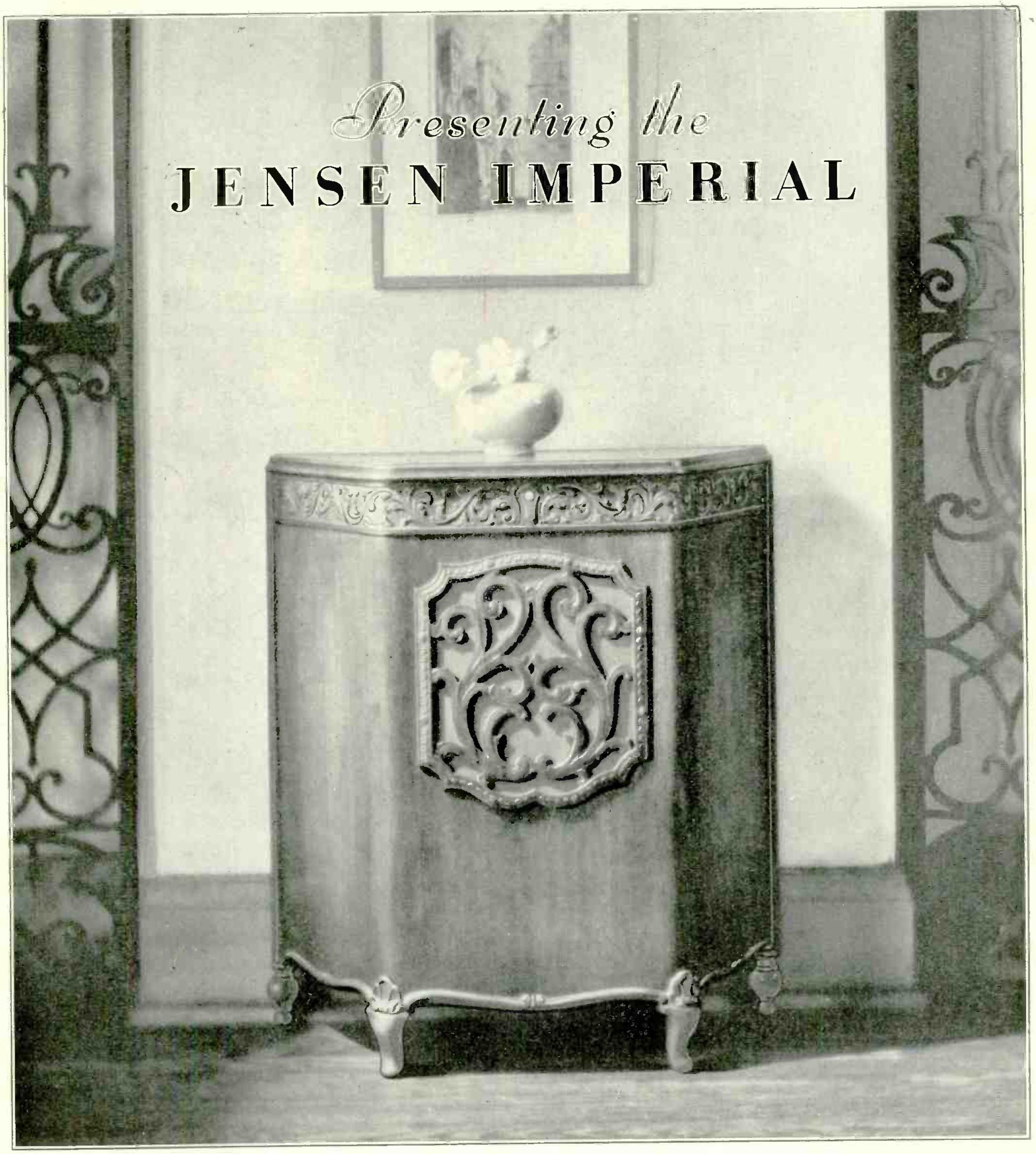
APRIL, 1929 25 CENTS

RADIO

IN THIS ISSUE

- Remote Control by Radio
- R.F. Amplifier Design
- Uses for Neon Lamps
- R.F. Coil Resistance Measurements
- Short Wave Receiver With Constant Regeneration



The Jensen Imperial, a magnificent reproducer with the new Auditorium Dynamic Unit perfected by Peter L. Jensen. Furniture design by Everett Worthington. · · · Music and radio loving America will demand this newly perfected reproducer capable of concert hall volume from push-pull amplifiers of the 250 type, but retaining full brilliance at softest living room volume. · · · Used with any type of radio receiver the superiority is the same. Models are now available for either 110 volt A. C. or D. C. operation. · · · Address the Jensen Radio Mfg. Co., 338 North Kedzie Avenue, Chicago, Ill., or 212 Ninth Street, Oakland, Cal.

JENSEN PATENTS ALLOWED AND PENDING. LICENSED UNDER LEKTOPHONE AND MAGNOVOX PATENTS.

RADIO

Established 1917

Published Monthly by the Pacific Radio Publishing Co.

ARTHUR H. HALLORAN, *Editor* — H. W. DICKOW, *Business Manager*

P. S. LUCAS, *Associate Editor* — A. I. RIVETT, *Draughtsman*

FRANK C. JONES, *Technical Advisor*

Entered as second-class matter at Post Office at San Francisco, California

Subscription Price, $2.50 per year in U. S. and Canada
$3.00 in Foreign Countries

Address all communications to

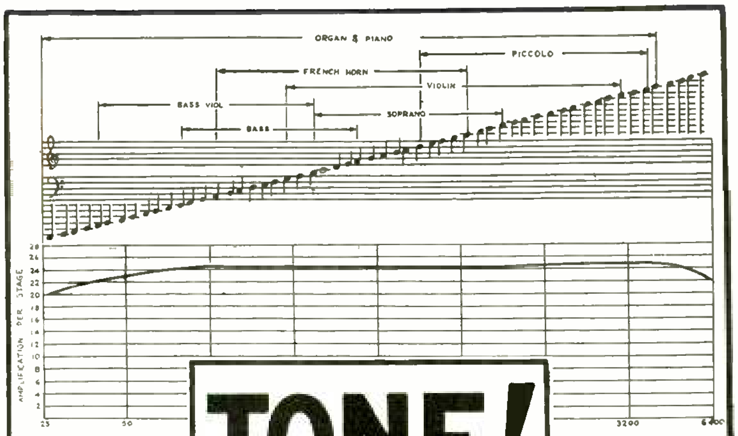
PACIFIC RADIO PUBLISHING COMPANY
Pacific Building, San Francisco, California

VOL. XI — APRIL, 1929 — No. 4

CONTENTS

FORECAST FOR MAY ISSUE

"How the Movies Are Made to Talk" is graphically described by Arthur Hobart. P. S. Lucas tells of the application of "Modern Ideas in a Portable Receiver." His story on "The Marshall Short-Wave Receiver," unavoidably omitted from the April issue, is also definitely scheduled for the May number. Another delayed story is Harry R. Lubcke's "Inexpensive High Range Voltmeter." E. E. Power describes "The Routine of Set Testing." E. A. Tubbs explains the "Design of Audio Frequency Filters." John P. Arnold discusses the principles employed in various scanning systems, describes several types of light-sensitive cells, and tells of an experimental phototelegraphic printer. G. F. Lampkin discusses "Transmission Monitoring." R. Wm. Tanner tells of improved methods for C.W. and phone operation. A. Binneweg, Jr., describes the construction of a 50-watt short-wave transmitter. Frank C. Jones discusses the design problems of detector circuits.



TONE!

Curve of Type "A" Sangamo Straight Audio Transformer showing uniformity of amplification at all audible frequencies

BETTER Transformers
for every radio need!

"X" Line Transformers

- Type AX straight audio amplification, list price $6.00
- Type BX Push-pull Input unit, list price 6.50
- Type CX-171 Push-pull Output Transformer, for 171 or 250 power output tubes for cone speaker, list price 6.50
- Type DX, same as CX except for 210 and 112 power tubes, list price 6.50
- Type HX Push-pull Output for 171 or 250 Power Output tubes to match the impedance of moving coil of Dynamic loudspeakers, list price 6.50
- Type GX, same as HX except for 210 and 112 power tubes, list price 6.50
- Type E Output choke to match impedance of the various type power tubes, list 5.00

"A" Line Transformers

(Similar to X line, but with special core metal to give slightly better curve)

- Type A straight audio amplification, list price $10.00
- Type B Push-pull Input transformer for all tubes, list price 12.00
- Type C-171 Push-pull Output, for 171 or 250 type power tubes with cone speaker 12.00
- Type D-210, same as C except for 210 and 112 power tubes 12.00
- Type H-171, Push-pull Output for 171 or 250 power tubes for Dynamic Speaker, list price 12.00
- Type G-210, same as type H except for 210 and 112 tubes 12.00
- Type F Plate Impedance for use as a choke to prevent oscillation and for impedance coupled amplifiers, list 5.00

SANGAMO ELECTRIC CO.

Springfield, Illinois — 1061 Howard Street, San Francisco, Calif.
750 Subway Terminal Bldg., Los Angeles, Calif.

For 30 years pre-eminent manufacturers of Electrical Precision Instruments

PIN THIS TO YOUR LETTERHEAD AND MAIL

SANGAMO ELECTRIC CO.,
Springfield, Illinois, U. S. A., Dept. 4422.

☐ (For manufacturers) I am interested in engineering data regarding your transformers.

☐ (For dealers) Please send data on Sangamo Condensers.

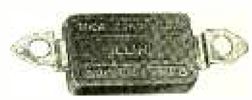
☐ (For set builders) Please send circulars describing your apparatus and latest audio hook-ups.

SANGAMO

No item can cost so little and cause so much trouble in a receiver as a fixed condenser. This fact is especially appreciated by the manufacturer with an eye to the service problem. Likewise experience has shown that a fixed condenser is not necessarily a good condenser just because it is moulded in Bakelite.

The immunity to thermal changes and to mechanical damage rendered by the Bakelite enclosure is supplemented in Sangamo Condensers by accurate rating and sound construction of the mica condenser within the Bakelite casting.

The standard line of Sangamo Fixed Condensers leave the factory tested to maximum variation of 10%.



NEW!

Condensers for Manufacturers

While the Sangamo Condensers shown *at the top of the page* have always been popular with manufacturers, there has been a demand for condensers of the same quality of a size and shape more suitable for factory set design and production. For manufacturers' use only we have designed the Sangamo "Illini." The connecting lugs may be bent to any position required without impairing the condenser.

Prices on request

dition to having been engaged for several years in research work at the California Institute of Technology, where his brilliant achievements have been of great interest to the scientific world.

THE PRICE

Kennedy Royal Receivers are listed at prices that will carry a distinct popular appeal.

LICENSE PROTECTION

All Kennedy Royal Receivers are manufactured under protective licenses, issued by RCA, Hazeltine and others.

THE KENNEDY MERCHANDISING POLICY

Kennedy Royal Receivers will be marketed through a strong chain of selected, recognized distributors—on a sound basis offering a highly encouraging and profitable opportunity to distributors and dealers alike.

DISTRIBUTORS

Think how much the name Kennedy has always meant in radio! Think *how much more* it means now, under the completed expansion plans for producing receivers which incorporate all the latest refinements of design and even anticipate definite future developments. It offers unusual opportunities that call for immediate action...The Kennedy distributor organization is rapidly being rounded out! Telephone...Telegraph...Write—*Now!*

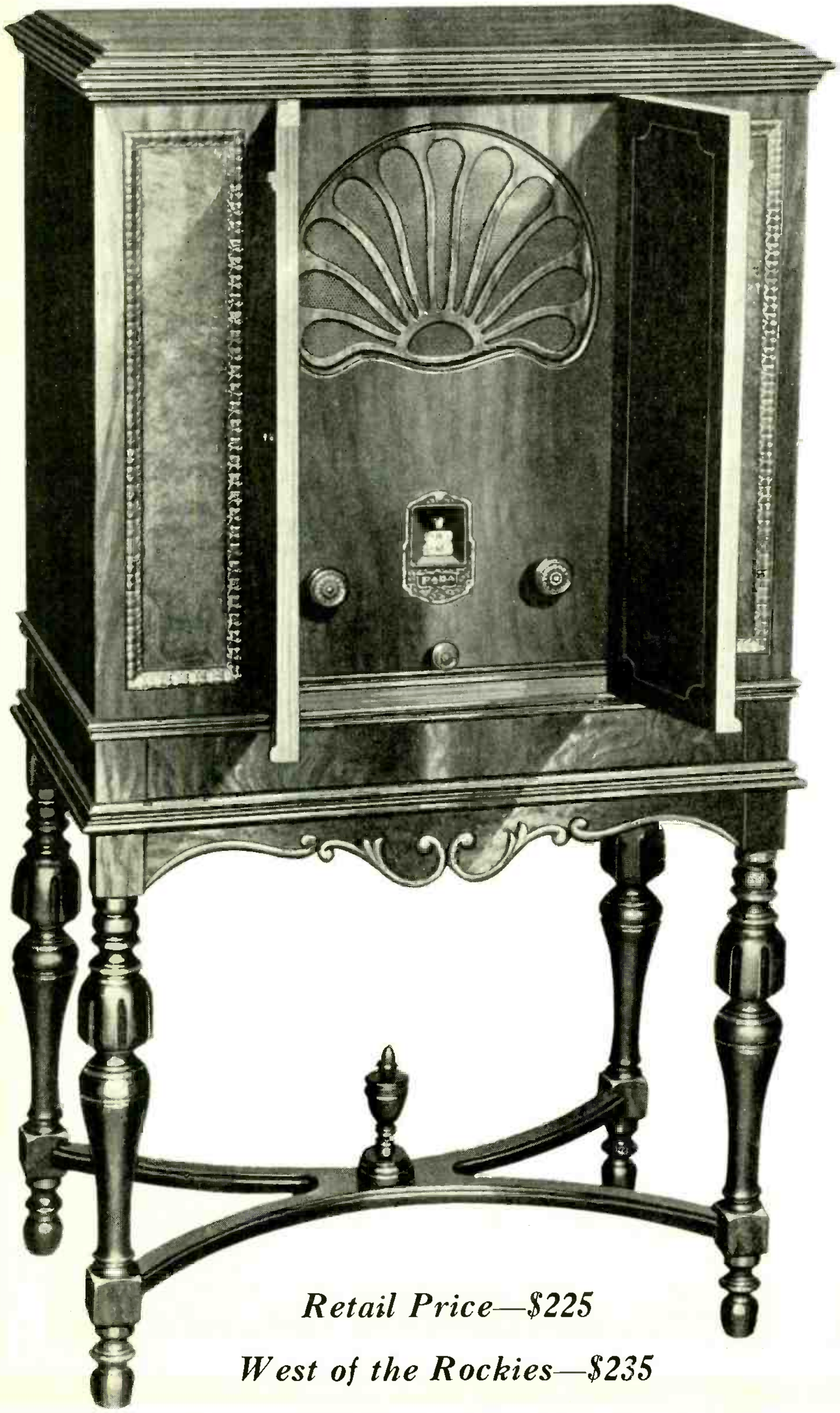
COLIN B. KENNEDY CORPORATION
SOUTH BEND, INDIANA

KENNEDY

The Royalty of Radio

FADA
Radio

Single Dial FADA 32



Retail Price—$225

West of the Rockies—$235

With
Dynamic Speaker

EVERY really worth while—up to the minute improvement known to modern radio is found in this beautiful console—it is the set you have been waiting for, and now here it is!

2, 171-A tubes in push-pull power amplification—5, 227-type indirect heater A.C. tubes and rectifier—smooth volume control—built-in Fada dynamic speaker—single tuning knob—illuminated single dial—reproduction not affected by line voltage fluctuations — completely self-contained in walnut console cabinet—operates from A.C. light socket (90-130 volts, 50-60 cycles)—yes it is a neutrodyne.

Write for Catalog No. 5145

Fada models and radio phonograph combinations from $110 to $890. Speakers—Magnetic — Dynamic — $30, $55 and $72.50, (prices slightly higher West of the Rockies).

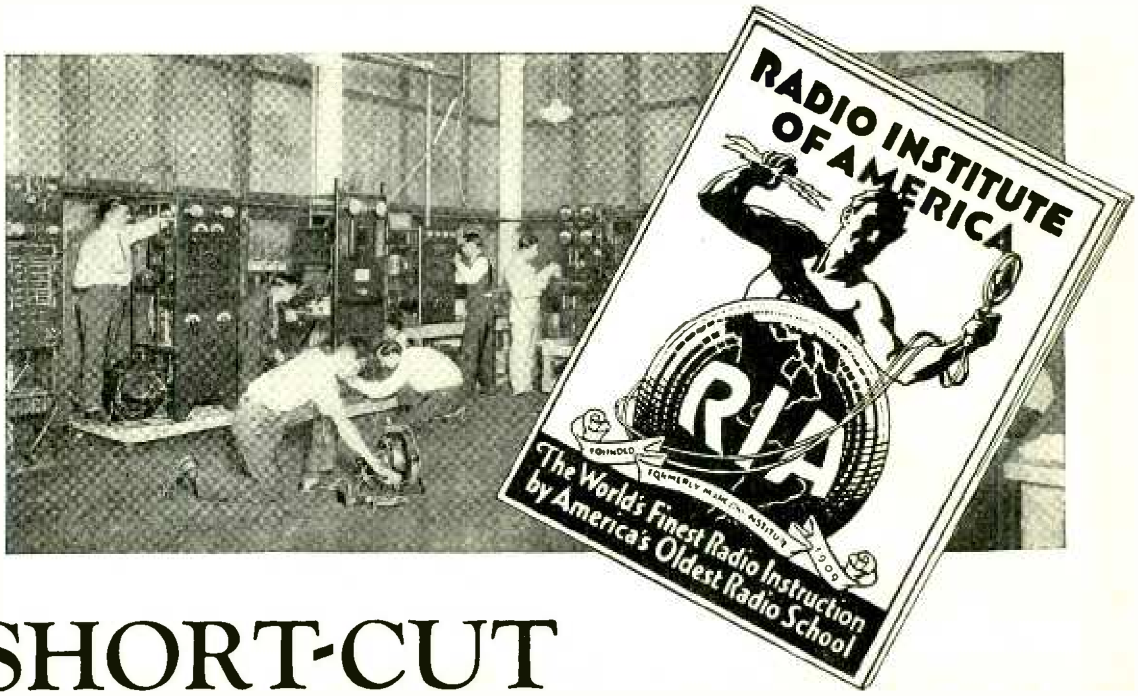
F. A. D. Andrea, Inc.

Long Island City, N. Y.

Chicago Office
2619 So. Michigan Ave.

San Francisco Office
5 Third Street

Yours FREE!



The SHORT-CUT to BIG MONEY in RADIO

"WORTH over $5,000 to me!" "Never so thrilled in my life!" "Never dreamed Radio was so easy to master!"

So scores of men write of this wonder-book which tells how to achieve brilliant success in Radio. Send for your copy—it's Free!

Glorious New Opportunities

Radio needs you! Over 30,000,000 sets need servicing. Over 2,000 ships carry radio apparatus. There are 50,000 radio dealers, 4,000 radio manufacturers, scores of broadcasting stations. And now Television, transatlantic Radio Telephony, and Photoradiograms open up brilliant new possibilities! The Free book tells all about them. It tells also how you can make your spare time prepare you for success through a revolutionary new method of training.

Learn at Home with This Big Laboratory Outfit

You get the "how" as well as the "why" of Radio with this fine training. Only an hour a day—in spare time—is all you need to devote! As part of your course, you receive absolutely free of extra charge—a magnificent outlay of apparatus. With this outfit you learn to build fine sets and solve every problem in repair work. That is why our graduates have the confidence and ability to command big pay. That's why they're in big demand everywhere!

> **RADIO AMATEURS!**
>
> Don't look upon Radio as a mere plaything. Thousands of men are making big money at it—and so can you!
>
> Just a little commercial training is all you need to give you that professional confidence and ability. You can secure this training in your spare time . . . through a marvelous home-laboratory course sponsored by the Radio Corporation of America. Our big FREE Radio Book tells all about it.

Training sponsored by Radio Corporation of America

Our graduates enjoy greater success because they're posted right up-to-the-minute in everything in Radio. Radio's greatest achievements originate in the gigantic laboratories of the Radio Corporation of America. This great Radio organization stands back of every lesson in the RIA course.

Money Back if Not Satisfied

The course prepares you for success in all phases of Radio—manufacturing, servicing, selling, ship and shore broadcasting, radio operating and many others. Includes Television, Photoradiograms, and radio equipment. A signed agreement assures you of complete satisfaction upon completion of the course—or it won't cost you a single penny!

Send for this Free book now

Why wait years for success that can be yours in only 9 months? Read this Free book. It gives you the real dope about Radio and tells you all about the famous course that has enabled us to place thousands of our students in fine positions, usually from 3 to 10 days after graduation! Mail coupon now. Radio Institute Of America, Dept. RA-4, 326 Broadway, New York.

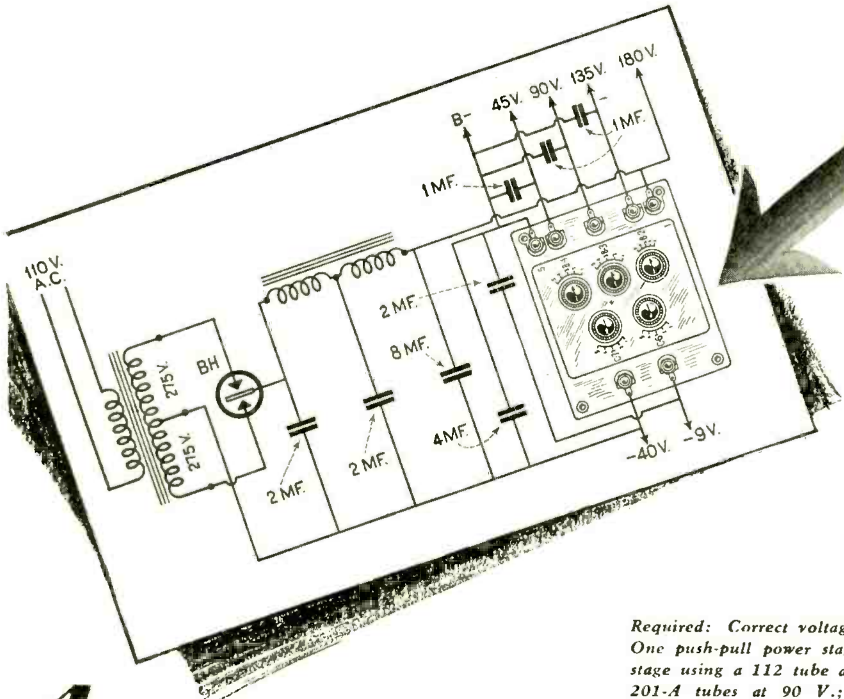
RADIO INSTITUTE OF AMERICA
Dept. RA-4, 326 Broadway, New York

Gentlemen: Please send me your big FREE 50-page book which tells about the great opportunities in Radio and about your famous laboratory-method of guaranteed radio instruction at home.

Name ....

Address ....

....



HOW would YOU solve this VOLTAGE PROBLEM?

Required: Correct voltages for a nine-tube Superheterodyne with: One push-pull power stage, using 171 tubes at 180 V.; one R.F. stage using a 112 tube at 135 V.; three intermediate stages using 201-A tubes at 90 V.; two detectors and one oscillator using 201-A tubes at 45 V.—also grid biases of 9 and 40 volts. Assume an input voltage of 220 and consider the various current drains.

Answer:-

The TRUVOLT DIVIDER

U. S. Pat. No. 1676869
and Patents Pending

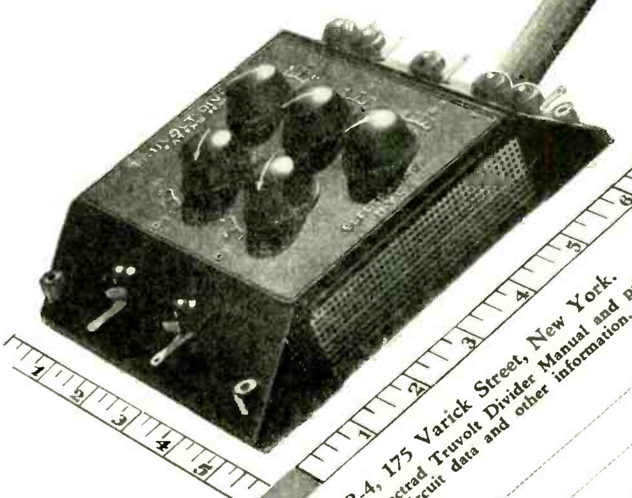
LIST PRICE $12.50

CORRECT plate and grid voltages for any form of receiver from any type of B eliminators are best controlled by the Truvolt Divider. The Truvolt Divider is a universal, wire-wound resistor with five variable taps. Three of these taps will furnish any required voltages from +20 to +160, a binding post gives a fixed supply of 180 volts, and the two remaining taps will supply any grid biases from —1 to —40 volts. Carefully calibrated, each control knob, merely by the use of simple tables and graphs, can be quickly adjusted for any required voltage.

It eliminates the need of an expensive high resistance voltmeter and difficult calculations. It dispenses with troublesome individual resistances for the various voltages—avoids complicated wiring.

The Truvolt Divider is compact (only 5½" x 6¾") and good looking. It is made of genuine Bakelite and is designed for baseboard or sub-panel mounting or may be used as the front panel of a metal eliminator cabinet. Your dealer sells it or can get it for you.

Electrad specializes in a complete line of controls for all Radio purposes, including Television.



ELECTRAD, INC., Dept. PR-4, 175 Varick Street, New York.
Please send me Free copy of Electrad Truvolt Divider Manual and put me on your mailing list for circuit data and other information.
Name ....
Address ....
City ....
State ....

175 Varick Street, New York

ELECTRAD INC.

RADIO

VOLUME XI | APRIL, 1929 | No. 4

Radiotorial Comment

THE reason for the success of a radio service man is like that of the great painter, who, when asked with what he mixed his colors, replied "brains." All that the modern testing equipment can tell about radio troubles is of little avail unless the repair man can apply the information correctly. Radio repair work should not be allowed to fall into the same disrepute as has that of the guesswork auto mechanic. The man who will hold his own in the business of radio service is the man who, given *y* and *z*, can find *x*, and then remedy the trouble with the greatest neatness and dispatch.

