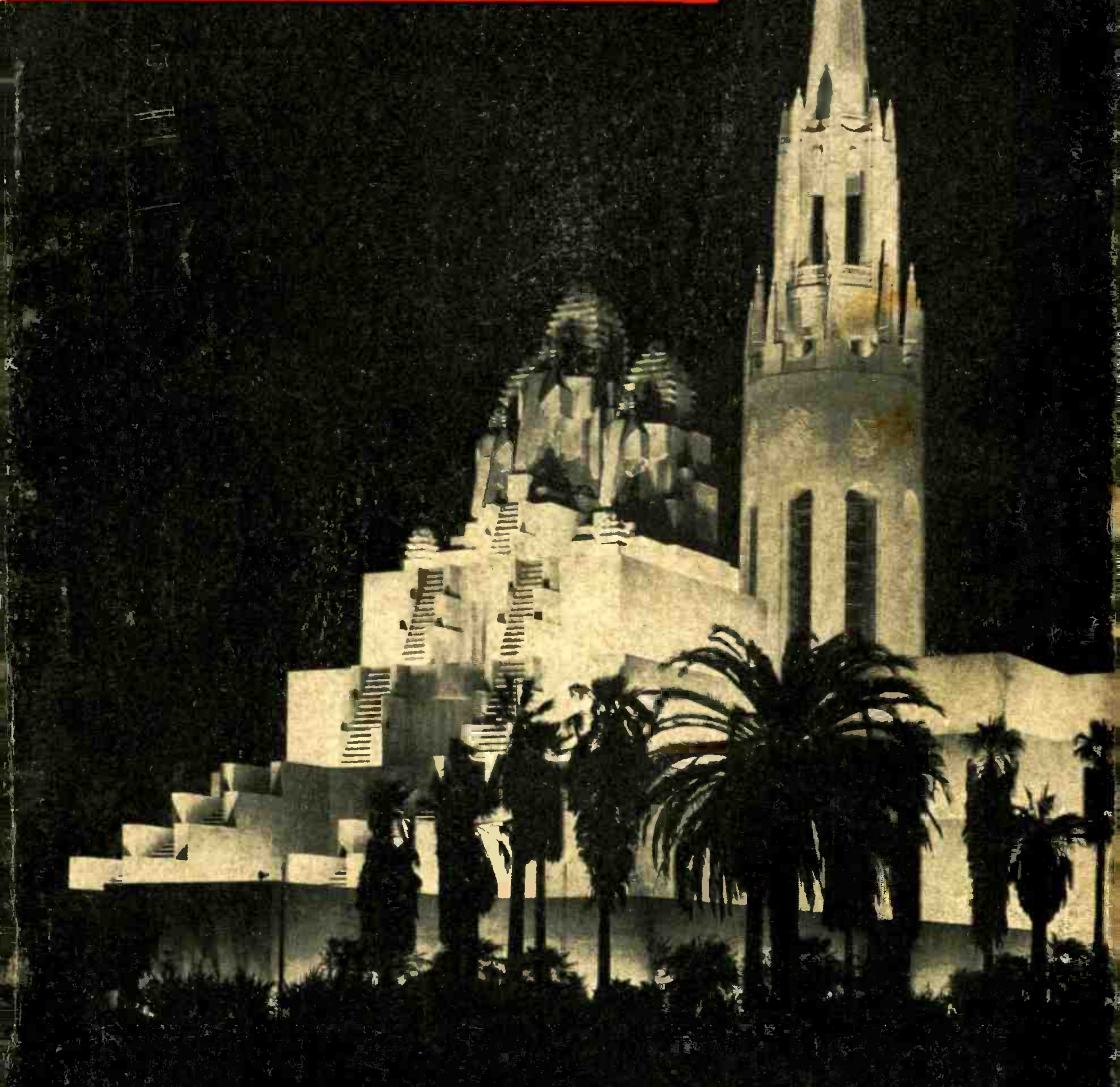
RADIO

ESTABLISHED 1917 A 238



- NEW HIGH EFFICIENCY DOUBLER
- SIMPLE 2½ METER TRANSMITTER
- THE "QUADIRECTIONAL RHOMBIC"
- A COMPACT ALL-BAND PORTABLE

The Worldwide Authority of
Amateur and Shortwave Radio

★

April 1939

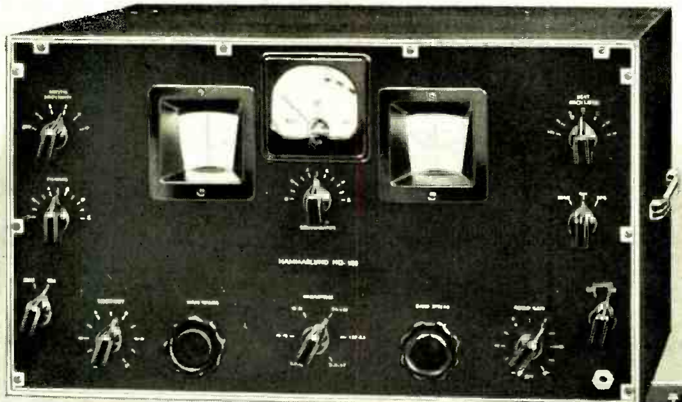
NUMBER 238

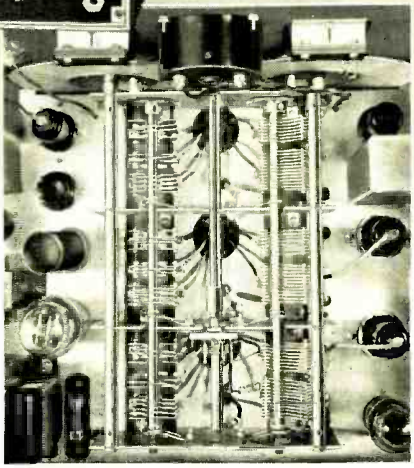
30c IN U.S.A AND CANADA

[illegible] in United Kingdom. 2s [illegible] Australasia

9.7~555 METERS

High Performance ON ALL BANDS





THE NEW "HQ-120" amateur communications receiver has been designed from the standpoint of obtaining peak performance on all bands. Special circuit arrangement and tuning condenser construction has made it possible to maintain practically uniform sensitivity throughout all amateur bands. It is no longer necessary to confine your activities to certain bands because of receiver limitations. This high, uniform sensitivity coupled with the new variable crystal filter is a very desirable combination. The band-width of the filter can be adjusted to permit full benefit of sensitivity even in the most crowded phone or CW bands. Sensitivity and selectivity must be combined for perfect results. One without the other is useless. In addition, the "HQ-120" has many other outstanding features. The antenna compensator permits perfect circuit alignment, maximum sensitivity and maximum image rejection on all bands with all popular types of antennas. The special 310° band-spread dial calibrated in each of the amateur bands from 80 to 10 meters permits the operator to tell at a glance the frequency of the incoming signal or that of his own transmitter.

SPECIAL FEATURES

★ The special tuning condenser assembly has 15 sections—9 for band spread and 6 for main tuning. This provides uniform gain on all amateur bands.

★ Accurately calibrated "S" meter reads in "S" units from 1 to 9 and up to 40 db. above "S-9". Accurate on all bands due to uniform receiver gain.

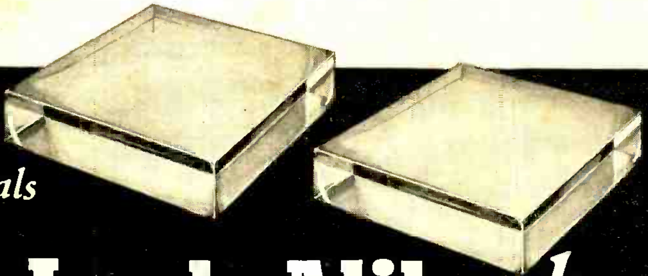
★ Noise limiter for reducing automobile ignition QRM and similar disturbances. Extreme aid in receiving weak signals on 10 and 20 meter bands.

WRITE DEPT. R-4 FOR 16-PAGE DESCRIPTIVE BOOKLET

HAMMARLUND MFG. CO., INC.
424-438 WEST 33rd ST., NEW YORK

Canadian Office: 41 W. Av. No., Hamilton

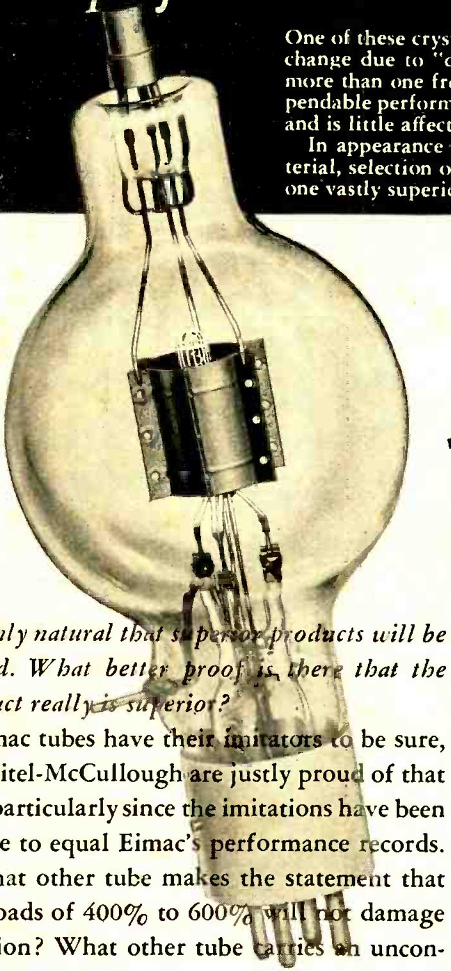
Two
Quartz Crystals



They Look Alike *but*
in performance there is a vast difference!

One of these crystals is an erratic performer; has a wide frequency change due to "drift"; gives low power output and operates on more than one frequency. The other crystal is excellent; gives dependable performance on only one frequency at high power output and is little affected by temperature change.

In appearance they are identical but proper choice of raw material, selection of the cutting axis and precision fabrication make one vastly superior to the other.



and so it is with VACUUM TUBES

It's only natural that superior products will be copied. What better proof is there that the product really is superior?

Eimac tubes have their imitators to be sure, and Eitel-McCullough are justly proud of that fact, particularly since the imitations have been unable to equal Eimac's performance records.

What other tube makes the statement that overloads of 400% to 600% will not damage emission? What other tube carries an unconditional guarantee against tube failures which are caused by gas released internally? What other tube will operate at equal efficiencies?

Last season the DX contest saw every winner (first, second and third in both phone and CW contests) using Eimac tubes. This is a record that probably will never be equalled.

That Eimac tubes do have superior characteristics is a fact recognized by the world's leading radio engineers and thousands of progressive amateurs. Step into line with the world's leaders by installing Eimac tubes in your transmitter. With proper handling you too can rank at the top in amateur radio communications.

See your dealer for information or write.

Eimac TUBES

EITEL-McCULLOUGH, INC., San Bruno, California

RADIO

7460 Beverly Boulevard, Los Angeles

Phone: YOrk 7226 Teletype: L A 319 Cables: Radiopubs, Los Angeles

Branch Advertising Offices: NEW YORK, 101 W. 31 St., Phone: CHickering 4-7399
CHICAGO, 3606 N. Bernard St., Phone: JUNiper 5575

Production Office for "RADIO": EAST STROUDSBURG, PA., 45 Lackawanna Ave.
Phone: Stroudsburg 1734 Teletype: SDBG 74

Correspondence

Direct all manuscripts, subscription and book orders, payments, and general correspondence to the home office at Los Angeles. Regarding advertising, see notice at right. Unusable, unsolicited manuscripts will be destroyed unless accompanied by a stamped, addressed return envelope.

Rates

SUBSCRIPTION RATES: Two years, $4.00, or $2.50 yearly in U. S. A. (add 3% tax in California), Canada*, Newfoundland*, Cuba*, and Mexico*. To Pan-American countries and Spain, $0.50* per year additional. Elsewhere† (except New Zealand), $1.00* per year additional. New Zealand only: 18s.6d. yearly, local currency, from Te Aro Book Dept, Ltd., 64 Courtenay Place, Wellington. Special issues are included only with subscriptions of one-half year or longer. Refunds on cancelled subscriptions will be made at the difference between the rate paid and the rate earned.

THREE YEAR SUBSCRIPTIONS at the rate of $5.00, net, in advance, are accepted from the U. S. A. and contiguous countries* only. Such subscriptions must be sent direct to our home office, not through agents.

SINGLE COPY PRICES: Prices are for regular issues; prices for special issues may vary but are usually those shown in parenthesis. At newsdealers, book stores, and radio parts dealers, 30c (50c) per copy in U. S. A. and Canada. By mail, postpaid, from home office, 30c (50c) in U.S.A., Canada*, Newfoundland*, Cuba*, and Mexico*; 35c* (55c)* in other Pan-American countries and Spain. Elsewhere†, 40c* (65c).*

BACK ISSUES, when available, 5c extra net. Back issues will not be included in subscriptions.

***REMITTANCES** must be payable at par in continental U. S. A. except as follows: Canadian bank, postal, and express orders and postal notes accepted; add 10c exchange to Canadian bank checks. From elsewhere, remit by bank draft (preferred) or international money order.

†BRITISH remittances: for the convenience of British customers we quote sterling prices (and accept British postal orders and cheques payable at par in London) valid whenever £1 = $4.70 or more. When exchange is lower, increase sterling amount proportionately or remit in dollars. Subscriptions: 1 year, 14s. 6d.; 2 years, £1 5s. Single copies, 1s. 8d. (special issues, 2s. 9d.—see above).

The Editors . . . .
. . . . of "Radio"

EDITOR

W. W. Smith, W6BCX

ASSOCIATE EDITORS

Ray L. Dawley, W6DHG
Frank C. Jones, W6AJF
K. V. R. Lansingh, W6QX
E. H. Conklin, W9BNX
CHICAGO

CONTRIBUTING EDITOR

Herbert Becker, W6QD

EDITORIAL AND TECHNICAL ASSISTANTS

Leigh Norton, W6CEM
Faust R. Gonsett, W6VR
Jack Rothman, W6KFQ
Kennard D. Moore, W6PDB
B. A. Ontiveros, W6FFF, Technical Draftsman

●

Business Staff

Los Angeles

K. V. R. Lansingh, Publisher
A. McMullen, Managing Editor

Sales Department

John Snetsinger, Circulation and Advertising Manager; **E. M. Johnson,** Assistant Advertising Manager; **M. Zeis,** Chief Subscription Clerk; **F. Taylor,** Chief Book Sales Clerk.

New York

V. R. Lansingh, Eastern General Manager

Chicago

C. W. Nelson, Asst. Advertising Manager

East Stroudsburg

W. E. McNatt, Jr., Production Manager

Advertising

Advertising inquiries may be directed to our nearest office. For fastest service, prepare advertising copy in duplicate; send original copy and cuts (fully mounted and mortised) to East Stroudsburg where "Radio" is printed; send duplicate copy, proofs of cuts, and space order to the advertising department at Los Angeles. No advertisment will run until the home office telegraphs its approval.

Miscellaneous Notices

IF YOU MOVE notify us in advance. We cannot replace copies sent to your old address. See "Changes of Address" notice elsewhere in this issue.

Radio is published ten times yearly (including enlarged special annual number) about the middle of the month preceding its date; August and September issues are omitted.

PUBLISHED BY RADIO, Ltd., Technical Publishers, 7460 Beverly Blvd., Los Angeles, California, U.S.A.

TITLE REGISTERED at United States Patent Office.

PRINTED IN U.S.A. by Hughes Printing Company, East Stroudsburg, Pennsylvania.

RESPONSIBILITY will not be accepted for subscriptions placed with unauthorized agents. Prospective subscribers are urged to inspect carefully the credentials of anyone soliciting their business. Agents are never authorized to vary the rates quoted on this page.

BRANCH OFFICES transact a cash business with customers who call in person; mail orders and orders on open account should be sent only to Los Angeles.

Principal Foreign Agents

Europe: N. E. Read, 24, Church St., Oswestry, Shropshire, England. Australia: "The Bulletin", Box 2521BB, Sydney; McGills, 183 Elizabeth St., Melbourne; Swain & Co., Pitt St., Sydney. New Zealand: Te Aro Book Depot, Ltd., 64 Courtenay Place, Wellington. South America: F. Stark, Caixa 2786, Sao Paulo; "Revista Telegrafica", Peru 165, Buenos Aires; Edi'orial Pan America, Peru 677, Buenos Aires. South Africa: South African Radio Publications, 40 Trust Buildings, Fox Street, Johannesburg.

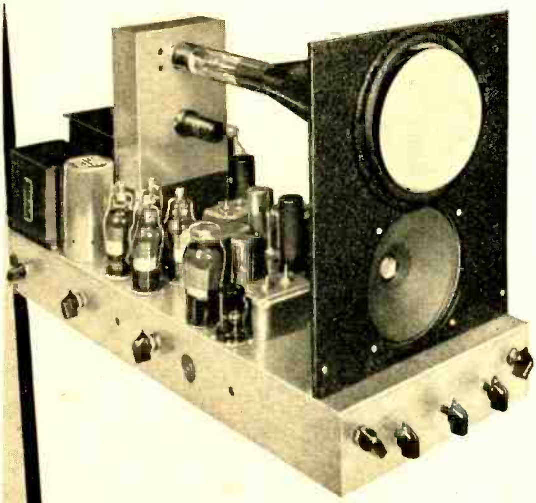
The Worldwide Technical Authority of Amateur, Shortwave, and Experimental Radio

RADIO, *April, 1939, no. 238.* Published monthly except August and September by Radio, Ltd., 7460 Beverly Blvd., Los Angeles, Calif. Entered as second-class matter Feb. 6, 1936, at the postoffice at Los Angeles, Calif., under the Act of March 3, 1879. Additional entry at East Stroudsburg, Pa. Registered for transmission by post as a newspaper at G.P.O., Wellington, New Zealand.

IT'S HERE AT LAST

THE MEISSNER

TELEVISION KIT!!



SOUND as well as VIDEO—both in one unit!

★

The New Shock-proof design!

★

Meissner quality at a price anyone can afford to pay!

★

Meissner OFFERS YOU practical TELEVISION because Meissner has put years of time in research to be READY when REAL TELEVISION arrived. It is HERE NOW!

★

Get your name in NOW for the first information!

Two models—one with 3-inch and one with 5-inch tube!

★

The last word in modern TELEVISION!

WRITE *Meissner* **TODAY FOR FULL DETAILS!**

DEPT. A-4, MT. CARMEL. ILL.

