you would like to see run, or any criticisms that you may have in mind. Your letters are always welcome.

Laurence M. Cockaday

www.americanradiohistory.com

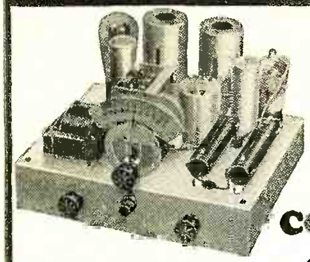
# only $37.50 11-TUBE Super-Het.!

Completely Assembled *with* Large Dynamic Speaker

**Pentode Variable-Mu and *Real Automatic Volume Control***

**30 DAYS FREE TRIAL**

## *New* 13-Tube and 15-Tube ALL WORLD-ALL WAVE COMBINATIONS!



## MIDWEST 4-TUBE SHORT-WAVE CONVERTER

**World-Wide Short-Wave Reception**

Converts any A.C. set of adequate sensitivity into a short-wave receiver for reception of police calls, airplane conversations, ships at sea, and, under favorable radio conditions, broadcasts from foreign stations.

This amazing new short-wave converter employs 4 tubes, self-powered. It uses one 280, one 224, and two 227 tubes. In combination with a 9-tube Super-Het, it gives you a 13-tube ALL-WORLD, ALL-WAVE combination. When used with the very latest model Midwest 11-tube super-heterodyne, shown above, it gives you a total of 15 powerful tubes, and ALL-WORLD, ALL-WAVE reception unbeatable even in receivers costing several times as much.

Don't confuse this 4-tube self-powered converter with cheap one- and two-tube converters that are not self-powered. The Midwest Converter actually gives better performance than many converters costing twice as much.

Now you may get SHORT-WAVE broadcasts—airplane calls—police signals—standard long-wave broadcasts—all with one combination set. Hear U. S. stations from coast to coast, and from Canada to Mexico. Hear the Canadian stations, Mexico, Cuba, South America, ships at sea, foreign stations! A Midwest 13-tube or 15-tube combination gives you ALL that's desirable in radio. These wonderful new combinations are sold at amazingly low direct-from-factory prices. When you receive our big new catalog and note the low prices, 30-day free trial offer, terms as low as $5.00 down, you'll be positively amazed. Mail the coupon right now—get the surprise of your life.

MIDWEST ALL WORLD ALL WAVE

## Deal Direct with Factory SAVE UP TO 50%

**TERMS** *as low as* **$5.00 DOWN**

Never have such powerful sets been offered at Midwest's amazing low prices. You save the middlemen's profits. Your outfit will reach you splendidly packed, rigidly tested, with everything in place ready to plug in. No assembling! Entertain yourself for 30 days absolutely FREE—then decide. And don't forget—every MIDWEST outfit is backed by an absolute guarantee of satisfaction. You take no risk. Mail the coupon now!

## Read This Letter!

This is but one of many letters received from delighted Midwest buyers:

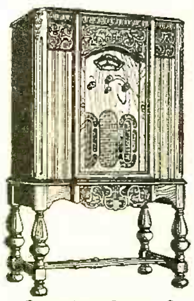
Winterpark, Fla., Mar. 2, 1932.

Midwest Radio Corp., Cincinnati, Ohio.

Gentlemen:

During the past week I logged the following: FYA, Pontoise, France; GBW, Rugby, England; HVJ, Vatican City, Italy; XDA, Mexico City; VK2ME, Sydney, Australia; VE9GW, Bowmanville, Canada; 12RO, Rome, Italy; G5SW, Chelmsford, England; CGA and VE9DR, Drummondville, Canada. Also picked up many amateur and airport stations from all over United States. Numerous ship, shore and transatlantic phones from both sides and an Hawaiian Test Station came in clear and sharp. Several Spanish and German-speaking stations have also been received but not yet identified. Have received every broadcast from FYA, morning and afternoon, for over a week with wonderful tone and volume. The Midwest Combination Set is certainly one to be proud of.

WM. S. TETER.



**Complete Line of Consoles**

The big FREE catalog beautifully illustrates the complete line of gorgeous Midwest Consoles. "Deluxe," Highboy and Lowboy models.

## MAIL FOR BIG FREE CATALOG AND LIBERAL TRIAL OFFER

**Midwest Radio Corp.**
**Dept. 69,**
**Cincinnati, Ohio**

( ) Send me SPECIAL USER AGENT'S PROPOSITION

Without obligation send me your new 1932 catalog and complete details of 13- and 15-tube All-World, All-Wave Combinations, 4-tube Converter, 9- and 11-tube Super-Heterodynes, low factory prices, easy terms and liberal 30-day free trial offer. This is NOT an order.

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

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

Town............................................

State...........................................

# MIDWEST RADIO CORP.

**Dept. 69** **(Est. 1920)** **CINCINNATI, O.**


www.americanradiohistory.com

## Advance Information on the Trade Show

*The June issue of* RADIO NEWS, *which will be on the newsstands just prior to the Chicago Radio Trade Show to be held this year in May, will contain advanced information on new radio developments to be displayed for the first time at the show. This issue of* RADIO NEWS *will also feature a series of articles by the leading radio authorities on future developments in radio. It will be packed with useful information to servicemen, dealers and the trade in general, on what is to be offered for next year's radio market. Detailed descriptions of new devices and apparatus in television, in public address systems, in electronic control of machinery, will be included.*

*All the latest news of technical development of new radio designs and new applications of radio principles, both in the radio field and associated fields, will be combined in this new and larger June issue. There will be editorial material of importance to every radio man, no matter what special line he may be interested in.*

*If you cannot attend the trade show, and we hope you can, you will find in* RADIO NEWS *for June a worthwhile substitute for a visit to this Chicago radio exposition. Be sure that you have your newsdealer reserve a copy of this outstanding issue of* RADIO NEWS *for you. Don't miss it!*

The Editors

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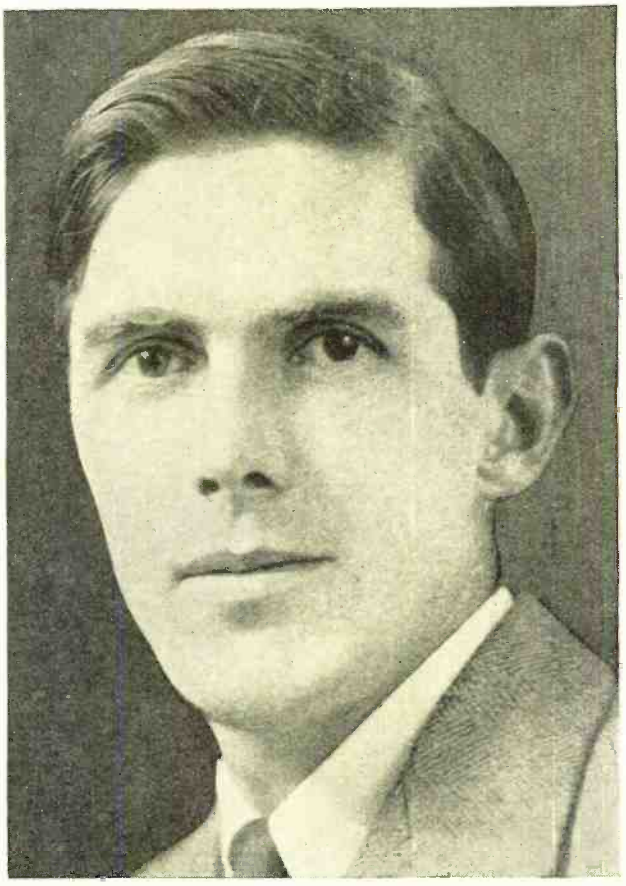


## Pioneering the Ultra-Short Waves

*The heyday of the radio-experimenter has not passed! Today, as never before, the demand for new and less congested channels has given a tremendous impetus to pioneer experimental work. Ten years ago, two hundred meters was considered a short wavelength, but now wavelengths down to ten meters are vitally important. Today attention is being directed to the ultra-short wavelengths below ten meters and progress of great importance is being made. In this fascinating field, where radio waves begin to assume the properties of light, where static is almost completely absent, and where skywaves and fading begin to disappear, entirely new phenomena have placed powerful tools in the hands of the engineer. And engineers have not been slow to use these tools.*

*I am told that in Berlin, where the "man-made static" caused by the use of direct-current power makes the usual channels unsatisfactory, routine broadcasting and re-broadcasting is now being carried on at seven meters with entire success. In New York City, the NBC broadcasts television and sound at wavelengths between four and six meters. In Hawaii, the Mutual Telephone Company, in collaboration with RCA, has already tied the land-wire facilities of the various islands into one great system, by means of numerous radio links operating in the vicinity of seven meters. Thus a new chapter in the history of electronics is being written.*

RADIO NEWS *has accepted the task of reporting this progress, and the swiftness with which its editors have recognized its importance, as demonstrated by the featured articles on the I. T. & T. Trans-English Channel communication with waves of but 18 cm. in length and the following series on ultra-short waves as well as their physical, optical and biological effects, is at once a great credit to them—and a challenge to the well-informed experimenter.*

James Millen

Vice-President,
National Company, Inc.

www.americanradiohistory.com

Ingenious Experimenters Originate Many New Radio Ideas

*Working in their home laboratories, these myriads of curious young men are continually bumping into new and important facts and phenomena that are so speedily adding to the knowledge of radio technique. Many of them work, throughout the daylight hours, in radio factories and laboratories, coming home in the evening to their attic or cellar laboratory to resume their experiments in their own way and following their own bent. Much of the original research, for the revolutionary ideas and developments now incorporated in modern receivers and transmitters, has been done in these home laboratories; final development being brought to a conclusion in the laboratories of the manufacturers*

www.americanradiohistory.com

Radio News

VOLUME XIII — May, 1932 — NUMBER 11

EXPERIMENTAL RESEARCH AND

# THE EXPERIMENTER

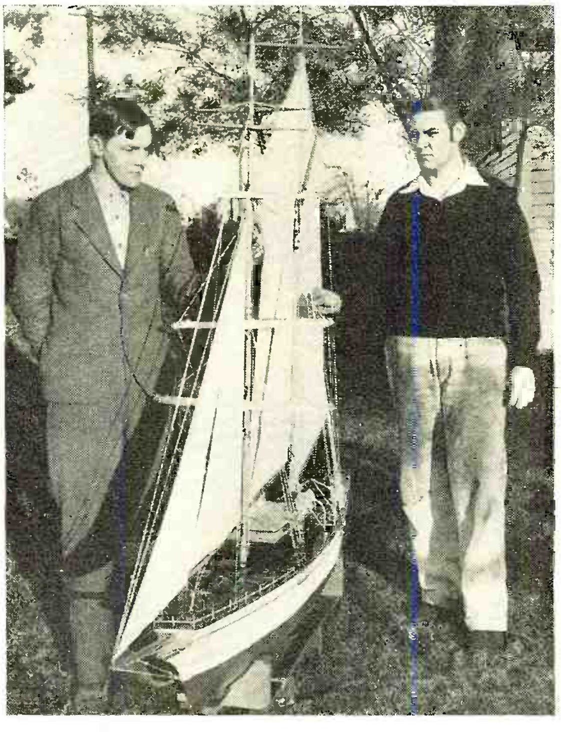
Radio research workers, both professional and layman—seeking after the physical truths of the radio science—have a field of experimentation and application not offered by any other branch of investigation. And the thought that anyone working along these lines may stumble on an absolutely new principle that would open up new realms of radio possibilities, stirs the imagination

By Laurence M. Cockaday

EXPERIMENTAL research is a scientific activity not without its lure and self-satisfying qualities to the man who is interested in new knowledge and the results and benefits obtained from the application of new knowledge. From the towering mentalities of the great researchers, the Faradays and Maxwells of past days to our Edisons, Marconis and Steinmetzes and down through all the ages of lowly experimenters, this urge has been apparent. From the prehistoric man, signalling by arm motions from a hilltop to a distant member of the tribe, to the modern experimenter signalling around the world on the short-waves, the prime urge of research has been to gain knowledge, to determine new truths of the physical world around us.

There are only three generally accepted ways for determining truth: the method of determining truth through *revelation,* the method of determining truth through *meditation,* and the third method of determining truth by *experimentation.*

The first method is that of the ancient Delhi priests and the religionists of all time. The truth as so determined is handed down to man through some mysterious revelation, as in the Delhi oracles, or by dreams sent through some divine agency. By the second method, which was evolved and practiced by the Greek philosophers, truth was believed to be evolved in the minds of thinkers by serious and long-continued meditation. The third method determines truth by making an experiment over and over again to see whether the the same thing happens repeatedly, without any important degree of variation.



REMOTE CONTROL EXPERIMENT

*Two members of a radio club who built and installed experimental radio controlled unit for sailing large model yacht (see story in this issue)*

This third method is the scientist's method for determining truth. It is the method of "try it and see." It is the only truth that science will accept. The chief tool of this method is the *experiment.* The scientists say: "Anything you can prove by experiment may be safely accepted as a truth. Anything that cannot be proven or disproven by experiment must be treated as *mere theory.*"

Theoroies are also useful to the research worker in radio, as in all fields of scientific endeavor. although they must not be relied on too fully. All the other tools the experimenter needs to furnish are "brains" and the "will to do"!

All of our present-day developments, the complete comfort and safety applications of our modern machine world, are based upon experiments and the substantiated theories of earlier research workers. In the radio field, observations have always been followed by theories, later substantiated or repudiated by experiment. Every modern radio experimenter, whether he is working in the completely equipped laboratories of world's largest research organizations or working with a bare minimum of scientific apparatus in his home laboratory, may share these fundamental tools of science.

The radio experimenter must be encouraged! Keeping him fully informed of latest developments in radio as well as offering educational technical data are the main duties of a radio publication. In this issue, which is dedicated to the experimenter, the department "With the Experimenters" has been especially featured.



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# With the Experimenters

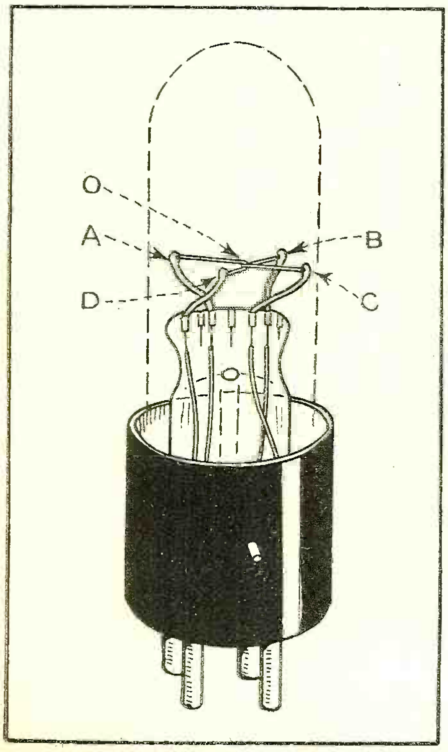
## *Home-made Thermocouples, A Handy Bench Lamp, Improving the Antenna, Safety Switch, Code Practice Key, Driving Iron Pipe Grounds, Pepping Up*

### *A Plug-in Thermocouple for R.F. Measurements*

IN the back of every thermoammeter common to the radio laboratory is a small device known as a thermocouple. It is the heart of the instrument, and without it the associated d.c. meter could not measure radio-frequency currents. The function and construction of the thermoammeter is simply this. A radio-frequency current flows through a short length of resistance wire, which in turn is heated as per the well-known formula:

$$P = RI^2$$

in which P is the small amount of power consumed by the instrument and displayed as heat; R is the resistance of the heater wire; and I the current flowing through the heater. At the center of the heater wire is soldered the couple (the hot junction) which is two pieces of dissimilar wires. The other two ends of the couple (the cold junction) are led to the two terminals of a milliameter. The phenomenon known as the Seeback effect is responsible for the current that actuates the milliameter.



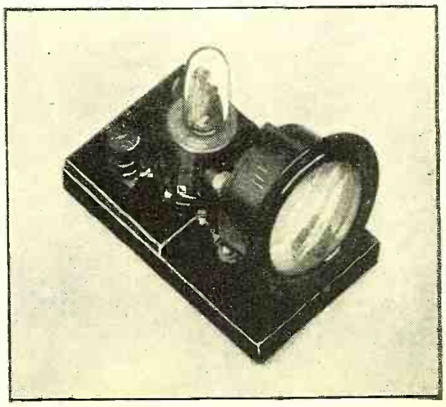

Most thermoammeters will stand but a ten per cent. overload, and for this reason a burnt-out thermoammeter is a most frequent nonentity on the shelf of the radio experimenter. Since it costs half the instrument's worth to have it repaired commercially, it often remains in its state of uselessness.

May we add to the already endless uses for burnt-out radio tubes one more. An ideal thermocouple can be built from the base, stem, and associated leads of a four-prong tube.

Remove the glass envelope of an –01a or other 4-prong tube, leaving the element support or stem solidly in the base, clip the support wires at the top of the stem. Remove the plate, grid, and filament leaving half an inch of the leads projecting above. Arrange the four leads, which should all be the same length, so that the upper ends form a half inch square. With some of the wire, usually nickel or nichrome, from the grid of the dismantled tube form a V by soldering to two adjacent points of the square, the point of the V being in the center of the before-mentioned square. A clean piece of copper wire from an old audio transformer about the same size as the grid wire forms another V, and the points of the two V's are hooked together. The copper V should be pulled tight and soldered to the two remaining points of the square, as shown in the drawing.

If the radio-frequency or altering current is run from one point diagonally across the square to the other point, a thermal d.c., e.m.f. of small magnitude will be observed at the other two corners of the square. The burnt-out thermoammeter may now be called to use again. Locate the two leads in the thermoammeter that connect to the hair springs and solder them to the two terminals of the back of the case. Now the tube base couple may be connected and radio-frequency or alternating currents measured. Five amperes, more or less, is a fair load for the one described above.

The new couple may now be calibrated against a standard and will remain constant indefinitely if handled carefully. By retrieving wires of various sizes from wire-wound resistors such as the Electrad a number of couples may be made which will cover the entire range of r.f. current used by the experimenter. The wire on these



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# in the Home Laboratory

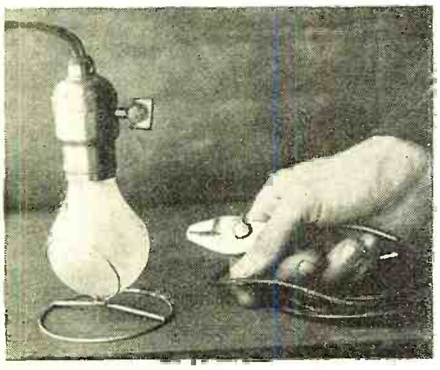
## *Simple Screen-Grid Connector, DX'ers Corner, Set Used as Set Tester, Cheap Transmitting Phonograph Pick-ups, Condenser Lubrication*

resistors is either nichrome, constantan, or advance. By calibrating against standards and with the old scale used arbitrarily, a graph may be plotted—current versus scale reading—for each couple. A plug-in thermocouple arrangement makes a very useful laboratory instrument. Copper against nickel, advance, nichrome, or constantan all give high thermoelectric powers, so the builder should not be without materials.

Do not try to calibrate any thermoammeter with direct current, as different readings for the same current will be obtained when the polarity is reversed. This is due to the fact that a perfect point contact between the heater and couple is generally impractical, and some of the calibrating current may get through to the milliammeter. However, any commercial-frequency alternating current is quite satisfactory for calibration purposes as well as radio-frequency current.

A final touch of refinement may be added to the couples by enclosing them in the bottom half of one-inch test tubes. The test tubes can easily be cut by taking one turn of No. 28 resistance wire around the tube and passing a current through the wire. The current should be sufficient to bring the wire in free air to a cherry heat. With the wire in position, a few seconds heating, and a very clean break will result. When the sharp edge is held in a gas flame, the end may be flared out with a piece of hard wood. After being set in plaster of paris colored black with common dye, the whole unit presents a commercial appearance. It will be found that the mouth of the shortened one-inch test tube fits the recess between the envelope and stem of the tube, and the plaster of paris holds so rigidly that the unit is found to be quite sturdy.

GEORGE A. ARGABRITE,
Los Angeles, Calif.



### *Handy Bench Lamp*

A light around the bench or job in a home is often a mean thing to handle and work with. The photo at the left shows a rather novel but quite practical little affair which is nothing but the snap and frame rings from an old decorative parlor light shade. You can set, hang or lay the light just where you want it, and it will stay there. The ring is an easy thing to carry in the kit. These shades can be procured new for the sum of ten cents. Cut the shade off and throw it away. Convenience in using the light is worth many times that amount.

FRANK W. BENTLEY, JR.
Missouri Valley, Iowa.

### *Simple Screen-Grid Connector*

George H. Nakao of Honolulu, Hawaii, suggests a simple screen-grid clip. He employs an ordinary Fahnstock clip—a clip off an old B or C battery will do—bent as shown in the drawing.

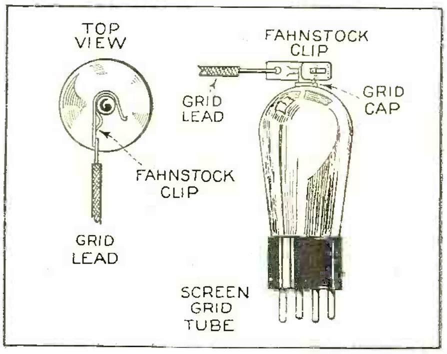
### *Photo-Electric Cell Applications*

Experimenters are evincing active interest in photo-electric cells and their practical applications. One application that offers extensive possibilities is found in using a photo-electric cell to operate a light switch to automatically turn on lights at sundown and turn them off again at sunrise.

Equipment of this nature can be readily constructed by following the circuit shown herewith.

The photo-electric cell, PE, is the Weston Model 594 Photoronic Cell, and works into a Weston Model 634 relay (R1). This relay is of the very sensitive type required to operate directly out of the cell. The relay, R2, is of the power type and is capable of breaking a one-ampere circuit, thus permitting the control of electric lamps totaling up to 100 watts in power (L). The switch, SW, may be an ordinary double pole, double throw knife switch.

With this equipment, wired as shown, the cell is placed in such a position as to be fully exposed to daylight, yet protected from the light of the lamp it is to control. While the day remains bright the coil of R1 is energized, holding the circuit open. But when dusk falls the cell becomes inactive, the coil of R1 is no longer energized, and the armature is released, allowing the circuit to close. This energizes the coil of R2, closing the a.c. circuit through the armature and causing the lamp to light. At the break of

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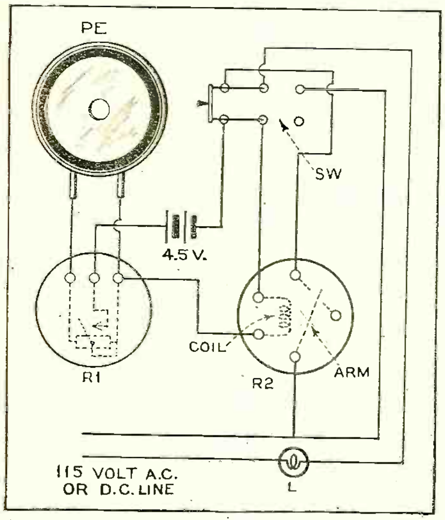
day the action is reversed, thus turning off the lamp. It it is desired to turn off the lamp manually at any time it is accomplished by simply opening switch SW. Or the lamp can be turned on by throwing this switch to the right.

When the system is first put into opera-




tion, the relay R1 is adjusted at dusk so that the arm just makes positive contact and the lamp lights.

Readers who are interested in experimenting with photo-electric equipment will find help in a 24-page booklet recently issued by the Weston Company in which are described ten different circuits and experiments, one of which is that described here. Any reader desiring a copy of this booklet may obtain same without charge by addressing a request to RADIO NEWS, Department W., 350 Hudson Street, New York City.

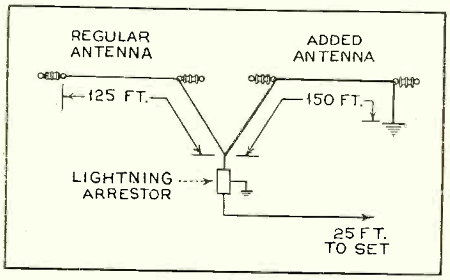
### *Improving the Antenna*

Referring to the static reducer in your Experimenters section in the December issue, by Charles Unterberg, Cristobal, Canal Zone, I wish to make the following suggestions and reports:

I have been using such an arrangement, in effect, for more than seven months, and have seen several such grounded antenna systems installed, all with good results. I have found, however, that such an arrangement works best in conjunction with the regular antenna. When so used it rounds out the signal strength in all sections of the dial.

With a grounded antenna alone (length 150 feet, lead-in 30 feet), I have found frequencies of 550 k.c. to about 900 k.c. favored at least 50% over those from 900 k.c. to 1500 k.c. In other words, the arrangement did not boast the signal in the 900 k.c. to 1500 k.c. range over that obtained with the regular antenna system, but did on the 550 k.c. to 900 k.c. range.

My regular antenna consists of a 125-foot wire with a 25-foot lead-in to the receiver. To this I added a grounded antenna 150 feet in length, connecting the latter to the lead-in from the regular antenna, as shown in the drawing. I have found the 150-foot length best for this added portion of the antenna system, although others may find




a longer or shorter wire more effective, depending largely on the length of the regular antenna to which the addition is being made. The height of the added portion above ground does not seem to be at all important so long as it is four feet or more. As a matter of convenience, mine is twelve feet high.

This scheme is well worth trying in any location because it boosts the signal to noise ratio to such an extent that ordinary noise doesn't mean a thing.

GEORGE E. CONNER,
Lewiston, Calif.

## DX'ers Corner

*MANY experimenters are DX fans—either chronic or occasional. There are a number of organized activities in this field in which such fans would be interested, but which unfortunately receive relatively little publicity, with the result that those who would be most interested are likely not to know of them at all.*

*"With the Experimenters" will therefore give more attention to this absorbing field by frequently including a "DX'ers Corner," in which will be given information on current activities in long-distance reception. It is felt that this activity on the part of* RADIO NEWS *will help to foster development work on highly sensitive receiver design and will therefore serve a real purpose in the forward march of radio, in addition to making an interesting hobby even more interesting.* —*The Editors.*

### *$5000 DX Contest*

Right now the world's greatest DX contest is running. This is the competition sponsored by the E. H. Scott Laboratories, Inc., manufacturers of the well-known Scott all-wave receiver, and limited to owners of this receiver. Prizes amounting to several hundred dollars are being offered for the best monthly logs for each of the months from January to June, inclusive, of this year. In addition, a number of prizes are being offered for the best record of reception for the entire six months. These prizes are topped by one of $2000 cash, or a trip around the world, with all expenses paid, and $500 thrown in for spending money.

This is a real competition. Logs submitted by competitors must include details of the programs heard and all reception must be confirmed. Reception is limited to that from foreign stations.

It so happens that the editor of this department is one of the judges and has had an opportunity of looking over the logs submitted covering January reception. These have been most impressive, some of the individual competitors having confirmed logs of programs from as many as 25 foreign countries during the month and some of them providing detailed records of 100 or more individual programs from these foreign stations.

DX fans who own Scott receivers will find it worth while to enter this competition. Whether they succeed in winning prizes or not, they are sure to obtain a great deal of fun from it. Other fans who do not own this particular make of receiver will find it interesting to read the reports of reception of some of the logs of the prize winners, which RADIO NEWS hopes to publish in forthcoming issues. These records will be something to shoot at.

### *International Short-Wave Club*

DX enthusiasts will find it worth while to affiliate themselves with one or more of the organizations which have developed in this field. Two or three of these have come to the attention of the writer, outstanding of which is probably the International Short-Wave Club of Klondyke, Ohio. Mr. Arthur J. Green, president of this club, has this to say:

"The club was organized October, 1929,

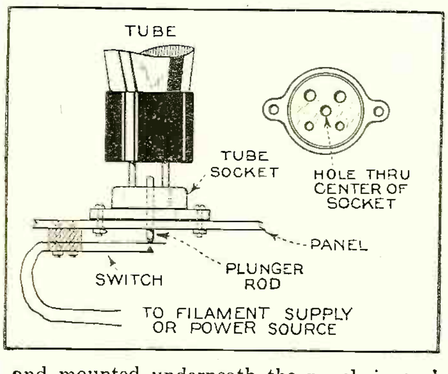
(*Continued on page* 959)

### *Safety Switch*

When building tube testers in which a switch must be turned off as soon as the tubes are tested or in the tube tester described in a recent issue of RADIO NEWS, damage to the milliammeter may result if the switch is not turned off as a battery is connected across the milliammeter. If the tube tester were to stay idle for a few days with the switch turned on a damaged milliammeter may result.

I have devised an automatic switch, as described here, which would prevent this happening.

A tube socket having a hole through its center is first procured. This is mounted in its permanent position on the panel or sub-base and a hole of the same size and directly under that in the socket is drilled through the panel. A switch consisting of two of the contact blades and the fibre spacers from an old jack is then assembled




and mounted underneath the panel, in such a position that the tip of the upper jack blade is directly under the hole in the socket and panel. The two jack blades should be spaced so that they are normally spaced slightly apart. Finally a short rod, slightly smaller in diameter than the hole, is slipped down through the hole in the socket until its lower end rests on the upper jack blade. Its length should be such that its upper end projects about 3/32 inch above the top of the tube socket. The entire assembly is shown in the drawing herewith.

When the tube is inserted in the socket it pushes down on the rod, causing the upper

(*Continued on page* 958)

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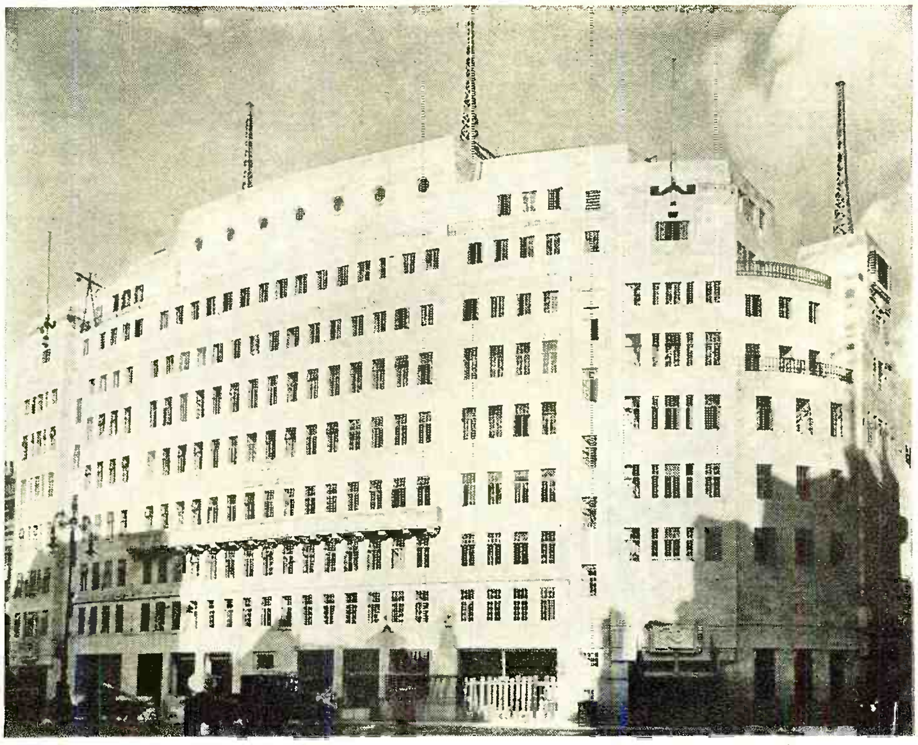

# London's Radio City

*Since the formation in 1923 of the British Broadcasting Company, a monopoly under government charge, little has been heard of broadcasting progress in the British Isle. The author, who has been making a complete survey of radio development in England for* RADIO NEWS, *brings back with him an interesting description of Britain's newest broadcasting project*

*By* Samuel Kaufman

OPERATING along the conservative lines of Government supervision, England has long been considered far behind other nations in matters of broadcasting. Early in 1932, however, the BBC, in one gigantic stride, launched an entirely new physical and technical set-up which raises England to a satisfactory par with other countries.

In London, the antique and makeshift studios of the BBC, at Savoy Hill, have been replaced entirely by a modern, expertly-designed studio structure known as Broadcasting House at Langham Street and Portland Place. The structure, ten stories high and of modernistic design, contains twenty-two studios from which originate most of the national programs for the entire British Isles as well as all of the London regional broadcasts.

### *Huge Control Room*

The new Broadcasting House is the just pride of millions of English listeners who view the project as the "Radio City" of the British Isles.

The twenty-two studios of Broadcasting House range in size from small chambers, for speakers, to huge auditoriums for concerts and vaudeville broadcasts. A single control-room is utilized for all studios. On this matter British and American radio men have always disagreed. The Britons claim that a single control-room is more efficient and economical than independent control-rooms for individual studios. Through their long experience at Savoy Hill, where a single control-room was also used, the British engineers claim that, through careful rehearsal and production methods, their programs go on the air in a more satisfactory manner. Inasmuch as the control operator does not watch the microphone performers through a glass window, as American operators do, there is no method of correcting such a fault as standing too near the microphone. The announcer, who is also production man, uses his judgment in the placement of singers and musicians and depends entirely on the control operators' reports of rehearsals for the direction of the actual broadcast.

SIR HARRY LAUDER

*He will make London's populace laugh louder and heartier over the new stations*

### *The Building Layout*

All of the studios in Broadcasting House are in the center of the building. Only offices, reception rooms and waiting rooms are on the outer rim of each floor. For this reason, all of the studios must be artificially lighted and ventilated. Better sound-proofing is claimed to have been effected by placing the studios on the center of each floor.

The concert hall on the main floor is the largest studio in the new development. In addition to the performers, the auditorium accommodates 550 persons on the main floor and 200 on the balcony. A vaudeville studio on the basement floor

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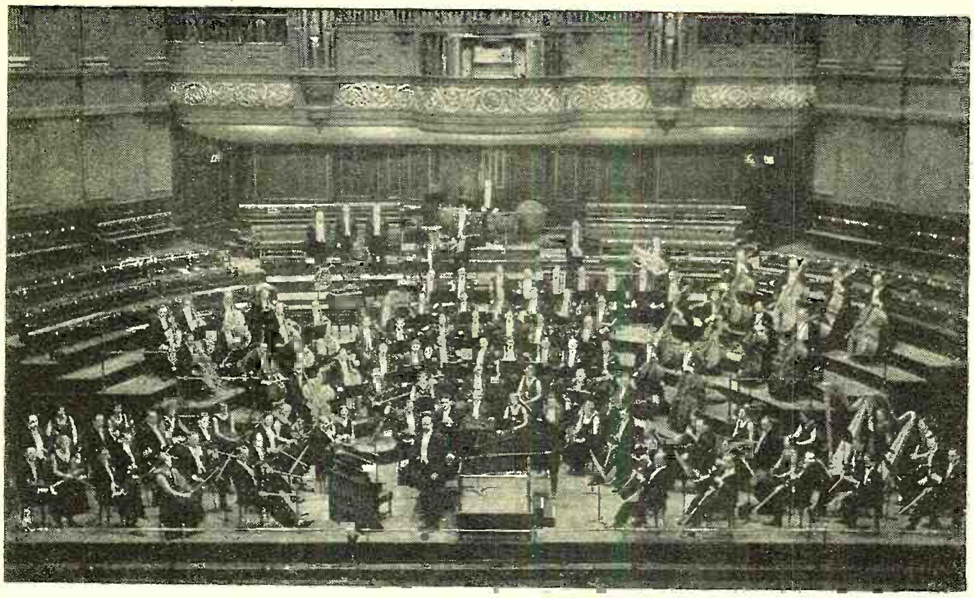


NEW SYMPHONY ORCHESTRA IN QUEEN'S HALL

*Broadcasting the works of the old and new composers will continue to take place in this hall over the new British stations designed to broadcast with great fidelity*

is also built along theatrical lines but accommodates only eighty persons. The religious program studio on the third floor is two stories in height and is decorated in an ecclesiastic manner. A musical comedy studio, also two stories in height, is on the sixth floor and a large military band studio is on the eighth floor.

Dramatic broadcasts have always been given much attention by BBC officials and an elaborate suite of studios has been reserved for this type of broadcast. Special rooms have been set aside for the furnishing of sound effects. Often, five or six studios are utilized for a single dramatic broadcast. The portions of programs coming from the various studios and the sound effects are all blended through a mixing panel in the centralized control room. All of these programs, of necessity, are carefully rehearsed over long periods before going on the air.

AFTER A CRYPTIC REMARK

*George Bernard Shaw in a moment of pause letting a particularly "biting" phrase find its mark in the minds of his listeners who are tuned in to the new station*

Modernistic design predominates throughout all of the studios. Powerful lights are used and a complete air-conditioning plant supplies all of the studios with washed, refrigerated air. In designing the new studios, experts found that special-sized studios for various types of broadcasts effect better acoustic results. This accounts for the long chain of odd-sized studios throughout the structure. Special chambers are reserved for talks, singers, dance orchestras and instrumentalists. Each one is designed for the particular type of program assigned to it. Composition, wall-board and felt and paper combinations are used for sound insulation.

### *Optimum Reverberation*

In the design of the Broadcasting House studios, the optimum reverberation time has been found to be a bit less for microphone pick-up than if the rooms were used for a present audience. The concert hall, which has a volume of 150,000 cubic feet, is to have a reverberation time of two seconds. The vaudeville studio, which is 30,000 cubic feet in volume, is of a 1.3 seconds period, while a small studio used for radio debates has a 0.6 second reverberation, corresponding to a volume of 2,300 cubic feet.

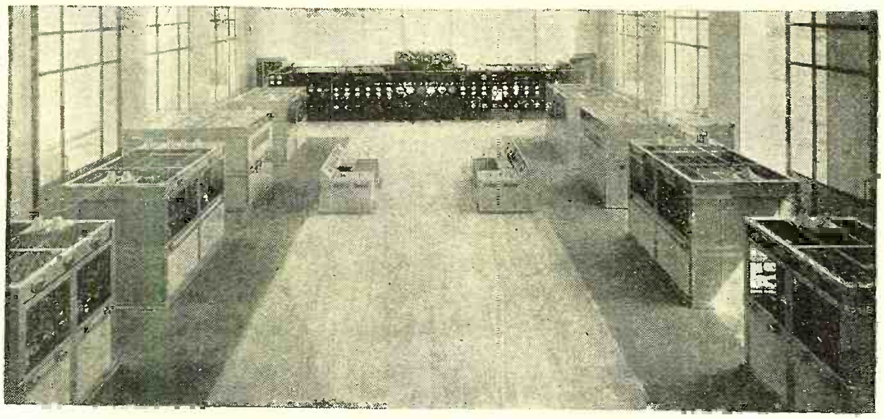
At the end of 1931, there were approximately 4,000,000 licensed listeners — that is there were 4,000,000 registered owners of receiving sets in England. Major L. F. Atkinson, a BBC director, told the writer that there are about five listeners to each set.

Each set owner must pay an annual license fee of ten shillings to the Post Office Department. These fees are in turn presented to the BBC for operation expenses. Inasmuch as there are no commercial programs in the British Isles, the licensing fees must be used to pay for broadcasting. An additional revenue is obtained by the three official publications, "Radio Times," "The Listener," and "World Radio." These papers are all weeklies, and aside from the revenue from the sale of copies, there is a substantial income from the advertisement columns.

Broadcasting in England, Scotland and Wales is maintained through ten transmitters in five zones. The territory is divided into five zones designated as London Regional, Midland Regional, West Regional, North Regional and Scottish Regional. The headquarters are respectively at London, Birmingham, Cardiff, Manchester and Edinburgh. The BBC also maintains a Northern Ireland outlet at Belfast. Each of the five zones has twin transmitters—one for a national or "network" program and the other for a local or "regional" program. In launching this system, early this year, the new transmitters were put into operation gradually and the entire system as a unit was scheduled to be in operation this month.

### *Control Seven Transmitters*

The control-room of Broadcasting House, in London, must serve for seven transmitters—the five National stations, the Daventry long-wave station, and the London Regional. Programs are presented from 10:15 a.m. to 10:45 p.m. daily, with occasional periods of silence between. An average of eighty-five to ninety hours of programs, weekly, go on the air over the



TRANSMITTER HALL AT BROOKMAN'S PARK

*At the rear can be seen the general power panels, while at the sides are the oscillator and modulator circuits, with the two control desks situated at center*

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National network. The Control room of the headquarters structure is one of the busiest parts of Broadcasting House. In addition to taking care of both the National and London Regional programs, the control apparatus must also serve numerous rehearsals and auditions throughout the day.

### *Arrangement of Apparatus*

The room has been divided into two sections, one for broadcasting, the other for rehearsals. There are six control positions in the transmission section and four positions in the rehearsal room. Speech amplifiers are set on two rows of racks running the entire length of the room. Each control position has a volume control device, a mixing panel, studio switches, studio signal light controls, and special keys with which to set up the desired circuits.

As the program is about to begin, the studio announcer presses a button which operates a buzzer in the control room and lights a green lamp on all of the control positions. The operator at the master control presses a button which dims the green lights and throws a switch which lights a red lamp in the studio as well as red lamps on each control position, indicating that the studio is on the air. The program control is in the hands of but one operator at a single time. The signals on the other control positions merely indicate which studios are on the air. The control men listen-in by means of headphones. Inasmuch as rehearsals and auditions often take place at the same time as a broadcast, the use of separate loudspeakers in the centralized control room is not considered practical. A public address system is wired through the offices and conference and reception rooms. Controls for this apparatus are also in the control room.

THE BOTANY LESSON—VIA RADIO

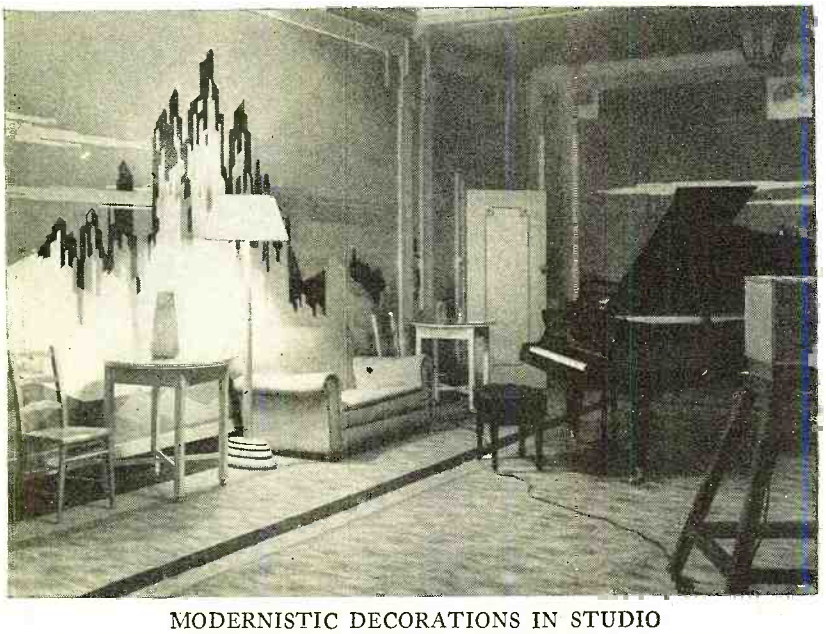
*View in one of the classrooms in the Wembley School as nature study texts are being broadcast over the British local station. The radio receiver is in front of the classroom, while the students examine plants regarding which the instructor is lecturing*

BBC engineers have recently adopted the decibel meter for control purposes. The scale reading of this device is proportional to the logarithm of voltage or power. The meter can be calibrated in decibels and have a linear scale. This will mean a more useful scale because a greater range of intensities is indicated. The instrument has been standardized for use throughout the BBC studio control rooms and transmitters throughout the nation are being equipped with them.

Very few recording, or electrical transcriptions, are used for broadcasting purposes. A complete recording plant is maintained for the purpose of recording rehearsals and certain broadcasts of historical importance where a permanent transcription will be valuable. In some instances, such important recorded programs, are rebroadcast at a later date.

The Brookman's Park transmitters were the first to be completed for the new British system. These transmitters serve the London area. The second twin transmitters were the North Regional. Work on the remaining twin transmitters was progressing at this writing, with the old transmitters in the remaining zones still functioning. All broadcasting is done on medium waves with the exception of the high-powered station 5XX at Daventry. The Daventry station utilizes the 1554-meter channel in order to reach districts on the British Isles not served by the other stations. All of the new transmitters were tentatively designed to operate on 50-kilowatts power, but some have been stepped-up to higher-power; Brookman's Park has been operating on 70-kilowatts.

According to plans, each of the new twin stations will approximately follow the design of the North Regional. Three vertical masts with T-shaped tops, each 500 feet high, are used at this point. Technically, these are somewhat similar in operation to the half-wave vertical antenna of WABC, at Wayne Township, New Jersey. Four Diesel engines supply power for the transmitters. A three-months' oil supply is stored in two huge tanks on the premises. A 200,000-gallon reservoir is on the grounds to supply water for the power plant and also to cool water to flow through the water-cooled transmitting tubes. Batteries for the speech-input equipment are housed on the first floor of the transmitter building where the battery control switchboard is located. In the event the private cable circuits, bringing programs to the transmitter from remote points, fail, the station is equipped with especially designed apparatus to relay the national program received from Daventry.



MODERNISTIC DECORATIONS IN STUDIO

*This is the Number Three studio at Savoy Hill. Notice the rather novel lighting arrangement obtained from the wall decorations, supposedly a night effect of tall buildings in great cities*

### *Checking Programs*

The transmitter is equipped with a special room for checking each program as it goes out. There is also a small studio at the transmitter for emergency or test purposes. The old local relay stations in this zone were closed when the new transmitters went on the air.

Just as the design of the North Regional stations followed the design of the Brookman's Park units, the remaining units were planned to be erected along identical lines, with the possibility (*Continued on page* 969)

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NEWEST APPARATUS FOR SLOW-MOTION STUDIES OF

# High-Speed Oscillations

***Although researches in the range of infra-radio frequencies may not at the present time seem to offer any new channels for transmission and reception, apparatus for producing electric currents of these frequencies do offer chances for visible and other physical examinations of the higher frequencies. This article deals with some interesting long-wave apparatus***

*By* Thomas Clifton

IN our endeavor to learn more about the radio sciences, we have investigated electromagnetic waves at the frequencies of the usual radio band. In addition, we went to the short waves and to the ultra-short waves, not longer than a few inches, which have been comprehensively discussed for the first time in RADIO NEWS.

### *Ultra Long Waves Not Explored*

The gap between quasi-optical waves and infra-red also has been bridged, thus giving us now a complete electromagnetic spectrum from radio waves to ultra-violet light and even to shorter wavelengths, higher frequencies which are known as X-rays, gamma rays of radioactive materials and even the shortest rays known today, the cosmic rays, which are now to be investigated further by a united campaign on problems relating to cosmic radiation. This work is to be directed by Arthur H. Compton, winner of the Nobel prize.

We are therefore familiar with the electromagnetic spectrum up to the highest frequencies. There are, however, electromagnetic waves, similar to radio waves, which have been almost unknown to the scientific and technical mind of today: these are the very long waves, the quasi-stationary frequencies of only a few cycles per second or even less than that. Very little research has been done in this field of super long waves.

One reason for this may be that no direct effect for the improvement of wireless communication is expected from investigations in the super long-wave range and scientific efforts have been conducted, most of the time, with an eye to the immediate practical application of the desired technical results.

We have seen the radio sciences extended over the limits of a narrow and highly specialized science and art, including in their technical development almost any phase of modern life—communication, biology, technics, medicine, optics, etc.

Today, most of the long-distance communication is done along the channel of short waves, in spite of the prophecies of a few theorists who twenty years ago said long-distance work was possible only with waves of a few miles in length.

It was practical experimentation, the empirical *try it out and see,* that in many instances uncovered the facts which supported a new method of doing things "which could not be done." Increased knowledge has presented better theories, given us more facts to work with in producing greater practical performance.

We have investigated the shorter wavelengths of electromagnetic radiation. But we have left almost untouched the longer waves. Why?

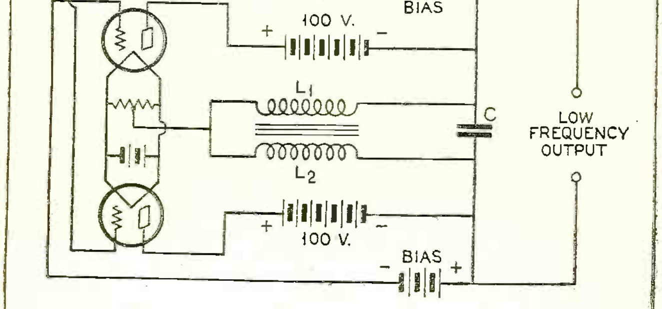
Of course, theory says we might not find the desired *direct* application for the communication field or open up a broad enough channel for a satisfactory number of new transmitters, so as to warrant the experimental expense. In addition, theory says the resonating ability of oscillating circuits at these long wavelengths is on a decreasing scale; the machines become bulky and much power is needed, etc., etc.

### *More Study of Long Waves Needed*

But is this really true? Are there no other facts which, added to our present state of knowledge, would make the field of super long waves a commercially profitable one in various branches? Of course, under our present state of development we must not expect immediate results and practical awards. What we need is more actual, clean, empirical knowledge of facts and then the future applications to the industrial and economic problems will take care of themselves.

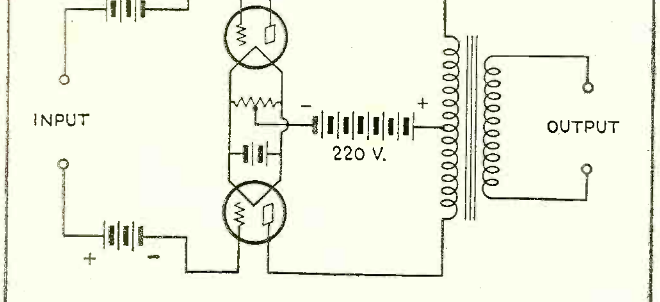
In the development of high-frequency equipment, electronic tubes and kindred equipment, we are continuously confronted with problems arising from effects which were not expected. More basic knowledge is needed about the action of electronic energy and matter, about the physical properties of electromagnetic oscillations so as to avoid erratic behavior in the manufacturing of industrial products designed for commercial purposes, and to improve the product and reduce manufacturing costs.

Excluding these undetermined factors, we will come a good deal nearer to a solution of these problems if we are able to follow these electrophysical actions—processes of high speed usually—in greater detail. The cathode-ray oscillograph gives a means for analyzing a part of these actions. But it is




INFRA-RADIO FREQUENCY GENERATOR

*Figure 1. This is a push-pull circuit for an oscillator generating frequencies as low as one cycle per second*




PUSH-PULL AMPLIFIER

*Figure 2. Amplifier to be attached to the output of the circuit shown in Figure 1 for strengthening the slow-speed impulses*

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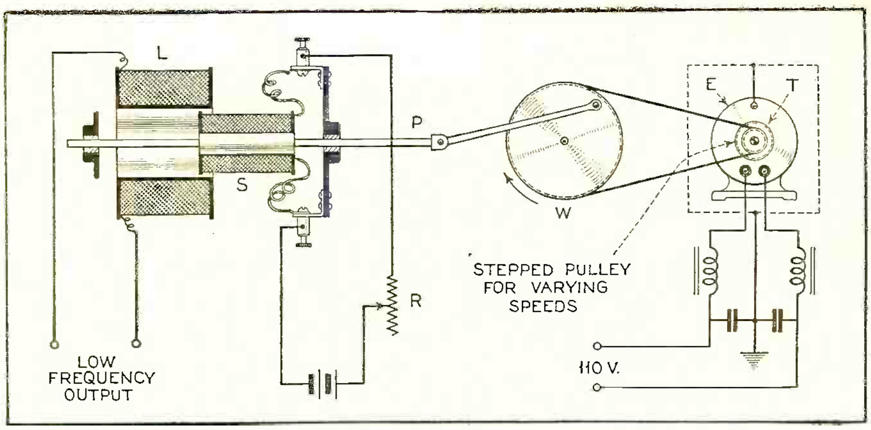
expensive, not foolproof, and difficult to handle, especially in connection with photographic recording.

There are two different methods of investigating the physical principles of high-speed wave phenomena. One is to increase the speed of the recording instrument to give it satisfactory characteristics for investigating the tremendously fast action under study. The other would be to slow down the wave action so that we could follow it with well-known and fully understood recording instruments and sensations. This latter is the line of procedure we will deal briefly with here.

The slowing down high-speed and high-frequency wave performance to bring it to the understanding of the average student, so that it can be investigated with inexpensive and foolproof apparatus, seems to be worthy of investigation. In various industrial processes we have learned a lot about action and performance by slow-motion pictures and slow-motion methods. In the radio and high-frequency sciences a slow-motion process would be especially promising for the investigation of high-frequency circuits and other electronic equipment and for the demonstration of the principles of radio physics in lectures.




MACHINE GENERATOR FOR INFRA-LONG WAVES

*Figure 3. This is the Saxl machine which, driven by an electric motor, develops very slow frequency oscillations as low as one cycle in a number of seconds. It furnishes sufficient power for visual and electrical observations in the laboratory*

With a simple apparatus, constructed by Dr. Frederic Moeller, it is now possible to produce very slow electromagnetic oscillations with—naturally—an extremely long wavelength. Frequencies as low as one cycle per second have been produced with this apparatus, giving an excellent means for radio investigation.

By using this super long-wave generator, as an input, it is possible to follow up, directly, with simple and fully understood instruments found in almost any laboratory, the intricate action of high-frequency phenomena.

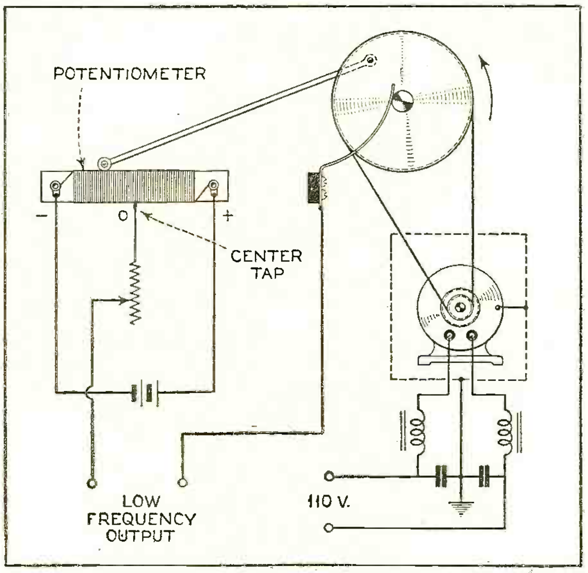
One early disadvantage in the creation of very-long electromagnetic waves was the bulky and expensive equipment that had to be used. Dr. Moeller has produced a tube generator for these wavelengths which has a power output of a number of watts.