* * *

RADIO service men are confronted with the dual task of repairing sets of ancient vintage and of servicing the latest models of a.c.-operated equipment. Many of the old battery-operated sets which are brought in for repair or remodeling are "orphans." Essential information concerning their circuits is lacking and often can be secured only by laboriously tracing a maze of wiring. Likewise it is frequently difficult to secure circuit diagrams of new sets which are not regularly handled by the service man's firm. Much of this required information is available in the back files of radio magazines, which should be an integral part of the service man's equipment. Many enterprising radiotricians maintain a circuit notebook, wherein they incorporate all circuits which come to their attention.

* * *

RADIO terms may be used to illustrate the achievements of many people who are successfully serving the general welfare while also successfully conducting their business and family duties. Regard their regular duties as the continuous output of a CW transmitter, the carrier wave if you please. Regard their public welfare work in service clubs or charitable organizations as the modulation which is superimposed upon the carrier wave. The influence of their work depends mutually upon the power of their carrier wave, and the quality of their modulation. Usually it is only by their modulation that they are judged. This picture may help someone who is patiently working for the public good without expectation of reward.

* * *

WHEN is a radio message "commercial correspondence"? What is the criterion which should govern an amateur operator when accepting or delivering a message? This is a question which has agitated amateur radio for a long time and which has not yet been answered satisfactorily to all concerned. The intention is clear but the interpretation varies.

The United States amateur regulations clearly define an amateur station as one which is "operated by a person interested in radio technique solely with a personal aim and without pecuniary interest." Furthermore, "amateur stations are not authorized to broadcast news, music, lectures, sermons, or any form of entertainment, or to conduct any form of commercial correspondence." But what is commercial correspondence?

The intention is that an amateur should not transmit messages which are concerned with matters of business or with affairs having to do with financial gain or loss. An amateur may transmit any message which has no relation whatsoever to business transactions.

This intention disbars that rather liberal interpretation under which many amateurs have transmitted messages for which they received no direct pecuniary return. It also disbars the acceptance of any message which "might just as well be sent by mail, so far as its importance is concerned." For there are many business transactions in which time is not the most important consideration.

One great distinction between the acceptance of a message by a commercial concern and by an amateur is responsibility for delivery. An amateur can make no guarantee in this respect nor does he assume any responsibility for non-delivery. So an extreme interpretation might limit amateur acceptance to such messages concerning which it would make no material difference whether the message was delivered or not.

But such an interpretation would be too strict, for it would remove much of the incentive for the fine traffic work in which amateurs have proven so competent. What is the use in sending "love and kisses" when the recipient doesn't care whether she gets them or not? Nor would the public be interested in using amateur radio if all its facilities were devoted to such insipid traffic.

Perhaps the best definition as to what might constitute amateur traffic, in contrast to what is commercial correspondence, is contained in the stipulation under which the Western Union Telegraph Company issues its complimentary franks. This provides that the free message privilege shall be used only for the personal, family and social messages of the holder and shall not be used for his personal business.

Such an interpretation of the character of messages submitted to him would assure the amateur that he is not violating the law in either its spirit or letter. It may at least suffice until some more authoritative definition is formulated.

* * *

THE Federal Radio Commissioners have troubles of their own. Since the last comment in these columns, two more of them have resigned, the Senate has kept them on the anxious seat as to whether they shall draw their future salaries for three or for twelve months a year, and one of the courts has decided that they were all wet in ordering WGY to shut down after sundown. Furthermore eleven of their other decisions have been appealed to the courts.

The resignations of Pickard and Caldwell, the only members who knew anything about radio, were in no way retarded by any spirit of harmony among the Commissioners. Their absence would have left the Commission without any knowledge of what it's all about, were it not that rare good judgment was exercised in the selection of Arthur Batchelder and C. N. Jansky Jr., as their successors. Mr. Batchelder has had long experience as Radio Supervisor in the Department of Commerce and Prof. Jansky has an expert knowledge of the entire radio situation.

The Commission, as now constituted, is well qualified to act as an appellate body after March 15, as was originally intended when it was created. In its membership are men who possess sufficient radio, judicial and political background to pass wisely upon appeal from the decisions of the Radio Division of the Department of Commerce.

That Congress extended the life of the Commission as an administrative body for eight months, is a matter of regret to all who are sincerely interested in stabilizing the broadcast situation. The Radio Division could have cleaned up the mess that has been made by the Commission's blunderings and the Commission could have competently reviewed any appeals from the Division's decisions.

Just what effect the present situation will have upon the eleven appeals which are pending in the courts is problematical. If the court decisions in these cases are along the lines indicated by the WGY decision it will again be necessary for Congress to pass a new set of radio laws.

The WGY decision nullified much of the power which the Commission has exercised in other controversies. It stated that WGY is entitled to full-time operation, with 50,000 watts on 790 kilocycles, thus virtually renewing an expired license without the formality of a Commission hearing. In accordance with this opinion the Commission would be obliged to issue broadcast licenses to all applicants and would have no authority to specify how much power a station may use.

As this decision will undoubtedly be appealed to the United States Supreme Court, any comment as to the constitutionality of the law is not warranted here. If the present law is found to be defective Congress will speedily remedy the defects. Consequently there is little likelihood of a prolonged repetition of the chaotic conditions which preceded the establishment of this unfortunate Commission.

A Night and Fog-Flying Radio Laboratory

By S. R. WINTERS

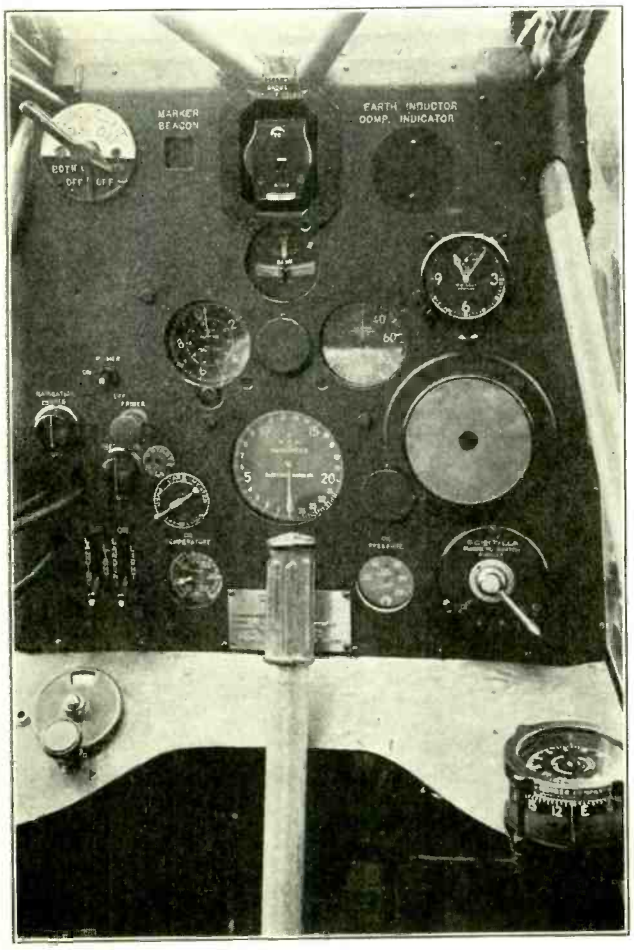
THE research laboratory takes wings! The problems incident to aircraft communication and the guidance of airplanes by radio may now be studied during flights. A plane outfitted by the Radio Laboratory of the Bureau of Standards enables the research worker to emerge from academic walls and subject radio instruments and other safety devices to the practical tests of navigation. Intended primarily for experimenting with the radio beacon system during night flying and for flying and landing in fog, this laboratory on wings figuratively and literally lifts the scientist from an atmosphere of theory to an air of performance—where instrumental equipment either meets the rigid tests of service or fails under the stress of action.

A 4-passenger Fairchild FS-2 airplane was virtually rebuilt internally in the conversion process from a passenger-carrying plane to a scientific laboratory. The two center seats were removed, giving way to radio equipment—space sufficient to accommodate a complete transmitting station and three receiving sets. The front instrument board underwent a radical revision—displacing the conventional instruments for daytime flying to facilitate the installation of equipment designed for navigation during darkness and fog. For instance, the front instrument board includes a pair of vibrating reeds for charting the pilot's course unerringly; space is provided for the installation of a marker radio reed indicator beacon—a sort of milestone on the highways of the air, inasmuch as radio signals from a ground station inform the aviator of his location with respect to landing fields. In addition, the pilot's instrument board includes a panel which affords indirect lighting for night flying.

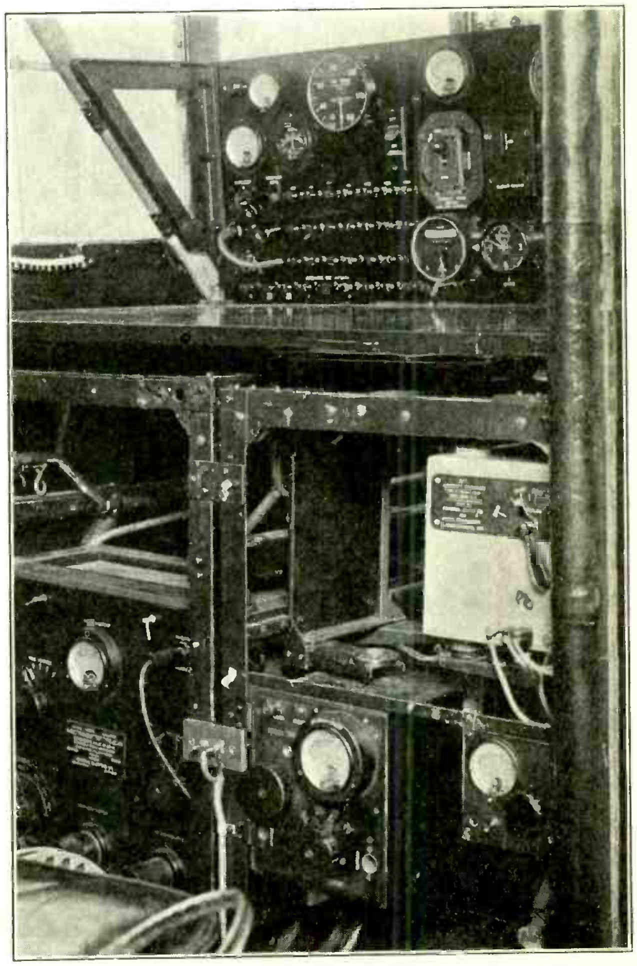
The instrumental equipment is mounted in form of a desk, the top of which is shock-proofed so as to admit of additional installations without undue vibration. Back of the desk is a panel board on which are mounted the various test instruments. This panel also accommodates a course indicator or vibrating reeds for receiving the guiding radio signals from a directional beacon and a marker-beacon indicator for charting the exact location of the plane. A handful of battery terminals is available, at this panel board, for attachment to the radio receiving outfits and also to permit of rapid connection with other apparatus during flight. This desk panel likewise includes a partial duplication of the flight instruments—thus making it possible for an observer to follow the flight maneuvers when navigating at night.

To facilitate observations by the lone pilot, a special switching arrangement on the panel board transfers the output of either of the three radio receiving sets from the observer's desk panel to that of the pilot, and vice versa. A volume control—accessible to pilot and observer, permits of the regulation of the incoming radio signals to a suitable strength or sound level.

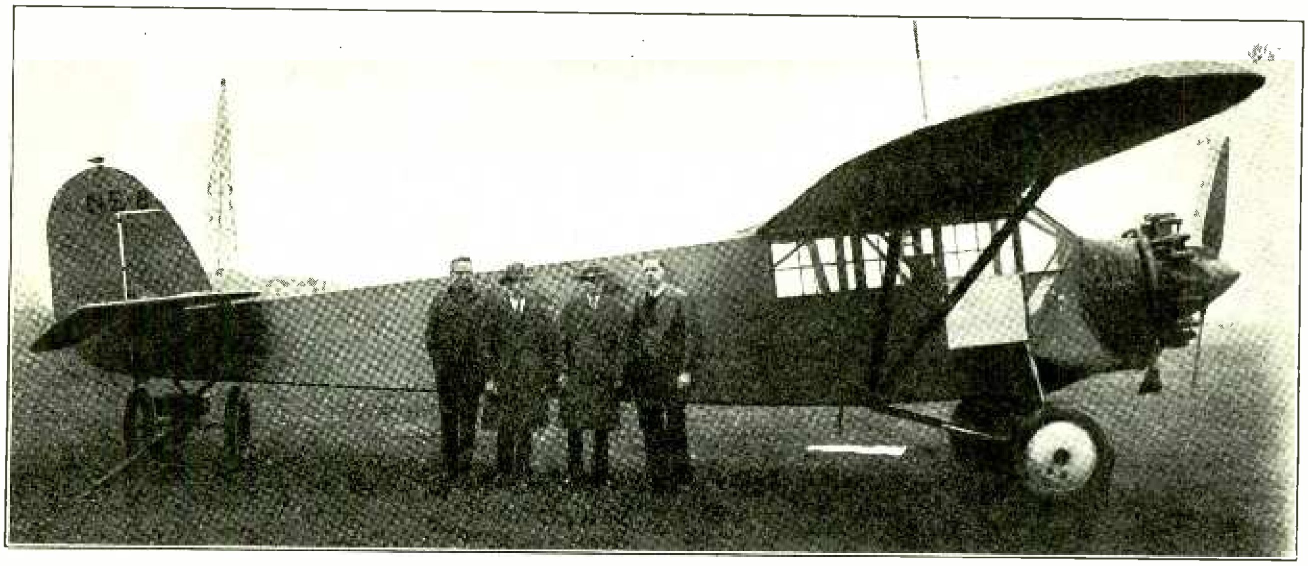
The airplane engine is completely shielded—including the installation of a specially shielded spark plug—and igni-



The Pilot's Instrument Board



The Observer's Desk



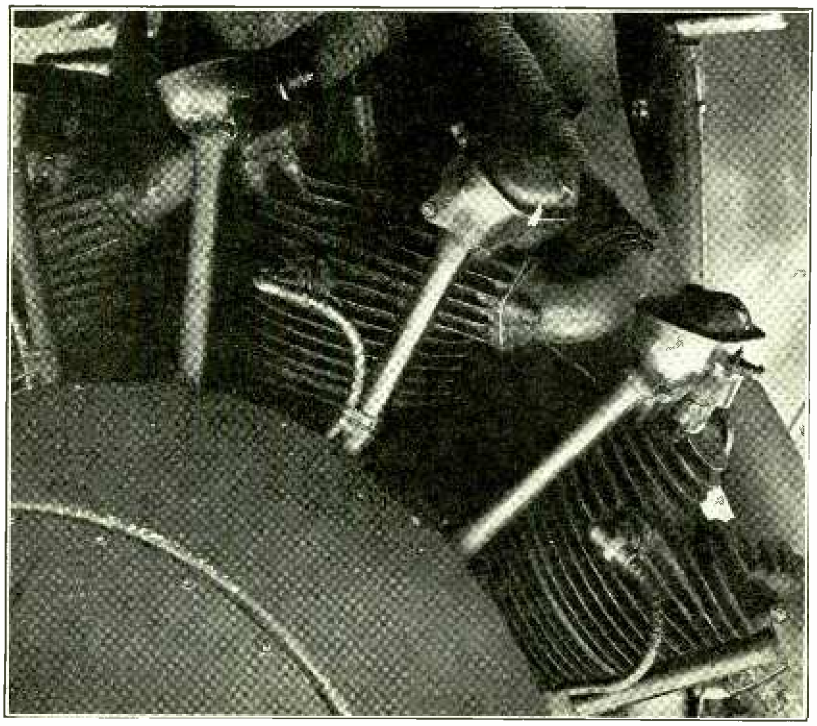
The Flying Radio Laboratory and Its Developers

tion interference with radio reception has been conquered. This obstacle once threatened the success of radio-telephone communication on aircraft.

A trailing wire is employed as a radiating system for the transmitting set, whereas a 6-foot vertical pole suffices as a pick-up system for the ultra-sensitive radio receiver. One of the latter—designed by Harry Diamond of the Radio Laboratory of the Bureau of Standards, is a 6-tube outfit, including a shielded-grid unit, weighs 15 pounds, and has extreme sensitivity and selectivity. The other two receiving sets are equipped with five tubes, employ a single control, and in the design of the Radio Frequency Laboratories weigh only nine pounds, including shock-proof mounting. The entire radio equipment—including transmitter, receiving sets, batteries, generators, and other accessories — weighs approximately 250 pounds.

A substantial reduction in weight of the complete radio equipment was effected with the introduction of a double-voltage generator. Formerly, a low-voltage generator was employed which charged a storage battery and the latter, in turn, drove a dynamo. The dynamo had a high voltage, the necessary power supply for the plates of the tubes. Now, however, the radio transmitter derives its electric energy from a double-voltage, direct-current generator, which is driven directly by the airplane engine. This double-voltage generator weighs only 32 pounds—representing an appreciable reduction of weight in comparison with previously used power-supplying units.

This outfit is a composite product of the laboratory staff, including Harry Diamond, in charge of the Bureau of Standards' research program on radio aids to aviation, Francis W. Dunmore, F. G. Kear, and F. G. Gardner. It will occasionally commute from College Park, Maryland, over various routes along the civil airways. The transmitting set will establish communication with the laboratory staff and ground radio stations, and the three radio receivers will be employed to intercept directional and marker beacon signals as well as weather reports by radio-telephone. The distance reception range is about 200 miles, including beacon and radio-telephone signals from Hadley, New Jersey; and Bellefonte, Pa.



The Shielded Ignition System

PICTURES FROM THE ARCTIC

The New York *Times* reports that the *Graf Zeppelin* will carry complete phototelegraphic apparatus on its proposed trip of exploration over the Polar regions in 1930. While the explorers are at work, pictures of the places they visit and the finds they make will be broadcast. Powerful radio stations will relay the picture signals throughout the world. What system of picture transmission will be used, if these plans are carried out, is not yet known, possibly the apparatus of Professor Korn. Whether amateur experimenters will be able to pick up the signals will depend on how near they are to the rebroadcasting stations. Short-wave transmission will no doubt be employed.

The latest vogue in radio cabinets calls for the addition of a revolving color cylinder, whereby soft lights of various colors are thrown on a pleated white silk grill cloth in the loudspeaker compartment. The cylinder is illuminated from within and is geared to a motor, so that it revolves at various slow speeds.

Remote Control by Radio

How a 400-Watt Transmitter Is Operated Without Wire Connection From Several Five-Watt Substations

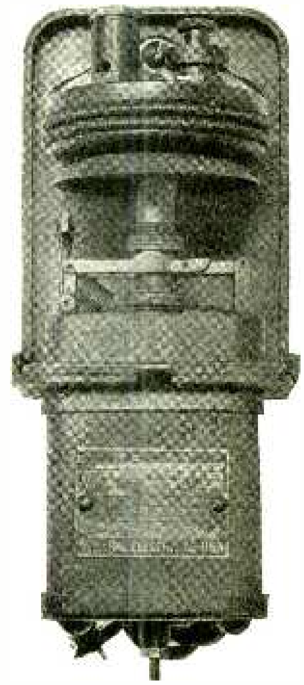
By G. F. LAMPKIN

IF IT were light enough, one could see an array of radio apparatus around the room: a three-tube receiver and accessories on the table to the rear; power-panels with switches, meters, and contactors, at the side; and in front, two short-wave transmitters above a meter and transformer cabinet, and a third transmitter at the side. If it were light enough—but the only light comes weakly from the rectifier tubes—the *B*-eliminator kenotron, and over in the corner, a tungar. They burn, as do the three receiver tubes, day and night.

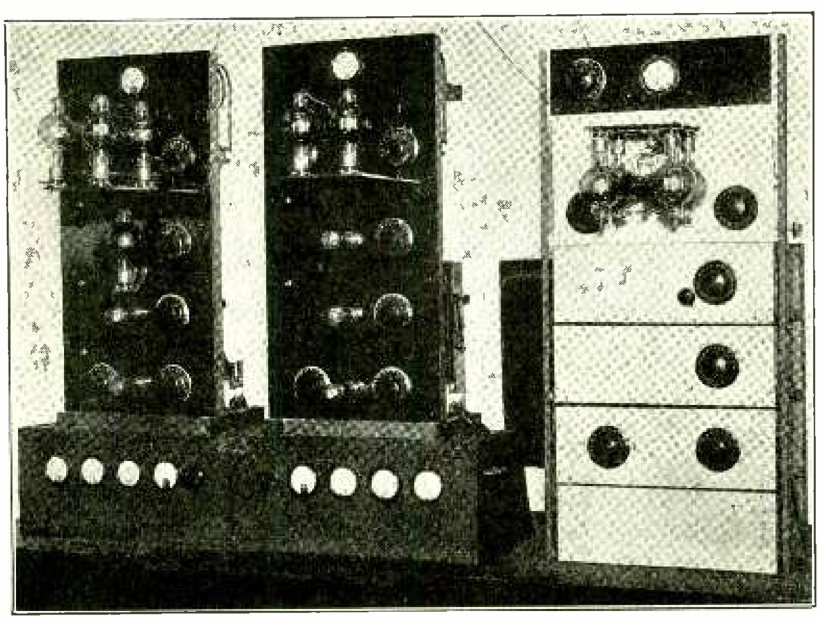
Five miles away an amateur's headphones register a CQ, R4 or 5, pure d.c., 32 meters, New Zealand ZK3ZA calling United States. The final AR breaks through. Alongside his receiver is an inconsequential 5-watt transmitter, whose output is radiated from a single short-wire aerial down among the trees and houses; and the wavelength is near 150 meters. Nevertheless, from the amateur's key comes KAZK3ZA de W8CAU. . . . A relay on the power panels hums for two or three seconds, contactors clack together, a motor generator in the next room gets under way. The big 40-meter transmitter on the left stands out as its tubes throw yellowish light over the room. Some fraction of 400 watts of crystal-controlled energy widens out over the world. And the dots and dashes spell ZK3ZA de W8CAU. . . . The contactors drop out after the end of the transmission and darkness again closes in.

Remote control, not by telegraph or telephone lines, but by radio, is a standard operating procedure at W8CAU. Any night in the operating room atop Swift Hall of the University of Cincinnati the transmitter may start up. The signals may be addressed to a ham in the next state, asking for a QSR; or they may acknowledge signal reports and a message from West Africa. But since the janitor closed the building after classes the operating room has not been unlocked. One can go home to worry over the calculus or electrical problems incurred in the classes—delve into them until the brain runs dry—then through W8CAU ask a chap what sort of weather he is having in Ecuador.

Operation by radio remote control is not the sole means of using the transmitting equipment at the station. Rather it is supplementary to the usual method of working. There is a control desk in the center of the room. It has a short-wave receiver, message rack, telegraph keys, a heterodyne wavemeter, call book, all the necessary appurtenances in an amateur station. Members of the operating staff hold scheduled tricks or drop in at spare times. The remote-control system is maintained to enhance the usefulness of the station. It enables operators who have stations of their own to become "substations" of the big crystal-controlled set. Ten watts into a little transmitter on 150 meters is ample to control the outfit from a distance of five miles. One operator uses a 45-volt *B* battery as power supply on his control transmitter. Stations W8AET, W8AHP W8AJC, W8ALK, and W8CMX have all operated as substations since the system was inaugurated some 18 months ago.



The Heart of the System, an Air-Bellows Delayed-Time Relay



Three Crystal-Controlled Transmitters at W8CAU-W8YX, 400-watt, 40-meter Telegraph, 200-watt, 20-meter Telegraph, 400-watt, 80-meter Telegraph and Telephone

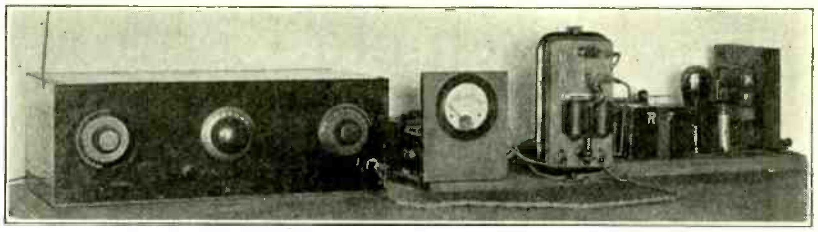
The heart of the system is an air-bellows relay having a delayed-time characteristic. The relay is revamped and adjusted so that it requires about three seconds to close, or open, its contacts. Keying impulses from the remote-control receiver operate a sensitive, though rugged, contact-closing relay. This in turn operates the delayed-time relay and a keying relay in series. Holding the key on a control transmitter down for three or more seconds causes the delayed-time relay contacts to close, which starts up the motor generator and transmitter filaments. The keying impulses then are transmitted on by the 40-meter layout; and as long as the incoming dots and dashes do not cease for more than three seconds the apparatus remains running. A lapse of three seconds is sufficient to drop out the delayed-time relay and shut the station down—save for the ever-burning control receiver.

The three tubes in the receiver are the type used in the telephone repeater work. Since August 11, 1927, they have burned continually. The UX-213 in the eliminator has claim to an even longer life, and the tungar for continual trickle charging began burning Thanksgiving Day, '27. Ordinary 201-A tubes lasted about a week in the receiver. But the telephone tubes are good. The rectifier tubes are operated well below rating.

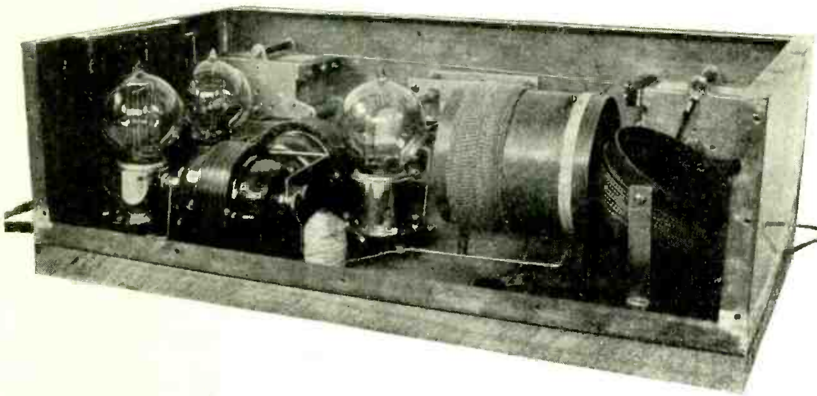
The receiver circuit is regenerative detector, one stage audio amplifier, and one amplifier-rectifier stage. The detector heterodynes the incoming signal to feed audio frequency to the amplifier. The last tube is biased so that normal plate current is a tenth or so of a milliampere. Three or more milliamperes flow when the keying impulses come through, and so operate the contact-closing control relay. The circuit diagram in Fig. 1 develops details of the scheme. Tuning the antenna helps to keep the control-transmitter down to ten watts, as also does smoothing the output of the amplifier-rectifier with a one microfarad condenser. The latter raises the value of the d.c. output. The amplifier filaments light from raw a.c. On the detector a storage-battery-trickle-charger combination is necessary—a.c. produces prohibitive hum. A *B*-eliminator pack completes the power supply. The receiver is totally shielded, chiefly as a dustproofing precaution.