"A FAMOUS NAME FOR TWO DECADES"

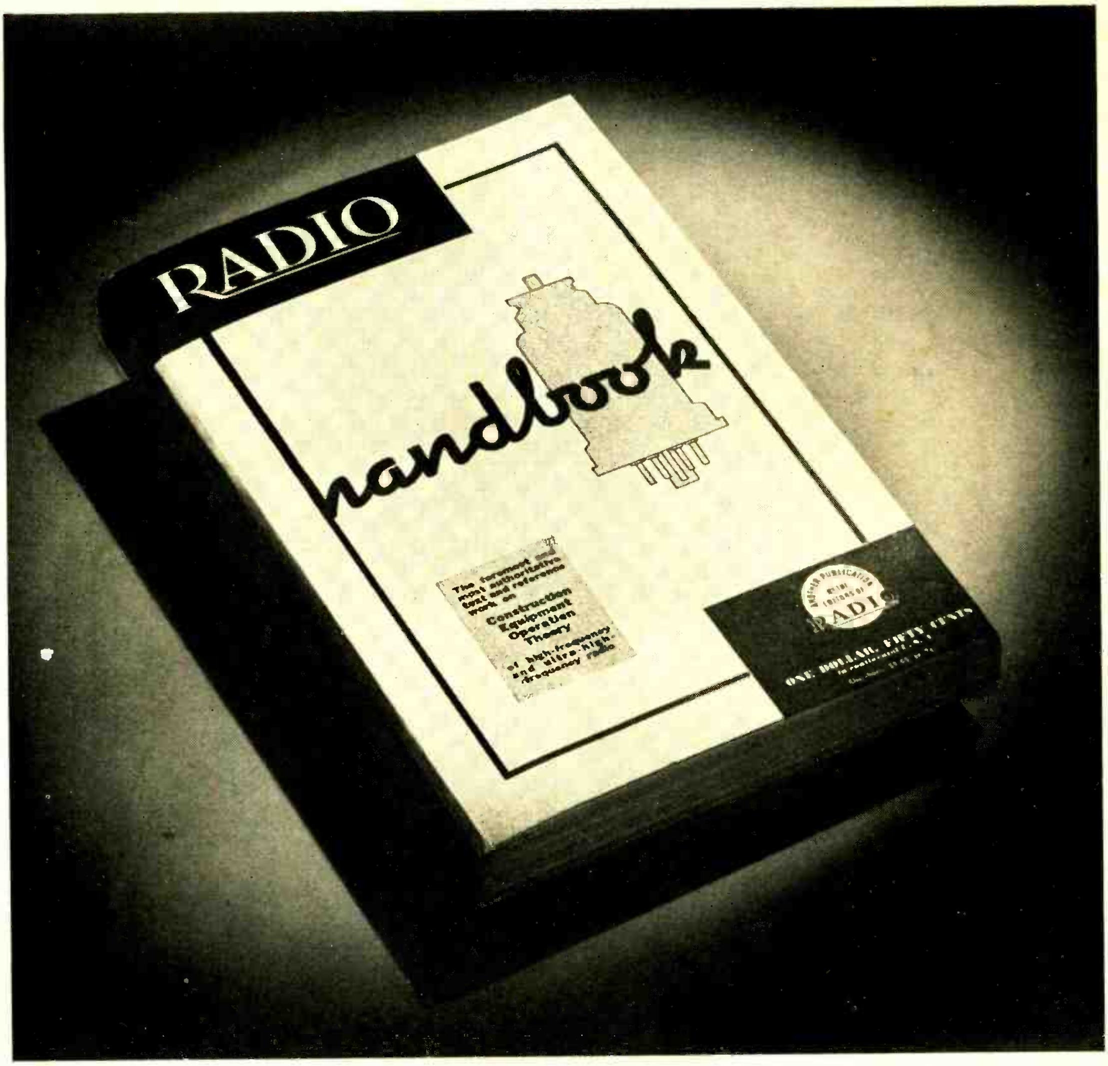
MAIL COUPON

MEISSNER MFG. CO.
Mt. Carmel, Illinois, Dept. A-4
Please *rush* me information on TELEVISION KITS!!

Name ______________________

Address ______________________

City ______________ State ________



ORDER YOUR COPY . . . *TODAY!*

The new, 1939 "RADIO HANDBOOK" with over 550 pages, profusely illustrated, is the foremost and most authoritative text and reference work on Construction . . . Equipment . . . Operation . . . Theory of high- and ultra-high frequency radio obtainable. Get it from your local radio parts dealer, or order direct from us.

ONE DOLLAR, FIFTY CENTS
In Continental U. S. A.
$1.65 Elsewhere

RADIO LIMITED *Technical Publishers* 7460 Beverly Boulevard, Los Angeles

April • 1939 **No. 238**

RADIO

Table of Contents

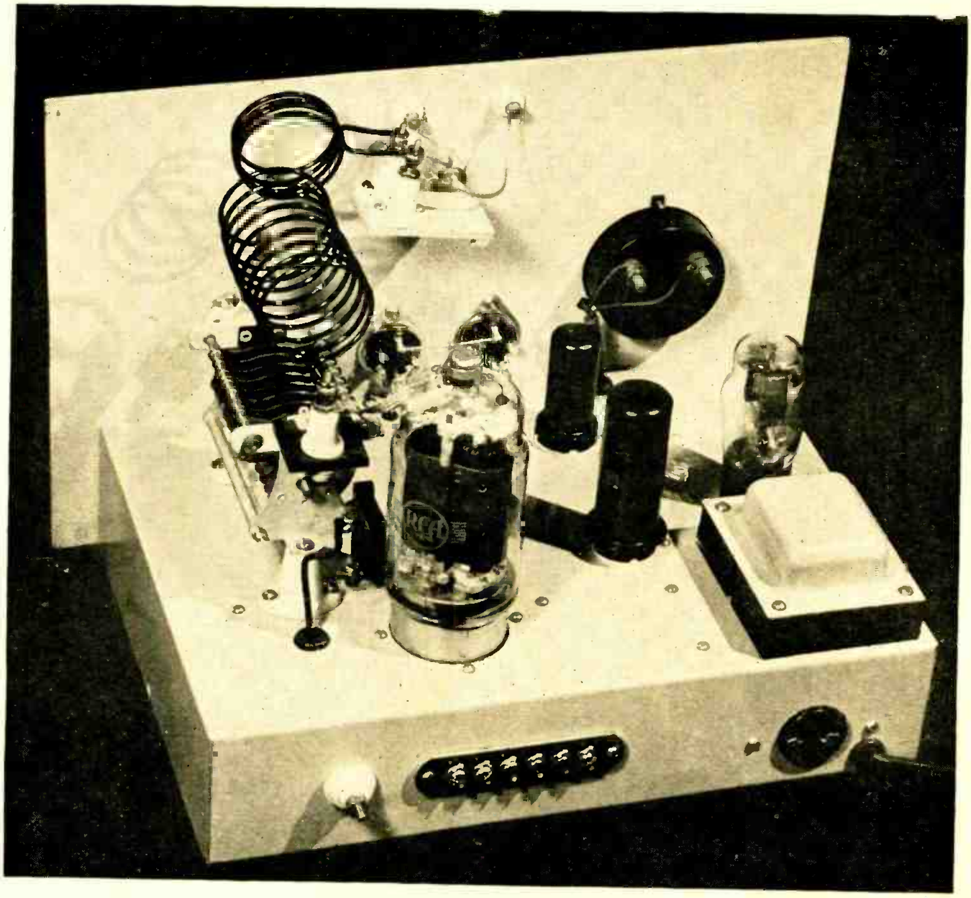
Cover— "Tower of the Sun," Treasure Island (See page 64)

ARTICLES

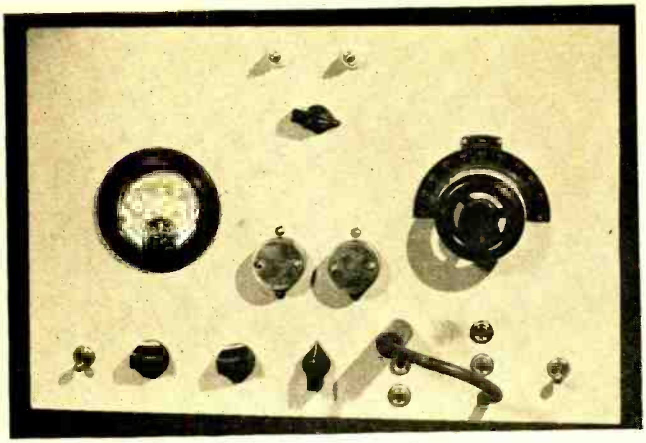
MISCELLANEOUS FEATURES

DEPARTMENTS

THE WORLDWIDE TECHNICAL AUTHORITY OF AMATEUR, SHORTWAVE, AND EXPERIMENTAL RADIO



Rear view of the 813 transmitter. The bias rectifier and transformer may be seen at the extreme right. The variable antenna coupling assembly is visible in the center of the panel. The coils shown are those for 20 meters.



Front panel view of the 813 rig. Crystals are mounted on the panel, where they are easily available for quick frequency change. The two insulators at the top of the panel are for antenna connections.

An 813 Bandswitching Transmitter

By LEIGH NORTON,* W6CEM

Due to their low excitation requirements and elimination of neutralization problems, the new large beam tetrodes lend themselves nicely to single-unit transmitter construction. The 813, for instance, requires only one-half watt of driving power for full output. The grid-to-plate capacitance of this tube is only 0.2 μμfd., allowing it to be operated on frequencies as high as 30 Mc. without neutralization. With the excitation and neutralization factors eliminated, or at least greatly simplified through the use of such a tube, the design and construction of a compact 250-watt transmitter becomes a relatively simple problem. Even by erring on the conservative side and assuming that as much as five watts of driving power are required, the exciter may be an extremely simple one, and the use of a little care in the physical layout of the transmitter will forestall any tendency toward self-oscillation in the 813.

The transmitter shown in the photographs provides an output of from 175 to 250 watts on the 10-, 20-, 40- and 80-meter bands. Except when changing to or from ten meters, only one coil need be changed when changing bands. The rest of the bandswitching operation is taken care of by a single three-section isolantite tap switch. The final amplifier plate coils plug in atop the final tuning condenser, where they are easily reached from the front. For 10-meter operation, both the tank coil and the antenna coil are changed.

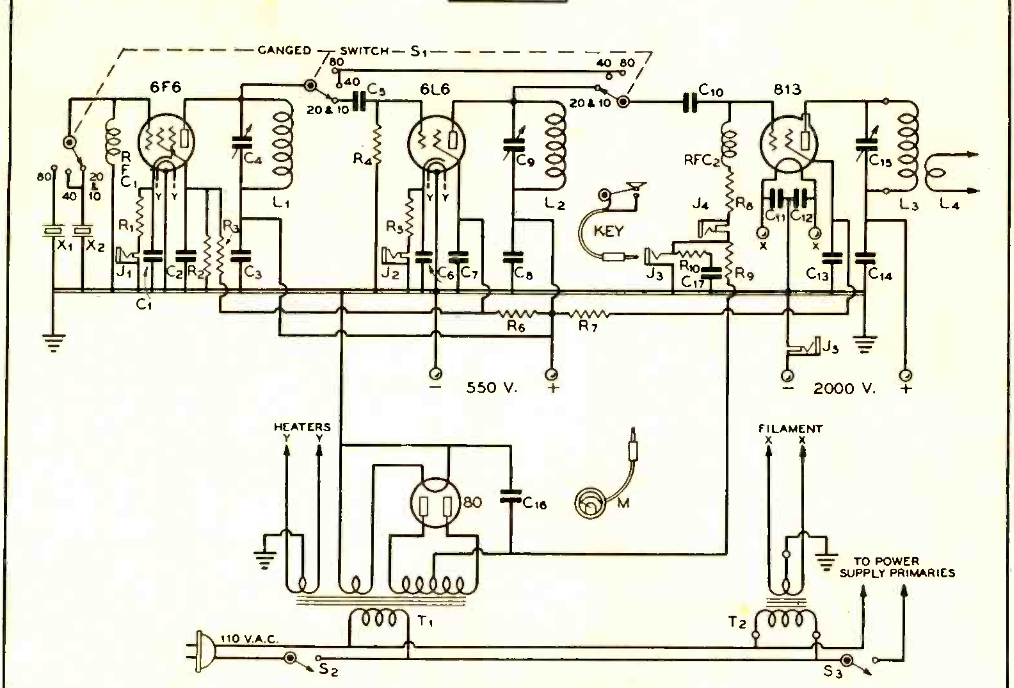
Circuit Details

The crystal oscillator stage uses a cathode-biased 6F6. Either 80- or 40-meter crystals are selected by the first section of the bandswitch. The 80-meter crystal is used only when operation on that band is desired, the 40-meter one being used on all other bands. By the use of a 150-μμfd. condenser at C_4, the plate tank circuit is enabled to hit both 80 and 40 meters. The number of turns on the plate coil, L_1, must be carefully adjusted to allow the circuit to cover both bands, however.

Output from the crystal stage is carried

---

* Technical Assistant, RADIO.



General wiring diagram of the bandswitching transmitter.

C_1—.006-µfd. mica
C_2—.01-µfd. 400-volt tubular
C_3—.006-µfd. mica
C_4—150-µµfd. midget variable
C_5—50-µµfd. mica
C_6—.006-µfd. mica
C_7—.01-µfd. 400-volt tubular
C_8—.006-µfd. mica
C_9—150-µµfd. midget variable
C_{10}—50-µµfd. mica
C_{11}, C_{12}—.002-µfd. mica
C_{13}—.006-µfd. mica
C_{14}—.002-µfd. 5000-volt mica
C_{15}—55-µµfd. variable, 4500-volt spacing
C_{16}—2-µfd. 600-volt paper
C_{17}—.05-µfd. 600-volt tubular
R_1—1000 ohms, 10 watts
R_2—20,000 ohms, 10 watts
R_3—5000 ohms, 10 watts
R_4—100,000 ohms, 1 watt
R_5—1000 ohms, 10 watts
R_6—15,000 ohms, 10 watts
R_7—10,000 ohms, 10 watts
R_8—25,000 ohms, 10 watts
R_9—500,000 ohms, 1 watt
R_{10}—100 ohms, 1 watt
T_1—Broadcast receiver transformer. 700 v., c.t.; 6.3 v., 2.5 a.; 5 v., 2 a.
T_2—10 v., 5 a. (mounted in power supply)
J_1, J_2—Single closed circuit jack
J_3—Single open circuit jack
J_4, J_5—Single closed circuit jack
X_1—80-meter crystal
X_2—40-meter crystal
S_1—Three-section three-pole four-position switch (see text)
S_2, S_3—Heavy duty s.p.s.t. toggle switch
RFC, RFC_1—2.5 mh.

to the second section of the bandswitch where it goes either to the 813 grid (through the third section of the bandswitch) for 80- or 40-meter operation, or to the grid of the 6L6 doubler-quadrupler for 20- and 10-meter operation. A combination of cathode and grid-leak bias is used in this stage. Because more than ample power is available to drive the final stage, it is possible to use the rather high value of 1000 ohms in the cathode of the 6L6. This high bias limits the plate current on the stage to about 30 milliamperes when it is operated without excitation, as it is when the transmitter is on 80 and 40 meters. As in the crystal stage, the plate tank of the doubler-quadrupler is designed to cover two bands. L_2 is of such a size that it tunes to both 20 and 10 meters with the 150-µµfd. condenser, C_9.

From the plate of the 6L6, output is carried to one point on the third section of the bandswitch. This section of the switch is placed in the grid of the 813, where it selects output from either the crystal or the doubler-quadrupler stages. As in the other section of the switch, one point serves for both 20- and 10-meter operation. When changing from 20 to 10 meters, or vice versa, it is necessary only to retune the 6L6 plate circuit and place the proper coils in the 813 plate circuit.

The Final Amplifier

Except for the keying system used, the 813 stage is quite conventional from an electrical standpoint. Screen voltage is obtained from the low voltage power supply through a 10,000-ohm resistor, R_7. By using a fairly high resistance such as this, the screen current is prevented from going high enough to damage the tube should the key be closed while the exciter stages are turned on but plate voltage is not being applied to the 813.

The final stage is block-grid keyed, blocking bias being obtained from a small broadcast receiver type transformer which also supplies the heaters of the 6F6 and the 6L6. By operating the exciter filaments from the bias transformer in this manner, it is impossible to place the transmitter in operation without first applying bias to the final stage.

Voltage from the bias supply is fed to the grid of the 813 through a 500,000-ohm resistor, R_9. Keying is accomplished by shorting out the bias, the 500,000-ohm resistor limiting the current passing through the key. Since the total grid and bias-bleeder current amounts to but a few milliamperes, there is no arcing at the key and keying is smooth and trouble free. The 2-μfd. condenser across the bias supply is not for filtering purposes but is used merely to smooth out the peaks in the output voltage. A simple condenser and resistor combination, C_{17}-R_{10}, effectively eliminates key clicks.

Since the single-ended tank circuit requires a rather high capacity condenser, a 55-$\mu\mu$fd. unit is used at C_{15}. The coils are proportioned so as to give optimum L/C ratio on each band. Too much capacity across the plate coil results in lowered efficiency, while insufficient capacity lowers the circuit Q to a point where the maximum output point is different from that at which the plate current is minimum.

Mechanical Details

Due to the aforementioned low excitation requirement of the 813 it becomes possible to build the exciter stages with the intention of obtaining maximum convenience rather than maximum output and efficiency. It is thus not necessary to give serious thought to the effect of doing such unorthodox things as mounting coils so that they barely clear the chassis and using extremely high C/L ratios on some bands. It is almost a certainty that there will be sufficient excitation in spite of the apparent inefficiency of the mechanical design. This proved to be the case with this transmitter—there is more than ample excitation available on all bands.

The chassis measures 10 x 14 x 3 inches. The bandswitch occupies the center portion of the chassis. The particular switch used is a rebuilt standard three-section four-position isolantite affair. With the aid of two long pieces of threaded rod, four pieces of hollow brass rod, and a piece of flat brass strip to turn the two rear sections, the switch was extended to a length of 6½ inches. This brings the rear section near the grid terminal on the 813 socket. The center section was located slightly forward of the center of the switch, where it is conveniently close to both the plate of the 6F6 and the grid of the 6L6. Switches such as this may now be easily constructed from a kit of parts supplied by the manufacturer. The front section of the switch is used for switching the crystals. The second section is in the plate of the crystal stage and the third section is the one in the grid of the 813, of course.