Figure 1 shows a wiring diagram of this tube generator. No grid resistances or capacities in the grid circuit are employed. The inductance coils L1 and L2 are wound around a large iron core and consist of 6000 turns each. They have a direct-current resistance of 1800 ohms and an inductance, if put in series, of about 800 henries. The iron cross-section is about two inches square.

### *Two Seconds Needed for One Oscillation*

If the capacity C is 40 microfarads the time of one oscillation is 1.5 seconds. By reducing the current and the voltage further, the time factor could be made as high as two seconds, with this equipment. Naturally, the energy of the generator itself is extremely low. By introducing, however, sufficient amplification, up to 5 or 10 watts of energy can be secured. Figure 2 shows such an amplifier. It is wired in push-pull fashion, each grid being biased separately and receiving its voltage impression from opposite parts of the generator output condenser. At a frequency of one cycle per second the generator delivers about 70 volts at the terminals of the generator coil, giving an effective voltage of about 50 volts.

As the amplifier is wired in push-pull, each grid is impressed with an alternating voltage of about 25 volts, which is satisfactory for the purpose of controlling the action of the low-mu amplifier tubes.




ANOTHER MACHINE GENERATOR

*Figure 4. Here is an alternative mechanical generator system driven by a motor. A small rotor passes over the windings of a potentiometer to develop a sign-wave current*

For producing still lower frequencies with a direct output of satisfactory energy, Dr. Irving J. Saxl has designed an extremely simple mechano-electrical apparatus which, without the aid of tubes, gives plenty of energy, directly, at frequencies as low as one oscillation in three seconds. This apparatus has the additional advantage of delivering a current which is practically sinusoidal. With this type of infra-slow-frequency generator it is possible to change the frequencies to be experimented with readily. Almost any slow-motion effect of the oscillations can be produced and these are dirctly visible in their phase characteristics.

Figure 3 shows one form of this machine generator. A motor, E, drives a transmission, T. The motor is fully shielded against radiation so that no harmonics can be superimposed on the actual machine. The wheel, W, the speed of which can be easily regulated from the transmission, T, moves a piston, P, upon which is wound a solenoid, S. This coil is connected through a resistance, R, to a voltage supply, B. By regulating the resistance, R, a controlled current can be sent through the windings of the solenoid, thus making possible variations in its field intensity. Driven by the piston, this solenoid dips into the inductance coil, L, and produces in it an alternating current, the frequency of which depends upon the speed of the piston.

### *Frequency Control*

The current induced in the coil, L, will have its frequency controlled easily by changing ratio of the transmission, T. The current amplitude can be controlled by the amount of current sent through the solenoid, S, from the battery, B, thus giving simple means to the experimenter for working under varied conditions.

Another method for producing slow, alternating currents of sufficient energy by means of simple mechano-electric machines is shown in Figure 4. This second machine has a contact which is driven mechanically at different speeds and moves periodically over a potentiometer wire, thus producing harmoniously increasing and decreasing currents in an electrical circuit. Intensive currents can be produced with this device without additional amplification. Thus all the experiments with slow- (*Contoinued on page 957*)

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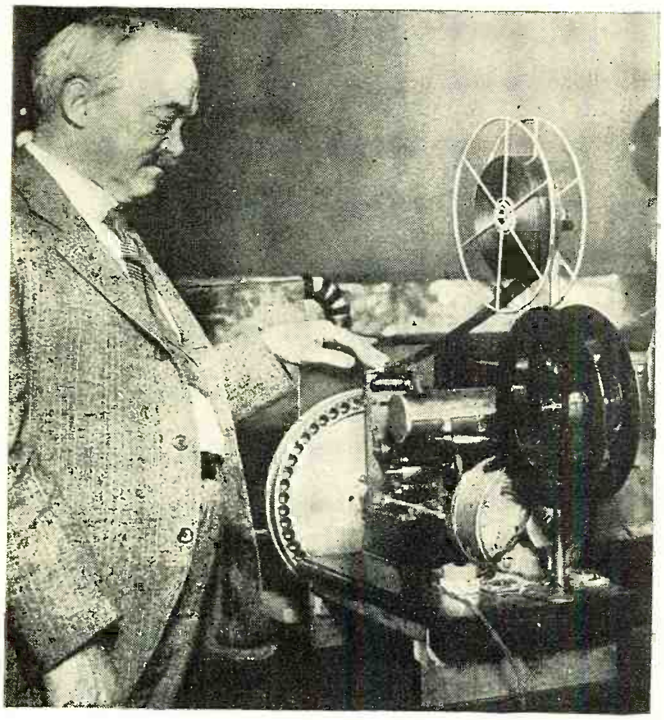
# Lens Design for

*Television technique has progressed for the experimenter to know as applied to scanning and article, gives the simple formulas for and types of lenses*



JENKINS LENS SCANNER

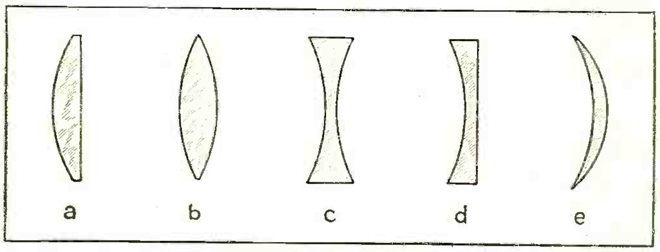
*Here is one of the first lens-scanning discs as used by C. Francis Jenkins in a machine for broadcasting radio moving pictures*

**By Ralph**

AS radio communication called for a great amount of investigation in the field of sound and acoustics, so television is calling attention to many optical problems. Fortunately, the optical laws are better known than most of the acoustical laws, and both physical and geometrical optical relations are well covered in literature. The particular problem that confronts the experimenter, in constructing the most modern projection systems of television reception, is the selection of suitable lenses for the scanning disc, or in adapting the equipment to use lenses that are available but whose properties may not be known.

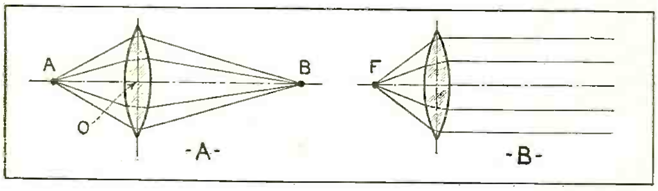
Unless extensive polishing and checking processes have been used in the grinding process the lenses may all have certain variations which will have important bearings on the results when used in television. This article will review some of the optical laws and will give their applications to the particular problems involved in scanning.

A simple description of a general-purpose lens is furnished by three items: the diameter, the type of lens (plano-convex, etc., as illustrated in Figure 1), and the focal length. In the case of special lenses, where the grinding does not follow simple spherical surfaces, a more complete description is necessary, but, fortunately, television scanning does not require their use. The plano-convex and the double-convex shapes are best fitted for the particular requirements of scanning. Inasmuch as either type can be designed to have the same focal lengths,




TYPES OF LENSES

*Figure 1. A is a plano-convex lens, B a double-convex, C a double-concave, D a plano-concave and E a meniscus*




FOCUSING LENSES

*Figure 2. At A is a lens that focus points at A and B. At B is a lens with a focus point at F and another one at infinity*

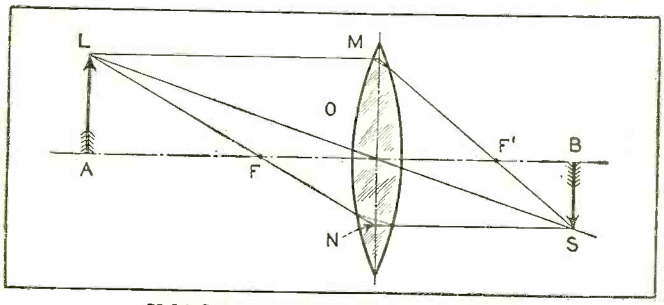
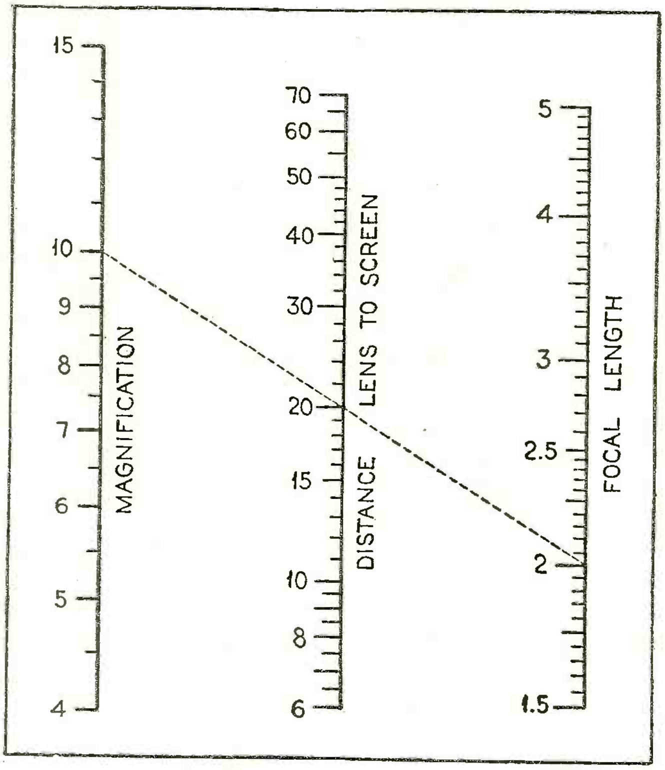



IMAGE PROJECTED BY A LENS

*Figure 3. This diagram shows a graphical location of any image projected through a single lens system*




MAGNIFICATION CHART

*Figure 7. This chart shows the inter-relation between magnifying power of a lens together with distance from lens to screen and focal length*

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# Scanning Discs

***now to the stage where it is important something about the optical methods reproduction. The author, in this lens working including both the length that are applicable***

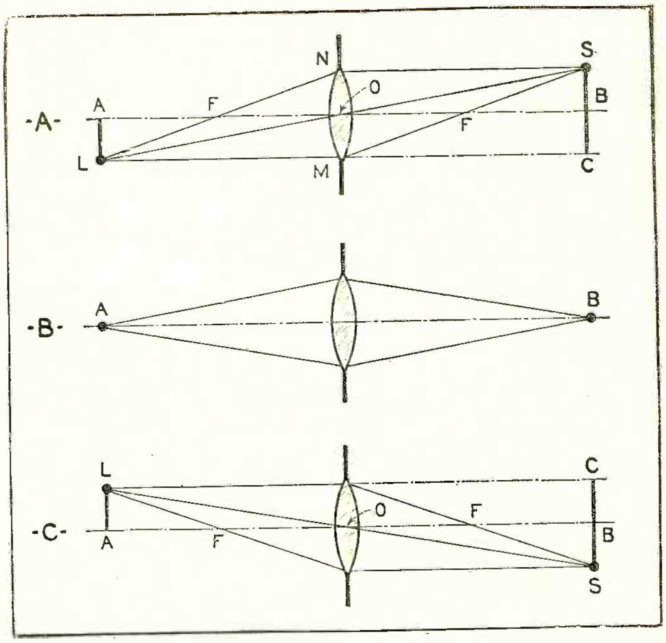
R. Batcher

the following analysis can be used for either type.

A lens operates on the principle that a ray of light changes direction when changing from one medium, such as air, to a denser medium such as glass and vice-versa. In Figure 2, a bundle of light rays originating at some point A on the axis of the lens are refocused at a point B on the other side of the lens. It may be shown that the physical distances AO and BO are related by the following equation:

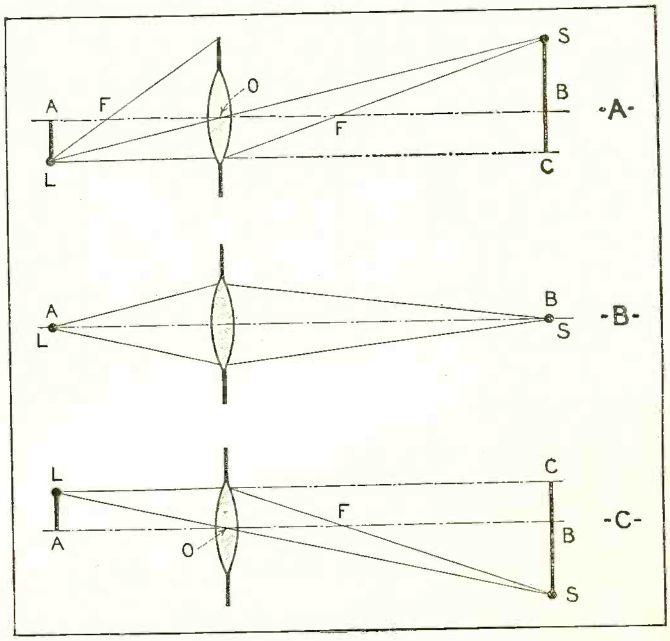
$$\frac{1}{AO} + \frac{1}{BO} = \left(\frac{D'}{D}\right) - 1\left(\frac{1}{r_1}\right) + \left(\frac{1}{r_2}\right) = \frac{1}{F} \qquad (1)$$

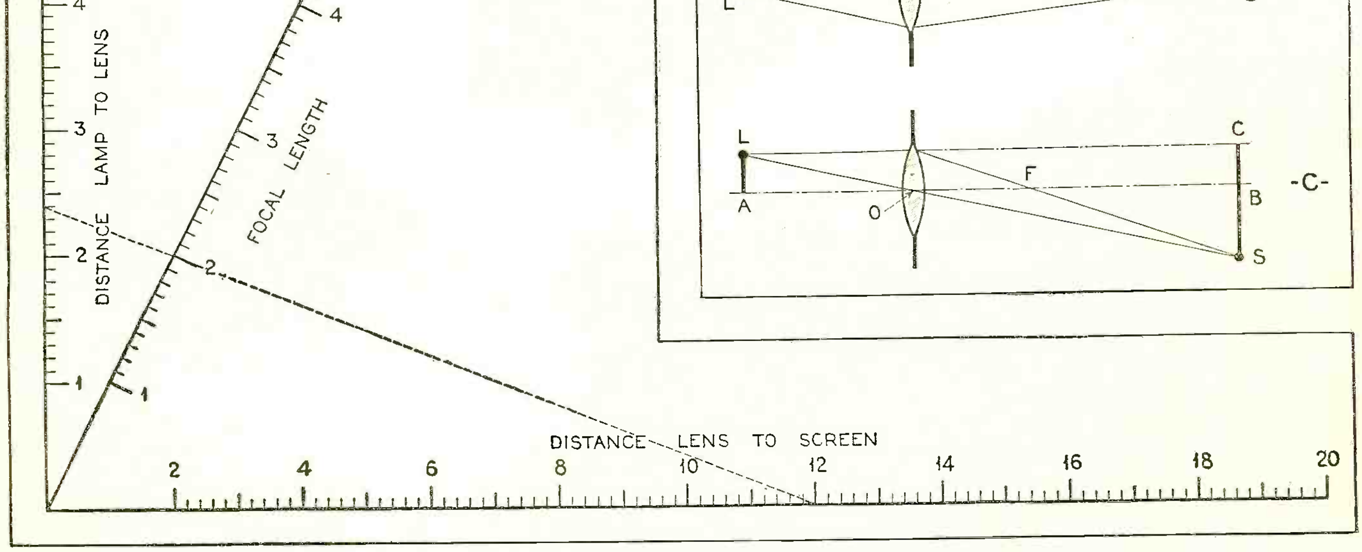
where $\left(\frac{D'}{D}\right)$ is the relative optical density of the glass with respect to that of air, and $r_1$ and $r_2$ are the radii of the curved surfaces. Since all these factors $\left(\frac{D'}{D}\right)$, $r_1$ and $r_2$ are constants for a given lens, they are usually combined into one constant $\left(\frac{1}{F}\right)$, where F is called the focal length. It is impossible to determine the focal length of a lens from measurements alone, without knowing the optical density of the glass (which is known technically as the *index of refraction*). The value of this item averages between 1.5 and 1.6 but may run up to values a little under 2 for certain dense types of flint glass. It is, of course, possible to determine, (*Continued on page* 961)




PROBLEMS IN TELEVISION PROJECTION

*Figure 5. Above shows three focus points in the diagrams A, B and C and how a lens system accomplishes this. Below, Figure 6, is shown three other diagrams at A, B and C in which the focal length has been considerably reduced*




A CHART THAT SOLVES OPTICAL PROBLEMS

*Figure 4. This is the focusing chart for finding the distance from lens to lens and the distance from lens to screen or lenses of varying focal lengths between one and five inches*

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# HOW A GROUP OF AMBITIOUS RADIO-CONTROLLED

"HARD APORT"

*David Bammes spelling out the dashes on the transmitter key that steers the "Alita." The power for the transmitter is obtained from dry cells within the case*

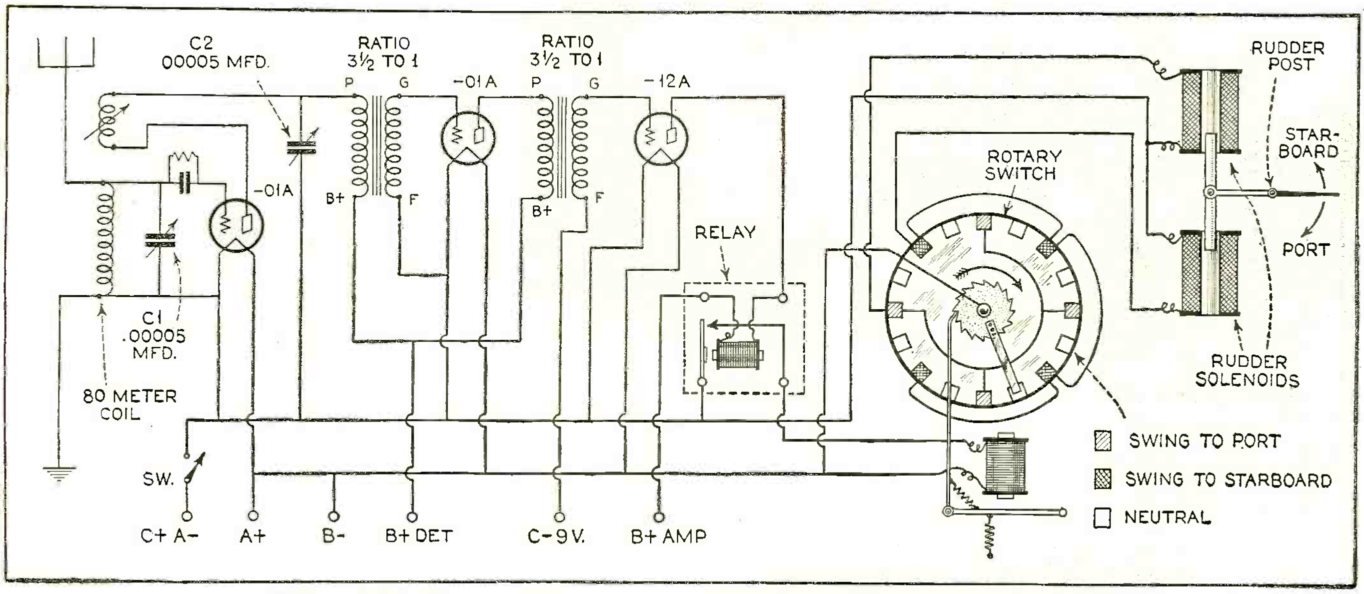
***Remote control radio apparatus was a boys' club at Pomona and installed structed by members. The model can lake and answers each turn of the helm key of the transmitter with***

*By* Andrew

WITH a low-power transmitter, using a Colpitt circuit, slightly modified from a description in the May, 1931, issue of Radio News, and a receiver embodying a ratchet relay-switch for controlling the rudder, a group of boys at Pomona, California, spend their spare time guiding a seven-foot sailing vessel around a nearby lake. These club members are able to sail the boat out from the shore, put it through maneuvers and sail it back to the starting "port" as if it were manned by a full crew. When being put through its paces, it is quite a beautiful and "uncanny" sight to watch.

### *The Receiver and Transmitter*

The receiving set is of the regenerative type used by "hams" throughout the country for short-wave reception, with a carefully balanced relay across the output in place of the regulation ear 'phones. A 112-A type tube is used as the power tube. The transmitter works on a B voltage of 135 volts and a standard 6-volt A battery. The transmitter operates on 80 meters. The range is about one-quarter of a mile. A regulation telegraph key is used to break the circuit. For code messages, the transmitter will carry about 25 miles, although sufficient power for operating the boat can be transmitted only about one-hundredth that distance. The ratchet relay-switch replaces the customary 'phones or loudspeaker on the receiver and this throws the rudder from neutral to right-or-left or from either of these two extremes to neutral. Dashes are used entirely, with one impulse for every move. Thus, one dash moves the rudder from left to neutral, but to change the rudder from neutral to left three dashes would be required,




THE COMPLETE RECEIVER AND REMOTE CONTROL RELAY PARTS

*Figure 2. This is the schematic wiring diagram for the regenerative receiver for 80-meter reception using two stages of audio-frequency amplification. The power tube, which is a type -12, works into a relay that controls a solenoid-operated rotary switch that in turn energizes the rudder solenoids. The rotary switch controls the port, starboard and neutral positions of the rudder*

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# EXPERIMENTERS BUILT A

# SAILING "YACHT"

*designed and built by the members of on a model sailing yacht, also con- be put through maneuvers on a small as the operator on shore presses the the proper radio signal*

**R. Boone**

sending it (theoretically) right, neutral and then left. The relays work so rapidly, from the radio impulses, however, that the rudder does not actually move from neutral to right before swinging left.

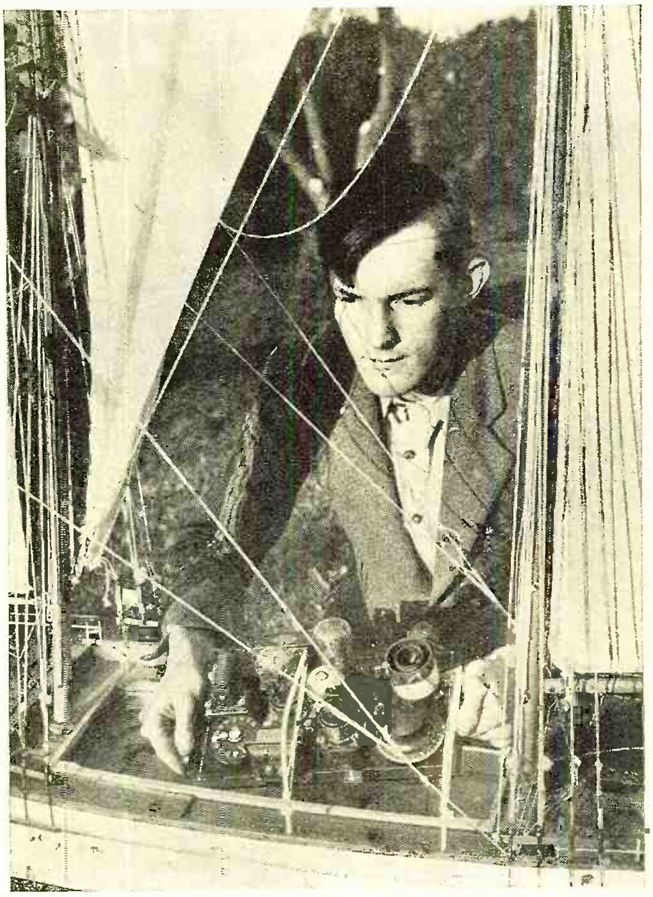
The receiver is a modification of the "Junk Box" receiver, described in RADIO NEWS some time ago, with one more stage of audio amplification. It also was built by the members of the radio division of the Pomona Model Yacht Club. (Blueprints of the "Junk Box" receiver can be obtained by sending 25 cents to RADIO NEWS.)

As explained by Herman R. Howard, instructor in automotive mechanics at the Pomona High School and Junior College, and organizer of the model yacht club, the boys use, for the receiver tubes, one 112 type and two 201 type tubes, with a B voltage of 90, a C voltage of 22 volts (or less) and an A voltage of 6 volts. Approximately 18 feet of wire is used in the aerial and it may be found best to use a small condenser in this circuit. The total weight of the receiver is about 40 pounds, with batteries and equipment, all of which are set down within the ship. A ground is made by connecting to the keel of the boat.

### *Rotary Switch Controls Rudder*

Much care should be taken in the balance of the relay on the output side of the set. A relay of about 1000 ohms resistance is employed. A home-made magnetically operated rotary switch, automatic in action and wired so that the contacts are separated by a neutral point, is also employed. This is connected direct to the solenoids of the rudder, as shown in Figure 2.

Both transmitter and receiver were (*Continued on page* 968)

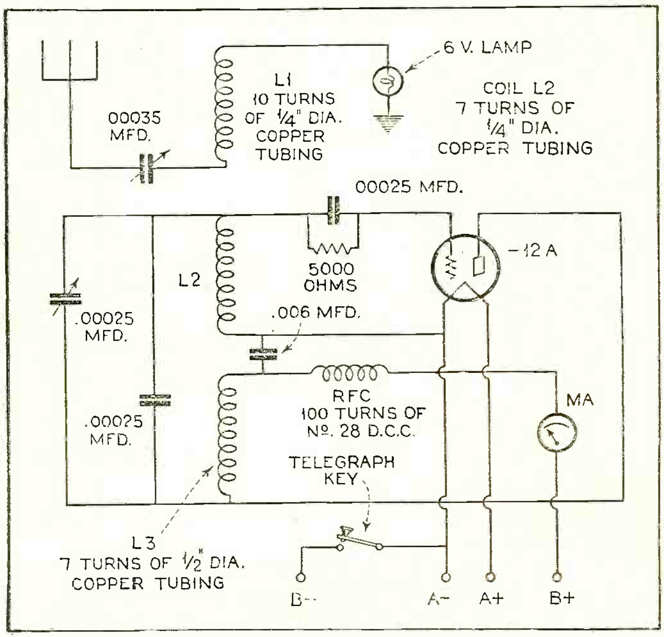


"RADIO, AHOY"

*Placing the remote control receiver equipment in the hold of the model yacht. The cabin deck is removable and serves as a weather shield for the apparatus*

EMBRYO REMOTE CONTROL ENGINEERS

*Homer Howard at key of a portable transmitter and David Bammes with the finished transmitter in the laboratory room of the Pomona Model Yacht Club*




TRANSMITTER FOR THE "ALITA"

*Figure 1. This diagram gives the complete circuit wiring data, as well as the constants for the various condensers, coils and resistors used in the hook-up*

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# What Tube Shall I Use?

*This month additional data is given on the selection of the proper tubes to meet any power output stage requirements and includes an original tabulation of tube data which deserves a prominent place in any service shop or laboratory*

*By* Joseph Calcaterra

*Part Two*

BEFORE attempting to decide on the type of speaker and tubes required, it is important to bear in mind the limitations imposed by the conditions which must be met by the receiver or amplifier. These limitations are imposed by the type of power supply that is available and the amount of money which is available for the construction of a suitable power supply unit. High filament and plate voltages and current drains come high in cost because of the expense of rectifiers, transformers and chokes to provide and handle such voltages and currents. In this respect the problem is similar to that confronting a car buyer.

In buying a car, performance of cars cannot be considered until after the amount of money that is available has been decided. It is obviously a waste of time to consider the performance features of Lincolns, Cadillacs and Packards when a thousand dollars is all that is available for the purchase of a car. The search for quality and appearance must be limited to cars that are in the thousand-dollar class.

In certain cases, a compromise must be made between the results we would like to attain and the limitations imposed by the necessity for keeping the cost down to given limits.

Contrary to general opinion, it is unnecessary to use the tube having the greatest power output to obtain best results. In many cases, a tube of lower power output will give equally good reproduction at lower cost for tubes and associated equipment.

In Table III, the available power tubes and combinations of tubes have been arranged in the order of undistorted power output, together with the additional data which is required to make an intelligent determination of the tube or combination of tubes best suited to accomplish a given purpose, that is, to furnish the required undistorted power to drive one or more speakers under different conditions of operation.

### *Choosing Your Tubes*

It might be well to discuss here the features or characteristics of an ideal power tube so that we may have some goal to shoot at or a yardstick by means of which we can measure the relative merits of various types of power tubes.

In determining the relative merits or suitability of power tubes for a given purpose, the factors which should be considered are:

1. Undistorted power output characteristics.
2. Signal input voltage required to obtain maximum undistorted power output.
3. The filament, plate and grid voltage and current requirements of the tubes.
4. Efficiency of circuits and adaptability of tubes to such circuits.
5. A.c. plate resistance characteristics of the tubes and load characteristics required to obtain maximum undistorted power output.
6. Cost of tubes.

The first requirement of any power tube or combination of power tubes in the last or power audio stage is that it have sufficient undistorted power output to meet the demands of the conditions under which it is to be used. The amount of undistorted output required is determined largely by the size of the room, auditorium or character of the place in which the speaker and amplifier are to be used and by the power requirements of the speaker or speakers to be employed. The required output should be sufficient to eliminate any possibility of overloading or distortion. Ability to produce tremendous volume is not sufficient, the volume must be produced without distortion.

The better the design of the audio stages preceding the power amplifier, from the standpoint of passing low frequencies, the more important it is to employ a power stage capable of providing sufficient power output, and a high enough grid bias to handle the peak signal voltages applied to the input of the power tube.

This calls for careful design and matching of the power tube stage with preceding audio amplifier stages and for suitable controls to eliminate overloading of the amplifier stage.

### *Input Voltage Important*

The power output rating of a tube is generally accepted as the maximum power which can be supplied to a load without introducing more than 5 percent second harmonic distortion due to the curvature of the tube's plate current-grid voltage characteristic. It is important to remember that the rated power output of an amplifier tube is no guarantee that it will supply that power to the loudspeaker. Unless the stages of amplification preceding the power stage are designed to impress a high enough signal voltage on the input of the power tube, the maximum power output of the tube will not be realized. The power output of a tube is proportional to the square of the input voltage, thus a tube such as the -50 type designed to provide an undistorted output of approximately 4600 milliwatts (4.6 watts), with a signal voltage of 58.8 r.m.s. when operated at a plate voltage of 450 and grid bias of 84 volts, would provide an output of only 1150 milliwatts if the grid signal voltage available were only 29.4 volts r.m.s. Under such conditions practically the same results could be obtained at lower cost by using a -45 tube with 250 volts on the plate and a grid bias of 50 volts.

The second important characteristic for maximum tube economy is that the output should be produced with as low a signal input as possible. The lower the signal input required by a power stage, the lower the cost of the equipment, since fewer and less costly stages are needed to build up the signal from the output of the detector to the input of the power stage. A lower signal input requirement may eliminate the need for a preceding audio stage, or may also make possible the design of a detector with lower output and consequent improvement in the tone quality by eliminating the possibility of detector overloading.

In the absence of exact figures on the maximum r.m.s. voltage or peak voltages which can be applied to the various tubes to produce maximum undistorted output, the grid bias voltage figures can be taken as fairly accurate indices of the peak signal voltage inputs required for the various tubes to produce maximum undistorted power output.

### *Supply Voltage Requirements*

The third important and desirable characteristic is that the total voltages (filament, plate and grid bias) and the total current requirements (filament, plate and screen grid) be as low as possible, consistent with satisfactory output characteristics, so as to keep the cost and bulk of the power supply equipment down to a minimum and keep operating costs low.

Where the plate and grid voltage supply source is limited, this limitation must, of course, be taken into account in selecting the proper tube to use in the output. A -47 tube, for instance, requires a plate voltage of 250 volts and a grid bias of 16.5 volts (total 266.5 volts and current drain of 39.5 ma.) to provide a maximum undistorted power output of 2500 milliwatts. A -45 tube, on the other hand, provides an undistorted power output of only 2000 milliwatts with a plate voltage of 275 volts and a grid bias of 56 volts, a total voltage required of 331 volts, as against the 266.5 volts

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## TABLE III
### POWER TUBES AND COMBINATIONS ARRANGED IN ORDER OF UNDISTORTED POWER OUTPUT FOR EACH CLASS

| | UNDISTORTED POWER OUTPUT, MILLIWATTS | TYPE OF TUBE | NUMBER OF TUBES USED | CIRCUIT USED IN POWER STAGE | PEAK SIGNAL VOLTAGE FOR MAX. OUTPUT | NEG. GRID BIAS, VOLTS | TOTAL PLATE AND GRID BIAS VOLTAGE REQ'D | PLATE VOLTAGE | PLATE AND SCREEN GRID CURRENT MA. | FILAMENT OR HEATER TOTAL | | A.C. PLATE RESIST., OHMS | RECOMMENDED LOAD RESIST., OHMS | LIST PRICE OF TUBES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | VOLTS | AMPS. | | | |
| | **GROUP 1: A.C. TUBES; "A", "B" AND "C" SUPPLY FROM A.C. LIGHTING LINES** | | | | | | | | | | | | | |
| 1 | 11,500 | -50 | 2 | PUSH-PULL | 168 | 84 | 534 | 450 | 110 | 7.5 | 2.5 | | | $12.00 |
| 2 | 9200 | -50 | 2 | PARALLEL | 84 | 84 | 534 | 450 | 110 | 7.5 | 2.5 | 900 | 2175 | 12.00 |
| 3 | 8500 | -50 | 2 | PUSH-PULL | 140 | 70 | 470 | 400 | 110 | 7.5 | 2.5 | | | 12.00 |
| 4 | 6800 | -50 | 2 | PARALLEL | 70 | 70 | 470 | 400 | 110 | 7.5 | 2.5 | 900 | 1835 | 12.00 |
| 5 | 6250 | -47 | 2 | PUSH-PULL | 33 | 16.5 | 266.5 | 250 | 79 | 2.5 | 3.5 | | | 3.80 |
| 6 | 6000 | -50 | 2 | " " | 126 | 63 | 413 | 350 | 90 | 7.5 | 2.5 | | | 12.00 |
| 7 | 5000 | -45 | 2 | " " | 112 | 56 | 331 | 275 | 72 | 2.5 | 3.0 | | | 2.80 |
| 8 | 5000 | -47 | 2 | PARALLEL | 16.5 | 16.5 | 266.5 | 250 | 79 | 2.5 | 3.5 | 17,500 | 3500 | 3.80 |
| 9 | 4800 | -50 | 2 | " | 63 | 63 | 413 | 350 | 90 | 7.5 | 2.5 | 950 | 2050 | 12.00 |
| 10 | 4600 | -50 | 1 | SINGLE-STAGE | 84 | 84 | 534 | 450 | 55 | 7.5 | 1.25 | 1800 | 4350 | 6.00 |
| 11 | 4000 | -45 | 2 | PARALLEL | 56 | 56 | 331 | 275 | 72 | 2.5 | 3.0 | 835 | 2300 | 2.80 |
| 12 | 4000 | -45 | 2 | PUSH-PULL | 100 | 50 | 300 | 250 | 68 | 2.5 | 3.0 | | | 2.80 |
| 13 | 4000 | -10 | 2 | " " | 78 | 39 | 464 | 425 | 36 | 7.5 | 2.5 | | | 14.00 |
| 14 | 3400 | -50 | 1 | SINGLE-STAGE | 70 | 70 | 470 | 400 | 55 | 7.5 | 1.25 | 1800 | 3670 | 6.00 |
| 15 | 3200 | -45 | 2 | PARALLEL | 50 | 50 | 300 | 250 | 34 | 2.5 | 3.0 | 875 | 1950 | 2.80 |
| 16 | 3200 | -10 | 2 | " | 39 | 39 | 464 | 425 | 36 | 7.5 | 1.25 | 2500 | 5100 | 14.00 |
| 17 | 2500 | -47 | 1 | SINGLE STAGE | 16.5 | 16.5 | 266.5 | 250 | 39.5 | 2.5 | 1.75 | 35,000 | 7000 | 1.90 |
| 18 | 2500 | -50 | 2 | PUSH-PULL | 90 | 45 | 295 | 250 | 56 | 7.5 | 2.5 | | | 12.00 |
| 19 | 2400 | -50 | 1 | SINGLE-STAGE | 63 | 63 | 413 | 350 | 45 | 7.5 | 1.25 | 1900 | 4100 | 6.00 |
| 20 | 2250 | -10 | 2 | PUSH-PULL | 62 | 31 | 381 | 350 | 32 | 7.5 | 1.25 | | | 14.00 |
| 21 | 2000 | -45 | 1 | SINGLE-STAGE | 56 | 56 | 331 | 275 | 36 | 2.5 | 1.5 | 1670 | 4600 | 1.40 |
| 22 | 2000 | -50 | 2 | PARALLEL | 45 | 45 | 295 | 250 | 56 | 7.5 | 2.5 | 1050 | 2150 | 12.00 |
| 23 | 1950 | -45 | 2 | PUSH-PULL | 69 | 34.5 | 214.5 | 180 | 54 | 2.5 | 3.0 | | | 2.80 |
| 24 | 1800 | -10 | 2 | PARALLEL | 31 | 31 | 381 | 350 | 32 | 7.5 | 2.5 | 2575 | 5500 | 14.00 |
| 25 | 1750 | -71A | 2 | PUSH-PULL | 86 | 43 | 223 | 180 | 40 | 5.0 | .5 | | | 2.80 |
| 26 | 1650 | -03 | 2 | " " | 80 | 40 | 220 | 180 | 40 | 3.0 | 3.0 | 5000 | 10,000 | — |
| 27 | 1600 | -45 | 1 | SINGLE-STAGE | 50 | 50 | 300 | 250 | 34 | 2.5 | 1.5 | 1750 | 3900 | 1.40 |
| 28 | 1600 | -10 | 1 | " " | 39 | 39 | 464 | 425 | 18 | 7.5 | 1.25 | 5000 | 10,200 | 7.00 |
| 29 | 1560 | -45 | 2 | PARALLEL | 34.5 | 34.5 | 214.5 | 180 | 54 | 2.5 | 3.0 | 950 | 1750 | 2.80 |
| 30 | 1400 | -71A | 2 | " | 43 | 43 | 223 | 180 | 40 | 5.0 | .5 | 975 | 2675 | 2.80 |
| 31 | 1320 | -03 | 2 | " | 40 | 40 | 220 | 180 | 40 | 3.0 | 3.0 | 1250 | 2500 | — |
| 32 | 1000 | -10 | 2 | PUSH-PULL | 44 | 22 | 272 | 250 | 20 | 7.5 | 2.5 | | | 14.00 |
| 33 | 1000 | -50 | 1 | SINGLE-STAGE | 45 | 45 | 295 | 250 | 28 | 7.5 | 1.25 | 2100 | 4300 | 6.00 |
| 34 | 925 | -71A | 2 | PUSH-PULL | 39 | 29.5 | 164.5 | 135 | 35 | 5.0 | .5 | | | 2.80 |
| 35 | 900 | -10 | 1 | SINGLE-STAGE | 31 | 31 | 381 | 350 | 16 | 7.5 | 1.25 | 5150 | 11,000 | 7.00 |
| 36 | 800 | -10 | 2 | PARALLEL | 22 | 22 | 272 | 250 | 20 | 7.5 | 2.5 | 3000 | 6500 | 14.00 |
| 37 | 780 | -45 | 1 | SINGLE-STAGE | 34.5 | 34.5 | 214.5 | 180 | 27 | 2.5 | 1.5 | | | 1.40 |
| 38 | 740 | -71A | 2 | PARALLEL | 29.5 | 29.5 | 164.5 | 135 | 35 | 5.0 | .5 | 980 | 1750 | 2.80 |
| 39 | 700 | -71A | 1 | SINGLE-STAGE | 43 | 43 | 223 | 180 | 20 | 5.0 | .25 | 1850 | 5350 | 1.40 |
| 40 | 660 | -03 | 1 | " " | 40 | 40 | 220 | 180 | 20 | 3.0 | 1.5 | 2500 | 5000 | — |
| 41 | 650 | -12A | 2 | PUSH-PULL | 32 | 16 | 196 | 180 | 15.2 | 5.0 | .5 | | | 3.00 |
| 42 | 520 | -12A | 2 | PARALLEL | 16 | 16 | 196 | 180 | 15.2 | 5.0 | .5 | 2500 | 5400 | 3.00 |
| 43 | 400 | -10 | 1 | SINGLE-STAGE | 22 | 22 | 272 | 250 | 10 | 7.5 | 1.25 | 6000 | 13,000 | 7.00 |
| 44 | 370 | -71A | 1 | " " | 29.5 | 29.5 | 164.5 | 135 | 17.5 | 5.0 | .25 | 1960 | 3500 | 1.40 |
| 45 | 312 | -71A | 2 | PUSH-PULL | 38 | 19 | 109 | 90 | 24 | 5.0 | .5 | | | 2.80 |
| 46 | 297 | -12A | 2 | " " | 23 | 11.5 | 146.5 | 135 | 12.4 | 5.0 | .5 | | | 3.00 |
| 47 | 260 | -12A | 1 | SINGLE-STAGE | 16 | 16 | 196 | 180 | 7.6 | 5.0 | .25 | 5000 | 10,800 | 1.50 |
| 48 | 250 | -71A | 2 | PARALLEL | 19 | 19 | 109 | 90 | 24 | 5.0 | .5 | 1125 | 1600 | 2.80 |
| 49 | 230 | -12A | 2 | " | 11.5 | 11.5 | 146.5 | 135 | 12.4 | 5.0 | .5 | 2650 | 4350 | 3.00 |
| 50 | 125 | -71A | 1 | SINGLE-STAGE | 19 | 19 | 109 | 90 | 12 | 5.0 | .25 | 2250 | 3200 | 1.40 |
| 51 | 115 | -12A | 1 | " " | 11.5 | 11.5 | 146.5 | 135 | 6.2 | 5.0 | .25 | 5300 | 8700 | 1.50 |

Continued on following page

required by the –47 tube. The slight difference in current drain for these two tubes is, of course, of minor importance.

### *Circuit Design*

There are three commonly used circuit connections for a power stage. The simplest type consists of a single tube stage. The single tube output stage is the least expensive from the standpoint of cost of tubes and associated equipment. Where a single tube is not sufficient to give the required total output power, two tubes of the same characteristics may be connected either in parallel or push-pull arrangement.

In comparing the results to be obtained by parallel and push-pull operation of power tubes, the important facts to be kept in mind are the following:

1. In a push-pull amplifier consisting of two tubes, the undistorted power output obtainable is commonly accepted as being 2.5 times the undistorted power output when using a single tube in the power stage. The plate resistance of the output stage is doubled so that an output coupling transformer should be used which takes this factor into consideration. The signal input required to give the additional power output must be twice that required for a single tube. The plate voltage required remains the same, but the plate current will be doubled. The grid bias voltage required, as measured

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between the grid and the cathode of each tube, remains the same and the same value of grid-bias resistance required for a single tube may be used if individual windings are employed for the filaments. If the filaments are connected in parallel to the same filament winding, the value of grid bias resistance required is half that for a single tube, because the current flowing through it will be the total plate current of the two tubes.

2. In a power stage in which the output tubes are connected in parallel, the undistorted power output is twice that obtainable with a single tube in the power stage. The plate resistance of the output stage is half that of a single tube and the transformer used to couple the loudspeaker load to the output of the power stage must be selected accordingly. In the parallel arrangement, the signal input required remains the same as for a single tube. The plate voltage remains the same as for a single tube, while the plate current required is twice that required for a single tube. The grid bias resistor, with the tube elements tied together, should be half that required for a single tube.

In general, where a high enough signal input voltage to operate two tubes in push-pull is available, the push-pull arrangement should be used because of its advantages in the way of increased undistorted power output, and savings in transformer and filter design due to the fact that less filtering can be used without increasing hum. But where the signal input available is limited, it is better practice to use the output tubes in parallel even though the undistorted output is only twice that of a single tube, and the second harmonic distortion and hum elimination characteristics of the push-pull amplifier are lacking.

In connecting tubes in parallel or in a push-pull arrangement, best results will be obtained only when the tubes are very closely matched as regards their mutual conductance and plate voltage-plate current characteristics. This is especially true when a single grid bias resistor and a common plate voltage tap is used for both tubes.

The use of –50 tubes in push-pull is not recommended under ordinary conditions unless special care is taken. To operate a –50 type push-pull amplifier at maximum output requires a signal of 117.6 volts r.m.s.

To obtain this high signal input requires the use of a high-gain voltage amplifier between the detector and power tubes, an arrangement that does not lend itself to stable operation and freedom from distortion unless special design and matching is used in those stages.

If greater output than is possible with a single –50 tube is required, the use of two –50 tubes connected in parallel will often be found to give more satisfactory results, since in that case the signal input required remains the same as for a single tube.

### *Impedance Matching*

The fifth consideration in the choice of power tubes is that of the a.c. plate resistance of the tube or tubes in the power stage and the load resistance required to obtain maximum efficiency.

Whenever possible, the use of a tube or combination of tubes requiring a low load resistance is desirable, since such characteristics give somewhat better response characteristics and require a less expensive output transformer to connect the output to the speaker. This factor, however, should not be given too much weight, since it is a comparatively easy matter to design suitable coupling transformers to match the output characteristics of any of the power tubes listed to the average speaker.

When using most single power output tubes of the three- and four-element type, it is generally considered that best output characteristics are obtained when the load resistance is equal to approximately twice the a.c. plate resistance of the tube. This holds approximately true for practically all the triodes except for the –20, which requires a load resistance only slightly higher than the plate resistance of the tube for best results. (*Continued on page* 965)

**TABLE III**

Continued from preceding page

| | UNDISTORTED POWER OUTPUT, MILLIWATTS | TYPE OF TUBE | NUMBER OF TUBES USED | CIRCUIT USED IN POWER STAGE | PEAK SIGNAL VOLTAGE FOR MAX. OUTPUT | NEG. GRID BIAS, VOLTS | TOTAL PLATE AND GRID BIAS VOLTAGE REQ'D | PLATE VOLTAGE | PLATE AND SCREEN GRID CURRENT MA. | FILAMENT OR HEATER TOTAL | | A.C. PLATE RESIST., OHMS | RECOMMENDED LOAD RESIST., OHMS | LIST PRICE OF TUBES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | VOLTS | AMPS | | | |
| GROUP 2: D.C. STORAGE BATTERY TUBES; "B" & "C" SUPPLY FROM DRY BATTERIES OR "B" & "C" ELIMINATORS | | | | | | | | | | | | | | |
| 1 | 1750 | –33 | 2 | PUSH-PULL | 27 | 13.5 | 148.5 | 135 | 35 | 2.0 | .52 | | | $5.50 |
| 2 | 1750 | –71A | 2 | " " | 81 | 40.5 | 220.5 | 180 | 40 | 5.0 | .5 | | | 2.80 |
| 3 | 1400 | –33 | 2 | PARALLEL | 13.5 | 13.5 | 148.5 | 135 | 35 | 2.0 | .52 | 25,000 | 3500 | 5.50 |
| 4 | 1400 | –71A | 2 | " | 40.5 | 40.5 | 220.5 | 180 | 40 | 5.0 | .5 | 925 | 2675 | 2.80 |
| 5 | 1312 | –38 | 2 | PUSH-PULL | 27 | 13.5 | 148.5 | 135 | 23 | 6.3 | .6 | | | 5.50 |
| 6 | 1050 | –38 | 2 | PARALLEL | 13.5 | 13.5 | 148.5 | 135 | 23 | 6.3 | .6 | 51,000 | 6750 | 5.50 |
| 7 | 700 | –33 | 1 | SINGLE-STAGE | 13.5 | 13.5 | 148.5 | 135 | 17.5 | 2.0 | .26 | 50,000 | 7000 | 2.75 |
| 8 | 700 | –71A | 1 | " " | 40.5 | 40.5 | 220.5 | 180 | 20 | 5.0 | .25 | 1850 | 5350 | 1.40 |
| 9 | 650 | –12A | 2 | PUSH-PULL | 27 | 13.5 | 193.5 | 180 | 15.2 | 5.0 | .5 | | | 3.00 |
| 10 | 525 | –38 | 1 | SINGLE-STAGE | 13.5 | 13.5 | 148.5 | 135 | 11.5 | 6.3 | .6 | 102,000 | 13,500 | 2.75 |
| 11 | 520 | –12A | 2 | PARALLEL | 13.5 | 13.5 | 193.5 | 180 | 15.2 | 5.0 | .5 | 2500 | 5400 | 3.00 |
| 12 | 260 | –12A | 1 | SINGLE-STAGE | 13.5 | 13.5 | 193.5 | 180 | 7.6 | 5.0 | .25 | 5000 | 10,800 | 1.50 |
| GROUP 3: D.C. TUBE FOR AUTOMOBILE OR D.C. DISTRICT USE; "B" & "C" SUPPLY FROM DRY BATTERIES OR POWER SUPPLY | | | | | | | | | | | | | | |
| 1 | 1312 | –38 | 2 | PUSH-PULL | 27 | 13.5 | 148.5 | 135 | 23 | 6.3 | .6 | | | 5.50 |
| 2 | 1050 | –38 | 2 | PARALLEL | 13.5 | 13.5 | 148.5 | 135 | 23 | 6.3 | .6 | 51,000 | 6750 | 5.50 |
| 3 | 525 | –38 | 1 | SINGLE-STAGE | 13.5 | 13.5 | 148.5 | 135 | 11.5 | 6.3 | .3 | 102,000 | 13,500 | 2.75 |
| GROUP 4: LOW-VOLTAGE (DRY CELL) D.C. TUBES; "B" & "C" SUPPLY FROM DRY BATTERIES | | | | | | | | | | | | | | |
| 1 | 1750 | –33 | 2 | PUSH-PULL | 27 | 13.5 | 148.5 | 135 | 35 | 2.0 | .52 | | | 5.50 |
| 2 | 1400 | –33 | 2 | PARALLEL | 13.5 | 13.5 | 148.5 | 135 | 35 | 2.0 | .52 | 25,000 | 3500 | 5.50 |
| 3 | 700 | –33 | 1 | SINGLE-STAGE | 13.5 | 13.5 | 148.5 | 135 | 17.5 | 2.0 | .26 | 50,000 | 7000 | 2.75 |
| 4 | 375 | –31 | 2 | PUSH-PULL | 45 | 22.5 | 157.5 | 135 | 13.6 | 2.0 | .26 | | | 3.20 |
| 5 | 300 | –31 | 2 | PARALLEL | 22.5 | 22.5 | 157.5 | 135 | 13.6 | 2.0 | .26 | 2475 | 4500 | 3.20 |
| 6 | 275 | –20 | 2 | PUSH-PULL | 45 | 22.5 | 157.5 | 135 | 13 | 3.3 | .264 | | | 6.00 |
| 7 | 220 | –20 | 2 | PARALLEL | 22.5 | 22.5 | 157.5 | 135 | 13 | 3.3 | .264 | 3150 | 3250 | 6.00 |
| 8 | 150 | –31 | 1 | SINGLE-STAGE | 22.5 | 22.5 | 157.5 | 135 | 6.8 | 2.0 | .13 | 4950 | 9000 | 1.60 |
| 9 | 112 | –20 | 2 | PUSH-PULL | 33 | 16.5 | 106.5 | 90 | 6 | 3.3 | .264 | | | 6.00 |
| 10 | 110 | –20 | 1 | SINGLE-STAGE | 22.5 | 22.5 | 157.5 | 135 | 6.5 | 3.3 | .132 | 6300 | 6500 | 3.00 |
| 11 | 90 | –20 | 2 | PARALLEL | 16.5 | 16.5 | 106.5 | 90 | 6 | 3.3 | .264 | 3150 | 3250 | 6.00 |
| 12 | 45 | –20 | 1 | SINGLE-STAGE | 16.5 | 16.5 | 106.5 | 90 | 3 | 3.3 | .132 | 8000 | 9600 | 3.00 |

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USING FILTER UNITS IN ELIMINATING

# *Street-Railway Interference*

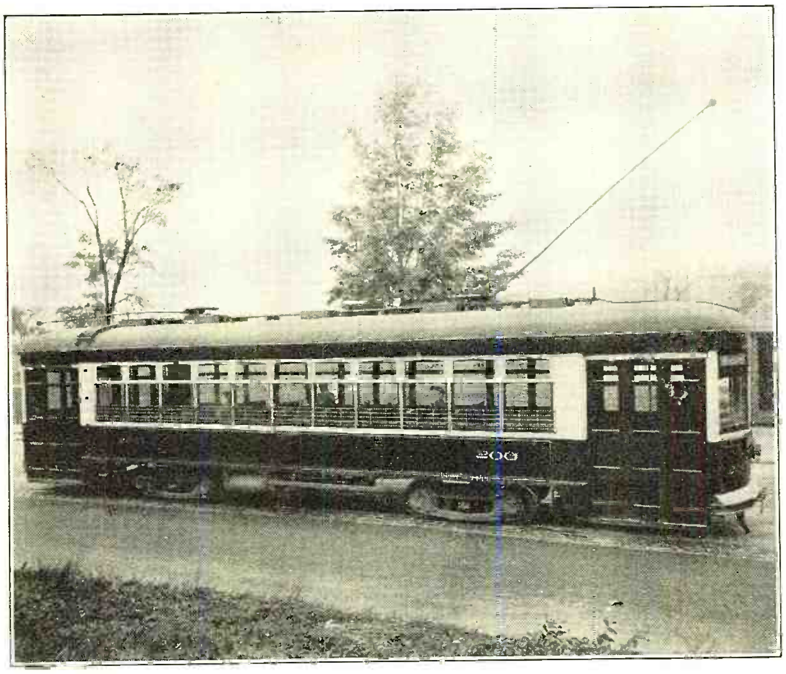
***To the layman the problems involved in eliminating inductive interference from railway cars passing through the streets may seem to be almost unsolvable. The author points out, however, that it can be done.***

*By* Tobe Deutschmann*

THE interference created by street cars and street railway equipment has for a long time been thought to be of such proportions that its elimination could not be expected. This belief, which has been generally accepted by broadcast listeners all over the world, has been a great stumbling block in the path of progress toward improved radio receiving conditions. The size of the apparatus has, undoubtedly, contributed largely to the idea that the elimination of street-railway interference would be both too difficult and expensive. Fortunately, radio interference is not directly proportional to the size of the apparatus involved. Consequently, the cost of preventing street-railway equipment from causing inductive interference is much less in proportion to the value of the equipment than is the cost for many of the comparatively small electrical appliances used in the home.