One-half milliampere can be made to operate the control relay in the receiver output, but normally the relay is adjusted so that three milliamperes is the minimum operating current. Currents of from 4 to 15 milliamperes are set up in the receiver output by the different control transmitters. The keying relay molds the transmitter output into dots and dashes. The 40-meter transmitter on the left is most used, although either the central 20-meter transmitter or the shielded 80-meter job can be left in service for remote-control use. The delayed-time relay does not close the power circuits directly, but through auxiliary contactors built to handle the heavy currents. Everything—receiver, control apparatus, and transmitter—operates from the 110 a.c. supply. Protection of the equipment is obtained by proper fusing

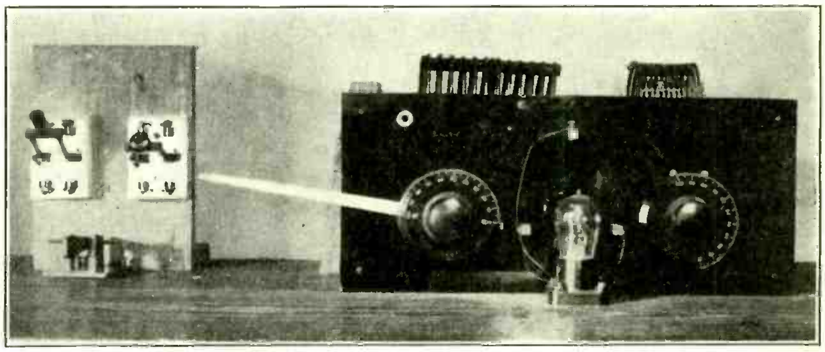
(Continued on Page 34)



Remote Control Receiving Equipment—Shielded Receiver, D.C. Milliammeter, Control Relay, and "B" Eliminator



Rear View of Remote Control Receiver



Typical Substation Control Transmitter

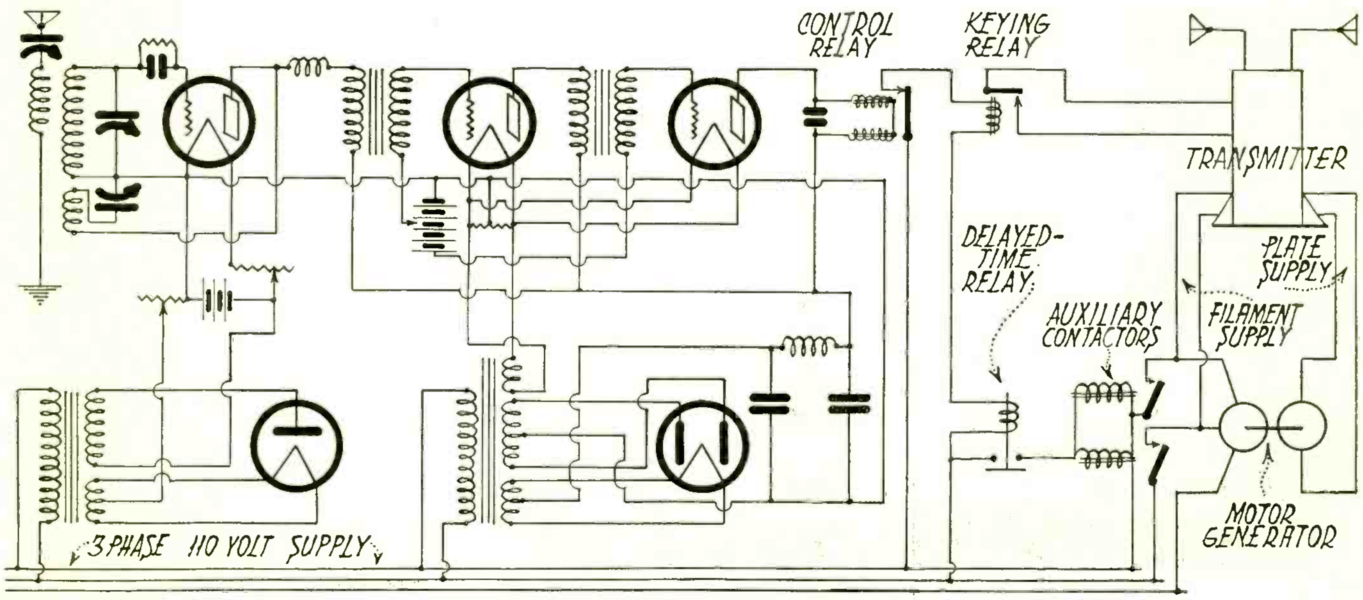


Fig. 1. Circuit Diagram of Receiving and Starting Equipment

The R. F. Amplifier

The Second in a Series of Articles on the Design of Factory-Built Receivers

By FRANK C. JONES

CHOICE of the method of radio frequency amplification to be employed depends somewhat upon the purpose to which the receiver is to be applied and also upon the cost of attaining the desired result. In other words, what is to be the degree of its sensitivity and selectivity for distant reception. Thus one manufacturer may decide to produce a radio receiver capable of picking up distant stations much better than other sets in the same price market. When this happens the usual result is a poor quality of reproduction because the audio amplifier and loudspeaker may be of inferior grade in order to put more money into the r.f. end of the set. Usually such sets are made with so-called "hair-line" selectivity in order to receive distant stations on wavelengths adjacent to local stations. This means a loss of higher audio frequencies due to side band cut-off, though there are certain methods of minimizing this effect.

Suppose wonderful distance reception is to be the big sales argument. Over one-third of the sets are sold in locations more than 50 miles from the nearest broadcast stations anyway, and for daylight reception, good sensitivity is necessary. Such a receiver should have at least three stages of tuned r.f. amplification, or its equivalent gain by some other method.

In order to keep the cost down, it is generally impossible to go beyond four tuned circuits. So each circuit should be designed to be fairly selective and provision made to properly "peak" the resonant periods of all of the circuits over the complete broadcast band. The latter is really a very difficult problem and means that the r.f. transformers and sections of the gang tuning condenser, respectively, have to be accurately matched. In addition to this, the condensers must have trimmer condensers or some method of varying the capacities in order to properly "peak" the r.f. amplification in the completed receiver.

Bending the end plates of either the rotors or stators of the variable condensers is generally unsatisfactory in the long run because the plates warp back out of proper electrical alignment. This is especially true of brass plate variable condensers. Again, receiver cost plays an important part. If the receiver is to fall into the $100 class, cheap aluminum plate variable condensers may be used and the end plates bent for proper gang alignment, rather than using trimmer condensers.

In any case it is necessary to figure the costs of matching r.f. coils and sections of the gang condenser by some means, such as shown in Fig. 1a and 1b.

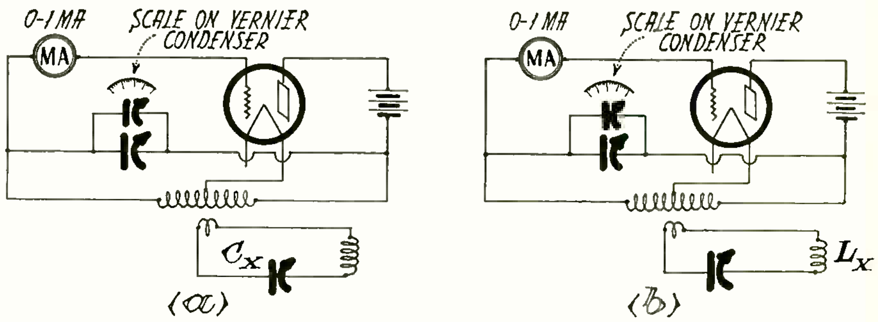


Fig. 1. Simple Oscillator Circuits for Matching R.F. Coils and Condensers

Simple oscillators like these are generally more practical than beat frequency oscillators in which an audible beat frequency is present, unless the sections or coils are absolutely matched. The beat-frequency type shows exactly how much a coil or condenser is out of alignment. Its accuracy is in the order of better than 1/10 of 1 per cent, which is closer than is necessary in manufacturing procedure. For practically all cases a match of from ½ to 1 per cent is close enough and reduces manufacturing costs a great deal. The final line-up test of the completed receiver will take care of such variations if any method of final alignment or "peaking" is available.

Let us first consider a receiver using only one stage of r.f. with a regenerative detector. The Browning-Drake is a familiar circuit which will give sufficient volume for local reception with sufficient selectivity in nearly all cases. It is cheap to build, but difficult to manufacture as a single control receiver, unless an untuned antenna stage tube is used. Even then, increase or decrease of the detector regeneration control usually throws that circuit out of line with a loss of amplification. Such circuits on distance reception depend entirely for gain, and particularly for selectivity, upon detector and r.f. regeneration. Even with the latter neutralized properly, the total maximum regeneration is about the same, and distant stations sound "drummy," due to side band cut-off.

The selectivity curve where regeneration is present to any degree has a very sharp maximum of from 500 to 2000 cycles in width. This of course causes a loss of all of the higher audio frequencies. The use of audio transformers having a peak on the high frequencies is unsatisfactory in this case because the degree of r.f. cut-off is variable while the transformer characteristic is not.

A more satisfactory arrangement is to use two stages of r.f. in a cheap set, since this will give nearly as much gain as the one stage plus regenerative detector. Usually a neutralized circuit is more satisfactory than a tuned r.f. circuit using grid resistors, due to the greater gain without danger of oscillation. The selectivity with the latter is generally very good on the upper wavelengths but poor on the lower range, due to a poor power factor condenser across the tuned circuit. This effect is due to the tube input capacity, from 20 to 60 micro-microfarads, being in series with the grid resistor across the tuning condenser. Theoretically, the grid resistor is used to just offset the negative resistance due to the plate circuit load in the normal three electrode tube circuits. The screen-grid tube practically eliminates this trouble and because of its low input capacity, usually about 5 mmfd., the grid resistor is very ineffective as a means of suppressing oscillation with these tubes.

The grid resistor or suppressor has its advantages in that it tends to reduce regenerative gain at the higher frequencies, which is very troublesome with straight neutralized circuits. This means that grid resistors can be used in a neutralized receiver having five or six tuned circuits without danger of poor selectivity. One new receiver this year uses five tuned circuits with both grid resistors and plate neutralizing condensers to very good advantage. That receiver uses a power detector and only one stage of audio amplification.

The number of tuned circuits depends somewhat upon whether three electrode tubes or screen-grid tubes are used, since better selectivity is obtainable with the latter when maximum gain per stage is not important. Four tuned circuits of proper design with three a.c. screen-grid tubes will give more gain and about the same selectivity as will five tuned circuits using 227 or 226 tubes. The selectivity curve of the latter will be of better form with steeper sides, which means less high frequency cut-off. In both cases it is assumed that each separate circuit tunes broadly enough to only slightly attenuate the high frequencies.

It is difficult to cover such a broad subject as r.f. amplifiers except to touch a few high lights of general interest. Perhaps a few comparisons between the r.f. design for a three-stage r.f., detector and two-stage a.f. receiver, and a four-stage r.f., power detector and one-stage a.f. receiver will help to cover this subject.

In the three-stage r.f. receiver, suppose it is desirable to have a gain of 10 per stage giving 1000 as the total r.f. gain, not including the voltage gain of a tuned input from the antenna. In the first place this gain of 10 per stage means that when '26 or '27 tubes are used, that some form of neutralization is desirable. This may be of the usual grid to following grid coil tap as shown in Fig. 2a, or plate coil to plate coil as shown in Fig. 2b. There are numerous modifications of both these schemes but the two shown are about the most economical to manufacture.

The first arrangement, Fig. 2a, is easy to handle, but has the disadvantage of throwing the tuning circuits out of alignment when the neutralizing condenser is adjusted.

The second scheme gets around the latter difficulty very nicely since it is not directly across any grid circuit. The neutralizing condenser in this case has to be of larger capacity, generally about 80 mmfds. and care has to be taken in designing the r.f. transformers. The direction of the primary winding is the same for both schemes, but in the latter the capacity between primary and secondary windings seems to be more important. If this capacity is very large, the phase relations are upset and neutralization of a three or four-stage r.f. amplifier becomes practically impossible.

In designing the r.f. transformers and shielding, certain compromises are necessary in order to arrive at the proper balance of gain and selectivity over the whole broadcast band. For example, a very efficient coil may be designed of large diameter, proper gauge of wire and turn spacing, but in actual practice it would be useless. The selectivity would be too great and the audio quality would suffer if three or more tuned circuits were used. It would be difficult to efficiently shield such coils, also, without taking up too much space. It is more economical and usually nearly as efficient to use small coils with small individual shielding cans.

The engineer is confronted in such design with the problem of obtaining the desired overall result. To determine the best methods, measurements of coil resistance at high, medium and low broadcast frequencies should be made with different dimensioned coils and shielding cans. The same sort of measurements should be made using an r.f. oscillator, an accurate attenuator, and a vacuum tube voltmeter. The latter measurements are especially desirable and quite necessary if any original work is to be done in designing a new receiver.

In general, such measurements show that coils of about the same physical dimensions have the following characteristics: Spaced winding with small wire gives lower resistance and greater gain at the higher end of the band. Larger wire, close wound, has higher loss at these frequencies in proportion to the losses at the low broadcast frequencies. This may be an advantage in that the actual overall gain of the receiver will be more nearly constant over the whole band since the regeneration at the high frequencies will be less. Usually the increased regeneration at this end gives nearly as good selectivity as at the upper wavelengths, *provided* the tuning condenser is in perfect alignment. Such is rarely the case in commercial broadcast receivers.

Spaced winding is more expensive than the other type but in production of matched coils it may be cheaper. The insulation of enameled or other insulated wire varies considerably and so if the coils are close wound to fill a given space on a tube, the turns may be different, and vice versa. Either gives different values of inductance and so makes the job of matching coils quite difficult.

However, if a certain tolerance can be allowed, the close-winding may be used at some saving in cost. For example, in a four-stage r.f. receiver, this type of winding may be used to obtain a certain degree of selectivity and gain as against a three-stage r.f. job using spaced winding. Greater variations are allowable in the former due to the use of more tuned circuits and the sacrifice of gain per stage is very slight. In most cases it is desirable to use the close winding in receivers using three or more tuned circuits if cost is the most important consideration. Probably this problem will become more acute when the a.c. screen-grid tube is more generally used, since selectivity will be an important item with fewer tuned circuits.

At present, with the usual low μ tubes, small sized coils 1 to 1½ in. in diameter and 1 to 2 in. in length, wound with No. 34 to 28 gauge enameled wire, are most popular. The losses due to small shielding cans are less with small coils, as can be readily checked experimentally, and so compensate for the lower coil gain in a tuned circuit. This coil efficiency factor can be expressed as $Q = L\omega \div r$ when the values of r, the coil resistance, and L, the coil inductance, are known from measurements. Incidentally, inductance measure-

(Continued on Page 35)

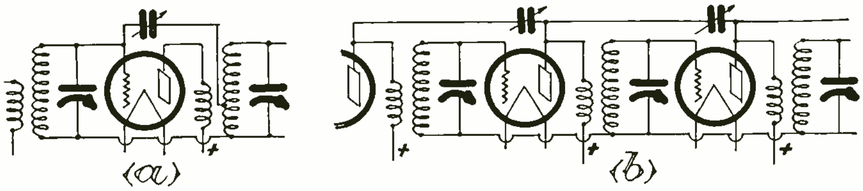


Fig. 2. Economical Neutralizing Methods

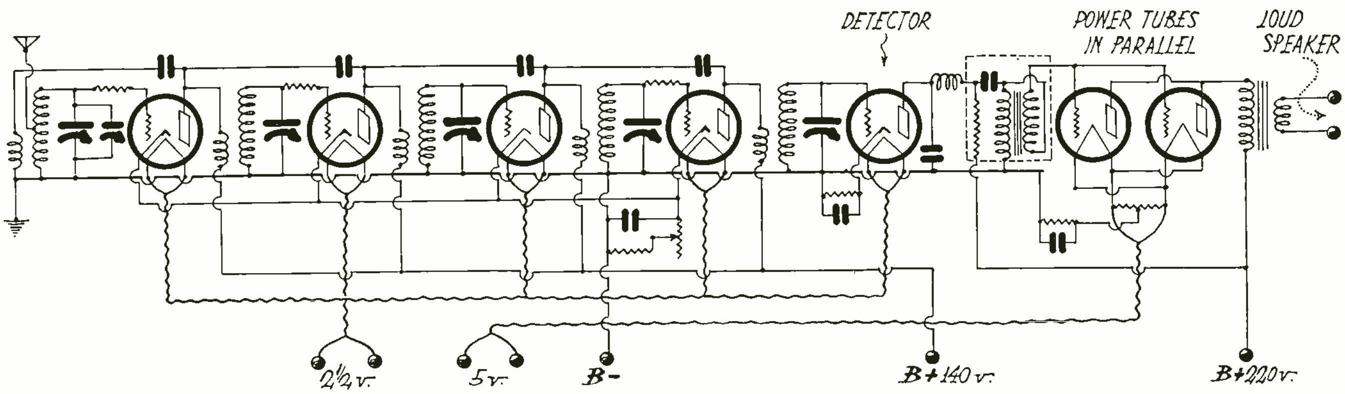


Fig. 3. Circuit Diagram of Four R.F., Power Detector, and One A.F. Stage Receiver

Radio Picture Transmission and Reception

Photoelectric Equipment and Methods for Visual Communication

By JOHN P. ARNOLD, *Departmental Editor*

A FACSIMILE PICTURE TRANSMISSION SYSTEM

A NEW type of facsimile still-picture transmitter was described by V. Zworykin of the Research Laboratories of the Westinghouse Electric & Mfg. Co. at the January meeting of the Institute of Radio Engineers in New York. This system does not require that an intermediate record, such as a photographic transparency or a gelatine relief, of the original picture be prepared for the purpose of transmission. The original, which may be a writing, drawing, or a photographic print, is merely placed on the sending cylinder and scanned in the usual way.

from each elemental area of the picture is directed by a parabolic reflector and mirror on the light-sensitive cathode of a magnesium-caesium, argon-filled photo-cell (Fig. 1).

As the photo-cell produces a current of the order of 1/20 of a microampere for the white portions of the picture, the signals require considerable amplification before they can be sent over the communication channel. For this purpose a three-stage amplifier of the resistance coupled type, using screen-grid tubes, was employed (Fig. 2). The voltage output of the third tube was about 40 volts, which is sufficient to operate the modulator of a broadcasting

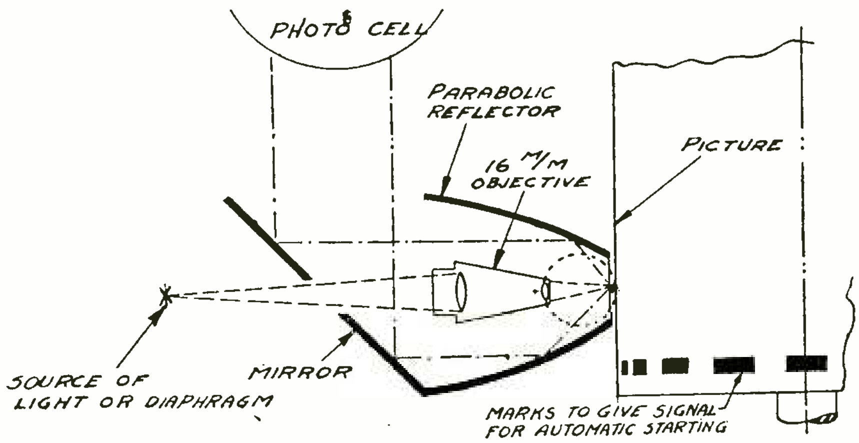


Fig. 1. Optical System of the Picture Machine

Heretofore the objection to this method has been that, as it is necessary to employ the reflected light from the picture rather than the intense illumination which can be secured by directing the light through a photographic transparency, the photoelectric currents thus generated in the output of a light-sensitive cell are very feeble and demand elaborate and efficient amplifiers to transmit the signals to the receiving station.

With the present system, it is said that these difficulties have been eliminated and that this method of transmission is particularly advantageous for commercial phototelegraphy in that the process of photographing the original picture is dispensed with.

The scanning process consists in placing the original picture on the rotating sending cylinder, which is also moved in the direction of its axis, in order that a fixed beam of light may explore every portion of the picture. This beam of light is concentrated on the picture by means of lenses, and the reflected light

station through a line of considerable length.

Mechanically, the receiving apparatus is identical with the transmitter. A standard bromide photographic paper, 5x8 inches in size, is placed on the receiving cylinder and the recording is

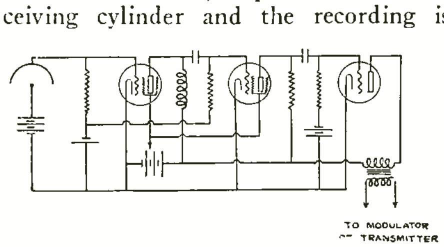


Fig. 2. Photo-Cell Amplifier

effected by means of the light supplied by a grid-glow discharge tube. This is the familiar Knowles grid-glow tube employing helium gas (Fig. 3). It is stated that a discharge of about 15 milliamperes at 400 volts is sufficient to produce satisfactory blackening of the bromide paper.

The ordinary radio set is said to be

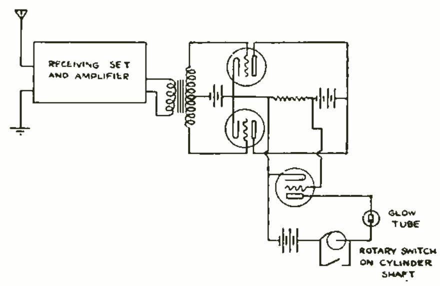


Fig. 3. Glow Tube Control Circuit

suitable for receiving, and transformer-coupled audio amplifiers, if the gain is fairly uniform between 2000 and 4000 cycles, may be used. In the laboratory tests a standard R. C. A. short-wave receiver having a stage of screen-grid r. f. amplification, detector, and two stages of audio was employed.

The received picture may be recorded as either a positive or negative by a simple control which causes a strong picture signal either to increase or decrease the light supplied by the Knowles tube.

The synchronizing of the sending and receiving apparatus is accomplished by the familiar method of periodically correcting a source of frequency at the

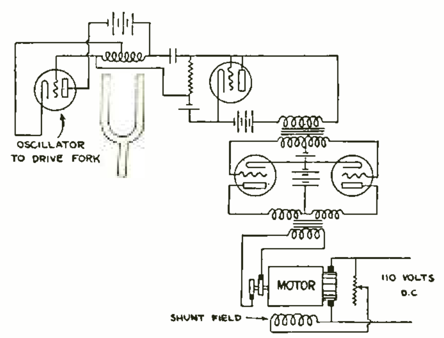


Fig. 4. Synchronizing System

receiving station by impulses from the transmitter, using for this purpose 70-cycle tuning forks to control the motors which drive the cylinders (Fig. 4). After this is effected, an automatic starter for the receiving apparatus is provided. This was described as follows:

"On the front end of the transmitting cylinder a band of black and white spots is engraved. This can be seen in Fig. 1. When the picture is started, this band first comes under the scanning spot. As a result, the corresponding frequency is produced by the transmitter and reproduced by the receiving amplifier. This frequency operates a small tuned relay (Fig. 5), which in turn

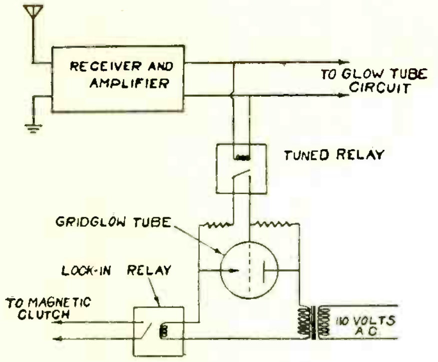


Fig. 5. Automatic Starting Arrangement

starts the grid-glow tube. The current passing through the grid-glow tube operates a lock-in relay which completes the circuit to the magnetic clutch; this starts the receiving cylinder."

Mr. Zworykin also discussed the recently suggested plan of broadcasting throughout the world a standard frequency from a number of stations. He indicated that this plan would provide an effective means of securing synchronizing signals for variously established systems of visual communication, including not only photo-telegraphic transmissions, but also the broadcasting of television images.

SYNCHRONIZATION IN VISUAL COMMUNICATION

(Concluded)

Another method which is a natural development of tuning-fork control is that devised by Harry Nyquist (U. S. Pat. 1,670,375; May 22, 1928). The complete system for both sending and receiving station is shown in Fig. 5. This system was developed for carrier current transmission over wire circuits, and it will be noted that both the picture and the synchronizing signals are transmitted over the same channel. Regarding the synchronization, the same motor, *21*, drives the two generators, *22* and *23*, the former producing a low frequency current for synchronizing and a high frequency carrier which goes to the modulator and upon which the picture signals are impressed. High and low pass filters separate these currents. Following the low frequency signals, in which we are interested, these pass through the filter, *40*, and the amplifier, *42*, and drive the synchronous motor, *51*. The frequency of this current is determined by the generator, *22*, at the sending station, and both cylinders, therefore, are made to turn and move along their axis at identical rates of speed.