Mechanical Construction

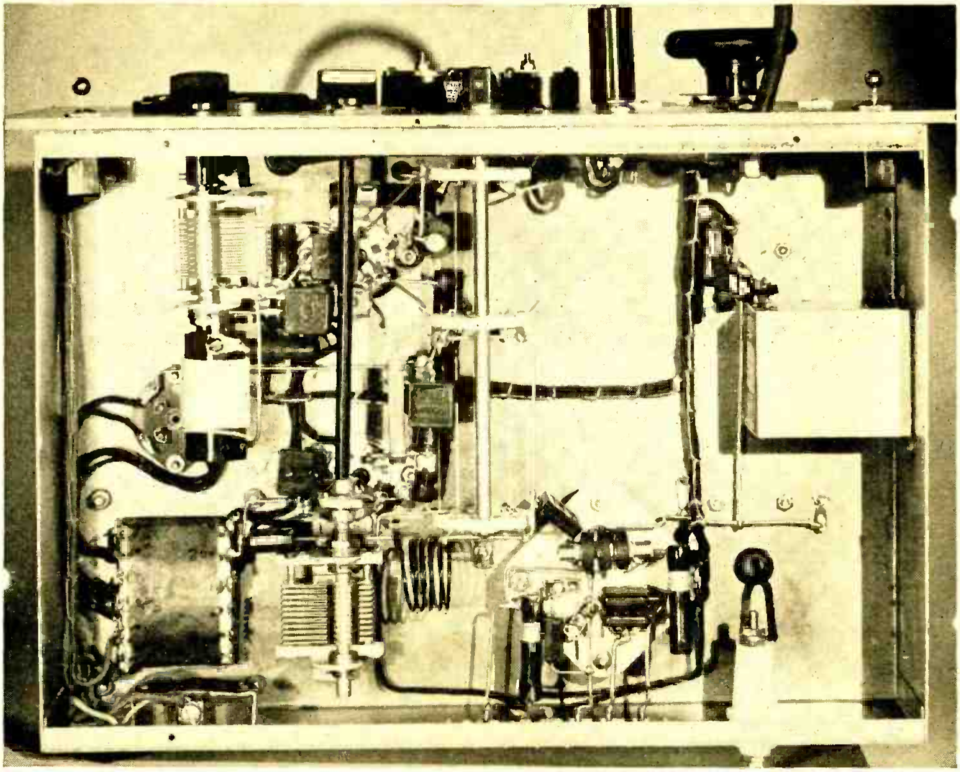
Looking at the transmitter from the top front, the exciter and bias supply occupy the left side of the chassis. The exciter stages are placed one behind the other just to the left of the bandswitch. The right side of the chassis is apportioned to the 813 and its associated plate and antenna circuits.

Underneath the chassis the various components are mounted as convenience dictates.

COIL TABLE

Band	L_3 turns	L_3 wire size	L_4 turns	L_4 wire size
10	6	no. 10	5	no. 10
20	9	no. 10	6	no. 10
40	19	no. 14	same as for 20 meters	
80	40	no. 14	same as for 20 meters	

L_3 is 1½" long and 1" in diameter for 10 meters. L_4 is ¾" long and 1" in diameter for 10 meters. All other L_3 coils are 2" in diameter and 5" long. L_4 for 20, 40 and 80 meters is 2" in diameter and 1¼" long.



All of the exciter components except the tubes are visible in this bottom view. The large block at the extreme right is the bias filter condenser.

The two tank coils are supported by their respective condensers. The crystal stage plate coil consists of 25 turns of no. 20 double cotton covered wire close wound on a 1-inch bakelite tube. This coil is supported on its front end by a large lug which holds it to the condenser rotor nut. On the other end, the coil is supported by a heavy piece of wire which also forms the stator connection to the condenser. The doubler-quadrupler plate coil is mounted between the rotor of its associated condenser and the "20- and 10-meter" terminal of the third section of the bandswitch. This coil has five turns of no. 14 wire and is ⅞ inch long and one inch in diameter. The coil is adjusted by squeezing or separating the turns until it hits both 20 and 10 meters.

Since the two exciter stage plates are series-fed, it is necessary to insulate the rotors of the tank condensers from the chassis. This is accomplished by mounting the condensers from the chassis on small pieces of bakelite rod which are drilled and tapped for 6-32 screws. The bakelite "standoffs" are each one-half inch long, this length allowing the rotor shafts to be brought directly out at the center of the front drop of the chassis.

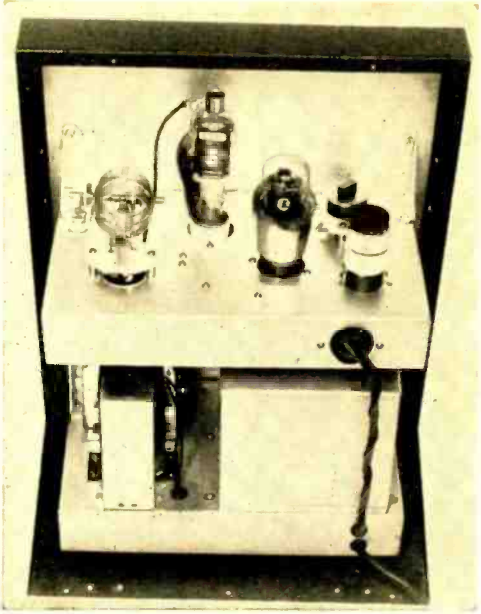
813 Stage

The 813 socket is mounted about one-half inch below the chassis by the use of short pieces of hollow brass rod. Mounting the tube below the chassis allows the plate connection to the tank coil to be shortened somewhat without resorting to raising the condenser and coil assembly unduly high above the chassis. As only five of the seven prongs on the 813 base are connected to tube elements, the remaining two terminals on the socket are used as tie points for the various resistors and condensers associated with the grid, filament and screen circuits.

Plate coils for the 813 plug in atop its plate condenser, which is mounted "upside down" on a pair of one-inch standoff insulators. Two through-panel-type jack-top insulators are used as coil mounts. The front one

[*Continued on page 74*]

The exciting voltage for a frequency multiplier or class-C amplifier should be sharply peaked and have a short pulse (angle of flow). This ordinarily means high bias and excitation power. By making use of some third harmonic in the excitation, the same effect can be realized with less bias and driving power.



High Efficiency Frequency Doubling

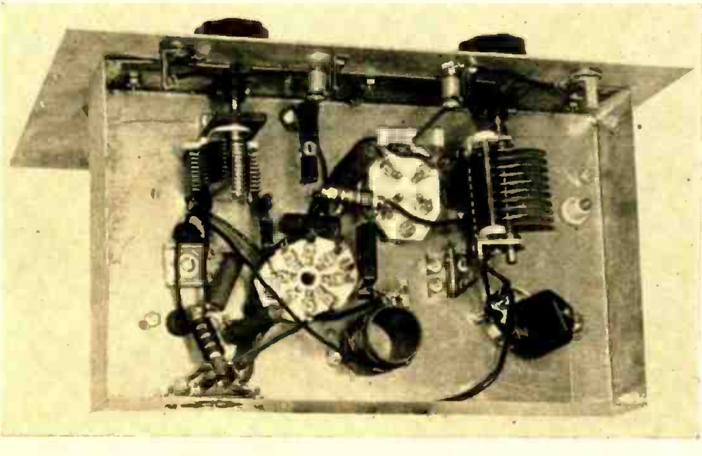
By FRANK C. JONES,* W6AJF

Frequency doublers play a very important part in the operation of short-wave transmitters. By proper design of the doubler stages, their cost often can be reduced for a given power output without any sacrifice in quality of parts. In many transmitters the output can be increased on the higher frequency bands by utilizing the full capabilities of the existing tube complements, with very small readjustments or changes in circuit constants. This article is for the purpose of clarifying the operation of standard frequency doubling circuits and to present a new circuit which has many advantages.

The simplest frequency doubler circuit is shown in figure 1 in which the impressed grid frequency is doubled in the plate circuit. The tube, a triode, tetrode or pentode, is normally operated with high grid bias and high r.f. excitation in order to obtain a reasonable output on the second harmonic.

The d.c. power input to the plate of the doubler tube is usually from 2 to 4 times as much as the r.f. power output from the stage.

Associate Editor, RADIO



Bottom view of the r.f. chassis of the 6L6G-809 exciter. The power supplies are in the lower deck of the rack.

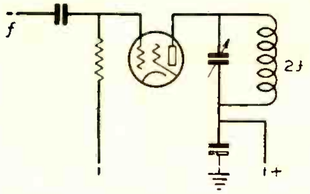


Figure 1. Simplest type of frequency doubler circuit.

The efficiency ordinarily is around 30 per cent in the case of triodes and from 30 to 50 per cent for tetrodes or pentodes.

The r.f. power gain from the grid circuit to the plate circuit may be less than one, and seldom is more than two, which indicates that a large amount of grid circuit drive is being used. There are several reasons for the requirement of large values of grid excitation: first, to produce a low operating angle of plate current flow for efficient doubler operation, and second, to overcome a natural degeneration in the doubler circuit at the second harmonic.

Figure 2 shows the plate and grid r.f. voltages developed across the tuned plate and grid circuits of the doubler stage. The plate voltage swing is twice as high in frequency as the grid swing for its main component, and one of the minimum values occurs at the maximum positive grid voltage portion of the cycle. The plate current flows during a small portion of the 360 degrees of one cycle; and power loss in the tube becomes smaller as the number of degrees through which plate current flows is decreased. If the sine wave of grid driving voltage is flattened out by any means, the plate current will flow for a longer period per cycle and the plate power loss will be increased at the expense of r.f. power output.

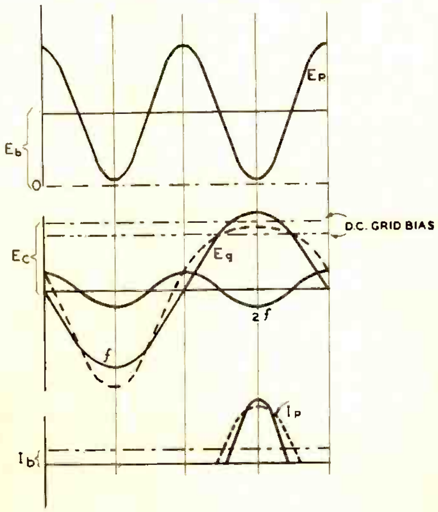


Figure 2. Phase relations and wave shapes of plate and grid voltages developed across the plate and grid circuits of the doubler shown in figure 1.

The solid curve of grid voltage E_g indicates the effective value of exciting voltage for a triode or other type of tube which is not thoroughly screened. As can be seen readily, the d.c. grid bias can be made higher if higher r.f. grid voltage is available, and the plate current can be made to flow over a smaller angle. The result will be higher efficiency in the plate circuit, since the r.f. grid voltage will exceed the d.c. grid bias over a smaller portion of the positive peak of the exciting wave. Normally a frequency doubler has as much or nearly as much d.c. grid current flowing as for a regular class-C amplifier, but it should have from two to six times as high a d.c. grid bias.

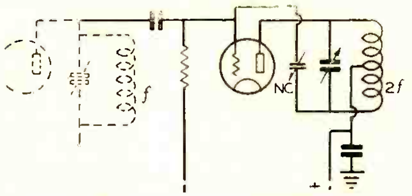


Figure 3. Split-plate-tank neutralized doubler circuit to eliminate degeneration due to capacitive feedback within the stage.

Degeneration in Doublers

Unfortunately a degenerative effect takes place in a frequency doubler because of the grid-to-plate capacity of all but perfectly shielded screen-grid tubes. Any grid-to-plate capacity feeds back r.f. voltage as indicated in figure 2 and produces a peaked negative value and a flattened positive value of grid driving voltage as shown by the dotted curve of E_g in figure 2. The sharpened negative peak is of no benefit; however, the flattened positive peak means that plate current flows over a larger portion of the cycle. This results in more plate dissipation and much less r.f. output power. To offset this, the grid drive must be made excessively high and the r.f.

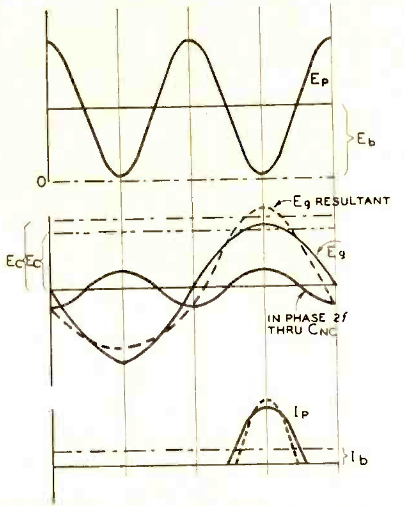


Figure 4. Resulting wave shapes produced by increasing the capacity of the neutralizing condenser to the point where the exciting wave form becomes sharply peaked.

output may be less than the exciting r.f. power.

Neutralization

If the grid-to-plate capacity of the triode (or imperfectly screened tetrode or pentode) is neutralized with a split-plate-tank circuit and neutralizing condenser as shown in figure 3, no "out of phase" second harmonic voltage appears across the input circuit. There is usually several hundred ohms impedance even at the second harmonic of the tuned grid circuit. The neutralizing condenser can be increased in capacity to feed back second-harmonic voltage across the grid impedance in order to peak the effective grid driving voltage as shown in the dotted curve of figure 4. This results in lower angle of plate current flow, greater plate circuit efficiency, and less plate loss. The extent to which this idea can be carried is limited by shunt loss at the fundamental frequency through a larger value of neutralizing condenser-to-ground through the low impedance (at fundamental frequency) plate tank, or by self-oscillation at the second harmonic due to excessive feedback.

At very high frequencies, the circuit of figure 1 may become too regenerative, due to a tuned-plate tuned-grid oscillator circuit effect, unless a screen grid tube is used. In many transmitters, the value of NC in figure 3 can be increased to from 1 to 2 times the actual neutralizing value with resulting increase of doubler output for a given value of grid excitation. The circuit of figure 3 with a by-passed coil center tap or with split-stator tuning condenser should be used in preference to an "unneutralized" frequency doubler for all triode tubes. The circuit of figure 1 is suitable for tetrodes or pentodes which have little or virtually no plate-to-grid capacity.

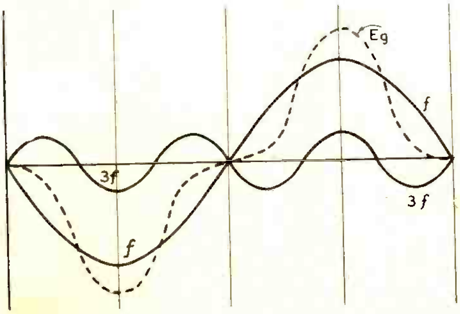


Figure 5. *f* indicates wave form of sine wave exciting voltage; 3*f* indicates third harmonic component that is added; dotted line, E_g, shows the resulting highly peaked excitation wave form that is obtained. This type of exciting wave form is excellent for driving doubler stage.

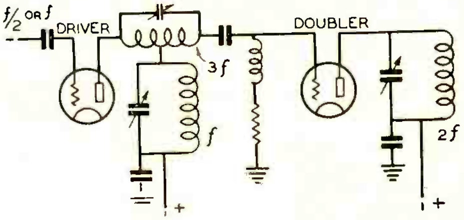


Figure 6. Drawing showing the method of inserting the third-harmonic tank circuit in the excitation lead between the driver and the doubler stage in order to obtain the proper phase relation between the fundamental component and the third harmonic.

Exciting Voltage Wave Form

When doubler or class-C amplifier circuit operation is analyzed, it is readily seen that a peaked value of grid voltage would greatly increase the efficiency of operation for medium or low values of grid excitation. The sine wave of grid voltage "f" in figure 5 cannot itself be peaked because of the preceding tuned plate circuit. A tuned circuit always tends to smooth the pulses of driving plate power into a sine wave. However, if some third harmonic can be added to the fundamental in the proper phase relation, the result is a very peaked wave form as shown by the dotted curve of figure 5. The third harmonic, "3f," must be added so as to peak the positive part of the grid driving voltage. A moderately sharp, narrow peak of grid voltage with medium d.c. bias, will have about the same effect as a sine wave of very high amplitude and high C bias as far as plate circuit efficiency is concerned. The power gain through the class-C amplifier or doubler can be increased in this way if the source of third harmonic voltage can easily be obtained.

This can be accomplished with an external third harmonic generator tube or by means of the very simple circuit illustrated in figure 6. A small tank circuit tuned to "3f" is connected into the plate circuit of the driver tube as shown in figure 6 and the driver tube generates its own "f" and "3f" frequencies in the proper phase relations. The "3f" tank must be center tapped as indicated in order to reverse the "3f" voltage across the grid circuit and so to aid the "f" voltage on its positive peaks. The total tank capacity across the "3f" coil consists of the effective output capacity of the driver tube, stray capacities, tuning condenser across "3f" coil, and grid input capacity of the driven tube.

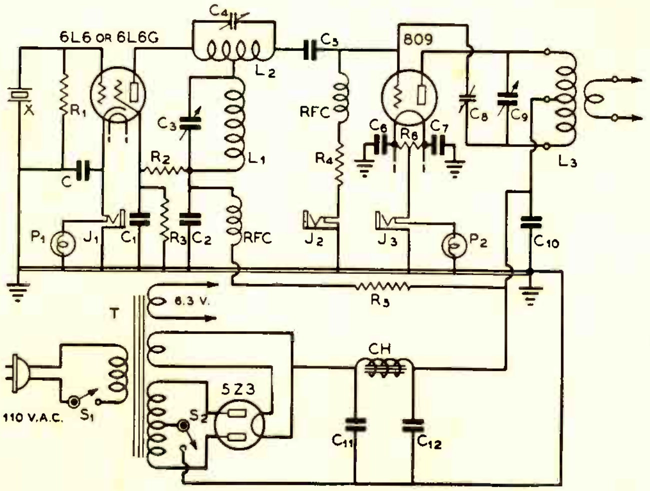
If the first and last named capacities are approximately equal, the "3f" tank coil can be center tapped exactly; however, the exact point of tapping is not at all critical. In practically all cases a center tap is satisfactory. If the driver tube is a neutralized buffer stage, the tuning condenser across the "f" coil should be a split-stator type in order to provide a low impedance path to ground for the "3f" center-tap energy.

Applying the New Doubler Circuit

This new doubler circuit in tests with a 6L6 driver and an 809 doubler showed an increase in power output of 10% and a decrease of d.c. plate current of 10% in the 809 stage. This represents nearly a 25% increase in output for a given input. Often a 10% increase of efficiency could be obtained, which makes this circuit as a doubler approach the efficiency of a class-C amplifier. Also, a 10% increase in efficiency (say, from 30% to 40%) permits more than a 50% increase in output for a given plate dissipation, and it is usually the latter factor which limits the output obtainable from a doubler.

The exciter illustrated in the photographs and in figure 7 uses the new doubler circuit both for doubling and for quadrupling in the 809 circuit. A perfectly standard 6L6G crystal

[*Continued on Page 78*]



Wiring diagram of the Jones peaked-wave form exciter.