The extent of filtering required on any street-railway system will naturally depend upon the type and condition of the equipment being used. It is possible, however, to outline a standard procedure which may be taken as a guide to the requirements of any street-railway system.

Since the filters are usually designed to suppress only such interference as may be created by the normal operation of electrical apparatus which is maintained in good condition, it is obvious that the first step to be taken in the filtering of a street-railway system is a careful checking of both the mechanical and electrical condition of rolling stock, overhead, track, shop equipment, sub-station equipment and the bonding of rails. After this has been done, filtering of various parts of the system may be undertaken with a high degree of assurance.



A NOISELESS TROLLEY CAR

*Figure 2. Inhabitants of Manchester, New Hampshire, do not have radio interference when this car, which has been carefully shielded and filtered, passes their home*

Although there are many parts of a street-railway system which may be responsible for some interference, the street car itself, being most conspicuous, is given first consideration. In the filtering of the street car, the car is considered as a unit rather than as a combination of several interference sources. In order to determine what procedure should be followed in filtering as applied to the car, however, it is necessary to understand the manner in which street-railway interference is distributed as well as to note where it may originate.

In keeping with the fundamental rule that interference results from the making or breaking of electrical circuits, it is apparent that driving motors, compressor motor, controller contacts, call buzzers, and the various light and heater switches in the car are likely to be sources of interference. This interference travels along the various wiring circuits of the car and is carried out on the trolley. (See Figure 1.) From the trolley wire this interference may be inductively transferred to feeders, secondary distribution networks, primary distribution networks, and other wiring circuits. With these facts in mind, it is apparent that interference must be kept from reaching the trolley.

This is accomplished by application of suitable filter units to the various interference sources in the car, and by use of special sectional filters in the trolley circuit. The installation of these filters in the electrical circuit of the car is shown in Figure 3.

This is a simplified diagram of the electrical circuits of a two-motored street car. As the diagram shows, a type SC-100 filter section is connected directly in series with the main lead from the trolley to the controller. This filter, being inserted directly in the trolley line, effectively prevents the conductive transfer of interference to the trolley and feeder. If maximum benefit is to be obtained from the use of such a filter the connecting lead from the trolley to the filter should not be coupled with any other part of the car wiring. In the case of the car shown in the diagram, this is a relatively simple matter, since the two main feed lines to the two controllers are carried down at opposite ends of the car and lead directly into the controllers. In certain types of cars, a single lead is carried from the trolley, down the center of one side of the car and is branched beneath the car and carried to the controllers at opposite ends. When this condition is encountered, it may be necessary to rearrange some of the wiring circuits in order to prevent coupling between the trolley lead and other wiring circuits.

In addition to the use of the type SC-100 filter section it is necessary to apply other sections at the various sources of interference throughout the car. As shown in diagram Figure 3, a type SC-2 section is required at each driving motor. This section is mounted directly on the motor frame and connected

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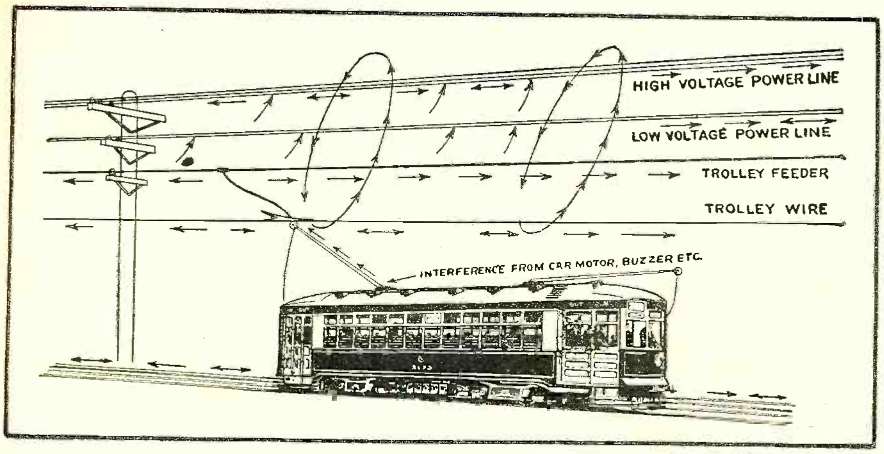



HOW INTERFERENCE IS RADIATED BY TROLLEY WIRES

*Figure 1. This drawing shows by diagram how currents are introduced through the ground and trolley to the overhead wires that bring the interference to your radio antenna*

in the brush circuit. One type SC-2 section is required for application to each driving motor in the car. It is also necessary to apply a type SC-1 section to the compressor motor.

Further verification of the statement contained in the introduction of this article that interference is not necessarily proportional to the size of the apparatus involved is found in the fact that while the interference created by driving and compressor motors is seldom audible for more than one block from the trolley wire or feeder, interference created by call buzzers has been known to cover an area as much as 12 blocks from the trolley wire and feeder. In order to overcome this call buzzer interference, a type SC-1 section must be applied to each buzzer.

Fortunately, it is not necessary to filter the push-buttons and the various switches in the car, as the type SC-100 section which is connected in the trolley lead prevents the interference from these switches from reaching the trolley wire. There is, however, one further interference source which must be given careful attention if satisfactory reduction of street car interference is to be obtained. The controller contains many contacts which are made and broken many times while the car is in operation. In order that the elimination of the interference created by these contacts may be assured, care must be taken in the location of the type SC-100 filter section with relation to the controller. It is mounted under the car directly beneath the controller. To complete the elimination of controller interference, a type SC-1 section is connected directly across the controller terminals. Field tests have shown that when street cars are equipped in this manner there is no evidence of interference from any part of the car.

### *Fixed Sources of Interference*

There are, of course, other parts of a street-railway system which should be considered, if satisfactory radio reception is to be obtained. These include signal systems, section gaps and substation apparatus. The interference originating in the sub-station is created by the rotary converters and is carried along the trolley and feeder systems. In practically all cases a simple application of condenser and coil unit sections prevents the interference from being carried out on trolley or feeder systems and thus provides improved radio reception in the vicinity of the sub-station.

The fact that so simple an installation provides satisfactory interference suppression is a further refutation of the mistaken idea that there is any electrical apparatus too large to be filtered.

The question has often been asked as to whether the benefits accruing to a railway company are sufficient to warrant the expense of the installation of filters.

The following is an extract of a communication addressed to an electric railway company:

"October 17, 1931.

"Your letter of October 15 received. Some time ago we purchased . . . one radio interference set and equipped one of our trolley cars. This worked so well that we purchased twelve additional equipments. About half of these are now installed and they are giving wonderful results.

I would suggest that you purchase one equipment similar to that used by us and try it out on your system. If it works out as well as the ones we have purchased, I am sure you will be entirely satisfied, as will the radio listeners.

If we can be of any further service, please call upon us.

Very truly yours,
J. BRODIE SMITH,
Vice-President and Gen'l Manager."

The following extract will be of further interest to those interested in the general interference problem, relating to street cars. This communication was in response to a request for information from the Honolulu Rapid Transit Company, Honolulu, Hawaii:

"September 24, 1931.

"You letter of September 11th received. We purchased one equipment . . . and tried it out on one of our worst cars and it worked in a most satisfactory manner. This worked out so satisfactorily that we have placed an order for twelve additional equipments. The residents along the line where the equipped car was operated were naturally very much delighted with the operation of the device and we have heard so many favorable comments that we decided to place the order as above.

The city has a radio inspector. I asked for his opinion of the above device and am enclosing a copy of his reply.

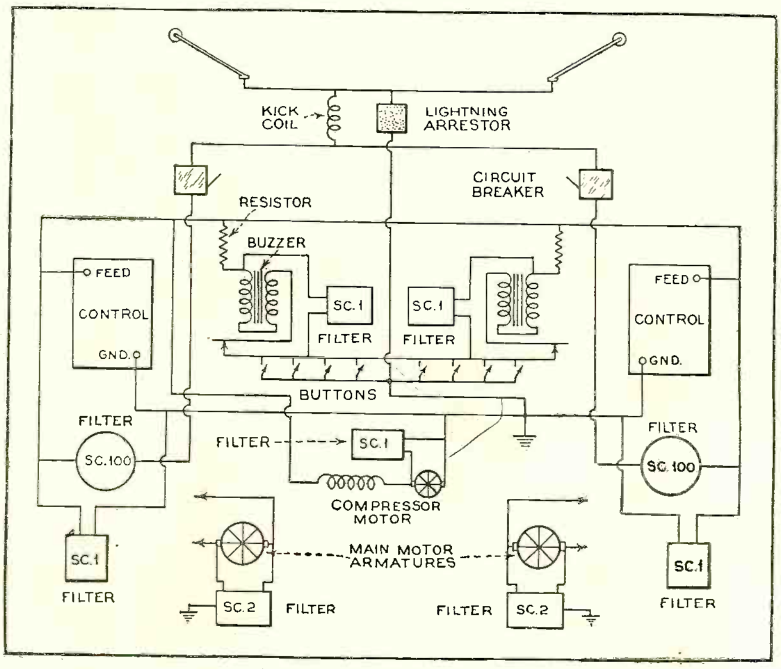
Very truly yours,
J. BRODIE SMITH,
General Manager."

The following is an extract from J. R. Holmes, city radio inspector:

"Sept. 24, 1931.

"On installing this equipment on a car which had been troublesome from every point, such as brushes, generators, etc., it was found by actual working tests to eliminate these usual troubles in every respect."

From the above, it is seen that street car interference can be eliminated and the question is firmly one of public relation between the radio listeners and traction companies.




FILTER TROLLEY CIRCUITS

*Figure 3. Shows how the various filter units are placed in various positions in the power wiring of the trolley car to eliminate interference*

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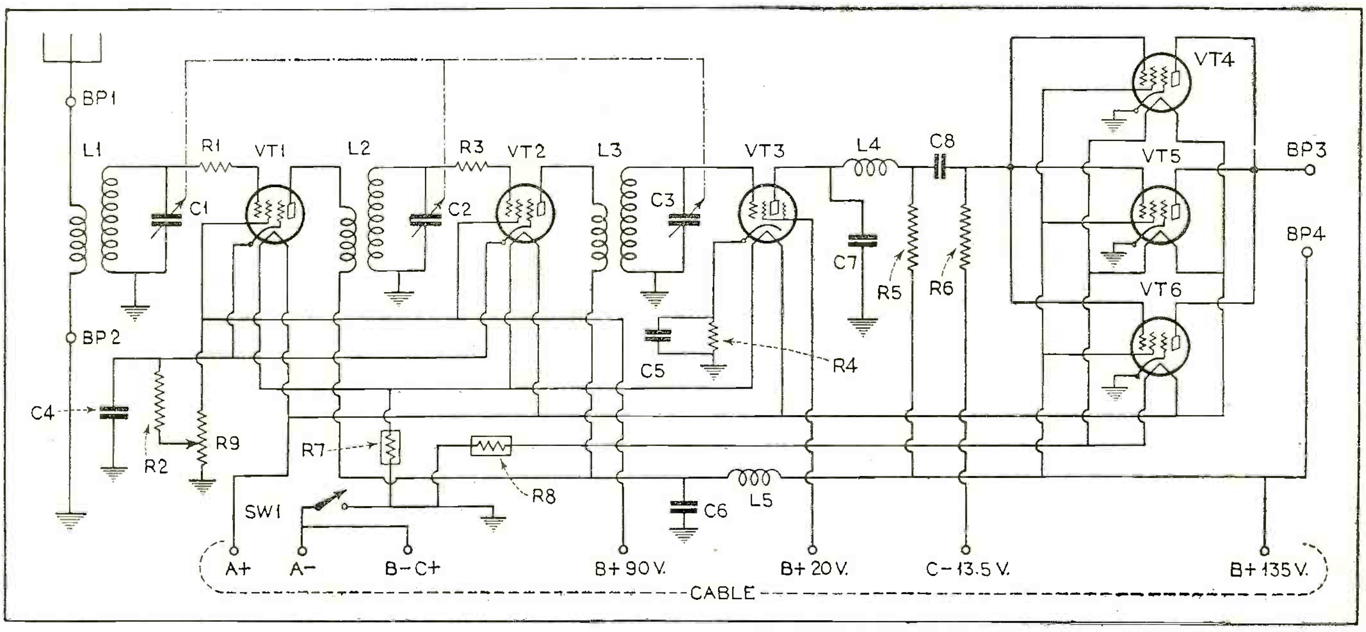
*Paralleling three pentodes in the output circuit gives greater volume handling ability. Two variable-mu R.F. pentodes produce fine sensitivity and selectivity*




HOW TO BUILD A BATTERY OPERATED

# PENTODE RECEIVER

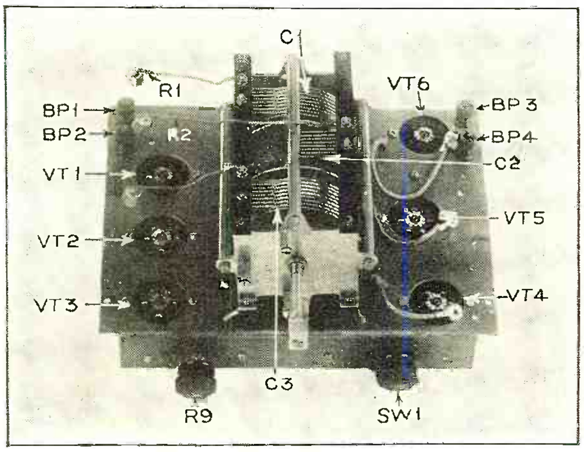
*By* H. G. Cisin

THE Five-Pentode Midget has been designed to serve two distinct purposes. First of all, it is an ultra-modern battery set, of excellent selectivity, sensitivity and power. It can operate a standard dynamic reproducer and there is no trace of hum or the background noise so common to a.c. receivers. The new variable-mu pentodes are especially effective in reducing cross modulation and modulation distortion over the entire range of received signals. Moreover, they allow easy control over a wide range of signal voltage, without the use of a special "local-distance" control.

### *Good for "DX"*

Secondly, this receiver, with slight variations to obtain maximum sensitivity, is the ideal set for the inveterate distance fan. It should bring in enormous distances. In fact, the writer considers it to have greater potentialities in this respect than the original "Find-All Four," which boasted verified reception on the broadcast (not short-wave) band of stations in Sidney, Australia; Tokio, Japan, and scores of European stations. However, since this circuit is so very new, it is too early for verifications and the real possibilities of the set, as regards distance reception, are at present only a matter of conjecture.

The receiver employs two tuned r.f. stages, a tuned power detector and a single resistance-coupled audio stage. The variable-mu −39 type pentodes are used in the two r.f. stages, a −36 type screen-grid tube is used as a detector, while three type −38 pentodes are connected in parallel in the output stage. All six tubes are of the quick-heating type. With the three power pentodes in parallel, it is possible to obtain nearly as high power output with only 135 volts on the plates as could be obtained from a type −45 tube with a plate voltage of 250 volts. Furthermore, the −45 tube would require a 50-volt C bias, as compared to 13.5 volts for the −38's. Combining the three pentodes in parallel also lowers the output impedance to about 4500 ohms, and this value is practically equivalent to the primary impedance of the output transformers used on most standard makes of dynamic speakers.




THE TOP VIEW

*An idea of the compact size can be gained from this photo. All parts are mounted on the metal chassis. Single-control tuning is provided (dial not shown). The two lower knobs operate the volume control and on-off switch*

Single-dial control is attained through the use of an efficient, accurate three-gang condenser. The potentiometer in series with the cathodes of the variable-mu pentodes varies the control-grid bias, thus giving smooth volume control. These tubes have a mutual conductance of 980 (with 135 volts on the plates), when the bias is minus 3 volts. At minus 30 volts, the mutual conductance is only 10, while at minus 40 volts the mutual conductance approaches zero. The fixed resistor, R2, prevents the bias from being reduced below the necessary minus 3 volts minimum.

A radio-frequency choke is used at L4 to keep r.f. currents out of the audio portion of the circuit. The r.f. choke, L5, isolates the r.f. plate circuits from the audio plate circuit, thus preventing distorting interaction between them.

The set is constructed on a small 16 to 18 gauge iron chassis,

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only 10 inches wide by 7½ inches deep by 1½ inches high. The chassis is first drilled for the sockets. Holes are then drilled for the variable condenser brackets and for the three coil bases. Fastening holes are also drilled in the rear chassis wall for the amperites and the .1 mfd. fixed condenser and in the front chassis wall for the volume control potentiometer, the r.f. choke, the fixed condenser and the "on-off" switch. It is also necessary to drill a hole in the rear chassis wall for the seven-wire cable.

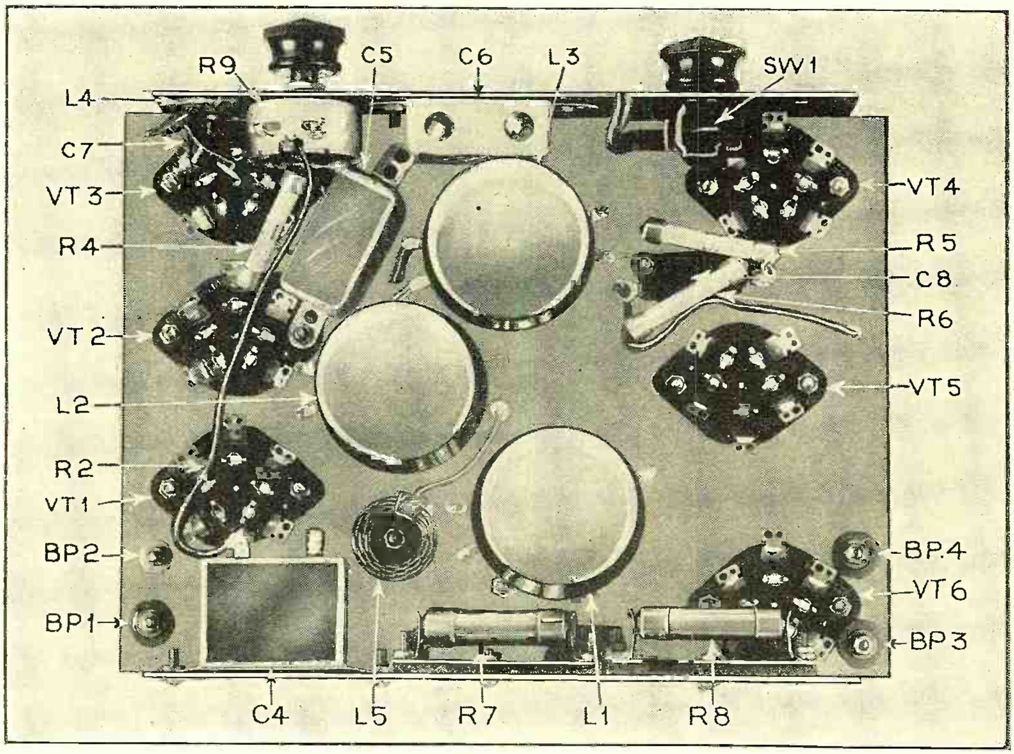
Mounting holes should be drilled in the chassis for the two fixed condensers, C5 and C8, and for the four binding posts. In addition, holes are required for the wires coming up through the chassis to the stators of the variable condenser sections and to the control grids of the three pentode tubes.

The parts should now be mounted as indicated in the top and underside views. The sockets are mounted first. While sockets VT1, VT2 and VT3 are being fastened, the tube shield bases should also be secured with the same mounting screws. Shields are not necessary on the three output pentodes. The two variable condenser brackets are mounted next, then the parts which go on the front and rear chassis walls. Next the coil bases are attached to the underside of the chassis, and also the fixed condenser C8 and the r.f. choke L5. The binding posts are mounted. Post BP2 is grounded directly to the chassis. The other binding posts must be carefully insulated, with composition or mica washers. Condenser C5 is held in place by one of the screws used to fasten socket VT2. The three resistors, R4, R5 and R6, are soldered in place while the set is being wired. Condenser C7 is soldered to the plate terminal of socket VT3. The flexible resistor, R2, also serves as the lead between condenser C4 and the center terminal of the volume control potentiometer. Finally, the variable condenser is mounted on top of the chassis.

### *Step-by-Step Wiring Directions*

The filament circuit is wired in first. All heaters are in parallel. The -38 heaters are wired in one group, while the two -39's and the -36 are wired in a second group. The wire from the A plus cable connection goes directly to both groups. The A minus cable wire and the B minus-C plus cable wires are connected together to form a common lead going to switch SW1. The other side of the switch is grounded to the chassis. The grounded side of the switch is then connected to each amperite. From the opposite side of amperite R7 connection is made to the negative side of the group of -39's and -36. From the opposite side of R8 connection is made to the negative side of the -38 group. Thus, one amperite controls each group.

The grid circuits are wired next. The stators of condenser sections C1, C2 and C3 go to the caps of tubes VT1, VT2 and VT3, respectively. The screen-grid (double grid) connections on all six tubes are made at the "G" terminals of the sockets. (The "G" terminal is the one isolated from the other four). The clips going to the caps of the three pentode tubes VT4, VT5 and VT6 may be wired together. This connection is then brought down to the side of condenser C8, which connects to resistance R6. The three "G" terminals at the sockets (from the space-charge grids) are also connected together and the common lead goes to the B plus 135 cable wire. It should be noted that the cathode grids of all five pentode tubes are connected directly to the cathodes inside the tubes and hence no additional connections are required externally. Plate circuits are wired next, then the cathodes, by-pass condensers and volume control. The "G" terminal of the antenna coupler, L1, is connected to the antenna post, BP1, while the "F" terminal is wired to the ground post, BP2. This completes the wiring.




BELOW DECK VIEW

*This view was taken before completion of the wiring, to more clearly show placement of parts*

If wired in accordance with the above directions, the Five-Pentode Midget battery set will not oscillate even on the lower wavelengths, but will be quite stable and still reasonably sensitive. However, if great distance reception is the sole consideration, resistors R1 and R3 should be short-circuited or taken out. Reducing the value of resistor R2 until the minimum of minus 3 volts bias is obtained will also increase the sensitivity. After these changes are made the set will be rather critical and more difficult to control (as regards oscillations), but it will surely bring joy to the fan who is out after distance records. The -36 type tubes may be substituted for the -39 type tubes, if desired. In this case it is merely necessary to reduce the screen-grid voltage from 90 volts to 67.5 volts.

### *Parts List*

C1, C2, C3—Cardwell triple variable condenser, type 317-C shielded, .00035 mfd. (each section)
C4—Aerovox filter condenser, type 207, .1 mfd.
C5, C6—Aerovox by-pass condenser, type 260, .25 mfd.
C7—Aerovox mica condenser, type 1460, .001 mfd.
C8—Aerovox Mica Condenser, type 1460, .01 mfd.
L1—Conoid shielded antenna coupler
L2, L3—Conoid shielded r.f. coils (*Continued on page* 968)

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*Chatty bits of news on what is happening before the microphone. Personal interviews with broadcast artists and executives. Trends in studio technique.*

PETE DIXON AND ALINE BERRY IN "RAISING JUNIOR"

# Backstage *in* Broadcasting

*By* Samuel Kaufman

CHARLES "BUDDY" ROGERS, youthful star of the talking screen, is now under the exclusive management of the NBC Artists' Service. George Engles, NBC vice-president, announces that Buddy has deserted the screen to organize and conduct his own orchestra and sing over the network. At this writing, it is expected that Rogers will be identified with one of New York's fashionable hotels in his new radio and musical enterprise. Buddy plans to have about thirteen pieces in his orchestra. He has already done some singing in talking picture work and has been well received.

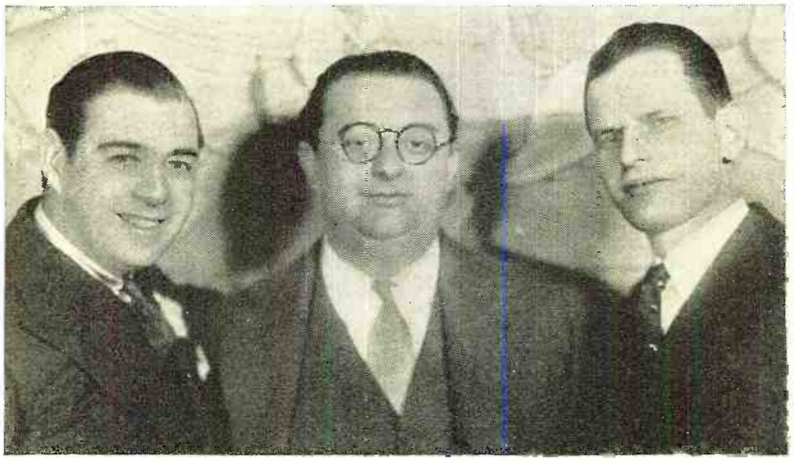
NOT so long ago, Peter Dixon was on the publicity staff of the NBC. He and his wife, Aline Berry, are now featured on the daily NBC "Raising Junior" programs, which are written by himself. Dixon, a native of Canada, started his business career as a newspaper carrier in Texas and, after a year, became a cub reporter. It was this experience that may have prompted his "Cub Reporter" programs which preceded "Raising Junior." He went from the newspaper to an oil tanker running between Texas and Mexico, serving as mess-boy and second cook. This was followed by six months in a steel shipyard in Canada. He then returned to newspaper work, serving on numerous dailies from Arizona to New York during a nine-year period. In order to do a series of stories for an Oklahoma newspaper, he became an actor for a week at a Tulsa theatre. It was there that he met Miss Berry, ingenue lead in the local stock company, and they were married five months later. His "Raising Junior" series will be two years old next September.

IN recent months a rapidly mounting number of radio stars of the NBC and CBS have been making successful appearances on the vaudeville stage. In many instances, the vaudeville bookings have proven sensational, breaking many attendance records. The chief detriment to the growth of radio artists' vaudeville bookings is the fact that radio bookings cannot be neglected and the artists must always be on hand for scheduled broadcast periods. Thus, many network stars, whose popularity would warrant lucrative personal appearance contracts in numerous cities, are forced to remain in the "key" city for their radio broadcasts. Vaudeville appearances, in those cases, are limited to theaters in the local and suburban area of the originating studio location. It is only at considerable expense that networks can arrange to pick up programs from various distant cities a radio troupe may visit on a vaudeville tour. Nevertheless, this is being done more and more frequently. Late in May, the Camel Quarter Hour cast, the CBS daily period featuring Morton Downey, Tony Wons and Jacques Renard's Orchestra, will complete a twelve weeks' vaudeville tour of the East and the Middle West, having broadcast the daily feature from each city without interruption.

WHEN radio sprung to the fore as a leading entertainment medium, entertainers were drafted from all walks of life to fill microphone roles. The stage, the screen, the concert hall, the press, the pulpit and other mediums contributed personalities to the art. But radio talent fortunately did not fall into a routine classification. Novelties and innovations must constantly be introduced on air programs to attract and hold the listeners' interest. One of the sched-

(*Continued on page* 969)

BUDDY ROGERS



MORTON DOWNEY JACQUES RENARD TONY WONS

VON LUCKNER

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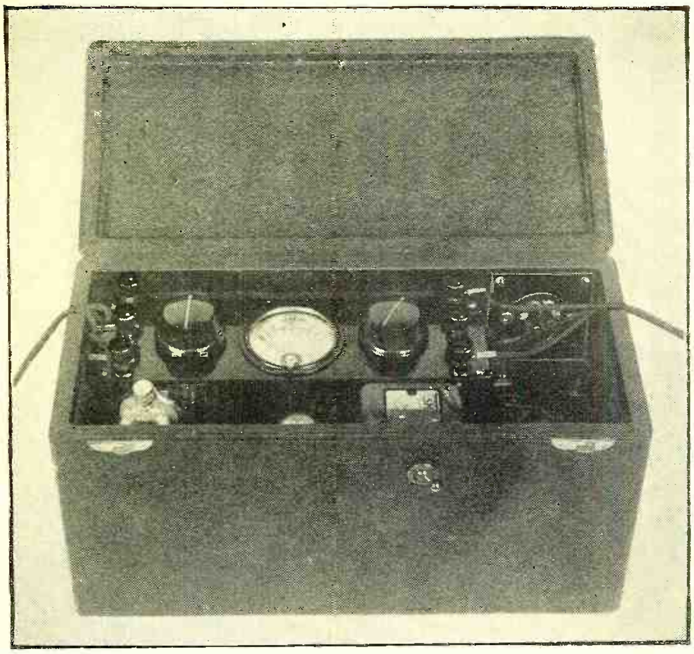


A CLOSE-UP OF THE AMPLIFIER

*The complete amplifier is housed in a leather-covered case. The only control on the outside is the "on-off" switch which controls the entire installation. The neat appearance of the case makes concealment of this unit quite unnecessary*

# The Radio News MULTI-EAR-AID

*By* S. Gordon Taylor

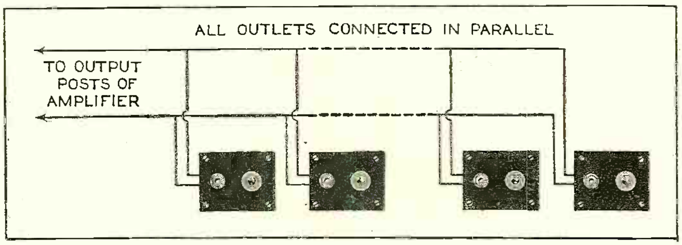
In churches and schools the benefit of a group hearing-aid installation cannot be measured in dollars and cents—but from the spiritual or educational standpoints the benefit is perhaps greater than that gained by theatres.

Certainly no one, interested in the work of a school or church, or financially interested in commercial projects catering audibly to large numbers of people, can afford to neglect the possibilities outlined here.

The radio serviceman is the logical one to sell group hearing-aid systems. Outside of a handful of individuals or concerns that specialize in the installation of hearing-aid equipment, there is no one so well qualified. Not only can the serviceman sell the idea and make the installation—he can actually assemble the equipment as described in this and in the next article. Such activities are in themselves highly profitable and have the added advantage that many deaf persons who find group hearing aids helpful will turn to the one who made the installation for individual hearing aids, built-in equipment for the home, etc.

CHURCHES, theatres, deaf classes in schools and institutions, lodges, clubs and auditoriums—all find a need for group hearing-aid systems which will enable those with impaired hearing to hear what is going on. Bearing in mind the statistics gathered from various sources, indicating about five million really hard-of-hearing persons in the United States, it is evident that for every hundred persons in an audience there are four or five who actually need some sort of hearing aid—or there would be this number if it were not for the fact that persons with impaired hearing are not likely to participate in group activities which require more or less normal hearing.

In the case of a theatre which has an average attendance of, let us say, one thousand, there are probably from forty to fifty potential customers, daily, whose defective hearing keeps them away. Assuming an admission charge of fifty cents each, the profit in catering to this faction of the public is self-evident, especially as the group hearing-aid equipment needed is not expensive.



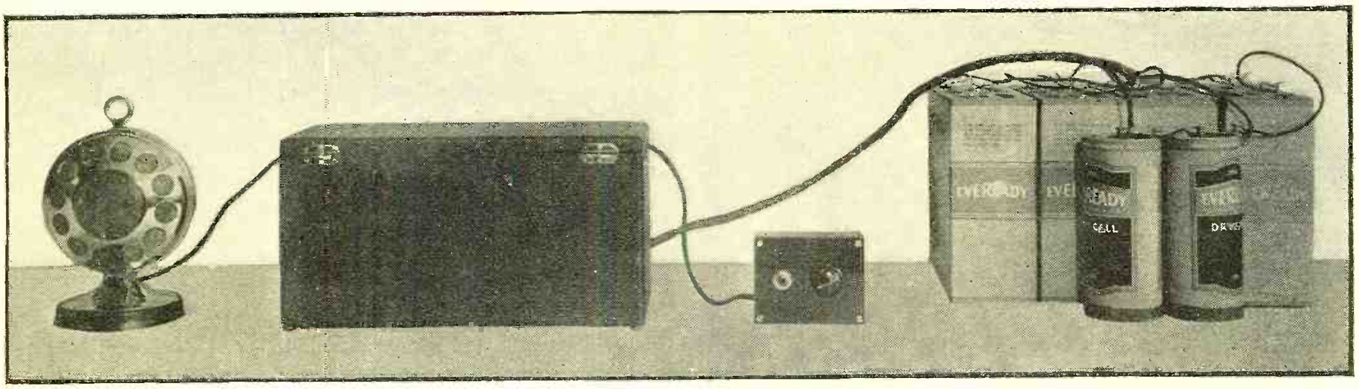

THE OUTLET WIRING CIRCUIT

*Figure 3. All outlet boxes are wired in parallel. B.X. or conduit are not required, as this is a low-voltage system*

## *Operates Thirty Headphones*

Last month instructions were given for adapting the RADIO NEWS Ear Aid to operate as many as six individual headphones. For such small installations this equipment is satisfactory and low in cost. For larger installations, the RADIO NEWS Multi-Ear Aid is described in full detail in this article.

The system to be described this month is of the battery-operated type. A special high-grade, single-button carbon microphone is employed, feeding into a two-stage, high-gain amplifier. This amplifier, in turn, feeds the output system, which may consist of any number of individual headphones up to thirty or more, each headphone outlet being equipped with an individual volume control to




THE COMPLETE EQUIPMENT

*The microphone, left, is connected to the input of the amplifier. The output of the latter is then fed to the outlet system which may include up to thirty outlet boxes and headphones, although only one is shown here. The batteries connect to the amplifier by means of a cable and a simple plug-in arrangement*

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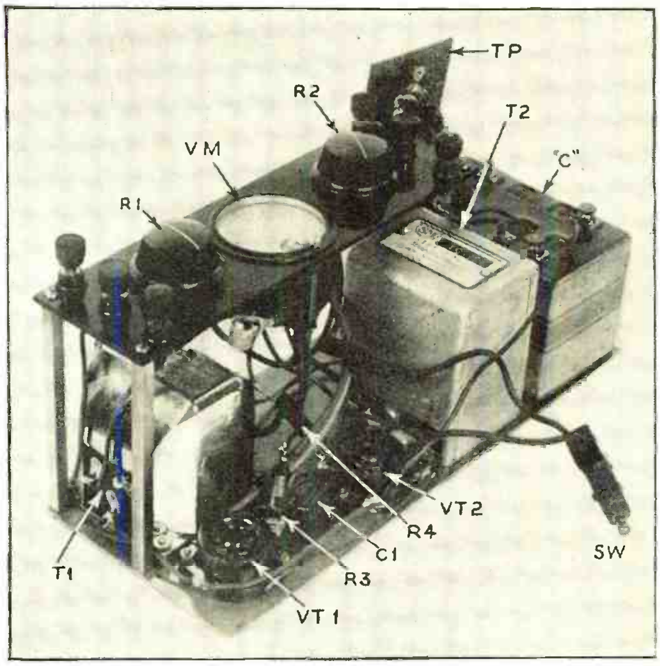
*Designed for installation in churches, theatres or other assembly places, and easy to build and install. This group hearing aid will permit up to thirty hard-of-hearing persons to listen-in comfortably with headphones*




THE AMPLIFIER CHASSIS

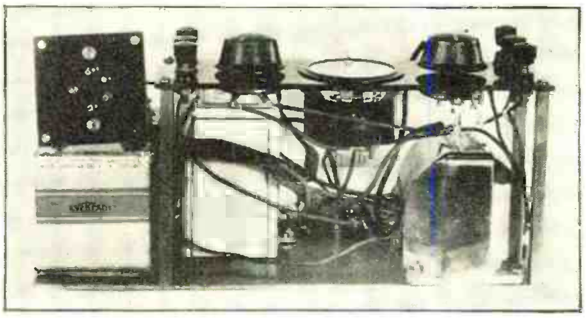
*Figure 2. When out of its case everything is easily accessible. All battery connections are made by means of the cable plug (TP), which mounts on the rear wall of the amplifier case*

enable each listener to adjust the sound to satisfy his needs.

In view of the trend toward a.c. operation, it may seem rather strange to design amplifier equipment to be operated from batteries. However, battery operation offers certain advantages which compensate for the greater convenience of the a.c. type of equipment. It may be added, however, that design work on an a.c. model is being carried on at the present time and such a model will be described in full detail later.

There are two reasons for making the first model a battery-operated job. In the first place, there are a great many people who prefer battery-operated amplifiers for headphone use, because of the difficulty of completely eliminating the hum in the a.c. type. However, where the users are hard of hearing, they are not likely to hear the hum anyway, provided it is kept down to moderate levels, and this is probably not a serious drawback. A more important consideration is that a great many churches are not wired for a.c. lighting. Some are equipped for d.c., others have their own low-voltage power plants, while others are not equipped with electric light at all. A battery-operated group hearing-aid can be used anywhere, whereas one of the a.c. type is necessarily limited to locations that are equipped with this type of service.

In the battery-operated model of the Multi-Ear Aid, the inconvenience of batteries has been reduced to a minimum. The total plate-current consumption for the amplifier has been kept down to less than 8 ma., with the result that a set of medium-size B batteries will last about one year. The A-battery consumption, including the drain of the two tubes and the microphone, totals slightly over 200 ma., which means that a single pair of dry cells should last for 110 to 150 hours of actual operation.



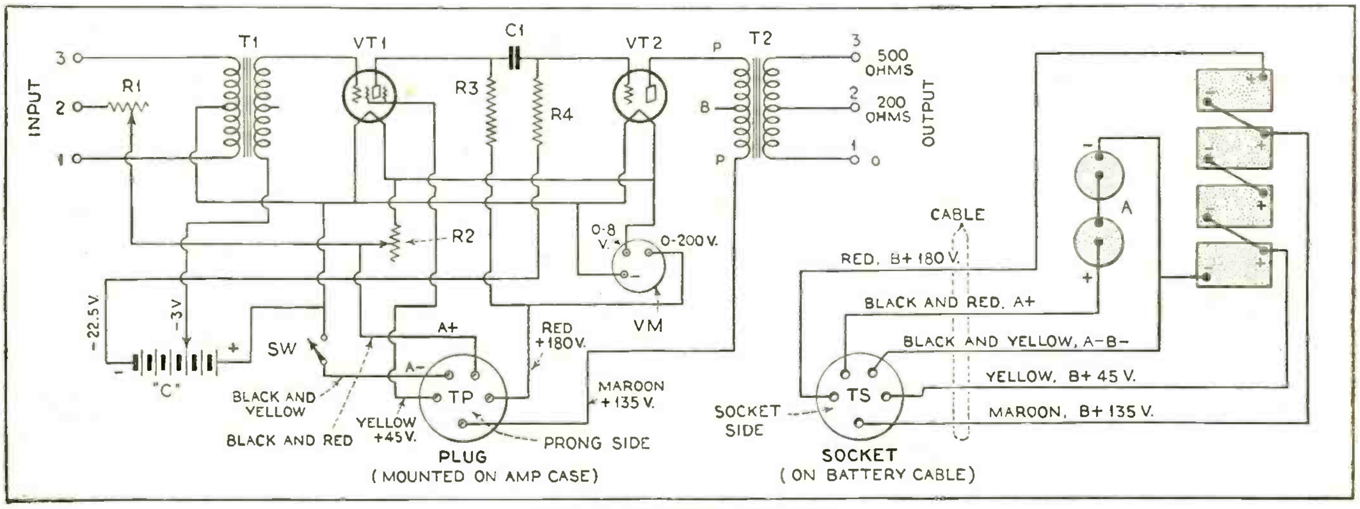
REAR VIEW OF THE CHASSIS

*The simplicity of construction is self-evident. The battery cable plug is shown at the left*

As a matter of convenience, a two-range voltmeter is included in the amplifier. Thus an instantaneous check on the voltages of both A and B batteries may be made.

In a hall or church where the equipment is in use for perhaps six to ten hours a week, the dry cells will require replacement once every four or five months; the B batteries about once a year or so. In a theatre, however, where the equipment might be operated several hours each day, the relatively short battery life would be a drawback, and a.c.-operated equipment might be more desirable.

Before going into a detailed




THE AMPLIFIER CIRCUIT

*Figure 1. The input connections provide for either single or double-button microphones. The output transformer is also tapped to provide for different loads*

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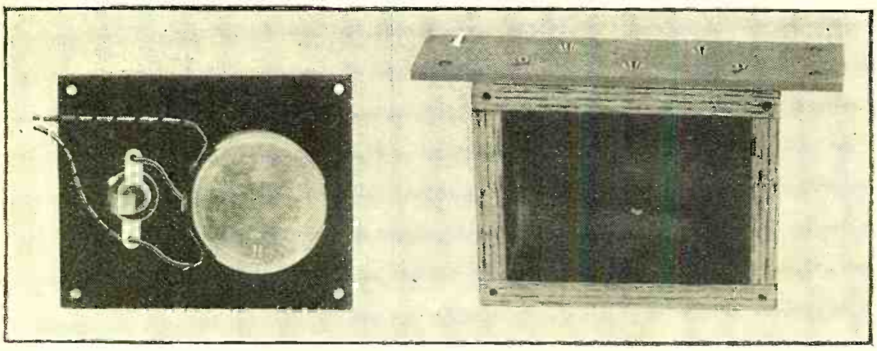


THE OUTLETS

*Each box, 3½ inches by 2¾ inches by 1⅜ inches, includes a 'phone jack and volume control mounted on its front panel. The panel is removed to show connections, the broken line showing the installation wiring. The universal mounting strip is shown in position for underseat mounting*

description of the equipment some further information on the characteristics and effectiveness of the outfit will be in order.

While the Multi-Ear Aid is designed primarily for speech reproduction, the average hard-of-hearing person will find its musical reproduction extremely satisfying—probably even better than the original music would sound to his unaided ear. The overall characteristic has purposely been made to rise with the frequency, thus compensating for the greater loss of hearing at the higher frequencies which is typical of the average person of impaired hearing. Its rising characteristic also has the added advantage of better speech reproduction because of more clear-cut articulation. The result of these considerations is that the speech reproduction from this equipment is satisfactory to a person of normal hearing and doubly so to the average hard-of-hearing listener.

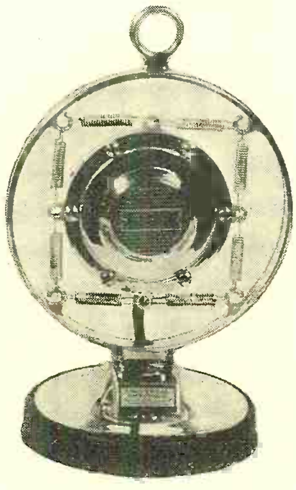
The good tone quality is one of the two outstanding requirements for equipment of this type. The other is an adequate volume level to make the speech clearly understandable to persons who have suffered extreme hearing loss. In this respect, the Multi-Ear Aid will take care of practically anything short of the most extreme cases of deafness.

With thirty headphones connected in the output, and all operating with the volume controls set for *maximum*, any person to whom the speech would be understandable with his unaided ear one foot from the speaker's lips, could clearly understand the speech through any one of the thirty headphones, provided the microphone was placed not more than five feet from the speaker. With six to a dozen headphones in the output circuit, the microphone could be about twenty feet away and still give the same volume of reproduction.

Normally speakers in a church or hall speak quite loudly and a person who could not understand them with the unaided ear, one foot away, would be extremely deaf. For persons with such extreme hearing loss the Multi-Ear Aid would be satisfactory when limited to about eighteen headphones—and with the microphone placed not more than four feet from the speaker. This assumes, of course, that all headphones would be operated at full volume. In actual practice, persons of less impaired hearing than the extreme example mentioned would normally cut down on their volume controls, thus consuming less of the output power and allowing more for the outlets having the volume controls set at maximum. It is apparent, therefore, that the above estimates of the number of outlets permissible lean toward conservatism.

The circuit of the group amplifier is shown in Figure 1, while Figure 2 shows a photograph on which each part is marked with the same designating symbols employed in Figure 1.

Following the circuit through from input to output, we have first the input transformer T1, which was selected for its excellent quality and because its secondary impedance is unusually high, with the result that a higher input is provided to the grid of the first tube.



THE MICROPHONE

*Here the microphone is shown, spring-suspended in a mounting ring of the table type, with the covers removed. The stand shown here is chromium plated, but is also available in bronze*

In the matter of volume control, it will be noted that there has been a deviation from usual practice; the variable resistance, R1, is placed directly in series with the battery supply to the microphone, instead of connecting a potentiometer across the secondary of transformer T1. This arrangement offers the advantages of smoother control, easy compensation for dropping voltage of the dry cells and minimum current consumption.

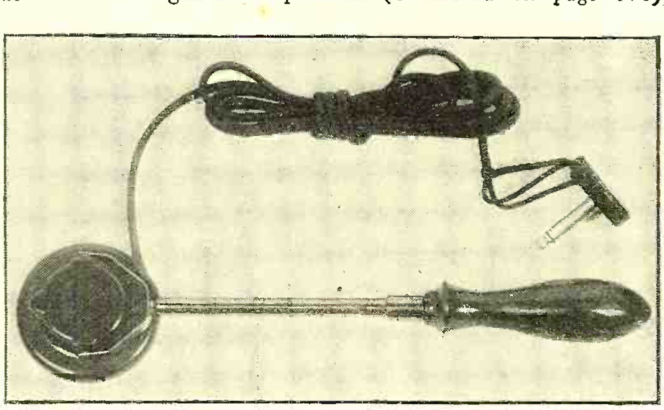
A type -32 screen-grid tube (VT1) is employed in the first stage because of the high voltage gain provided by this tube when using resistance coupling of suitable values. A far higher gain is obtained than would be possible with any three-element tube, even with transformer coupling to the output tube, and a saving in weight, space and cost is obtained in eliminating the transformer.

The resistance coupling is conventional—except in the use of a .02 *mica* condenser instead of one of the paper by-pass type. The mica condenser insures minimum leakage and is breakdown proof, the latter a feature of vast importance in such equipment as this.

The output tube (VT2) may at first glance seem rather inadequate in its power-handling ability. However, tests have shown conclusively that for this particular service it is quite ample. Relatively low power is required in the output for headphones—even using thirty of them at high volume. It is more important to avoid overloading by using a tube which permits a rather high grid swing, and in this respect the -31 type is superior to the -33 pentode or any of the battery tubes except the -71, and this one is impractical for dry-cell operation. In exceptional cases, where more than thirty headphones are required, a type -71 tube may be used in place of the type -31. This will necessitate the use of four dry-cells or a 6-volt storage battery, a separate rheostat for the -32 type tube and the connection of R1 to the tube side of this latter rheostat instead of to the battery direct. Also, only half of the primary of the output transformer will be used and the plate voltage for the output tube increased to 180 volts.

This output transformer is a special type exactly suited to the requirements of this amplifier system. Its primary impedance (using the full primary) is just right for the -31 tube load. Its tapped secondary likewise matches the headphone load—the entire secondary being used for loads consisting of up to about twelve outlets, and the 200-ohm tap being used for outlets in excess of this number.

It is well to point out the importance of using the specified auxiliary equipment. In designing the Multi-Ear Aid the greatest care was exercised in selecting parts which would work together to produce (*Continued on page* 970)



HEADPHONE EQUIPMENT

*Here is one of the light-weight headphones with handle and plug, ready for use*

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MORE ABOUT

# The "Twin-Grid" Tube

*Last month the author and inventor described a new tube in which there are two identical control grids. This tube opens up new possibilities in radio circuit design, more of which are described this month*

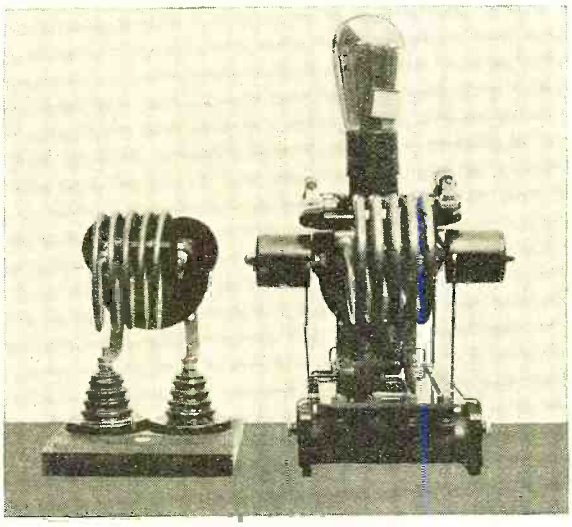
By Marion W. Taylor

*Part Two*

THROUGH the application of the Reversed Grid Potential Balance properties of the Twin-Grid tube, which were discussed last month, a circuit for effectively eliminating undesirable noises in the broadcast or commercial receiver has been devised and is shown in Figure 6. The circuit is fundamentally the same as that employed in the Automatic Volume Control, with the exception that the grid currents are supplied individually rather than from a common source, the difference of potential being controlled in the supply circuits rather than in the actual grid circuits.

How this circuit actually balances out undesirable noises such as static, cross talk, motor hum, and other forms of local interference may be more clearly understood from the following example: Let it be assumed that two duplicate receiving circuits A and B are connected to the same antenna-ground circuit or systems, so that any energy therefrom will be equally distributed to the two circuits. Connect the output of both receivers to the primaries of the interference balance transformer as illustrated, so that any signal from the receivers will be induced simultaneously and at opposite phase on the duplicate grids of the balance tube. It will be seen therefore, that so long as the two circuits A and B are tuned to the same signal, there will be no corresponding pulsations in the plate circuit of the Twin-Grid tube, due to the balancing action of the grid charges as explained. If, however, the two circuits are first tuned to the same signal, and then either circuit A or circuit B is detuned, so that the signal in that circuit is lost, the balance within the Twin-Grid tube is disturbed, and the signal from the tuned circuit is reproduced in the plate circuit of the tube.

It is a well-known fact that the atmospheric disturbances known as "static" when present, are audible thruout the entire broadcast band, and are received with practically the same intensity regardless of wavelength. Since circuits A and B are energized from the same source, any atmospheric disturbances in one circuit will occur in the other circuit with almost equal intensity regardless of wavelength at which the circuits may be operating at any given time. Therefore to receive a signal free from static it is only necessary to tune one circuit to the desired signal and tune the other circuit a few meters above or below this signal. The signal, having no opposition, will be reproduced in the plate circuit, while the static disturbances will balance out. This also holds true for other forms of interference not affected by tuning.



A COMPACT TRANSMITTER

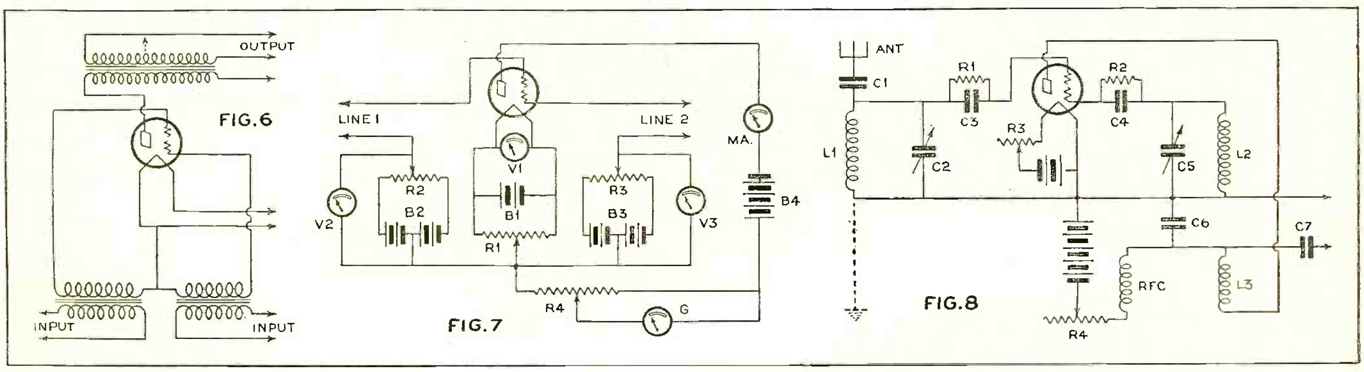
*This shows a complete radio telephone transmitter. At the right is the transmitter proper, surmounted by the tube. The unit at the left is the antenna tuning circuit*

### *Twin-Grid Bridge Circuit*

A vacuum tube bridge circuit combining the sensativity and flexibility of the vacuum tube voltmeter with the accuracy and simplicity of the Wheatstone Bridge has been devised for measuring minute units of electrical energy, resistance or capacity.

A simple form of bridge circuit is shown in Figure 7, and consists of a Twin-Grid tube, the duplicate grids of which are connected to a pair of branch circuits in each of which is incorporated suitable apparatus to bring these two circuits to electrical balance.

Balancing of the circuits may be obtained by either of two methods. The bridge may be operated as a calibrated direct reading unit, or as an indicating device in a group of instruments




THREE CIRCUIT APPLICATIONS OF THE "TWIN-GRID" TUBE

*Figure 6 shows a circuit for eliminating static or other similar interference. Figure 7 shows it used in a bridge arrangement. In Figure 8 it serves as the frequency changer in a superheterodyne receiver*

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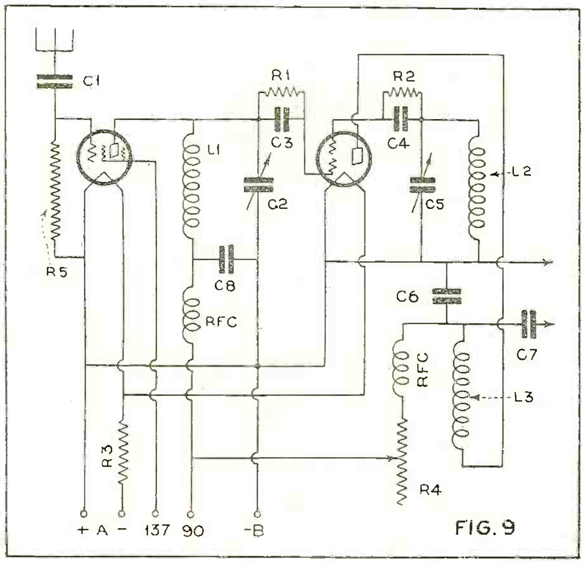
comprising a balancing system in which the unknown value is induced in one branch circuit and known values induced in the other branch circuit, the known values being varied until balance is obtained at which time the value of the two circuits is the same.