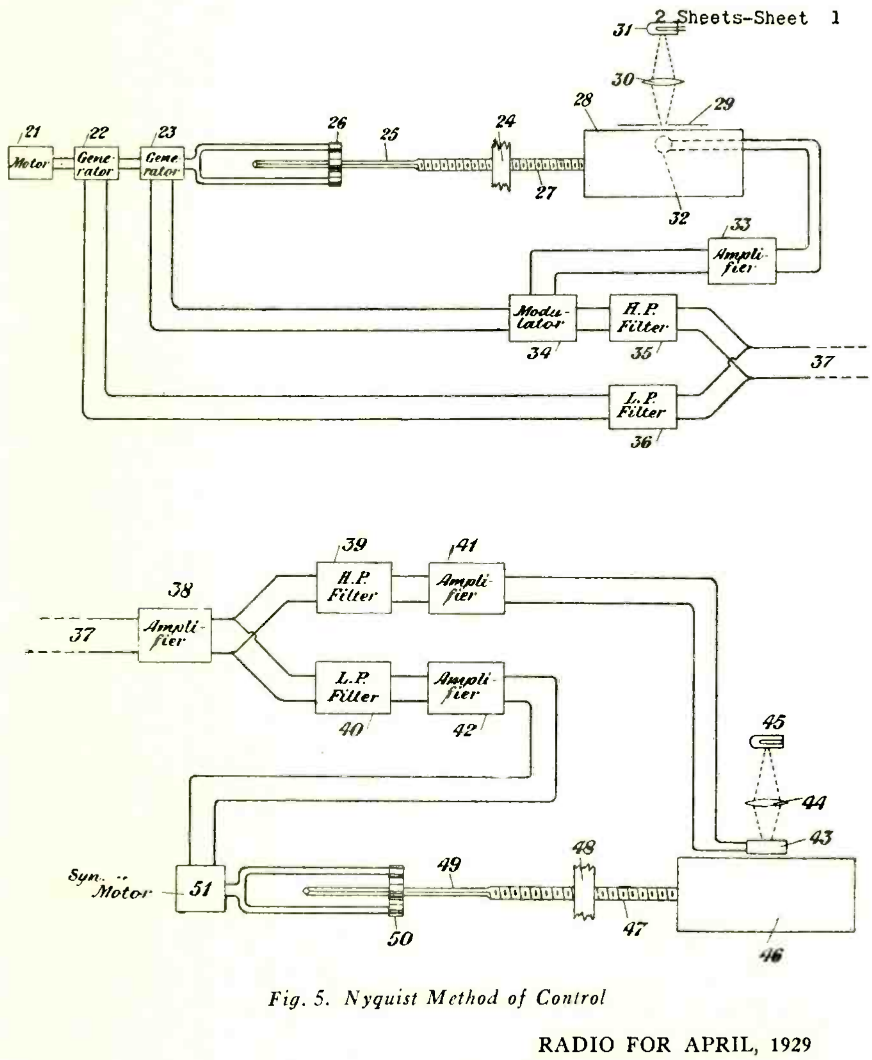


Fig. 5. Nyquist Method of Control

II. Television

The problem of synchronization in television is practically identical with that in phototelegraphy, but the necessity for operating the scanning and reproducing apparatus at high speeds makes synchronism more difficult to attain. Numerous methods have been suggested to accomplish this. Some of these have already been described in this department and need not be repeated here.

The simplest method of controlling a scanning disc of the Nipkow type is to adjust the speed of its driving motor with resistances in series with the power supply. This is an inexpensive means of obtaining approximate synchronism, but is hardly worth while for other than experimental work. A novice (or an expert, for that matter) who tries to keep the images "in frame" by controlling the motor with a rheostat finds himself in a situation comparable with a flyer who takes the "stick" of an airplane for the first time. With such a rough adjustment, the tendency is to overcontrol. This tends to displace the images on the receiving screen to the right or left of the receiving screen, and holding the picture in the center of the frame for any length of time becomes quite a feat. Such a method then is too crude to be considered satisfactory where practical work is concerned.

A method suggested by C. F. Jenkins of Washington, D. C., employs a friction drive. The scanning disc at the receiving station is not mounted on the motor shaft as is usually the case, but is simply placed on a shaft on which it is free to turn. A 1/20 h.p. motor has a 3-in. rubber disc mounted on its shaft, and the pressure of the edge of this disc against the scanning disc rotates the disc. The motor is mounted on a table or bench which can be moved back and forth in order to change the driving point between the two discs. This movement in a straight line toward and away from the center of the scanning disc naturally varies its speed of rotation, although the motor itself is allowed to run at its natural speed, whatever that may be. Some suitable mechanical arrangement (rack and pinion, etc.), should be devised so that the motor bench can easily be moved back and forth. The chief difficulty will be to always maintain a firm pressure between the two discs when the point of drive is changed. However, this sort of control will be made much more satisfactory than a resistance in series with the motor.

The method employed in the Bell Laboratories television demonstration is described in the quotation which follows. It will be noted that this is quite similar to the phototelegraphic synchronizing method shown in Fig. 5.

"At the receiving station the scanning disc or the rotating brush, as the case may be, must be driven exactly in step with the scanning disc of the sending apparatus. At each station a direct-current motor does the main work of driving the scanning apparatus. Mounted on the same shaft with this motor, and thus in a position either to help or to hinder its action, there are two other machines. At one station (e. g., the receiving station) these two machines act as generators of alternating currents. At the other station (e. g., the sending station) the two machines act as motors. The currents from the two generators are transmitted to the two motors.

"The motors are of the 'synchronous' type, and each tends to keep in step with the generator from which it receives current. The generators, in other words, are 'master control-circuits' for the motors. Connecting the generators with the motors insures synchronism, therefore; because if the d-c motor at the sending station is driving its shaft slower than the shaft at the receiving station, the synchronous motors assist and accelerate it. Similarly if the shaft should be running faster than synchronously the synchronous motors would act against its rotation and retard it into synchronism.

"Two different frequencies are generated and synchronous motors corresponding to these two frequencies are used. One motor, the larger one, operates at the frequency with which complete images of the scene can be formed (e. g., eighteen). To prevent it from 'hunting,' that is, from small variations in speed alternately above and then below that corresponding to eighteen cycles per second, the second and smaller motor assists the control. This synchronous motor, operating at 2000 cycles, in the range of telephonic rather than power frequencies, insures that the rotating mechanisms at the two stations shall not be out of step with each other by more than the amount represented by half of one of the small holes in the scanning disc.

"The currents, from the two generators to their respective motors, being of markedly different frequencies, may be transmitted over a common circuit without confusion. This circuit is in addition to that required for the transmission of the current from the photoelectric cell and, of course, in addition to the third circuit which would be required for talking currents when, as would in general be the case, telephone sets were provided at the two stations so that telephonic communication was accompanied by television."

The foregoing methods of synchronism are those used in television systems employing the Nipkow scanning disc or similar apparatus. The employment of oscillating mirrors for scanning requires other methods for obtaining synchronism. It is worth while, then, to describe a typical system of this sort. Henry C. Egerton (U. S. Pat. 1,605,930; Nov. 9, 1926) is the inventor of the system shown in Fig. 6. Two mirrors, *2* and *3*, at the sending and receiving stations respectively, are so mounted that they are free to vibrate about two axes at right angles to each other. The oscillation of the mirrors, so that they scan the subject and reproduce the images in some regular manner, is imparted by electromagnets energized by electron tube drivers. The sources O_1 and O_2 of alternating current may also be of the electron tube type and produce currents of different frequencies. Each of the filters, F_1 and F_2, at both stations, selects a particular synchronizing current from the line and applies it to one of the electromagnetic drivers through an amplifier, *A*. Various phase shifting and equalizing devices are necessary, but these need not be described.

It will be clear that, with the apparatus as described, the sources, O_1 and O_2, will supply two different frequency currents to the line, *13*, and that the analyzing and picture-forming mirrors will each oscillate at a constant amplitude on one axis at the frequency of one of the currents and at a constant amplitude about another axis at the frequency of the other current. As this occurs in an identical manner at both stations, synchronism of the two processes can be maintained and the subject as it is scanned will be reproduced on a receiving screen.

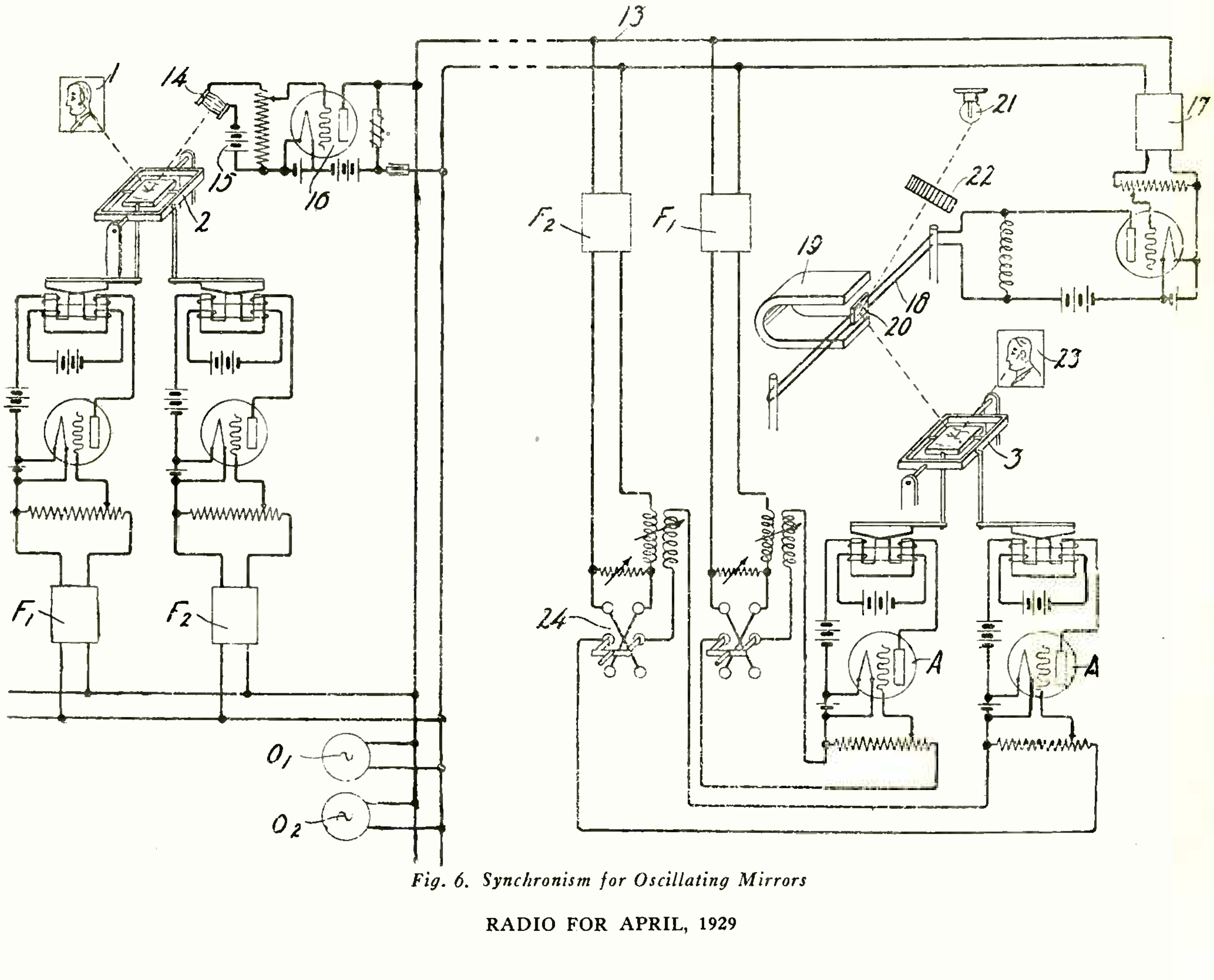


Fig. 6. Synchronism for Oscillating Mirrors

WHAT MEANS VISUAL COMMUNICATION

A system of terminology for visual communication is sadly wanting. Although we have not decided to do anything definite about it, the following definitions, many of them in current use, are submitted for the disapproval of those who have the time to criticize them:

Visual Communication.—The interchange of information or messages in a visual form by means of electric currents. (See *photo-telegraphy, television,* etc.)

Subject.—The information which is to be incorporated in a visual message, a likeness or similitude of which is reproduced at the receiving station. The subject may be a natural object or scene, or a drawing, writing, photograph, etc.

Image.—A representation or similitude; a reproduction, transient or permanent, of the subject at the receiving station.

Phototelegraphy.—A form of visual communication dealing with such subjects as writing, drawings, photographs, etc. (A misnomer, although in general use. *Still picture* transmission is a synonym.)

Television.—A form of visual communication dealing with such subjects as natural objects and scenes, which are reproduced with whatever motion is inherent in the subject. (*Color television* includes the factor of color as well as motion. *Motion picture television* refer to subjects which are transmitted from a motion picture film and which are reproduced at the normal rate of projection, i. e., about sixteen images per second.)

Elemental Area.—The smallest unit area of the subject which is intended to be distinguished from adjacent unit areas in the received image.

Photoelectric Cell.—An electron-discharge device, light-controlled and light-operated, used to convert the relative brightness of the elemental area of the subject into varying electric currents. (Synonyms: *photo-cell, light-sensitive cell.*)

Glow-discharge Lamp.—A gas-filled electron-discharge device, its light intensity varying with the electric currents from the transmitter employed to reproduce the elemental areas of the subject at the receiving station when used in conjunction with a scanning device.

Scanning.—The process of analysis or breaking up the subject into its elemental areas at the sending station and the process of synthesis or reconstructing the image at the receiving station.

Scanning Speed.—The rate at which scanning mechanisms operate.

Message-frequency Range.—The range of frequency components of the image signal wave which are generated in the output of the photoelectric cell.

Image-repetition Frequency.—The number of complete images transmitted per second in television.

Isochronism.—Scanning mechanisms moving, vibrating or rotating in equal intervals of time.

Synchronism. — Maintenance of two or more mechanisms not only at the same speed, but also in step, phase, etc.

SOME CHARACTERISTICS AND USES OF NEON LAMPS

The purposes for which gas-filled glow-discharge tubes are used is constantly increasing. They have already become more or less familiar to the man in the street since they have been employed as night lamps, advertising signs, airplane beacons, and for testing ignition systems of gasoline engines. Radio fans know them as rectifiers, voltage regulator tubes, resonance indicators in wavemeters, and as a source of illumination in television receivers. But this is only a partial list. They are also useful as sensitive voltmeters, for sound recording, and many other industrial and scientific applications.

In a paper by Herbert J. Reich in the *Journal* of the Optical Society of America (Vol. 17, pp. 271-288; Oct. 1928), some interesting characteristics of these tubes are reported. Herein is also a discussion of a photoelectric effect which has been observed in these tubes, occurring only in a lesser degree than that found in cells which are especially designed for the purpose of utilizing the effect.

Before undertaking to present some of the facts drawn from this paper, it might be well to review our knowledge of the construction and operation of such devices. In the first place, they are often called neon lamps, as they are usually filled with neon, although other gases—helium, krypton, xenon, for example—might just as well be used and would be quite as satisfactory from the standpoint of operation. The glow-discharge device itself is a diode or two-element tube, containing an inert gas at pressures ranging from about 1 to 5 millimeters of mercury. The two electrodes may vary in size, shape, separation and location, depending on the purpose for which they were constructed. Neon, helium and argon are the gases generally employed, and each has a characteristic glow-discharge. The salmon-pink glow of the neon lamp is probably the most familiar.

Either a. c. or d. c. potentials may be applied across the electrodes, but considering here a d. c. source, as the voltage is gradually increased, at a certain critical value—called the *sparking* or *striking* potential—the gas will become ionized and a glow-discharge occurs in the tube. When the tube is properly constructed, this glow will appear to originate from one of the electrodes. An increase of the applied potential above the sparking potential will result in a proportionate increase in the current between the electrodes as well as in the brightness of the glow discharge. On this account the tubes may be used for the reconstruction of television images. This current, however, will continue to increase to a point where the tube will be ruined. For this reason the current is limited by using a high resistance in series with the tube, to prevent this occurrence when the applied voltage becomes too great. It is also a fact that when the applied voltage is reduced, the discharge does not now cease at the sparking potential, but not until it reaches a still lower value, known as the *extinction* potential.

The exact values of these two potentials depend not only on the physical structure of the tube, but also on the nature and pressure of the gas. Hence a number of glow-discharge tubes would show a much larger departure from average characteristics than, for instance, an equal number of standardized radio tubes like the UX-201A. This is true of photoelectric cells where it is also difficult to obtain cells with like characteristics. In oscillating circuits, the critical values in glow-discharge tubes will, moreover, vary with frequency.

The oscillator circuit which was used for studying the photoelectric effect in glow-tubes, but which is also useful for other interesting studies and experiments, is shown in Fig. 1. The glow

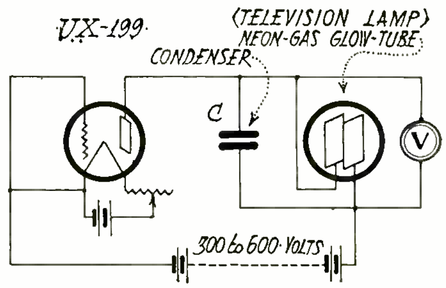


Fig. 1. Oscillator Circuit for Studying Photoelectric Effect

lamp is made to oscillate (as was described recently in these columns in connection with a neon lamp stroboscope) when a condenser is shunted across the electrodes of the tube and a potential is applied. In this case the frequency of the discharge is controlled either by changing the capacity C or by adjusting the filament current of the UX-199 tube. Thus it is possible to obtain periodical discharges or flashes. For absolutely steady conditions, which are necessary in scientific investigations, about twenty minutes are required, but for other applications this should cause little inconvenience.

Another interesting phenomenon was incidentally noticed by Mr. Reich. "It was found during the course of this work that the sparking potential could be controlled to a considerable extent by the charge induced on the surface of the glass. This charge was varied by means of wire or tinfoil wrapped around the

(Continued on Page 36)

R. F. Coil Resistance Measurements

By Frank C. Jones

Of several methods used to measure the r.f. resistance of an assortment of r.f. transformers of various shapes and sizes, the circuit shown in Fig. 1 proved to be most reliable. It employs a fairly powerful r.f. oscillator, as will be explained later. The actual resistances were obtained by halving the r.f. current through the coil *L* by means of a calibrated variable resistance *R*.

The theory is simple. The series circuit L_1, *C*, *L*, and *R* is tuned to resonance with the r.f. oscillator frequency by means of *C* in order to obtain a fairly large value of current through *L* and to give a zero reactance series circuit. Then an increase of resistance of this circuit will affect the current directly, since it is already only limited by the resistance of the whole circuit.

Coupling a few turns to the unknown coil *L* and connecting a vacuum tube voltmeter across this coil is a very satisfactory method of reading the current flowing through *L*. The voltage and current are directly proportional to each other, since the impedance of the coil is constant for a given frequency. This means that halving the current through *L* by increasing *R*, will halve the current induced in L_2 and the voltage across L_2 as read by the vacuum tube voltmeter. This voltmeter may be made from a '99 tube, a 0-200 range microammeter, and a few small batteries and resistors. A small bucking battery of 4½ volts was used to cancel out the plate current flowing through the microammeter.

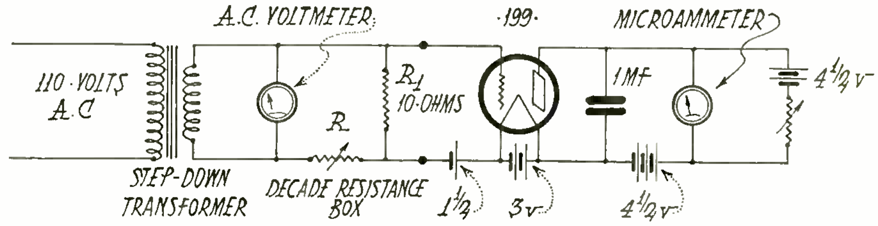


Fig. 2. Calibrating Circuit for V. T. Voltmeter

Such a vacuum tube voltmeter is very handy for reading low ranges of r.f. voltages. It may be calibrated from 60-cycle a.c. voltage, as shown in Fig. 2, by using some known resistor R_1 of say 10 ohms and the calibrated resistance box *R* which is to be used in the coil measurements. A General Radio Decade resistance box having tenths, units and tens of ohms is very satisfactory for use as *R*. A step-down transformer such as a bell transformer is a good source of low voltage and an a.c. voltmeter of 0-3 or higher range may be used as a standard. The ratio between R_1 and the sum of R_1 and *R* gives the portion of voltage impressed across the vacuum tube voltmeter. By this means the latter may be calibrated down to small fractions of a volt easily and rapidly. Incidentally, such a voltmeter should be frequently recalibrated, as aging of the tube and batteries affect its calibration.

In running curves of coil resistance over the broadcast band of frequencies, the r.f. oscillator is adjusted to different known frequencies. The condenser *C*, Fig. 1, is then adjusted for maximum reading of the vacuum tube voltmeter and this reading then adjusted by means of the attenuator R_1 to some fixed point on the scale of the microammeter. Then *R* is increased from zero up to such a

(Continued on Page 37)

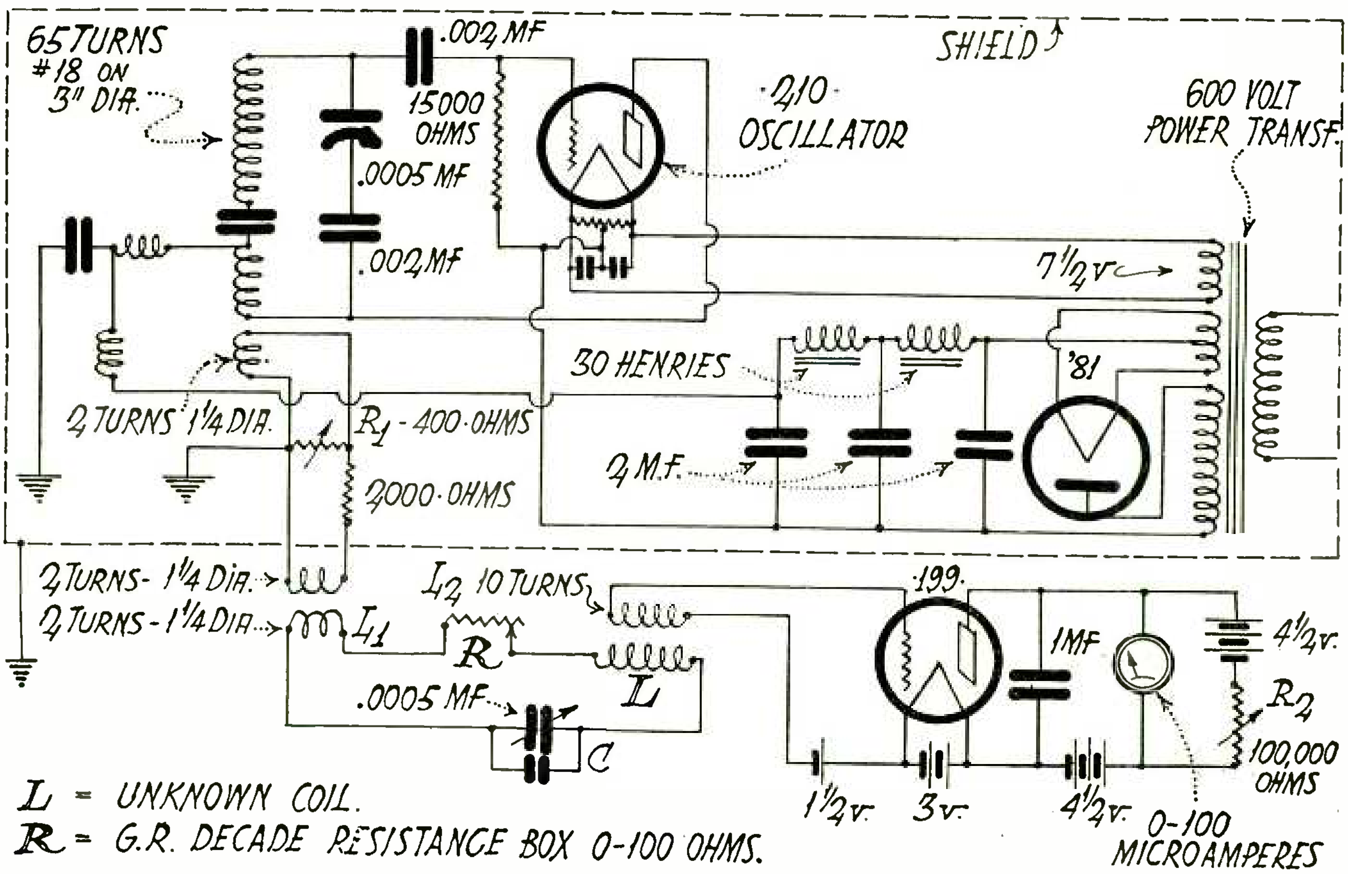


Fig. 1. Coil Measuring Circuit

Mind Reading by Radio

By Max P. Gilliland

Any radio amateur can stage a mystifying and amusing act for a school, club, or church program by employing a midget radio receiver and transmitter to aid in answering questions asked by the audience. The act must be presented in costume in order to conceal the receiver and headphone.

The author has successfully used a short-wave tuned-plate tuned-grid transmitter for this purpose, together with a two-tube regenerative receiver housed in a cigar box. A transmitter circuit diagram is not shown, as each amateur has his own ideas in this respect, and many good ones have been published in Radio in the past. The tuned-plate tuned-grid circuit is stable, and with two 7½-watt tubes, one as oscillator and the other as modulator, requires no speech amplification, the microphone feeding directly into the grid of the modulator through a transformer. The Heising system of modulation was used. Plate supply at 660 volts was obtained from an eliminator using 125 m.a. tubes. A single wire antenna and counterpoise were found to suffice.

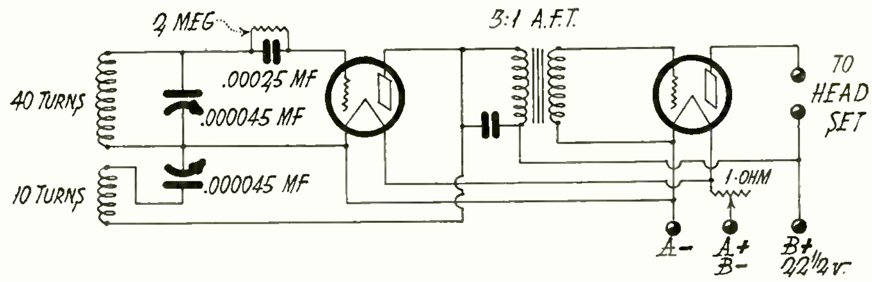
The receiver must be as small as possible. The one described was concealed within a cushion upon which rested a crystal ball. It used a regenerative detector and one stage of audio amplification. Western Electric type 215A tubes were used, as they were the smallest available. The wave-length was 80 meters. A longer wave would have been impracticable, first, because interference would have resulted in the broadcast band, and secondly, because the coils and condensers would have been of a size that could not be easily concealed. Using inductances with a 3/4-inch diameter, midget tuning units, peanut tubes, and a smaller transformer, it was possible to build the entire outfit, including batteries, into a cigar box.

Two small but strong wires lead from one corner of the cushion, which should be held close to the body, under the costume and up to the telephone receiver concealed beneath the operator's turban. No antenna was used, the coils themselves picking up all the energy, as the set is never very far from the transmitter. A diagram of the circuit and assembly appears on this page.

The third essential to the successful presentation of an act of this kind is the monitor system. This should be located at some advantageous point that commands a full view of the stage. It should also afford an opportunity to watch the operator when the latter is in the audience. The back drop should be in two sections that may be parted a trifle at some point, or else a fair-sized peephole provided. It is absolutely impossible to conduct the act without a prompter. The operator does not always understand the questions broadcast and frequently must resort to some kind of distress signal. It is the duty of the prompter to watch the progress of the act at all times and make such requests for repeats and offer suggestions when necessary.