C,C_1,C_2—.01-µfd. 600 volt tubular
C_3—100-µµfd. midget variable
C_4—3-30-µµfd. mica trimmer
C_5—.00005-µfd. mica
C_6,C_7—.01-µfd. 800-volt tubular
C_8—10-µµfd. neut. condenser
C_9—50-µµfd. 2000-volt variable
C_{10}—.006-µfd. 2500-volt mica
C_{11},C_{12}—2-µfd. 1000-volt oil filled
R_1—150,000 ohms, 1 watt
R_2—5000 ohms, 10 watts
R_3—17,500 ohms, 10 watts
R_4—15,000 ohms, 10 watts
R_5—4000 ohms, 50 watts
R_6—100-ohm c.t. resistor
T—1200 volts c.t., 200 ma.; 6.3 v., 4 a.; 5 v., 3 a.
CH—20-hy. 150-ma. choke
S_1—A.c. line switch
S_2—Plate voltage on-off switch
P_1—2-volt 60-ma. pilot lamp
P_2—6-volt 150-ma. pilot lamp
RFC—2.5-mh., 125-ma. r.f. choke
Coils-Conventional for band—see text

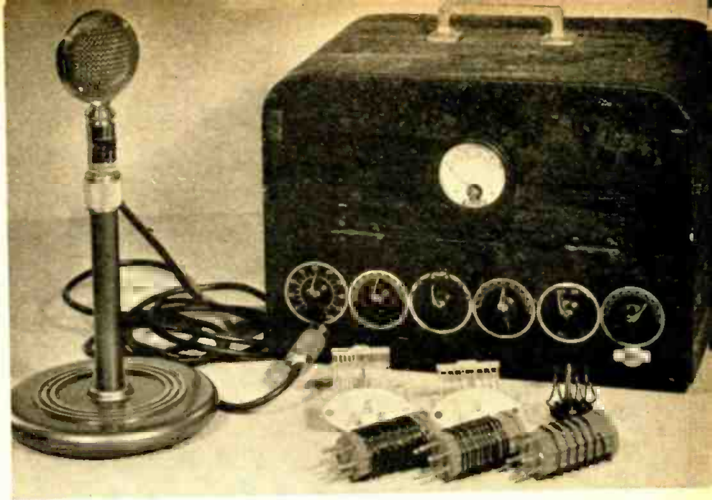


Figure 1. Showing the portable all ready to go. All it requires are an antenna and 110 volts a.c. For portable work the microphone is unscrewed from the stand, which is used only at the home station.

A Compact All-Band
PORTABLE TRANSMITTER

By DONALD G. REED,* W6LCL

Here is a portable transmitter that covers all bands from 5 to 160 meters and has better quality than the majority of amateur rigs heard on the air. The only thing found in a home transmitter that is lacking in this little job is power, and even so the power is sufficient to work a surprising amount of dx.

For some time it has been the ambition of the writer to build a compact, completely self-contained, low-powered multiband transmitter which would conform to the best practices of modern design.

A brief outline of the complete transmitter would be more or less as follows: In the r.f. section we must have a crystal (or high-stability e.c.) oscillator. For frequency multiplication a buffer-doubler is needed to excite the final, a class-C amplifier. This much is necessary before we are ready to consider the modulator, which preferably should incorporate a high-gain speech amplifier to allow the use of a crystal microphone.

To conform to good practice we must have complete frequency coverage of all the amateur phone bands with as few coils as possible. Good filtering is of course requisite in the power supply and complete metering is a point not to be overlooked just because the rig is to be low powered. So much for the essentials of completeness.

All of the above should apply to any transmitter, regardless of size or power, but to live up to each requirement in a job that can be carried in one hand is another, and a far more interesting problem.

The Exciter

Being the proud possessor of a complete, though somewhat dog-eared file of RADIO dating back to 1934, a complete survey of the field was made, to determine just which of the many circuits and tubes have stood up under the test of time and practical application. The tube choice for all-around ruggedness and performance was none other than the twin-triode, 53 or 6A6, to be used as the crystal oscillator and buffer-doubler stage, driving a beam-power tube of later design as the final modulated stage.

A 6A6, running well within the limits set by thousands of experimenters, gave ample

---

* 2454 Lyric Avenue, Los Angeles, Calif.

excitation on the frequencies we wished to cover. By introducing controlled regeneration into the crystal stage, the plate tank on the oscillator may be tuned to twice crystal frequency. This regeneration adjustment may then be forgotten as far as tuning is concerned. Doubling again in the buffer-doubler allows straight-through operation of the final on ten meters from a 40-meter crystal.

Modulator

The one stumbling block in the path of compactness is the modulator. While ample audio power can be produced in a small space by using class-B operation, this usually calls for a separate power supply to eliminate the reaction of varying current drain upon the other circuits. As we hoped to use one power transformer for all purposes, this condition could not be tolerated.

Class A_1 Operation of Beam Tubes

Investigation of the characteristics of the beam-power tubes brought to light a fresh field of operation. Actually it is nothing new, as most of us have at some stage of our experience used the underlying principle to gain modulating power to the greater or lesser detriment of quality. The tube manual, however, actually condones and gives operating data on what is called class-A_1 single-ended operation of the *beam-power tubes.*

This class-A_1 condition is a narrow band of operation and is reached at that point when the plate begins drawing additional current, but before grid current starts flowing. The actual power output is almost doubled, especially with fixed or semi-fixed bias, over the pure class-A rating before distortion increases materially. This slight increase in plate current at full modulation (in the neighborhood of five to seven ma. in this transmitter) is not enough to disturb the plate voltage to the other circuits drawing power from the common supply.

Speech Amplifier

A 6A6, cascade connected, has worked out very well as speech amplifier. It is advised, however, that the constants used in this job be followed quite closely, as it is possible to get much more gain from the cascade-connected tube than is necessary.

Tube Selection

The tube selection, therefore, is as follows: A 6A6 oscillator and buffer, driving a T21 in the final, with another 6A6 for speech amplification, driving the T21 modulator. A 5Z3 rectifier in the power supply section completes the selection.

Modulator-to-Final Coupling

A transformer was chosen as the coupling medium between the T21 modulator and the T21 final amplifier for two rather important and often neglected reasons. In the first place, if conventional Heising choke coupling (as

Figure 2. Top view of the portable, showing how the front panel drops forward to allow changing of coils when the unit is in the cabinet. Note the "double ended" buffer coil. One end is merely a jumpered 5-prong tube socket, sawed off and mounted on the top of the regular coil form.

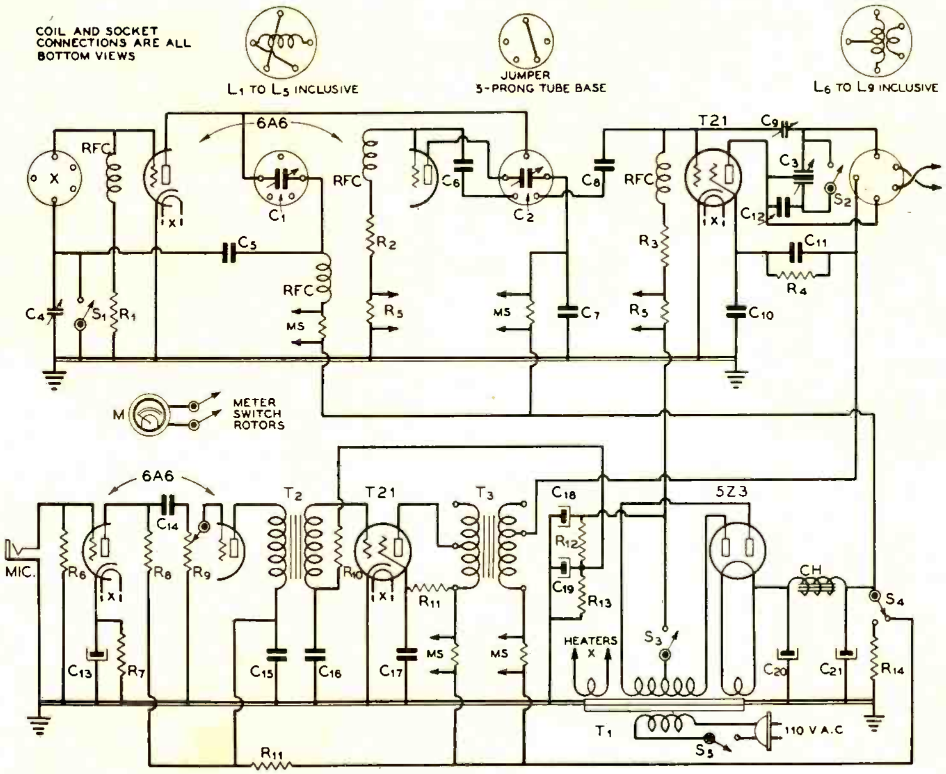


Figure 3. Complete wiring diagram of the portable transmitter.

C_1, C_2—50-μμfd. midget variable

C_3—35-μμfd. per section split-stator

C_4—.00037-μfd. mica trimmer

C_5—.001-μfd. mica

C_6—.0001-μfd. mica

C_7—.001-μfd. mica

C_8—.00015-μfd. mica

C_9—6L6-type neut, cond.

C_{10}, C_{11}—.006-μfd. mica

C_{12}—.00005-μfd. mica, 1000-volt

C_{13}—10-μfd. 25-volt elect.

C_{14}—0.25-μfd. 600-volt tubular

C_{15}—1.0-μfd. 600-volt tubular

C_{16}—0.25-μfd. 200-volt tubular

C_{17}—0.25-μfd. 600-volt tubular

C_{18}, C_{19}—25-μfd. 50-volt elect.

C_{20}, C_{21}—8-μfd. 475-volt (600 peak) elect.

R_1—10,000 ohms, 1 watt

R_2—50,000 ohms, 1 watt

R_3—10,000 ohms, 1 watt

R_4—10,000 ohms, 3 watts

R_5—100 ohms, 1 watt

R_6—1 megohm, ½ watt

R_7—500 ohms, 1 watt

R_8—25,000 ohms, ½ watt

R_9—500,000-ohm potentiometer

R_{10}—50,000 ohms, 1 watt

R_{11}—10,000 ohms, 1 watt

R_{12}—150 ohms, 10 watts

R_{13}—250 ohms, 10 watts

R_{14}—3500 ohms, 50 watts

MS—Meter shunts, see text

RFC—2.5-mh. 125-ma. chokes

T_1—800 v. c.t., 200 ma.; 6.3 v. 4 a.; 5 v. 3 a.

T_2—3:1 audio transformer

T_3—15 watt Class-B output transformer, connected to give 2:1 (approximate) impedance ratio (see text)

CH-15-hy. 200-ma. choke

S_1—Regeneration on-off switch

S_2—Additional tank capacity switch

S_3—Plate voltage on-off switch

S_4—S.p.d.t. exciter tune switch

S_5—100-volt a.c. line switch

Coils—See coil table

used in the majority of low-powered and portable transmitters) is employed, there will be no provision for impedance matching between the modulator and modulated tubes.

This is another way of saying that the modulator tube will be unable to modulate the amplifier stage 100 per cent on peaks since it is theoretically impossible for the peak voltage at the plate of the modulator to vary from zero to twice normal. However, by means of the matching transformer it is possible to step up the voltage output of the modulator to a value that is then sufficient to swing the plate voltage on the final from zero to twice normal. Again, this is another way of saying that the impedances will be properly matched between the modulator and the final amplifier.

The other reason for using a transformer instead of a choke was to reduce the distortion due to core saturation in the comparatively small modulation choke that it would have been necessary to use because of space limitations. By using a transformer it is possible to buck out most of the magnetizing flux caused by the d.c. flowing to the modulator and the final. It is necessary that the d.c. flux due to the modulator plate current be cancelled to an extent by the flux due to the final. To determine when the two fluxes are in the proper polarity (tending to neutralize), connect the final amplifier to the proper taps on the secondary of the transformer. Then place a screwdriver against the core of the transformer, connect the two leads to the modulator and apply the plate voltage to the rig. Note how much pull there is from the core to the screwdriver. Then reverse the two leads to the modulator (reverse only these two) and apply the plate voltage; the way of connecting the modulator leads which gives the least amount of pull is the proper hookup.

The modulation transformer used in this job is one made for a pair of 46's when 20 watts was their output rating. The secondary is tapped at 3500 and 5000 ohms and by using all or half of the primary some flexibility of impedance matching is gained. The taps used for best results were one half of the primary and zero to 3500 for the r.f. load. Other similar transformers of later design can be used, and may work better on different taps. The best taps can be determined by a little experimenting, and will usually be the ones giving approximately a 2:1 impedance (1.4:1 turns) step-up ratio.

For maximum output from modulator tube in A_1 operation it is necessary to ground the cathode and supply fixed bias to the grid. This is done by means of a dropping resistor in the center tap of the high voltage winding of the power transformer. It is the drop across this resistor R_{13} which furnishes the bias while the additional 50,000-ohm resistor R_{10} in series with the bias lead is for filtering purposes (together with the filter condenser C_{16}). To the story on "Care and Feeding of 807's" in the January issue of RADIO we owe the connections for by-passing the screen.

Selection of Parts

The single power transformer has plenty to do, and must be selected with care. Anything smaller than the one herein specified is a risk. While all parts were selected for ample safety margin it will be well to stick fairly close to them and not try to skimp. Filtering is accomplished in the usual manner, though condenser input was necessary to obtain the necessary smoothing with a single section filter and to provide the desired output voltage with the transformer shown.

The chassis used by the writer is a scant 8 x 12 inches, which allowed just enough room to place the filter choke, condensers, power transformer, rectifier tube and modulation transformer across the back edge. The chassis

COIL TABLE

L_1 70 turns no. 24 enam., closewound
L_2 38 turns no. 24 enam., closewound
L_3 20 turns no. 14 enam., spaced to 1¼"
L_4 11½ turns no. 14 enam., spaced to 1¼"
L_5 5½ turns no. 14 enam., spaced to 1¼"

L_6 160-meter mfgd. plug-in coil
L_7 20-meter mfgd. plug-in coil
L_8 10-meter mfgd. plug-in coil
L_9 5-meter coil. 4 turns no. 14 c.t., 1" dia., spaced 1". Link, 1 t.

Coils L_1 through L_5 wound on standard 1½" dia. plug in-coil forms.

Coil Positions for Various Bands

Band	Osc. Socket	Buffer Socket	Final Socket
160	L_1	Jumper	L_6—S_2 closed
80	L_1	L_2	L_6—S_2 open
40	L_3	Jumper	L_7—S_2 closed
20	L_3	L_4	L_7—S_2 open
10	L_4	L_5	L_8—S_2 open
5	L_4	L_5	L_9—S_2 open

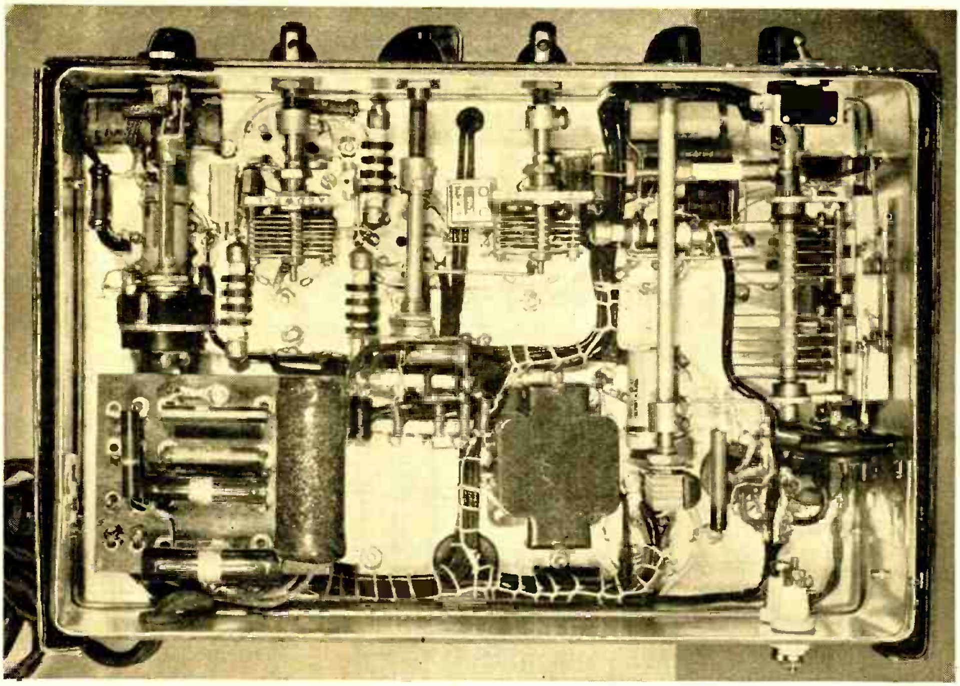


Figure 4. Bottom view of the transmitter. All leads not carrying r.f. are cabled. Extension shafts are used on practically all controls to permit placing of the variable components so as to result in the shortest possible leads.

is made by a local manufacturer for several of the leading radio companies, and is particularly easy to work on because the sides of the chassis are removable, leaving the top with only a half-inch rim, which makes assembly and wiring a pleasure. However, slightly larger chassis with cabinets to match are readily available; these will allow a more roomy layout.

One unique feature of the homemade cabinet is worthy of special mention. The cabinet is made with a closed top. To make coil changes the two rotating catches are released, allowing the top half of the front panel to open down, giving access to the row of coils, the two switches and the crystal. This tricky stunt is not at all hard to do. The panel is simply cut across at the chassis line, and hinged so it will open outward. The catches are shown in detail in the sketch. The meter is in the upper half, connected to the meter switch by flexible leads.

For home station operation the handle on top can be removed and any number of things stacked (as per usual) on top of the cabinet. The unique cabinet design produces quite a saving on the neck muscles, plus the advantage of not singeing your fingers, as one often does in reaching down from the top, gently leaning the tender back of a finger or two against a sizzling hot tube while changing coils.

Layout

The parts layout, as seen in the photograph, is somewhat unconventional. Each part is placed in the most advantageous spot, with relation to its job and the other parts. Extension shafts are less expensive than long r.f. leads, believe it or not.