While only the simplest form of bridge is illustrated in Figure 7, the circuit is extremely flexible and may be varied so as to be utilized in almost any measurement of electrical values including resistance, impedance, frequency, capacity, etc.

### *Dupelidyne Circuits*

The term "Dupelidyne Circuit" may be applied to any Twin-Grid system of heterodyne reception in which a desired signal is received at its own frequency and is induced on one grid circuit, a generated signal of another frequency induced on the other grid circuit, the result of the combined frequencies producing a signal of a third frequency in the plate circuit where, thru suitable arrangement, it may be amplified and re-detected.

A simple form of Dupelidyne Circuit is shown in Figure 8. It consists of a radio receiving system comprising antenna and coupling condenser C1, inductance L-1 tuned by variable condenser C-2 and feeding energy to one of the Twin grids thru grid condenser C-3 and grid leak R-1; a means of generating a signal of a different frequency, comprising inductance L-2 tuned by variable condenser C-5 and feeding energy to the other grid element thru grid condenser C-4 and grid leak R-2; and inductance L-3 coupled to inductance L-2 thru by-pass condenser C-6 for the purpose of regeneration. The filament is energized by current from battery A controlled by variable resistance R-3. The plate circuit receives its energy from battery B whose value is controlled by variable resistance R-4 which functions as a regeneration control. Radio frequency choke R.F.C. restricts the high frequency current to its proper channel. The output of the circuit is coupled to a suitable amplifier thru by-pass condenser C-7.




SHORT-WAVE CONVERTER CIRCUIT

*Figure 9 includes a "twin-grid" tube used as the frequency changer following one screen-grid r.f. stage*

### *Dupelidyne Short-Wave Converter*

A Dupelidyne short wave converter for receiving short wave programs on a broadcast type receiver is illustrated in Figure 9. The circuit is fundamentally the same as that shown in Figure 8, with the addition of a preceding stage of radio frequency amplification for the purpose of increasing the signal strength.

This unit, when added to a broadcast receiver converts the whole into a heterodyne type receiver in which the converter produces the "beat" signal, the broadcast unit acting as an intermediate-frequency amplifier, second detector, and audio-frequency amplifier.

Another form of Twin-Grid short wave converter circuit is shown in Figure 10. The circuit is fundamentally the same as that shown in Figure 9 with the exception that the Twin-Grid tube has been relieved of its function as an oscillator and acts only as a mixing valve for producing the heterodyne signal. An extra tube has been added as an oscillator to supply the frequency necessary to produce the beat note. This beat frequency is supplied to the Twin-Grid mixing valve thru resistance R-6.

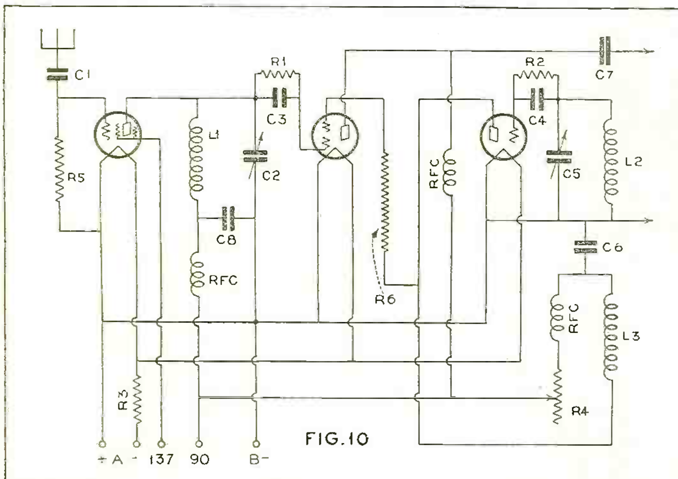
The output of the unit is coupled to a suitable amplifier thru by-pass condenser C-7.

### *Twin-Grid Reflex Circuit*

Because of its ability to operate on two frequencies at the same time, the Twin-Grid tube is highly efficient in reflex circuits.

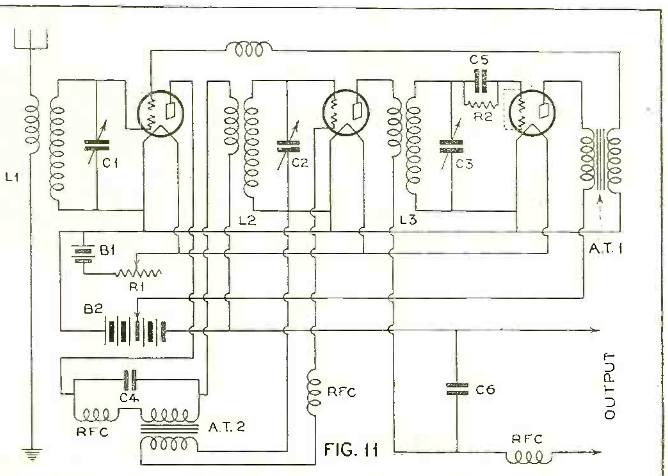
One form of reflex circuit is shown in Figure 11 in which the three Twin-Grid tubes provide two stages of radio frequency amplification, detector, and two stages of audio frequency amplification. The circuit consists of an arrangement of apparatus for amplifying signals at radio frequency, a means for detecting the amplified signal, and an arrangement of apparatus for further amplifying the detected signal at audio frequency.

In actual operation, the signal is received from the antenna-ground system (or other energy collecting device) thru the tuned radio-frequency transformer L1, the secondary of which forms one grid circuit of the first Twin-Grid tube. Into the plate circuit of this tube is connected in series a radio-frequency choke, RFC, the primary of audio transformer AT2, and the primary of tuned radio-frequency transformer L-2. Shunted across the radio frequency choke and the primary of the audio transformer is by-pass condenser C-4. Upon reaching this plate circuit, the signal, being at radio frequency is prevented by the radio-frequency choke from entering the primary of the audio transformer and is by-passed thru condenser C-4 to the primary of the second (*Continued on page* 966)




ANOTHER SHORT-WAVE CONVERTER

*Figure 10 is similar to Figure 9, except that the new tube serves only as a mixing tube*




A REFLEX CIRCUIT

*Figure 11. The new tube is readily adaptable to reflexing for reasons explained in the text*

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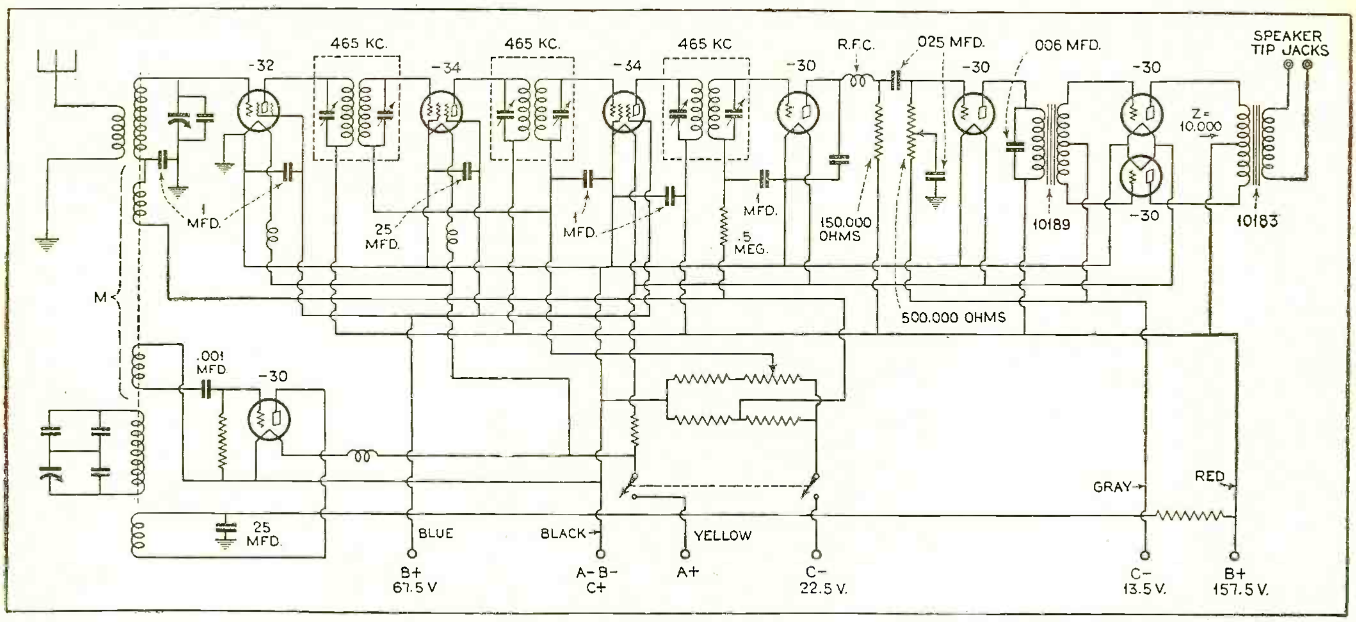



THE SCHEMATIC CIRCUIT DIAGRAM

*Figure 1. One feature of this new receiver is the elimination of both preselector circuits and r.f. amplification ahead of the first detector. This is made possible by the use of a relatively high intermediate frequency*

## NOVEL FEATURES IN THE DESIGN OF A NEW

# TWO-VOLT "SUPER"

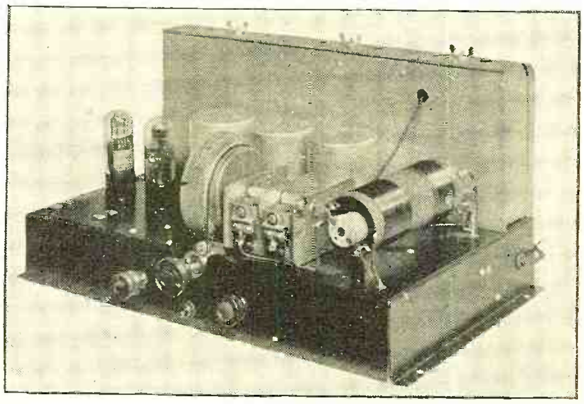
***R.F. pentodes, 465 kc. intermediate frequency, low A and B drains and 1 watt output, using -30's as power tubes, are some of the features of this new eight-tube superheterodyne for air-cell operation***

### *By* McMurdo Silver*

SOMEONE has aptly said that an engineer is one who accomplishes $10.00 worth of results with $1.00 worth of material. And while it may be charged that this quip suffers somewhat from rhetorical exaggeration, it does bring out in a very graphic way just what the radio engineer must strive to accomplish. But this must never be at the expense of the quality of the product; rather there is a continuous effort to improve quality and performance by bettering the efficiency of the system and components. Every new technical development must be carefully scanned, exhaustively tested and then put into practice just as soon as it has proven its worth. Then, strange as it may seem, the better way frequently proves to be the more economical way!

Typical of the results obtainable from the line of attack outlined above is the new Silver-Marshall 727DC two-volt superheterodyne to be described in this article. Briefly, this set is a battery-operated superheterodyne receiver featuring three of the most recent developments of the radio industry—the new -34 type 2-volt variable-mu r.f. pentodes, 465 kc. intermediate-frequency amplification and Class B audio amplification. Better yet, the performance naturally to be obtained from a correctly engineered circuit of this type, is secured with remarkably low battery drains—a fact of significance to radio listeners who are not among the more fortunate who are supplied with commercial a.c. service.

*President, Silver-Marshall, Inc.



A CHASSIS OF UNUSUAL APPEARANCE

*Figure 2. The layout is unusually simple. The shield box at the rear contains six of the tubes, each in an individual shielding compartment*

The circuit, shown schematically in Figure 1, makes use of eight two-volt tubes. The first detector is a type -32 screen-grid tube, which has a much higher mutual conductance than its closest relative, the well known -22. The new -34 super-control r.f. pentodes are employed in the two i.f. stages. The -34 differs from the ordinary screen-grid tube in that a "suppressor grid" is interposed between the plate and screen. The "suppressor grid" is internally connected to the negative filament terminal and thus eliminates the secondary emission which normally takes place in the ordinary screen grid tube when operating with considerable grid swing and rather low plate voltage. As is the case with the -51 and -35 vari-mu tubes, the control grid voltage plate current characteristic of the -34 shows a widely extended cut-off so that it is possible to control volume by control-grid bias voltage variation without running into distortion. Of course, such a characteristic is inherently free from cross-modulation interference and distortion. The remaining five tubes are the beating oscillator, second detector, first audio and output stage and are all of the -30 general purpose type.

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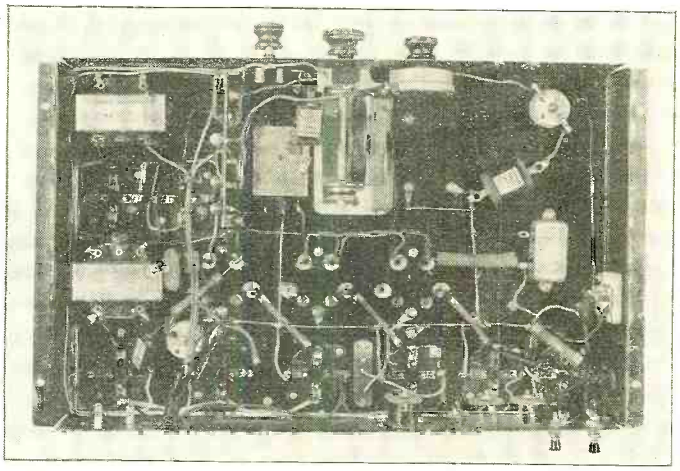
As to performance, it might be mentioned that the sensitivity of this receiver ranges between 6 and 3 microvolts absolute, or in terms of microvolts per meter, from 1.5 to .75—a sensitivity which can really be appreciated to the utmost only under the prevailing conditions of low noise level and reduced field strengths which characterize most rural areas.

The chassis is designed around the well known air-cell battery. Freedom from destructive acids and the assurance of approximately a year's service without replacement when used under proper operating conditions, has resulted in wide public acceptance of this type of A supply in isolated locations. However, the life of the battery is greatly shortened if the maximum permissible drain of 0.65 amperes is exceeded, and conversely, the life expectancy is considerably lengthened as the drain is reduced below the figure mentioned. Since the eight two-volt tubes are rated at 0.06 amperes each, the parallel drain is evidently only 0.48 amperes or well under the permissible maximum.



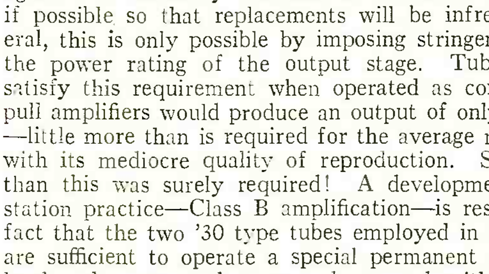
ALL SHIP-SHAPE BELOW DECK

*Figure 3. Note how all "grounds" are tied together by wire to avoid stray r.f. currents in the metal chassis*

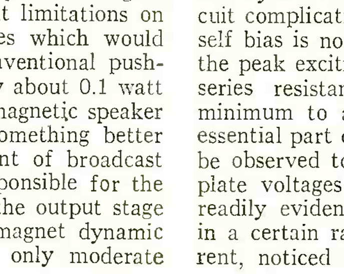
Plate voltage is obtained from three 45-volt blocks, with a tap taken off at 67.5 volts for screen voltage supply. Here again it is extremely desirable to economize on battery drain if possible so that replacements will be infrequent. In general, this is only possible by imposing stringent limitations on the power rating of the output stage. Tubes which would satisfy this requirement when operated as conventional push-pull amplifiers would produce an output of only about 0.1 watt—little more than is required for the average magnetic speaker with its mediocre quality of reproduction. Something better than this was surely required! A development of broadcast station practice—Class B amplification—is responsible for the fact that the two '30 type tubes employed in the output stage are sufficient to operate a special permanent magnet dynamic loudspeaker at good room volume and with only moderate plate-current requirements, a job requiring about 1 watt of audio power. The subject of Class B amplification has received the attention of the writer (see RADIO NEWS for February) and others in the technical press, and it will therefore not be necessary to discuss the matter in detail here. Several interesting points, however, are worthy of attention.

A Class B stage resembles a conventional push-pull arrangement in circuit, but here the resemblance ceases, for the grids are biased almost to the point of plate current cut-off. In the case of the receiver described here the output stage plate current (total) is a little less than 1 ma. when no excitation is supplied the grids. When a signal is applied, the plate current rises to about 10 ma. for average room volume and fluctuates about this value in accordance with the modulation. Since the remaining tubes draw about 12 ma. the total drain under these conditions is 22 ma. As almost one-half of the total drain is due to the output stage, the battery current will be materially reduced as the volume is lowered, or as it varies throughout the range of a reproduced program. This is in direct contrast to the conventional push-pull operation in which the plate current, as measured with a d.c. milliameter, is essentially constant.

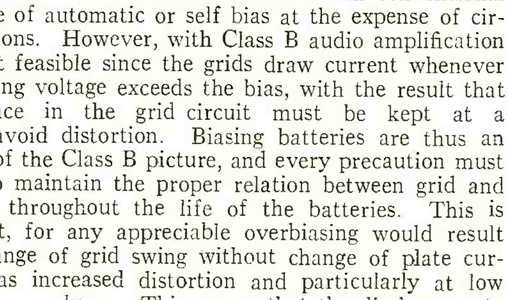
Under ordinary conditions encountered in the usual run of battery receivers, the plate voltage drops gradually as time goes on, while the grid bias remains practically constant, or nearly so. This is of course due to the fact that there is a considerable load on the plate battery, while deterioration of the C battery is entirely a matter of shelf life. As a result, the tubes operate under correct conditions only when the batteries are new, and are over-biased after the set has been in operation for some time. This could be eliminated in conventional sets by the use of automatic or self bias at the expense of circuit complications. However, with Class B audio amplification self bias is not feasible since the grids draw current whenever the peak exciting voltage exceeds the bias, with the result that series resistance in the grid circuit must be kept at a minimum to avoid distortion. Biasing batteries are thus an essential part of the Class B picture, and every precaution must be observed to maintain the proper relation between grid and plate voltages throughout the life of the batteries. This is readily evident, for any appreciable overbiasing would result in a certain range of grid swing without change of plate current, noticed as increased distortion and particularly at low volume. This means that the discharge rate of the C battery must be carefully matched to that of the plate batteries. A glance at the wiring diagram in Figure 1 will show how this is accomplished. Bias for the various stages is taken from a voltage divider network connected across the 22½ volt terminals. A portion of this network consists of a volume-control potentiometer which applies from −3 to approximately −22½ volts to the control grids of the intermediate-frequency amplifiers. Approximately 8 volts is tapped off another section of the voltage divider system for first and second detector bias. A 13½ (*Continued on page 962*)




SENSITIVITY CURVE




SELECTIVITY




FIDELITY—ANTENNA TO SPEAKER

*Figure 4, left. The sensitivity as shown by this curve exceeds that of many modern a.c. receivers. Figure 5, center. Ten kilocycle selectivity is obtained at 100 times down, in spite of the absence of tuned r.f. and preselector circuits. Figure 6, right. The speaker when connected to the set partially compensates the rather sharp drop at the high frequency end of this curve, tending to flatten the curve considerably*

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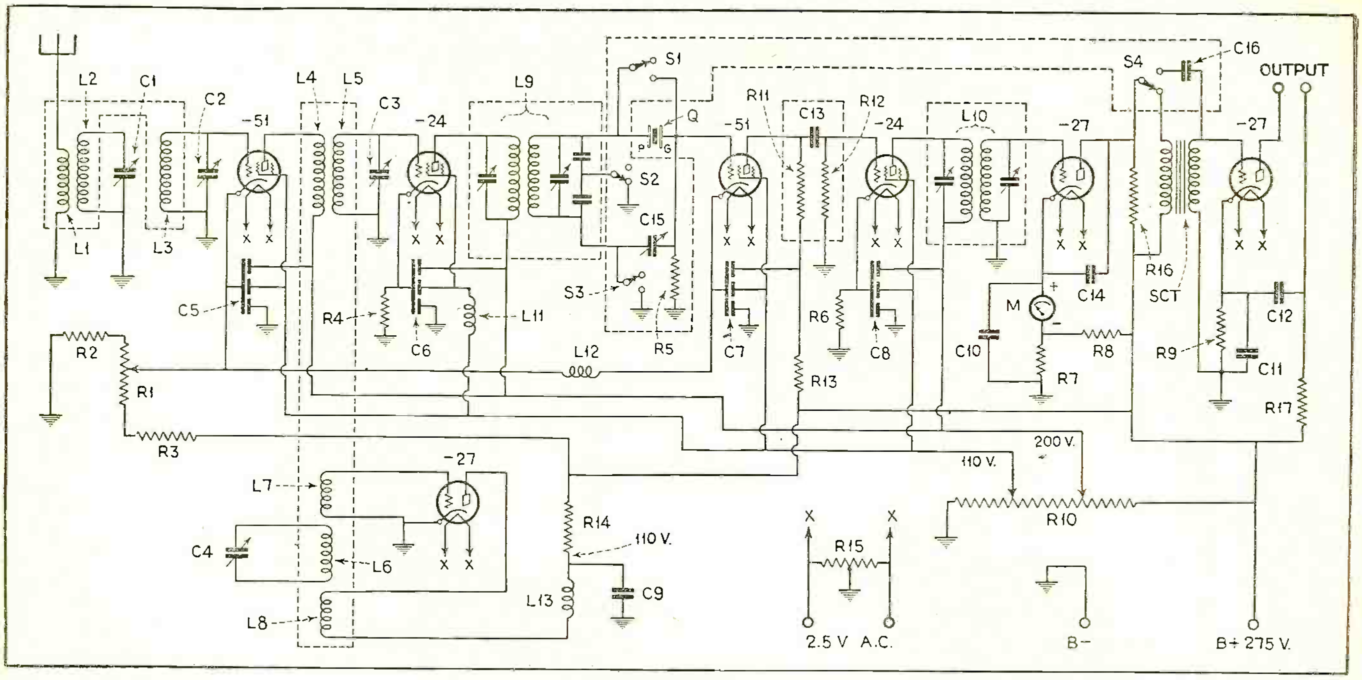


WIRING DIAGRAM OF THE TUNING UNIT

*Figure 1. The output may be connected to any standard amplifier and power supply*

## HOW TO BUILD A MODERN STENODE

# Quartz-Crystal Receiver

***In the article last month the quartz-crystal tuned receiver was discussed and the author suggested new arguments to show that greater than ten kilocycle selectivity, with good quality, is a practical possibility. This month he provides constructional data on the 1932 model and conversion details on last year's model***

*By* Zeh Bouck

*Part Two*

AS we pointed out in our preceding article, the principle argument advanced by the proponents of the Stenode is the fundamental proposition that it is possible to compensate the high audio-frequency attenuation, accompanying ultra sharp tuning, without destroying the selectivity gained by sharpening the circuit. Following the preparation of our original paper, an interesting laboratory set-up has demonstrated this possibility to a marked degree.

The arrangement consists of a Stenode receiver and a crystal-controlled oscillator tuned five kilocycles below the frequency of WEAF. The set is tuned to the oscillator frequency, and carefully balanced. (In other words, the balance control is at its neutral position, and the resonance curve is symmetrical. At an off-balance position, as used for beat-note elimination, WEAF'S signal could be discriminated against still further, with a single sideband effect, which, however, would render the experiment inconclusive.)

### *The New Receiver*

With the oscillator on, WEAF breaks through with inverted modulation, due to the sidebands of the station beating with the temporarily unmodulated oscillator carrier. The only note maintaining its true frequency, and this is considerably attenuated, is an occasional 2500-cycle tone. In other words, WEAF's carrier, five kc. off resonance, has been so attenuated that it is incapable of demodulating its own sidebands in the presence of even a very weak carrier, five kc. away, to which the receiver is tuned. When the oscillator is turned off, and the receiver left tuned to its frequency, with the volume control set for normal response to local stations, WEAF, twenty miles from the laboratory, is practically inaudible, again showing the very great attenuation of its carrier frequency.

However, when the oscillator is modulated, the high notes (on the oscillator carrier), neighboring 5000 cycles, are distinctly present. In other words, a gain in selectivity has been effected—beyond the limits which determine ten-kilocycle station separation—without loss in quality!

It is the primary purpose of the present article to indicate the differences between the present advanced Stenode model and its immediate predecessor of last Fall—to provide the information necessary to the modernization of the former receiver. At the same time, effort will be made to include sufficient constructional details as will enable the experienced radio mechanic to build the Stenode, starting from scratch. While the variations between present and former models are such as to effect marked improvement in reception, they occasion only minor changes in the actual constructional technique, and the standard Stenode books and blueprints remain excellent texts on Stenode theory, general and specific instruction, and operation.

The 1932 Stenode is best described in reference to the circuit diagram of the tuner unit appearing in Figure 1. This tuner, which incorporates one stage of audio-frequency amplification, can be used in conjunction with any high-grade power amplifier (single or push-pull tubes) and power supply unit capable of supplying 2.5 volts a.c. for the heaters and 275

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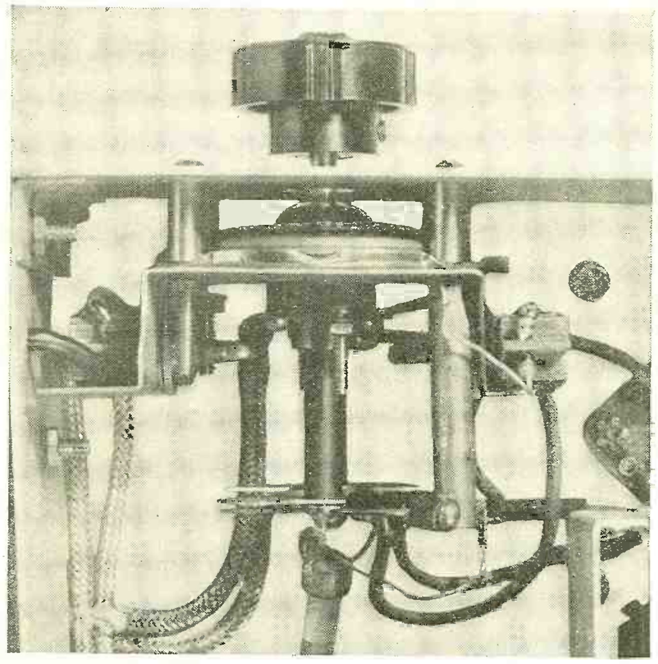
volts d.c. for the plates. The audio output of the tuner is of excellent quality, regardless of whether the receiver is operated as a Stenode or an ordinary superheterodyne. Seven tubes are employed in the tuner unit—a type -51 in the high-frequency amplifier, a -24 as first detector, a -27 oscillator, a type -51 in the first i.f. socket followed by a -24, a -27 as second detector and the same in the a.f. stage.

Coils L1, L2 and L3 are in the usual preselector circuit and provide adequate image-frequency reduction. L1 and L2 are wound on a single form, and L3 on another form of the same size. These three coils are mounted in the same shield—dotted lines throughout Figure 1 enclosing commonly shielded parts. The high-frequency stage is coupled to the first detector through L4 and L5, while L6, L7 and L8 are in the oscillator circuit. L4, L5, L6, L7 and L8 are wound on the same tube, providing adequate coupling between the oscillator and first detector circuits. L9 is the special input i.f. unit which received detailed attention last month. In addition to the usual tuning condensers, the secondary is shunted with the small center-tapped capacitor, making possible the bridge input circuit across the crystal, Q. L10 is a more or less standard and broadly tuned i.f. transformer, inputting to the second detector. L11, L12 and L13 are radio-frequency choke coils.

### *Oscillator Tuning Without Padding*

Condensers C1, C2, C3 and C4 tune their respective circuits. The rotor plates on C4 are specially curved, so that the oscillator circuits tracks 175 kc. above the preselector, r.f. and detector. The use of the oscillator-tracking condenser, designed by the author and described in RADIO NEWS for July, 1931, eliminates the necessity for padding condensers and simplifies the adjustment of the circuit. C5, C6, C7 and C8 are standard triple-section condensers, by-passing to cathodes. The only other condensers worthy of special note are C13, the coupling condenser in the resistance-coupled i.f. stage; C15, the small balancing condenser; and C16, the coupling condenser in the first a.f. stage when the receiver is operated as an ordinary superheterodyne.

Resistor R1 is the volume control, varying the bias on the -51 type tubes in the r.f. and first i.f. stages. R2 is the usual bias-limiting resistor, while R3 completes the circuit. R4, R6, R7 and R9 are grid-bias resistors. R10 supplies the correct voltages to the screens and plates, while R13, R14 and R17 are independent series resistors. The important voltages have been indicated on the diagram, and the resistors should be adjusted to provide these values within fairly close tolerances. R5 and R12 are grid leaks. The quartz crystal, Q, is mounted

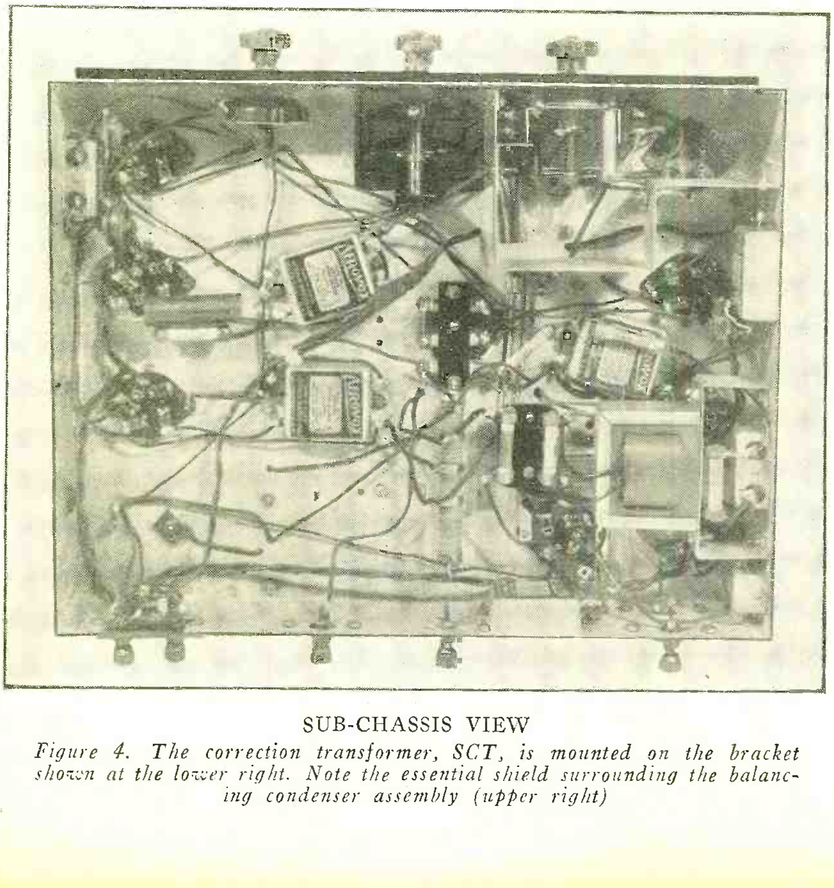


CLOSE-UP OF THE BALANCING CONDENSER

*Figure 5. The condenser itself is short-circuited by the rotor plate coming in contact with the spring when the condenser is all the way out. Above the balancing condenser is shown the switch assembly*

in a vacuum tube with a standard UX base. Connections are made to the plate prong and to the cap atop the tube. There are no adjustments of any kind associated with the crystal, and as far as we can determine, its life is subject only to the limitations of mechanical breakage. The permanent crystal holder within the vacuum cannot get out of adjustment.

Switches S1, S2, S3 and S4 are automatically actuated by the balancing condenser C15 and are used to select operation either as a Stenode or as a straight super. When the balancing condenser is turned all the way counter-clockwise, the receiver operates as an ordinary superheterodyne. A slight turn to the right throws the receiver over to Stenode operation, and the balance control may then be operated for the Stenode effects.



SUB-CHASSIS VIEW

*Figure 4. The correction transformer, SCT, is mounted on the bracket shown at the lower right. Note the essential shield surrounding the balancing condenser assembly (upper right)*

In Figure 1, all switches are shown in the Stenode position, the bridge input circuit being utilized with the second detector connected through the correction transformer, SCT. This transformer, in conjunction with the condenser C14, is so designed that practically perfect compensation is effected for the loss of the higher audio frequencies as the signal is passed through the Stenode system. The primary impedance of SCT is considerably lower than that of the resistor R16, which has no noticeable effect on the Stenode output.

### *Ordinary Super or Stenode*

When the receiver is operated as an ordinary super, the correction circuit is eliminated, the second detector being coupled to the first audio tube through resistor R16 and condenser C16, the secondary of transformer SCT acting as an impedance leak. At the same time the quartz crystal, Q, and the balancing condenser, C15, are shorted, and the ground is removed from the center-tap of the bridge condensers, making it possible to utilize the full output across the secondary of L9. The re-resonating effect of the very slight capacity change across this coil is negligible.

The inclusion of this switch, permitting the use of the receiver either as a Stenode or an ordinary super, is desirable for several reasons. On quiet nights—when exterior background noise is at a minimum—the increased sensitivity as a straight super (due to the

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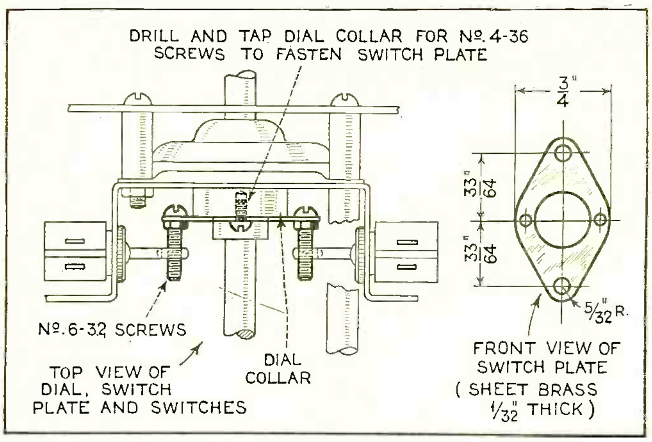



MECHANICAL DETAILS OF THE SWITCH

*Figure 6. The mechanical arrangement for throwing two switches at one time, by turning the balancing condenser dial*

fact that the entire output of L9 is utilized) may be used for DX reception from stations clear of interference. Also, the receiver is slightly easier to tune as an ordinary superheterodyne. On the other hand, the turn of a single knob provides the advantages of Stenode reception—reduction in exterior background noises, super-selectivity for the reception of distant stations through local and distant interference, and the elimination of heterodyne whistles.

When operating as a conventional superheterodyne, the receiver may be tuned aurally. However, when the Stenode features are functioning, it is practically necessary to tune for a maximum deflection on the meter, M.

It will be desirable, at this point, to indicate the differences between the 1932 circuit and its immediate predecessor. The most obvious variation is the inclusion of the Stenode-super switch just described. A type -27 tube has been substituted for the -24 in the correction or first audio stage, and the correction transformer has been redesigned for an improved compensation curve. A superior degree of isolation of the first a.f. and oscillator plate circuits has been achieved by the inclusion of resistors R14 and R17, resulting in more stable operation and a reduced tendency toward oscillator drift. The sensitivity has been increased by changing the value of the i.f. coupling resistor, R11. And the heaters have been grounded through the conventional center-tap resistor, R15.

## *Constructional Details*

The general mechanical arrangement and the method of construction are best indicated in the accompanying illustrations. Figure 2 shows the chassis layout, while photographs, Figures 3 and 4, indicate the mounting procedure and placing of parts. The layout is practically identical with that of the 1931 Stenode. Figure 5 is a close-up of the switch, while Figure 6 gives further details of its construction. Figure 5 shows the manner in which the balancing condenser on the old model may be readily modified in accordance with the circuit requirements of Figure 1. (It follows, of course, that if it is not desired to operate the receiver as an ordinary superheterodyne, the switching arrangement may be eliminated—thus simplifying both construction and modernization. However, with the switch-balancing condenser readily available, the combination receiver is highly recommended.)

It is important that all leads to these switches be carefully shielded, and that a type of shielding be used which does not introduce an inordinate amount of capacity in the circuit.

Particular care should be observed in lining up the condenser and the dial. If they are not perfectly in line, the resulting binding will cause the dial to slip on the low-ratio adjustment, limiting the action to the high 250-to-1 ratio. When the condenser and dial are mutually aligned there will be no slippage, and the low-ratio adjustment should be certain and continuous over the entire tuning range.

Another point of caution is to isolate all a.c. leads from the vicinity of the correction transformer, SCT. Due to the extremely high gain of this unit and the amplification in the succeeding stage, the slightest trace of an induced hum will be annoyingly audible in the speaker output.

It is important that the by-pass condensers incorporating the three .1 mfd. condensers be connected with the common terminal to cathode, *not to ground.*

The pre-selector, r.f., first detector and oscillator coils should be mounted on brackets so that they are in the center of their respective sections of the large shield can. The pre-selector and r.f. secondary are mounted vertically, in binocular fashion, while the long detector-oscillator coil is held by stilts in a horizontal position. This is shown in the photograph, Figure 3.

## *Making Any "Super" a Stenode*

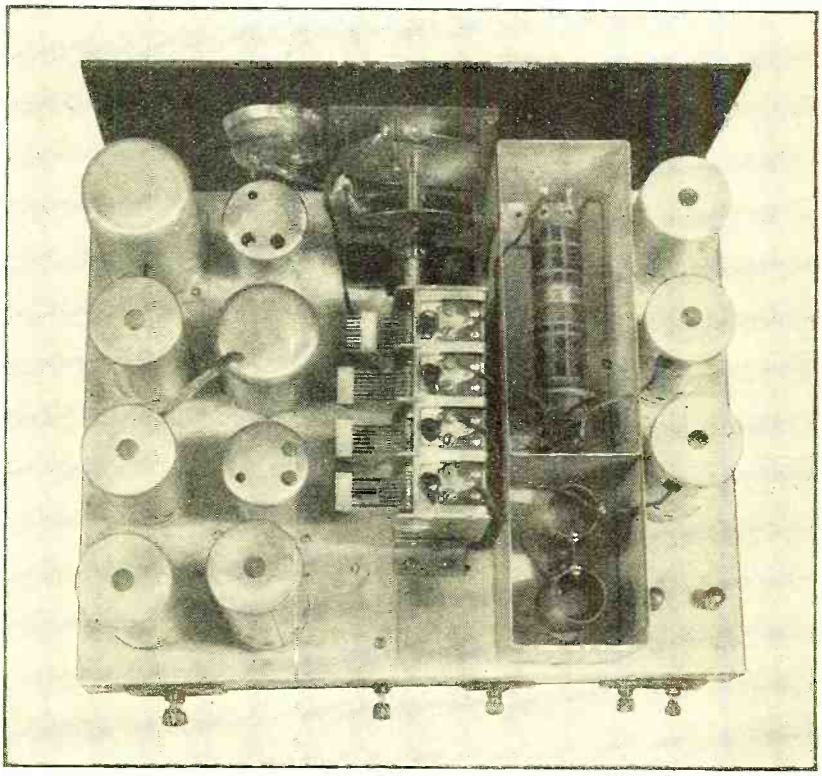
Looking at Figure 3, the individual cans in the three rows, running from the panel to the rear, are identified as follows:

*Left-hand row*—Oscillator tube, first detector tube, r.f. tube.

*Center row* (just behind the meter)—Input i.f. unit, resistance-coupled i.f. unit, output i.f. unit, second detector tube.

*Right-hand row*—Quartz crystal Stenotube, first i.f. tube, second i.f. tube, first a.f. tube.

Considering the essential fact that the Stenode is nothing more than a superheterodyne in which the intermediate-frequency amplifier is sharply resonated by means of a quartz crystal, with the high-frequency attenuation compensated following the second detector, the question arises from the owners of many supers as to the possibility of converting their present receivers to Stenode operation. There is, of course, no fundamental reason why this cannot be done. However, the engineering difficulties are considerable, and it is a task that we should hesitate to recommend to other than an engineer or expert perfectly familiar with Stenode theory and practice, and the vagaries of ordinary superheterodyne operation. The general experimenter will find it preferable to avail himself to the special Stenode parts and the specific layout suggested, all of which have been engineered to produce a highly satisfactory receiver with a minimum of (*Continued on page* 963)



TOP VIEW OF THE TUNER

*Figure 3. Shows the cover of the coil can removed. The section of the condenser nearest to the dial is the special oscillator tracking capacitor*

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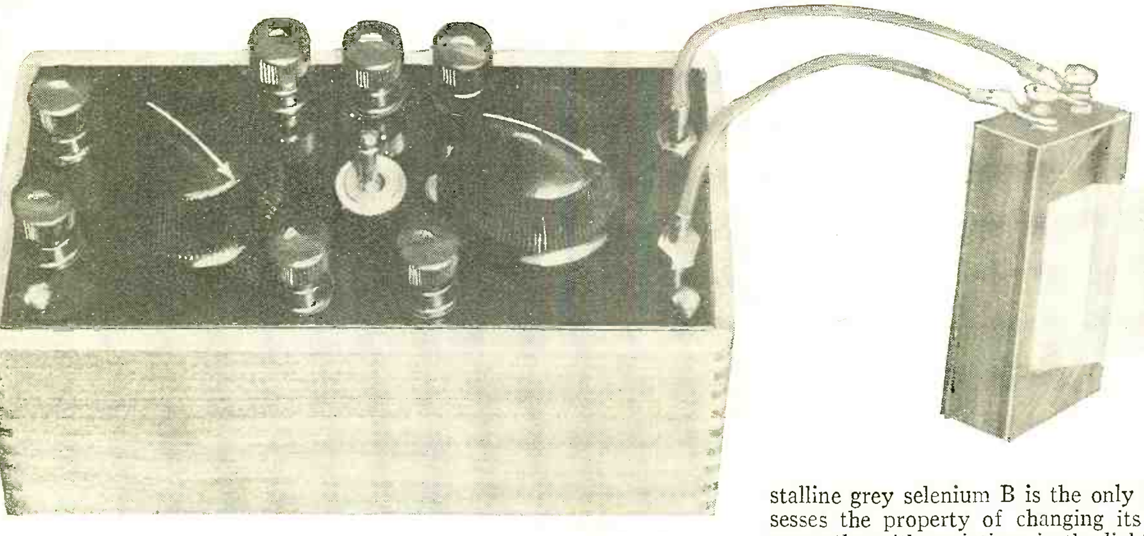


# BECOMING ACQUAINTED WITH THE COMPLETE LIGHT

*By* Bernard J. Montyn

DURING the last few years the selenium cell has been more or less neglected. Many people are under the impression that the reaction of the selenium cell to fluctuations in the incident light is necessarily slow and that therefore the cell could never be used at audio frequency. This is not exactly so; it has been found that this lag was due to an incorrect way of using the cell rather than to the properties of selenium.

The concentration on the solution of talking movies and television has focused attention on the metal-oxide cell. But for the purpose of controlling machinery by light, the selenium cell is preferable because of its greater sensitivity and its economy. In all those cases where the cell has to actuate a relay, selenium permits a saving in cost, not only by its own low price but also because it eliminates the necessity of amplifying the current impulses.

The experimenter will find that with one of these selenium cells and a comparatively simple, inexpensive relay, he can put together a small device which can perform many interesting tasks. As an example, it can be set to make or break a connection at a certain illumination; therefore it should be very handy for the turning on of lights or signs as soon as the light is below a certain minimum. This is better than controlling such a sign by a clock, for darkness comes at a different time each day and sometimes it may be so dark during the daytime that one would have the lights on. The selenium cell will take care of all this and turn the light off again when daylight returns. This is, of course, just one of its many possible applications.

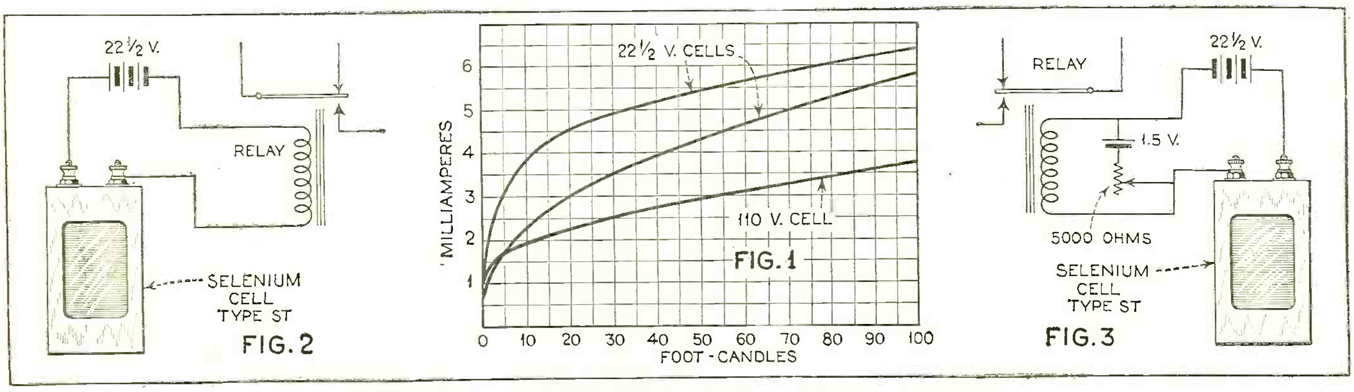
Selenium exists in several allotropic forms. Four of these are crystalline. Crystalline grey selenium B is the only form which possesses the property of changing its conductivity in sympathy with variations in the light falling upon it. It is obtained from the other forms by annealing at 200 degrees Centigrade (392 degrees Fahrenheit).

Just what change occurs in the selenium when light falls upon it is not well known; it is thought that it is a variation in ionization. This ionization starts immediately with the change in illumination, but it takes time before the entire mass of material has been converted. Since this has been discovered the selenium was spread out much thinner, so that it is all exposed to the light and there is less of it. Thus the time of the reaction has been decreased materially and it is claimed that certain types of cells do not show evidence of any time lag until they are used at frequencies above 10,000 cycles.

We are now concerned in this article with experimental and industrial applications only and, so far as these purposes are concerned, there is no appreciable time lag caused by the cell.

The photo-cells and the relay described in this article are manufactured by the Luxtron Devices Co. of Brooklyn, New York. They can be obtained for 22½-volt battery operation or for 110 volts. Although the action is a little better with the batteries connected in one way, there is no objection to connecting the 110-volt cell across an a.c. line in the absence of a d.c. line.

Different types of these cells were measured in the RADIO NEWS Laboratory and some of the curves are shown in Figure 1. These measurements were made by connecting the cell in series with a battery and a milliammeter and placing it at different distances from a known light source. At the same




SENSITIVITY CURVES AND FUNDAMENTAL CIRCUITS

*Figure 1 shows sensitivity curves on two 22½-volt Wein cells showing the average variation between production samples and one sensitivity curve on a 110-volt Wein cell. Figure 2 shows a simple fundamental circuit for using the Wein selenium cell and Figure 3 shows another simple fundamental circuit for cancelling dark current*

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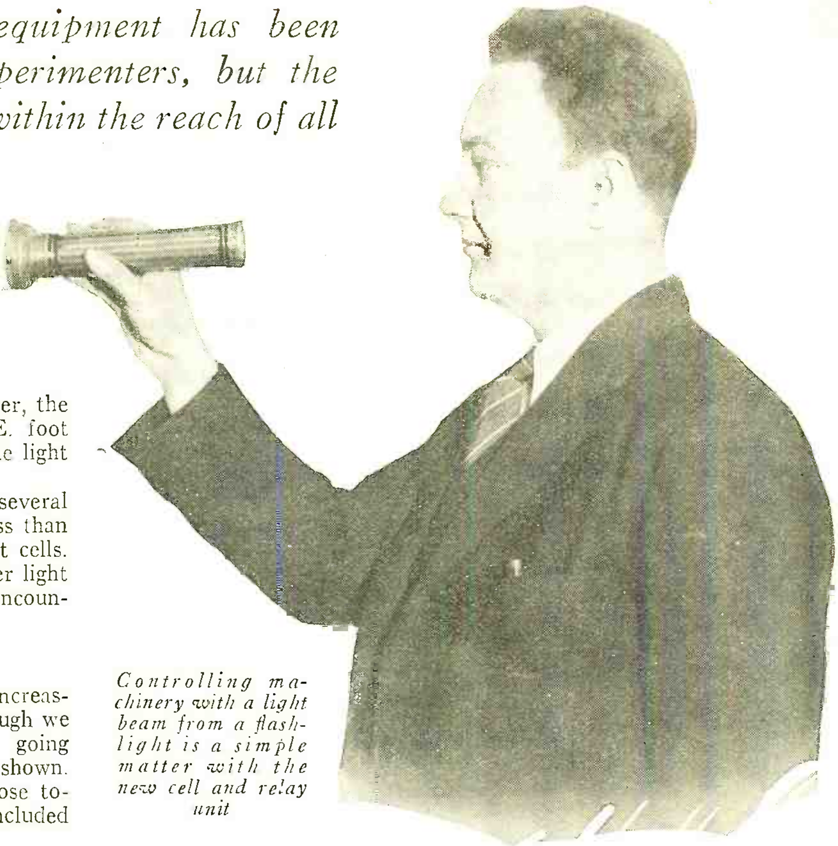
*¶ Heretofore light-sensitive equipment has been too expensive for most experimenters, but the apparatus here described is within the reach of all*



*Controlling machinery with a light beam from a flashlight is a simple matter with the new cell and relay unit*

time that the current was read on the milliammeter, the illuminated was measured on a standardized G.E. foot candle meter, placed at the same distance from the light source.

When the cell is in the dark—covered with several layers of black cloth—the current is somewhat less than 1 ma., but this varied somewhat with the different cells. It is fortunate that the steepest rise is at the lower light intensities, as these are the ones that are being encountered in practical applications.

### *Sensitivity Curves of Cell*

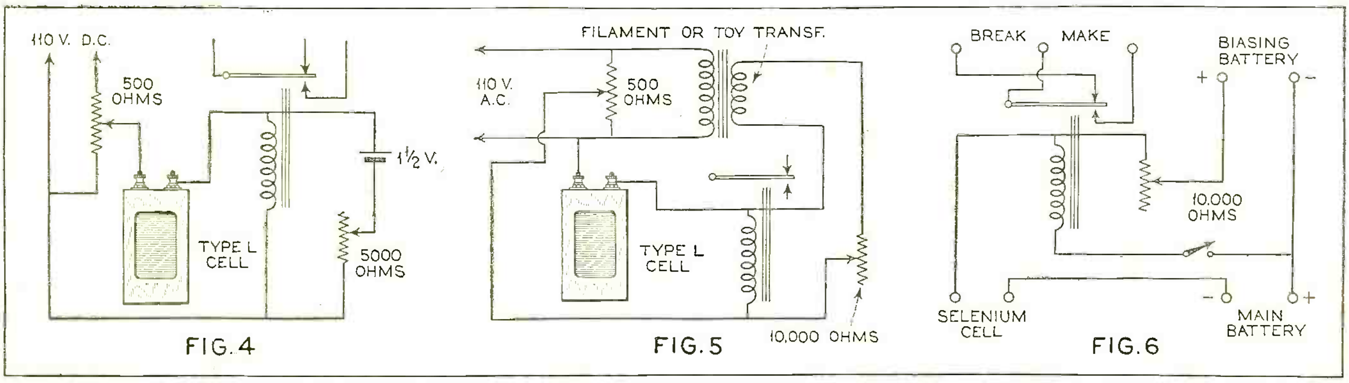
Theoretically, the curve should be different for increasing light and for decreasing light. However, although we repeated the same measurements going up and going down, the curve nearly coincides with the one shown. The "up" curve and the "down" curve are so close together that it would lead to confusion if we included them in Figure 1.

To obtain a satisfactory relay is the hardest part of the work in building a photo-electric device. The one shown, manufactured by the Luxtron Devices Co., will close at about 2 ma. and the contacts are such that they will handle 3 or 4 amperes at 110 volts. With this instrument it becomes possible to control lights and small motors directly with the cell and relay with the omission of any amplifiers or additional apparatus.

This relay is supplied with both make-and-break contacts and an adjustable spring. The distances of the contacts can also be varied. With this arrangement, the same relay can be adapted for widely different functions.

The simplest way of hooking up the cell and relay is shown in Figure 2. This will answer very well in some cases. The relay can be made to trip at the correct light intensity by adjusting it and by changing the voltage on the cell. This adjustment can be made so that the contacts are opened again at another light intensity. However, in many cases it will not be possible to have the armature fall off at the right moment because of hysteresis; it takes less current to hold it than it did to attract the armature. As an example, suppose that the current is 1.6 ma. normally; this will not be sufficient to attract the armature. Now the light increases and the current becomes 2.5 ma. This will, of course, be enough to close the contacts. When the light falls back to its original value, the armature *may not fall back!* This effect may pe eliminated by neutralizing the "dark current." It is done by connecting another battery across the relay and a rheostat in series with it. If the polarity of this auxiliary battery has been chosen properly, the dark current can be partially or wholly neutralized and the normal current might become 1 ma. in the example just given. When the light is increased, the current will now rise to 2 ma. and this is still sufficient to close the contacts. When the current drops down to normal again it will become 1 ma., which is low (*Continued on page* 955)

# CONTROL OF MACHINERY BY A SENSITIVE UNIT




CIRCUIT FOR POWER LINE OPERATION AND A SPECIAL CIRCUIT

*Figure 4 gives a circuit diagram for 110-volt d.c. operation with a 1½-volt balancing arm. Figure 5 shows a complete 110-volt a.c.-operated circuit with balancing current furnished through a small transformer. Figure 6 shows the Universal unit described in this article and illustrated at the top of the page*

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# A $12.05 Short-Wave Set

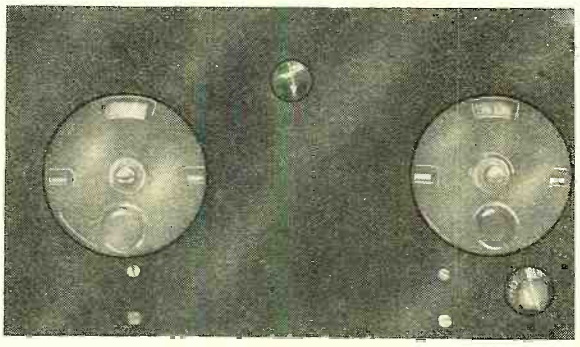
*Here is a simple short-wave receiver for those who, from choice or necessity, prefer to make most of their own parts*

By Glenn Ellsworth

IN constructing this receiver our purpose was to obtain a receiver that would bring in various stations working on the higher frequencies, including the air-mail ground stations and "hams" (phone and code), along with the numerous short-wave broadcasting stations of the United States and Canada.