There are two forms of apparatus that may be used here. One is an ordinary telephone circuit. This necessitates the use of head-phones. The other uses an ordinary microphone coupled to a loudspeaker through the amplifier. This is much better as it permits both the person operating the transmitting set and the "magician," who broadcasts the answers to the questions, to hear the prompter's reports. Such an arrangement is invaluable when someone in the audience springs an unexpected question on the "psychic."

The actual procedure, once the equipment is in operation, is ridiculously simple.



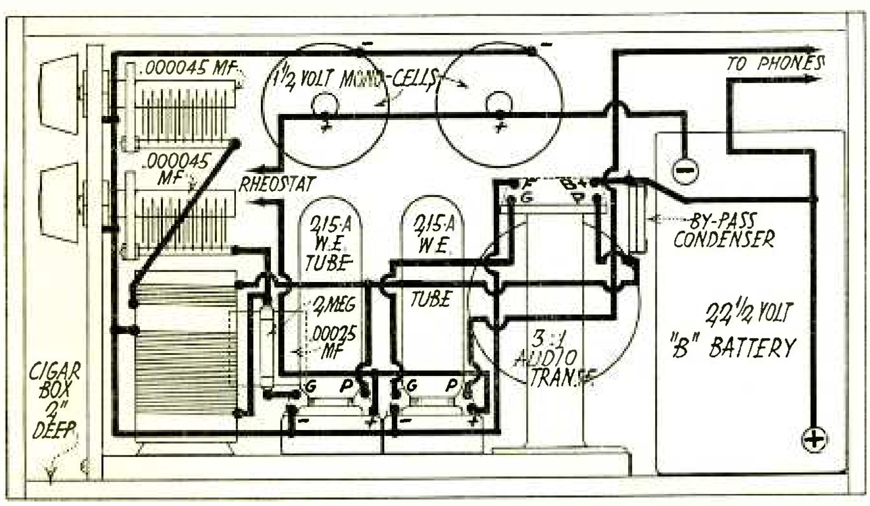
Receiver Circuit Diagram

Colored slips are distributed throughout the audience, the assistants being careful that certain colors are given out in certain sections; e. g., red—upper balcony, right, etc. While this part of the act is going on the "magician" may be conducting the usual run of legerdemain. This enables the audience to write their questions and the assistants to collect them. The tricks also serve as something to hold the attention as the slips are being substituted for blanks as each attendant reaches the stage. These are emptied into a large glass bowl, well in the center and away from everything.

In one case the performer, in order to make the act more mystifying, had a young girl assistant conduct the seance while he was absent from the platform. What really happened was that he repaired to the broadcasting room, where the real questions had been taken and read the answers himself. Indeed it did seem terribly simple when a young girl could step in without notice and make all the replies correctly.

It has been found that a second reading of the question is necessary to insure a good understanding unless the same pair have been working together long enough that they have become thoroughly familiar with each other's voices. Following the question, the answer and such advice as the operator may need is given twice. Then a pause for a report

(Continued on Page 38)



Arrangement of Parts in Receiver

The Band Pass Filter

An Analysis of the Tuned Plate-Tuned Grid Circuit as an R.F. Amplifier With the Screen-Grid Tube

By GLENN BROWNING

BESIDES the two methods of obtaining r.f. amplification with screen-grid tubes, as discussed by the writer in March 1929 RADIO, some consideration should be given to the tuned plate-tuned grid circuit. It will be recalled that the other two methods were the tuned impedance and the tuned r.f. transformer having a high coefficient of coupling; and, furthermore, that the comparative amplification is 3 to 2 in favor of the tuned impedance, while the comparative selectivity is 3 to 2 in favor of the transformer. For the same amplification, the tuned impedance could probably tune as sharply as the transformer so that the choice resolves itself into determining which is the most stable and most economical to build.

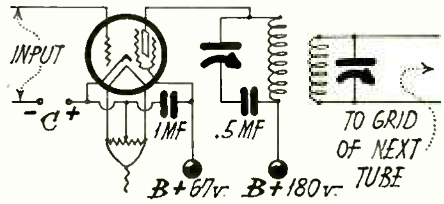


Fig. 1. Screen-Grid Tube in Tuned Plate-Tuned Grid Circuit

In the case of the tuned plate-tuned grid circuit shown in Fig. 1, the great amount of amplification obtained by tuning the plate of the screen-grid tube can apparently be passed on to the grid of the next tube by another tuning circuit coupled to the plate, thus also apparently giving greater selectivity and, furthermore, giving a double peak with a flat top and steep sides, as in a band-pass filter. But the only difficulty is that the system does not act in quite this way!

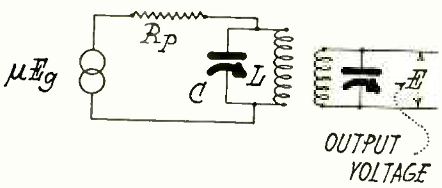


Fig. 2. Equivalent A. C. Circuit of Fig. 1

Fig. 2 shows the equivalent circuit of an amplifier tube working into a tuned impedance system where μE_g is the voltage in the plate due to an incoming signal. R_p is the plate resistance, L the inductance in henries of the tuning coil, R the inherent resistance in the tuning coil and condenser, C is the capacity of the condenser, f is the frequency of the incoming signal in cycles per second, and ω is $2\pi f$. It is evident that we can replace the voltage built up in the plate circuit of the tube by another voltage in series with the coil condenser system, as shown in Fig. 3, and if this voltage has

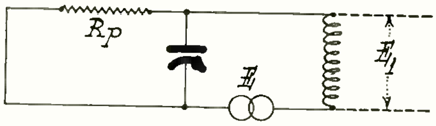


Fig. 3. Tuned Impedance

a certain relation to μE_g, the two electrical systems are identical in every way. The reason for making this change in the position of the input signal is that it simplifies the mathematics.

It is now proposed to show that the tuned grid-tuned plate possesses no advantage over the tuned impedance or transformer systems; that is, the amplification of the former is roughly only fifty per cent of the tuned impedance and the selectivity is no greater. In fact, the band pass effect which it does give is not constant over the broadcast spectrum and the adjustment of the coupling between coils is so critical that even with laboratory apparatus it takes some little time to make the correct adjustment. Even when this adjustment is made, say for

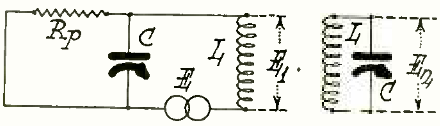


Fig. 4. Tuned Impedance with Coupled Circuit

200 meters, it is not correct for 550 meters.

Fig. 4 shows another tuned circuit coupled to the tuned impedance shown in Fig. 3. The output voltage of the two are represented by E_1 and E_2:

$$E_1 = \frac{EL\omega}{R + \frac{\omega^2 L^2}{R_p}} \qquad (1)$$

$$E_2 = \frac{EL\omega}{2\sqrt{R\left\{R + \frac{L^2\omega^2}{R_p}\right\}}} \qquad (2)$$

The actual amplifications given by the two circuits separately with a screen-grid tube are shown in Fig. 5A. E_1 represents the voltage due to the tuned impedance, and E_2 is the voltage given by the tuned plate-grid system. If the two coils and two condensers are identical in Fig. 4, the ratio of the voltages across the two systems are:

$$E_2/E_1 = 1/2\sqrt{\frac{R + \frac{\omega^2 L^2}{R_p}}{R}} \qquad (3)$$

It should be noted that the input signal was held constant.

It remains to calculate this ratio for the different frequencies in the broadcast band. The plate resistance of the CeCo screen-grid tube was 400,000 ohms. The coils used for checking the

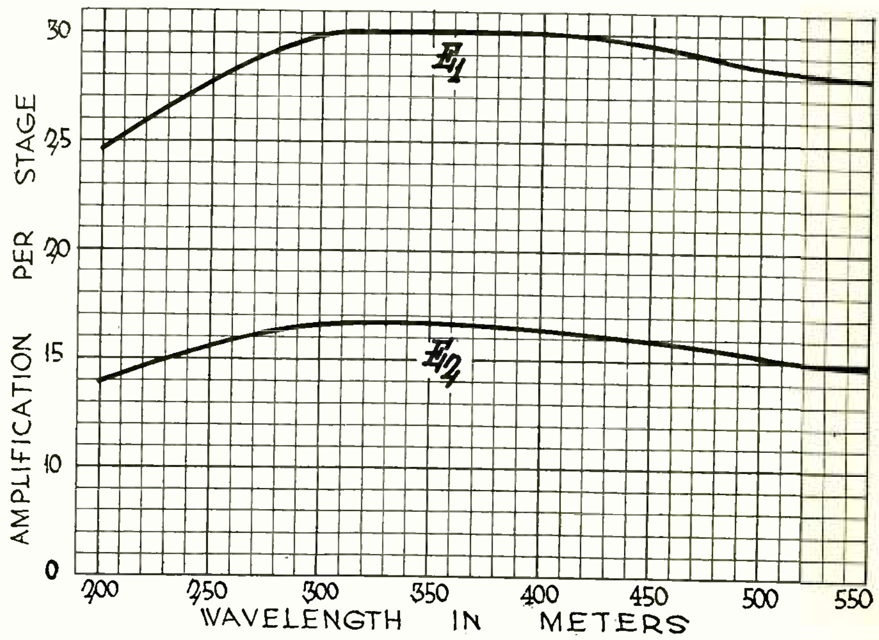


Fig. 5-A. Voltage Amplifications with a Screen-Grid Tube

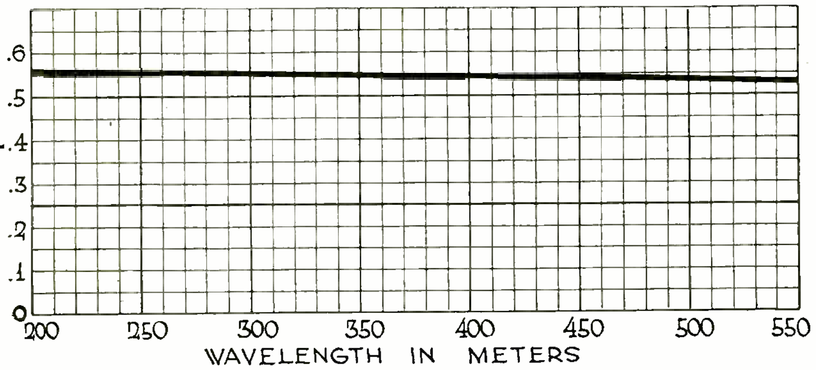


Fig. 5. Ratio of Voltage Amplifications

theory had an inductance of .20 mh. with an r.f. resistance varying from 22 to 9.2 ohms. These values were used in calculating the above ratio. Fig. 5 gives the result, where E_2/E_1 is plotted against wavelength. It is now obvious that the second tuned circuit cuts down the amplification of the tuned impedance system to almost half. This result was checked by laboratory measurements and the two curves obtained were almost the same. In fact, the laboratory work was done first and the writer was surprised to see how little amplification could be obtained by the tuned plate-tuned grid method and this led to a careful examination of the theory involved.

Before examining the selectivity of the two circuits, let us digress slightly to gain an idea of what takes place in the coupled circuit arrangement in Fig. 4. The coupling is said to be deficient, critical, or sufficient accordingly as $M^2\omega^2$ is respectively less than, equal to, or greater than $R^2+(RL^2\omega^2)\div R_p$. If the coupling between the coils is so small as to be less than a certain minimum value, the voltage developed across the second coil will be less than the maximum and the resonance curve of the circuit will be as indicated by Curve 1, Fig. 6. If the coupling is increased to critical, the voltage across the second coil will have a certain maximum value and the resonance curve will be as shown in

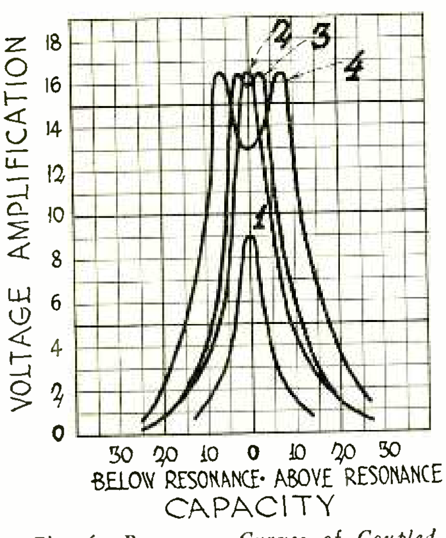


Fig. 6. Resonance Curves of Coupled Circuits; Capacity versus Voltage

Curve 2. Any further increase in coupling does not increase the voltage across the coil, but gives rise to two peaks, as shown by Curves 3 and 4. This shows that the circuits are most selective when the coupling is less than critical, but in the latter case the amplification also decreases.

The selectivity of the circuit shown in Fig. 3 depends upon $R+(L^2\omega^2)\div R_p$; i.e., the smaller the value of this factor, the sharper the tuning. In the case of Fig. 4, the sharpness of tuning of either circuit at critical coupling is dependent on $2R+(2L^2\omega^2)\div R_p$. This is just double the value for a single circuit. As there are two tuning circuits, each with half the selectivity of a single tuning system, the two will tune just as sharp as the one and no sharper.

From the foregoing discussion it would seem much better to use a multiple stage radio frequency amplifier and obtain the band pass effect by somewhat staggering the stages, rather than to try to get a band pass effect by means of coupled circuits.

The writer has endeavored to prove that the tuned plate-tuned grid circuit is not the logical solution of a band pass filter. The circuit looks at first as if it had all the advantages one could ask for, but, upon careful examination, had the following disadvantages: First, only about half as much amplification can be obtained with the screen-grid tube as would be obtained with a tuned impedance. Second, when the coupling is enough to get a band pass effect, the selectivity is no better than the tuned impedance. Third, the coupling necessary for the band pass effect is not constant from one end of the broadcast band to the other. Fourth, the coupling to obtain the band pass is quite critical, in fact too much so for commercial purposes.

The writer has based all the screened-grid tube measurements on the CeCo A.C. 22 which, to his knowledge, was the first a.c. screen-grid tube to be brought out. However, as this goes to the magazine, a check has been made with an R.C.A. a.c. 222, and the characteristics of the two were found to be practically identical.

RESISTANCE AND CAPACITY MULTIPLIERS FOR A.C. VOLTMETERS

By C. W. GUYATT

WHILE a meter capable of measuring a.c. voltages from 50 to 1000 volts is often too expensive for the experimenter, he can use a 15-volt meter for this purpose by providing proper multipliers. These multipliers may be either fixed resistances or condensers, connected as shown in Figs. 1 and 2.

With a resistance multiplier the value

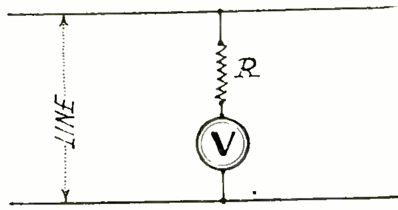


Fig. 1. Meter With Resistance Multiplier

of the unit is determined from the formula $R=R_v\ (m-1)$, where R_v is the resistance of the voltmeter, m the multiplying factor, and R the resistance of the unit which is to be connected in series with the meter. One much-used type of a 0-15 a.c. voltmeter has a resistance of 150 ohms. If this is to be used to

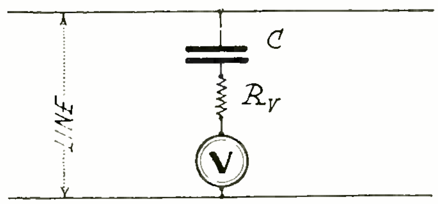


Fig. 2. Meter With Capacity Multiplier

measure 150 volts, m is 10. Consequently $R=150\ (10-1)=1350$ ohms.

As resistance units are not always available at such an odd value, it may be necessary to use a standard unit, say 1200 ohms, and a different multiplying factor. Then $m=(R+R_v)\div R_v=(1200+150)\div 150=9$.

The resistance unit must be capable of radiating the heat which will be developed when large currents are carried at high voltages. As the 15-volt meter cited draws .1 ampere for a full-scale reading, the 6000-ohm unit necessary for a 500-volt reading would develop heat from $RI^2=6000\times(.1)^2=60$ watts. One remedy for avoiding the bulk and expense of such a unit is to use a meter which requires less current. The other is to use a fixed condenser as a multiplier.

A condenser in series with the resistance R_v of the meter constitutes an impedance Z across the line. $Z=\sqrt{R_v^2+X_c^2}$ where X_c is the reactance of the condenser and is equal to $1{,}000{,}000\div(2\times3.14\times f\times C)$, where f is the frequency of the voltage to be measured (usually 60 cycles) and C is the mfd.

(Continued on Page 39)

Constant Regeneration Short-Wave Receiver

A Simple One-Tube Set or Adapter Which Can Readily Be Built for Reception of Code, Music or Pictures

By R. Wm. Tanner

The "thrill" of long-distance short-wave reception, whether of code, music or pictures, can be simply and inexpensively achieved by employing the receiver whose construction is here described. While no claim is made that it will do as fine work as a more elaborate multi-tube set, this receiver at Springfield, Ohio, during less than a week's operation, gave daytime reception of amateurs from both coasts, Hawaii, Alaska, Cuba, Porto Rico and England, as well as many broadcasters and commercial stations.

It is designed to have constant regeneration, regardless of the tuning condenser setting. It is selective and sensitive, of low cost, compact and light in weight, and easy to construct and operate. By means of five plug-in coils it may be tuned to the 10, 20, 40, 80 and 160 meter bands. It may be used either for head-phone reception or as an adaptor with an existing audio amplifier.

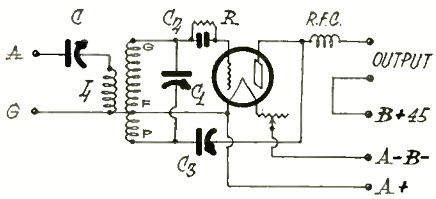


Fig. 1. Circuit Diagram of Short-Wave Receiver Having Constant Regeneration

C—Antenna condenser, .000025 mfd.
C_1—Secondary condenser, .000075 mfd.
C_2—Grid condenser, .00015 mfd.
C_3—Regenerative condenser, .000025 mfd.
L—Plug-in coil (See text).
R—8 megohm grid leak.
R_1—Amperite for '01-A or '99 tube.
RFC—Radio frequency choke, (See text).

The circuit, as shown in Fig. 1, is of the familiar Hartley type, excepting that the plate condenser C_3 is of smaller capacity than usual. By tapping the inductance L at its exact electrical center and increasing the capacity of C_3 to give a point just below oscillation, the regeneration may be held constant regardless of the setting of C_3. This is the principle of the Rice neutralizing circuit.

The point just below oscillation is the most sensitive adjustment for the reception of speech, music or ICW signals. CW signals are received by setting C_3 at a slightly higher capacity, dependent upon the wavelength until the tube spills over into oscillation.

Lightness in weight and compactness in size are accomplished by using midget condensers and "tube base" plug-in coils.

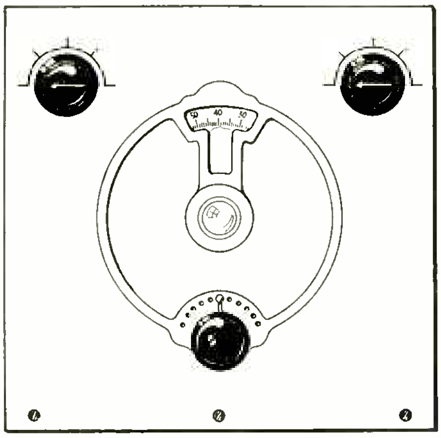


Fig. 2. Front Panel View

Fig. 2 shows a front panel view. The dial in the center is for the secondary tuning, the left-hand scale regulates the degree of antenna coupling or selectivity, and the right-hand one controls the regeneration or sensitivity. One control was eliminated by employing a fixed filament resistance instead of the usual rheostat.

The scales may be put on by the builder or by a regular engraver. It is not a hard job to do. The only tools required are a pair of carpenter's steel dividers and a steel rule. It is first necessary to locate the centers for the condenser shafts with a center punch. Then set the dividers for a radius of ⅞ in. and scratch in the semi-circle. The short lines are ¼ in. long. When completed, the lines are filled in with a paste made of white lead and linseed oil. The knobs which come with the midget condensers are fitted with an engraved pointer.

Fig. 3 shows a side view, giving an idea of the manner in which the condensers are mounted. The front panel

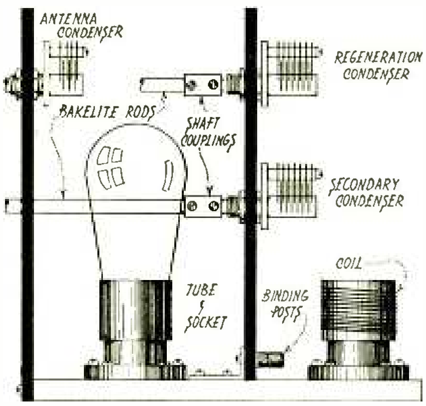


Fig. 3. Side View

is 7 in. square by ⅛ in. thick. It is fastened to the baseboard by means of three wood screws. The back panel is 7 in. wide by 6½ in. high and is mounted 3½ in. to the rear. Two small brass angles hold this to the baseboard. These angles are made of 1/16 in. stock ½ in. wide. See Fig. 4a for details.

The method of mounting the secondary tuning and regeneration condensers eliminates troublesome hand capacity effects as, in this circuit, the rotor plates could not be at ground potential. Even with 3½ in. separation between the condensers and the dials, a grounded copper shield was found necessary when tuning to the 10 and 20 meter bands. The shield is cut ½ in. smaller on all sides than the panel. If real thin copper is used it may be glued to the panel, otherwise it may be mounted by means of machine screws in each corner. When

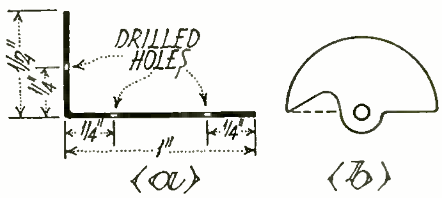


Fig. 4. Details of Brass Angles and Condenser Plate

wiring the set, the shield is connected to the ground binding post.

The shafts of the secondary and regeneration condensers are connected to the dials by ¼ in. bakelite rods. These rods are sold in 8 in. lengths, so that one may be cut in two pieces to the required length, leaving ⅝ in. projecting beyond the front panel on which to mount the dial and knob.

Some sort of a device will be needed to couple the rods to the condenser shafts. These may be bought at the radio store or they may be easily constructed by the builder. The simplest coupling is made of a piece of bakelite or fiber ¾ in. long by ½ in. square. A hole is drilled through the center, slightly smaller than the shaft. Then the bakelite rod is forced in one end and the condenser shaft in the other. A tight fit is absolutely necessary. Two of these couplings are needed. In the event that bakelite or fiber cannot be procured, brass or even hard wood will do.

The antenna coupling condenser is mounted directly on the front panel, as hand capacity effects in this part of the circuit are not bothersome. Before mounting, cut a hole in the copper shield ½ in. larger than the hole drilled for the condenser shaft so as to prevent grounding the rotor plates.

While the usual straight line capacity type of condenser is satisfactory for the selectivity and sensitivity controls, a straight line frequency condenser is better for the secondary tuning, especially in separating the stations at the low end of the scale. If a .000075 mfd. s.l.f. condenser is not available, a s.l.c condenser can be modified by filing the rotor plates to the form shown in Fig. 4b. The plates should be removed from the condenser, clamped together, filed, and reassembled, making sure that the direction of rotation of the plates corresponds with the direction of rotation of the tuning dial.

All of the parts, except the condensers, are mounted on the baseboard as shown in Fig. 5. The tube socket is placed between the front and rear panel, with the grid and plate connecting terminals facing towards the back. The coil socket is placed close to the edge of the baseboard directly to the rear of the tube socket. This makes for the shortest possible grid and plate leads. Where the wiring is brought through the back panel, large holes about ½ in. in diameter are drilled.

The .00015 mfd. grid condenser should have clips for the grid-leak. This is placed close to the grid terminal of the coil socket. The radio-frequency choke, *RFC*, consists of 200 turns of No. 36 enameled wire, slot wound in eight sections of 25 turns each on a ¾ in. diameter wooden form. The slots are cut 1/32 in. deep with a hacksaw. This manner of winding reduces the distributed capacity to a minimum, thereby broadening the useful range of the choke. This should be mounted so that its field does not interact upon the field of the tuning inductance, 3 or 4 in. separation being sufficient.

The seven binding posts are placed directly on the rear panel. Appearance might have been improved by employing a terminal strip and mounting it on the baseboard.

COIL TABLE

WAVE LGTH.	ANTENNA TURNS	SECONDARY TURNS	
10	2	4	No. 20 green S. S. spaced
20	2	8	No. 20 black enameled spaced
40	4	16	No. 16 white S. C. C. spaced
80	5	30	No. 20 grn. S. S. close wound
160	8	50	No. 28 white S. C. close wnd.

All coils tapped in exact center

The coils are wound on burned-out UX tube bases, the winding data of which is given herewith. Different colored wire is used for each coil so as to facilitate selection of the proper coil when making a quick change.

Before soldering the leads to the prongs, plug one of the bases into its socket and note which is the grid, plate, etc., and then solder the bottom lead to the *P* prong, the top one to the *G* prong and one of the *F* prongs to the center tap. The other *F* prong goes to one end of the antenna coil.

The antenna coils are wound about ¾ in. in diameter and placed inside of the bases. If No. 18 or 20 wire is used, the coils may be bent in any position to get a better degree of coupling than is possible with the antenna condenser alone. When putting each inductance into operation, the antenna coil is bent to give good signal strength with fair selectivity. This adjustment is made with the antenna condenser set at half capacity.

All of the wiring is done with No. 14 bare copper wire, more for mechanical strength and appearance than for reduction of high-frequency resistance.

After the set is assembled and wired, a pair of headphones may be connected to the output terminals together with the antenna, ground and battery connections. Plug in each coil separately and set the regeneration at maximum value. Now adjust the position of the antenna coil for fair volume with a good degree of selectivity. If a "hole" develops in the tuning range, i. e., a point where oscillations cease, the capacity of the antenna condenser may be decreased until the tube oscillates over the entire range.

If phone signals are desired set the regeneration control to the point just below oscillation. When CW or code signals are to be received, the regeneration control is set slightly above the oscillation point.

A 199 type tube may be used in place of the 201-A with practically the same results, except a slight decrease in wavelength for each coil. If one is to be used, the 4-ohm filament resistor should be replaced by a 50-ohm unit when a 6-volt battery is the source of supply.