Looking at the bottom of the chassis, reading from left to right we see sockets for the 6A6 speech, crystal oscillator plate tank, crystal, 6A6 exciter, buffer plate tank, T21 final amplifier and the final tank coil. Behind the speech socket is mounted the gain control, while the microphone jack is connected by a piece of shielded cable for later mounting, when the sides of the chassis are added. The "Trim-air" condensers are mounted on the forked brackets made for this purpose, though their usage is slightly different than the conventional method. The bracket is mounted on the stator holding screws, at the back of the

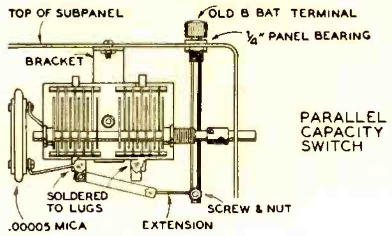


Figure 5. Detail drawing showing the method of installing the "additional capacity" switch to the final tank condenser. The .00005-µfd. mica condenser is also placed in parallel when this switch is closed.

condenser, instead of to the isolantite end plate. The foot of the bracket is held by a 6-32 screw and nut which is passed through the hole in the center of the tube socket. The bracket foot must be filed away to provide clearance from the socket connections. A small solder lug makes the jumper over the coil socket connector on the cold side. Such short leads do much to promote high efficiency. If the tube sockets employed do not have the center hole a small standoff will serve to hold the bracket.

The particular split-stator final tuning condenser was chosen for several reasons. First, only one section is used on most bands. This gives a good L/C ratio on the higher frequency bands. By use of the capacity paralleling switch, S_2, we add the necessary capacity to correct the ratio for the lowest frequency. The mechanical structure made the electrical arrangements possible and allowed the condenser to be mounted on edge by use of the one simple L-shaped bracket shown in the sketch.

Directly behind the final tube is the modulator socket, with the rectifier tube socket in the same line. The stand-by switch, which breaks the B-minus lead, is mounted over this socket. In one corner we have the tie points for connections to the modulation transformer and in the other we have the bakelite resistor terminal block. On the meter switch will be seen R_3. It was an after-thought and should have been mounted on the terminal block.

The interstage audio transformer, T_2, plainly visible in the photograph, is mounted on one of the bolts that holds the power transformer. It was found necessary to space it from the chassis by the thickness of one 8-32 nut to avoid hum pickup coming from the power transformer.

Meter Switching

The use of meter-switching instead of the cumbersome plug and jack system is a refinement that all of us will welcome. Not only does it eliminate the "hot" meter jacks on the panel, but the awkward length of cable to run from the meter to the jacks also is eliminated. It also cleans up a troublesome lot of wires inside the chassis and allows one meter to be used where a number of them previously have been almost a necessity. We firmly believe that the system deserves much greater popularity than it now enjoys.

Meter Shunts

The making of shunts is a simple matter. The resistance wire can most easily be obtained by tearing down an old rheostat taken from a defunct battery set. The ones to use are the ones with the finer wire, not the coarse-wound type. Removed, the wire is straightened by clamping one end in the vise, and, grasping the other end firmly with your pliers,—heave!! Not too hard, though; it breaks comparatively easily. Clean the wire thoroughly with emery cloth so that soldering will be possible.

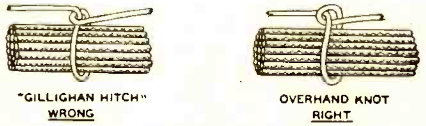


Figure 6. The proper and improper methods of lacing cables. The overhand knot will still bind the cable tightly should the lacing twine between hitches become frayed and broken; the "Gillighan hitch" will pull out and unravel.

To remove the original shunt, open the meter, using extreme care. Remove the dial and clip, if possible, the lugs holding the shunt. *If you simply must unsolder the shunt to avoid losing part of it, apply the soldering iron to the negative terminal first, removing the shunt at that end before touching the iron to the other, or positive terminal.*

The reason for this caution is that heat, applied to the junction of the resistance wire and the copper lug, will cause a current to be generated as in a thermo-coupled r.f. meter. This current is great enough to swing the needle of your meter right over against the soldering iron, with the possibility of bending the pointer or ruining the movement.

With the shunt removed, your 100-ma. meter will have a full scale deflection of somewhere around 5 or 8 ma., depending upon the make of the meter. The exact full scale deflection may be determined by running about 5 ma. through both this meter and another meter in series. With the shunt removed we have a low-range milliammeter for the reading of grid current to the second section of the 6A6 and to the T21. The resistors R5 have sufficient resistance (very high in comparison to that of the meter) that they do not act as shunts. They are merely for the purpose ot providing a path for the grid current when the meter is not in the circuit.

For reading plate current to the three r.f. stages and to the modulator, we want a 100-ma. scale. To get this, we will need four meter shunts, MS, identical to the original meter shunt. These are constructed from the resistance wire already mentioned. Only three shunts need be constructed if the original meter shunt is used as the fourth.

The shunts are adjusted by running about 50 ma. through a borrowed milliammeter of 0-100 or 0-75 ma. and trimming each shunt until the meter reads exactly the same as the borrowed reference meter. Care must be taken that the 50 ma. is not run through the meter while it is unshunted, or it may be ruined. The way to avoid this is to run the current through a long piece of the resistance wire, permanently connected in series with the borrowed meter, and then tap the unshunted meter across more and more of the resistance wire until it reads the same as the other meter. The resistance wire between the meter terminals is the correct amount for one shunt. Cut it this exact length, roll it around a pencil or large nail to coil it in the form of a spring, and it is ready to solder into the circuit.

Repeat the process for the other two shunts. Do not just cut two more shunts the same length as the measured one and assume the resistance will be the same, as it might be off a slight amount, due to non-uniform cross section of the resistance wire.

The Hi-Lo Test Switch

As the modulator and final tubes draw most of the total current from the power supply, switching them off to allow testing of the oscillator and buffer stages when changing bands would cause the voltage to jump to an unsafe value. The switch, S_4, reroutes the voltage to R_{14} through which the current flows to ground. The resistor is calculated to hold the voltage approximately the same as when the two larger tubes are being supplied.

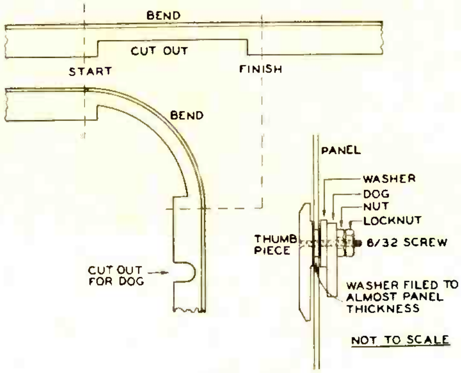


Figure 7.

Detail drawing showing the method of bending the angle iron over the curved portions of the box and showing the method of making the "thumb latch" panel locks.

Wiring

In a job of this size hay-wiring cannot be tolerated. All wires, other than those carrying r.f. currents, should be neatly cabled. The photographs show the path followed by the cable, which is laced in place, not pre-formed as is sometimes done. A little study of the wiring diagram and the parts layout will show you how the cable is planned. In lacing, be sure to use the overhand knot, which is correct, instead of the "Gillighan hitch," which is both nautically and mechanically wrong.

Tank Coils

Complete specifications are given in the table for winding all tank coils. The jumper connections on coils L_1 to L_5, together with the one in the jumper plug, are for routing the excitation. This eliminates a switch, which could have been used for this purpose.

A word of explanation is in order regarding the final tank coils. It will be found that the 10- and 20-meter coils will tune nicely with S_2 open. The 160-meter coil will resonate at 160 meters with the switch closed, and hits the 75-meter phone band by opening the switch. This condition is due to the extremely short r.f. leads and the very low circuit capacities. Though the 3900 to 4000 kc. coverage is tuned with a maximum of about 25 $\mu\mu$fd. the second harmonic was found to be within reasonable limits unless the transmitter was coupled to a 40-meter antenna for 80-meter operation. As this type of radiator

[*Continued on Page* 79]

RECEIVING PULSES

from the Ionosphere

By ALBERT W. FRIEND,*
W8DSJ-W8KIU

In the concluding installment on the making of ionospheric soundings, the author describes how to receive the transmitted pulses and interpret them, thus enabling one to make measurements of the ionosphere height, determine critical frequency, and thereby obtain much interesting information enabling one to predict conditions on the h.f. bands.

Let's take a look at the ionosphere. We can't see it but we may easily observe its effects, measure the layer heights and determine the critical frequencies by watching the pulse patterns on the cathode-ray oscilloscope. Equipment for producing pulse keying (or modulation) of the transmitter has already been described in earlier issues of RADIO.[1] What now remains to be considered is the reception and interpretation of the pulses of signal reflected from these ionized regions high above the earth.

If only amateur frequencies are available the experimenter must be content with single-frequency operation, or at best with a series of frequencies in the 160- to 20-meter bands. If this investigation grows upon him and the urge for more complete investigation must be satisfied, it may be possible to obtain a special experimental license which will allow the use of a greater number of channels. Later, if more time, money and experience are available, he may draw upon them to aid him in obtaining a sweep-frequency experimental license to cover all necessary frequencies by continuous simultaneous changing of the transmitter and receiver tuning controls in synchronism.

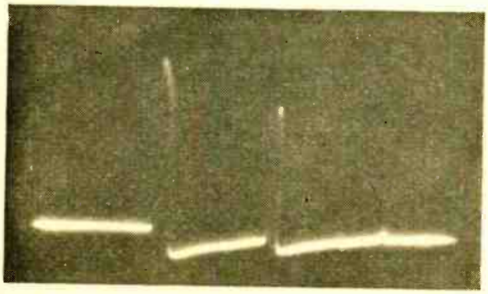


Figure 1. The oscilloscope pattern showing the direct (ground), F and two times F pulses. Linear sweep was used. Height 306 km.

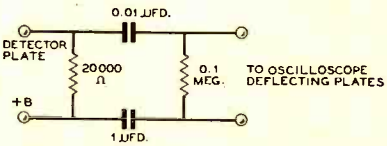


Figure 2. Receiver output to oscilloscope deflecting plate network.

The Receiver

The requirements for the pulse receiver are entirely in opposition to those for a good c.w. receiver. A high order of selectivity is intolerable since the sharpness of the pulse depends upon broad band acceptance circuits. The

---

* Asst. Professor, West Virginia University (W8XAW- W8XNR).

[1] A. W. Friend, "Ionospheric Sounding for Amateurs," RADIO, Jan., 1939, p. 99; A. W. Friend, "Pulsing Amateur Transmitters for Ionospheric Soundings," RADIO, Feb., 1939, p. 28.

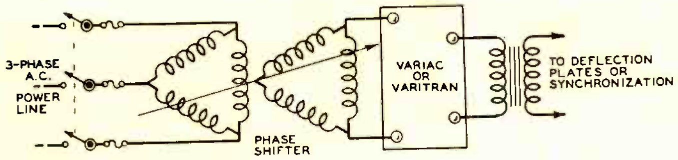


Figure 3. Three-phase line-connection diagram for induction-type phase shifter with voltage control device.

higher harmonics of the pulse frequency must be admitted in order to allow the pulse of signal to start and stop very abruptly.

Any fairly sensitive communications receiver which may be controlled to give broad tuning or which normally has only moderate selectivity will probably prove acceptable for this service. Regenerative receivers must be avoided in any case.

It is advisable to investigate the decoupling circuits throughout the receiver from the input stage to the detector output. The product R times C for each by-pass condenser and decoupling resistor combination should be calculated. If R is in ohms and C in microfarads, this product should be always smaller than 150 or greater than 20,000 in order to avoid the possibility of reactions in the circuit due to condenser charge and discharge transients. This rule may also apply to cathode bias resistors and their by-pass condensers. For instance a receiver may have an r.f. amplifier with a 2000-ohm cathode resistor and a 0.1-μfd. by-pass condenser. The product $RC = 2000 \times 0.1 = 200$ which is just slightly too high. The condenser could generally be changed to 0.03 μfd. without serious effects in normal operation. This new value would then give $RC = 2000 \times 0.03 = 60$ which is quite an acceptable value. In most circuits this condenser might well be cut down to 0.01 μfd. with no trouble at all. In the i.f. stages, however, the by-pass condenser should not be reduced much more than is necessary to give satisfactory pulse reception. In many receivers no changes at all will be necessary.

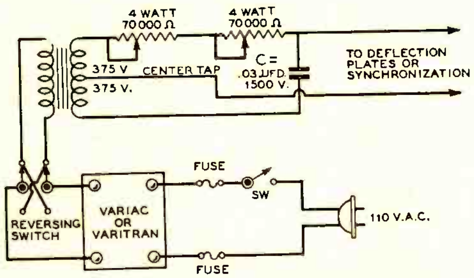


Figure 4. Condenser—resistor-type balanced phase shifter for single-phase operation. This design gives a phase shift of 230 degrees. 310 degrees shift may be provided by changing C trom 0.03 μfd. to 0.1 μfd. and either decreasing the operating voltage or installing 25-watt resistors.

A third important point to be investigated is the circuit following the detector. *Not a single audio frequency choke or transformer may be left in the circuit* connecting the detector output to the oscilloscope terminals. The ordinary audio-frequency amplifier in the receiver must never be used to amplify the pulse signals for application to the oscilloscope. If audio monitoring is desired any type of class-A audio input stage may be *resistance coupled* to the detector output provided this coupling does not seriously alter the pattern on the oscilloscope screen. If more signal amplitude is required after detection the only solutions are the use of a higher power transmitter, a higher gain receiver, or the addition of wide band resistance coupled amplifier to the receiver. This amplifier must approach, somewhat, the video frequency type in that frequencies from 50 cycles per second up to perhaps 50,000 or more cycles per second must be amplified uniformly. There is no cause for worry about this device, how-

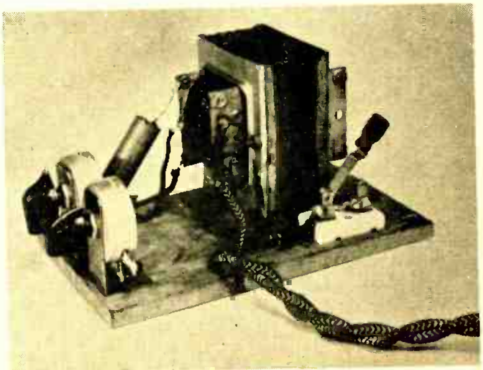


Figure 5. An experimental model of the phase shifter of figure 4.

ever, since most superheterodynes have plenty of output from the detector to give more than ample oscilloscope deflection.

The majority of manufactured communications receivers have been found to operate quite well when the output is taken directly from the headphone jack. After making arrangements for connecting directly to the detector output circuit the RCA types ACR-136 and ACR-175 and the Hallicrafters Skyrider sets have been found to give satisfactory operation. There is no doubt that most other makes of sets will operate just as well. In fact, an old all-wave broadcast receiver has given good service when properly connected. In some cases it may be desirable to shunt the i.f. tuned circuits with resistors to broaden the tuning, but generally this will not be necessary.

Figure 1 shows an oscillogram of the pulse output from the receiver in use at the station. The transmitter being received had 200 watts peak pulse output and was located about 200 yards from the receiver. The transmitted pulse length was 100 microseconds. In order to minimize the direct signal from the transmitter with respect to the reflected signal from the ionosphere, the transmitting and receiving antennas were both horizontal and turned end to end. Obviously the antenna systems should have maximum directivity straight up when a signal is to be reflected from the ionosphere, and the direct (ground) wave should be reduced as much as possible. A vertical antenna *must not* be used.

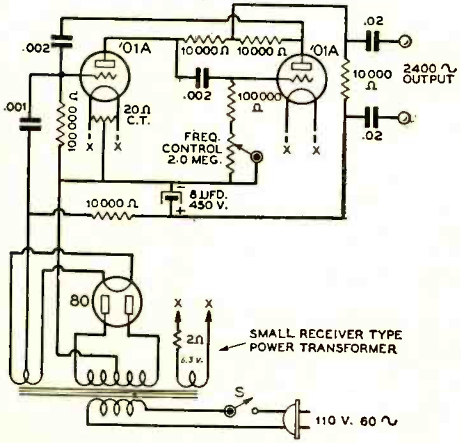


Figure 6. A 2400-cycle per second synchronized multivibrator circuit for calibration purposes.

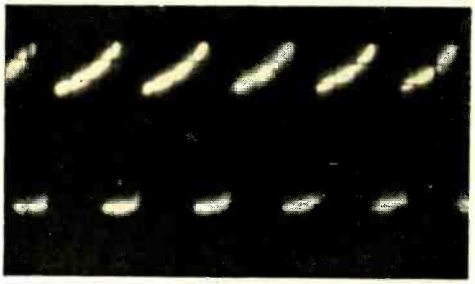


Figure 7. One of the numerous possible multivibrator wave forms which are dependent upon the relative circuit constants and the output points of the circuit.

The output from the receiver was taken directly from the headphone jack through a coupling network shown in figure 2. This network operates to couple the plate circuit of the detector tube to the vertical deflecting plates of the oscilloscope, and it is arranged to reduce the "kick back" effect of the trace after the pulse.

Figure 1 also shows F-region reflections. The first reflection is the first ionosphere pulse returned from a height, $h_F = 306$ kilometers. The second reflection is produced by the pulse wave reflected twice from the same (F) region. It traveled from the earth to the F region, back to the earth, where it was reflected back to the F region again, and then back to the receiver. This made two complete round trips to the F region. The second reflection, therefore, appears as though it came from a region of height equal to twice h_F (the height of the F region) or 612 km.

The Oscilloscope

Any ordinary oscilloscope with or without a linear sweep circuit may be used. A one-inch tube is satisfactory, but it will be found that at least a two-inch screen gives much greater definition. Figure 1 was photographed on a standard three-inch tube using direct connection to the vertical deflection plates and amplified 60-cycle synchronized linear horizontal sweep.

If the provision for linear sweep with external synchronization is available, the entire measuring equipment may be made quite simple and confusion due to overlapping of the return sweep will be entirely eliminated.

Positioning the Pulses on the Screen

Obviously there must be some adjustment for positioning the pulses on the cathode-ray viewing screen. The direct (or ground wave)

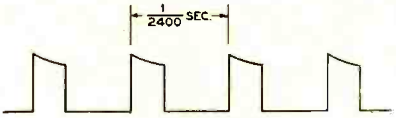


Figure 8. Timing by means of the calibrated multivibrator output wave.

pulse must be placed toward the starting end of the sweep with the succeeding reflected pulses following as the sweep progresses toward the other side of the screen. The synchronizing and sweep frequency adjustment controls of most oscilloscopes provide for a small measure of positioning but very seldom will this adjustment even approach an adequate amount. Some external phase shifting device must be used to control the ignition time of the sweep control tube. It is desirable that this sweep control potential shall be approximately sixty to ninety degrees (one-sixth to one-quarter cycle) out of phase with the pulse control voltage at the transmitter.

If two or three phase power is available the correct phase may sometimes be chosen so as to produce the desired phase relation between the transmitter and receiver power line voltages. In most cases this arrangement will not be satisfactory. Usually a device for phase shifting must be employed. In case the expense is not a major factor a rotable coil induction type phase shifter may be purchased for about $200 from the States Company in Hartford, Connecticut. This unit has a worm driven dial calibrated in degrees of phase shift. The calibration is very convenient for ionosphere height measuring. Figure 3 shows the connection diagram for this unit.