We mention $12.05, because that was the initial outlay for all the parts we had to buy. Doubtless the fan building this set will need to purchase some of the parts that we found in the radio junk box, but this will be offset by the probability that he will have in his own junk box at least some of the parts for which we were forced to pay hard earned cash.

When this little three-tuber was ready for the air, we were agreeably surprised by the performance. Not only did the required air stations come through better than we had hoped, but at noon (Pacific Time), while eating our lunch, we listened to G5SW. This station was playing American music which came through with some fading and quite a bit of noise, but the announcement was loud and clear. Considering the lack of shielding and the losses that must be present through various junk parts used, we thought this was very fair reception.



LOOKING AT THE FRONT

*Figure 1. The dial at the left controls the ganged tuning condensers. The one at the right regulates regeneration. The upper control is the tuning vernier and the knob at the lower right regulates volume. The panel is a piece of pine with tinfoil pasted on the back to serve as a shield*

### *The Parts Used*

Many of the parts were taken from an old Fusaformer set that cost us $2.00. This provided the tuning condensers, sockets, etc. The parts we found we needed and which account for the $12.05 outlay are as follows: Twenty-two inches of inch and a quarter (outside diameter) bakelite tubing, $1.25; 1 15-ohm fixed resistor, 35c; 1 50-ohm rheostat, $1.00; 2 condensers, .01 mfd., $1.50; 2 odd panels, 20c; 1 type –32 screen-grid tube, $3.30; 2 used volume-control arms as taken from an Atwater Kent model 40, cut to shape as in Figure 7 (x) costing us 10c; three feet of ½-inch strap iron, 10c; 1 grid leak, 4 meg., 35c; 1 midget condenser, $1.25, and an old Bradleystat used in the positive leg of the detector plate condenser, 10c. Then in the junk box we found an old nineteen-plate condenser which we used for the capacity unit in the plate circuit of the detector tube.

Several burned-out –01A tubes were deprived of their bases, and these were used for the plug-in coil mountings, then two old panels, reasonably free from holes, were purchased for 10c, along with 2 vernier dials for 60c.

The old Fusaformer yielded the supply of machine screws and nuts, while battery nuts taken from dry cells acted as spacers for the units we wished to mount back away from the main panel.

Now that we have all the parts listed, suppose we go into details on the construction of the various assemblies.

We used the side of a pine box for both the panel and the sub-panel. The section used for a panel was cut to a size of 8 by 14 inches, given a heavy coat of brown Duco on the finished side, and when this had dried thoroughly we gave the opposite side a thick coat of shellac, and after it had started to get sticky we took the foil from an old condenser and covered the back with it, being careful to lap the strips so there would be a good electrical connection. The sub-panel was cut to a size of 12 by 5 inches, given a coat of shellac on both sides, and when partially dry we gave one of the sides a coating of the condenser foil and allowed it to dry (see Figure 2).

Two pieces of the strap iron were cut to a length of 14½ inches, bent 1¾ inches from each of the ends, as at Figure 3, and drilled for machine screws to fasten the brackets to the panel and sub-panel. If preferred, two pieces of wood may be used in place of the iron.

### *Mounting the Tuning Condensers*

The condenser panel was cut from an old bakelite panel to the side of 9¾ inches by 3½ inches with four holes drilled in the corners of the panel far enough in to assure plenty of strength to this part for the support of the tuning condensers (see Figure 5, at A).

Discs for single-control unit may be roughly shaped from wood, bakelite, metal or whatever the constructor wishes, with

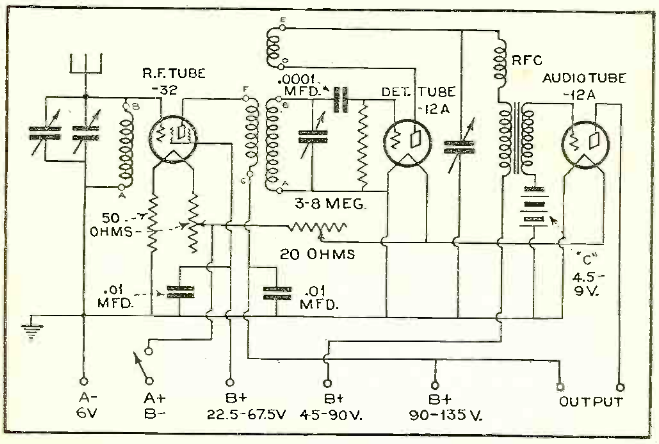
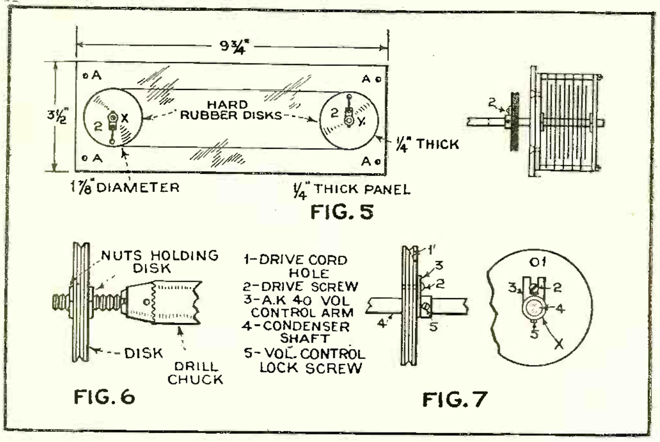



FIGURE 10. THE CIRCUIT DIAGRAM




DETAILS OF GANG TUNING MECHANISM

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a hack-saw. Dress them to some semblance of a circle with a coarse file, then drill a ¼-inch hole at the center, place a ¼-inch bolt through the hole, fasten the job securely in an electric drill as shown in Figure 6, and hold the same file against the face until the disc comes to a perfect circle. Now with a small three-cornered file, cut the groove to accommodate the cord for driving the two condensers as a single unit, by holding it against the revolving face of the disk.

The finished discs should be placed in a vise, one at a time, drill a hole large enough to accommodate the cord used to drive the condensers, starting at the bottom of the groove and holding the drill at such an angle that it will come out near the screw (2), Figure 7, under which the cord is looped as in Figure 5. The size of screw 2 should be 6-32.

### *Extending Condenser Shaft*

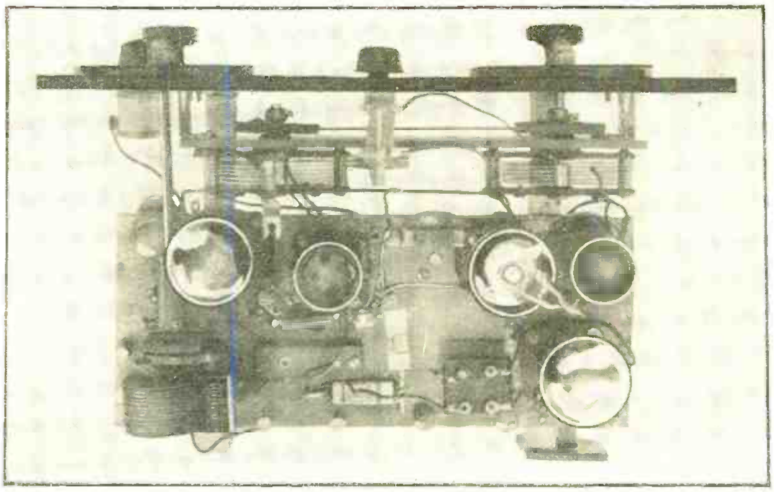
Figure 8 will give a general idea of the extension necessary to bring the drive through to the panel for the accomomodation of the vernier dial. The length of this extension will depend on the distance the mounted tuning unit is to be set away from the main panel, but, allowing for a fair margin of safety, this extension should be at least 2 inches in length.

Drill a hole at a depth of ⅜ of an inch, directly down the center of the condenser shaft, with a drill that will allow a deep, clean thread of an eight or a ten-thirty-two tap to be run in, then dress down the end of the piece of metal used for the extension so a die will put a good thread over the part to be threaded. This finished, screw the extension into the condenser shaft, draw it tight, drill a small hole through the completed job and run it full of hot solder. This will form a key that will prevent any loosening between the main shaft and the extension.

### *Assembling the Tuning Unit*

Mount the tuning condensers in their respective positions (at least 6 inches center to center), slip one of the drive discs over each condenser shaft, followed by the old A.K. volume-control arm that has been shaped as shown in Figure 7 (x). Lock each disc at the volume-control arm as in Figure 5 (x) and (y), set the condensers at their maximum capacity and run the drive cable with the volume-control arms (used as couplers hooking the discs to the shafts) set in the positions shown in Figure 5. Drill the holes in the main panel for the accommodation of this unit, and with the nuts from the old dry cells space the condenser unit the desired distance from the main panel and fasten securely.

This is shown in detail, Figure 9, with all the data on the assembling and design of the various parts going to make up this unit. A is a small piece of bakelite, D condenser, E insulating bushing used to insulate the condenser shaft from the copper tubing (or metal rod) at F which acts as the extension shaft, G represents 6-32 machine screws that act as clutch and centering screws for the regeneration condenser.



THE TOP VIEW

*Figure 2. This shows the location of the various parts on the sub-panel. The r.f. stage is at the left front and, to its right, the detector stage. The single audio stage is at the left rear*

In the assembling of this receiver a 50-ohm fixed resistor is fastened directly to the negative terminal of the radio-frequency tube socket with a 50-ohm rheostat in the positive side. This rheostat is mounted on the under side of the sub-panel, with the shaft sticking through so the proper setting may be secured without disturbing the set proper. Then from the arm of the rheostat the wiring may be run directly to the filament switch and then to the A battery positive, bringing the grid return of the r.f. tube to the A— end of the fixed resistor to give the proper C biasing for the radio-frequency tube.

Owing to the smallness of the coil forms, there may be a little difficulty encountered in getting the windings down through their respective prongs as the forms are wound. However, we used a pair of long-nose pliers with very satisfactory results.

If desired, the tubing of the antenna coupler and the detector units may be wound before the two sections are cemented together.

Directions will be given for the winding of one set of coils, with the length of tubing, number (*Continued on page* 966)

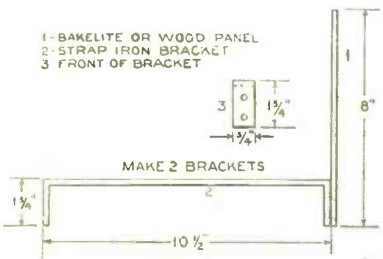



FIG. 3

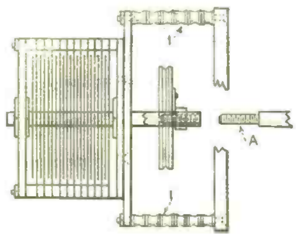



FIG. 8

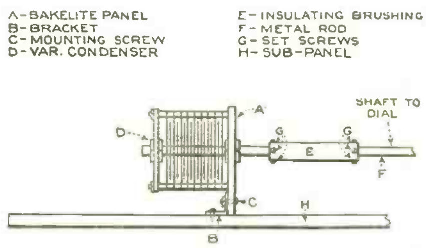



FIG. 9

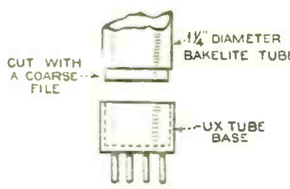



FIG. 11

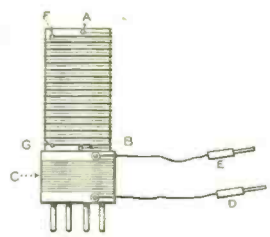



FIG. 12

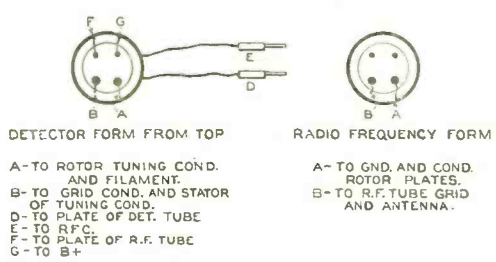



FIG. 13

ASSEMBLY DETAILS FOR CHASSIS AND COILS

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# MODERN RADIO PRACTICE IN USING GRAPHS *and* CHARTS

***Calculations in radio design work usually can be reduced to formulas represented as charts which permit the solution of mathematical problems without mental effort. This series of articles presents a number of useful charts and explains how others can be made***

*By* John M. Borst

*Part Five*

MANY people have difficulty in determining resistance values needed for radio circuits and determining the power consumed. The chart of Figure 1 is designed to simplify these calculations.

In Figure 1 are shown four scales on which are measured off: *current, watts, voltage drop* and *resistance*. The resistance in a circuit and the power can be found with but one index line, drawn through the divisions on the *voltage* and *current* scales. This chart consists really of two charts: one for the calculation of resistance, by Ohm's Law, and one for the calculation of power consumed. They have been drawn so that the current and voltage scales coincide and therefore both equations are solved at once with one operation. In general you cannot have more than two independent variables in this type of alignment chart and not more than one in the cartesian co-ordinate type, unless the third dimension is added. In the case of this month's example, you can choose only two—and any two—of the four variable quantities; the others are the determined ones.

Besides permitting the instantaneous determination of resistance and wattage in a circuit or branch in which the current and voltage are known, this chart is a great aid in calculating bias resistors for tube circuits and for voltage-divider design. Both these problems are nothing but specific applications of Ohm's Law.

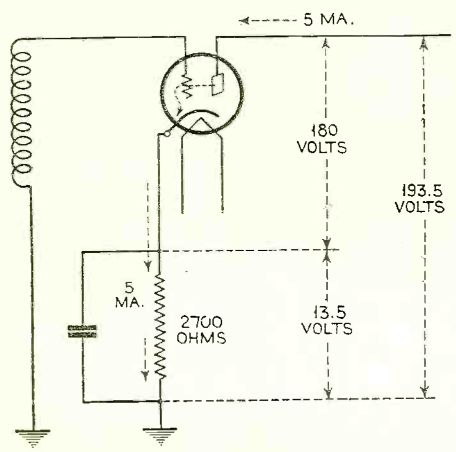
### *The Bias Resistor*

There is really nothing difficult about the figuring of a bias resistor for a tube. Simply run an index line from the division representing the plate current on the *current* scale, through a point on the *voltage drop* scale, corresponding to the desired grid bias. This line, when produced, intersects the extreme left-hand scale where the resistance can be read off. At the same time, this line intersects the *watts* scale where one can see the dissipation in watts. In the case of the average bias resistor, this will be very small. For larger tubes and for transmitters, it is necessary to choose a resistor with the proper power rating. If the resistor is to be in continuous service, it is often desirable to use one which is rated at several times the actual dissipation in watts.

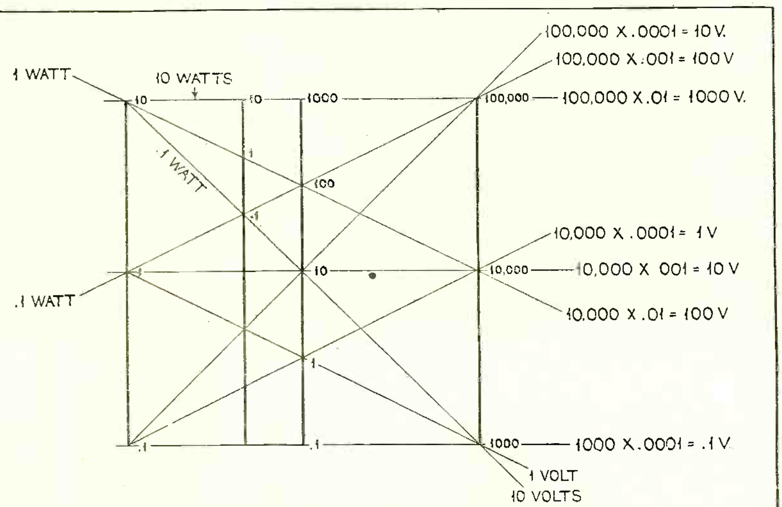
*Example:* Let us suppose that the bias resistor for a -27 type tube has to be found (see Figure 2). In the manufacturer's specifications we find the plate current is 5 ma. and the required grid bias -13.5 volts. Drawing a line from 5 on the *current* A scale through the point 13.5 on the *voltage drop* scale, we find that it intersects the *resistance* scale at 2700 ohms and this is the resistance needed. The power dissipation is .0675 watts as found on the *watts* (A) scale. If two tubes are used in push-pull and they have the same bias-resistor, one must of course add the currents of the two tubes before referring to the chart; similarly, when dealing with a screen-grid tube or a pentode, the screen and plate current must be added, for they both pass through the cathode lead.

### *The Voltage Divider*

The next puzzling problem is the design of the voltage divider. There are those who claim that a voltage divider cannot be figured out or that the calculated factors never check up in practice. It should be kept in mind that the calculations of these voltage dividers is based on the "average" tube characteristics and that many tubes deviate from the average. Therefore, when the divider is finally hooked up there may be small discrepancies. Then there is the difficulty of having to use a resistor of an odd value which will generally be the case if the calculation is to be followed exactly. Generally, the nearest standard size is chosen (another discrepancy). The commercial resistors used for this purpose are not precision products and they (*Continued on page* 967)




CALCULATING THE BIAS RESISTOR




CONSTRUCTION OF THE CHART

*Figure 2, Left: This drawing shows how bias is obtained by means of a resistor in the cathode lead. Figure 3, Right: When the two outer scales are given, the voltage- and power-scales are found with the automatic method. Draw index lines connecting values on the outer scales which have the same product. The intersection is a point of the voltage scale and thus locates it. The location of the power-scale is found in a similar way*

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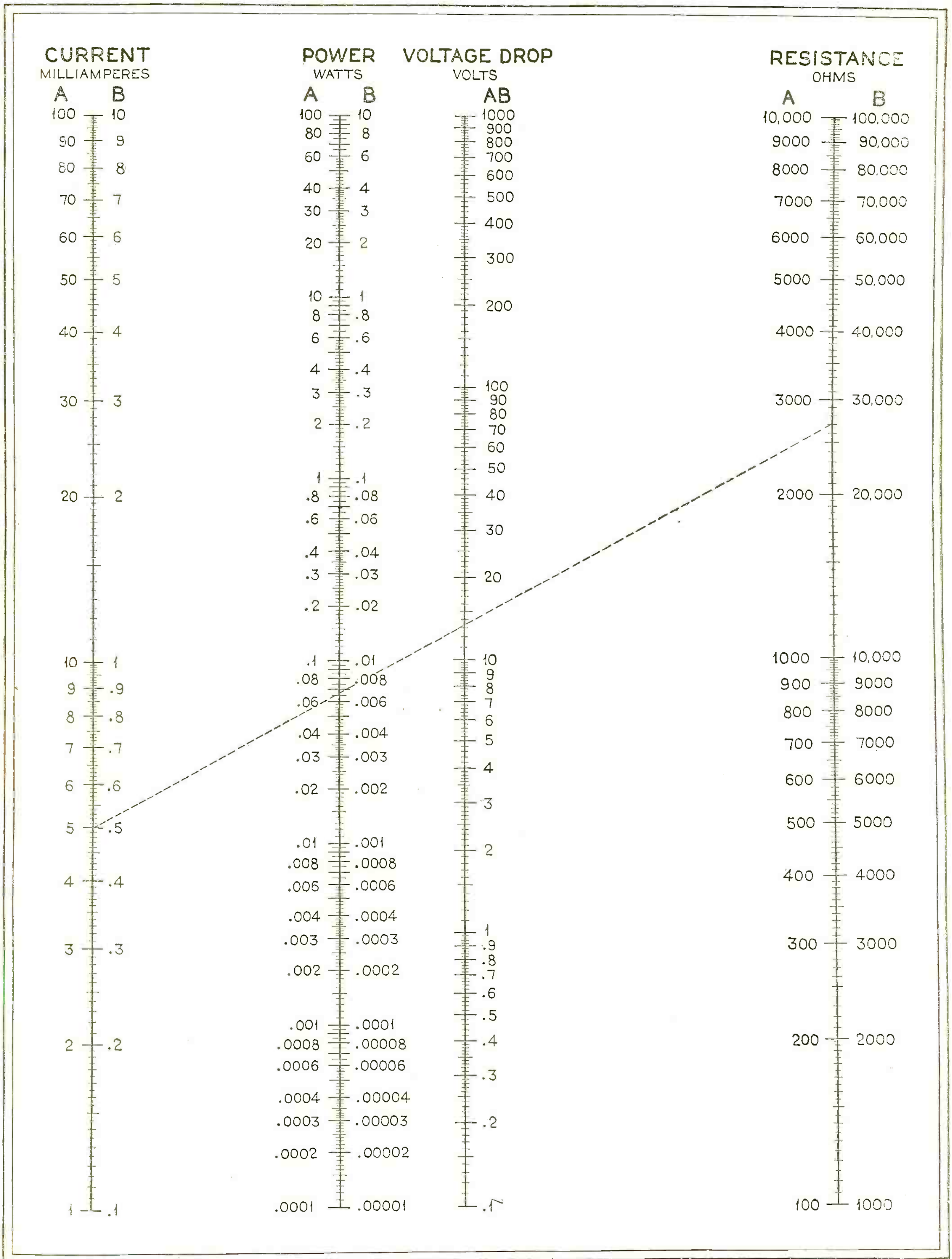
# Ohm's Law and Power Consumption




AIDS IN RESISTANCE CALCULATION

*Figure 1. This chart enables the user to solve the two equations $R = E/I$ and $P = EI$ simultaneously. When any two of the four quantities are given the others can be found with the aid of a ruler. The four values, satisfying the two equations, are on a straight line*

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# A Serviceman's Oscillator

***Here is another portable oscillator—a combination job which offers sufficient merit to rate careful study on the part of the serviceman or experimenter***

*By* Mervyn R. Rathborne

A FLEXIBLE and portable radio-frequency oscillator outfit, such as the one described in this article, is a useful addition to the equipment of the practical serviceman engaged in testing and repairing modern broadcast receivers. For localizing receiver defects, aligning tuning elements, neutralizing r.f. amplifiers, making sensitivity and selectivity tests and detecting weak or faulty tubes the saving of time effected by an instrument of this kind will more than offset the cost of parts and labor involved in its construction.

If the requirements of a serviceman's portable oscillator are examined in detail it is found that the following factors are involved:

First. An oscillator capable of being tuned to any frequency within the broadcast band;

Second. An instrument which can be quickly set at a certain frequency, with assurance that it is operating on the frequency desired and no other;

Third. A readily portable outfit which is self-contained and occupies little space;

Fourth. A unit capable of maintaining accuracy of calibration over long periods of time and one accurate enough for all ordinary tests;

Fifth. An oscillator capable of being adjusted to *any* of the frequencies used in superheterodyne intermediate amplifiers;

Sixth. An instrument that will align the tuning elements of a receiver in a minimum amount of time, one that eliminates the necessity of having to check each condenser-coil combination twice.

Seventh. A unit which can be either internally or externally modulated;

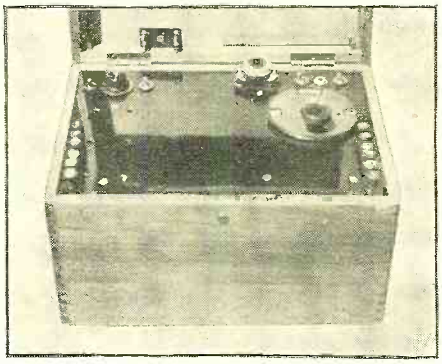
Eighth. An oscillator which is ruggedly constructed, inexpensive to build, having a minimum number of controls combined with ease and simplicity of operation.

In addition to satisfying the above requirements the instrument described herein is capable of performing the many duties usually accomplished by the conventional general utility oscillator.

## Constructional Details

As shown in the photographs, two oscillators (a "fixed frequency" and a "general purpose" unit) are mounted on an aluminum panel and installed, together with necessary batteries in a metal lined "ditty box," measuring nine by thirteen by seven inches deep.

The fixed frequency unit, mounted between two 7 by 3 inch pieces of 3/16 inch bakelite, spaced 5¾ inches by four No. 8 brass rods, employs a Hartley circuit. The tuning elements consist of a number of fixed condensers, shunted by home-made variable trimmers, connected across a center-tapped Silver-Marshall tuning coil (Type No. 142). The lower plates of the trimmers are shim brass and the upper plates hard drawn spring brass, the dielectric is ordinary stove mica, cut slightly larger than the plates, which measure ¾ inch by ⅜ inch. Screws securing the trimmers to the upper bakelite strip are spaced (1 17/64 inches) so they fit into mounting holes of Sangamo fixed condensers, placed beneath the panel. The values of these fixed condensers have been chosen so, as each one of them is connected across the coil, the resulting LC combination is resonant to a frequency slightly higher than the one desired from the combination in use. By adjusting the trimmers the frequency of each combination may be varied slightly, permitting a choice of frequencies easy to apply mathematically and convenient to use in determining points on response curves as they fall directly on ordinates when plotted on conventional graph paper. Six holes in the main panel permit the trimmers to be varied while the oscillator is in operation without removing it from its shielded box.



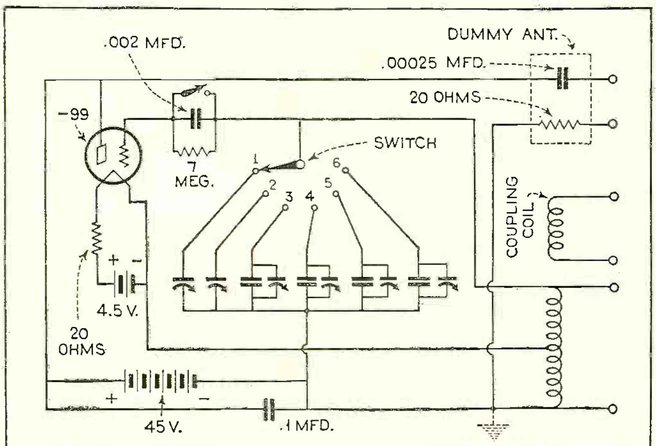
THE COMPLETED UNIT

*The fixed-frequency oscillator, on the left, has only three controls, an "off-on" switch, a "c.w.-i.c.w." switch and a "frequency selector." One loading coil is plugged into the general-purpose oscillator and another may be seen resting on the edge of the cover of the box*

A Yaxley tap switch mounted on the panel provides an easy and rapid means of connecting any one of the condenser combinations across the coil. The frequencies chosen in this case were 550, 700, 850, 1000, 1250 and 1500 kilocycles. The fixed tuning feature makes it possible to rapidly and accurately obtain a sensitivity or response curve from a receiver without having to carefully adjust an oscillator dial for each frequency. This makes the use of a printed "frequency-dial reading" curve unnecessary.

Internal modulation is accomplished by cutting in a .002 mfd. condenser, shunted by a seven megohm gridleak, into the grid circuit, c. w. is secured by shorting out the condenser and leak. A toggle switch on the panel permits a rapid change from c. w. to modulated c. w.

The general purpose oscillator is similar to the fixed frequency unit in design. This instrument is mounted between two, 6 by 7 inch pieces of 3/16 inch bakelite. The same types of circuit and coil are used here as in the unit previously described. A General Instrument Corp. "no-loss" variable condenser tunes the coil to any frequency within the broadcast band. For adjusting superheterodyne




| FREQUENCY VALUES | | | |
|---|---|---|---|
| SWITCHPOINT | FREQUENCY | FIXED CAPACITY | VARIABLE CAPACITY |
| 1 | 1500 KC. | NONE | 2 PLATE COND. (SEE TEXT) |
| 2 | 1250 KC. | " | 3 " " " |
| 3 | 1000 KC. | .00005 MFD. | 2 " " " |
| 4 | 850 KC. | .0001 " | 2 " " " |
| 5 | 700 KC. | .00015 " | 2 " " " |
| 6 | 550 KC. | .0003 " | 2 " " " |

CIRCUIT OF FIXED-FREQUENCY OSCILLATOR

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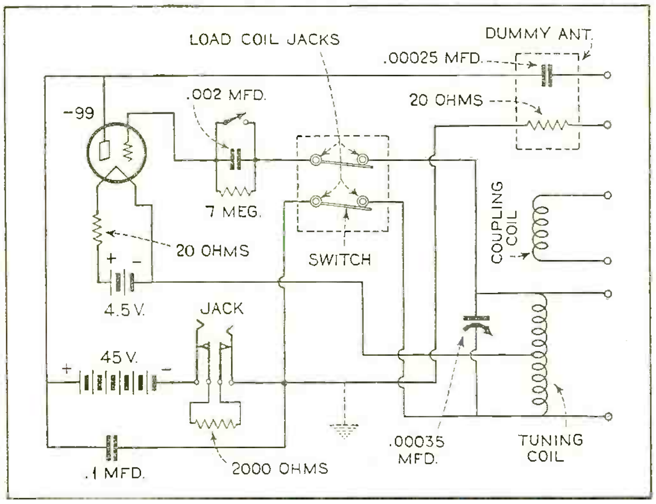
intermediate amplifiers the oscillator may be tuned to the frequency desired by plugging loading coils in series with each end of the S-M tuning coil. These loading coils are mounted on strips of 1/8 inch bakelite, measuring one by two inches; each strip is provided with four General Radio plugs, which fit into G. R. insulated jacks mounted on the panel. By means of a built-in switching device the action of inserting the coils automatically opens both grid and plate circuits and connects the loading coils in series with these circuits.

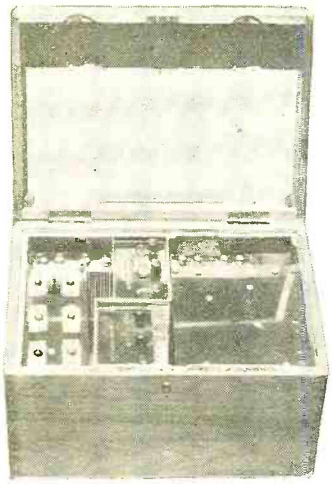
As shown in one of the accompanying photographs two spring brass strips make contact with the ends of two of the G. R. jacks, a small glass bead, extending inside each jack, is attached to each strip. As the plugs are inserted into the jacks their tips come into contact with the glass beads and force them downward. The pressure on the beads causes the strips to be forced away from the end of the jacks, opening the associated circuits and cutting in the loading coils. A number of loading coils, made from discarded Remler Best 45 kc superhetrodyne intermediate frequency transformers, make it possible to obtain a continuous range of frequencies from 40 to 1500 kcs. from the oscillator.




CIRCUIT OF GENERAL-PURPOSE OSCILLATOR

For obtaining zero beat between the two oscillators or for using the "click" method of indicating resonance a pair of phones may be plugged into the jack provided in the plate circuit. In order that the oscillator plate current will not change as the phones are connected a 2000 ohm resistor is connected across the jack, this is cut in when the phones are removed from the circuit. To use this oscillator as a grid-dip meter a 0-1.5 milliammeter, provided with a special mounting having two G. R. jacks, may be inserted into the two left hand (grid circuit) loading coil jacks. Plate current readings may be secured by plugging a suitable meter into the phone jack. This unit is internally modulated in the same manner as the "fixed frequency" instrument.

Twelve binding posts on the panel permit the outputs of both oscillators to be taken directly from across the tuning coils, from coupling coils (formerly the primaries of the S-M coils), or from dummy antennas. Each oscillator may be used independently, the two can be used together at zero beat, or they can beat against each other for obtaining hetrodyne modulation or for making selectivity tests.



METHOD OF ASSEMBLY

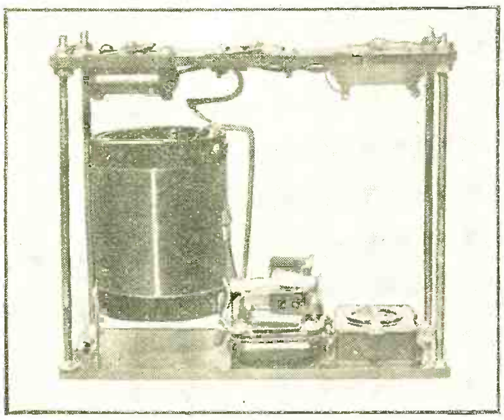
*View showing both oscillators mounted in shielded box. The aluminum panel (removed in this view) supports both units and rests on the dividing partition and the turned-in edge of the shielding box. This lining and partition are continuously soldered at all joints*

Type -99 tubes are used in both units, and each unit is supplied with filament and plate potentials from Burgess No. 2370, 4½ volt "C" and No. 5308 "B" batteries. Each set of batteries is contained in the shielded compartment containing the oscillator it supplies with current. The aluminum panel is finished with black automobile Duco and polished to a high luster.

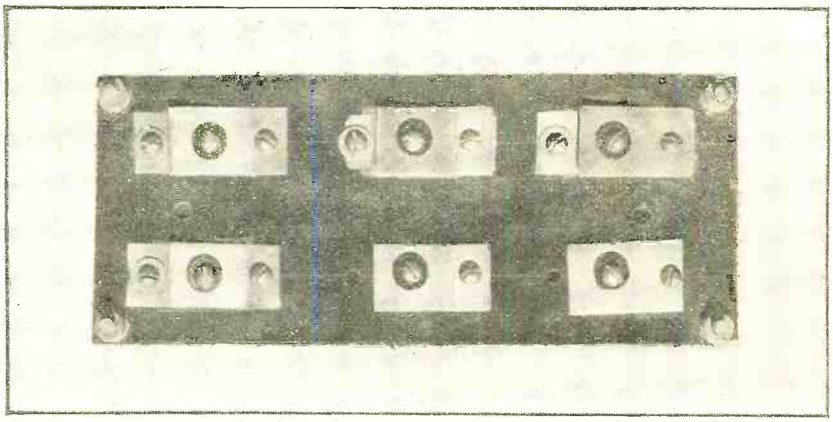
### *Possible Uses*

A good sized volume would be necessary to enumerate all the tests it is possible to make with an oscillator outfit of this kind. Servicemen will find it chiefly useful for lining up and neutralizing t.r.f. and superhetrodyne intermediate amplifiers, obtaining sensivity and selectivity comparisons and curves, detecting faulty tubes and checking for oscillation and noises in broadcast receivers.

By using both oscillators a pair of r.f. tuned stages can be lined up simultaneously. This is accomplished by setting the "fixed frequency" oscillator to a frequency on which it is desired to check the receiver under test and tuning the "general purpose" driver until zero beat is indicated in the phones connected in its plate circuit. When zero beat is obtained the oscillator coils should be connected across the condensers of two adjacent r.f. stages by means of flexible leads, and the trimmer condenser of one of these stages adjusted until zero beat is again obtained. Before the oscillator coils are connected across the receiver condensers both drivers are oscillating at the same frequency, when the tuned receiver circuits are connected the drivers will continue to oscillate at the same frequency, provided each receiver circuit is adjusted to this particular frequency. Thus, if two oscillators are working together at zero beat and if two receiver tuned circuits are connected across the oscillator coils and these circuits are adjusted to



FIXED-FREQUENCY UNIT



TOP OF THE FIXED-FREQUENCY OSCILLATOR

*Right: Details of trimmer condensers. The holes through which the trimmers can be adjusted are shown in the photograph of the completed unit. Left: Details of the trimmer condensers and the manner in which they are connected to the fixed condensers are shown*

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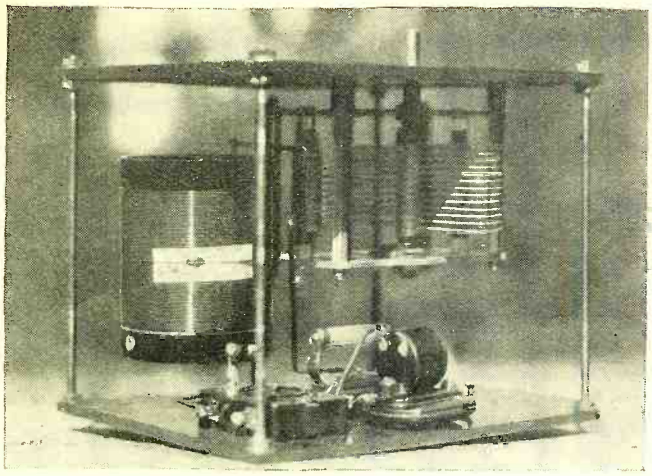


THE GENERAL-PURPOSE OSCILLATOR UNIT

*The coil is attached to the variable condenser with brass angles (not visible). The choke coil shown was found to be unnecessary and is not included in the completed unit*

the oscillator's frequency no sound will be heard in the phones, as all four circuits are tuned to the same frequency. After two stages have been lined-up the leads to the tuned circuits can be interchanged and another tuned circuit adjusted.

Neutralization may be accomplished in the conventional manner by using one oscillator (modulated) and a tube with one filament prong cut off. The receiver should be placed in operation with the oscillator coupled to its antenna circuit and the dummy tube inserted in each successive r.f. stage while the neutralizing condenser for the stage containing the dummy tube is varied until no oscillator signal is heard in a loudspeaker connected to the output of the receiver. When the receiver is properly neutralized the oscillator signal will not be audible when the dummy tube is inserted in any one of the r.f. amplifier sockets.

Sensitivity comparisons may be made by using the fixed frequency unit and a vacuum tube voltmeter, or other device for measuring small r.f. currents. If a vacuum tube voltmeter is employed it should be equipped with a double-pole double-throw switch so its input can be connected to either oscillator output or to receiver output (r.f.). A convenient point on the tube voltmeter scale for oscillator output; in order to maintain its output constant for all frequencies, the oscillator should be adjusted to give this chosen voltmeter reading each time its frequency is changed. Maintaining uniform oscillator output, the voltmeter should be switched over to read receiver output and the values noted for each frequency. By using frequencies as ordinate and receiver output voltmeter readings as absissas a response curve can be plotted.

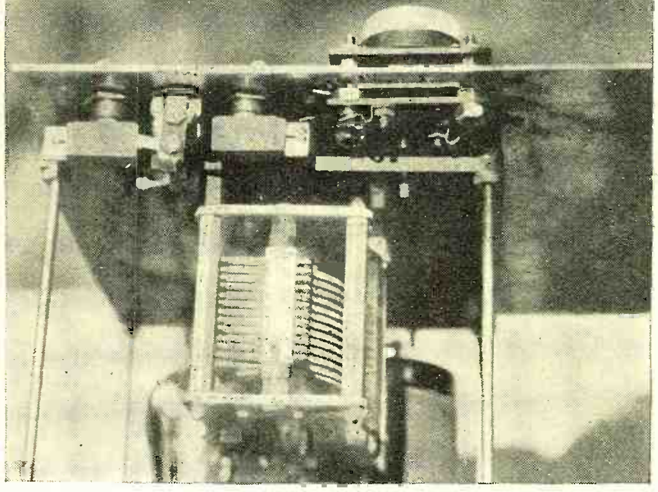
Another method of obtaining sensitivity measurements is to place a 500,000 ohm. variable resistor, having a graduated dial, across the vacuum tube voltmeter input and, by means of a double-pole double-throw switch, alternately connect the voltmeter to the oscillator and receiver outputs. Connected to the oscillator, the voltmeter resistance should be adjusted until a convenient reading near the lower end of the voltmeter scale is obtained, throwing the double-pole switch will connect the receiver output to the voltmeter and result in an increase in the meter reading. By varying (decreasing) the value of the resistance until the meter indicates the same reading as obtained with oscillator input and noting the change in the resistor dial reading it is possible to obtain an indication (the difference between the two resistor dial readings) of a receiver's response to the frequency applied. When using this method it is necessary to have a table of average resistor dial readings, obtained from a number of receivers of standard make, a comparison between the values given in the table and those obtained from the receiver under test will give a "figure of merit" of response for the latter.

Although vacuum tubes may show uniform characteristics when tested in the usual type of emission tester or serviceman's test kit, there may be a wide variation in their performance when used in actual radio circuits. Slight defects, not apparent when tubes are tested by any of the usual methods, are revealed by an oscillator and vacuum tube voltmeter. Using a set of "standard" tubes, which have been carefully selected, tested and are known to be uniform, in conjunction with an oscillator-voltmeter outfit the performance of the regular receiver tubes may be checked. The testing outfit should be set up, the "standard" tubes placed in the receiver and the voltmeter reading noted. If the regular tubes are put in the sockets one at a time and the voltmeter read as each change is made, any tube defects or weaknesses will be revealed by a low voltmeter reading. For making difficult demonstrations or for satisfying d-x fans, checking and matching the tubes in a receiver will often mean the difference between a sale and the loss of a customer.

For making selectivity comparisons a vacuum tube voltmeter should be connected at the output (r.f.) of a receiver and both oscillators coupled to the antenna circuit. The fixed frequency unit should be adjusted to the frequency desired and the tube voltmeter reading noted. Placing the general purpose oscillator in operation and tuning it to zero beat with its companion driver will approximately double the tube voltmeter indication. If the dial of the variable condenser of the general purpose unit is slowly turned, the voltmeter reading will decrease until it has fallen to the value indicated when only the fixed frequency oscillator was supplying excitation. The number of degrees through which the oscillator dial must be turned to lower the voltmeter from maximum reading to the value obtained from the "fixed" oscillator is an indication of selectivity. By performing this test on a number of highly selective receivers of standard makes and making a reference curve from the readings thus obtained, a standard may be established to which the selectivity characteristics of any receiver may be compared.

External modulation of the general purpose unit is accomplished by plugging the output of a modulator into the phone jack in its plate circuit. Using the following method, it is possible to determine the percentage of this external modulation with a fair degree of accuracy. For calibrating the oscillator, two meters and a 400-ohm variable resistor are needed. An O-2 thermo-couple milliammeter should be inserted in the grid loading coil jacks and a direct current voltmeter connected to measure plate volts.

The 4000-ohm resistor is connected in series with the negative "B" battery lead (across the phone jack) and provides a means of varying the voltage applied to the plate. Using a convenient grid meter reading, such as one milliampere, as a starting point, the plate voltage should be varied in steps of one or two volts, and the readings of both meters noted for every value of $E_p$. Plotted, these meter readings will result in a linear curve, or, in other words, the alternating grid current will vary directly as the plate voltage (d.c.). By assuming the one milliampere grid current reading to be zero modulation and zero grid current to be 100% modulation, it is possible to compute (by reading the $I_{g(osc)}$, $E_{p(dc)}$ curve) the number of alternating current (audio frequency) volts (peak) which must be introduced (*Continued on page* 956)



LOAD COIL CONNECTIONS

*This view shows the details of the switching arrangement whereby the grid and plate circuits are opened by inserting the loading coils and automatically closed when these coils are removed*

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# News *and* Comment

***A page for the news of the whole radio industry, including important trade developments, new patent situations, comments by leading radio executives, notes, rumors and opinions***

*Reported by*

**Howard S. Pearse**

### *New York Leads in Radio*

WASHINGTON, D. C.—New York State now leads all states in the total number of radios reported during the 1930 census, according to latest figures announced by the U. S. Census Bureau. At the same time New Jersey took the lead over all other states in the proportion of its families having radios.

Of the 3,162,118 families counted in New York as of April 1, 1930, there were 1,829,123 that replied in the affirmative when asked by the census enumerators whether they had radios. This is 57.8 per cent of the total. With an average of four persons found in each family, the total number of home listeners in the state on that date was 7,316,492.

New Jersey's radio census reveals that 63.4 per cent of its homes had radios, or 625,639 out of 987,616 families. With New Jersey's average 4.1 persons per family, the number of listeners may be estimated at approximately 2,565,200.

### *"Hot" Programs Keep Station Warm*

CLEVELAND—At radio station WHK, here, the rectifying and amplifying tubes of the transmitter do double duty, keeping the station comfortably warm and providing hot water for the washroom, in addition to performing their normal tasks. Only in extremely cold weather is it necessary to use emergency oil heating equipment.

The tubes, having a plate potential of 10,000 volts, are water-cooled. Normally, the heating effect raises the cooling water to a temperature of about 120 degrees. If it goes to 180, the station is automatically shut down. The cooling water is conducted to the basement where it passes about a copper coil, heating water in a hot-water tank that supplies the washroom. Then the water from the tubes passes through a series of cooling coils, the heat being carried away by fans. When it is desired to heat the station, air that passes over these coils is conducted through a pipe and floor register to the rooms above. Otherwise, the heated air is discharged into the outside atmosphere.

It is interesting to note that the heat developed by the tubes does not come from the filaments. It is produced by the bombarding of the plates by the billions of electrons shot out from the filaments.

### *Airways Radio Stations*

WASHINGTON, D. C.—Thirty new radio range beacons for the guidance of aircraft in flight and 10 new airway communication stations for broadcasting weather and other information to pilots will be installed along the federal airways during the current fiscal year, according to the Aeronautics Branch, Department of Commerce. In addition, 15 uncompleted radio beacon stations are to be placed in operation before July 1, 1932.

Twenty-eight of the 30 beacon stations will be located at Paulsboro, N. J.; Charleston, S. C.; Raleigh, N. C.; Jacksonville, Fla.; Alma, Ga.; Mobile, Ala.; Montgomery, Ala.; Birmingham, Ala.; Gainesville, Ala.; Jackson, Miss.; Smiths Grove, Ky.; Shreveport, La.; New Orleans, La.; Little Rock, Ark.; Oklahoma City; Memphis, Tenn.; Texarkana, Ark.; Springfield, Mo.; Pontiac, Ill.; Rockford, Ill.; St. Paul-Minneapolis; Milwaukee, Wis.; LaCrosse, Wis.; Fargo, N. D.; San Diego, Cal.; Gilroy, Cal.; Coalinga, Cal., and Spokane, Wash. Sites for the two others remain to be chosen.

The 15 beacon stations to be completed are at Pittsburgh; Harrisburg, Pa.; Wichita; Amarillo, Tex.; Winslow, Ariz.; Kingman, Ariz.; Albuquerque, N. M.; Willows, Cal.; Fontana, Cal.; Dagget, Cal.; Shasta City, Cal.; Medford, Ore.; The Dalles, Ore.; Portland, Ore., and Seattle.

The 10 new weather broadcasting stations are to be located at Mobile, Ala.; Titusville, Fla.; Miami, Fla.; Houston, Tex.; San Antonio, Tex.; Springfield, Mo.; Minneapolis-St. Paul; Pueblo, Colo.; Milford, Utah, and Spokane, Wash.

### *Argentine "Goes Midget"*

WASHINGTON, D. C.—Like their northern cousins, dwellers in the Argentine, who enjoy a radio broadcasting service that ranks only behind that of the United States and Canada in the western hemisphere, have "gone midget." The depression has hit them, too, and they are buying diminutive receivers that sell around $140 there. Purchases are made largely through an electric power company, which sells the sets on an installment basis, according to Charles H. Ducote, Assistant American Trade Commissioner at Buenos Aires. American sets lead the market, though the Philips Company of Holland is a strong competitor. Last reports showed there were 400,000 radios in the Argentine. There are 43 stations, 20 in Buenos Aires. Sets must be registered but no license fee is charged.

### *Koenitzer Promoted by Belden*

CHICAGO—Russell Koenitzer has been appointed representative in the Detroit-Cleveland territory by Belden. Russ has been with Belden for over seven years in the production, sales service, and advertising divisions. With this experience he has gained a thorough knowledge of Belden products and a wide acquaintance in the automotive, electrical, and radio merchandising fields.

In his new territory he will have complete charge of the Belden complete line of aerial kits, aerial wire, lightning arresters, and other Belden radio wire accessories.

### *French Radio Development*

PARIS, FRANCE—If France's new government retains office, something like $2,500,000 will be expended from the 1931-32 budget for the development of broadcasting. One proposal that has been advanced calls for the erection of a series of 60,000-watt stations so located as to cover the entire country. French radio development, however, is still divided between two schools of thought—one wanting a state monopoly and the other wanting private enterprise with government regulation.

### *Philology and Radio*

STOCKHOLM, SWEDEN—Radio will in time polish off local dialects and at the same time make the common language richer in words and their use more accurate, predicts Professor Otto von Friesen of the University of Upsala, who is an internationally known linguist and a member of the Swedish Academy which annually picks the winner of the Nobel Prize in literature. What he says about the effect of broadcasting in Sweden holds true, of course, in other countries.

Like most lands, Sweden has many dialects, and when a person speaks on the national radio program it is often possible to tell from his enunciation what province he comes from. It is the deliberate policy of the Swedish broadcasting service, which is under the control of the press, to admit all and every dialect and not attempt any restriction of its speakers.

### *Director Senses Moral Danger in Song Lyrics*

BOSTON—Radio, guest in 15,000,000 American homes, must be purged of all that is unwholesome and the ether must be made safe for decency. Such is the bristling fiat that has been issued by John L. Clark, program director of WBZ-WBZA, Boston-Springfield, to announcers, production men, dance band maestros and others who he says are guilty of "mouthing gags of the double entendre, sexy songs or worse."

Clark sees a decadence of radio programming if those who guide stations do not keep a sharp watch. Stations and networks, he maintains, must maintain a strict self-censorship on songs and gags. So must the makers of electrical transcriptions or recorded programs. If they fail, he sees the censorship burden falling upon the announcer on duty "as the last sentinel." He would even let the engineering department "throw the switch" if the announcer fails.

"To me," says Clark, "it seems the bad lurks in the spoken word and the word that is sung. The danger is not in instrumental sounds, except unskilled jazz that racks the nerves. The danger lurks, like a slow, insidious poison, in the lyrics of songs. The words of cheap songs beat against the ears and the minds of impressionable listeners, attacking the moral strata, weakening and undermining the very foundations of morality."

### *Television Integral with Radio*

NEWARK, N. J.—Asked what would be the effect of television on present-day radio sets, George Lewis, radio engineer and vice-president of Arcturus Radio Tube Company, states that the radio set of today would always be an integral part of television receiving.

"The two systems must be operated simultaneously for satisfactory results," says Mr. Lewis. "One depends on the other in bringing synchronized programs to the home."

### *Broadcasts to Australia*

CINCINNATI—The special series of radio entertainments now being broadcast by the Crosley Radio Corporation over its

(*Continued on page* 973)

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# *Student's* Radio

*This series deals with the study of the It contains information of particular in high schools and colleges. The ing out current*

**By Alfred A.**

## Question Box

PHYSICS and science instructors will find these review questions and the "quiz" questions below useful as reading assignments for their classes. For other readers the questions provide an interesting pastime and permit a check on the reader's grasp of the material presented in the various articles in this issue.

The "Review Questions" cover material in this month's installment of the Radio Physics Course. The "General Quiz" questions are based on other articles in this issue as follows: More About the "Twin-Grid" Tube; How to Construct and Operate a Vacuum-Tube Voltmeter; With the Experimenters; How to Build a Battery-Operated Pentode Receiver; The RADIO NEWS Multi-Ear Aid; Using Filter Units in Eliminating Street Railway Interference; Phenomena nderlying Radio; Lens Design for Scanning Discs; Controlling Machinery by a Light Sensitive Unit; Novel Features in a New Two-Volt "Super."

### *Review Questions*

1. *What is the N. E. M. A. and the R. M. A. standard method of arriving at the maximum rating for resistors of the vitreous enamel type?*
2. *What current can safely be carried by a 5000-ohm resistor which is rated at 20 watts?*
3. *If a 10,000-ohm resistor is to carry .006 amperes, what will be the required rating in watts?*
4. *What would be the required rating in watts, and the resistance value for a grid-bias resistor if the current through the resistor is .002 amperes and the bias required is 6 volts?*
5. *At what percent of their maximum watt rating is it advisable to work resistors? At what percent of their maximum current rating?*
6. *Under what conditions is it permissable to employ resistors at their maximum ratings?*

### *General Quiz on This Issue*

1. *Why, in a Class B audio amplifier, is self-biasing of the output tubes undesirable?*
2. *On what portion of its grid-voltage, plate current curve does the tube work, in the vacuum-tube voltmeter described this month?*
3. *What is the "Dupelidyne" circuit? What advantages does it offer?*
4. *Briefly describe the construction and operating principle of a simple, home-made themocouple.*
5. *In measuring the gain per stage in a resistance-coupled amplifier, at what two successive positions is the vacuum-tube voltmeter connected?*
6. *What advantage is gained by employing three pentodes in parallel in an audio output stage?*
7. *Is a flat characteristic desired in amplifier equipment used by those who are partially deaf?*
8. *What is the scientist's method for determining the truths and facts of physics?*
9. *Can inductive interference from street cars be eliminated from radio reception? How?*
10. *Enumerate some of the physical actions which liberate electrons? Ions? Heat?*
11. *With what simple apparatus can electrical machinery be controlled by light waves?*
12. *How are lenses used in television? How can one determine the proper focus for a given lens or determine the proper curvature for a lens to be used with a given focus? Name the various kinds of lenses.*

FIXED resistors of high resistance (several hundred thousand ohms or more) and which are to carry very little current are made by depositing either carbon, or a metal such as tungsten, on glass or other insulating material. The deposit may be placed on a thin glass filament placed within a protecting glass tube or may be deposited on the inside wall of a glass tube. A metal cap at each end serves as a connection to the deposit as shown in the upper part of Figure 1. Such units have practically no inductance and have very little capacity. They are used as grid leak resistances or as plate coupling resistors, for vacuum tubes. It is possible to make these resistors in high resistance values at considerably less cost than the wire-wound types.

Fixed resistors of small size are also made by compressing powdered carbon with a binding material as shown in the lower part of Figure 1. These can also be manufactured very cheaply and are being used extensively in radio receivers.

### *Some Standard Types*

Figure 2 shows five resistances, three of which are variable by steps or continuously. A is a resistor with a rotary contact arm which varies the resistance between the two output terminals. B is a fixed resistance covered with insulating cloth with two soldering wire terminals. C is a spiral-wound resistance, wound on an insulating tube with movable contact rings for resistance adjustment. D is a rotary variable resistance, the contact of which is inside the metal case. It is equipped with potentiometer terminals. E is a fixed resistance of the ballast type, used to maintain constant filament current in battery-operated tubes. It consists of lengths of fine iron wire enclosed in an airtight glass tube with metal connecting caps at the ends which mount the unit in a special clip mounting.