Filing down the plates of the secondary condenser reduces the capacity somewhat, and it is well to add a turn or two more than those specified to each coil and after putting the receiver into operation, take off a turn at a time until the center of the amateur bands falls in about the center of the tuning dial.

Almost any type of antenna can be used, but a single No. 14 enameled wire 60 ft. long and as high as possible is recommended. Sometimes noises, developed by telephone or high voltage electric lines, cause a great amount of interference. These cannot be completely eliminated but they can be reduced by employing a counterpoise in place of the ground connection. This may well consist of 30 to 50 feet of copper magnet wire run under the carpet or around the baseboard. Its use has a tendency to bring in the noises on one or two "humps" on the dial instead of spreading them all over "the lot."

No audio amplifier has been described as some may want to use this set as an adapter to their regular broadcast receiver. Any good two-stage transformer coupled unit may be employed for code or phone reception. If television signals are also to be received, a three-stage resistance coupled amplifier will be required with a power tube, not smaller than a '71, in the last stage.

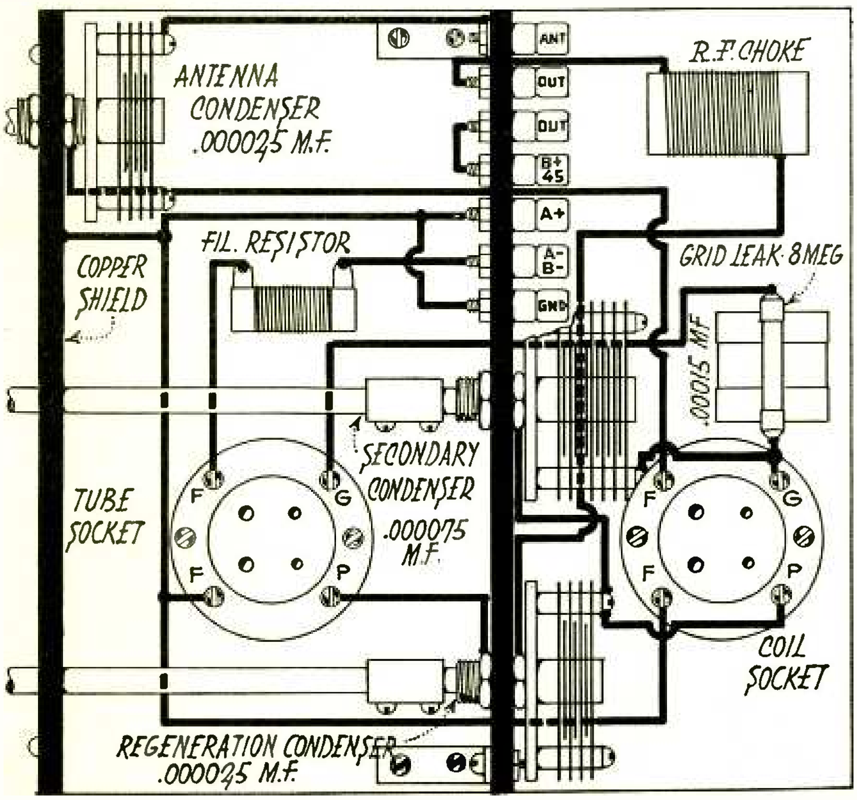


Fig. 5. Parts Layout

TECHNICAL BRIEFS

INVERSION of speech sounds, as used to impart secrecy in radio telephony, consists in transmitting low notes as high notes, and high notes as low notes. This inversion of the frequency scale is accomplished, first by modulating the sound frequencies with a carrier wave, whose frequency is slightly greater than that of the highest speech frequency which is to be transmitted, and secondly by using the lower sideband to modulate the radio station's carrier wave. The original sounds are restored at the receiver by repeating the process which led to their inversion.

PERMINVAR is an iron-cobalt-nickel alloy, whose permeability is nearly double that of iron and is remarkably constant for different flux densities. It also has an extremely small hysteresis loss. It is particularly useful in the manufacture of filter coil cores. It consists essentially of 45 per cent nickel, 25 per cent cobalt and 30 per cent iron, melted together in a silica crucible in a high-frequency induction furnace. Its properties are dependent upon subsequent heating and cooling treatment. A study of its magnetic properties is presented in September, 1928 *Journal of the Franklin Institute* and January, 1929 Bell System *Technical Journal*. While its permeability is considerably less than that of permalloy, its other properties admirably fit it for use in communication circuits.

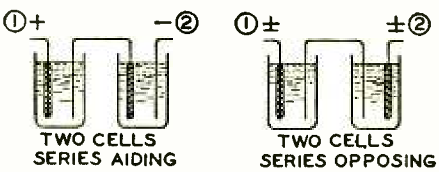
VARIATION from the 135 volts recommended for the plate of the '22 tube has but little effect on its plate current, a range from 90 to 135 volts causing but slight change in the tube's mutual conductance. But any variation from the 45 volts recommended for the screen grid has considerable effect, 22½ volts, for example, reducing it from 1.5 m.a. to 0.6 m.a.

However, any reduction in plate voltage greatly reduces the amplification constant and plate resistance. With 135 volts on the plate the mu is 290 and R_p 850,000 ohms, while with 90 volts the mu is 175 and the R_p 500,000 ohms, assuming a screen-grid voltage of 45, a negative bias of 1.5, and a filament of 3.3 volts.

The CX-322 tube may also be used to advantage as a high-mu tube for resistance-coupled audio-frequency amplification. When used in this manner, the screen-grid voltage may be lowered to values as low as 22.5 volts to compensate for the voltage drop caused by the coupling resistor in the plate circuit. With this connection, a voltage amplification of 35 per stage may be obtained with flat frequency characteristics down to 50 cycles and below (depending on the size of the blocking or coupling condenser) and extending on the high frequency end to well above 10,000 cycles.

THE capacity of an electrolytic condenser made up of film-coated aluminum plates "formed" to 30 volts is about 1000 times greater than that of a paper condenser, being about 1.16 mfd. per sq. in. of area. Cells for use in pulsating-current circuits, rectified a.c., consist of alternate filmed and non-filmed electrodes in an ammonium borax solution, the non-filmed electrode being connected to the positive terminal so as to maintain it at a higher positive potential than the electrolyte. In an a.c. circuit such a cell operates as a rectifier, and may also be so employed.

The A. T. & T. Co. are using such condensers in 1000 mfd. units (at 1000 cycles) to exclude the hum introduced by battery-charging apparatus and signaling equipment. The electrodes are assembled in large heat-resisting glass jars and the electrolyte is covered with a thin layer of paraffine oil to prevent evaporation and sweating, covers also being sealed with paraffine. The filmed electrodes should have about 65 per cent of the total area and the non-filmed electrodes about 35 per cent. The filmed electrodes are of practically pure aluminum (99.5 per cent). The non-filmed should consist of less than 99 per cent aluminum. Great cleanliness is necessary in assembling them, neither being touched with the hands after a film is formed.



Principles of Electrolytic Condensers for Pulsating and for A.C. Circuits

The electrolyte is a mixture of ammonia, boric acid and water, a typical mixture calling for 50 c.c. 28.5 per cent ammonia, and 600 grams of boric acid in 19 liters of water. The filmed electrode is "formed" by suspending it in the electrolyte and impressing upon it the d.c. voltage under which it is to be subsequently operated, 300 volts being the maximum.

The characteristics of this type of condenser are thoroughly discussed in January, 1929 Bell System *Technical Journal*. A suitable condenser for operation on alternating current by having two filmed electrodes in the same solution so as to give the series-opposed arrangement is illustrated herewith. The "series aiding" connection is used for removing the hum from pulsating current and the "series-opposing" connection for storing electrostatic energy in a.c. circuits.

A NEW hot cathode mercury vapor tube, the UX-866, is now available to furnish the plate supply for amateur transmitters. The cathode is a ribbon-coated filament which draws 5 amperes at 2½ volts. The mercury vapor is at low pressure so that a peak of 5000 volts may be passed in one direction and of 15 volts in the other direction, thus giving a high voltage rectification due to the electron emission from the filament.

The tube is rated in terms of its maximum peak inverse voltage, 5000 volts, and the peak current, 0.6 amperes. As the peak inverse voltage in a single phase circuit is 1.4 times the transformer voltage, a 3500-volt transformer is used to work the tube at its highest efficiency. The plate current depends upon the voltage drop in the filter circuit. The recommended circuits use two tubes to give full wave rectification. Various rectifier and filter diagrams showing the tube in circuits supplying from 450 to

3000 volts are printed in the instructions which accompany the tube.

The use of two small quartz crystals whose periods of vibration differ sufficiently to produce an audible beat has been found by August Hund to be as satisfactory as a generator of a constant audio frequency as is a tuning fork. A report of his conclusions appears in the United States Bureau of Standards *Journal of Research* for February, 1929. The circuit consists of two independent piezo-electric generators of frequencies F_1 and F_2. The beat note produced by their combined output is amplified by a screen-grid tube and detected by an '01-A tube to give an output frequency of F_1 and F_2.

The new Radiotron a.c. screen-grid tube has the following characteristics:

Heater voltage	2.5
Heater current	1.75
Plate voltage	180
Plate current	4 m.a.
Screen-grid voltage	75 max.
Screen-grid current	0.3 m.a.
Control-grid voltage	—1.5
Heater bias voltage	—9, depending on circuits.
Amp. factor	420
Plate resistance	400,000 ohms
Mutual conduction	1050
Capacity-grid to plate	.010 mmfd.
Input capacity	5 mmfd.
Output capacity	12 mmfd.
Base	Standard UY
Size bulb	5¼ in. x 1 13/16 in. max. dimen.

The new tube may be used in r.f., a.f. or detector circuits. In the latter the plate coupling resistance should be from 200,000 to 500,000 ohms and the screen-grid voltage from 20 to 45 volts. Transformer coupling in r.f. circuits is recommended in order to prevent oscillation at some audio frequency due to high impedance B supply in a.c. operated sets.

While the sensitivity of a detector using a grid bias is less than that of one using a grid condenser and leak, it is possible to apply a much higher signal voltage to the biased detector tube without overloading it. A '27 tube has maximum sensitivity with a negative bias of 2 or 3 volts, but will show distortion under high signal voltage from the r.f. amplifier unless the bias is increased to at least 6 volts. Any sacrifice in the sensitivity of the detector can be overcome by using '22 tubes in the r.f. stages.

When using circuits in which the output stage is fed direct from the detector, without the use of the usual first audio stage, it is necessary to apply a grid bias of from —18 to —22.5 volts to the grid of the detector, so that a very large r.f. signal can be impressed without causing the grid to draw current. With high values of negative grid bias, the detector is less sensitive than with lower values, the ratio being about three to one, and the variations in tubes are more marked than is the case when lower values of grid bias are employed.

Taking these factors into consideration, it will be found that it is usually preferable to retain the first audio stage, using low ratio transformers to provide improved tone quality.

Voltage regulation of a power unit for a radio receiver depends not only on the regulation of the power transformer but also on the voltage drop in the filter circuit. A unit that wastes considerable current in comparison with the current required for the receiver and amplifier has better regulation than one which does not waste so much current. This factor is of considerable importance in the design of a voltage divider for use with different kinds of receivers.

An electrostatic loudspeaker of the uni-lateral type developed by Colin Kyle is illustrated in Fig. 1. It consists essentially of a curved plate *6*, a dielectric *3* and a film of goldleaf *5*, these constituting the condenser. The heavy

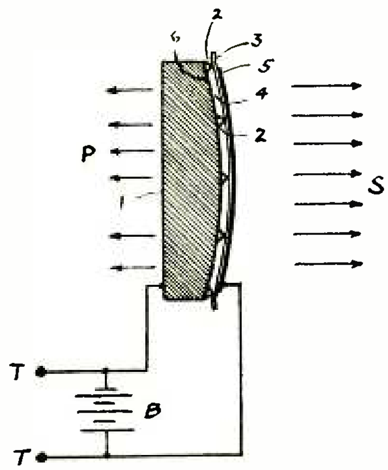


Fig. 1. Diagram of Kyle Electrostatic Speaker

plate *6* is perforated with a series of holes to release the back pressure of air and carries a series of transverse ribs *2* over which the dielectric *3* is tightly stretched. The goldleaf is mounted directly on the dielectric.

A single unit has an area of about 8 by 12 in., and a depth of 1½ in., including the heavy support *1*. From three to six such units are used to make a typical speaker. A baffle board is not used as the sound *S* is transmitted from the diaphragm 3-5 as a plane wave and the back pressure *P* passes through the perforations.

The terminals *T T* are connected to the output of a power tube through a transformer whose input and impedances match those of the tube and speaker, respectively. A polarizing battery *B* maintains a steady voltage between the two condenser members. A choke coil may also be used as a coupler. The speaker is adaptable to any standard radio receiver, the necessary high polarizing voltage being supplied through a transformer and rectifier which is a part of the complete speaker.

This speaker is claimed to be extremely sensitive and to have better low and high frequency characteristics than the dynamic type. Published response curves show a remarkable freedom from "hills and valleys."

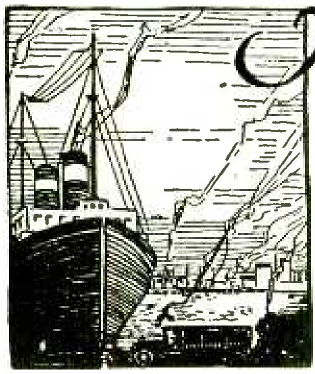
Bakelite can be sawed straight with a hacksaw after clamping the bakelite between two pieces of scrap iron, held in a vise. The edges of the iron bars should lie along the line to be sawed and the saw teeth continually pressed against them. A flat file will remove any slight roughness.

Short-wave equipment is given credit in the annual report of the Radio Corporation of America for the corporation's ability to handle a greatly increased amount of traffic. It "has solved the most difficult problems with which international radio communication has had to contend." But the long-wave, high-power stations are still necessary for continuous and efficient service under some conditions.

The report shows the R. C. A. Communications, Inc., is operating marine coastal stations at Chatham, Mass., Tuckerton, N. J., San Francisco, Calif., Chicago, Ill., Buffalo, N. Y., Portland, Ore., New London, Conn., New York, N. Y., Galveston, Texas, Los Angeles, Calif., Cleveland, Ohio, Duluth, Minn., Port Arthur, Texas, East Moriches, N. Y.

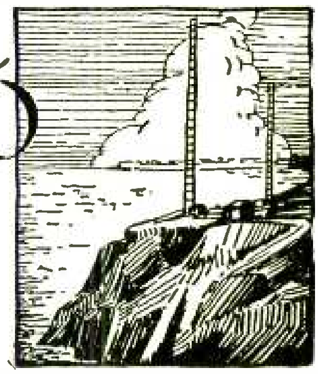
These maintain transatlantic communication with Great Britain, Norway, Sweden, France, Germany, Poland, Italy, Holland, Belgium, Turkey, Portugal and Liberia; transpacific communication with Hawaii, Japan, Philippines, Dutch East Indies, French Indo-China, Hong Kong, and Shanghai (via Philippines), and Australia (via Montreal); and South American communication with Argentina, Brazil, Colombia, Venezuela, Dutch Guiana and West Indies, Porto Rico and Cuba. Service is now handled directly between Tokio and San Francisco.

The marine and aircraft radio services are handled by the Radiomarine Corporation of America, another R. C. A. subsidiary, which has 1360 American vessels under contract.



The COMMERCIAL BRASSPOUNDER

A Department for the Operator at Sea and Ashore



Edited by P. S. Lucas
R. O. Cook, *Assistant*

To the casual observer the man who earns his livelihood by pounding brass at sea is snugly settled down in a blind alley job. He is the only man on the ship who has no chance of promotion. He has reached the top in one short climb and must either sit back with the satisfaction of his attainments or spend his time complaining that the top isn't high enough. The casual observer has gone on to say that brasspounding is for kids and cripples; that an up-and-coming he-man in this day and age is not satisfied with himself unless he is progressing; unless he can look ahead ten or twenty years and visualize himself in a higher, more responsible position in life.

Insofar as the "top" of the operating profession is as humble as it is, the casual observer might be right. Unless it can offer the operator a growing future, brasspounding *is* a blind alley job. But the casual observer's observations are too casual in overlooking the fact that every year finds a large percentage of radio operators who have spent their time wisely at sea and have graduated to a more progressive line of work ashore. The years they spent in the so-called blind alley job prepared them for a brighter future than would the same amount of time spent in a bank or a routine office job. Although his work might be classified as a blind alley job, the operator who can see around the corner sees it as a stepping stone to something higher.

It is often asserted that the transience of the radio operator, the fact that he is here today and gone tomorrow, is one of the chief causes for his unappreciated status. Yet how can we expect a man to sit down and be satisfied with a job that holds no future for him? Rather let us encourage him to make the most of his time; to study and prepare himself for greater work ashore. A man's first lesson in self-training is to become proficient in the duties to which he is assigned, even though his eye is on a future step in his career. He will have paid his "tuition" only if he can have left the brasspounding profession a little bit better for his having been in it.

The comment to which Jack Bront refers in the following letter bewails the fact that the ideas and ideals brought forth in the Commercial Brasspounder do not reach the authorities who have power to act upon them, and suggests that the operator reader take it upon himself to pass them along to his steamship company officials. Jack's cleverly illustrated letter is very interesting, and bears the thought that tolerance may bring greater satisfaction than unrest. If every operator would look to his own skill, reliability and thoughtfulness for the other fellow, the profession would be a much pleasanter one. Moreover, the respect of the other officers and steamship officials, which is in reality the key to our future, would be much more readily bestowed upon us.

LETTERS TO THE EDITOR

Sir—The department editor's comment on page 55 of the October Radio is a step in the right direction. A little thought *and effort* in this direction will accomplish something.

The ham-commercial debate proves interminable—interesting and instructive regardless. Sensible facts are re-discovered in any discussion. Indisputable, we must crawl before we walk. A patriarch does not spring from the cradle—nor does any expert avoid a novitiate. Amateurs precede the professional.

Nevertheless one man's toy may be another's toil. Idlers may swing by in pleasure cars wrought in sweat and grime and insufferable toil, at the forbidding maws of blast furnaces, or in blind gropings in the ghostly labyrinths of mine diggings.

Radio telegraphy originated in infancy—but today it is grown up. Amateurs, "pros" and scientists are thanked. But the so-called game has matured before its co-developers. Radio men are young men. It's a young man's game—but the business, comparatively, is fat and forty.

An important fundamental cause for present conditions rests at the door of young fellows entering the business past and present. Youth tolerates conditions and accepts matters with careless indifference regardless of consequences and like the old prospector accepting a cross-eyed burro: "I'll take her as she looks." A mature profession rests in the hands of youth.

Who ever heard of an operator with a staysail attachment of whiskers? "Up at the office," Sparks is a young fellow, fine, bright, dumb or crazy—as the intelligence or passing idle thought of the SS. official may indicate. But, inevitably, he is a young feller.

The operator is regarded in no other light, and SS. officials yet fail to become conscious of his passing years and the growing necessity for provision for the stabilization and amelioration of his conditions and his emoluments. Elders dismiss youth with tolerance and idle indifference. Corporations remain, as ever, frigid, impervious mammoths—yet officials are human and their hides can be impaled and carried home on a suitable lance. Re-read the department editor's comment, heretofore mentioned, and start off on the right foot.

So far, the young men in this so-called game have failed to find a sober, sharply defined perspective which more mature years will bring. There is no general trend of thought. Pretty theories, it is true, are advanced as to what the SS. companies should do—or what the radio concerns ought to do—but little is suggested as to what the *operator* can or will do. Thought is vague and in ferment. Unrest is prevalent. Objectives are obscured.

(Continued on Page 40)

"After the first dozen or two ships sink under a man, of course his code speed improves"

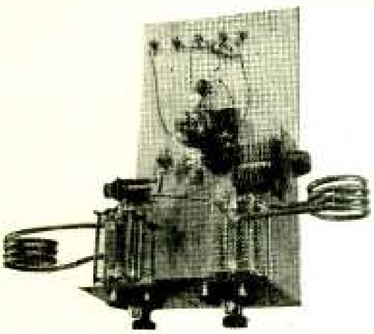
With the Amateur Operators

CONSTANT FREQUENCY TRANSMISSION WITHOUT ADDED EXPENSE

By A. Binneweg, Jr.

Although it is admitted that crystal control and r.f. amplification are ideal methods for obtaining a constant frequency output from a short-wave transmitter, it might as well be agreed that equal results are obtainable from a self-excited set if the latter is properly constructed and adjusted. And while the Rolls-Royce and Packard of short-wave transmitters are nice to have, the Ford will turn the corners more easily and can be counted on to get you where you want to go.

To make the self-excited transmitter meet the requirements of the narrowed bands, painstaking care must be taken in order that the utmost efficiency may be had. Every little loss has its effect upon the strength and character of the output. Hence it must be reduced to a minimum. The tube must



Constant Frequency 20-Meter Transmitter

not be overloaded or its elements will expand irregularly with the heat. The dielectric and not the insulation of the condensers must be relied upon to transfer the current through the circuit and the coils must be wound with sufficiently heavy conductor so that very little heat and subsequent expansion will result.

It is well known that a comparatively high ratio of capacity to inductance stabilizes the frequency to a great extent. When using this system, however, it will be found that larger oscillating currents circulate through the coils, necessitating the use of large copper tubing in the latter in order to avoid excessive heating. When a tuned grid-tuned plate circuit is used, the above statement applies only to the plate circuit as the current in the grid circuit is comparatively small, and a smaller conductor may be used. If ¼-in. tubing is used in the plate coil (and that size is about right for a 7½-watter), the same stuff must be used as connectors for that circuit, for these are also well loaded, even though the inter-turn heat is absent.

All coils should be fastened tightly and the contacts kept clean. Variable stopping condensers for grid and plate are superior to fixed, as the proper value may be chosen for any frequency. Better efficiency may be had if the r.f. chokes are tuned to some period near the frequency used; a stunt most easily accomplished by tapping the coils, as the "tuning" is not sharp. The usual 10,000-ohm grid-leak, .001 mfd., or smaller filament by-pass condensers, and 300-ohm resistor across the filament for center-tap are satisfactory for efficient operation of the improved transmitter.

The antenna should not be allowed to swing any more than absolutely necessary, but if it insists on doing so the best way to offset the resultant effect upon the emitted oscillation is to couple the antenna coil very loosely to the plate coil and detune slightly. A few more guys in the antenna, a larger size of wire or tubing, a greater distance between antenna and nearby grounded objects,

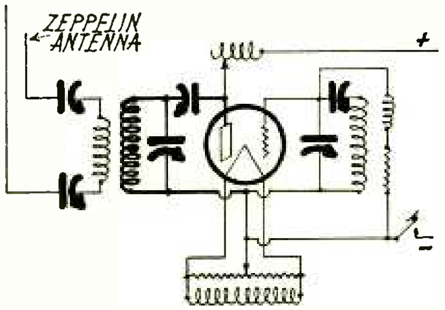


Fig. 1. Circuit Arrangement for Constant Frequency Short-Wave Transmitter

will be the result of time and trouble well spent.

Very often it will be found that properly adjusting the transmitter will do as much to eliminate the insistent "modulation" of a signal as the addition of a whole section of filter. In the Hartley circuit less grid excitation often shows surprising results along this line, and right here it might be well to repeat that unless a good monitoring system or an honest and hard-hearted friend living a few blocks away is available, it is next to impossible to get an exact idea of the purity of the transmitter's output. Checks over the air are seldom reliable.

The "zeppelin" antenna indicated in the transmitter circuit is a type used in many amateur stations. Many amateurs use a

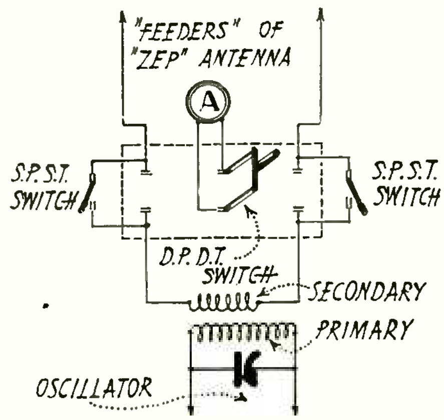


Fig. 2. Switching Arrangement for Zeppelin Antenna

radiation-meter in each "feeder," the cost of which is often quite a fraction of the value of the average set. By using the simple switching arrangement shown in Fig. 2, it is possible to use but one meter. The single instrument is switched from one line to the other; the open line is shorted by the proper switch, and the other is opened.

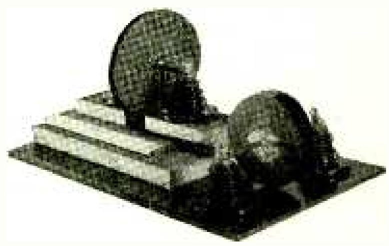
Another advantage is that both S. P. S. T. switches may be closed, and the meter temporarily used for other work, the set still being available for operation. For general use, a good hot-wire meter is best, as it can be used to measure anything from d.c. to antenna current. Any antenna meter has many other uses. The antenna switch may be easily made in some cases from the old "Murdock" changeover.

BLOCKING CONDENSERS

By A. Binneweg, Jr.

The parallel plate, air dielectric, condenser is of considerable use at the higher frequencies. With the proper size of plates and plate spacing it can be made to withstand the usual voltages necessary for plate-blocking. It is also economical, simple in construction and easily calibrated.

Those shown in the illustration consist of two wall insulators and a pair of copper plates to which copper tubing leads have been soldered. Brass plates may be used if desired. The effectiveness of the condenser depends largely upon the connections between tubing and plates. To attach these leads, a hole may be drilled through the cen-



Home-made Blocking Condensers

ter of the plate, the tubing passed through, spread out and soldered; or the tubing may be soldered directly to the back. The former is the stronger, but is not as good for close spacing if that is ever necessary.

The insulators are mounted on blocks high enough for the largest plates to clear the baseboard. Various sizes of plates are constructed and are easily inserted at the insulator screws in order to change the capacity range. One insulator is fixed in position and the other is movable so that the correct value may be obtained.