For the average amateur of moderate means who has only single-phase power available, an almost as convenient a device may be constructed for about five dollars. This unit will enable the operator to use the regular single-phase 110-volt, 60-cycle source of power and shift the phase throughout most of the 360-degree range. The output must be purely voltage with practically no power consumption.

The connections to the electrostatic deflecting plates of a cathode-ray tube or to the grid of a class-A amplifier stage or sweep control tube adequately fulfill this requirement. It should, therefore, be obvious that the circuit, which is shown in figure 4, may be used to provide for phase shifting with a sine-wave sweep at power line frequency or synchronization of any linear sweep circuit with that frequency in any desired phase relation. Figure 5 shows an experimental model of the phase shifter.

Figure 9. Calibration scale for the oscilloscope screen. A strip of transparent material may be used.

The variac or varitran voltage control, in the 110-volt input line, is used for adjusting voltage to give the desired sweep rate when the output is used for sine-wave horizontal deflection on the oscilloscope or for synchronization input adjustment when linear sweep is used. If sine-wave sweep is desired the transformer should be the ordinary 50- to 70-ma. 750-volt center-tapped type normally used in small receiving sets. For synchronization purposes only, a center-tapped 100- to 200-volt transformer should be more than sufficient in any case.

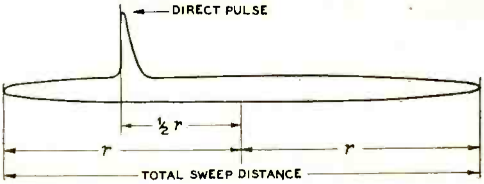


Figure 10. Distances on the sine-wave sweep.

The working of the phase shifting arrangement should be quite obvious after a brief examination. For a 90-degree phase shift the resistance, R, is equal to the capacitive reactance

$$X_c = \frac{10^6}{2\pi fC}$$

of the condenser, C, where f is in cycles per second and C is in microfarads. When R is reduced to zero the output is effectively connected across the lower half of the transformer secondary, which is ninety degrees from the above condition. Intermediate values of R give intermediate values of phase angle. When R is made greater than X_c the phase angle shifts the other way so that if R could be made infinite the phase angle would be just 180 degrees different from that when R equals zero (ninety degrees the other way from the phase angle when R equals X_c).

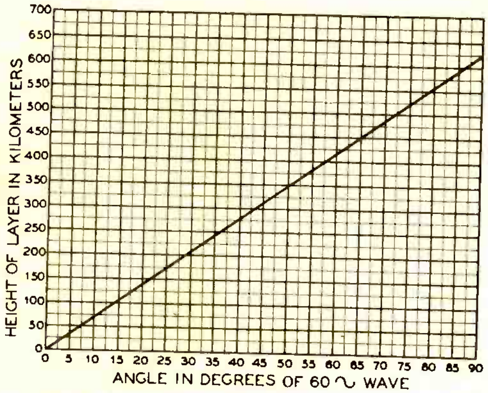


Figure 12. Graph for finding virtual layer height from the phase shift angle.

When R equals about ten times X_c the maximum practical phase shift will have been reached. Usually when the same power line is used to supply both the transmitter and receiver the sweep should be about sixty to ninety degrees out of phase with the line, so R should approximately equal X_c in most cases. The reversing switch in the primary is used to reverse the connections and produce a 180-degree phase shift. This may be used to place the received pulses on the left to right sweep of the sine-wave or to produce a one-half sweep displacement on a linear sweep.

If a linear sweep circuit is used it may be of interest to note that not all manufactured cathode-ray oscilloscopes have a left to right sweep. Some manufacturers (DuMont for instance) use a right to left sweep. This means that the first pulse received (the direct or ground wave) will always appear to the right of the reflected signals from the ionosphere. This should cause no confusion if the fact is kept in mind that the result is due only to the sweep circuit design and has nothing to do with the external circuit. In making observations, external sweep synchronization by connection to the phase shifter should always be used in order that the pulses may be correctly positioned on the screen.

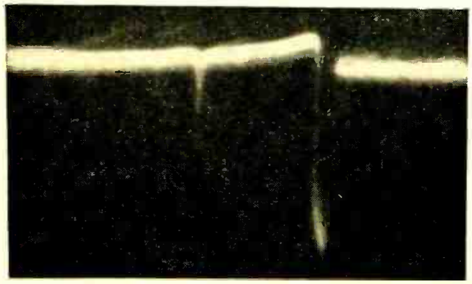


Figure 13. Cathode-ray oscilloscope pattern showing direct and F-region pulses (plus the usual QRM) with reversed sweep direction on the DuMont three-inch oscilloscope. h_F is 306 km.

Calibration and Height Measurement

In order to determine the virtual height of the regions from which pulse echoes are obtained it is necessary to measure the time interval between the direct and the reflected pulses. This may be accomplished by the use of a known fixed time rate of sweep, so that a given distance of sweep represents a certain time interval. A second method involves the use of a calibrated phase shifting device by means of which the various received pulses may be centered on a fixed index line for measurement of the phase angle change required to move the pulses into position. Both systems have characteristic advantages.

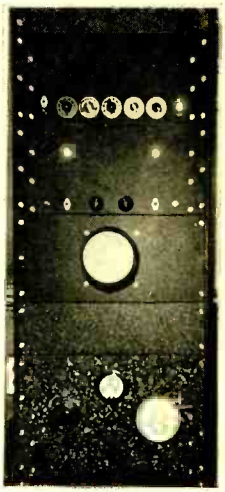


Figure 14. Rack-mounted receiving assembly at West Virginia University.

In either case some time measuring arrangement must be used. Perhaps the most satisfactory calibrating device is a multivibrator unit locked with the 120-cycle ripple from a full-wave power rectifier unit. This unit may be used to generate a 2400-cycle timing wave locked in synchronism with the power frequency, so as to produce a stationary pattern on the synchronized sweep to be calibrated. If measurements are to be made on a "linear sweep" using a transparent ruled screen or a pair of calipers to indicate the distance, the first point to take note of is that most sweep arrangements *positively do not* produce a

[*Continued on Page 68*]

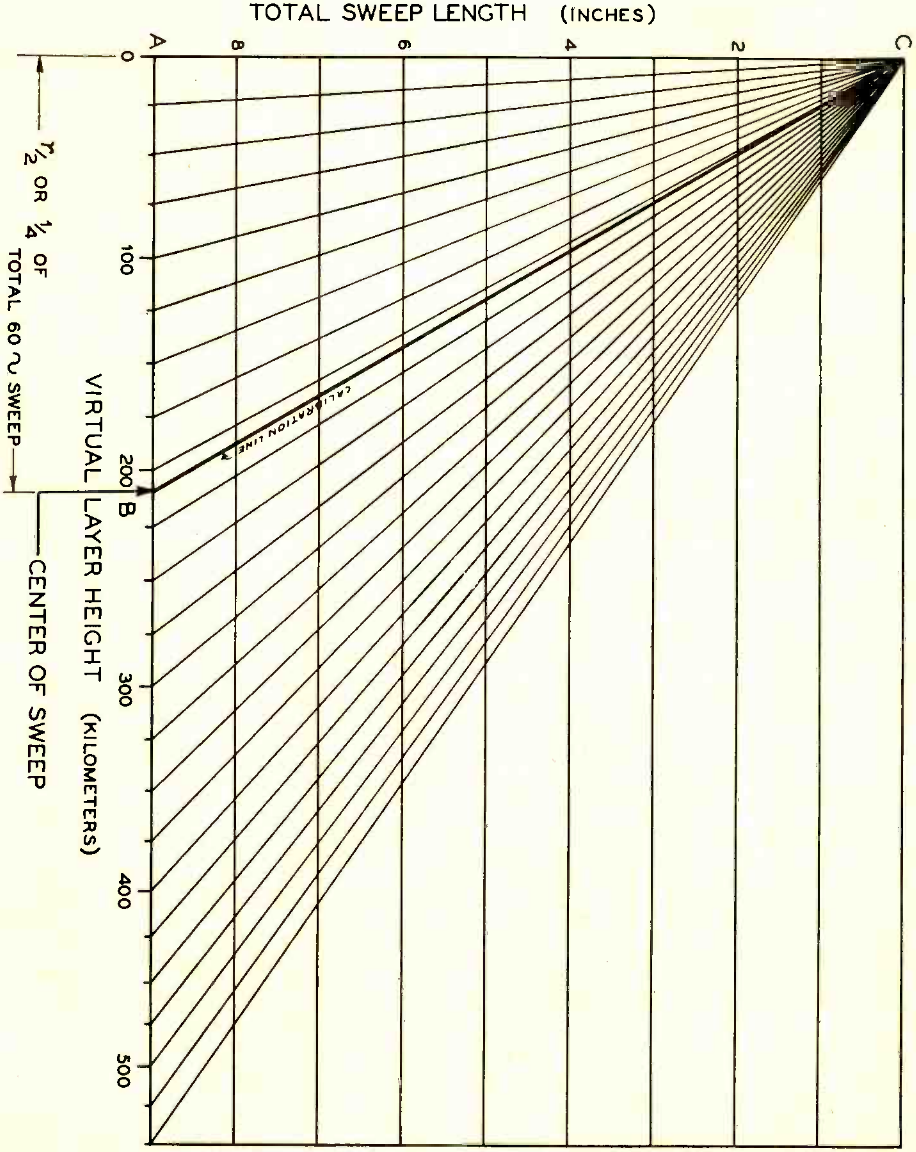


Figure 11. Chart for marking the calibration points on the oscilloscope screen layer height scale.

Figure 1. Perspective view of remodeled 32-F r.f. unit, showing revised tube and coil layout. The sawed-off tube shield to the left of the crystal houses the 20-meter 53 doubler coil, which is permanently left in the circuit though used only for 10-meter operation of the final amplifier.

Rebuilding Collins 32-B's and 32-F's To Include 28-Mc. Operation

By JAY C. BOYD,* W6PRM

A few years ago the Collins Radio Company sold a large number of small transmitters known as their models 32-B and 32-F. The former model used the then popular 47 crystal oscillator, a 46 buffer-doubler, and a pair of parallel 46's in the final. Modulation was effected by a pair of 46's in class B, with appropriate speech amplifier. Two power supplies, furnishing 300 and 400 volts were included. The latter model was quite similar except that it used 841's (high-μ 10's) in the buffer and final positions. It also included an extra audio amplifier stage and a pi-type antenna tuning unit.

Unfortunately, there was no provision for 10-meter operation, as that band was not popular at the time. An owner of one of these excellent little rigs, desirous of working some 10-meter dx, asked for an opinion of what to do to "get 'er on ten." He had tried winding more coils but had little success in making it go. The final amplifier being wired in parallel and lack of sufficient excitation at that frequency made satisfactory 10-meter operation well-nigh impossible.

An examination of the little transmitter resulted in the conclusion that merely changing tubes and patching here and there might not result in efficient operation and, since the power was somewhat limited, operation had to be reasonably efficient. It was decided that a major operation on the r.f. unit would be necessary, leaving the power supplies and audio equipment as it was.

Revising the Tube Lineup

While the description relates to rebuilding a particular transmitter, the same general design should prove quite satisfactory for a rig using a pair of 10's, 841's, 801's, T20's or TZ20's. The buffer plate voltage should be raised to about 450 volts if 600 volts or so is used on the final.

The new layout was evolved by beginning with the final amplifier and working back-

---

* 2119 Longwood Ave., Los Angeles, Calif.

If you are one of the many owners of the early models 32-B or 32-F Collins transmitters who would like to get on 28 Mc., you can do an excellent job of modifying the r.f. section to cover this band by following the instructions given by Mr. Boyd.

wards. The owner had already substituted a pair of ceramic-based 10's in the final and there seemed no reason to change them. The circuit would have to be rearranged in push-pull, though, and the final coils and condensers changed to something that would balance. Mounting a split-stator tuning condenser next to the tubes would afford short, equal leads and still be in alignment with the original tuning dial layout, thereby utilizing both the former chassis and panel.

A new set of final tank coils were made up, these plugging into the mounting on top the tuning condenser. A ganged, dual neutralizer was made up to order but is now listed as a regular stock item. Mounting this below the chassis, near the tube sockets, makes for very short leads, allowing one setting to hold for all bands. A 45-volt C-Battery was added to hold plate current down to a low value in case of excitation failure. For c.w., a key is placed in series with this battery and ground.

With the new final amplifier decided upon, selection of an appropriate buffer was next in order. One of the new T21, ceramic-based beam tetrodes was chosen, since this tube will give good doubler output with the rather low plate voltage available. The nice feature of this type of tube is that there is still enough grid-to-plate capacity to allow easy neutralization. It thrives on a very moderate amount of grid drive, even when multiplying.

As the transmitter was originally built, the buffer current was obtained from the 300-volt power supply. This proved, as expected, insufficient to provide proper 10-meter excitation; so it was necessary to borrow its power from the 400-volt supply, which already furnishes current for the final and modulator.

This was first connected to the final filter condenser terminal. Some of our modulation found its way to the final amplifier grids, making this stage oscillate at audio frequency as well as nearly sending the writer to a well-padded cell. Insertion of choke CH_1 and condenser C_{10}, and keeping coupling condensers C_{11} and C_{12} down to .00025 $\mu\mu$fd., removed this trouble.

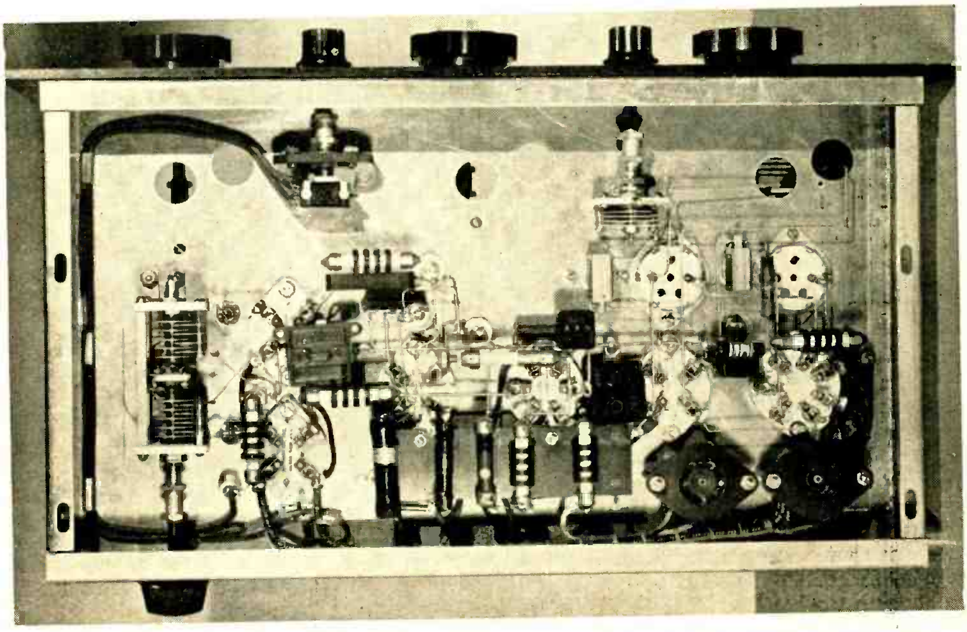


Figure 2. Bottom view of the revamped r.f. chassis. Orderly placement of small parts allows neat wiring that is easy to trace. The dual condenser is the "twin neutralizer." The two "naked" wafer sockets are for power cables, not inverted tubes.

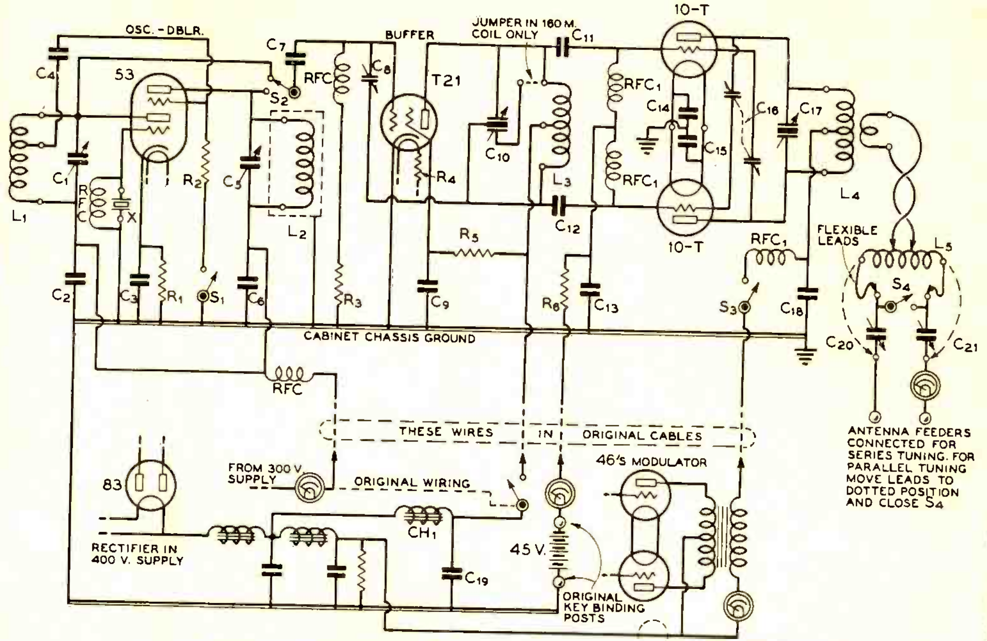


Figure 3. Wiring diagram of rebuilt r.f. unit. Components marked with asterisk (*) denote new parts. Others are from original unit.