### *Power Control Elements*

Adjustable high resistances for controlling B eliminator output voltages, vacuum tube plate currents, etc., are usually constructed from a mixed mass of carbon powder which is a conductor, and mica flakes which are insulators. The resistance is lessened by compressing the mixture (by turning a knob) to force the carbon particles into closer contact, and is raised by releasing the pressure, whereupon the springiness of the mica separates the carbon particles and reduces the area of contact. The mica also prevents "packing" of the carbon particles when compressed. A porcelain case encloses the inside parts. More recent resistors of this type use a metal case in order to dissipate the heat more readily. They are therefore able to handle more power without overheating.

Ordinary commercial resistors are accurate to within 10 percent of their marked value. Precision resistors are more expensive and are made more carefully. They are usually baked at 120° C. for several hours to prevent slow change of resistance with time, and are finally covered with paraffin wax.

### *Watt Dissipation of Resistors*

When current flows through a resistance, heat is produced. This heat must be dissipated to the surrounding air if the resistance is to operate at a steady temperature. The heat developed is proportional to the product of the resistance in ohms and the square of the current in amperes.

$$W = I^2R$$

This product equals the number of watts of electric power being used up in the development of heat in the resistor, and

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# Physics *Course*

***physical aspects of radio phenomena. value to physics teachers and students Question Box aids teachers in lay- class assignments***

Ghirardi*

*Lesson Ten*
*(Continued from Lesson Nine)*

## Resistances in Radio Resistance Alloys, How the Resistance Units are Actually Made and Used

because of this fact, resistors which are to handle any appreciable current are generally rated according to the number of watts they will safely dissipate, as well as the number of ohms resistance they have. The standard method of arriving at the *maximum* rating of resistors of the vitreous enamel type is the input in watts required to produce a temperature rise of 250 degrees Centigrade (482 degrees Fahrenheit) at the hottest point of the resistor, when the resistor is surrounded by at least one foot of free air, the surrounding air being at a temperature not exceeding 40 degrees C. (104 degrees F.).

This is a standard of the National Electrical Manufacturers' Association and the Radio Manufacturers' Association.

The heating of resistors in radio receivers, while chiefly due to the electric power dissipated in them is also increased by their proximity to other warm or hot parts such as vacuum tubes and other resistors, and to lack of sufficient air circulation.

### *Safe Operating Currents*

The safe current in amperes which may be carried by a resistor of given rating in watts and resistance is found by the equation:

$$I = \sqrt{\frac{W}{R}}$$

where W = allowable watt rating of the resistor and
R = its resistance in ohms.

*Example 1:* A certain 2000-ohm resistor has a rating of 80 watts. How much current will it safely carry?

*Solution:*

$$I = \sqrt{\frac{W}{R}} = \sqrt{\frac{80}{2000}} = 0.2 \text{ amps. or } 200 \text{ milliamperes. Ans.}$$

If the resistance and the current to be carried are known, the wattage rating of the resistor to be used can be calculated from the formula, $W = I^2R$.

*Example 2:* A C-bias voltage of 4.5 volts is to be obtained by having the plate current of 3 milliamperes of a –24 tube flow through a resistance. What must be the resistance in ohms and the minimum watts dissipation rating of the resistor used for this purpose?

*Solution:*

$$R = \frac{E}{I}, \quad 3 \text{ milliamperes} = \frac{3}{1000} = .003 \text{ ampere}$$

$$R = \frac{4.5}{.003} = 1500 \text{ ohms. Ans.}$$

$$W = I^2R = .003 \times .003 \times 1500 = .0135 \text{ watt. Ans.}$$

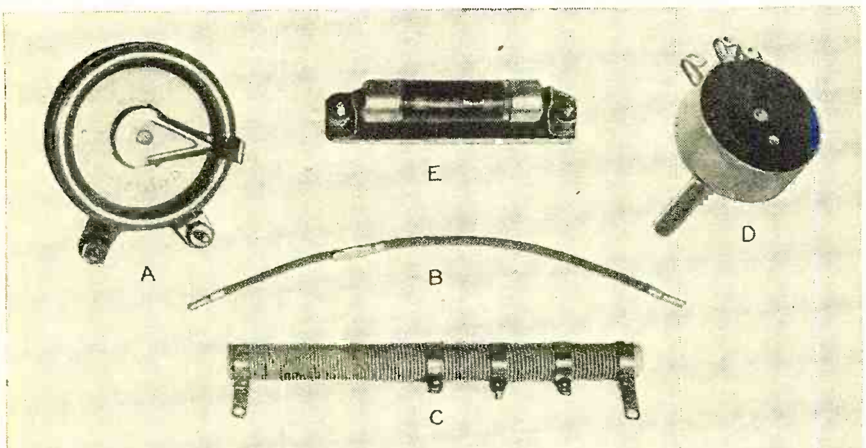
As a matter of safety and to insure long life, resistors are generally operated at about 25% of their maximum watts dissipation rating and at about three-fourths of their maximum current-carrying capacity rating. Such use makes plenty of allowance for poor ventilating conditions such as are found in the usual installations.

### *Heating in Resistors*

Where there is no danger of damage to other parts from the heat developed by the resistors, or where the ventilation is very good, it is permissible to use them at the higher "Maximum" ratings.

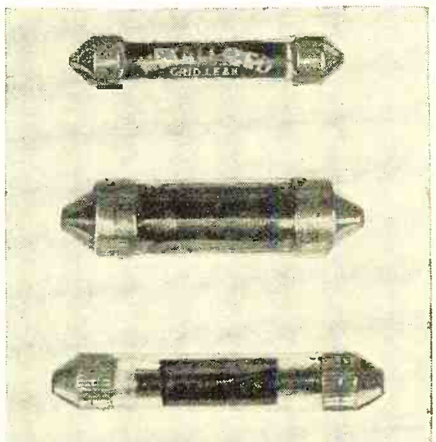
It should be remembered that the watts dissipation rating of a resistor is based on the supposition that the current flows through the entire resistor. In case the resistor has taps provided and the full current flows only through part of the resistor, the watts dissipation rating is proportionately lowered.

The student should familiarize himself with the symbols used on radio circuit diagrams to represent the various types of resistors: fixed, variable, tapped ,etc.




VARIOUS TYPES OF RESISTORS

*Figure 2. The resistors A and D are variable by means of sliders contacting the resistor element. B is a fixed resistor, insulated with a cloth braid, with soldering lugs on the end. C is a resistor wound on an insulated tube with movable taps. E is a standard filament resistor for automatic filament control*



SMALL FIXED TYPES

*Figure 1. Here are shown three resistors equipped with end contacts that enable mounting between standard clipped mountings*

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# Radio Science Abstracts

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

*Conducted by*
## Howard Rhodes

*Servicing Superheterodynes*, by John F. Rider. Published by the Radio Treatise Co., Inc., New York City.

The superheterodyne circuit is so generally used in receivers today that a service book, devoted entirely to the subject, is well warranted, especially when we consider that the operation of the circuit involves a number of principles that are peculiar to the superheterodyne system of reception. The amount of space devoted to the super in most service books is insufficient to cover the subject with the detail it deserves—and requires, if the reader is to really learn sufficient about the subject to service intelligently this type of receiver.

If Mr. Rider continues to prepare service books he will soon be able to announce his own personal "Five-Foot Shelf" of the world's best service books. Whenever we examine one of his books for review, we are impressed by the many practical hints and pointers that are obtained only from intensive reading of service literature or a great amount of practical experience. Altogether too many service books have been prepared by authors with but an academic knowledge of the subject, with the usual result that the book proves of little practical aid in the solving of the service problems. Rider, on the other hand, tries *not* to be academic, but rather to give the reader —the serviceman—information that he will be able to use, time and time again.

A major part of the book, "Servicing Superheterodynes" is devoted to the individual functions of the various units used in a superheterodyne and to analyzing and locating faults, not only the common faults, but also a number of faults that might ordinarily prove difficult to locate.

About the first third of the book covers the general principles of the superheterodyne, with particular reference to beat frequencies and the manner in which they are obtained by interaction between the incoming signal and the local oscillator.

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*1932 Official Radio Service Manual, Volume 2; Complete Directory of All 1931-1932 Radio Receivers.* Published by Gernsback Publications, Inc., New York City.

Apart from his instruments there is probably nothing more important to a serviceman in his work than his file of circuit diagrams. Sets can be serviced without having a circuit diagram, but how much simpler that service job becomes if a complete schematic diagram is available!

This 1932 edition contains some 575 pages of diagrams and technical data, plus a complete index of the entire contents. Many of the circuit diagrams show the actual values of parts and tables of the voltage and current readings which should be obtained at the various sockets in the receiver.

The first hundred pages of the book discuss the radio circuits and theory. There are many curves of tubes characteristics, equations for calculation of power output, detector circuits, rectifier and filter circuit design, and other essential data. There is also a chapter on servicing sound-picture apparatus.

In general the data given in these chapters is accurate and well written; an exception is the page devoted to electrolytic condensers. The measurement of capacity of these condensers is *not* difficult, as the text states, but is really simple, involving only a low-voltage transformer, a voltmeter and a milliammeter. Also, many electrolytic condensers don't freeze at 18 deg. F. *above* zero, as stated in the text, but freeze at temperatures *well below* zero.

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### *Review of Papers Published in the March, 1932, Issue of the Proceedings of the Institute of Radio Engineers*

*Sensitivity Controls—Manual and Automatic*, by Dorman D. Israel.

If we assume a receiver of extreme sensitivity such that a one-microvolt signal, modulated 30 percent, will produce 20 volts output and that the input signal may be as much as one volt, then an attenuation of 1,000,000 to 1 or 60 db is required in the sensitivity control to maintain constant output. Furthermore, if we assume that with an input of 1 volt it should be possible to reduce the output down to ½ volt, then an additional attenuation of 40 to 1 is required, giving a necessary overall attenuation of 40,000,000 in voltage or, with higher modulation, about 160 db.

Based on these reasonable assumptions, the author considers the design of various control systems, capable of giving an attenuation of 160 db. This attenuation may be obtained in manual controls, which function by decreasing the r.f. voltage input, or, by altering the operating characteristics of the r.f. amplifier tubes. The former method gives a high noise-to-signal ratio at low-volume levels because the tube gain is not reduced. The latter method is very good when tubes with remote plate-current cut-off are used. In many circuits these two methods of control have been combined. In the final parts of the paper the author discusses automatic volume control circuits.

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*Design and Characteristics of a New Power Radiotron for High Frequency Operation*, by M. A. Acheson and H. F. Dart.

This paper describes a new tube, the UV-858, designed especially for high frequencies; it is a three-element water-cooled tube. The highest practical operating frequency is 40,000 kc. (7.5 meters), at which 9 kilowatts output can be obtained, when unmodulated. Over most of the high-frequency range the output is about 20 kilowatts; at low frequencies (say 1500 kc.) the output is about 27 kilowatts. In certain tests the tube has been operated at frequencies as high as 65,000 kc. (4.5 meters). The maximum permissible plate voltage varies between 20,000 and 10,000 volts, decreasing as the operating frequency is raised. The tube generates considerable power when used as a Barkhausen oscillator, with the grid as the most positive element.

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*A Mechanically Resonant Transformer*, by Ross Gunn.

A transformer for use in the audio-frequency band is described, whose output potential is remarkably selective to fre-

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quency. In its simplest form the diaphragm of a telephone receiver is replaced by a tuned reed, of magnetic material. When a frequency is applied to the receiver, corresponding to the natural frequency of the reed, it is set in vibration and its motion may be used to generate potentials in another receiver unit, adjacent to the tuned reed. A typical transformer has a selectivity of 115 cycles at a frequency of 1500 cycles. The transformer will handle code signals up to about 30 words per minute, after which the "tails" become noticeable and the dots become blurred.

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*The Operation of Vacuum Tubes as Class B and Class C Amplifiers*, by C. E. Fay.

A simple theoretical development of the action of a vacuum tube and its associated circuit, when used as a class B or class C amplifier, is given. An expression for the power output is obtained and the conditions for maximum output are indicated. The way in which the tuned-plate circuit filters out the harmonics in the pulsating plate-current wave is illustrated by a hypothetical example. A set of dynamic output-current characteristics is developed, graphically, from a set of static-characteristic curves. The class B dynamic curves are found to give a better approximation to a straight line than the class C curves, because of the reversed curvature which appears at the lower ends. It is pointed out that the screen-grid tube should function similarly to a three-element high-mu tube in this type of operation. Experimental results are shown to verify this point.

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## Review of Contemporary Periodical Literature

*A Clock-Controlled Constant-Frequency Generator*, by A. B. Lewis. Bureau of Standards Journal of Research, January, 1932.

A synchronous motor-generator set is described in which the motor is forced to rotate in synchronism with signals from a standard clock-circuit. The result is obtained by first running a specially wound motor, synchronously, from a three-phase 60-cycle line. The field of the motor is then rotated, electrically, about the motor frame by an amount which exactly compensates the departure of the frequency of the three-phase line, from true 60 cycles. The output of the generator can be used to operate cycle counters, synchronous timers and other light-duty synchronous machinery; the generator has an ultimate load-capacity of 4 kw. The accuracy as a timing machine is about 0.004 second, plus or minus.

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*Frequency Characteristics in Film Recording and Reproducing*, by George Lewin. Electronics, February, 1932.

A discussion of the frequency-response characteristics of film recording and reproducing units. Curves are given, showing the overall response of the light valve, the recorded print and the theatre amplifier. It is shown that the final response is *down* about 15 db, at 6000 cycles.

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*Vacuum-Tube Performance vs. Manufacturing Tolerances*, by W. Charton. Electronics, February, 1932.

This article indicates the extent to which the characteristics of a tube are altered, by given variations in the spacing and shape of the elements. Curves are given showing the variation in tube constants as a function of the grid pitch an dthe eccentricity of the plate.

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*A New Voltage Quadrupler*, by William W. Garstang. Electronics, February, 1932.

The author describes an arrangement of condensers and rectifiers which make it possible to obtain, at the output, four times as much d.c. as could be obtained from a single rectifier. Voltage doublers are also described. The article gives diagrams of the final commercial units.

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*Calculation of Loudspeaker Efficiency*, by Irving Wolff. Electronics, February, 1932.

An excellent article on the factors affecting loudspeaker efficiency and the manner in which it can be calculated. The calculations are illustrated by practical examples. It is stated that the material forms part of a chapter on loudspeakers to appear in a handbook for radio engineers, to be published by the McGraw-Hill Book Company.

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*Quartz Crystal Resonators*, by W. A. Marrison. Bell Laboratories Record, February, 1932.

An interesting article on the quartz resonator, with particular reference to the different methods of cutting the slab. By cutting the crystal in a certain manner flexural vibrations can be used, giving frequencies, with certain types of mounting, as low as 1000 cycles.

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*Origin and Development of Radio Law*, by William J. Donovan. Air Law Review, November, 1931 (official publication of The American Academy of Air Law).

A review of court decisions dealing with radio subjects, since about 1927. It indicates the trend of such cases and the considerations involved in reaching these decisions. An interesting article to station managers and others whose work brings them in contact with the legal phases of radio.

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*The Important First-Choke in High-Voltage Rectifier Circuits*, by F. S. Dellenbaugh, Jr., and R. S. Quimby. OST, February, 1932.

The first of a series of articles on the characteristics of modern filter circuits. This article discusses the effect on performance of the inductance of the first choke in a choke-input-type filter; in this type of filter, no condenser is used across the output of the rectifier. It is shown that this choke has an optimum value; the optimum value of inductance being obtained by dividing the load resistance, in ohms, by 1000. With this value of inductance the peak current from the tube will be but slightly higher than the d.c. load current; the filtering is improved and the heating of the transformer is much less.

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*The Design of the Band-pass Filter*, by N. R. Bligh. The Wireless Engineer, February, 1932.

A rather complete discussion of various types of band-pass circuits as they find application in radio circuits. The author considers the factors which affect the response characteristic, with particular reference to systems giving a constant band width.

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*Moving Coil Magnets*, by C. E. Webb. The Wireless Engineer, February, 1932.

This article is concerned with the electromagnetic circuits of dynamic loudspeakers. A method is described which permits the accurate measurement of the flux-density in the air gap; a ballistic galvanometer is the basis of the method. Because of certain refinements in the method, it is possible to determine the uniformity of the flux-density, throughout the gap.

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*Uber Die Lichtelektrischen Eigenschaften Des Cadmium Insbesondere Den Einfluss Von Gasen Auf Dieselben.* (On the Photoelectric Properties of Cadmium and the Influence of Gas Thereon.) Ann. der Physik, Vol. 10, No. 5.

Evaporation of cadmium in cells which have been thoroughly degassed gives cadmium films whose long-wave limit is about $304 \times 10^{-6}$ mm.

The photo-electric effect is decreased by oxygen, nitrogen, hydrogen, carbon-dioxide and argon, when these are carefully dried before the experiment. Water vapor increases the photo-electric action.

Sealed cadmium cells, filled with an undried rare gas, show fatigue, with maximum sensitivity that is greatest just after the cells are made.

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*Die Entwicklung des Fernsehens* (The Development of Television), by F. Fuchs. "German Museum, Discussions and Reports." Third year, Volume 5. (Translated by John Borst.)

This booklet describes in simple, non-technical language the development of television and telephotography since 1875, the year of the discovery of the light-sensitive properties of selenium. It is shown that the first attempts were failures, due to the inertia of the selenium cell, the lack of a suitable light source in the receiver and the absence of amplification.

The problem of television can be resolved into five components. First, the perfection of a photo-electric cell which has no inertia and which is sensitive to the different colors in the same proportion as the eye. Second, the light source at the receiver must be capable of giving a brilliant enough light and to vary, without lag, the variations of the received signal. Third, the scanning systems must divide up the image into a sufficiently large number of elements to produce a reasonable image at the receiving end. Fourth, the scanning devices at the transmitter and the receiver must be kept in synchronism, and, last but not least, the signal must be transmitted by wire or radio.

This booklet devotes one chapter to each of these five problems. In such a short space one could not expect an exhaustive treatment of all proposed schemes in the art of television transmission. It is rather surprising how well the author covers the subject in but 28 pages.

The book should be of interest especially to the beginner in television and to the intelligent layman who wishes to keep informed of the latest technical developments.

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*Rundfunk-Jahrbuch, 1932* (Broadcast-Yearbook, 1932). Published by the Reichs-Rundfunk-Gesellschaft, Berlin. (Translated and abstracted by John Borst.)

The Germans have gone to an unusual amount of trouble and expense in making up their yearbook. It is printed on the finest paper and illustrated with over 300 beautiful photographs.

As would be expected from such a book, it reviews the events and development in the German broadcasting world during the past year and it attempts to predict what will happen in 1932.

We were especially interested in the chapter entitled "Listeners and Justice." The broadcast listener, it says, has a right to receive his programs and no interference is to be tolerated. The owner of interfering machinery can be legally forced to install filters—if the radio receiver was in use before the interference began—otherwise nothing can be done about it. The German listener pays a tax of 2 RM. (50 cents) per month. Exemption is granted to disabled war veterans, invalids and the idle.

Other chapters include: Experiments on ultra-short waves, Hello! America, How far are we with television?, New buildings, new artistic possibilities, Electro-acoustic musical instruments, and many others. There are some very popular explanations of radio troubles and definitions of standard symbols, but no technical discussions.

The book is intended for everyone who is interested in radio, regardless of their technical knowledge.

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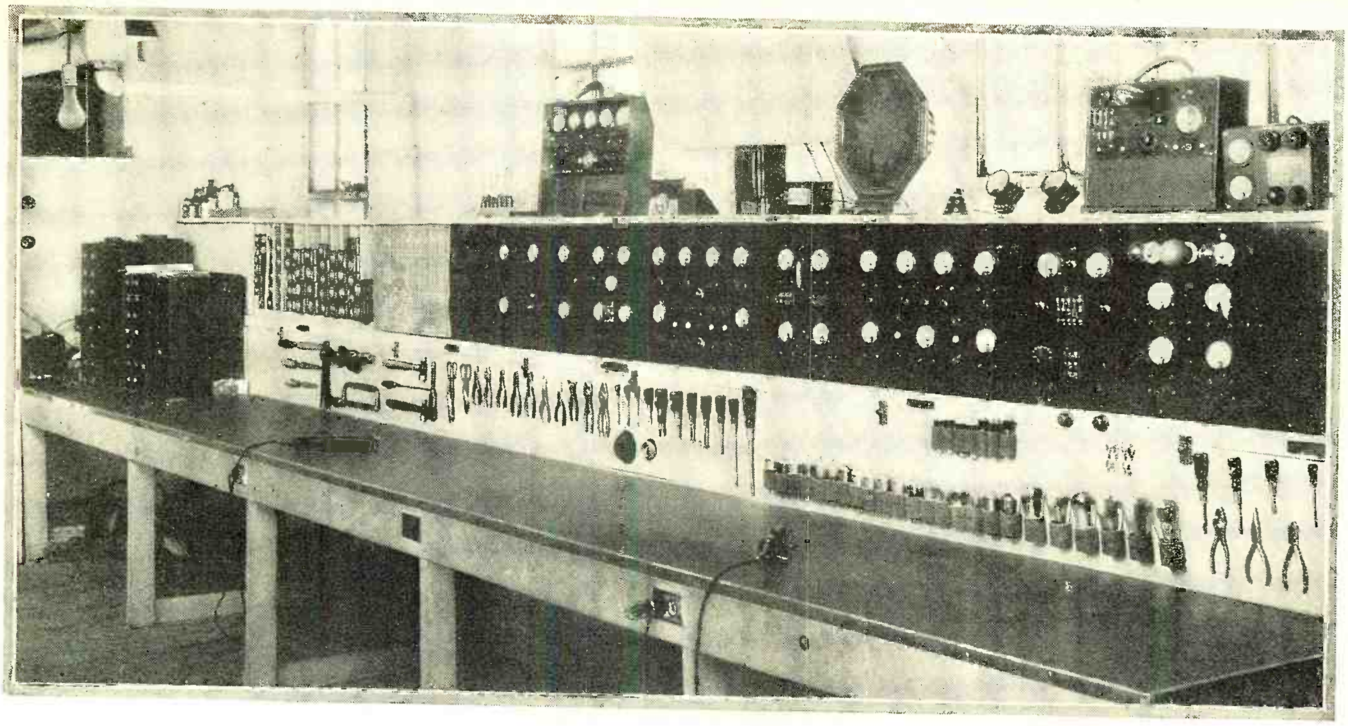


# The Service Bench

*Advertising and Publicity for Enterprising Servicemen—Service Hints; Atwater Kent 40 and 42, Radiola 86, Victor RE57, Stewart Warner 950—An Idea for Rural Servicemen—Testing Small Fixed Condensers—Service Kinks*

Conducted by
**Zeh Bouck**

PUBLICITY and advertising are the oil and grease on the cogs of modern industry. Advertising is a direct and unequivocating plug for a product or one who sells it. As far as the serviceman is concerned, it may take several forms, aside from the mouth-to-mouth advertising of satisfied customers.

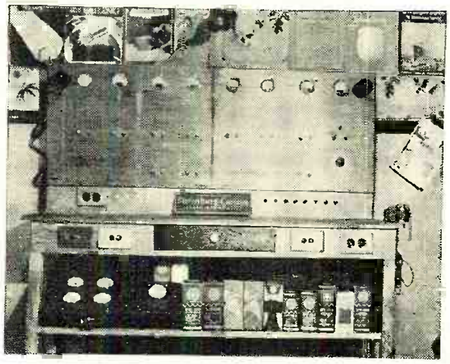
The shop sign itself may be made an attractive advertisement. The manufacturers of practically all receivers and tubes are glad to supply their dealers and representatives with a variety of signs, from the simple placard to the flashing electrical display, at cost. These signs incorporate the dealer or serviceman's name in an advertisement of their own products.

If the serviceman possesses a service truck, he should take advantage of its possibilities as a mobile advertisement. Each side should be placarded with a forceful and colorful declaration of name and specialty. Several slightly unconventional ideas for such signs are contained in the suggested newspaper advertisements on the opposite page. The truck should be maintained clean and shining. The wording of the sign should be simple—the colors brilliant but attractive and not "sickly."

### *Newspaper Advertising*

Newspaper advertising is useful in two ways. In the first place it provides an effective method of direct appeal. Secondly, it paves the way for the free appearance of publicity items. The amount of space taken will be determined, for the greater part by the rates—which are reasonably low in all but the large city newspapers. It will be found generally that a series of small advertisements is much more effective than a few attempts at large space, at the same cost.

You will find on the page opposite sample newspaper advertisements for the radio serviceman—advertisements running the entire gamut of space and appeal. They have been prepared with a thought to providing elasticity. The space may be varied in several cases by changing the length of stock borders, and the majority of the layouts admit of considerable latitude in copy. However, in many instances, it will be desirable to change only the name of the service organization. The types used in the portions of the advertisements that have been set up, are standard fonts, and can be duplicated or very closely approximated by almost any local printing shop.



*A Canadian service bench—that of A. Bellemare, Shawinigan Falls, Quebec. Extremely neat, light and roomy. The service bench itself can be made an interesting display, contributing considerably to service and accessory sales.*

These ads can be used by the serviceman in several ways. Line-cuts can be made to any desired size, direct from the illustrations shown. Such cuts, of course, will duplicate the type exactly. The portions devoted to the names of the servicemen can then be mortised out, and new names substituted in a harmonizing type. Your local printer can do this for you. Another possibility is to make line-cuts only of the display or illustrative material, and to reset the complete advertisement in accordance with your own requirements. Also, the Service Bench has made arrangements whereby the serviceman can be supplied with mats of the entire series of twelve advertisements at the nominal cost of one dollar. Send in your requests with a check or a dollar bill pinned to your letter, addressed to Dept. M, Radio News. These mats are standard single and double column sizes and include all hand work—pictures, display lettering and in some cases borders—but not set-up type. From these mats, your local printer can make stereos, and set up the advertisements as shown here or with variations as you require them. This will save you the large sum ordinarily spent for the cuts.

The accompanying advertisements are by no means limited to newspaper publication, and many of them are readily adaptable to postcards, envelope stuffers, blotters, stickers and circulars.

### *Publicity*

Publicity is necessarily less direct than advertising. It may be described, for our purposes, as material of a more general nature in which the name of an individual, or a product, receives a favorable mention. Its

(Continued on page 952)

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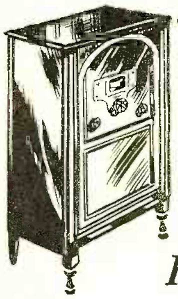
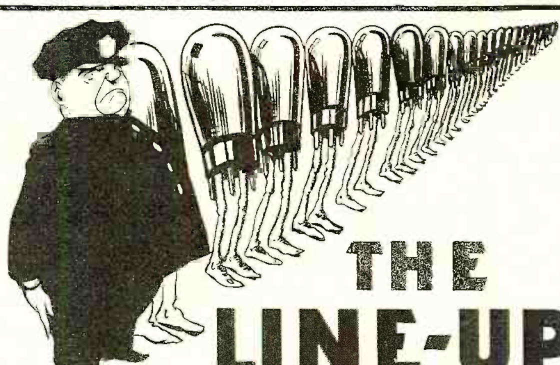
# Radios!



HIGH QUALITY RECEIVERS bought, sold and serviced. Television, short-wave sets and converters. Home demonstrations. Our prices are the lowest compatible with sincere, expert attention to your radio needs.

*HOGAN'S* Radio Shop HAINES FALLS Telephone 628



# THE LINE-UP

**Let Us Check Your Tubes**

*One By One!*

One bad tube is enough to spoil reception. It will take our experts only a few minutes to locate the offender! And the cost is nominal.

**Hogan's Radio Shop** HAINES FALLS

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**EXPERT RADIO SERVICE**
**HOGAN'S SHOP**
**Haines Falls, N. Y.**

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# RADIO

We can fill your every radio need from installation to repair. Finest equipment in Haines Falls!

**HOGAN'S**

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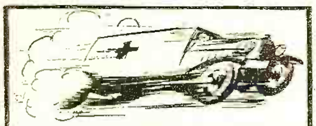

# The Radio Hospital

Rush calls are our specialty. Day or night a phone call brings an expert for any job from a tube replacement to a complete overhaul!

**HOGAN'S RADIO SHOP**
*Emergency Call 628!*

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## "Service" Advertisements That Will Bring You Business

THESE nine sample newspaper "Ads" have been developed by the advertising department of Radio News especially for the benefit of our servicemen readers. They can be used with your own name inserted in place of the specimen name. They will bring in new business you could never get in any other way. Read the Service Bench for further information and our special offer.

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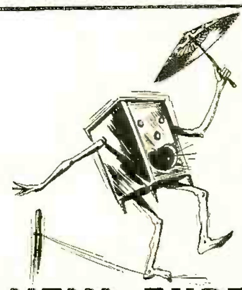

**NEW TUBES WILL MAKE YOUR SET PERFORM**

**Poor tubes are the cause of 90 per cent of all radio ills. Let us check your tubes when the complaint is—fading—poor volume—unnatural tones—noisy reception—or just a plain dead radio!**

**HOGAN'S RADIO SHOP**

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**RADIO SERVICE**
**Low Cost**
**Repairing**
**Installation**
**HOGAN'S**
**Haines Falls**

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# BROADCASTING THE FACTS

**Service!**

**Modern equipment! Expert Personnel! Courteous immediate attention! Fair and Moderate charges! For radio SERVICE in the finest sense of the word call on—**

**Our Mike**
**Haines Falls 628**

**The Hogan Radio Shop**
**HAINES FALLS, N. Y.**

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# FREE RADIO!

**INSPECTION SERVICE**

It costs you nothing to secure our expert opinion. If your radio is working perfectly you will be told so. If it needs attention, we shall give you an estimate for fair, square service.

**HOGAN'S RADIO SHOP**
**HAINES FALLS, N. Y.**

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primary purpose is to bring such an individual or product to public notice, and by repetition to establish said individual or product in the minds of prospective clients or purchasers. We give below several examples of the type of news publicity which the editor of the average rural or semi-rural newspaper is glad to publish. While these items cannot, of course, be copied verbatim, they provide a good idea of newspaper style, and, in some instances, only a few changes here and there will be necessary to make them fit in with actual local events.

## YOUR FAVORITE PROGRAM WHILE YOU RIDE

*Auto Radios Improved by New Tubes*

The pleasurable possibilities of automobile radio installations have been considerably enhanced by the perfection of new vacuum tubes designed to provide greater sensitivity and improved quality, according to the report of Walter Hogan, radio technician of Haines Falls.

Mr. Hogan declares that two definite improvements in vacuum tubes result in automobile radio reception which compares favorably with the best parlor program. A new type of cathode employing a separate heater—a design which is responsible for the excellent reception on the modern all-electric receiver—makes the tubes practically shock-proof, and eliminates much of the noise heretofore experienced when the radio has been operated with the car in motion. The second improvement is the adaptation of the pentode principle to radio-frequency circuits, which makes the receiver vastly more effective on the low voltages to which a battery set is necessarily limited.

It is believed that these new tubes will add considerably to the pleasures of motoring during the coming season. Mr. Hogan declares that he will be pleased to demonstrate the improvement effected by these tubes to anyone having an auto equipped with a radio receiver.

However, in rural publications, particularly when the way has been greased with a small ad, there will be no editorial objection to the final line of out-and-out advertising. Here's another:

## LOCAL RADIO SHOW EXHIBITS NEW MODELS

*Latest Radio Developments on Display at Hogan Shop*

Late model radio receivers and recent radio developments exhibited in the last New York and Chicago radio shows are being displayed at the Hogan Radio Shop for the benefit of those in Haines Falls who were unable to attend the annual exhibit.

Among the equipment being shown are receivers employing the new variable mu and pentode types of tubes, as well as automatic volume control. Receivers of all classes, ranging from a four-tube midget to an eleven-tube superheterodyne, are on display. World-wide demonstrations of short-wave reception and an experimental television set-up are attracting considerable attention.

Mr. Hogan believes that television reception from New York stations will be possible in the very near future.

During the period of the local radio show the nightly broadcast of the Albany Symphony Orchestra will be rebroadcast from the loudspeaking system in front of the Hogan store.

Once again we are on the borderline between advertising and publicity, but the news kick will generally be strong enough to justify it.

A definite news and publicity angle is indicated in the following:

## SCHOOL PRINCIPALS TO ADDRESS CLASSROOMS FROM OFFICE

*Microphone Speaker Arrangement to Eliminate Unnecessary Auditorium Assemblies*

Recent developments of radio-amplifying and loudspeaking systems are finding application in a wide variety of fields, and many city schools are now installing apparatus which makes it possible for the principals, or visiting notables, to address any or all classes from the principal's office. A microphone similar to that employed in a broadcasting studio is installed in the office, and is inter-connected through an amplifier with a series of loudspeakers in the various classrooms.

Dr. Barry, principal of the Haines Falls High School, has expressed his interest in such a system, and Walter Hogan, local radio and sound expert, has estimated the cost of such an installation in the Round Hill School at approximately $1200. It is understood that the school board will vote on this expenditure at the next meeting.

Another interesting item, that hits a little more closely home, works up as follows:

## RADIO RECORD CLAIMED FOR HAINES FALLS

*'Round the World Radio Made Possible on Standard Receivers*

By the use of what is called a short-wave converter, Walter Hogan, local radio expert, succeeded in receiving a radio program, broadcast direct from Australia, on a standard receiver. As Australia is approximately twelve thousand miles away—the maximum possible distance on this world of ours which is twenty-four thousand miles in circumference—Haines Falls is justified in claiming a World's Record!

Mr. Hogan declares that his record could be duplicated on almost any receiver. The converter is easily connected, and in no way interferes with the normal operation of the set. In addition to extremely long-distance reception, Mr. Hogan says that the converter makes it possible to receive the police broadcasting stations which are now operating in all principal cities. According to Mr. Hogan, these alarms and directions to squad cars are often more interesting than the familiar musical and advertising broadcasts.

# All in a Day's Work

Leaky and open condensers are responsible for a good portion of service work. We are glad to present two contributions, by servicemen readers, on this subject.

"It will sometimes happen that by-pass and filter condensers will test 'okay' in ordinary continuity tests, and yet are subject to considerable leakage at the voltages under which they normally operate.

"A simple means of determining this condition is by the use of a CX-374 and a 'B' battery or eliminator high-voltage source. If the condenser is 'okay,' there will be *one* red flash in the tube when the voltage is applied with the condenser and tube in series. If the condenser is leaking, there will be a series of intermittent flashes. If the condenser is shorted, there will be a continuous glow. I am using this test on my own test panel, and find it highly practical and convenient. Harry L. Gray, Independence, Iowa."

Along similar lines of thought, Mr. Alfred E. Teachman of Woonsocket, R. I., contributes the following:

"The opening of a bypass condenser can cause a marked inefficiency in the operation of a set. It occasionally happens that a condenser will open and heal again, causing an off-and-on-again condition that is very difficult to locate. This condition is often complicated by the fact that there are several condensers which may be responsible for the trouble. As it is expensive to change them all, some way must be found to locate the defective unit. One method is to go over the circuit with a spare by-pass condenser until a position is found that restores reception. This method, however, is anything but certain, due to the fact that the charging current will often cause the defective condenser to heal.

"A method which gets around this trouble is to connect a 10-ohm, 100-watt rheostat in series with the filament of the –80 type tube. The rheostat is advanced until the trouble appears, and then reduced until the –80 is 'out.' Connect the spare by-pass across a suspected condenser, and advance the rheostat slowly to its full-on position, bringing up the plate voltage to the receiver slowly and without surges. Repeat this process, if necessary, until the defective condenser is located."

It should be borne in mind that this method of location is for "opens"—not "shorts" or leakage.

### *Atwater-Kent 40 and 42*

"We have had several of these sets in the shop afflicted with an apparently incurable howl, while heating up. Changing tubes and testing condensers gave no hint of the trouble. On checking the audio wiring we found that the secondary of the audio transformer was connected backwards—that is, the blue wire, or F, to the grid and the black wire, or G, to the grid return. We have run into the same trouble when the primaries have been reversed."—Charles E. Anderson, Claysville, Pa.

### *Radiola 86 and Victor RE57*

Mr. E. Barton Blett, Grand Rapids, Michigan, expert on these receivers, passes on the following dope:

"Occasionally the serviceman runs across a new machine which is normal in every respect except when recording. In this position, the amplifier does not seem to deliver enough pep to cut the groove of the record.

"In back of the amplifier are two terminals to which are connected a pair of wires, black and black with red tracer, from the control switch on the motor-board. On the straight radio models, these terminals are bridged over with a link, completing the output transformer-voice coil circuit. In the combination receiver, these terminals are linked by the control switch when in the radio or record position, but are bridged by a 150-ohm resistor when in the radio or home recording positions. This is done to lower the loudspeaker output to a suitable level for monitoring. One side of this resistor is grounded, and also one side of the output and pick-up circuit. When the two wires are transposed from their correct positions, both sides of the output circuit are grounded, accounting for the lack of pick-up response.

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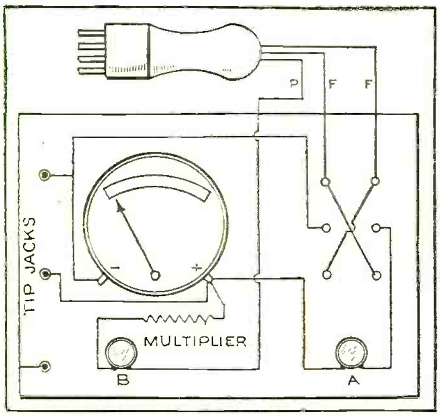
"When wired correctly, the lead with the red tracer is connected to the terminal closest to the -45 type tubes.

"These two combinations make excellent amateur public-address systems by linking these two terminals together (shorting out the resistor), setting the control switch for home recording, and speaking into the microphone. Volume is controlled by the Electrola volume control."

### *An Idea for Rural Serviceman*

Correspondence indicates that there is a profitable place for the rural serviceman specializing in the battery type receivers. Mr. N. Hadley, of Alert Bay, British Columbia, Canada, comes through




with the following money-making suggestion:

"I am employed as an operator in the Canadian Government radio station at Alert Bay, and have built up a lucrative service business in my spare time. There being no power in this part of British Columbia, all the receivers are, of course, battery operated.

"While checking up on my service cards some time ago, I noticed that a large number of my service calls were for the replacement of tubes burned out through the faulty installation, by the broadcast listener, of new 'B' batteries. This gave me the idea that a cheap connection tester would find a ready sale—the idea resulting in the circuit shown in drawing. I made up a number of them and found that as soon as the BCL got the hang of the gadget, a sale was made. With each tester I supplied a chart showing only the sockets of the set owned by the buyer, and indicating the correct voltages for each tube. The BCL has only to connect up his batteries, plug in the tester at each socket, and then by means of two push-buttons (one marked 'A' and the other 'B') determine that the voltages read correctly. It is then safe to insert the tubes and turn on the set. Also, by the use of the tip jacks and leads, the voltmeter may be used for other and conventional purposes. I sell these testers for $7.50 apiece.

"Servicemen living in rural districts should find this a profitable instrument to make up. It is readily salable after a service call for tube replacement.

"The panel is made of three-ply—5-inch by 5-inch. The meter is a Readrite 0-8-160 volts. A Marco d.p.d.t. switch is used for filament reversing. Three tip jacks supply terminals for exterior tests. A piece of broomstick is drilled through the center and formed to make an adapter handle when fastened to a tube base—either UV or UX, depending on

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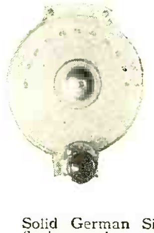
In addition to the parts shown below, NATIONAL CO., INC., makes a full line of Transmitting Condensers, Parts and Transformers for Every Kind of Broadcast Receiving and Short Wave Circuit, Amplifiers, Power Supplies. Write for our catalog sheets—NR-5-32.



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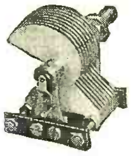

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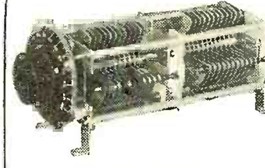

**TYPE TMP SPLIT STATOR TYPE TRANSMITTING CONDENSER**

Especially suited for 60 M C amateur and experimental work on "High C" and push-pull transmitters. Heavy aluminum straight-line capacity plates, with rounded edges and polished all over. Insulation is CROLITE. Made for 3000 and 6000 volts.

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Available to cover from 33 M C to 150 k. c. Forms are moulded R. 39, new low-loss coil material developed by Radio Frequency Laboratories exclusively for us. Blank forms are also available for winding experimental coils with 4, 5 or 6 prong bases.

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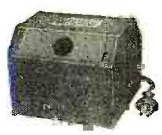
Type B has well known V. V. Variable Ratio of 6-1 to 20-1; bakelite cover; dial is quickly attached without special tools. 5" Diam. New Type BM is 3" diam., for use on small receivers and transmitters. Made with fixed ratio only.

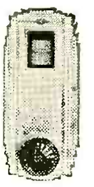


**SHORT WAVE POWER UNIT, TYPE 5880**

A separate unit for S.W.A.C. power supply. Power transformer has electrostatic shield between windings, R.F. Filter on Rectifier tube and special filter section, for humless operation. Separate 2.5 Volt Filament Supply. R.C.A. Licensed.

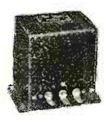
**NATIONAL NC-5 SHORT-WAVE CONVERTER MOST POWERFUL MADE**

Easily attached to any set in 10 minutes. Works on any set. Has two extra stages of amplification. No plug-in coils. Has own built-in power supply, R.C.A. Licensed. In standard metal cabinet model, and De Luxe Model with solid inlaid mahogany cabinet, shown above.



**DRUM TYPE VELVET-VERNIER PROJECTION DIAL TYPE H**

Has same velvet smoothness of all V. V. Dials. Scale is projected in color on to ground-glass screen and reads the same from any position, with enlarged figures and scale divisions. Easy to read—no parallax.



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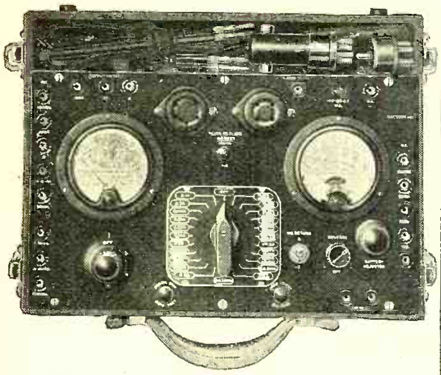
# HOW WESTON TEST SETS



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**Contains complete information on Weston Radio Testing Equipment.**

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the type socket. I made up the push-buttons from strip brass and binding-post tops. The panel is mounted in a box 5 inches by 5 inches by 1½ inch and attractively stained. Two flexible leads with 'phone tips on each end complete the equipment. The three tip jacks are marked 'common,' 'high' and 'low.'"

### *Stewart Warner Specialties*

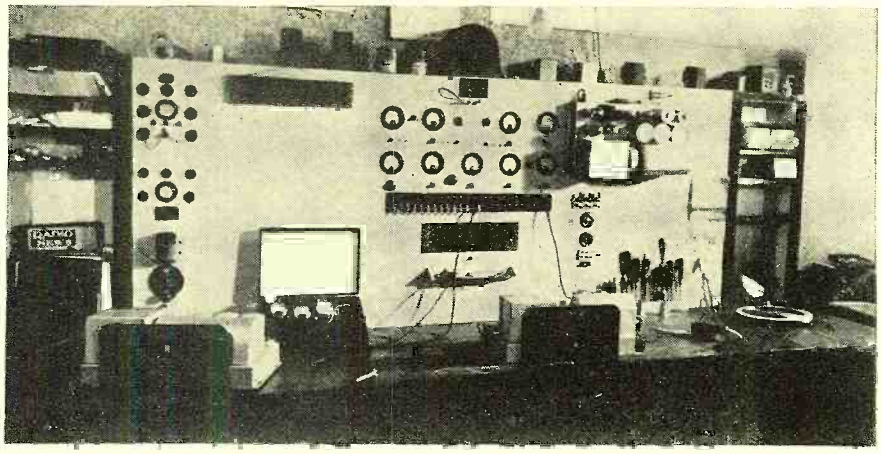
"Servicemen may easily render a distinct service to owners of the Stewart-Warner series 950 in the way of improving performance. First remove the chassis from the cabinet, and take off the plate covering the bottom. In the right-hand corner of the base, with the rear of the chassis facing you, there is a strip of bakelite, 3 inches by ½ inch, covered on both sides with insulating paper. Two wire-wound resistors are mounted on this strip. The smaller section is toward the rear of the chassis, and two leads, one yellow and the other black, are soldered to one terminal. Remove these leads, and resolder to the center terminal of this resistance strip.

"Should oscillations occur, examine the ground. It is essential that a low-resistance ground be available. Test the screen-grid voltage, which should not exceed 75 volts. Remove the cover over the tuning condenser, and clean the clips between the gangs. Be sure there is no possibility of feedback in the external wiring—such as between the antenna and the terminal strip or the antenna and the loudspeaker cord.

"This change brings up the sensitivity of the receiver considerably by increasing the r.f. plate potential from 165 volts to about 190 volts. If effected with the precautions mentioned, stability will not be sacrificed.

"The resistance strip to which reference has already been made seems to be a weak spot in this series. Occasionally it will be found desirable to bridge the smaller section with a 1000-ohm resistor.

"JAMES A. ROBINSON,
" Methuen, Mass."



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*The service shop of the Zenith Electric Company, Knoxville, Iowa. A highly practical layout in all respects—standard receiver, turntable for audio-frequency comparisons, adequate meters with switch and plug controls and readily available tools*

### *Testing Small Fixed Condensers*

Some dope on checking small capacitors—contributed by R. L. Minor, of the Vivier Music Company, Brownsville, Texas.

"These little condensers which are so plentiful in the modern receiver—anything from .25 mfd. down to triple 0 nothing—may be readily tested for shorts by a continuity measurement, but checking for an open is another story. They won't take enough charge to kick a meter or make a spark, and very few service shops can boast of a capacity bridge. Also the recommended method of checking larger condensers for opens with a low wattage lamp in series with 110 volts a.c. is equally out because the small capacities, even if okay, will not pass enough juice to light the lamp.

"However, we may borrow a tip from the above-mentioned method. Connect one of those little neon lamps, merchandised as 'Test-o-lites' and under other trade names, in series with the condenser and the 110 a.c., and we have a test that is fairly reliable in detecting opens in even the smallest radio condenser. A very convenient method of using this idea is to employ one of the series plugs which are furnished with Amperite line ballasts. Plug this into a receptacle, connect the neon lamp leads in one side and the test leads on the other. The neon lamp draws so little current that the test leads can be held in the bare hands without danger of shock." (Ed. Note: As Mr. Minor implies, the capacity-bridge test is the ideal method of checking small capacities for opens. And a rough bridge is a simple and inexpensive bit of apparatus to throw together. However, when no bridge is at hand, and Mr. Minor's suggestion leaves you in doubt, try substituting a new condenser, or shunt the suspected copacitor across a tuned circuit and note the amount of resonance shift.)

Mr. H. F. Pitzer, of Baltimore, Md., sends us the following jottings from his service notebook:

"Pick-ups are not the mysterious things most servicemen believe them to be. So long as the coil is good, the only other thing likely to go wrong is the rubber cushion. This rubber hardens and either restricts the motion of the armature or permits it to touch the pole pieces, resulting in lack of volume or poor tone. When in doubt, change the rubber.

"With the increase in sensitivity noted

(*Continued on page* 955)

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# Light-Sensitive Unit

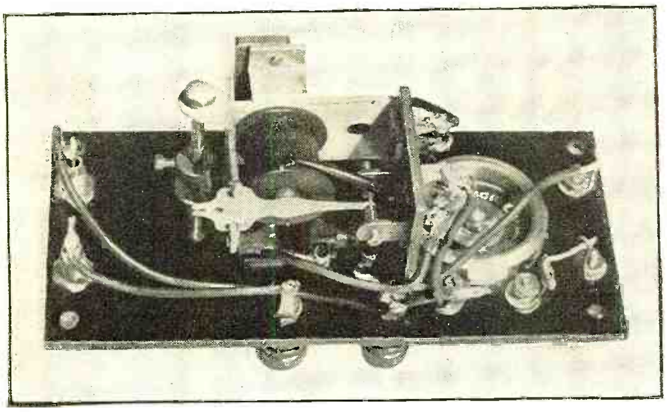
(*Continued from page 937*)

enough to release the armature readily.

Sometimes one might wish to have the relay close at the least amount of light. In that case, the auxiliary battery should be connected so as to aid the current flowing through the windings until it is just below the minimum which will trip the relay. It may then be necessary to change the voltage on the cell in order to find the proper adjustment. With some ingenuity on the part of the experimenter, the circuit can be adjusted for nearly any condition. A diagram of the circuit using the auxiliary battery is shown in Figure 3.

In Figure 4 is a diagram of a 110-volt selenium cell connected to the d.c. line by means of a potentiometer. In Figure 5 an arrangement is shown for a.c. connections. In this case the auxiliary voltage can be obtained from the same source by means of a filament or toy transformer.

The photographs show an arrangement of a photo-cell, relay and potentiometer, all hooked up and applicable to any condition. The selenium cell is connected to the unit by two cords which may be of any length. This permits it to be placed in inaccessible locations without having to place the whole instrument there with it. The relay is placed in the box, but it can be adjusted from the outside. One of the knobs adjusts the tension of the spring, and the distance of the contacts can be adjusted with a small screw-driver inserted through a small hole in the box. The second knob belongs to the rheostat in the compensating circuit. All connections have been brought outside, for connecting the batteries and the circuit to be controlled. The diagram of this experimental unit is shown in Figure 6. The whole has been mounted in a box 2½ inches by 5½ inches by 2½ inches deep. When one looks at the parts contained in it, one might think it impossible to place them in so small a space, but it is done by mounting the relay on a brass angle with the switch directly above it.



REAR VIEW OF UNIT

*This illustration shows the subpanel arrangement of parts in the unit described*

The sidewise mounting of the relay is necessary if both knobs are to be on the panel. The relay knob turns a shaft whereon a thin thread is wound and the thread is tied to the end of a spring. When the dial is turned, the thread is wound or unwound. This changes the tension on the armature spring.

If biasing is necessary, a battery of 3 or 4½ volts can be connected to the binding posts, marked for that purpose. However, if no balancing is needed, this battery may be omitted and the circuit then becomes like the one in Figure 2. The main battery, which gives the voltage for the photo-cell, can be a 22½-volt B battery for the 22½-volt model (the ST cell). Model L is designed for 110 volts either d.c. or a.c. In this case the two battery binding posts are connected to the light socket unless one wants to use a 110-volt B battery.

The resistance of model L is 5 times that of an ST cell; this makes the current about the same in both cases and the balancing circuit will be right regardless of what conditions are encountered.

Since the current through the average cell varies between 1 ma. and perhaps 6 ma. in some cases, we must make the range of the biasing circuit the same. It was first thought that this could be obtained with a rheostat of 5000 ohms and a single 1½-volt cell. However, it developed that a 5000-ohm rheostat of such a small dimension is not available and another one of 10,000 ohms was substituted. The result is that one can regulate the balancing current down to a lower value with a 1½-volt battery, but if it is to be large and the rheostat has to be turned up all the way, the adjustment becomes critical. The circuit can be adjusted better, in this case, if a battery of 3 volts is used. A 4½-volt tapped C battery answers for all purposes.

When the experimenter has constructed

# The Service Bench

(*Continued from page 954*)

in the current models of good receivers, we find a let-up in the care with which such receivers are installed, effectively counteracting the gains engineered into them by the manufacturer. Some servicemen seem to believe that any kind of an aerial or ground will do, and proceed to connect to a light outlet, BX cable, radiators and even drain spouts without any consideration of their actual efficiency as a collector of radiated energy. Another drawback to slipshot installation of this kind is the fact that a complete power circuit may be formed around the house wiring, antenna and ground, resulting in burned-out fuses or antenna coils.

"I find most of the dealers and servicemen test a 600-volt condenser for shorts with a 4.5-volt C battery! We employ a power-pack incorporating two -81's to supply a testing voltage equal to that under which the apparatus being tested is worked. A 300-volt condenser may test perfecly on 100 or even 200 volts, and yet break down when its rated voltage is applied. If a condenser is to be used immediately following the rectifying tubes, it should be tested at the peak voltage—approximately 1.5 times the rated working voltage."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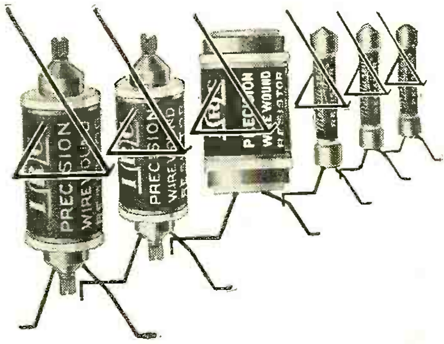

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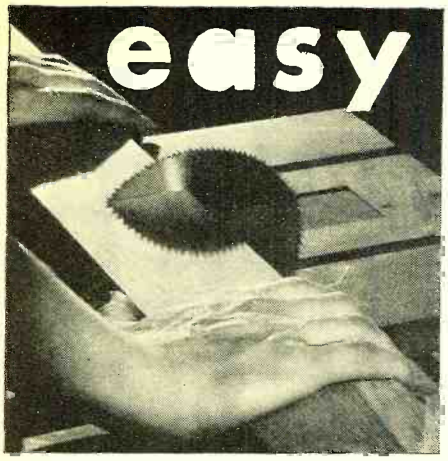


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*easy to use*


this unit he must first carefully make all the initial adjustments. The tension of the spring, the distances between the contacts of the relay and the biasing current are to be set carefully in order to make the unit function right. As long as the conditions remain the same the unit then can be left alone.

After some experience has been gained these adjustments will become easier and one will be able to foretell just which positions of the dials will be right for a specific purpose.

When a light shines on the photo-cell and one passes an object between it and the light, the relay will release its armature and attract it again—if it has been adjusted right. When the speed of the moving object is increased it happens sometimes that the relay will not trip fast enough. This is due to magnetic properties of the relay rather than to the cell. The effect can be eliminated, for the greatest part, by adjusting the distances and the tension on the armature more critically. While the armature is attracted it is closer to the magnet than it is in the open position. This is a second reason why it takes less current to keep the armature there—the first, mentioned above, is due to hysteresis.