The values at different spacings can easily be figured for plotting a curve. If a small

(Continued on Page 37)

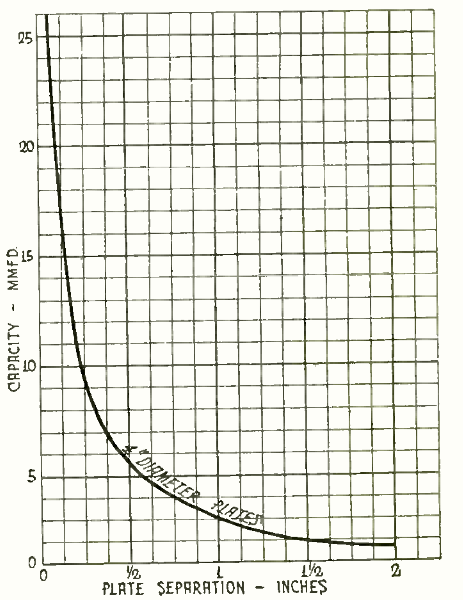


Fig. 1. Typical Calibration Curve of Parallel-Plate Condenser

Inside Stories of Factory Built Receivers

THE GILFILLAN MODEL 100

This new receiver has four r.f. stages and power detector using '27 tubes, and one audio stage with two '71-A tubes in parallel. Plate current is supplied from an '80 full-wave rectifier in a separate power pack. It is designed to have good audio characteristics without audible a.c. hum.

Four stages of tuned r.f. amplification are used to give great sensitivity and sufficient amplification to give loudspeaker reproduction of faint signals by the single audio stage. The sensitivity is kept nearly uniform throughout the broadcast band by means of grid resistors and neutralizing circuits. The five tuned circuits give sufficient selectivity to allow the use of the grid resistors. Single tuning control is effected with a five-gang condenser. Volume is controlled by a 50,000-ohm tapered resistance in series with the cathodes of all the r.f. stages. This varies the grid voltage and thus the plate current and plate impedance of these tubes. A 450-ohm resistance is always in this circuit so that the r.f. tube bias is never less than the value recommended for the '27 tube.

The neutralizing circuit consists of rather large semi-variable neutrodon condensers connected from plate to plate of the r.f. tubes. This arrangement has less effect on the tuning of each r.f. stage than when connected in the usual grid circuit methods. Because of this, individual trimmer condensers for each tuned circuit are necessary, except for the antenna and detector circuits. A variable trimmer is used on the former and a small fixed one on the latter. The latter is necessary due to the smaller input capacitance of the '27 tube when used as a detector.

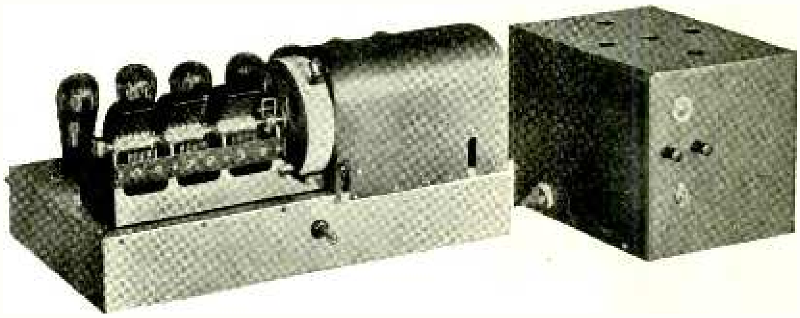
The power detector is coupled to the power amplifier through a special auto-transformer having its primary resonated at a low frequency in order to give a good response at those frequencies. This is done because of the high plate impedance of this type of detector, which measures between 30,000 and 50,000 ohms under normal operating conditions.

In order to get away from the "booming" effect, the special transformer has a good high frequency response, and the r.f. amplifier does not appreciably cut off these high frequencies, due to side-band cutting. By using five tuned circuits, each one fairly broad in its resonance curve, it is possible to attain a band-pass effect with very excellent selectivity. The power detector does not cut off the high frequencies as does a grid-leak type detector, and also will handle a much greater output.

The plate voltage on the power tubes and power detector is 220 volts, allowing 40 volts bias for the '71-A tubes. The effective detector voltage is from 120 to 160 volts, due to the drop through the detector plate resistor, and the plate current is about 1 milliampere when the set is tuned to the carrier of a broadcast station. Bias is provided by means of a 25,000-ohm resistance in the cathode circuit of this tube. Power tube bias is obtained by means of an 1100-ohm resistance in the negative plate return of the two '71-A tubes.

Using two '71-A tubes in parallel not only allows greater output but also provides a good plate current drain to actuate the field of the dynamic loudspeaker. The voltage divider does not draw much current, as it consists of nearly 80,000 ohms with only a 4000-ohm section designed for heavy current drain (to the r.f. tubes). The 75,000-ohm resistance is used to protect the end filter condenser form voltage surges and resultant blow-outs.

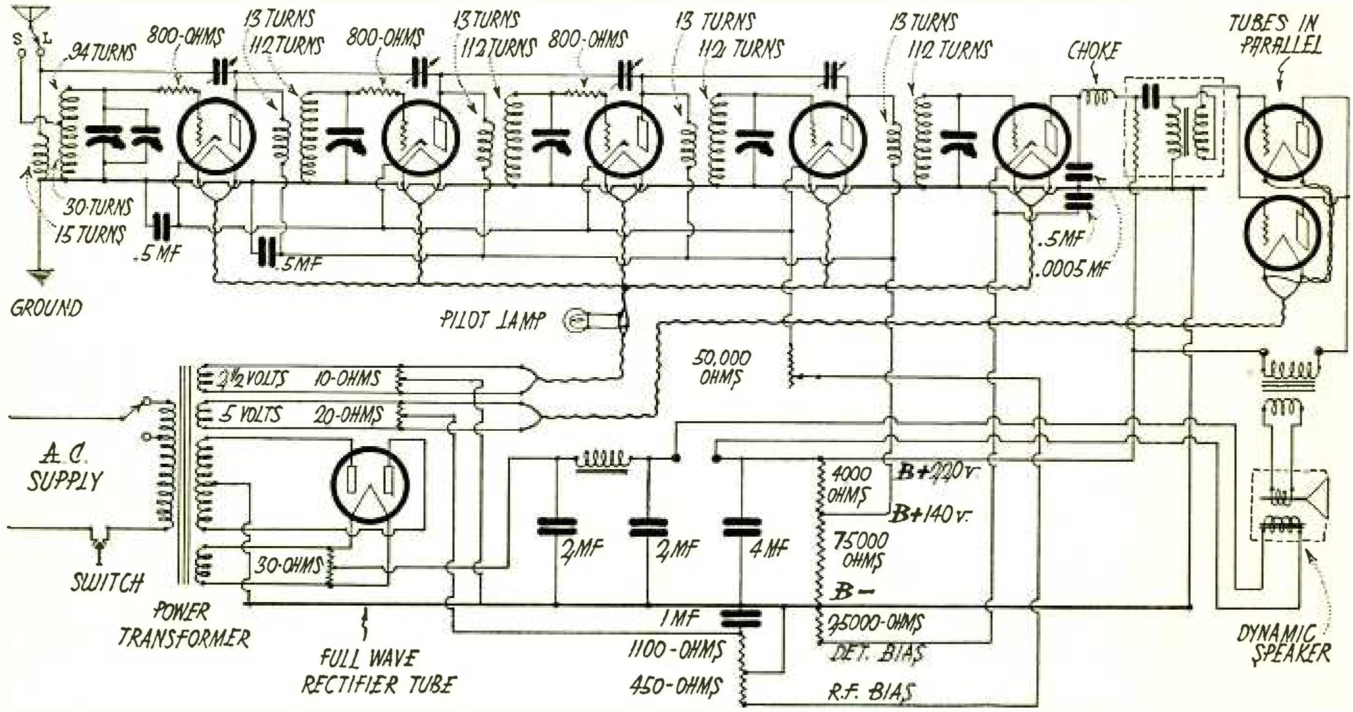
The receiver is furnished complete with a Gilfillan dynamic loudspeaker in a novel two sliding-door console cabinet, with the speaker and power pack in one compartment and the chassis in the other.



Chassis of Gilfillan Model 100

NEW ARCTURUS TUBES

Arcturus type 145 and 122 tubes are the latest additions to the 2½-volt a.c. filament type. The former is a power tube which delivers 1.7 watts with 250 volts on the plate and 50 volts on the grid. The latter is a screen-grid tube of the heater cathode type mounted on a UY five-prong base with control grid brought to a cap on top of the tube. It requires a plate potential of 180 volts, shield grid potential of 75 volts and control grid bias of 1.5 volts.

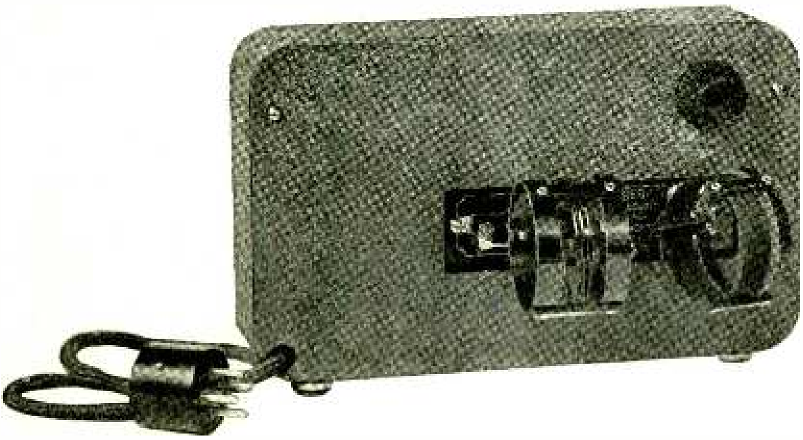


Circuit Diagram of Gilfillan Model 100 Receiver

Radio Kit Reviews

THE "AERO-CALL" SHORT WAVE ADAPTER

This is a one-tube short-wave tuner for use in conjunction with the audio amplifier of a broadcast receiver. It is built into a metal cabinet 9 inches long, 5½ inches high and 2½ inches deep. The plug-in coils are mounted in the rear and the tube is inside the cabinet, leaving only the tuning dial and the regeneration control on the front.



Rear View of "Aero-Call" Short-Wave Adapter

The adapter is sold in two forms: one for use with d.c. receivers and the other for use with a.c. sets. Filament (or heater), cathode, plate and ground connections are brought to the unit through the plug which is inserted in the detector socket of the broadcast set, the detector tube of this receiver being placed in the adapter socket. The antenna must be disconnected from the broadcast receiver and hooked onto the short wave unit in the rear.

One feature of the adapter is a filter control knob in the rear which is designed to eliminate motorboating when a *B* eliminator is used. Once this control is set it need not be varied. Three plug-in coils are used, covering all waves from 26.2 to 90 meters. The same antenna inductance is used for each coil, as its coupling is variable.

The Sunset "Sensitizer," a Los Angeles product, consists of a flat strip of soft copper, carefully insulated with linen and shellac. When bent around the base of the detector tube and connected to the antenna post the capacity between the antenna circuit and tube elements causes the tube to oscillate. By adjusting the volume control the set may be operated just below the point of oscillation with increased sensitivity of the detector.

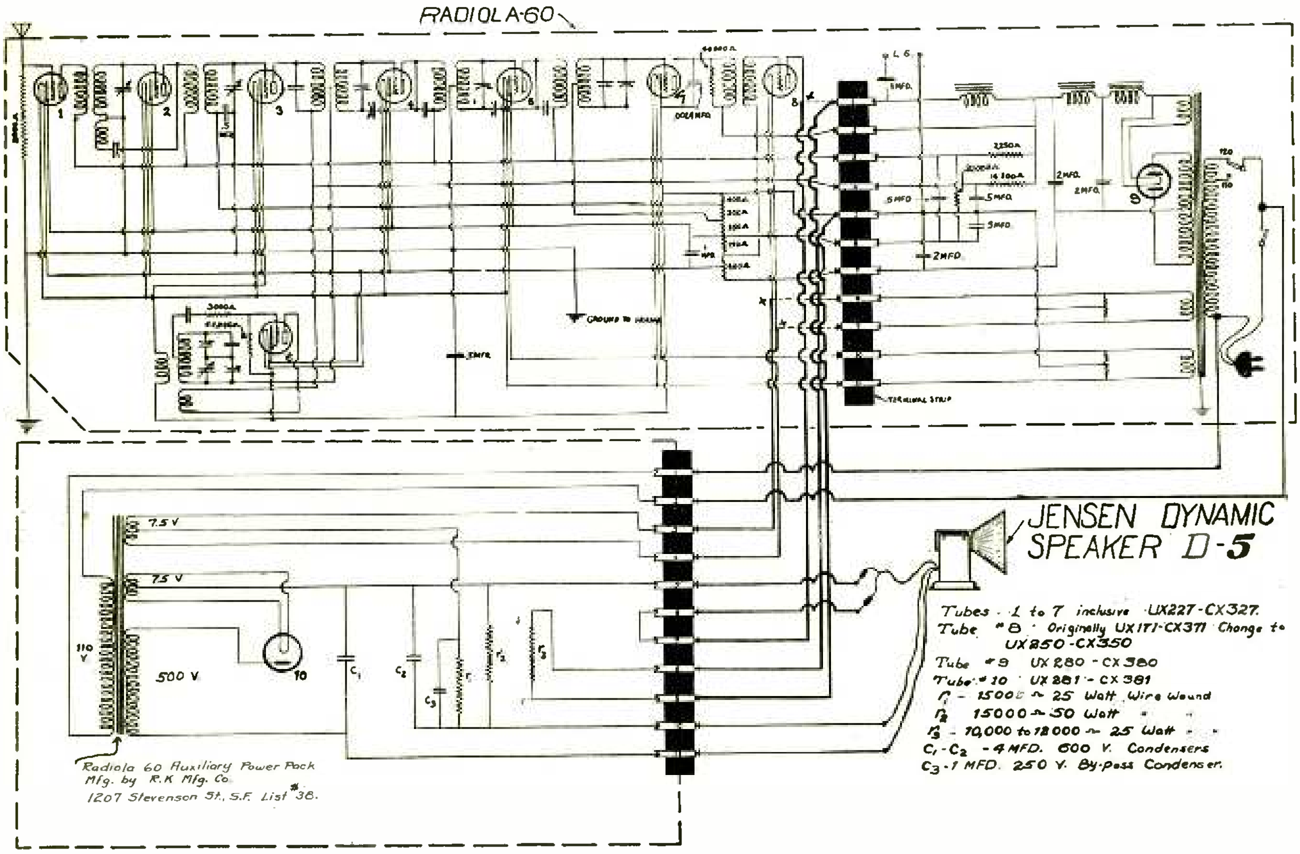
AUXILIARY POWER-PACK FOR DYNAMIC SPEAKER WITH SUPERHETERODYNE

TO MEET the demand for a power amplifier and filter system which will satisfactorily operate a dynamic speaker from a superheterodyne receiver such as the Radiola 60, Brunswick 5NO, or Graybar 330, the Jensen Radio Manufacturing Company offers that shown in the picture and circuit diagram herewith. It calls for the substitution of a '50 tube for the '71-A ordinarily used and the addition of an '81 rectifier tube and associated equipment to supply the correct filament and plate voltages to the '50 tube. The apparatus and connections have been carefully designed to give the finest tone quality from the use of a Jensen D-5 unit.

The design of the several receivers mentioned is such that any change in the voltage divider in the chassis causes unsatisfactory performance unless a proper balance is maintained. Accordingly a 10,000-ohm resistance R_3 is connected between lugs Nos. *1* and *5* of the terminal switch so as to draw 12 m.a. from the power-pack already in the set, this being equivalent to the load of the '71-A tube.

The *C* bias for the '50 tube that is placed in the '71-A socket of the receiver is obtained by means of the resistor R_1. The field of the Jensen D-5 unit is so connected that it acts as a choke in the half-wave rectifying system of the auxiliary power-pack. The 7½-volt filament supply for the '50 tube is supplied from the auxiliary power-pack to wires *8* and *9* of the receiver. The condensers shown as C_1 and C_2 are 4 mfd. 600-volt filter condensers, C_3 being a 1 mfd. 300-volt by-pass

(Continued on Page 44)



Circuit Diagram for Attachment of Auxiliary Power-Pack to Radiola 60

REMOTE CONTROL BY RADIO

(Continued from Page 14)

of the circuits. The three-phase motor of the generator set obviates difficulties in starting up. The transmitter can run continously without harm.

It would require only a sticking contact on the control-receiver relay to keep things running full blast throughout the night. However, the contacts do not stick—they are tungsten. If the detector howled, the rectifier-relay combination would not know the howl from a heterodyne, so until the regeneration was reduced the station would be on the air.

Not only are there such mechanical and electrical possibilities with the system. The human element must be reckoned with. Two substations trying to use the central station simultaneously would make hopeless cases for the fellows on the other ends. Such does not happen, because a substation operator listens ten minutes to see if W8CAU is in use before he opens up. Likewise, discretion in the matter of keeping station logs, answering acknowledgment cards, transferring messages, and so on, smooths out the operating routine. More than often a multi-cornered chat occurs over the system between substation operators. Each listens to W8CAU on his 40-meter receiver, and takes turn in the conversation. Each can hear W8CAU, or for that matter any other station to which he is tuned, even when his own key is down. What an outsider thinks when he hears a station talking to itself and answering its own questions is problematical.

To keep the control circuit in working order the control transmitters must occasionally be retuned. It is not a matter of meters, but only a few hundred cycles. The picture of one of the control transmitters shows a 12-inch handle on the dial of a small condenser, which is in parallel with the main circuit condenser. By listening on the wave of W8CAU and swinging the vernier slowly it is simple to know when the control transmitter comes again in tune. Often the circuit performs for weeks without frequency adjustment. Only static in the form of local lightning storms queers the system. Not by starting up the apparatus, for it is a most unusual flash that lasts three seconds; but after the transmitter has been started by a substation the lightning hashes the keying into unintelligibility. Once in a while an X-ray machine in the physics laboratory tries its hand at transmitting crystal-controlled energy on "short" waves.

Interference, either intentional or accidental, from other stations around 150 meters is possible, although as yet it has not happened.

THE R. F. AMPLIFIER

(Continued from Page 16)

ments have to be made at broadcast frequencies since close shielding varies this quantity over such a wide frequency range.

These values of coil gain are useful in comparing different coils when plotted in the form of curves, since the coils may be of different inductances. Plain resistance curves mean nothing for comparison unless the inductances are exactly the same over the whole broadcast band.

The number of turns of wire for coils of a required inductance may be determined from tables and charts. In calculating the value of inductance necessary for a given variable condenser, it should be remembered that the tube input capacity, coil distributed capacity, wiring capacity, etc., are in parallel to the tuning condenser, changing both its maximum and minimum values of capacitance. It should also be remembered that adjacent shielding or similar objects of metal decrease the inductance and often increase the r.f. resistance.

If coil resistance measurements are made, the selectivity curves per stage may be calculated from the formulae

$$X = 4\pi Ld \text{ and } Z = \sqrt{r^2 + X^2}$$

where X is the reactance at a frequency differing by d megacycles if L is in microhenrys. This is the series reactance of the tuned circuit and the second formula takes into account the coil and condenser circuit resistance r. The first formula is approximate, but is accurate enough for this type of work.

These curves should be checked experimentally by means of the r.f. oscillator and vacuum tube voltmeter. The overall selectivity and gain curves of a several stage amplifier usually depart from the calculated values of single stages squared or cubed because of poor tuning alignment, common plate and grid supply circuits, and other regenerative or non-regenerative feedbacks.

The r.f. oscillator and vacuum tube voltmeter are also very useful in checking dielectric losses of different variable condensers and tube sockets which are connected across the tuned circuits.

In closing this discussion, the circuit of a new receiver is shown in Fig. 3 in which four stages of r.f. power detector and one stage of audio are used to obtain practically the same gain as a three-stage r.f. receiver, detector and two-stage audio amplifier. By following some of the ideas set forth in this article it was found possible to get as much overall gain with better r.f. selectivity in the arrangement shown than was possible with the other receiver mentioned. The number of by-pass condensers and isolating r.f. chokes or resistors was cut down to a minimum and the retail price of the receiver lowered by over one-third. The a.c. hum was reduced without impairing the audio quality in the least. The elimination of the by-pass condensers was made possible by the circuit design and placement of parts. The grid resistors were used to produce a more even gain over the whole broadcast band since the selectivity, that is, wave shape, was fine enough to allow this when using five tuned circuits.

NEON LAMPS

(Continued from Page 20)

outside of the tube and connected to various parts of the circuit, either directly or through a high resistance. The applied voltage could be adjusted so that discharge occurred only when this shield or external grid was connected to one of the electrodes. This phenomenon is similar to that observed in the Knowles grid-glow tube, and can without doubt be used for similar purposes. When the output of a radio set was connected between the shield and one electrode, and the voltage applied across the electrodes properly adjusted, discharge took place in response to the higher amplitudes of the receiver output."

The experiments conducted in reference to the photoelectric effect in glow tubes, since they are purely scientific, may best be studied from the paper itself. The conclusion reached, however, was that the photoelectric effect (that is, the emission of electrons due to the action of light on a substance) was caused by small amounts of alkali metals deposited on the walls and electrodes of the tube. It appears that such metals are either deliberately introduced into commercial cells to increase their speed of operation and the intensity of the glow or are introduced unintentionally in the processes of manufacture and evacuation. This effect has also been noticed in some radio tubes and other rectifiers where alkali metals are employed. In any event, in the glow tubes which were studied, traces of sodium were discovered, to which the photoelectric effect is traced.

Fatigue was also noted in these tubes, such as is evidenced in inferior types of photoelectric cells, and for probably the same reasons—occluded gases, surface films, impurities, etc. Since such cells have not been designed to use the photoelectric effect and the care in manufacturing not so important, it is to be expected that fatigue would be noticeable.

As some readers may wish to study more fully some of the characteristics of glow tubes, the following papers deserve especial attention: Oschwald & Tarrant, *Proc. Phys. Soc. Lond.*, 36, pp. 241, 262; 1924. Pearson & Anson, *ibid.*, 34, pp. 175, 204; 1922. Taylor & Clarkson, *ibid.*, 36, p. 269; 1924. Taylor, *Phil. Mag.*, 3, pp. 368, 753; 1927. Watson, *Proc. Chambr. Phil. Soc.*, 17, p. 90; 1912. Bedel & Reich, *J. A. I. E. E.*, p. 563; June, 1927.

R. F. RESISTANCE MEASUREMENTS

(Continued from Page 21)

value as to halve the voltage reading of the tube voltmeter. The value of R then is the value of the coil resistance desired.

In order that this value of R should be correct it is necessary that the coupling between this series circuit and the r.f. oscillator be extremely weak. This means that the r.f. oscillator has to be quite powerful in order to give good readings when such weak coupling is employed. This coupling has to be so weak that the r.f. oscillator coil resistance is not reflected into the series circuit to an appreciable amount. The r.f. oscillator tuned circuit has a finite impedance and the coupling to this of course reflects its impedance into that circuit since we are dealing with a power transfer device. With the arrangement shown, this effect is very slight, but in the first attempt along these lines with a '01A tube oscillator, the values of coil resistance were nearly 100 per cent too high at the high frequency end of the curves.

A 210 power tube should be used with at least 450 volts applied to the plate in the r.f. oscillator. This unit should be shielded carefully and the power pack should also preferably be shielded. This r.f. oscillator can be conveniently calibrated against local broadcast stations if a broadcast receiver is available. Zero beat between the radio station carrier frequency and the r.f. oscillator is the most convenient calibration method. The scheme has been described in numerous magazine articles in the past.

Curves of r.f. transformer secondaries are very useful in comparing different gauges of wire, insulation or spacing between turns, diameter and length of coils, and effects of shielding cans around the r.f. transformers.

This r.f. oscillator and vacuum tube voltmeter are also useful in measuring r.f. transformers when connected in tuned radio frequency amplifiers. The vacuum tube voltmeter for a higher range should have higher voltages in the various biasing batteries, unless some form of calibrated r.f. attenuator is used on the output of the r.f. oscillator.

BLOCKING CONDENSERS

(Continued from Page 30)

scale is provided at the side of the condenser, as in the illustration, capacity values can be read directly or from the calibration curve. The values as calculated for large plate separations will be off due to edge effects. For amateur work the curve (Fig. 1) will give a general idea of the values. It represents the actual capacity settings of an average condenser constructed with average care.

MIND READING BY RADIO

(Continued from Page 22)

from the prompter, who gives the O. K. for the next question.

Upon receipt of this the usual formula of "I get a strong vibration from the right side of the balcony, the name of ——, etc.," is gone through and the answer given by the "magician" is repeated with embellishments. Sometimes interruptions will occur that will make the repetition of advice from the operating room necessary. In this case the "psychic" should make some predetermined motion of the hand to indicate to the prompter that such assistance is necessary. In addition any other impromptu questions that the audience may ask should be answered, being first repeated so that the men behind the scenes may have the information forwarded to them and give such suggestions as are necessary.

The result of all this is that the audience is completely baffled. At one performance it was announced beforehand that the whole thing was a fake. You may imagine the excitement that prevailed throughout the presentation. Needless to say, no one was able to solve the mystery, and, to cap the climax, that particular evening the girl who was to answer the questions appeared on the scene with a tight-fitting organdie dress and a large blond wig. Imagine the consternation that ensued. It was thought at first that the whole act would be a fizzle, because of the bulge of the telephone receiver under the wig and the possibility of the wires leading up the back of the girl's neck being visible. But the collar of the dress was upstanding and she had another piece of material to match the dress which was used as a scarf, so the performance went off without a hitch. Poe once said that the best way to hide a thing is to place it in plain sight of everyone.

CHANNELS FOR PLANE COMMUNICATION

Sixty-four radio channels between 1,500 and 6,000 kilocycles have been reserved by the Federal Radio Commission for the exclusive use of air transport operators for radio communication to and from planes.

The decision, on the part of the commission, is the outgrowth of a recent meeting between transport operators and the aeronautics branch of the Department of Commerce. At the meeting, called by the Aeronautical Chamber of Commerce, operators agreed to establish and maintain a coöperative system of radio stations.

The channels will be used by operating companies for the handling of weather reports and private business.

The Department of Commerce, visualizing the chaotic condition which would necessarily result unless definite policies were established for radio facilities of the aeronautical industry, has provided for the certification of privately established radio facilities.

RESISTANCE AND CAPACITY MULTIPLIERS

(Continued from Page 24)

capacity of the condenser. For a .5 mfd. condenser and 60 cycle a.c. $X_c = 1{,}000{,}000 \div (2 \times 3.14 \times 60 \times .5) = 5200$ ohms. If $R_v = 150$, $Z = \sqrt{150^2 + 5200^2} = 5205$ ohms. Then the multiplying factor would be $m = 5205 \div 150 = 34.7$. This would increase the range of a 0–15 voltmeter to 0–520.5 volts, a convenient range for measuring *B* voltages.

The accuracy of this method depends upon the correctness of R_v and C. R_v can be determined by connecting the meter in series with a battery and milliammeter. Then $R_v = E \div I$, when E is the voltage of the battery and I the reading of the milliammeter in amperes. Commercial meters for 15-volt service have resistance varying from 150 to 2000 ohms. Some of the manufacturers furnish this information upon request.