C_1 — Original 133-µµfd. variable condenser
C_2, *C_3 — .002-µfd. 500-volt mica
*C_4 —.0001-µµfd. mica.
*C_5—25-µµfd. midget
*C_6—.002-µfd. 500-volt mica
C_7—.0001-µfd. mica
*C_8—6L6-type neutralizer
*C_9—.002-µfd. 500-volt mica
C_{10}—Original variable condenser. See text
*C_{11}, *C_{12} — .00025-µfd. 1000-volt mica
C_{13}—.002-µfd. mica
C_{14}, C_{15} — .006-µfd. mica
*C_{16}—15-µµfd. .070" air gap ganged neutralizer
*C_{17} — 180-180-µµfd. :050" spacing
C_{18}—.002-µfd. 1000-volt mica
*C_{19}—2-µfd. 600-volt paper
C_{20},C_{21}—Original 350-µµfd. .03" gap variable condensers in antenna coupler
*R_1—400 ohms, 5 watts
*R_2—25,000 ohms, 1 watt
*R_3—50,000 ohms, 2 watts
*R_4—1.33 ohms, 5 watts
*R_5—20,000 ohms, 10 watts
*R_6—5000 ohms, 20 watts
RFC — 2½-mh. r.f. chokes
*RFC_1—2½-mh. r.f. chokes
*CH_1 — 100-ma. 5-hy., not over 200 ohms
*S_1—S.p.s.t. toggle
*S_2—S.p.d.t. toggle
*S_3—S.p.s.t. rotary
*S_4 — Baby knife switch

L_1, L_3—Original plug-in coils (see coil table)
*L_2—20-meter doubler coil (see coil table)
L_4—New final coils with links (see coil table)
L_5—Antenna coupling coil

About Beam Tetrodes

With a plate potential of 400 volts, excellent doubler output was obtained by driving the buffer grid to four ma., using a 50,000-ohm grid leak. About five per cent more output was obtained with five ma. through a 40,000-ohm grid leak but the former conditions were considered more desirable. Under no conditions should the T21 grid current exceed five ma., as greater than 200 volts bias is an invitation to trouble.

While writing about small beam-power tetrodes it seems a good time to correct an erroneous impression regarding their grid driving power requirements. They have sometimes been advertised as capable of being driven with about a quarter of a watt. This may be true when operating as a straight amplifier—in fact, they have a habit of going off without *any* drive until they are carefully neutralized. But, like any other doubler, they require much more "push" for this class of service. Without having any accurate figures on the subject, the grid driving requirement appears to be about three watts when operating as frequency multipliers.

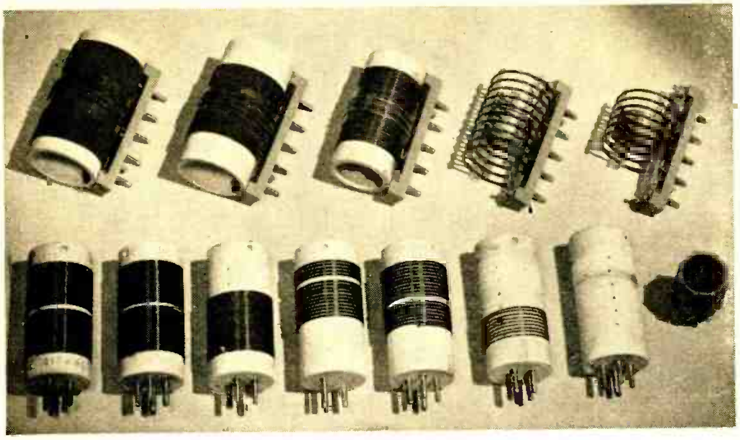


Figure 4. In the top row are the final amplifier coils; in the bottom row are the T21 buffer coils and, to the extreme right, the special 20-meter 53 doubler section coil.

Selecting the Oscillator

Having a 2½-volt heater for this stage, we *thought* we would use a 2A5, working as a straight crystal oscillator for all bands except ten meters. Here we tried using one of those new-fangled trick oscillator circuits that is supposed to give 20-meter output from a 40-meter rock. It worked fine with one certain crystal but with the five others tried oscillated at double crystal frequency, or any other frequency the tank was tuned to, not caring a whoop whether it was even in the band or not. Changing values made no difference.

It was changed to just about every sort of harmonic oscillator before we tired of monkeying with it. But results were always the same. Some crystals worked, others didn't, and neither aspirin nor prayers to Allah made any difference.

So we wound up by resorting to our old friend—the ever-reliable 53! The first section always works as a straight oscillator, with the second section usually idle. For ten meters this latter section is switched in for doubling from the 7-megacycle crystal frequency to 14 megacycles,[1] this being doubled again in the buffer to 28 megacycles.

There is nothing unconventional about the circuit but the physical layout was made to fit the chassis at hand. Since the 20-meter doubler coil is never changed, it is covered by a small shield can and located beside the oscillator coil.

With a plate potential of around 300 volts, output is about three watts when operating either as an oscillator or as an oscillator-doubler. At this voltage the crystal current is quite reasonable and the tube operates very stably. If more voltage is used both the crystal current and plate current tend to run wild unless carefully handled. But for driving beam-power tubes three watts of driving power is all we need, anyway.

Having decided on the tube lineup, a new circuit diagram and list of parts were drawn up. Examination showed it would be useless to try to retain any of the old wiring. This was removed but the power cabling was left intact. All resistors and r.f. chokes should be removed from the mounting strip very carefully, as most of them will be used again. Turn this strip over and be sure to remove those lugs which make ground connection on the mounting screws, as they may cause shorts in the new wiring scheme.

Replace the wafer sockets with the old-style ceramic type; they fit the same mounting holes. In rewiring the filaments use a 1.33-ohm resistor to drop the 7½-volt winding to 6.3 volts for the new buffer tube. If there is any difficulty obtaining such a resistor you can make up one from an old rheostat. If you have a 32-B rather than a 32-F, it will be necessary to add a 7.5-volt filament transformer to supply filament voltage to the 10's and, through the 1.33-ohm resistor, the T21. There is plenty of room on the r.f. chassis for this transformer.

Coils and Condensers

A split-stator condenser having 180 μμfd. per section and .050-inch spacing was selected so

---

[1] The 53, 6A6 and 6N7 are sometimes referred to as harmonic oscillators, but this is incorrect. They still are simply a triode oscillator and a triode doubler in one envelope.

there would be enough capacity for 160-meter operation with the plates nearly closed and 10-meter operation with them nearly open. The liberal condenser spacing prevents any danger of arcing, even with the final amplifier unloaded.

The final coil socket is mounted on a brass "U" strap which fastens to the ends of the condenser. The 80- and 160-meter coils were wound on ceramic forms. "Boughten" 10- and 20-meter coils were mounted on similar plugs while the 40-meter coil is one of the inductances used in the original antenna network.

The original buffer tuning condenser was used after first splitting its stator. This is done by removing this member, clamping it in a vise, and then carefully splitting it with a sharp hacksaw.

Half this condenser is used on the four higher frequency bands to make tuning easier and reduce the minimum capacity for more efficient doubling. On 160 meters the other section is picked up by a jumper in the coil. Moving this condenser near the buffer coil shortens its leads materially.

Since we already have a flock of the ceramic plug-in coils that came with the transmitter, we use them and save a lot of laborious coil winding. These have four prongs, making capacity coupling to the final almost a necessity, taking excitation off each end of the buffer coils. The impedance match seems about right for 10's, which have a medium-low amplification factor.

COIL DATA

20-meter doubler coil, L_2—14 turns #14 enameled, close wound to fit snugly inside 1¼" coil form; mounted vertically.

10-meter buffer coil L_3—6 turns #14 enameled, air-wound, 1" dia., spaced ¾" long and fitted horizontally inside original Collins ceramic form.

All other oscillator and doubler coils are original, but with ends and taps relocated. Oscillator excitation taps are one-third down from top of coil.

FINAL TANK COILS

160 meters—64 turns #18 d.s.c. on 1¾" form, 4 turn external link

80 meters—38 turns #18 d.s.c. on 1¾" form, 3 turn external link

40 meters—Taken from original pi-network, 3 turn external link

20 meters—12 turns #14 enam. 1⅝" dia., 2½" long, 2 turn internal link

10 meters—6 turns # 14 enam. 1⅝" dia., 1½" long, 2 turn internal link

The original coils can be used without rewinding, but it will be necessary to relocate their end and center taps to correspond with the new layout. The old buffer neutralizing windings are removed, which changes their inductance somewhat. The original 160-meter buffer coil becomes the 80-meter buffer inductance, while the old 160-meter final coil is now used as the buffer coil for that band. The 10-meter buffer coil is air wound and mounted horizontally inside its coil form. This makes visitors think we are using a blank form until they look inside. The 20-meter buffer coil is vertically mounted inside a new coil form and kept under cover just to hide it.

In making up plate coils for neutralized beam-power tubes one should be careful in keeping the windings on each side of the center tap equal. With the usual coils having a vertical axis the length of wire going from the top of the coil to its prong will be longer than the lower section. Don't forget this has a little inductance, too! Also, if the coil is wound too low on the form some inductance may be lost by its close proximity to the metal chassis. To insure all-band neutralization it may be helpful to omit a turn from the top half of the larger coils and spread the last top turn of the smaller ones. Another way to insure balance is by using the horizontal, midget air-wound buffer coils which several manufacturers are now offering.

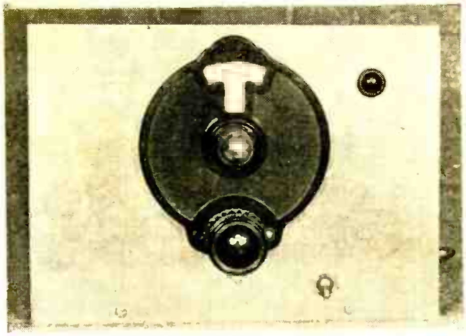
Metering

It was mentioned earlier that power for the buffer was taken from the 400-volt supply. This makes it necessary to change the buffer switch feeder wire over to the new condenser C_{19}. In the original hook-up one meter reads the oscillator plate current when that stage is running alone and the combined oscillator and buffer current when both stages are operating. In taking buffer current from the 400-volt supply we lose metering of the buffer stage. But don't worry about this as we can tune just as well, or better, by watching the final grid meter. Now the first meter reads total plate current of the 53, whether operating with one or both sections running.

With these changes made it now becomes necessary to close the "plate voltage" switch before the buffer operates. Since this also turns on the final and modulator voltage it was necessary to add another switch for breaking the final plate voltage when tuning up. A rotary snap switch placed on the r.f. panel balances with the added doubler tuning knob, being normally used only when checking neutralization.

[*Continued on Page 82*]

This combination monitor and frequency meter can be constructed very inexpensively. It monitors both phone and c.w. signals with sufficient volume to drive a small magnetic speaker.



A C.W.-Phone Monitor and FREQUENCY METER

By KENNETH L. KIME,* W6KSX

Besides serving as an excellent c.w. monitor, this instrument also can be used as a phone monitor and frequency meter. Many of the parts can be robbed from an old b.c.l. set, making the cost of the instrument surprisingly low.

A good frequency meter and monitor is not only very useful, but also is required by the FCC. However, I think the handbooks contain enough reasons for having frequency meters and monitors. It was not my problem to find one that would do the work sufficiently well, but to find one that would do it all. I wanted one that would monitor phone signals and not overload, would monitor c.w. signals and not be razor sharp in tuning, and at the same time serve as an accurate frequency meter.

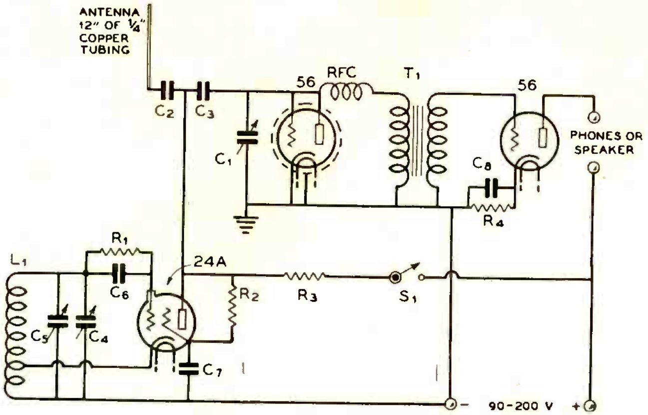
For over four years I tried to find a c.w. monitor that was not so sharp in tuning that the left hand had to follow continually the tuning on the monitor while the right hand was wagging the key, and the signal had to be retuned after every stop in transmission. Those were the types using regenerative detectors and were no good on phone signals, and were not so dependable as frequency meters.

A diode field strength meter and overmodulation indicator solved the problem of the phone monitor. Then the electron-coupled oscillator came under consideration for the frequency generating element. Heterodyning the oscillator signal against the incoming signal and feeding it into the diode was the logical answer. Building up the output of the diode was simple. Here is the monitor as it is now.

A 56 is connected as a diode and operates very well with a large signal input; however, this may be adjusted to the desired value by adjusting condenser C_1 which by-passes any excess amount of signal voltage, acting as a volume control. If it is desirable to adjust the volume for widely different outputs of the transmitter, I would suggest that C_1

---

* 2305 Oakwood Ave., Venice, Calif.



C_1—35-μμfd. trimmer
C_2—.0001-μμfd. mica
C_3—.0001-μμfd. mica
C_4—140-μμfd. mica trimmer
C_5—100-μμfd. variable
C_6—.0001-μμfd. mica
C_7—.01-μμfd. tubular
C_8—1-μfd. paper by-pass, 200 v.
R_1—2 meg.
R_2—25,000 ohms, 1 watt
R_3—50,000 ohms, 1 watt
R_4—2000 ohms, 1 watt
RFC—Midget r.f. choke
T_1—Interstage A.F.T.
L_1—30 turns closewound no. 20 d.c.c. on 1½" coil form. Cathode tapped 10 turns from ground end.

Figure 4. Wiring diagram of the combined monitor and frequency meter.

be changed to 100-μμfd. midget variable with front panel control.

The audio section is conventional and the output is sufficient to drive a small magnetic speaker. I find this the most practical method to use rather than try to switch over the phones from the receiver during transmitting periods. It also facilitates working duplex or break-in, for how many of us working break-in wear the phones clamped tightly to our ears? More often they are pushed forward on the head, and it is easy to read a moderate signal from the monitor speaker placed anywhere near the operating position.

There is nothing noteworthy about the beat oscillator, which tunes over the 160-meter band. A 24A was used as the oscillator because of its reputation for stability and because one was on hand. 6.3-volt tubes could be substituted if desired. C_4 is a 140-μμfd. trimmer condenser used as a band-set condenser. It can be seen just under the lower right edge of the coil as shown in figure 2. Sometimes I have found it is desirable for best c.w. monitoring to plug in a 40-meter coil in order to get a stronger beat. That is especially true of twenty and ten.

Construction

The panel is seven inches high and nine inches long and is of ⅛-inch aluminum. The dial tunes the 100-μμfd. beat oscillator condenser and the switch in the lower right corner breaks the plate voltage to the oscillator when the monitor is to be used for checking phone signals. The jewel in the upper right can be used to indicate the meter filaments are lighted, but, I must confess, it just fills up a hole in the panel. The pick-up antenna, which is twelve inches of ¼-inch copper tubing, comes up from the rear of the panel.

Figure 2 is a bird's eye view of the monitor. The 56 diode is in the lower left corner with its shield can removed, and just back of it is the 56 audio amplifier. The tuning elements of the oscillator occupy the center of the chassis and the 24A nestles down in the lower right corner. Back of it is the audio transformer, vintage of 1927. The antenna coupling condensers may be noticed in the opening in the rear of the chassis. The antenna is fastened to the nut on the bakelite strip that projects over the chassis opening near the rear of the transformer. The two outside binding posts on the rear of the chassis are the output terminals and the center one is ground. I might add here that the chassis was taken from an old Stewart Warner converter.

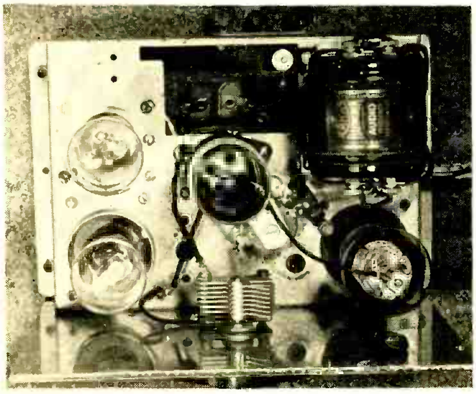
Figure 3 is a worm's eye view of the wiring. The socket in the upper left corner is the diode and the trimmer condenser over it is C_1 in the diagram. The cathode by-pass condenser is the large, metal-cased one in the upper center. The oscillator socket is in the upper right corner with the screen resistor and by-pass condenser and the plate dropping resistor. The power terminal strip is mounted on the right end of the chassis and in the lower center are the antenna coupling condensers. Most of the components were taken either from the "junk box" or an ancient b.c.l. set.

Now about the antenna coupling and the method of beating the oscillator output against the incoming signal. I tried several methods but found the one diagrammed the best. With one type the oscillator output would block the diode or be so strong that there was no beat note on the incoming signal. Another worked just the opposite, the incoming signal drowning out the oscillator signal. The method shown gives the best ratio of input from both sources, gives optimum coupling to the antenna from the oscillator for calibrating the meter against a receiver, and gives a nice input to the diode from a phone transmitter for monitoring or checking. The values of the condensers may be altered for the output of transmitters of greater or lesser power if it seems necessary.

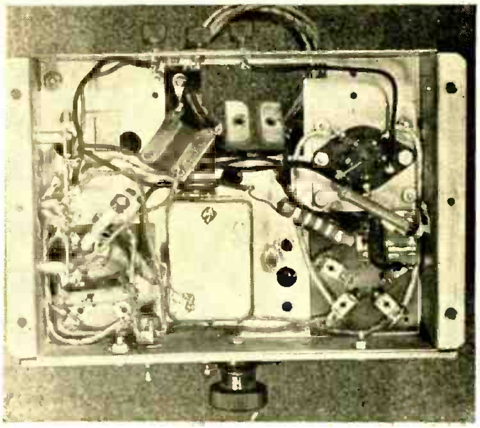
The power for the monitor comes from an old Majestic power pack plus a two and one-half volt filament transformer. This seems to work out much better than batteries did on other monitors built in the past. Variations in the line voltage do not noticeably affect the stability of the electron-coupled oscillator after it has warmed up for a period of about twenty minutes to one-half hour. Power is fed to the monitor through a cable and there is no noticeable pick-up of r.f. on it.

The 80-meter band runs from 20 degrees to 80 degrees on the dial, which makes nice tuning for either monitoring or frequency checking. To make high-frequency readings easier, the calibration chart covers 3500 to 4000 kc. (second harmonic).

Another good feature of this monitor when using a "band scooter" exciter is that it makes it easier to park on the other fellow's frequency; not that I care for this practice, but it works better than a super, especially one which has a variable pitch on the beat oscillator.



Top view of the combined monitor and frequency meter. It was built on an old Stewart Warner converter chassis. A shield fits over the diode-connected 56.



Under-chassis view. Placement of parts is not particularly critical, though the tank circuit of the beat oscillator should be made very rigid for the sake of stability.

It gives a continuous check on the operation of the transmitter and may be placed anywhere in the shack that is convenient. Of course, a can for the complete unit may be made up, or better yet, a complete chassis and cabinet with crackle finish may be obtained and the monitor dressed up in that way. Right now I use it just as it is, but the dust that accumulates has to be removed periodically.

It does the things I wanted it to, and in the manner I wanted them done, simply and easily, without being cranky and requiring coaxing. It makes traffic handling and schedules a pleasure.