If the magnet cannot be adjusted to work fast enough, another remedy is to make the variations in light larger by employing a stronger light.

If the relay is to be used for the making and breaking of a rather heavy current, it is best to eliminate contact sparks by connecting a condenser across the contacts.

In Figure 7 are shown the panel specifications and a drawing of the brass angle for mounting the relay. The holes in this brass angle are not in the middle, because there would not be enough room to mount it this way. This has to be done in order to keep the brass angle away from the toggle switch.

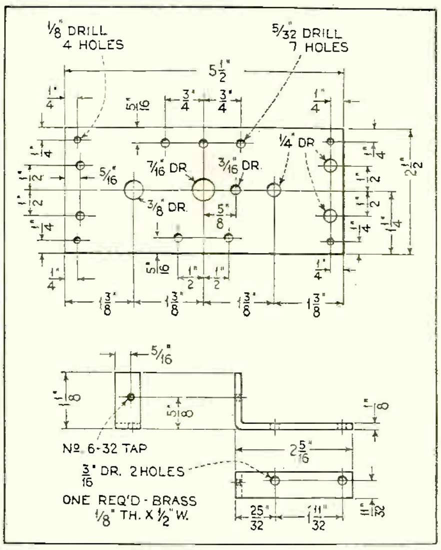


*Figure 7. Panel and bracket details*

### *Parts List for the Relay Unit*

1 Luxtron relay
1 Carter 10,000-ohm rheostat, model HI-R-X
1 bakelite panel, 2½ inches by 5½ inches by ⅛ inch thick, drilled as shown in Figure 7
1 toggle switch
7 Eby binding posts
2 phone tip jacks
1 brass angle (see Figure 7)
1 instrument box, 2½ inches by 5½ inches by 2½ inches deep (inside dimensions)

# A Serviceman's Oscillator

(*Continued from page* 944)

into othe plate circuit to obtain any desired percentage of modulation. For example, if a plate voltage of thirty-five gives an a.c. grid current reading of one milliampere, and sixteen volts on the plate result in one-half milliampere grid current of nineteen (35-16) volts (peak value) introduced into the plate circuit will result in fifty percent modulation, as reducing the plate potential by nineteen volts results in halving the oscillation current.

If a General Radio, Type 486, (or Western Model 571) 4000 ohm output meter is available, it is a simple matter to determine the alternating current output of any modulator (which may be any one of the excellent audio or beat frequency oscillators described in previous issues of RADO NEWS). The output meter should be connected across the modulator output, with a large (two or four mfd.) condenser in series, and its readings noted as the modulator plate voltage is varied. The value indicated by the output meter are r.m.s. values and must be multiplied by 1.4 to obtain "peak" modulator output volts. If the modulator is to be calibrated it should be equipped with plate and filament voltmeters. The output meter readings (multiplied by 1.4) can be plotted against modulator plate volts, the resulting curve giving the number of alternating current output volts (peak) for every value of voltage (d.c.) applied to the plate of the modulator tube. This sounds like a rather complicated and involved method of obtaining percentage of modulation, but in practice it proves to be quite simple. After both the radio-frequency oscillator and the modulator have been calibrated it is only necessary to connect them together, ascertain that filament of r.f. driver plate voltages are reasonably close to value used for calibration and adjust the modulator plate voltage to the percentage of modulation desired. It is an easy matter to obtain sufficient data from the two curves, "oscillator plate voltage—a.c. grid current" and "modulator plate volts—output meter," to make a curve or table giving the percentage of modulation with each value of modulator plate voltage.

It will be noted that the above tests are easy to make, and the data obtained is of practical value to servicemen. No mathematics is involved and, unless the percentage of modulation is to be ascertained, no special equipment is required. The oscillators described herein are primarily designed for making comparisons only, no absolute values of sensitivity or selectivity are obtainable, and the measurements obtained cannot be compared with those secured by other methods, such as I.R.E. standard tests. However, the tables derived from measurements of standard broadcast receivers will permit servicemen to establish their own standards of comparison, which will prove invaluable in making rapid tests for over all receiver efficiency and in locating defects.

### *List of Parts Required*

General—
1 Navy "ditty" box, 9" x 13" x 7" deep. May be purchased from dealers in government surplus equipment for /1.95.
1 Galvanized sheet iron shielding can, with transverse partition, to fit above box.
1 Aluminum panel, 9" x 13" x ⅛" thick.

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2 Bakelite panels, 3" x 7" x 3/16" thick.
5 Sangamo fixed condensers, various capacities (one with gridleak mountings—see circuit diagram.
1 Tuning coil, Silver Marshall, Type 142, this coil comes without a center tap, which must be made by constructor.
1 Aerovox blocking condenser, .1 mfd.
1 Gridleak, 7 megohms.
1 Socket, four prong.
1 Yaxley seven point tap switch.
2 Toggle switches, single-pole, single-throw.
2 Fixed resistors, 20 ohms.
Stove mica, shim brass and spring (hard drawn) sheet brass for trimmer condensers.

### *General Purpose Unit*

2 Bakelite panels, 6" x 7" x 3/16" thick.
1 General Instrument Corp. "No-Loss," .00035 mfd., variable condenser (or other good s.l.f. condenser).
1 Tuning coil, Silver Marshall, Type 142.
1 Sangamo, .002 fixed condenser (with gridleak mountings).
1 Socket, four prong.
2 Toggle switches, single-pole, single-throw.
1 Marco dial.
1 Yaxley jack, double circuit.
General adio plugs (number depending upon number of loading coils constructed).
4 General Radio jacks.
2 Fixed resistances, 20 ohms.
1 Fixed resistance, 2000 ohms.
1 Gridleak, 7 megohms.
Bakelite strips, 1" x 2" x 1/8" thick (number depending upon number of loading coils constructed—3 needed for mounting).

### *Miscellaneous*

12 Eby binding posts, long shank.
2 Type –99 vacuum tubes.
2 Burgess, No. 5308 B batteries.
4 Burgess, No. 2370 C batteries (for filament supply for –99's.
5 ft. Brass rod, No. 8.
Mounting feet and angles, 6/32 nuts and bolts, soldering lugs, Cowirco hook-up wire, 8/32 nuts and etc.

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## High-Speed Oscillations

(*Continued from page* 913)

oscillating currents may be performed with ordinary d.c. or a.c. instruments, the zero point of which is in the middle of the scale. Moving-coil-type instruments are preferable for these purposes. The inertia of the instruments used ought to be the same for all the indicating devices. It is therefore advisable to use instruments with small hands, for instance the Weston instruments of about 2½-inch panel diameter. It is also advisable to have a considerable damping in those instruments.

For teaching purposes, it is possible to show, with these devices, the phase angle between plate current and the voltages applied to the (high-) frequency circuit. The voltage in the different phases of the alternating current can be determined directly across condensers of different capacity and the oscillations shown.

The phase difference between the voltage across the condenser and the current passing through it can be demonstrated, directly.

The phase difference of 180 degrees between the two tubes of a push-pull circuit can be made directly perceptible.

With apparatus of the types shown it is believed that many new facts of importance can be found and illustrated that may add to the present information on the subject.



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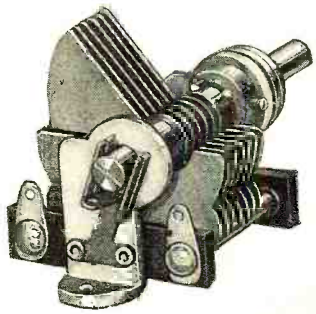

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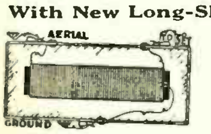


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# With the Experimenters

(*Continued from page 908*)

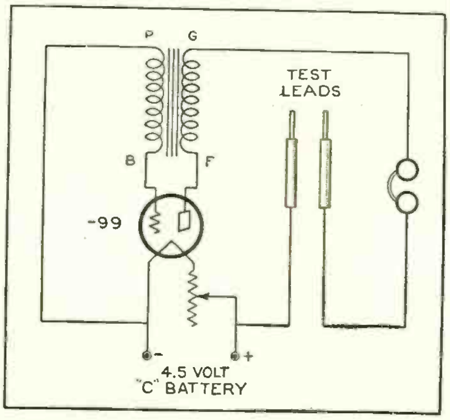
blade of the switch to make contact with the lower one and closing the circuit. When the tube is removed from the socket the switch circuit opens automatically.

Such a switch as this finds many possible applications around the service shop or experimental laboratory. It is especially useful in connection with dynamic speakers which draw their field supply from the plate supply circuit of a receiver and which are connected to the receiver and plate supply by means of a plug and socket. In such installations the removal of the speaker plug from its socket without first cutting off the power subjects the rectifier and filter system to a considerable strain. Through the use of a switch such as that described, to break the a.c. line, removal of the speaker plug would automatically cut off all power.

WM. NAKEN,
Chicago, Ill.

## *Code Practice Set Used as Tester*

I have found that a code practice set makes a good tester if test leads are substituted in place of the key. The high pitched sound, which this set produces in the




headphones is a good indicator. The tester may be used to test for shorts, open circuits or high resistances. The primary or secondcoils of unmarked audio transformers may be determined; for instance, a low pitched sound indicating the terminals of the primary, and a higher pitched sound indicating the terminals of the secondary. An open transformer will produce no sound. Resistors even over 500,000 ohms may be tested for open circuits.

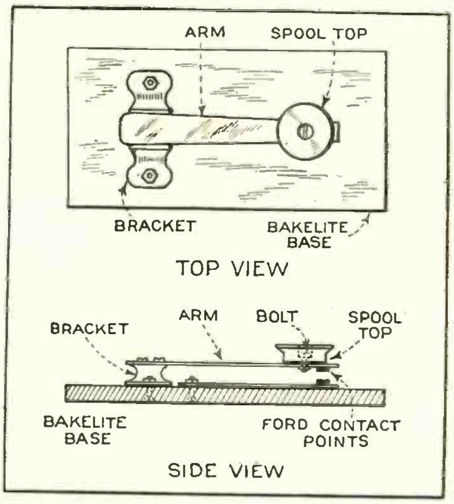
Short circuits of very high resistance may be found. The value of resistances may be found approximately. For instance, a 100,000 resistor when placed across the test leads will give a sound of a certain pitch. If a higher resistance is placed across the test leads the pitch becomes higher, and vice versa. High or low resistance shorts in condensers can also be detected. Coils of low resistance and of high resistance such as chokes and transformers may be tested to determine whether they are burned out or O. K. This tester is even more reliable than a voltmeter tester. I have used it several times for correcting troubles in receivers due to shorts and open circuits, and I have found it indispensible.

J. R. SMOLCHA,
McKees Rocks, Pa.

## *Cheap Transmitting Key*

I am attaching a drawing of a simple key which I made and have been using for some time now to practice code.

The key is made out of two contact points from a Ford spark coil. The bracket is taken off one of the contacts and the contact is attached to a piece of Bakelite which serves as the base for the key. The other contact arm is taken off the bracket, turned over and again attached to the bracket, and this part is then also bolted

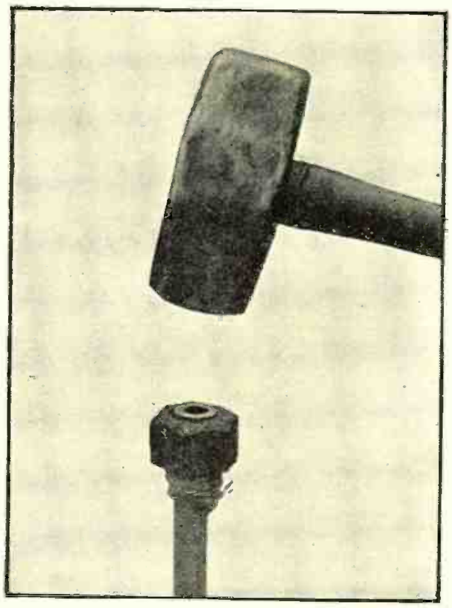



to the bakelite base. Finally, a round disk of Bakelite, or better still, one of the ends cut off an ordinary spool, is bolted to the upper contact arm to serve as the handle. If desired, a pair of binding posts may be mounted on the Bakelite and the two arms of the key connected to these.

ARCHIE J. MAUS,
Terre Haute, Ind.

## *Driving Iron Pipe Grounds*

Three-quarter-inch (O.D.) galvanized pipe is quite commonly used for ground wire connection, and it makes a good one, but driving a long piece of it down into even soft earth frequently burrs or splits and shatters the end pounded on. Special appliances are of course made for this job,



but when one is without them, the above photo shows a little method which can be used. A ⅞-inch nut will just snugly slip over this sized pipe. With plenty of stout heavy cord wrap the pipe just below the nut, so that just a small portion of the pipe will extend above. Drive the pipe down with any kind of a heavy hammer or small

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sledge. The end of the pipe will, of course, expand in the nut, but it cannot split or crack. The nut prevents that. When the pipe is down far enough, cut away the string or cord and, with a hammer, tap the nut some distance down on the pipe. File off the burrs you have made on the pipe end driving it, and tap the nut back up and off the pipe.

FRANK W. BENTLEY, JR.,
Missouri Valley, Iowa.

### *Pepping Up Phonograph Pick-ups*

While it is always possible that a phonograph pick-up may lose an appreciable portion of its residual magnetism, it is not probable, especially if it is one of a fairly high grade. If Mr. Ivan Lee, B. S. (author of the item "Rejuvenating Phonograph Pick-ups," on page 598 of the January issue) of Jersey City, will investigate this delicate piece of mechanism, he will likely find that rubber packing has lost its ability to act natural, and that if a new packing is substituted the magnet superposed over the pick-up, as described in his article, will be superfluous.

VERNE V. GUNSOLLEY,
Minneapolis, Minn.

### *Condenser Lubrication*

The manufacturers of variable condensers of modern design make the utmost effort to have the condensers accurate, quiet and non-microphonic. However, trouble is sometimes encountered in these respects in condensers of inferior construction. Sometimes these require a little more tension applied to the rotor shaft in order to avoid loosening and microphonic trouble, but when the tension adjusting mechanism is turned too tight, the rotor shaft will be too stiff in rotation unless the bearing is lubricated. It is generally known that the bearing of a condenser should not be lubricated because oil is a non-conductor of electricity. This trouble can easily be overcome simply by soldering a flexible wire or coil spring "pig-tail" between the rotor shaft, and frame (or rotor terminal). Since the rotor shaft is then grounded through this "pig-tail" rather than through its bearing, the bearing can be lubricated at will.

HAN TE-CHANG,
Peiping, China.

## DX'ers Corner

(*Continued from page* 908)

and at that time consisted of only three fans who desired to pool such information and data as they might have. The idea spread and in three months' time the membership had increased to over 200. Since that time it has been steadily growing, until now its membership represents 62 countries of the world and among its members are numbered at least one King, many Consuls and Consul-Generals, doctors, lawyers, and others in all walks of life.

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(*Continued on page* 960)


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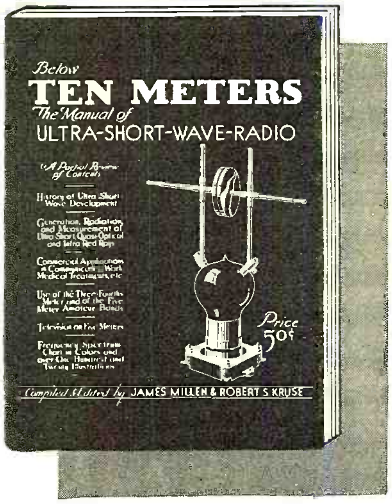


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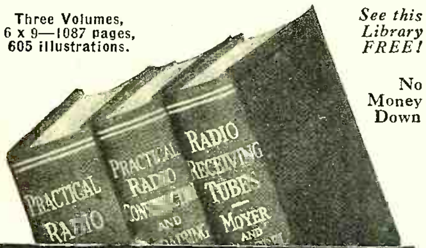


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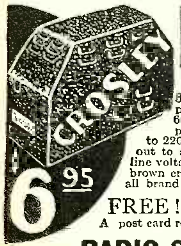


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# DX'ers Corner

(*Continued from page 959*)

## *The Transcontinental DX Club*

This is a club which was organized primarily in the interests of DX listeners in the broadcast band, although some attention is given to the interests of short-wave fans as well.

The express object of the club is to promote friendly and educational correspondence pertaining to radio, and to further the interest in the collecting of radio cards, stamps and letters of verification. Likewise to give accurate information concerning radio problems and particularly to distribute information concerning far-distant stations.

Each member is provided with the names and addresses of all other members, to facilitate exchange of correspondence and the establishment of new contacts.

Further information on this organization can be obtained by writing to Ralph H. Schiller, the Transcontinental DX Club, 42 Vincent Street, Hawthorne, N. J.

## *For the Early Birds*

A DX journey across the continent between the hours of 4 and 7 A.M. usually proves far more fruitful than the time spent in trying to lure a distant station out of the after-midnight jumble of static and congestion.

In a recent trip the writer found no less than nine new stations to add to the ever-mounting log. Those broadcasting at the time were chiefly Westerners, with a scattering of the almost local, though very elusive, low-powered stations.

WHDL, Tupper Lake, N. Y.; WPFB, Hattiesburg, Miss.; KFEL, Denver, Colorado, and WSYB, Rutland, Vt., were on the air with test programs, while KFXF, Denver, Colorado; KMMJ, Clay Center, Nebraska; WDBO, Orlando, Florida; KFBI, Milford, Kansas, and KFXJ, Grand Junction, Colorado, were blaring away with the usual nightly program of local news items, phonograph records and other features.

After hearing these stations, coming through with absolutely no interference, one wonders if it is not more profitable to follow the advice of the old adage: "Early to bed and early to rise . . ." By so doing we guarantee neither health nor wealth, but if luck is with you a few good "catches" and possibly a verification or two instead.

The following station schedules have been received directly from the stations themselves. All time quoted is Eastern Standard:

WMPC, Lapeer, Michigan, 1500 kc. with 100 watts of power, broadcasts every Thursday from 4 to 6 A.M.

WEHS, Cicero, Illinois, broadcasting on 1420 kc. with 100 watts of power, is on daily from 5 to 7 P.M. and on Sundays from 5 to 8 P.M.

WCLO, Janesville, Wisconsin, on the 1200 kc. channel with 100 watts of power, may be heard daily after 7:30 A.M.

KTAB, San Francisco, Cal., on 560 kc. with 100 watts of power, is on the air daily from 10 A.M. to 4 A.M. and on Sundays from 11 A.M. to 2 A.M.

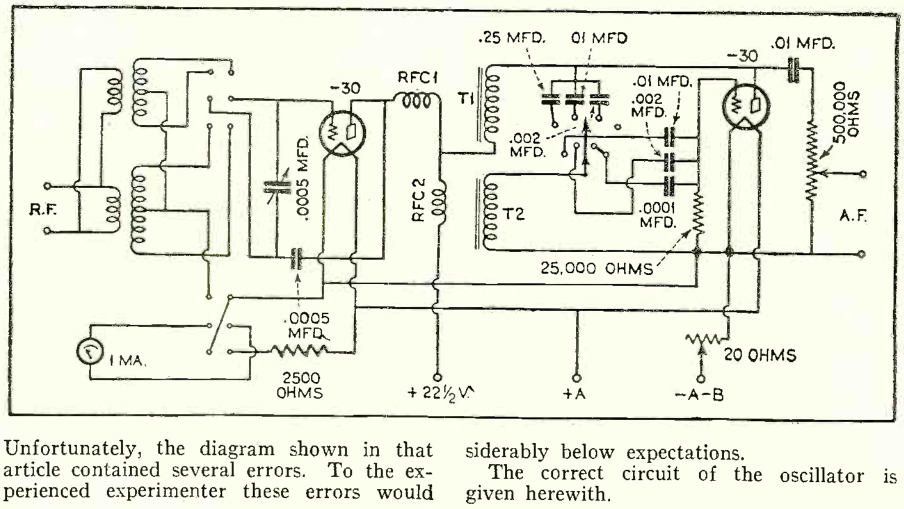
KJR, Seattle, Washington, operating on 970 kc. with 5000 watts of power, may be heard on Sunday, Monday and Tuesday from 11 A.M. to 3 A.M.

KFSD, San Diego, Cal., on 600 kc. with 500 watts of power, is on the air daily from 10:30 A.M. until 3 A.M.

JOHN J. CALDWELL,
New York City.

## *The All-Purpose Oscillator*

In the October, 1931 issue an article by C. K. Krause appeared under this head. Unfortunately, the diagram shown in that article contained several errors. To the experienced experimenter these errors would be more or less obvious, but it is possible that the incomplete connections may, in the cases of some less experienced constructors, have resulted in an oscillator that fell considerably below expectations.




The correct circuit of the oscillator is given herewith.

## *"Mike Smasher"*

PARIS—So rich and resonant is his voice that M. Raimu, well-known Parisian actor, is becoming known as the "mike smasher." The delicate microphone membranes are unable to withstand the frequency range of his voice. French technicians are considering developing a tougher instrument that shall be thoroughly Raimu-proof.

## *Lifeboats with Radios*

LONDON—A recent yachting disaster, in which a prominent Member of Parliament and five companions were drowned, may lead soon to a requirement that fast lifeboat cruisers equipped with radiotelephone apparatus shall hereafter patrol the entire British coast during stormy weather, says a trade commissioner's report to the Department of Commerce.

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# Scanning Discs Lens Design

(*Continued from page 915*)

experimentally, the focal length of a lens. The curvature of the surfaces is sometimes stated in units of *diopters*, although, technically, this term also involves the index of refraction. One *diopter* is the power of a lens whose focal length is one meter. Thus a lens having a focal length of 20 centimeters (approximately 8 inches) would have a refracting power of 5 *diopters*. In the following analysis the focal length will be used instead of the dioptric equivalent.

The focal power relation (1) has several interesting properties. If either AO or BO is "infinity," as would be the case when the light rays are parallel, Figure 2b, such as in direct sunlight, F is found to be the distance from the center of the lens to the point where the rays come to a focus. This furnishes the simplest method for the experimental determination of the focal length of a lens. Figure 4 provides a simple method for obtaining a solution for Equation 1, where a straight line intersecting the center scale will indicate points on the other scales that satisfy this relation.

In order to illustrate these principles, a series of problems will be illustrated graphically in order to show how light rays are collected and refocused on the screen under various conditions. First the principles will be shown whereby images of objects located away from the axis of the lens are reproduced (see Figure 3). In this diagram the object AL is placed parallel to the plane of the lens. Imagine that one ray of light from the point L goes through the center of the lens O. Since it leaves the glass at the same angle that it enters, it is undeflected and continues on in the direction OS. Another beam of light from L will cross the axis through the focal point F and upon reaching the plane of the lens will be deflected in a direction parallel with the axis. It will eventually intersect the line OS at the point S. If the screen is located perpendicular to the axis so that it intersects this point, the image of AL will be sharply focused on it as BS. It can be shown from symmetry that a ray from L traveling parallel to the axis such as LM is deflected to pass through the focus point F′ and if continued will also pass through S. Any two of the above three rays can be used to locate the position of the image.

In practice the present types of television discs are provided with lenses having focal lengths from 1.5 to about 3 inches. Generally speaking, lenses of the larger diameters are designed with longer focal lengths to decrease errors. On the other hand, the greater distance that the screen must be moved out to secure the required magnification precludes the idea of having the screen integral with the television cabinet.

In tracing out the actual ray path from a stationary light source through a moving-lens system the procedure is very similar. Three positions will be illustrated in Figures 5 and 6 which differ only in the lamp-to-lens spacing and therefore in the magnification. These diagrams are based on the assumption of a point source of light. With most types of crater lamps this condition is closely realized.

The light source L produces a conical beam of light directed toward the screen, the center of which is designated C. If the momentary position of the lens is such that its axis is displaced by an amount AL, according to the principles outlined in the description of Figure 3, the rays will be refocused at the point S. In Figure 5 the distance LM is equal to MC, and the displacement of the point S from the center of the screen SC = 2 AL. Figures 5b and 5c also represent other instantaneous conditions where the lens is first centered, and then displaced an amount AL in the opposite direction. Figure 6 represents the same problem, but the lamp is located closer to the scanning disc AF = ½ FO, to illustrate how greater magnification is obtained. In these figures it will be found that the distances AO and BO correspond to the Equation (1).

It will be seen that the light source cannot be moved nearer the lens than the focal length of the latter, or else the transmitted light cannot be focused on the screen. The closer the lamp is placed to the position F, the greater the magnification. Figure 7 is a chart that enables the required positions to be readily determined, where a straight line across the appropriate values of focal length and magnification intersects the third scale at a point that shows the required distance from lens to the screen.

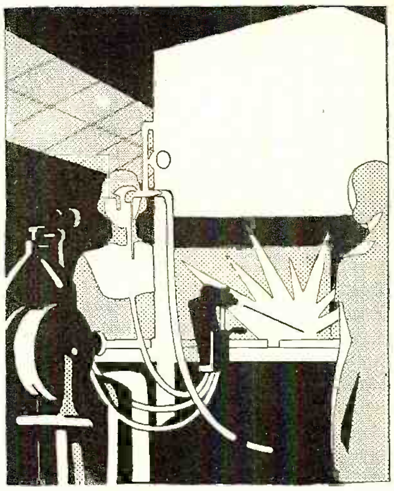
In previous paragraphs the grinding variations were mentioned. In general, the important ones are: variations in the focal length and in the optical centering. The latter is due to the optical center of the lens (the line connecting the centers of curvature of the two surfaces) not coinciding with the physical center. This has the same effect as if the lens mounting hole was mislocated by an equal amount. This displaces the picture line either in a tangential direction (which will produce a blurred strip in the picture) or will displace the line radically (which permits a dark streak to show up on the screen.) Frequently this effect can be partially compensated for by rotating the lens around in the mounting hole by an amount determined by experiment, so that the distortion is less effective. Unless the lenses are held to closer limits by specifications, center variations might have a value of around .005 inch.

If all lenses come from the same source and are prepared in the same way, practically no variations in the focal lengths should be found. The extent of the effect can be shown by a numerical example: Assume the normal focal length is 2 inches and that a certain lens has a value of 1.95 inch. A magnification of 10 is used, and that the distance between centers of lenses is 1 inch. This particular lens will produce a line 10.25 inches long. Since the greatest displacement (⅛ inch) occurs at the edges of the picture, even this error might not be serious. If it happens that the particular lens is not located near the center of the series in the spiral, this additional magnification may cause two adjacent lines to be superimposed, however, causing the usual dark streak.

It is not difficult to pick out a lens, having excessive errors, by successively screening over various holes in the portion of the disc that produces the section of the picture in which the distortion occurs. If the line is displaced but is of the same length as the others, the trouble is due to either eccentricity of the optical axis or to an error in the location of the mounting hole. If the individual line is of a different length, the probable cause is that the focal length is different.

Another effect of less magnitude may be produced by differences in the thickness of the lens and in mounting systems, where small differences are found in the positions of the lenses wherein not all of their optical centers lie in the same plane. The actual change in magnification is directly proportional to the displacement relative to the distance between the lamp and lens. That

(*Continued on page 962*)

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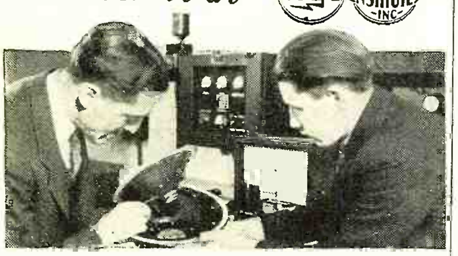

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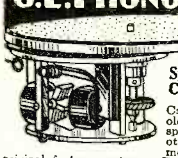

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# Two-Volt Superheterodyne

(*Continued from page 932*)

volt tap is brought to the Class B output stage grids through a separate lead in the battery cable.

There are two possible methods of loading the C battery. The former method consisted of leaving the bleeder system, which was of relatively high resistance, permanently connected across the battery terminals thus producing a continuous low drain. This scheme, while infinitely more satisfactory than no loading at all, was based entirely on rough estimates of the probable number of hours that the set would be operated and on data collected from life tests of the batteries. If the set were operated either considerably more or less than the estimated time, the desired relationship between the B and C voltages would not obtain. Engineers of the National Carbon Company determined after a year's experimentation that intermittent draining at the proper rate while the set was actually in use would produce exactly the desired result, and this system was forthwith incorporated in the 727-DC. Notice in Figure 1, that an additional switch, ganged to the customary ON-OFF switch in the filament lines, is necessary to completely isolate the C battery when the set is not in use. Naturally a truly proportional draining will result only with the type of batteries for which the set was particularly designed. These are the Eveready Layerbuilt No. 486 B batteries and the No. 768 22½-volt C battery or their equivalents.

By this time the reader is no doubt wondering about the possibilities of image-frequency responses in a circuit which apparently has little discrimination against unwanted carriers. As a matter of fact, the present circuit has a two-to-one signal to noise ratio advantages over the more selective siamese input system, including that of evident economy, and in actual tests it has displayed a remarkable freedom from image difficulties. Responsible in no small measure for this situation, is the use of 465 kc. intermediate-frequency amplification. This increases the separation of possible image frequencies from the desired carrier by a factor of 2.65 over the conventional 175 kc. system. Assuming that the desired station is at 550 kc., the corresponding image point would lie at 1480 kc. Evidently there are image points within the broadcast band for only three channels, namely 550, 560, and 570 kc. The wider separation of these points from the desired frequency means that for the same image response ratio as would be obtained under the 175 kc. system, we must provide the same amount of attenuation as before, but at points which are 2.65 times as far off the resonance curve of the carrier-tuning circuit.

Figure 2 is a front view of the chassis, at the right of which is mounted the high-Q input circuit assembly. The antenna coil is wound on a small bobbin suspended in the front end of the coil form. Immediately behind it is the secondary or first detector coil. The diameter, shape factor and wire size and spacing of this coil have been carefully chosen to give the highest possible ratio of inductive reaction to resistance (Q) the criterion of coil quality. At the rear end of the same form is wound the oscillator tank circuit. The oscillator is thus magnetically coupled directly to the first detector inductor instead of through an auxiliary pickup coil in series with the first detector cathode. The highly efficient transfer of energy from the antenna to the grid of the first tube results in a vastly improved signal to noise ratio over a siamese or other preselection system.

The use of 465 kc. intermediate-frequency amplification necessitates a great deal of care in amplifier design. Since coil losses increase rapidly with frequency, the i.f. transformer construction must be designed for high efficiency. The need for thorough shielding of components is also evident at this frequency. As can be seen in Figure 2, all tubes except the output pair are mounted with the special shield assembly extending along the rear of the chassis. This shield is divided into tube compartments by vertical fins attached to the front side. A one-piece cover, enclosing the top and back of the tube compartments, completes the shielding while allowing convenient removal or insertion of tubes from the rear of the cabinet. Figure 3, a bottom view of the chassis, shows the beautiful simplicity of assembly. Notice the extensive application of ground buses which prevent regeneration due to circulating currents in the chassis. Another interesting point is the diminutive size of the by-pass condensers—due, of course, to the use of the higher intermediate frequency.

Adequate swing for the grids of the Class B stage is secured by a preliminary stage resistance—coupled to the second detector in the conventional manner. The grid circuit of this tube contains also a treble-attenuating tone control for discrimination against static and for those who do not prefer the abundance of highs finally delivered from the compensated special permanent magnet dynamic. The overall fidelity from antenna to ear is more nearly horizontal than the characteristic displayed in Figure 6, which was obtained with a pure resistance load.

To sum up, the 726DC receiver is an inexpensive, highly sensitive superheterodyne

(*Continued on page 963*)

# Lens Design

(*Continued from page 961*)

is, a displacement of 1/34 inch between the center of an individual lens and the normal plans of the other lenses would cause a 1% change in the magnification when the lens-lamp separation is 1.6 inch. An intentional displacement of this sort is sometimes used to compensate for variations in the focal length in some of the individual lenses.

The lens requirements for television scanning discs are really simple, inasmuch as the several distortional factors that complicate the design of many other optical instruments are unimportant here. An enumeration of some of these, however, might be of interest. We find:

1. Color of chromatic aberration; due to a variation in the index of refraction of glass with the wavelength of the color of light. Since one color (only) is to be transmitted, a sharp focus can always be made.

2. Spherical aberration; due to the fact that lens surfaces ground to a true spherical curve have a greater magnification at the edges than at the center. The effect, in television, might be to vary the light intensity at some portions of the projected spot, but this is not important with present-day standards.

3. Astigmatism; which is never present in lenses that are ground true, except to a slight extent for rays entering the lens at a sharp angle, a condition never found in scanning.

With the elimination of all complicating factors from lens design, and utilizing the nomographic charts included herewith, it is believed that this problem becomes a simple routine.

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# Quartz-Crystal Receiver

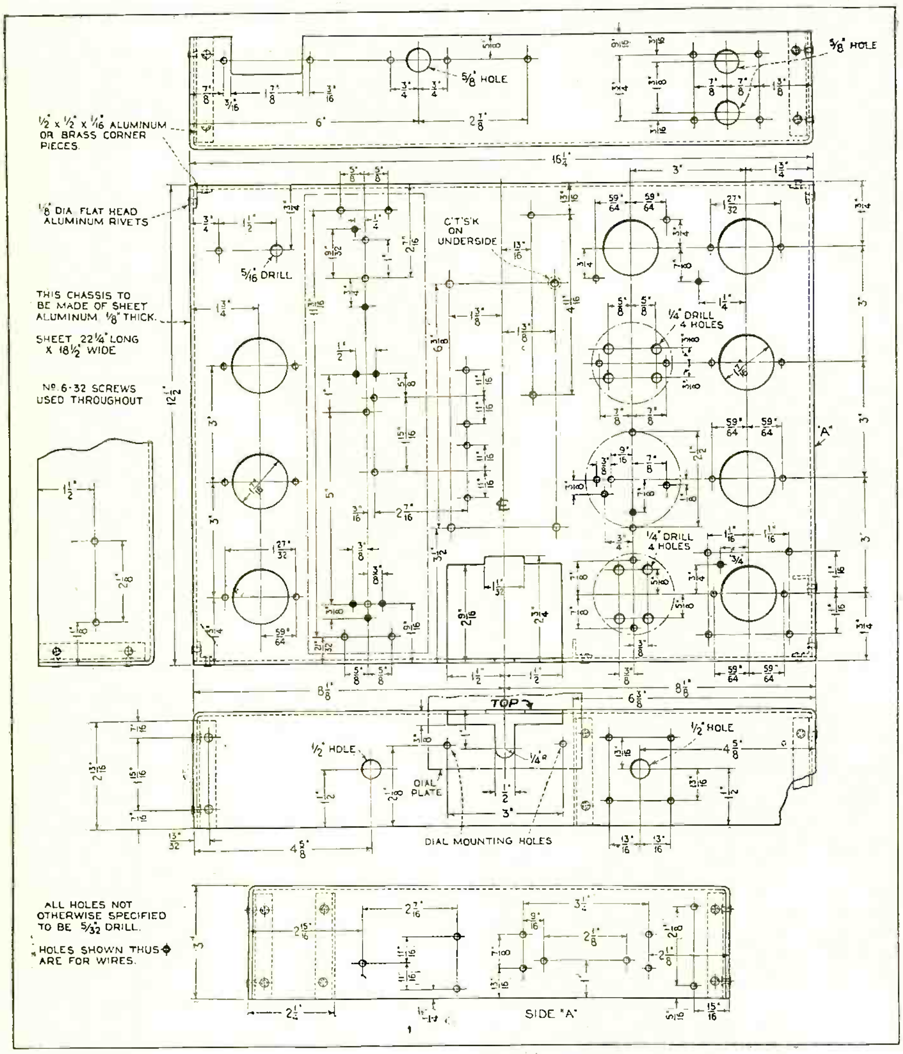
(*Continued from page 935*)

individual responsibility for the design.

The difficulty of designing a different Stenode is also increased by the fact that, at the present writing, there are relatively few Stenodes in operation which may be used as a basis of comparison. The following outline of the chief operating characteristics of the Stenode described in this article will be of assistance to the constructor making his first experiments with the Stenode:

When operated as an ordinary superheterodyne, the sensitivity should compare favorably with that of any good super, averaging about 5 microvolts per meter. It will tune slightly more broadly than a sharply peaked super. The quality is excellent. In other words, it is an all around, good superheterodyne.

As a Stenode, the sensitivity drops to between 10 and 15 microvolts per meter. (This is quite adequate sensitivity, but it may be compensated, if desired, by increasing the length of the antenna. Selectivity, due to the superior rejection characteristics of the crystal tuned circuit, will be practically unaffected by this change.) Exterior background noises, such as static, should be noticeably reduced. Tube noises, however, may be slightly up, due to the increased audio amplification, and the fact that noise frequencies are somewhat favored in the correction circuit. The receiver should be phenomenally silent between stations. The receiver should be easy to tune and should hold its tuning point indefinitely after the tubes are thoroughly hot. The selectivity is many times greater than when operated as an ordinary super, and it should be practically impossible or extremely difficult to tune when the low ratio control is used.




THE CHASSIS LAYOUT

*Figure 2. This has not been changed from that of the earlier model, which may be readily converted into the newer receiver*

# Two-Volt "Super"

(*Continued from page 962*)

receiver with performance paralleling that of many a.c. line receivers. It operates a dynamic reproducer, although the battery drains are undeniably the lowest of any receiver of comparable performance on the market today. Its band width of 27 k.c. at 10,000 times down means positive 10 kilocycle selectivity. Cross-modulation image interferences are negligible despite sensitivity better than that of the average run of superhets.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With this ratio the stations will be passed over with a characteristic "chirp." A distinct balance point is noticed at about the half way position on the balance condenser—a point of lowered background noise and an apparent increase in bass response. The balance control should be the same for all stations. With a local oscillator beating an incoming signal with an audible note (from 1000 to 5000 cycles) it is possible to eliminate, or greatly reduce, the whistle by a slight adjustment of the balancing condenser. The audio output should be more than adequate—sufficient to fill a small hall.

### *Parts List*

The Stenode circuit, as we have considered it, indicates several variations from conventional design requiring special parts. The following components have been engineered to conform with the peculiar requirements of the Stenode:

- 1 Stenotube—175 kc. quartz crystal, mounted in vacuum on a standard UX four-prong base (Q)
- 1 National compensating transformer (SCT)
- 1 DeJur-Amsco Bridge input i.f. transformer (L9)
- 1 National Stenodial—combination 5 to 1 and 250 to 1 ratios

The above parts are essential to the successful operation of the receiver, and no substitutions are recommended. The following components are also made especially for the Stenode:

- 1 National Stenode chassis, with shields, cans, brackets, sockets, hardware, etc.
- 1 National Stenode balancing condenser, complete with switches (C15, S1, S2, S3 and S4)
- 1 DeJur-Amsco output i.f. unit, type B-78 (L10)
- 1 DeJur-Amsco oscillator tracking condenser, four-gang, type Stenode ST (C1, C2, C3 and C4)
- 1 complete set of Stenocoils (L1, L2, L3, L4, L5, L6, L7 and L8)

While the use of the above parts greatly simplifies construction, and to a certain extent guarantees a successful Stenode, intelligent substitutions can of course be made by the engineer and expert. There is, for instance, no reason why a different preselector, detector and oscillator system cannot be employed. However, the coils and condenser should be used together, rather than attempt to match a substitution with one or the other. If a substitution is made for the balancing condenser, a three-plate capacitor should be used, having a maximum capacity of about 15 pf. A shortening spring should be so arranged that the condenser is short-circuited when turned all the way out to the left. Two H. and H. switches, type 21189, will also be required.

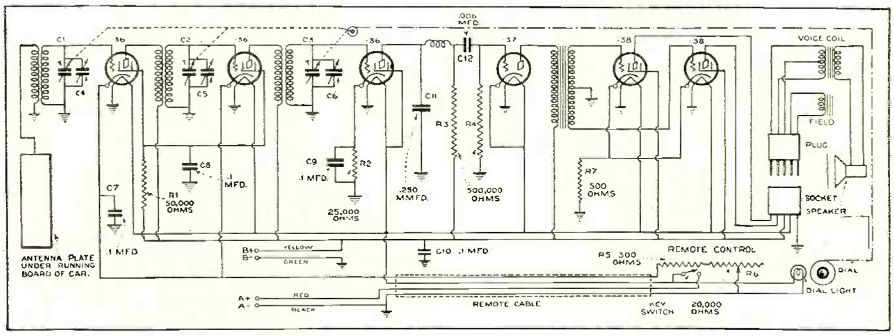
In addition to the special Stenode components listed above, the following standard parts complete the circuit:

- 3 r.f. chokes, 8 mh. (L11, L12 and L13)
- 4 Aerovox type 461-31, .1-.1-.1 mfd. condensers (C5, C6, C7 and C8)
- 2 Aerovox type 460, .1 mfd. (C9 and C16)
- 2 Aerovox .5 mfd. condensers, 200 volts (C11 and C12)
- 1 Aerovox .1 mfd. condenser, 200 volts (C10)
- 1 Aerovox mica condenser .00025 mfd. (C13)
- 1 Aerovox mica condenser .001 mfd. (C14)
- 1 Clarostat potentiometer, 10,000 ohms, left-hand taper (R1)
- 1 Electrad 250-ohm resistor, 2 watts (R2)
- 1 Lynch 50,000-ohm resistor, 2 watts (R3)
- 1 Lynch 12,500-ohm resistor, 1 watt (R4)
- 1 Lynch 250,000-ohm resistor, 1 watt (R5)
- 1 Lynch 1000-ohm resistor, 1 watt (R6)
- 1 Lynch 5000-ohm resistor, 1 watt (R7)
- 1 Lynch 75,000-ohm resistor, 2 watts (R8)
- 1 Lynch 2500-ohm resistor, 1 watt (R9)
- 1 Electrad type C voltage divider, with 2 clips, 25,000 ohms (R10)
- 1 Lynch 30,000-ohm resistor, 2 watts (R11)
- 1 Lynch 500,000-ohm resistor, 1 watt (R12)
- 1 Lynch 5000-ohm resistor, 1 watt (R13)
- 1 Electrad 10,000-ohm resistor, 25 watts (R14)
- 1 Electrad C-T 20-ohm resistor (R15)
- 1 Lynch 75,000-ohm resistor, 2 watts (R16)
- 1 Lynch 15,000-ohm resistor, 1 watt (R17)
- 1 Weston 0-10 ma. meter, type 506 (M)
- 8 Eby binding posts—Ant., Gnd., 2.5, 1.5, B—, B+ and 2 blank
- 10 feet shielded wire
- 50 feet Braidite hook-up wire
- 4 National grid-grips

The net cost of all the parts required for the tuner unit is between $60 and $70, depending upon the source of supply and the discount which the builder is able to command.

(In articles to follow, Mr. Bouck will describe a special power supply and amplifier unit, and give other details on the operation of the receiver, with additional data and suggestions for the experimental fan.)

## A Correction




*The circuit diagram of the Marquette Motor Radio, as shown on page 668 of the February issue, contained a reversed connection on the loudspeaker plug socket. The corrected diagram is being run herewith*

### *Delay Radio-Typewriter Service*

NEW YORK—Erection of two Pacific coast units of the long-wave radio-typewriter service for the automatic transmission of news to newspaper offices by radio will be delayed until December, 1932, according to plans of the American Radio News Corp., Hearst subsidiary, which is planning a series of such stations in various parts of the country. Both stations are in San Francisco.

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# What Tubes Shall I Use?

(*Continued from page* 920)

This general rule does not hold true for the pentode tubes such as the –47, –38 and –33 which have comparatively high plate resistances. In those cases, the best value of load resistance to obtain the rated power output varies from about one-fourth to one-eighth of the plate resistance.

When two tubes are connected in parallel or push pull, the plate resistance of the output changes in most cases and the value of load resistance which has been found to work best under such conditions is given in Tables II and III.

Because of the lack of information on the impedance characteristics of the average magnetic type loudspeakers, it is difficult to accurately match such types of speakers to the outputs of power tubes.

In the case of dynamic speakers however, accurate data regarding the impedance characteristics of the speakers are available and it is a comparatively simple matter to design or obtain a suitable coupling transformer to use between the output of the tube and the speaker. As a matter of fact, a suitable coupling transformer is usually incorporated as part of the speaker assembly, speakers being designed to be used with a particular type or number of power tubes.

The sixth important consideration involves the cost of the tubes required in the power stage to give the desired results.

The lowest cost tubes which can be used should be employed. This does not mean that cheap makes of tubes should be used. A –10 type tube for instance lists at about $7.00 whereas a –47 tube is listed at about $1.55 (at the time this is written). From the standpoint of electrical characteristics however, the –47 tube has advantages over the –10 tube for use as a power amplifier in equipment designed for it, although its cost is far lower.

The pentode tube, which many believe approaches the ideal power tube more closely than any other type so far developed, provides a tube of high grid-plate transconductance (mutual conductance) and high power sensitivity, characteristics which make possible a reduction in signal input to the power tube without affecting the power output. With 250 volts on the plate and screen grid and a control grid bias of 16.5 volts to the centertap of the filament winding, maximum power output of 2,500 milliwatts can be obtained with a signal input of 15.25 volts peak or 10.8 volts r. m. s.

The high power sensitivity of the pentode, requiring a smaller signal input for equivalent power output, makes it possible to work the pentode power stage directly out of a power detector, or where an audio stage is used, to reduce the signal output required from the detector and previous stages of radio-frequency amplification. This helps eliminate distortion due to detector and amplifier stage overloading. It makes possible the use of lower step-up ratios in audio transformers and the use of linear detectors, with consequent reduction in distortion.

For best results, with the –47 pentode, the impedance of the load should be within the range of 6,000 to 8,000 ohms over the frequency range which it is desired to reproduce faithfully. The recommended loads for the other pentodes are given in the table.

With these facts in mind, we can analyze the figures given in Table III which lists the tubes and combination of tubes in the order of their output power characteristics.

The arrangement followed has been to list the various commonly used combinations of tubes employed in the power stage for single, parallel and push-pull connections.

After the power output required has been determined, (this factor is governed by the volume of undistorted power required from the loudspeakers, the number of loudspeakers that must be used and the power required to drive the loudspeakers efficiently), the next step is to select the tube or tubes which will provide that output by a process of elimination.

To cite a concrete example let us say that we require, for a given installation, an undistorted output of at least 2,000 milliwatts. What is the tube, or combination of tubes which will give us the best results with a minimum expenditure?

A glance at Table III shows that there are several tubes or combinations of tubes which will provide an undistorted power output of 2,000 to 2,500 milliwatts under various conditions of operation (operating conditions Nos. 17 to 22). Now let us compare the figures.

The desired outputs can be obtained in some cases with single tubes and in others with two tubes connected either in parallel or push-pull. Where economy is an important point, it should be determined whether it is cheaper to use a single or double tube output but where quality of operation is the important factor, two tubes in push-pull will give better results. The figures show that this output can be obtained with a single stage output using a –50 tube, a –47 tube or a –45 tube. The same output can be obtained with a parallel combination of two –50 tubes, a push-pull combination of two –10 tubes or a push-pull combination of two –50 tubes, at the plate and grid voltages given.

A glance at the cost column of the total tubes used shows that the single –45 or single –47 tube is by far the most economical.

A glance at the "total supply voltages required" (total of plate and grid bias voltage) column shows that the lowest total voltage will be required by the single –47 and by the parallel or push-pull combination of the –50 tubes.

Another glance at the "Plate current drain" column (this includes the current drain of the screen grid in the case of the –47 tube) shows that the lowest current drains are provided by the push-pull combination of the two –10 tubes and the single –45 and –47 tubes. When the plate voltages required are considered however, the three combinations are approximately on an even footing.

But when we consider the "peak signal voltage required" column, the figures show that the maximum undistorted power of 2,500 milliwatts is obtained with the single –47 tube with only 16.5 volts input, a figure which is much lower than any of the others in the group. This advantage makes the single –47 tube stage the logical one to use in this instance. The slight disadvantage of the –47 from the standpoint that the load resistance required is higher than the other tubes in the group is more than offset by its other advantages.

In the case considered above, we have found that a single stage –47 power stage will give the required output and the stages preceding it should be designed to feed a maximum of 16.5 volts peak signal input to the power stage.

This same procedure can be followed in determining the best power tube or combination of tubes to use to obtain any desired undistorted power output.

The selection of tubes for best results in audio and radio frequency amplifier, detector, oscillator and rectifier circuits will be given in articles which are being prepared now and will appear in subsequent issues of RADIO NEWS.


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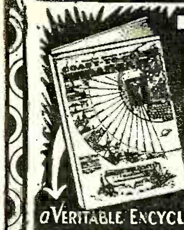
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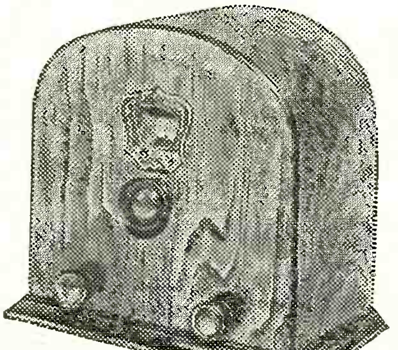

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# The "Twin-Grid" Tube

(*Continued from page* 930)

tuned radio-frequency transformer L-2, the secondary of which forms one of the grid circuits of the second Twin-Grid tube. Into the plate circuit of this second tube is connected the primary of the third tuned radio-frequency transformer L-3, and is further extended thru a radio-frequency choke to activate the responsive device. Shunted across the output terminals ahead of the radio-frequency choke is by-pass condenser C-6. The signal, upon reaching this plate circuit, energizes the primary of radio frequency transformer L-3 and is by-passed by condenser C-6 to the plate return. The secondary of tuned radio-frequency transformer L-3 is connected to grid condenser C-5 across which is shunted grid leak R-2, to form the grid circuit of the third Twin-Grid tube, which is the detector stage and renders the signal audible. Into the plate circuit of the third Twin-Grid tube is connected the primary of audio frequency transformer AT-1. The secondary of this transformer is connected thru a radio-frequency choke (RFC) to the second grid element of the first Twin-Grid tube, forming the second grid circuit of that tube. The signal having been detected and rendered audible, now re-enters the first tube. (It at once becomes apparent that the plate of this tube will carry currents of two frequencies, since one grid circuit is supplied at radio frequency and the other at audio frequency, both grid elements acting on the same electron stream. Since the path of the radio frequency current has already been given, only the audio-frequency current will be considered here). The signal, re-entering the plate circuit passes thru the radio-frequency choke energizing the primary of the second audio transformer AT-2, and passing thru the primary of tuned radio-frequency transformer L-2 to the plate return. The secondary of audio transformer AT-2 is connected thru a radio-frequency choke (RFC) to the second grid element of the second Twin-Grid tube forming the second grid circuit of that tube. The signal, reaching the plate circuit of this tube, passes thru the primary of tuned radio-frequency transformer L-3, thru radio-frequency choke (RFC), forming the output circuit of the receiver for activating the responsive device itself.

The filaments of the three tubes are shown as being connected in parallel and receiving their current supply from battery B-1, controlled by variable resistance R-1. The plate current for the tubes is supplied by battery B-2, which is shown as having a variable source of supply for the detector tube.

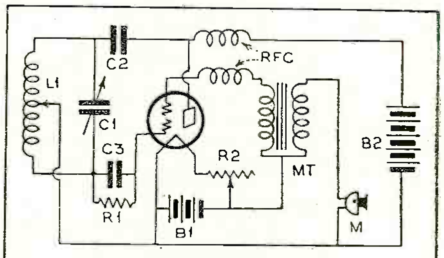

FIG. 12

AS A TRANSMITTING TUBE

*Figure 12. A single "twin-grid" tube can be used as both oscillator and modulator in a radio 'phone transmitter, as shown here*

A simplified form of radiophone transmitting circuit in which the same tube generates and modulates the carrier wave is illustrated in Figure 12.

The circuit consists of a Twin-Grid tube in which one of the grid elements forms the grid circuit of a Hartley Oscillator, the other grid element forming a part of the modulating system.

When the necessary apparatus is arranged as shown in the diagram and properly adjusted, the circuit will oscillate, producing the carrier wave. Because of the circuit arrangement of the modulating system, any sound capable of activating the microphone (m) will be impressed on the carrier wave since the modulating grid acts upon the same electron stream as the oscillating grid.

A short wave Oscillator-Modulator radiophone transmitter unit embodying the circuit illustrated in Figure 12 is pictured in the front of this booklet.

# A Short-Wave Set

(*Continued from page* 939)

and kind of wire and the size, other units may be wound at will to cover all the frequencies desired by the builder.

Give the inside, open end of the tube base a heavy coat of the Duco cement and press the tubing used for the winding of the inductance firmly into the base before the cement has had time to set. Allow this to dry and place the form in a vise so the large or filament prongs of the tube base are toward the constructor. (By using about a number 28 drill there will be plenty of clearance for any of the sizes of wire used in the construction of the coils.) Now to get on with the directions for the winding of the forms. Drill a hole at the top and as near the edge of the form as is convenient, slightly to the right of the form center, then 1⅝ inches lower drill another hole of the same size just to the left of center.

Positions for the ends of each winding are shown in Figure 12 at A and B for both the antenna coupler and the detector unit, with Figure 13 showing the relation of the ends of the windings to the prongs of the tube bases for both the detector form and the r.f. coils.

We used the four-prong bases and sockets for the reason that they were on hand; however, if the constructor desires, he may use any of the many coil mountings and forms found on the market, being sure to bring the grid, plate and tickler windings to their respective positions as found in the diagram of the circuits in Figure 10.

### *Tip Jacks for the Tickler Coil*

Owing to the fact that we used the four-prong tube bases for the coil mountings, it was necessary to bring the tickler coil out with two pig-tails equipped with phone tips and plugging each into pin jacks. The position of this winding is found in Figure 12 at C, showing the ends of the winding at D and E in the same chart.

All tickler windings are of number 30 d.c.c. unspaced and wound ⅛ inch below the grid windings. The ends go to the

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solder lugs and the pig-tails brought from there to the pin jacks.