The rating of the condenser must be accurate. Furthermore, the condenser should be able to withstand double the full-line voltage so as to obviate the possibility of burning out the meter.

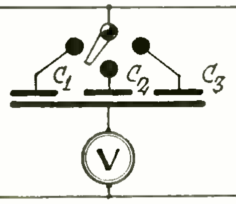


Fig. 3. Multi-Range Meter

Fig. 3 suggests an arrangement for a convenient multi-range voltmeter with several condensers which allow the use of different multiplying factors.

TROPICAL CYCLONIC STORMS

By M. Sylvestri, KDRD and A. B. Nolan, WOCA

Limits of the Regions of Origin

Region	Lat.	Long.
Hurricanes of the West Indies	12 to 28 N	55 W to 95 W
Typhoons of the Philippine Region	5 to 20 N	150 E to 115 E
Cyclones of the Bay of Bengal	8 to 22 N	100 E to 80 E
Hurricanes of the Samoan Region	10 to 30 S	160 W to 150 E

Percentage of Annual Frequency Each Month

	Jan.	Feb.	Mar.	Apr.	May	Jun.
West Indies	0	0	0	0	1	6
Philippines	2	.4	1	2	5	9
Bay of Bengal	0	0	0	0	6	12
Indian Ocean	22	19	18	15	6	1
Samoan Reg.	29	17.5	28	6	1	0

	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
West Indies	4	25	32	31	1	0
Philippines	16	16	19	14	11	5
Bay of Bengal	19	15	20	14	10	4
Indian Ocean	.5	0	0	1.5	7	10
Samoan Reg.	0	0	1.5	1	3	13

Average Yearly Number of Storms

West Indies	4
Philippines	21
Bay of Bengal	9
Indian Ocean	9
Samoan Region	4

COMMERCIAL BRASSPOUNDER

(Continued from Page 29)

Many causes for conditions are cited—along with remedies. Some fervently urge that all amateurs should be summarily boiled in transformer oil—others stress the indispensability of increase in "efficiency"—yet others deplore the lack of seniority system—ad infinitum.

Why not let the transgressing operator dawdle in his infantile practices at sea?—radio regulations and his own short vision will eventually hang him to a convenient yard arm of oblivion. In working organizations ashore, mob violence is not meted out to the idler or the incompetent who lays on

"Many an operator broke into the game at a few dollars a month and the captain's cast-off robes of state."

the back of his neck and sloughs his work. Remember—SS. officials do not tune in on ship waves every night, hear one transgressor splintering all radio decorum or "efficiency"—then slam down their receivers and chalk up all operators as infants, hooligans or what-nots undeserving of serious attention.

Radio and radio men got off to a poor start—and SS. officials have never gotten over the first (and lasting) impressions and tradition. Many an operator broke into the game at a few dollars a month and the captain's cast-off robes of state. They figure—if Sparks got along on that in the comparative radio antiquity of a few years ago—why should he not, at present, thrill to the vast inducement of 3.50 odd rain checks per diem, a brass coat and scoff with his highness, some six-foot squarehead king of the Chart Room?

SS. officials are not conscious of the present state of mind, nor of the present necessities of radio men—nor are they aware of any dissatisfaction or unrest as to conditions or wages. True, it is, they were aware of it seven or eight years ago—but not today. Who remembers the idle vagaries of any youth (or supposed youth)?

Who can blame the young fellows who rushed into radio at the beginning—under the meanest conditions—to allay themselves with the most astounding scientific sensation that ever startled man since he first opened his eyes to see the glaring sun? Did the old original telegraph company dissuade these lads to demand better conditions? Not by a jugful of ozone! The company was engaged in launching a newfangled contraption on doubting, hard-shell mariners, to function under the ultimately, most attractive (inexpensive) conditions. So tradition was established—and the same tradition entangles the footsteps of the operator today.

"SS. officials need lots of enlightenment."

SS. officials need a vast amount of enlightenment on present conditions—although they don't yet know it. Just how and when is the operator going to bring enlightenment to the dark continent inhabited by the SS. officials?

Kindest regards to all.

JACK BRONT.

SOME NEW SKEDS AND CALLS

By A. B. NOLAN, WOCA ex KDRD

KUO. Weather and arrivals to pilot boat—690 meters, phone. Week days—8:45 and 10 a. m., 12:30, 2, 4 and 6:30 p. m. Pacific standard time. Holidays and Sundays—8:45 a. m. and 4 p. m.

XC51—Mexico. Press. 43.5 meters. Trens News Agency, Mexico City. 8 p. m. P. S. T., in Spanish, and midnight in English.

Effective January 1, 1929, the calls of all U. S. lightvessels were changed. Those on the Pacific Coast are as follows: KCN, San Francisco Lightvessel; KCM, Blunts Reef LV; KCK, Columbia River Lightvessel; KCI, Swiftsure LV.

Effective February 1, 1929, W6XI CQs QTC 11:45 P. S. T. W6XI also listens for ships 36 to 37 meters 11 p. m. to 7 a. m. P. S. T. and answers 35.3 and 46.8 meters simultaneously. (W6XI is the short wave call of KPH.)

KPH also listens for KSOC, CW and ICW on 750 meters from 7 p. m. to 7:15 p. m., P. S. T.

Valparaiso, Chile, CCE, sends time at 4:45 p. m., P. S. T., on 1000 meters US system. If the signals fail he will say "señal nula" (signal annulled).

CCE also sends weather at 5:33 p. m. and 9:30 a. m., P. S. T.

FL, the Eiffel Tower, Paris, sends time at 11:55 a. m. and p. m., P. S. T., on 32.5 meters. The International system is used.

Rio de Janeiro, SOH, sends weather at 4 p. m., P. S. T.; 4 a. m., P. S. T., and 7 a. m., P. S. T.; also 1 p. m. The wave is 600 meters. The language is Portuguese.

Rio de Janeiro, SPR, sends weather on

1552 meters at 10:30 a. m., P. S. T., using the new International code. CW. The New International Meteorological code can be found in Radio Aids to Navigation, published by the U. S. Hydrographic office. It can be bought from the agents who sell Hydrographic publications, or it will be sent for 75 cents.

Z SIGNALS

By A. B. NOLAN, WOCA

The following signals are used by International radio circuits. They are not the same as the Z signals used by the Navy.

ZAN—We receive nothing.
ZAP—Acknowledge receipt.
ZCD—Your collation is different.
ZCO—Send by code each group once.
ZCS—Hold up your transmission.
ZCT—Send by code group twice.
ZCW—I am in communication with—.
ZDD—Make dots and dashes thus—.
ZDM—We are missing your dots.
ZDU—Our duplex is out of order.
ZFA—Our automatic system out of order.
ZFB—Your signals fade badly.
ZFS—Your signals fading slightly.
ZFT—What are conditions for triplex?
ZGS—Your signals are stronger.
ZGW—Your signals are weaker.
ZHA—What are conditions for automatic reception?
ZHC—How are you receiving?
ZHS—Send —— words per minute.
ZHY—We have your——.
ZIM—You are missing your dots.
ZKQ—Let us know when you are ready to begin again.
ZLB—Make long intervals.
ZLS—Disturbed by storm.
ZMO—Wait a minute.
ZMP—Perforator failed or mispunch.
ZMQ—Wait.
ZMR—Your signals are moderately strong and readable.
ZNB—We are not receiving your interpolations; will send twice.
ZNG—Conditions unfavorable for code reception.
ZNN—Everything stopped, provisionally.
ZOH—How many messages on hand?
ZOK—We are receiving at maximum speed.
ZPE—Send everything in plain language.
ZPO—Send text in plain language once.
ZPP—Send text only in plain language.
ZPR—Your signals readable.
ZPT—Send text in plain language twice.
ZRA—Automatic tape reversed.
ZRC—Can you receive code?
ZRO—Are you receiving at maximum speed?
ZSA—Stop automatic traffic.
ZSB—Your signals are not sharp.
ZSF—Send faster.
ZSG—Stop automatic and examine transmitter.
ZSH—Heavy static here.
ZSJ—Stop automatic traffic due to jamming.
ZSO—Transmitter slips once.
ZSR—Your signals strong and readable.
ZSS—Send slower.
ZSU—Your signals unreadable.
ZSW—Stop automatic traffic; signals too weak.
ZSX—Stop automatic; static too strong.
ZTA—Send automatically.
ZTB—We can not break in.
ZTF—Transmit twice as fast.
ZTH—Transmit by hand.
ZTV—Transmit by rapid automatic.
ZST—Transmit slips twice.
ZUA—Conditions unfavorable for automatic reception.
ZUB—We can not interpolate you.
ZVF—Variations to frequency in your transmitter.
ZVP—Please send V's.
ZVS—Your signals vary.
ZWC—Crackling static here.
ZWO—Send each word once.
ZWR—Your signals weak but readable.
ZWT—Send each word twice.

Press, Time, Weather and Music for Those Who Have Equipped Themselves With High Frequency Receivers

By F. T. Bearse, S.S. "Sylvan Arrow"

PRESS

GMT	Call	Wave	Comment
0900	KUP	47.6	S. F. Examiner, free.
1230	VIS	51.5	Sydney, free and paid.
	VAS	52.0	Halifax, N. S., paid.
1800-2000	NPM NPO	18.0	"QSF."
2100	KUP	47.6	S. F. Examiner, free.
0100	NPG	20.0	S. F. File.
0200	GBR	33.0	Rugby to GLSQ paid.
0600	WHD	36.4	N. Y. Times, free.
0500-0600	NPU	37.0	
0500	XDA	40-45	Only copied one night.
0700	NAA	37.0	Naval PX.
		TIME	
0255		37.0; 24.0; 74.0	
0755	NAA	37.0 only	
1655		37.0; 24.0; 74.0	
		WEATHER	
1800	NAA	18.0	Morning sked only so far.
0420	W6XI	46.8	Simultaneously KPH 2200 meter sked.
0330	NPG	35.0	
1530	NPG	35.0	
1110	XPI	35.5	Of interest to China run.

PHONE, OR BOTH PHONE AND TELEGRAPHY

ANE—Bandoeng, Java, Dutch East Indies, 13.93 m., Tuesday, Thursday, Sunday; 0800GMT on, works A-2ME es W2XAF. Experimental tests.

CGRX—Winnipeg, Canada, 26.50 m.; usually same time as KDKA.

JOAK—Japan, 72.00 m.; mostly on 72.0, but shifts to various waves from 72.0 down to 25.0 without much of a sked. On after 0700GMT.

PCJJ—Eindhoven, Holland, 31.40 m.; Tuesday, Thursday; from 16-20GMT; 23-03-GMT; Saturday; from 04-07GMT; 14-17GMT. World Station PCJJ will appreciate reports on transmission.

PCLL—KOOTWIJK, Holland, 16.0; Wednesday.

RFN—Khabarovsk, Siberia, 72.0; heard nearly every night from 0600GMT on.

RFN—Khabarovsk, Siberia, 32.5; this transmitter is usually on before the 72.0 meter one and is shut down before end of program, letting the 72.0 transmitter finish.

VIS/2ME—Sydney, Australia, 28.5 m.; Tuesday, Thursday, Sunday; 0800GMT on, tests with ANE and W2XAF.

2FC—Sydney, Australia, 28.5; Monday, Tuesday, Wednesday, Friday; 0900GMT on, when 2ME is working they split time.

6AG—Perth, Australia, 32.9; Friday; 0900-GMT on; Saturday Television Sked.

5SW—Chelmsford, England, 24.0; 1900-GMT-2400GMT; sometimes goes up to 0200GMT. On about every night except Saturday and Sunday.

Unknown Location, 37.5; Monday 1700GMT transmitting French language very QSA in Hankow, China.

This list comprises only the stations that were successfully received and identified. Many stations are heard, but due to foreign language and very few announcements, identification is very difficult. These schedules are subject to correction at any moment and I would be glad to hear from anyone, with some foreign schedules, the times of transmission and frequency used.

AUXILIARY POWER PACK

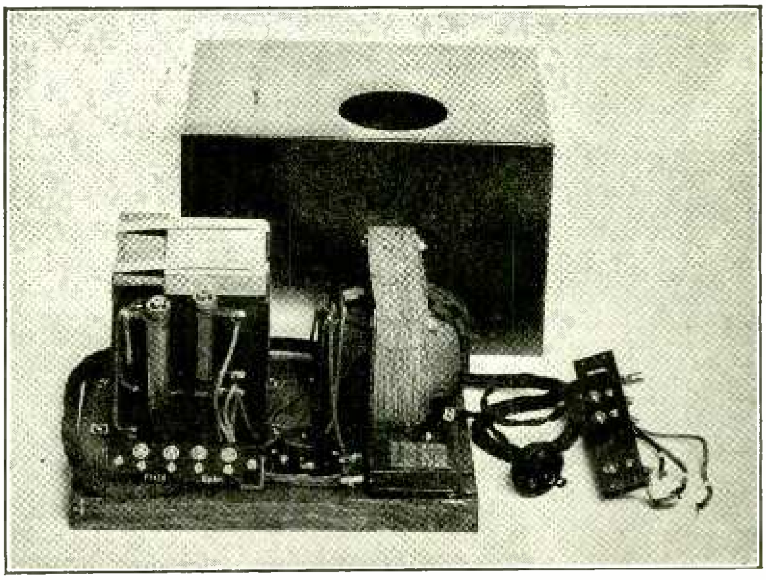
(Continued from Page 32)

condenser and R_2 a 15,000-ohm 50-watt resistor. As all Jensen D-5 units are equipped with anti-hum compensating winding, the hum from this arrangement is of negligible value.

All of these changes are automatically made through a cable from the power-pack to the receiver terminal switch. The wires which are attached to lugs No. 1, No. 8 and No. 9 of the receiver terminal strip should be removed. The wire from the cable marked No. 1 should be fastened to lug No. 1 of the terminal strip. Wires marked No. 5 and No. 6 should be connected under lugs No. 5 and No. 6 of the receiver terminal strip without removing the present wires. The special terminal strip, which is attached to the end of the cable, should be fastened under the screws which normally hold the protector guard, making sure that the ground (black wire) is fastened under the rear screws. The wire which was removed from lug No. 1 should now be fastened to the terminal No. 1 on the special terminal strip; likewise, wires No. 8 and No. 9 should be connected to the terminals marked No. 8 and No. 9 on the special terminal strip supplied with the pack.

The two pin jacks on the end of the speaker cord of the Jensen D-5 unit should now be connected to the two terminals marked "Speaker," and the two black field leads of the Jensen D-5 fastened to the terminals marked "Field." The supply connection to the power-pack should be connected to the receiver supply in such a way that the switch on the receiver will also turn the power-pack on and off.

A phototelegraphic system has been developed in the Army Air Corps laboratories at Wright Field, Dayton, O., by means of which photographs taken on the Pacific Coast can be sent by wire to Washington within thirty minutes. This speed was obtained by eliminating several steps usually required in the photographic processes.



Auxiliary Power Amplifier for Radiola 60

BOOK REVIEWS

"The Radio Manual," by George E. Sterling, edited by Robert S. Kruse, 5½ x 8 in., 666 pages, published by the D. Van Nostrand Co., Inc., 8 Warren St., New York. Price $6.

This book is of value to the radio operator, broadcast technician or engineer who works with various types of commercial apparatus. It also incorporates a thorough though simple treatise on the theory and fundamentals of the art which makes it very handy for the prospective operator or engineer. Motors and generators, storage batteries and charging circuits are treated in the customary manner. The theory and application of the vacuum tube includes the study of most of the modern power tubes used in the high powered transmitting stations as well as that of the four-element tube in its several forms.

Vacuum tube transmitters are discussed in their fundamental form from a theoretical standpoint and again in their commercial form, both as broadcasting transmitters and as marine equipment. Modulating systems and radio broadcasting equipment come in for considerable treatment, and many circuit diagrams of standard Western Electric equipment are shown. The latter add to the value of the book, as they have not heretofore been easily obtainable.

The chapters on measuring apparatus and vacuum tube transmitters are also full of information and diagrams of standard equipment with which the operator is required to become familiar. Arc and spark transmitters, commercial radio receivers and marine and aircraft radio beacons and direction finders are treated thoroughly and concisely.

A chapter on amateur short wave apparatus considerably widens the scope of the book, and the one on radio laws incorporates the latest changes in the United States regulations. The final chapter describes the methods of handling and abstracting traffic, gives rates of the various communication companies, and other data concerning the business side of the operating profession.

RADIOADS

A CLASSIFIED ADVERTISING SECTION READ BY BETTER BUYERS

The rate per word is eight cents net. Remittance must accompany all advertisements. Include name and address when counting words.

Ads for the May Issue Must Reach Us by April Fifth

IMAGINE AN ORGANIZATION with over 4,000 clients scattered throughout the world, all radiowise dealers, builders, experimenters, hams. Over $50,000.00 stock of high grade receiving and transmitting parts only, no sets. Spend $5,000.00 yearly on our own experimenting. Carry nothing until it passes our tests. 50c brings prepaid over four pounds catalog, circuits, data, etc. Weekly data (more than all radio magazines together)—20 weeks, $1.00; 52 weeks, $2.50. Sample "Over The Soldering Iron," 32-page experimenter's magazine, 25c. Full trade discounts to licensed hams and radiowise builders. We carry approved items advertised in RADIO. Kladag Radio Laboratories, Established 1920, Kent, Ohio.

FEBRUARY 10TH LOG BOOK—Just off the press. All the very latest changes for the entire U. S. and Canada. 32 pages, size 6 x 9. Logging chart for dial readings. All stations grouped two different ways for immediate checking. Plenty of station data. Everything you need. The most complete and most accurate log book yet published. Price only 25 cents per copy. Stamps accepted. When ordering be sure to ask for the 32-page February 10th, 1929 Book. Publishers of "RADIO," Pacific Building, San Francisco.

HERMANN SCHNITZEL, Der Perfesser Uf Der Ooniversity of Cincinnapolis, O-ho-ho, has prepared his radio lectures in the form of a complete booklet. 21 subjects in all. Interesting reading matter for humorous occasions. Thousands have been sold. These lectures were broadcast by radio on the Pacific Coast Network. Schnitzel's book will be sent to you upon receipt of 50 cents in stamps, coin or check. Publishers of "RADIO," Pacific Building, San Francisco, California.

DETECTOR TUBES—A.C.—Given free for a two-year subscription to "RADIO." The latest type Arcturus long life (2000 hour) 5 prong detector tube will improve reception. It is a remarkable tube. Hundreds of thousands in use. Send $5.00—get "RADIO" for 2 years and the Arcturus tube without a penny of extra cost. "RADIO," Pacific Building, San Francisco, California.

"B" ELIMINATORS REPAIRED, New Condensers installed; Chokes, Transformers, etc., repaired; $2.00 to $4.00. Fast Service. Clark Brothers Radio Co., Albia, Iowa.

RADIO SET AND TUBE TESTER.—An old established radio set and tube tester and general service business operating on paying basis can be bought at low figure. The sale will include rights to patents pending, stock on hand, complete equipment for manufacturing the tester, and laboratory equipment for general radio service work, good will. Big opportunity for man with enough money to operate on larger scale. This is the best tester on market today at any price and big money can be made by manufacturing on larger scale. Lack of finances reason for offering my business for sale. Write for details and literature. Kwik-Test Radio Laboratory, 82 Alfred Street, Detroit, Mich.

SCREW-HOLDING SCREW DRIVER! Amazing brand new patented invention! Retails $1.50. Factories, garages, electricians, auto, radio owners buy on sight! Exclusive state territory. Genuine opportunity earn big money. Free trial offer. Jiffy, 1042 Winthrop Bldg., Boston.

FOR SALE—Precision Laboratory Instrument made by Western Electric. Containing combination frequency and wave-meter, oscillator, high impedance voltmeter, calibrated capacity and inductance, amplifier, detector and galvanometer. 653 Hillcrest Ave., Westfield, N. J.

SALESMEN WANTED — Screw-holding screw driver! Amazing brand new patented invention! Retails $1.50. Factories, garages, electricians, auto, radio owners buy on sight! Exclusive state territory. Genuine opportunity earn big money. Free trial offer. Jiffy 1027, Winthrop Bldg., Boston.

ALFALFA SEEDS, hardy common varieties, $8.40, $10.20, $12.60 bushel; Grimm variety Alfalfa seed $18. Scarified sweet clover $3.90, $5.20; Alsike or red clover $15. Bags Free. Send for samples and catalogue. Kansas Seed Co., Salina, Kan.

SPECIAL—this month only. A 12 month subscription to MOTION PICTURE MAGAZINE and a 12 month subscription to "RADIO," all for the price of one. $2.50 for a full year subscription to both. "RADIO," Pacific Bldg., San Francisco.

WANTED—Low range Milliammeter, Thermo Galvanometer, calibrated wave-meter and heterodyne Oscillator; also other small radio laboratory apparatus. Must be high grade and reasonable. Joe Liken, 401 North Frisco, Tulsa, Okla.

SOUTH AMERICA, WORK! American firms pay fare, expenses if accepted. Opportunities! Tropical Service Bureau, 14606 Alma, Detroit, Michigan.

WANTED—Men to work with National Radio Service organization. No selling scheme. Radio Doctors, Inc., Dept. R., Essex St., Salem, Mass.

KELLOGG BROADCAST MICROPHONE, just reconditioned. Fifty dollars for cash. KFJI, Astoria, Oregon.

ANNOUNCEMENT
OF CHANGE OF MANAGEMENT

RADIO NEWS
SCIENCE AND INVENTION
RADIO LISTENERS' GUIDE & CALL BOOK
AERO MECHANICS
YOUR BODY QUARTERLY
AMAZING STORIES
HOW TO MAKE IT
SHORT WAVE MANUAL
AMAZING STORIES QUARTERLY
RADIO STATION WRNY
(Roosevelt Hotel, N. Y. City)

Arthur H. Lynch, I.R.E., formerly Director of Publicity and Assistant Advertising Manager of the Radio Corporation of America, and for four years Editor of Doubleday, Page & Co.'s "RADIO BROADCAST" magazine, is now Editorial Director and Advertising Manager of all the above enterprises.

B. A. Mackinnon, for twenty years Circulation Director of Pictorial Review, is now Business and Circulation Manager of the Experimenter Publishing Company and the Consrad Company.

These two men have been selected by the Irving Trust Company of New York, acting as Receiver for the Experimenter and Consrad Companies, to care for the above and other allied activities of these corporations.

Reorganization of the Editorial, Advertising and Circulation policies along lines which have long been recognized in these fields as being for the best interests of readers, listeners, advertisers and circulation agencies as well as newsdealers are already under way.

Full Speed Ahead!

IRVING TRUST CO., Receiver for
EXPERIMENTER PUBLISHING COMPANY, INC.
230 Fifth Avenue, New York City

FREE!

MEN! Here's the 'dope' you've been looking for

HOW TO GET INTO THE RADIO BUSINESS~

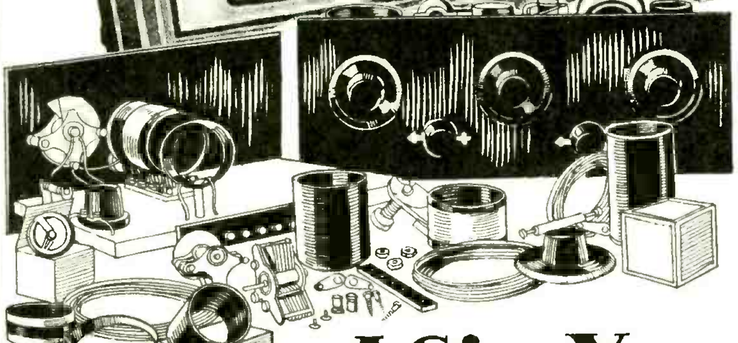
J.E.S.

Many Earn $50 to $250 a Week in Work That is Almost Romance

If you're earning a penny less than $50 a week, clip coupon now for FREE BOOK! New 64-page book pictures and tells all about the Radio business, hundreds of opportunities—in work that is almost romance! YOU can learn quickly and easily at home, through my tested, proved methods to take advantage of these great opportunities! Why go along at $25, $35, or $45 a week when you can pleasantly and in a short time learn how to hold the big-pay jobs?

Clip Coupon for Free Book

Don't envy the other fellow who's pulling down the big cash! My proven home-study training methods make it possible for you too to get ready for better jobs, to earn enough money so you can enjoy the good things of life. One of the most valuable books ever written on Radio tells how — interesting facts about this great field, and how I can prepare you in your spare time at home, to step into a big-pay Radio job. GET THIS BOOK. SEND COUPON TODAY.



J. E. SMITH, *Pres.*,
National Radio Institute
Dept. 9Q75
Washington, D. C.

I Give You 6 Big Outfits of Radio Parts

With them you can build 100 different circuits—learn the "how" and "why" of practically every type of Radio set made. This kind of training fits you to step into the good jobs—sends you out an experienced Radio expert. When you complete, my Employment Department will help you get a real big Radio job like Graduate Edward Stanko, now Chief Operator of Station WGR, or Frank M. Jones, 922 Guadalupe St., San Angelo, Tex., builder and operator of Station KGFI and Manager of the best equipped Radio shop in the Southwest, or help you start a Radio business of your own like Richard Butler, 1419 No. 17th St., Phila, Pa., who made around $500 a month compared with a small-salaried, no-future job as motorman when he enrolled.

My Radio Training Is the Famous "Course That Pays for Itself"

Spare time earnings are easy in Radio almost from the time you enroll. G. W. Page, 1807 21st Ave. S., Nashville, Tenn., made $935 in his spare time while taking this course. Al. Johnson, 1409 Shelby St., Sandusky, O., $1,000 in four months, and he didn't know the difference between a condenser and a transformer when he enrolled. I'll give you a legal contract, backed by N. R. I., pioneer and largest home-study Radio school in the world, to refund every penny of your money if you are not satisfied, upon completing, with the lessons and instructions received. Find out what Radio offers you, get the facts. Mail coupon—RIGHT NOW.

I Have Trained Hundreds of Men at Home for Big Radio Jobs. My Book Proves I Can Do the Same for You.

RADIO NEEDS TRAINED MEN!

ACT NOW~COUPON BRINGS MY FREE BOOK

J. E. Smith,
President,
National Radio Institute
Dept. 9Q75
Washington, D. C.

Dear Mr. Smith: Without obligating me in any way, send me your big FREE BOOK, "Rich Rewards in Radio," and all information about your practical home-study Radio Course.

Name ____________ Age ____

Address ____________

Town ____________ State ____________

Press of
THE JAMES H. BARRY COMPANY
SAN FRANCISCO