### *Table for Three Sets of Coils*

| Length of Tubing | Wire Size | Number Turns | Kind of Wire |
|---|---|---|---|
| *Antenna Coils* | | | |
| 2¼ inches | 22 | 17 | Enameled |
| 2¾ inches | 22 | 27 | " |
| 3¼ inches | 26 | 46 | " |
| *Interstage Coil Secondary (Spaced—Nos. 1 and 2, 1/16 inch; No. 3, 1/32 inch)* | | | |
| 2¼ inches | 22 | 17 | Enameled |
| 2¾ inches | 22 | 27 | " |
| 3¼ inches | 26 | 46 | " |
| *Interstage Coil Primary (Wound between turns of grid coil)* | | | |
| 2¼ inches | 30 | 17 | Enameled |
| 2¾ inches | 30 | 27 | " |
| 3¼ inches | 30 | 46 | " |
| *Interstage Coil Tickler (⅛ inch from lower end of grid, unspaced)* | | | |
| ........ | 30 | 11 | d.c.c. |
| ........ | 30 | 9 | " |
| ........ | 30 | 20 | " |

In considering the various sizes of wire that might have been used, we noted very little difference in the frequencies covered using several different sizes, selectivity was almost identical and the volume the same, but when we came to get into the variations of the spaced and the unspaced, we found a remarkable difference, the spaced winding having more volume combined with greater ease of handling and no dead spots, while the opposite was noticed on the coils wound with all inductance unspaced.

If the operator should desire to wind a greater variety of coils, for the lower or higher frequencies, the spacing between the turns for the higher frequencies should be about 1/16 of an inch, while that for the lower frequencies should be 1/32 of an inch.

This holds until coils for the broadcast band are to be wound, when the wire may be wound unspaced as on any of the commercial broadcast sets.

### *Notes on Operation*

Although the diagram of the circuits, Figure 10, shows a radio-frequency choke in the plate circuit of the detector (150 turns of number 30 d.c.c. wire on a ½-inch dowel) the set worked very satisfactorily without it; however, with the r.f. choke in the B positive of the detector, there was a total absence of dead spots, and the regeneration condenser turned in a little in at a time as we advanced toward the upper end of the dial readings.

When putting the finished set into operation, set the filament of the -32 r.f. tube at about 1½ volts for a trial, as this is the spot where the tube furnished us worked the best; if necessary, the voltage may be increased to the rated value.

We also found that 22½ B positive on the screen grid, with 67½ volts to 90 volts on the plate, gave us better reception when the Q.R.N. was bad, while with normal conditions we were able to use 45 on the screen grid, with the customary 135 on the plate.

The tube used in the detector socket was a type -12A. This gave more volume with lower plate voltage than any of the other types of tubes tried including the -40 and the -01A.

In case there might be some slight difficulty in the symptoms developed by the receiver, let us give the layman some idea of where to better his reception. Suppose that when the set is put in the air, the operator is unable to stop the oscillating of the detector circuit, while turning the tuning dial from 0 to 100. In the first place be sure the capacity of the feed back condenser is set at the 0 position, then lower the plate voltage of the detector tube; if the trouble still remains it will be necessary to take turns from the tickler coil, one or two at a time, until the set becomes stable.

On the other hand, if there should be no indication of an oscillating condition, a higher grid leak resistance, reversing the tickler coil windings, and building up the plate voltage might be tried. If none of these operations brings the desired results, you will have to add more turns to the tickler coil.

Should the reader have any trouble in operating the receiver, the author will be more than glad to cooperate in any possible way, but be sure there is enough postage enclosed for the forwarding of the reply. (Such inquiries addressed in care of RADIO NEWS will be forwarded to Mr. Ellsworth—THE EDITORS.)

# Graphs and Charts

(*Continued from page* 940)

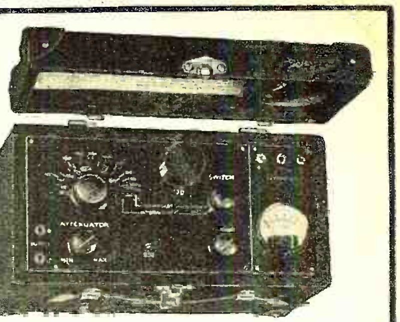
may vary 5 or 10 percent, either way. The applied voltages are not always correct and the insertion of the measuring instruments changes the circuit. We think it is now clear why these discrepancies occur and that they are no fault of the calculations.

The only alternative method is to hook up the circuit with power rheostats and to adjust them until the desired voltages are obtained. The rheostats can then be measured on the bridge while they are at the correct setting and can be replaced later with fixed resistors. This is a good method, but subject to as many errors, for each one of the causes of discrepancies cited above is present in this case.

But to come back to our voltage-divider design. This subject has been discussed by Mr. Jackowsky in the September issue of RADIO NEWS. The resistance of each section may be found from the chart as soon as the voltage drop across it and the current through it are known. At the same time the power consumed is found on the power scale.

### *D.C. Filament Circuits*

The chart is especially helpful for the determination of the series resistance in d.c.-filament circuits. For instance, suppose that three automobile-type tubes are to be connected in series. What is the resistance necessary to cut down the 110 volts d.c. to the required 18.9 volts and what is the power rating of this resistor? Subtracting 18.9 from 110 volts gives us 91.1 volts as the drop across the required resistance. The current is 300 ma. Now refer to the chart. The current range does not go up to 300 ma. It was not possible to do that and still have the chart large enough to be accurate. Therefore, mentally multiply all values on the *current* range and the *power* range by 10 and divide all values on the *resistance* range by 10. Now the current range goes up to 1 ampere. Drawing a straight line through 300 ma. and 91.1 volts, the resistance is found to be 303.7 ohms and the power 27.33 watts. It may interest the reader to know what happens if a 40-watt mazda lamp is used as a resistance. To



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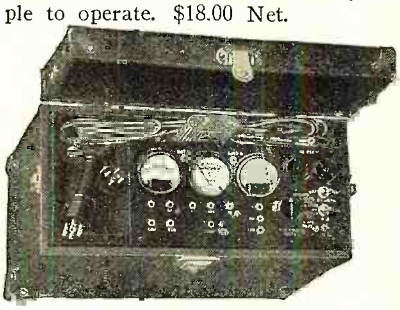

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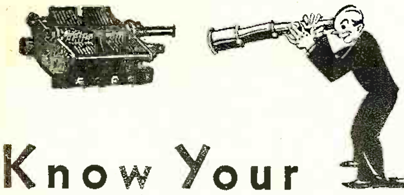

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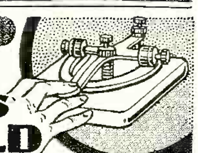

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find the resistance value of this lamp, draw another index line on the chart from 40 watts through 110 volts and find the current as 364 ma. and the resistance 302 ohms. This line will not intersect the *resistance* scale unless you do the range-multiplying stunt, just described.

Some of our readers may wonder why a 40-watt lamp has approximately the required resistance, while we just found that the power dissipation of the resistance is 27.33 watts. The answer is that the 40-watt lamp dissipates 40 watts when connected across 110 volts, but when the three tubes are in series with it the voltage across it drops to 91 volts, as we have seen above. This reduces the current in the same proportion and therefore the power consumed by the 40-watt lamp, when connected across the 91 volts, becomes $(91/110)^2 \times 40$ watts, or about 27 watts.

The resistance so calculated, however, would be that of the filament at full brilliancy. By decreasing the voltage, the temperature of the wire has been lowered and the resistance decreases. Therefore, one cannot use lamps without taking this into consideration. A 50-ohm rheostat in series with the lamp and the three filaments would permit a correct adjustment.

### *Construction of the Chart*

There is no great difficulty in understanding the chart construction, this time. The only thing new in it is the idea of the four scales. Really there are two charts which happen to have two scales in common. The first one consists of the Ohm's Law chart, comprising the *current, voltage* and *resistance* scales. Writing the equation in the form of $E = IR$, we see that this corresponds closely to the form we found for three parallel scales at equal distances. It is required only to calibrate the middle scale with a unit half as large as the one on the outer scales.

When this first chart is finished all that is necessary is to find the third scale of the next chart, for two of them are present already. Watts is the product of E and I; it will therefore be found in a scale somewhere between the E and I scales, but not in the middle, because the factors were plotted with a different unit. The unit of I, being twice as much as the unit on the E scale, the power scale must be twice as far away from I as it was from E. The proof of this is found in the article of this series in the March issue.

It is interesting to note that this last scale, the power scale, completes a third chart which would solve the equation $P = I^2R$. As the scales I and R are calibrated in the same units, the distance for the power scale from R should be twice as large as that from P to E. The reader can easily convince himself that the location of the power scale satisfies both these requirements.

From the same formulas, derived in previous installments, it is found that the modulus of the power scale should be one-third of the *current* or *resistance* scales and two-thirds of the *voltage* scale.

By the automatic method these conditions are discovered without any calculations. Beginning with the two outside scales, both right-side-up and with the same modulus, draw index lines connecting values which have the same product and the intersection shows the location of the *voltage* scale. Repeating the procedure by drawing lines connecting values of current and voltage which have the same product, one finds the location of the *power* scale. One has to find only one other point on these scales to determine the size of the unit. This is illustrated in Figure 3.

It is, however, not as simple as that, for one wants to cover a certain range on all of the scales and this will be found to require a paper of inconvenient dimensions. It is for this reason that the A and B scales were put in and we would have wished to put in another one if it were not for the reason that it might confuse the reader.

For extension of the scales, it should be remembered that if one multiplies all values on the *power* and *current* scales by ten, hundred, etc., the resistance values must be divided by the same factor; the voltage values remain the same in each case.

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## Pentode Receiver

(*Continued from page* 924)

L4, L5—Trutest r.f. chokes, type r.f. 64
R1, R2, R3—Electrad flexible resistors, type 2G-5000
R4—I.R.C. metallized resistor (Durham), type M.F. 4, 50,000 ohms
R5—I.R.C. metallized resistor (Durham), type M.F. 4, 500,000 ohms
R6—I.R.C. metallized resistor (Durham), type M.F. 4, 1 meg.
R7, R8—Amperites No. 227, with mountings
R9—Electrad volume control, type R1 202
SW1—Trutest toggle switch
VT1, VT2—Arcturus variable-mu pentode tubes, type 139A
VT3—Arcturus screen-grid tube, type 136A
VT4, VT5, VT6—Arcturus output pentode tubes, type 138A
Crowe "Moving Spot" dial
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6 five-prong wafer-type sockets
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3 45-volt heavy-duty B batteries
3 4½-volt C batteries
Wright DeCoster Infant Model dynamic speaker (vehicle chassis) equipped with 4000-ohm impedance (primary) output transformer

## Radio Yacht

(*Continued from page* 917)

built without cost to the boys from parts of cast-off sets donated to the club by Mr. Howard Wright of Pomona. The boat itself is brigantine-rigged, seven and one-half feet, overall length, of 14-inch beam and 14-inch draft. All cabins and deck fittings are made of solid mahogany and all state rooms are fully equipped and the ship is electrically lighted.

The boat was built by Mr. Howard while the radio is the work of David Bammes and Homer Howard.

Eligibility for membership in this novel club is based on enthusiasm for a hobby of some kind. The first products of the club were small boat models and car models and that work has expanded until it now includes short-wave radio experimentation. The club of 80 boys work and play under one roof, in harmony and friendliness, and dues of 30 cents a year cover maintenance of all supplies.

Not long ago the American Legion Post, number 30, of Pomona, took over sponsorship of the club and Legion members are helping to gather radio and other materials and are furnishing a solid moral support for these activities.

The complete ship model and its apparatus were "built from nothing."

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# London's Radio City

(*Continued from page* 911)

of some very few minor modifications.

Britain's long tardiness in advancing broadcasting was paralleled by almost unexcusable slowness in receiving-set progress. It was the invasion of foreign sets on the British market that made British manufacturers look to their laurels and try to match the invaders' offerings—if possible. The standards of receivers were rapidly raised and sets were able to reach out and receive programs of stations in Continental Europe. Thus, the BBC, although a monopoly, soon found it had competition. On modern receivers, French, German, Dutch and Irish programs came in almost as good as the local stations. Yet, the writer discovered, by interviewing several representative listeners, that Britons prefer their own programs and only occasionally tune-in a Continental or Irish program for the novelty of it.

It is only on rare occasions that programs from foreign shores are relayed by the BBC. Nevertheless, the monopoly is glad to cooperate with other nations in relaying programs of British origin to them. The Columbia Broadcasting System and the National Broadcasting Company rebroadcast British programs in the United States frequently. All of these programs heard in the United States from England are not typical English programs. As a matter of fact, the majority of them are designed especially for American audiences and are not heard at all in the British Isles. This is particularly true of the Columbia Broadcasting System's rebroadcasts of talks from London each Sunday. Although this series brings before the microphone some of England's major figures on timely topics of the day, the programs are not heard locally.

At any rate, the Britons are promised more of American programs in the future. They heard a few of our programs in the past, including an "Amos 'n' Andy" episode and a collegiate football game description. In the opinion of Major Atkinson, of the BBC, the broadcasts were not successful. He explained that listeners' tastes differ in the respective countries. And aside from the element of space, he told the writer that its ever-present companion, time, must be considered. When it's 7 p.m. in New York, it's midnight in London. This means that our choicest evening features would have to be rebroadcast in the early morning hours in England. Major Atkinson also mentioned the "unreliability of short waves" and the "high cost of trans-oceanic telephone circuits" as other reasons for the small amount of American program rebroadcasting in England.

British programs, while vastly different in structure and content than American programs, are undoubtedly popular with British listeners. There is a large amount of "talks" on the air; but the British listeners like talks. In fact, talks are so well received that the BBC publishes them and sells them in large quantities, shortly after the respective broadcasts. The trend is to long programs in England. The BBC gives much attention to musical broadcasts and its own symphony orchestra which is now one of the most important concert groups in Europe.

The English must be complimented on their originality in broadcasting dramatic programs. Great care and considerable time is given to this type of broadcast and the sound effects division does commendable work. The writer must also applaud the charity appeals which result in large contributions to worthy causes. The "S O S" messages, to locate missing persons, are also meritorious programs, while they may seem dull lapses to the unconcerned, the gaps are more than closed by the happiness and joy they bring to lost souls again united.

In the writer's opinion, America leads the world in broadcasting. However, a comparison between English and American broadcasting is difficult on account of the vastly different methods employed and the hundreds of transmitters in America compared to the mere handful in England.

In all, the chasm of broadcasting undevelopment in England has at last been bridged and the BBC now occupies a well-earned niche among world leaders of radio progress.

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# Backstage in Broadcasting

(*Continued from page* 925)

uled microphone performers was Count Felix Von Luckner, the "sea devil," who stars in the CBS Sunday series, "Adventuring with Count Von Luckner." In the programs, the Count personally relates the stories of his strange adventures at sea. Occasionally, dramatic casts enact episodes of his thrilling career.

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THOSE two droll "gloomchasers," F. Chase Taylor and Wilbur Budd Hulick, "Colonel Stoopnagle and Budd" of CBS fame, recently launched a new series of semi-weekly programs, under the sponsorship of the Procter and Gamble Company. Since they've been on the air, the pair have skyrocketed to popularity with their unusual style of mimicry and humor. And those who know them, learn that "Colonel and Budd" are just as funny away from the microphone. Following the success of his radio efforts over Stations WKBW and WMAK, in Buffalo, Taylor resigned his position as vice-president of a Buffalo stock brokerage firm in the fall of 1930 to devote his entire time to radio. Before that he was in the lumber business with his father. His partner, Hulick, has been a college football player, a saxophonist, a crooner, an announcer, a continuity writer, a radio production man, an actor, a soda clerk and a commercial representative for a telegraph company. Since the pair came together on the radio, they won much attention for their vocal imitations of celebrities. Taylor is noted for his imitations of former President Coolidge, Colonel Charles A. Lindbergh and Evangeline Adams. Hulick is best known for his radio impersonations of Rudy Vallee, Seth Parker, Bing Crosby, Cab Calloway and Morton Downey. Their constant buffoonery before the microphone makes their series one of the funniest on the air.

---

LITTLE JACK LITTLE—vocalist, pianist and composer—has been signed by the CBS and is now heard over that network


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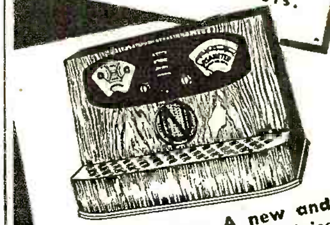

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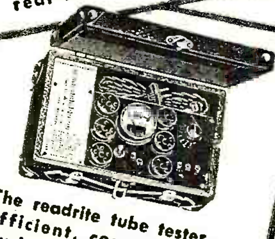

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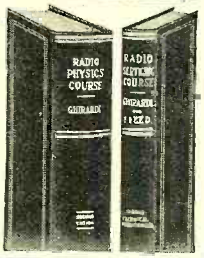


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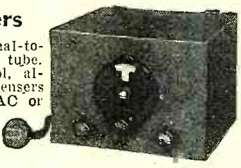

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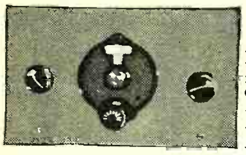

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exclusively. Thus, Little has joined the growing list of former NBC artists now in the stellar ranks of the CBS. Before coming to the NBC Little gained his initial radio prominence in Cincinnati. He is being featured on a morning series over the CBS every day except Sunday. He frequently features songs of his own composition. Little was born in England twenty-eight years ago and came to the United States in his boyhood. He attended school in Iowa but suddenly decided that song-writing would be more profitable than a college degree. His composing led to radio work and he soon gained wide attention through his microphone performances.

JACK LITTLE

SINCE the launching of the new Lucky Strike Hours on the NBC, many novel ideas have been incorporated in the series. The most interesting phase of the programs is the relaying of dance music from foreign lands. We were in London when Jack Hylton's Orchestra broadcast from that city to the United States on the Lucky Strike period. If the idea grows, the time element will have to be considered a major problem. It was 3 o'clock in the morning in London when the Lucky Strike program went on the air in New York—and that's quite late even for a dance orchestra. The program was not broadcast to domestic listeners, but all Londoners were proud that one of their favorite musical organizations was being featured in the United States. Since the termination of B. A. Rolfe's services on the series, each program features a group of noted dance orchestras picked up from various cities in this country as well as abroad.

JACK HYLTON

## Multi-Ear Aid

(*Continued from page* 928)

the best results at the lowest cost. The headphones, for instance, were selected primarily because of the relatively low impedance variation with frequency which results in maintaining a more uniform load, and therefore more dependable results. Also, the equipment has been selected to provide the rising frequency characteristic which is a special requirement of hearing-aid equipment. The substitution of some other type of microphone or headphones when used with the amplifier may accentuate the highs too much or attenuate them unduly and in either case prove correspondingly unsatisfactory. One of the reasons for the inability to prepare this article in time for the last issue was the necessity for testing a vast number of various parts required to strike a suitable balance in every part of the equipment.

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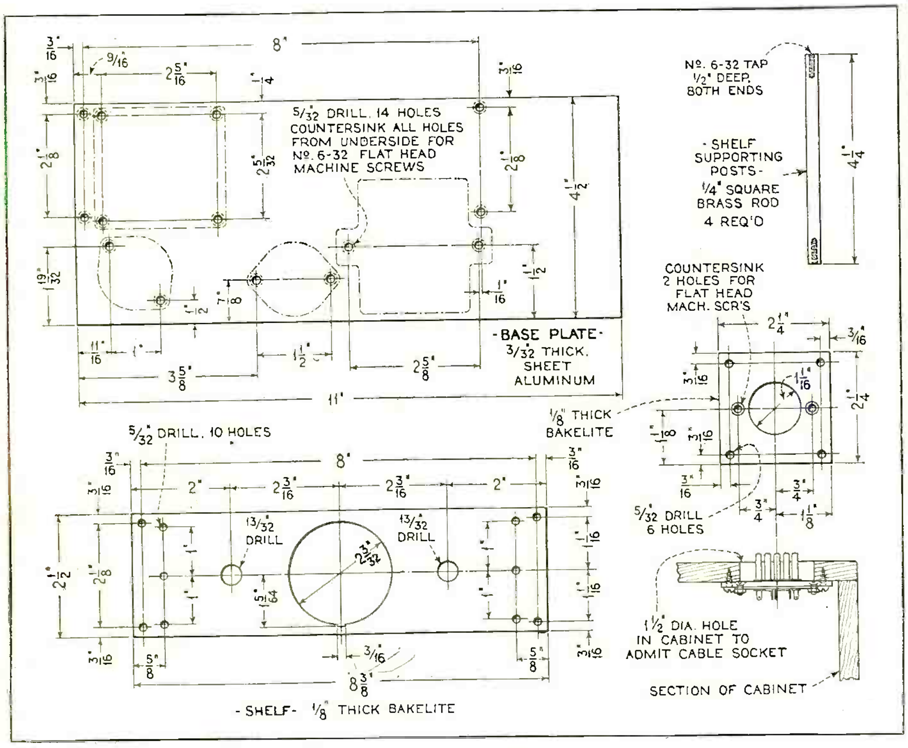
microphone is a high-grade one of the single-button type, the special adjustment providing just the right degree of sensitivity and the frequency characteristic required. This special adjustment is made at the factory and while this microphone in external appearance is identical with the regular Type A generally carried in stock by dealers, the latter will not be found anywhere near as effective with this group system.

The headphones were discussed in some detail last month. Electrically they are admirably adapted for this work, as explained above. Physically they are ideal, inasmuch as they weigh only two ounces each, complete, and are unusually small in size.

The outlet boxes are of wood, small in size, neat in appearance and convenient. They are made for universal mounting, either on edge or flat, depending on whether they are to be attached to the under side of the seat or to the back of the seat in front. They include a headphone jack and individual volume control potentiometer with undesirable effects of shocks, jolts or vibration. These rings are available, either for suspension from the ceiling or with a rubber-covered base for table mounting. Dust covers are also recommended. These are metal and screen affairs which fit over the front and back of the mounting ring.

The best distance from the speaker to the microphone will depend somewhat on the voice of the speaker and can best be determined by test. In a large room where the speaker's voice must be raised to a high level it will sometimes be best to keep the microphone eight or ten feet away, perhaps by suspending it from the ceiling. Also, if the speaker has a tendency to roam around the platform, the pick-up will be more effective if the microphone is a few feet in front of the platform. Or if he emphasizes his delivery by pounding on the pulpit or table, it is desirable to keep the "mike" out of harm's way—otherwise the pounding may be unduly impressive to those listening at the headphones.




DETAILS OF FITTINGS

*Here are shown drilling and cutting specifications for the base, legs, shelf and cable plug panel, for those who may wish to prepare their own*

knob. The jack and potentiometer are wired ready for use so that in installing the boxes only the two connections to the output line need be made on the job.

## *Installation*

It is convenient, usually, to locate the amplifier close to the microphone. In a church, for instance, the amplifier can be placed inside the pulpit, although a case covered in genuine leather has been used so that there is no necessity for hiding it. When the pulpit is not inclosed, the amplifier may be placed on top next to the reading lamp, and the microphone placed on top of the amplifier, if desired.

The batteries may be placed anywhere, as it is not particularly necessary to locate them near the other equipment, although doing so simplifies the wiring. If the battery cable is to be run any great distance, it will be well to consult the local building authorities concerning the requirements for the protection of the wiring.

The microphone should be mounted in a ring and suspended therein by the coil spring provided with the ring. This prevents the

If the pick-up is required from two points, the microphone may be moved or, if this is inconvenient, two microphones may be installed with a double-throw switch which connects either one to the amplifier.

The outlet boxes may be mounted in any convenient position. The most practical arrangement in churches is to mount them on the under side of the seats, with the volume-control panel facing forward and just far enough back from the edge of the seat to avoid being brushed against by persons entering or leaving the pew. Where folding seats are employed, it will usually be most convenient to mount the boxes on the back of the seat in front. Where movable chairs are used, the arrangement of the outlet boxes is somewhat complicated, but the problem can be overcome by fastening several chairs together as a single unit. The outlet boxes then can be mounted and wired and the entire group provided with an extension cord to be plugged into an outlet jack mounted on a nearby wall or in the floor.

Inasmuch as the system is designed to permit all outlets to be connected in parallel,

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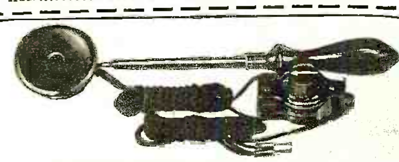

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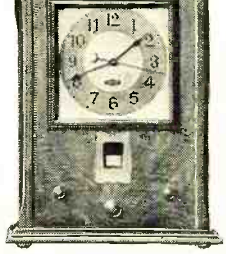

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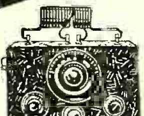

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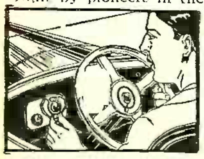

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the outlet wiring is simple. Also, it is what is termed a "signal circuit" by the underwriters and therefore requires only the simple protection usually given to bell wiring, telephone circuits, etc.

The line is extended from the amplifier output to the most distant outlet box, with branches leading to the boxes in between. The two wires leading to each box are run through the hole in the side of the box and then soldered to the outside terminals of the volume control potentiometer. Try connecting the completed line to taps 1 and 2 of the output transformer, then to taps 1 and 3, leaving them on the combination that provides best volume.

The boxes may be mounted by running screws through holes provided in the back, into the seat back. For under-seat mounting or in other cases where it is desired to mount the box on edge, the universal brackets obtainable with the boxes are employed.

### *Operation*

The operation of the system is simple, but there are a few points worthy of mention. After the equipment has been connected up as shown in Figures 1 and 3, the switch is turned on and the rheostat, R2, adjusted to show a two-volt reading on the meter. Subsequently this can be readjusted to compensate for the voltage drop resulting as the A battery ages.

The microphone rheostat, R1, can be turned as high as necessary to provide the required output volume. If necessary, where the installation is carrying a heavy output load, this control may be turned up full, but it is best to keep somewhat below this point to insure long microphone life. In no case should it be turned high enough to cause tube overloading. Usually from one-half to two-thirds on will be satisfactory while the A battery is fresh. This applies from 1½ to 2 volts to the microphone. As the battery voltage falls this control can be advanced proportionately.

When the A battery voltage drops to a point where advancing the rheostat R2 all the way barely brings the meter reading up to two volts, the dry cells should be replaced.

Pressing the button on the rim of the meter shows the total B battery voltage. When the voltage shown drops to around 135 volts it is time to lay in a new B battery supply.

### *List of Parts*

***Amplifier:***

C1—Aerovox type 1450 mica fixed condenser, .02 mfd.

R1—Carter type IR-400 potentiometer, 400 ohms

R2—Carter type M-20 rheostat, 20 ohms

R3—Aerovox type 1095 resistor with pigtails, 100,000 ohms

R4—Aerovox type 1095 resistor with pigtails, 250,000 ohms

SW—Carter type 210 off-on switch with one-inch mounting bushing and "on-off" marker plate

T1—Universal microphone transformer, type 1089

T2—Silver-Marshall "Life-Tone" output transformer, type 10,106

TP—Eby five-prong connector plug for panel mounting

TS—Eby five-prong connector socket for cable mounting

VM—Weston model 506 dual range d.c. voltmeter, 0-8, 0-200

VT1—Pilot sub-panel mounting socket number 216, equipped with type -32 screen-grid tube

VT2—Pilot sub-panel mounting socket number 216, equipped with type -31 two-volt power tube

Broderick Multi-Ear Aid fittings, cut, drilled and tapped ready for assembly. They include aluminum base, bakelite shelf, mounting legs and bakelite plate for mount-

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ing cable terminal plug (TP)

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6 Eby binding posts

5-Wire cable, one foot long, for connections to cable plug (TP)

5-Wire cable of required length, for connecting batteries to the amplifier

4 Eveready type 772 medium size B batteries, 45 volts

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1 Eveready C battery, type 768, 22½ volts

### *Auxiliary Equipment*

1 Universal model A (special adjustment) single-button microphone

1 Universal microphone suspension ring or model K desk mounting ring (finished in chromium or bronze)

1 set Universal model K covers for microphone (finished in chromium or bronze)

1 microphone cord, two-wire, of required length

### *Outlet Equipment* *(For ten outlets)*

10 Trimm "Featherweight" headphones, 1000 ohms, with cords and lorgnette handles or headbands

10 Carter No. 2 phone plugs, flat type

10 Broderick outlet boxes (each box includes a 10,000-ohm volume-control potentiometer and headphone jack, mounted and wired), with Universal mounting bracket

Wire for installing outlets (Number 16 stranded wire, twisted pair, similar to that used for telephone wiring is recommended)

## News and Comment

(*Continued from page* 945)

short wave station W8XAL, sister station of WLW, for the radio audience of New Zealand, is meeting with an enthusiastic reception on the part of fans in that distant island, according to advices being received by Joseph A. Chambers, Technical Director of the Crosley studios.

These special programs, which are broadcast on the fourth Thursday of each month over W8XAL at 5:30 A.M., E.S.T. (10:00 P.M., New Zealand time), are picked up by the New Zealand Broadcasting Company, an organization similar to the radio network systems in America, and are rebroadcast over its four stations scattered throughout the island.

### *Elect New Vice-President*

PITTSBURGH, PA.—At the meeting of the board of directors of the Radio Corporation of America, held recently, Mr. Harold Smith, vice-president of the Westinghouse Electric & Manufacturing Company, was elected a member of the board of the Radio Corporation to fill the vacancy caused by the recent death of Mr. H. P. Davis.

### *Radio Not Seasonal*

CHICAGO—Radio has stepped out of the class of seasonal merchandise and can be made to sell in every month of the year, J. Clarke Coit, president of the U. S. Radio & Television Corporation, manufacturers of U. S. Apex and Gloritone receivers, asserted in a statement to his sales force.

Radio receivers have been developed to a point where every service condition and virtually every price consideration can be met and all that is required is a combination of initiative and energy to make every month a good month, Mr. Coit declared.


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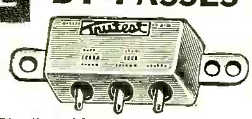

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**SAVE SERVICE TIME and MONEY**


TRUVOLT RESISTORS, with adjustable clips, mean quicker service and less investment in stock. All standard sizes.

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THE METAL DOOM, by David H. Keller, M.D. (Serial in three parts) Part I. In an almost perfectly appointed world, scientifically and mechanically speaking, living has become a greatly simplified matter—with reservations, of course. Accidents are liable to happen, naturally; serious ones. How would we all—intelligent beings, who believe that we can easily adapt ourselves to changing conditions—react to a drastic change?

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Prepared by Stenode Engineers in personal co-operation with

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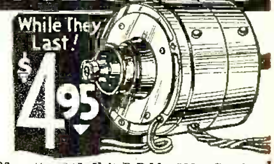


U. S. Gov. power generator for radio transmitting made by Westinghouse. Ideal for Amateur Broadcasting. Limited quantity purchased from U. S. Gov. Signal Corps. 250 to 550 meters. 200 watts. 110 Volt R.P.M. 4500. Can be connected direct, belt driven or wind propelled for Aeroplanes. Guaranteed new and perfect. Worth $75.00, but while they last, only $4.95, plus shipping charges. Send check or money order.

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**Put Pentode Tubes in Old Sets**


Replace the old 245's with the new 247's. There is a tremendous improvement in depth of tone and set sensitivity. The improved amplification strengthens weak signals, particularly in sets using 245 push-pull, and the improved tone turns sour old radios into new, sweet, musical instruments.

JUST INSERT ADAPTERS AND NEW 247 TUBES NO CHANGE IN WIRING

**SPECIAL INTRODUCTORY OFFER:**
**2 Adapters, 2 RCA Licensed 247 Pentode Tubes—YOUR PRICE $2.80 (Postpaid)**

You sell for $6.00. It's a bargain for your customer and you double your money with 5 minutes work. Every owner of an old set can be sold. ACT NOW ON THIS FAST MOVING MONEY-MAKER!

**2 Pentode Adapters Only (no tubes) $1.20**

MONEY BACK GUARANTEE! Try the two Pentode Tube outfit in a set. If not more than pleased with results, return your purchase anytime within five days and your money will be promptly refunded! If you do not have our new 1932 Radio Serviceman's Wholesale Price Guide, check in square below and it will be sent you.


The RADOLEK CO.
601 W. RANDOLPH ST.
CHICAGO, ILL.

Please send me....sets of 2 Pentode Adapters, 2 RCA Licensed 247 Pentode Tubes, $2.80 (postpaid).
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THE RADOLEK CO., 605 Canal Station, CHICAGO, ILL.


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# 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

### *Low-Voltage Electrolytic Condensers*

*Description*—A new line of compact low-voltage electrolytic condensers, designed for by-pass use in audio amplifiers and in plate and grid filters of the resistance capacity type, where low impedance and high capacity are required. For convenience in mounting and installation these condensers are available in two different forms, as shown in the accompanying illustrations: First, a rectangular-shaped metal can measuring 2 3/16 inches by 1¼ inches by 23/32 inch. Second, the cartridge style container. The condensers are obtainable in the following capacities and voltage ratings: Condensers of 125 volts rating; ten and fifteen mfd. Units rated for 50 volts; 4, 6 and 8 mfd. Condensers of 25-volt rating; 8, 10 and 20 mfd. capacities. The condensers for 125-volt rating in the cartridge type, measure 1 inch in

## RADIO NEWS Export Service

As a service to our readers in locations outside the United States of America, either commercial, professional or private individuals, RADIO NEWS will arrange to provide contact with leading American manufacturers of radio supplies and receiving equipment.

To utilize this service, clip and fill out coupon below and send it attached to your letter on which you list the types of apparatus you are interested in.

Our Export Service Department will refer your inquiries direct to the proper manufacturers, asking them to send you full particulars, catalogues, prices, etc.

* * *

Comme un service à nos lecteurs demeurant hors des Etats-Unis d'Amérique, soit établissements commerciaux, soit personnes privées, RADIO NEWS arrangera de procurer le "contact" avec les usines les plus importantes des appareils de T. S. F. en Amérique.

Pour utiliser ce service, coupez, signez, etc., le coupon sur cette page et envoyez le attaché à votre lettre en énumerant les types des appareils qui vous intéressent.

Notre Département d'Exportation fera suivre vos requêtes aux manufacturiers directement en les priant de vous envoyer toutes informations, catalogues, prix, etc.

* * *

Als einen Dienst für unsere Leser, entweder Kaufleute oder Privatpersonen ausserhalb der Vereinigten Staaten von Amerika, kann RADIO NEWS mit den führenden Amerikanischen Fabrikanten von Radio Apparaten Kontakt herstellen.

Für den Gebrauch dieses Dienstes schneide man den Kupon aus und sende denselben mit einer Liste von Apparaten die für Sie von Interesse sind.

Unsere Export Abteilung wird Ihr Schreiben umgehend an die betreffenden Fabrikanten weiter befördern, mit der Bitte Ihnen Auskünfte, Preise und Kataloge zu senden.

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Como un servicio especial a nuestros lectores que se encuentran fuera de los Estados Unidos de America, ya sean comerciantes, profesionales o personas privadas, RADIO NEWS tendra a bien ponerlas en contacto con los principales centros manufactureros de radio, de aparatos receptores y accesorios.

Para beneficiarse de tal servicio, sirvase recortar el coupón de esta página, enumere los tipos de aparatos que le interesen, y envienosla con su carta.

Nuestro Departamento de Exportación se encargará de ponerse en contacto directo con dichos centros, pidiendo le envien información completa, catalogos, precios, etc.

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RADIO NEWS Export Service Department

Kindly put me in contact with American firms manufacturing the class of radio apparatus noted on attached sheets.

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

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

Business.................................................................


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Prepare yourself now by learning these interesting branches: aircraft radio, broadcast station or studio, disc and film recording, talking pictures, servicing of home entertainment equipment, television. RCA Institutes—in four resident schools at New York, Boston, Philadelphia and Chicago—offer elementary and advanced courses based on 22 years experience and association with the largest research laboratory in the radio industry. Also, RCA Institute Extension Courses enable you to study at home in your spare time. Special laboratory equipment furnished. Outstanding graduates eligible for free scholarship at resident school. Tuition moderate.

RCA INSTITUTES INC.

RCA Institutes, Inc., Dept. RN-5, 75 Varick St., N. Y.
Gentlemen: Please send me your General Catalog. I am checking below the phase of radio in which I am particularly interested.

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☐ Broadcast Station or Studio ☐ Radio Operating
☐ Talking Pictures ☐ Servicing Home Entertainment Equipment
☐ Television

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Occupation.............................Age...........

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


Price of Receiver Complete with Cunningham Tubes and Eveready B-Batteries given on request.

The only auto radio that will give you the regular broadcast plus—short wave. Think of the thrill keeping in touch with police signals—aeroplane calls.

This you can have after installing the Marquette set, and just think, you can do the job yourself, it is so simple, no tools necessary. Don't be without one. You don't know what you are missing. Send your order today accompanied by money order or check.

*Descriptive circular on request.*

**MARQUETTE RADIO CO., INC.**
**110 West 18th Street, N. Y. City**

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**DEALERS—SERVICEMEN—EXPERIMENTERS—AMATEURS**

Our line of radio repair and short wave parts is complete. Nationally known quality parts at new low prices. FREE TECHNICAL SERVICE. Write on any problem you have.

—CATALOGUE ON REQUEST—

3747 Derry St. **HALL'S** Harrisburg, Pa.


www.americanradiohistory.com

diameter by 2¼ inches long. The remaining cartridge type units measure 2¼ inches long

by ⅝ inch in diameter.

*Maker*—Dubilier Condenser Corp., 4377 Bronx Blvd., New York City.

### *Radio Call Book*

*Description*—This log should meet a long-felt want among all types of radio listeners. It is an accurate, up-to-date list of the broadcasting stations of the United States, Canada,

Mexico and Cuba. It also includes a list of the short-wave broadcasting stations, police, aeronautical, relay and telephone stations of the world. The logs are headed by a con-

(*Continued on page* 976)

# Radio News Technical Information Service

The Technical Information Service has been carried on for many years by the technical staff of RADIO NEWS. Its primary purpose is to give helpful information to those readers who run across technical problems in their work or hobby which they are not able to solve without assistance. The service has grown to such large proportions that it is now advisable to outline and regulate activities so that information desired may come to our readers accurately, adequately and promptly.

Long, rambling letters containing requests that are vague or on a subject that is unanswerable take up so large a portion of the staff's working time that legitimate questions may pile up in such quantities as to cause a delay that seriously hinders the promptness of reply. To eliminate this waste of time and the period of waiting, that sometimes occurs to our readers as a consequence, the following list of simple rules *must* be observed in making requests for information. Readers will help themselves by abiding by these rules.

### *Preparation of Requests*

1. Limit each request for information to a single subject.
2. In a request for information, include any data that will aid us in assisting in answering. If the request relates to apparatus described in RADIO NEWS, state the issue, page number, title of article and the name of the device or apparatus.
3. Write only on one side of your paper.
4. Pin the coupon to your request.

The service is directed specifically at the problems of the radio serviceman, engineer, mechanic, experimenter, set builder, student and amateur, but is open to all classes of readers as well.

All questions from subscribers to RADIO NEWS will be answered free of charge, provided they comply with the regulations here set forth. All questions will be answered by mail and not through the editorial columns of the magazine, or by telephone. When possible, requests for information will be answered by referring to articles in past issues of the magazine that contain the desired information. For this reason it is advisable to keep RADIO NEWS as a radio reference.

Complete information about sets described in other publications cannot be given, although readers will be referred to other sources of information whenever possible. The staff cannot undertake to design special circuits, receivers, equipment or installations. The staff cannot service receivers or test any radio apparatus. Wiring diagrams of commercial receivers cannot be supplied, but where we have published them in RADIO NEWS, a reference will be given to past issues. Comparisons between various kinds of receivers or manufactured apparatus cannot be made.

Only those requests will be given consideration that are accompanied by the current month's coupon below, accurately filled out.

MAY, 1932
**Technical Information Coupon**
**RADIO NEWS Laboratory**
**350 Hudson 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 ..............................

EFFICIENT PHOTO CELLS CAN NOW BE BOUGHT AT LOW COST
LUXTRON CELL SIZE 1½"x¾"x3"
THE NEW LUXTRON KIT HAS THOUSANDS OF OTHER PRACTICAL APPLICATIONS IN ADDITION TO THOSE DESCRIBED BY BERNARD J. MONTYN
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COMPLETE KIT only $9.50
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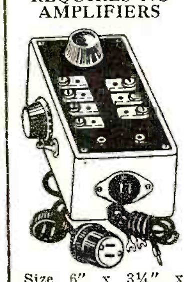
REQUIRES NO AMPLIFIERS



Size 6" x 3¼" x 3½" deep. LUXTRON R-1 RELAY (shown above in case)
ONLY $4.00 (Less case)
This Includes:
1 Light Sensitive Lux-Tron Cell, type "ST"
1 Relay, Controlling 110-Volt Circuit, type R-1
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Send $1 Only For Interesting Instructions and Diagrams.
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*Pioneers in Photo-Cell Devices Since 1900*
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New LYNCH RESISTOR Replacement MANUAL
with purchase of 10 LYNCH Metallized Resistors, or Manual alone may be bought for $1.00.
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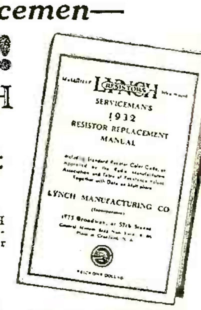

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Make a PROFIT
Service men make $90 *extra* per month, installing AMPERITE. Send $1.62 to Dept. RN-5, for dealers' sample and sales helps.

AMPERITE Corporation 561 BROADWAY, NEW YORK
AMPERITE Self-Adjusting LINE VOLTAGE CONTROL


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**COYNE**

**Don't spend your life slaving away in some dull, hopeless job! Don't be satisfied to work for a mere $20 or $30 a week. Let me show you how to make REAL MONEY in RADIO—THE FASTEST-GROWING, BIGGEST MONEY-MAKING GAME ON EARTH!**

**Jobs Leading to Salaries of $50 a Week and Up**

**Jobs as Designer, Inspector and Tester, —as Radio Salesman and in Service and Installation—as Operator or Manager of a Broadcasting Station—as Wireless Operator on a Ship or Airplane, as a Talking Picture or Sound Expert—HUNDREDS of Opportunities for fascinating, BIG Pay Jobs!**

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**AT COYNE IN CHICAGO**

We don't teach you from books. We teach you by ACTUAL WORK on a great outlay of Radio, Broadcasting, Television, Talking Picture and Code equipment. And because we cut out useless theory, you get a practical training in 10 weeks.

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***Is Now Here!***

**And TELEVISION is already here! Soon there'll be a demand for TELEVISION EXPERTS! The man who gets in on the ground-floor of Television can have dozens of opportunities in this new field! Learn Television at COYNE on the very latest Television equipment.**

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Talking Pictures, and Public Address Systems offer golden opportunities to the Trained Radio Man. Learn at COYNE on actual Talking Picture and Sound Reproduction equipment.

**Earn As You Learn**

You get Free Employment Service for Life. And if you need part-time work while at school to help pay expenses, we'll help you get it. Coyne is 32 years old. Coyne Training is tested—You can find out everything absolutely free. JUST MAIL the Coupon for My BIG FREE BOOK.

**H. C. LEWIS, President**
**Radio Division, Coyne Electrical School**
**500 S. Paulina St., Dept. 52-8C, Chicago, Ill.**

Send me your Big Free Radio Book and all details of your Special Introductory Offer. This does not obligate me in any way.

*Name*..........................

*Address*..........................

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


# What's New in Radio

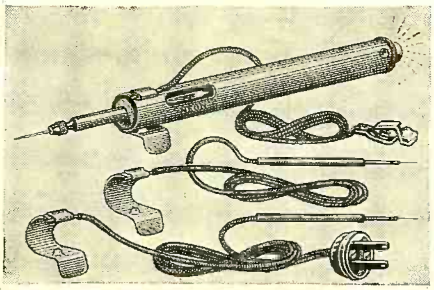
(*Continued from page 975*)

venient listing of frequency, call letters, location, time and type of station.

*Maker*—All American Service, 5707 N. Clark St., Chicago, Ill.

## *A Handy Testing Instrument*

*Description*—A trouble-shooting device that should prove popular for the serviceman, radio dealer and the experimenter. The instrument measures one-half inch in diameter by eight inches long and contains a neon lamp, and a three-volt miniature flashlight battery for the flashlight bulb which is mounted at one end of the device. The other end is provided with a testing prod which is equipped with a small knurled chuck to take a standard phonograph needle



as the prod point. The sharp end of the needle may be used for puncturing the insulation of wires, which is an advantage in testing. The instrument is complete with three different types of connecting cables provided with spring tension clasps that are easily snapped on and off to meet various tests. The connecting cable with either the spring clip or the test prod can be employed for general continuity tests. The connecting cable with the testing prod and the electrical plug cap is utilized with the neon testing feature.

*Maker*—Coast to Coast Radio Corp, 121 W. 17th St., New York City.

## *Resistor Kit*

*Description*—A handy resistor assortment packed in a light steel box measuring 6 inches by 5 inches by 1 inch and consist-


ing of thirty 2-watt carbon resistors ranging in value from 100 ohms to 10 megohms. For easy connections, a soldering lug is provided at each end of each resistor. Carbon resistors of 1 watt rating are also available in different values ranging from 500 ohms to 4 megohms. This type of resistor is furnished with a pigtail connection.

*Maker*—Morrill and Morrill, 30 Church St., New York City.


**FILTERMATIC PRODUCTS**

*Help you to get the BEST possible reception from your RADIO set.*

**SUPER-FILTERMATIC**
**The Modern Aerial**
**(INDOOR OR OUTDOOR)**

Thousands of satisfied users, praised by radio experts. Replaces all other aerials, reduces static, and noises. Especially good on distance reception. Helps to separate stations, does not connect in light socket (therefore eliminating hum and line noises). It is very compact, measuring only 1¾x2 inches, is absolutely non-corrosive and non-directional, installed in one minute, no tools needed. Will never wear out. Eliminates trouble and expense of lightning-arrester. Can also be used in conjunction with your present aerial.

**Price only $2.00 postpaid.**

*Satisfaction guaranteed or money refunded.*


**ALL PROGRAMS**
*Are Good with a FILTERMATIC. For all radios only* $1.00 *postpaid.*

Entirely automatic—no bothersome tuning. Improves tone, reduces static, brings in distance, increases volume, separates stations. Installed in one minute, no tools required, in series with your aerial or across your aerial and ground. *Satisfaction guaranteed or money refunded.*

*Send check or money order. C. O. D. 25% with order.*
(No foreign C. O. D.) Money back guaranteed after 5-day trial.
Service Men and Dealers Write for Particulars. Also information about Free local newspaper advertising.

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Licensed under R.C.A. Patents
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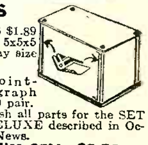
**ALUMINUM BOX SHIELDS**



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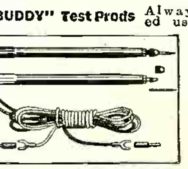
**"BUDDY" Test Prods** Always sharp pointed using phonograph needles, $1.50 pair.



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**SELENIUM CELL, $3.50**
Television Lenses, 13/16". 12c
Crater Neon Lamps.....$5.95
Condenser Coupling ......10c
Condenser Pulleys........15c
Insulated Coupling, ¼"..25c
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BLAN, the Radio Man, Inc., 89 Cortlandt St. Box N5, New York City

**SHORT WAVE SUBMARINER** **CONVERTER $12.50**
**ACROCYCLE OSCILLATOR $17.50**
AUTO-DIAL (Auto Radio) $40.00
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J-M-P MANUFACTURING CO., Inc.
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# WILL YOU ACCEPT THIS TIMELY BOOK

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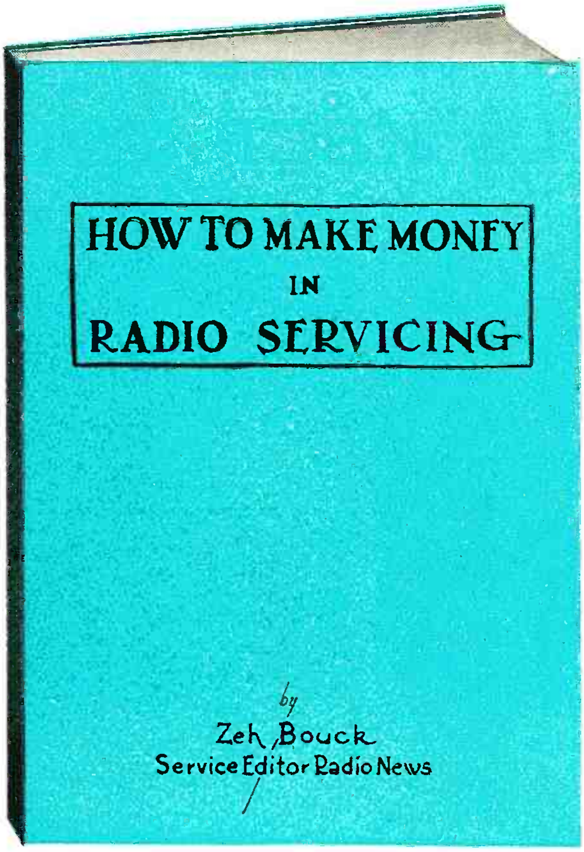


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Not only for the active service man, but also for the amateur and experimenter who desires to turn his knowledge and experience into practical money-making channels this book will prove indispensable. It tells you how, and when, and why to do things. It is *practical—up to the minute—and complete.*

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## Save $.75

And that is not all—in addition to securing the book FREE, you also save 75c on your subscription, as these eleven issues purchased on the newsstands would cost you $2.75.

To make money today in radio service work, you must be well equipped. This book starts right at the very beginning, and tells you what equipment you will need to be successful. It tells you how to get customers, and how to build up a clientele by every known means of advertising and sales promotion. Numerous sample advertisements are included with instructions for their use. Full details are given regarding local contacts with dealers, as well as arrangements with manufacturers.

And remember you get eleven issues of Radio News Magazine and this wonderful new book for less than thousands pay for the magazine alone.

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Such outstanding authorities as Dr. Lee De Forest, Guglielmo Marconi, Laurence M. Cockaday, Dr. Irving Saxl, Ernest Lee Gahricke, Carl Dreher, McMurdo Silver, J. E. Smith, S. Gordon Taylor, Lieut. William H. Wenstrom, Dr. E. E. Free, and scores of others of equal prominence in the radio field—write regularly for Radio News. You have at your command the experience of acknowledged experts. You can use their researches—their results—to build your own future in Radio.

**Don't delay—enclose $2 (bills, money-order, or check) in an envelope with the coupon below, and send it to us at once, as our supply of books is limited.**

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**RADIO NEWS, Dept. 5**
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RADIO NEWS, edited by Laurence M. Cockaday, needs no introduction to radio men. From the very beginning it has led every publication in the whole field. It gives you all the radio news—while it is news. Hot from the laboratories—just out of the experimental stations—all the newest happenings in radio—direct to you in Radio News. Radio today is the fastest growing, fastest moving industry in the world. Greater expansion is just around the corner. Television—short-wave developments—electronics. Astounding new things are happening—you will want to know about them in detail. And you can—by reading Radio News.

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**Introduction**—Servicing as a Profession—Business Methods and Profits—The Technical and Economic Ends of Servicing.

**Chapter One**—Equipment—The Service Shop—Fitting the Equipment to the Pocket-book—Truck Equipment.

**Chapter Two—Contacts**—Dealer Contacts and Contracts—The Local Lighting Company—Automotive Accessory Stores.

**Chapter Three—Advertising and Publicity**—Newspaper Publicity—Motion Picture Films and Slides—Billboards and Truck—The Shop Sign—Sample Publicity—Sample Advertisements.

**Chapter Four—Circularization**—A Good Letterhead—Mailing Cards—Sample Circulars—Stickers—Canvassing.

**Chapter Five—Service Procedure**—The Appearance of The Serviceman—Making the Service Call—Service "Don'ts"—Checking Over the Set—When to Take the Receiver to the Shop—Educating the Customer—Files and Records.

**Chapter Six—The Service Salesman**—Tube Sales—Set Sales—Shop and Store Displays—Impressing the Customer.

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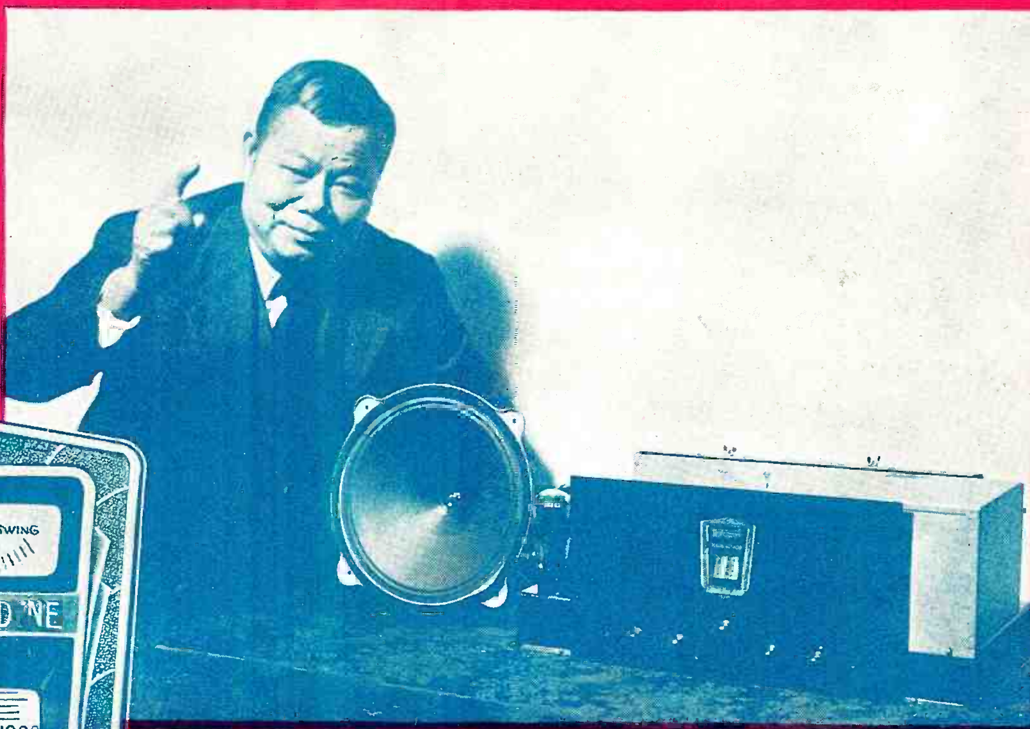


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