One precaution might be in order. The calibration of the instrument should be checked from time to time, as it will be found that slight retrimming of C_4 is sometimes necessary. The unit should *never* be relied upon for placing of an e.c. oscillator right on the edge of the band, especially on the higher frequency bands, where the chance for error is greater. Amateurs should keep well inside the bands when using e.c. oscillators unless a temperature controlled or low drift 50 or 100 kc. crystal standard is used to keep continuous check on the frequency.

The accuracy of the unit shown here is sufficient to indicate whether your transmitting crystal has taken off on another peak, and to find signals whose frequency is known. And for the small amount of money represented, that's pretty good. Besides, you have a good monitor.

The QUADIRECTIONAL Rhombic

The chief objection to the rhombic antenna as ordinarily used is its size and its inability to work several directions. The "quadirectional rhombic" described in this article possesses neither of these disadvantages; it is comparatively small in size and can be used to cover the four points of the compass on 10, 20 and 40 meters.

By DAVE EVANS,* W4DHZ/6

During the last two years, more has been written on the subject of directional antennas than on any other technical subject pertaining to amateur radio. And we are still far from our objective: an antenna that can be used on two or three bands, is substantially unidirectional yet directable around the compass, is compact in size, and provides a respectable power gain. The antenna to be described, a modification of the venerable rhombic or "Bruce," meets all of these qualifications except perhaps that of physical size. Even so, the space required by the array is not prohibitive for most amateurs, especially if only 10- and 20-meter operation is desired.

Most amateurs will agree that the terminated rhombic, with legs 3 or 4 wavelengths long and the optimum height above ground, is hard to beat when correctly adjusted. Because the power gain is so high and both vertical and horizontal patterns so sharp, precise adjustment is required for maximum performance. With everything "on the nose," the antenna will outperform any of the popular arrays commonly used by amateurs by at least 6 or 8 db. If you don't believe it, ask the Europeans about the 14-Mc signal W6GRL puts in over there with his rhombic. The only thing is that with a rhombic of this size the included angle, height above ground, and termination resistance must be *exactly* right or the gain falls off rapidly. For instance, when the W6GRL antenna is operated on 10 meters after being adjusted for best 20-meter operation, the reports are surprisingly poor, due to the fact that it is too high above ground (68 feet) for best 10-meter operation with such long legs. Lowering the antenna results in a tremendous increase in signal strength on 10 meters, but due to the long legs (6½ wavelengths on 10 meters) the pattern is actually *too sharp* to be of much use.

By making a rhombic much smaller in size, the adjustment are not nearly so critical, and while the power gain is not as great as that of properly adjusted rhombics having long legs, the gain is still greater than that of most of the simple directive arrays used by amateurs.

The Bidirectional Rhombic

There is nothing new about bringing the two opposite ends of a rhombic into the shack by means of a 700- or 800-ohm feed line, thus permitting the use of the antenna in two opposite directions. The terminating resistor is connected to one feed line and the transmitter or receiver to the other. By switching the two feed lines the directivity of the antenna is reversed.

At this point someone is sure to ask why we don't just leave off the terminating resistor, thus getting a bidirectional pattern from the antenna and making it unnecessary to bring an extra feed line into the shack. The answer is that a unidirectional pattern is desirable, as it cuts down QRM in the back direction both when transmitting and receiving. Also, a terminated rhombic, when working as it should, will outperform an unterminated rhombic of the same physical size in spite of the fact that a large portion of the transmitter output is dissipated in the terminating resistor. An "unterminated rhombic" is an altogether different type antenna, being in reality two "V" antennas back to back.

The "Good Bye" Directional Rhombic

We can say "good bye" to the directional limitations of the terminated rhombic by carrying the idea one step further and bringing in feed lines from *all four* corners of the array. Of course this requires that the antenna be perfectly square, which indicates rather short legs. This is all right, because we don't want the lobes too sharp anyhow, or we wouldn't be able to cover the compass very well even with four direction available. Also, short legs

---

* Hughes Aircraft Co., 7000 Romaine Ave., Hollywood, Calif.

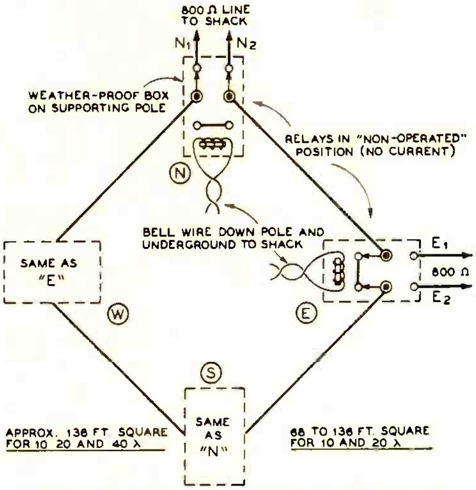


Figure 1. Schematic of the "quadirectional" rhombic. Best length for legs of 10- and 20-meter array is 100 ft. R.f. lines should leave antenna at right angles or bisect the angle made by adjacent legs for at least 20 feet. 10-, 20- and 40-meter array should be about 60 ft. high. 10- and 20-meter array should be about 40 ft. high. ("Effective" height above ground.) Note that connections for relays N and S are different from those of E and W. Relay lines may be paralleled and a single twisted line run to control position if latter is remote from antenna.

take up less room, at least when applied to the rhombic antenna, and do not require such precise adjustment of the antenna.

To get four directions instead of two, it is not only necessary to bring in four feed lines to the operating position or transmitter, but also to install a switching relay at each of the four corners of the antenna, right at the junctions formed by the legs of the array. (See figure 1.)

It is a proven fact that a terminated rhombic of a "compromise" height can be used with excellent results over a frequency range of three to one and with satisfactory results over a range of four to one. Thus, if we cut the antenna for 20 meters, it can be used on 10 and 40 meters. For a square rhombic the legs should be slightly less than two wave-lengths on a side. These dimensions are not critical, but rather are optimum, the dimensions one would use for the middle band of a three-band affair.

So we see that if we put up a square rhombic, approximately two wavelengths on each leg on 20 meters (136 feet), the array will make a good 10-, 20- and 40-meter antenna And by incorporating four transmissions lines and switching relays as already discussed, we not only have three-band operation but four directions as well.

The optimum height for this three-band antenna will be around 60 feet. The lobes will be somewhat sharper on 10 meters than on 40 meters, but will still be broad enough that by orienting the antenna carefully in the first place it will be possible to cover practically everything of importance on 10 meters. On 20 meters the lobes will be broader, and on 40 still broader; in fact, on 40 there will actually be some overlapping. In other words, on 40 meters it will be possible to hear and work stations midway between quadrants with good strength.

If the array is to be used only for 10- and 20-meter operation, it can be reduced in size and placed lower to the ground with improved results and better coverage on 10 meters. The optimum leg length for a square 10- and 20-meter rhombic is around 100 feet and the best height about 40 feet. In fact, if space limitations prohibit a larger array, the legs may be made as short as 68 feet for 10- and 20-meter operation. Results on 10 meters will be about as good as with 100-foot legs, but the gain will be reduced somewhat on 20 meters.

The problem may be summed up as follows: The optimum leg length for a square rhombic is just under two wavelengths. If the array is to be used on 10, 20 and 40 meters, it should be cut for 20 meters (136-ft. legs) and placed about 60 feet high. If the array is to be used only on 10 and 20 meters and sufficient space is available, the array should be cut for a frequency approximately midway between the two bands (100-ft. legs), and placed about 40 feet high. If space is restricted, a 10-20 meter array may be cut for 10 meters (68-ft. legs) and placed about 40 feet high.

Construction

A general idea of the switching arrangement is given in figures 1 and 2. The relays atop the poles supporting the legs of the rhombic need not have elaborate insulation, wide throw, or especially heavy contacts, because neither voltage nor current is particularly high, even when high power is used. The type of d.p.d.t. relay commonly used as a send-receive switch for switching a 500- to 600-ohm untuned line from receiver to transmitter will be quite satisfactory. The relays may be either of the a.c. or d.c. type, preferably low voltage so that ordinary bell wire or inexpensive twisted cord may be used between the relays and the control position.

If a.c. relays are used, they can be of such voltage that an ordinary bell ringing transformer or toy train transformer can be used to actuate them. One side of the low voltage winding should be grounded to prevent the wires to the relays from carrying interference or noise from the 110-volt a.c. line to the vicinity of the antenna. It is not necessary to run separate lines from the control position to all four relays. If the operating position is to one side of the antenna, as would be the case if the array were placed on an adjoining vacant lot, the relay wires may be connected together at the bottom of the nearest pole and a single twisted line run from there to the shack. This is possible because the relays are not operated individually, but rather as a group. With all relays operated the antenna transmits or receives in either of two opposite directions (depending upon position of terminating resistor) and with them non-operated it transmits or receives in the other two directions. It is a good idea to connect the relays so that the two opposite directions most ordinarily used are worked with the relays in the non-operated position. The markings "N", "E", "S", and "W", are merely for reference and do not *necessarily* indicate compass directions.

The r.f. lines to the operating position should have a surge impedance of between 700 and 800 ohms. No. 20 copper, spaced 6 inches, makes a suitable line. Smaller wire will result in some power loss and also is not sufficiently strong to be practical from a mechanical standpoint. Wood spreaders, boiled in paraffin, can be used for the sake of economy. The losses will be negligible, as the voltage is not high. The r.f. lines should preferably run down the poles for at least 20 feet before going off to the control position.

The control switch, shown in figure 2, may be of the ceramic insulated, ganged selector switch type. A five-gang, four-position switch such as the Centralab 2546 or Yaxley 165-C will have sufficient spacing for any power up to about 500 watts. The r.f. lines should be connected to the rear four gangs as indicated. It should be noted that each feed wire connects to a contact on each of *two* gangs. The jumpers were omitted from the diagram to keep it from appearing confusing. One of the wires from the r.f. line leaving pole "N" for instance, connects to N_1 on the rear gang, and by means of a jumper, to N_1 on the third gang from the rear. The other wire of the r.f. line from pole "N" connects to switch points N_2 and N_2, and so on for the rest of the lines.

With all the lines connected, transmission or reception will be in the direction of the pole indicated by the pointer. For instance, with the pointer on "N", the array will be directional in a line through poles "N" and "S", towards "N".

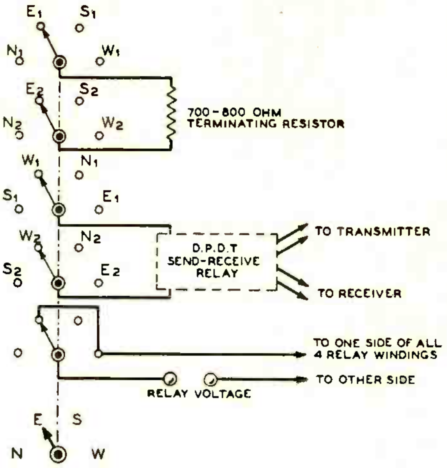


Figure 2. A five-gang, four-position switch permits changing of directivity by just "aiming the pointer." Note that each wire of each r.f. feed line connects to two different gangs. For instance, N_1 on one gang should be jumpered to N_1 on the other gang. These jumpers were omitted from the diagram for the sake of clarity.

The poles, relays, lines, and directions could just as well have been designated as A, B, C, D, or by 1, 2, 3, 4. It should be borne in mind that the antenna need not be oriented exactly as shown, with the pole marked "N" towards the north. After the array is up you can calibrate your direction indicator to read correctly for your particular installation.

A great circle map on your approximate location can be marked off in four quadrants to correspond to the orientation of your array and marked 1, 2, 3, and 4 if desired.

Termination

The best value of terminating resistor can be determined only by experiment. It should be adjusted until the forward gain is best. This will usually correspond to the value that gives the most uniform current distribution on the legs of the array. Do not worry about a *slight* indication of standing waves on the feed lines; they are relatively unimportant. The only trouble they can cause is unequal loading of the transmitter as the antenna direction is switched. If this effect is bad enough

[*Continued on Page 83*]

So You're Going Mobile!

By RAYMOND P. ADAMS*

About four out of every five amateurs—if you listen to their chatter both on and off the air and can believe what you hear—are either seriously contemplating the construction and operation of a mobile rig or are actually building (or buying) a transmitter-receiver assembly for car installation. You get the impression that the average ham is at least mildly interested in this possible extension of his activities and very probably will one day try his hand at a portable-mobile affair.

Well, and why not? It is a lot of fun, especially if you're on the road much of the time. Moreover, it's good practice, this business of mobile rig operation; you never know when you'll be called upon to handle emergency traffic from the family flivver.

But let's get down to a few pointers which may be helpful to the comparative newcomer in the mobile field—to the fellow, say, who's anxious to build and install a decent layout but doesn't know exactly what he's up against.

Receivers

If you're just going on 10 meters you can do one of two things so far as the receiver is concerned: build a complete superhet (no superregenerator, mind you) designed expressly for 28-Mc. operation, or build a converter similar to the one described by Gonsett in January Radio, designed to convert to around 1500 kc. and to be used in conjunction with any good b.c. car radio. The construction of a superhet, of course, isn't the easiest business in the world when physical compactness, high input sensitivity, good overall gain, and hashless powering must be considered—but it's altogether possible, and for that matter generally necessary if you have no b.c. job on hand. If you do have a standard car radio installed, then use it by all means, particularly if it is sensitive and quiet in operation, which is to say if it is the average instrument of up-to-date manufacture.

If you want a de luxe mobile u.h.f. super, consider this layout, which has worked extremely well for this writer:

1851 tuned r.f. stage, adjusted to peak efficiency (no gain control and no a.v.c.); 6K8 mixer, externally excited by a 6J7G and used very much like the older 6L7; 1500 kc. input i.f. stage using fixed-gain 6A8 converting to 456 kc.; controlled i.f. stage at 456 kc. using a 6K7; 6H6 second detector-Dickert noise limiter; 6F5 a.f.; 6F6 output.

Five- and ten-meter operation similarly calls for a choice between the use of a converter with a standard b.c. receiver and the use of a specially built superhet. There's no excuse now for the superregenerator on 10 meters, and for that matter on 5 meters either unless it's equipped with an r.f. stage to eliminate receiver radiation.

The converter previously mentioned makes a perfect front-end, either as a converter or as the r.f. section of a 5- or 10-meter superhet.

Oh, yes—a word about converted all-wave receivers. Some commercial models will work out very well as 10-meter mobile receivers. Others simply won't be worth a hoot. You can take the antenna off your present a.c. job, substitute a four-foot piece of wire, and ordinarily get quite good results. Good enough to warrant the conversion of the set, say, and its removal to the car. But the moment you actually effect the conversion and install the receiver for mobile use, the comparative efficiency goes way down. You can adjust your vibrator or dynamotor supply to give the very same voltage as the a.c. pack, you can have the operating conditions exactly the same; but the overall sensitivity drops away when the 110-volt line connection is removed.

Noise Limiting

About the best noise limiting circuit for the mobile receiver is the Dickert, described sufficiently well in the Radio Handbook to warrant no description here. It is automatic, self-adjusting to carrier level, and foolproof. No special components are required so long as the second detector is a 6H6. The usual spark plug distributors, etc., may be dispensed with entirely.

A 1-watt neon bulb across the speaker transformer primary is much simpler, and very much worth while even if not so effective as the Dickert.

---

* 392 High Drive, Laguna Beach, Calif.

Receiver Powering

While the dynamotor has been used in the past for powering mobile receivers, it is best to plan on a vibrator supply for the receiver, reserving the dynamotor for its more functional application as power unit for the transmitter.

While on this subject, may we suggest that you do *not* try your hand at the design and construction of a vibrator-type supply assembly. It is a very, very difficult business involving a definite relationship between vibrator, transformer, buffer condensers, and a certain, specific known load. If you do, you'll end up by copying some manufacturer's circuit, which probably won't work efficiently at all when you tie it down to the load your own receiver will present. Be sensible, and acquire a complete unit; you will certainly find a model which precisely meets your requirements, as there are several available, each with a switch permitting an adjustment for desired output under receiver load.

Vibrapack Installation

The vibrapack may be a self-shielded assembly complete with transformer, vibrator, power control switch, timing capacity and r. f. filter system (and tube and tube socket if the unit should happen to be of the tube rectifying kind); but even so the output *must* be filtered for a. f. Input and output electrolytic or paper capacitors will be required, with the input around 8 μfd. and the output a value between 8 and 30 μfd., depending on the degree of filtering desired. A filter choke, rated for 100 ma. capacity or better, having an inductance of between 5 and 15 henries, and limited in d.c. resistance to around 100 ohms for the higher output vibrapacks and 400 ohms for the low power units, will likewise be necessary. Consider the assembly simply analogous to the ordinary a.c. transformer-rectifier combination, and consider the output to be r.a.c. which must be smoothed in conventional fashion.

Don't use a two-section filter; it won't be necessary, as the filtering will be entirely adequate with a single choke and input and output capacitors in use. But don't substitute a speaker field for the choke.

Of course it's always good policy to make the power supply assembly, which is to say the vibrapack and its a.f. filter system, a separate unit, particularly if and when the receiver is unusually sensitive or compactly built. However, it *is* possible to mount pack and filter items on the receiver chassis if the general layout permits the positioning of these items at points well away from r.f. and high gain r.f. circuits, and if the vibrapack is single point grounded. It should be borne in mind that if the pack is too close to such circuits, especially if they are poorly shielded, magnetic coupling and hash radiation may be introduced. If the grounding is improper, considerable hash interference may be effected because of circulating ground currents.

"Hash" Elimination

Vibrapacks are filtered for r.f. in both "A hot" input and "B plus" output circuits, and the filtering is quite sufficient when the units are employed in powering transmitters and none too sensitive receivers. But it isn't always enough when receivers are high gain affairs. For the complete elimination of "hash" both the "A hot" and "B plus" should be r.f. filtered *at the receiver.*

The amount of filtering necessary invariably is peculiar to the individual layout, strange as that may seem, and is arrived at through trial and error experiment. Our own procedure is first to connect a 1-μfd. paper condenser from "A hot" to ground at the point of filament supply entrance, then a 0.5-μfd. paper condenser from "B plus" to ground (at the *receiver*) then, if these capacitors do not completely attenuate the interference on all bands, .01-μfd. mica condensers from both "A hot" and "B plus" to ground (replacing the paper items). The next move, if necessary, is to try both paper and mica condensers, with r.f. chokes between them, the filament choke having from eight to fifteen turns of no. 14 solid copper wire wound on a half-inch form, the B circuit item being a 2.5-mh. pie wound s.w. choke. The last, if the hash is down to inappreciable value, is to remove the paper capacitors, replacing them if interference reappears, leaving them out if they do no good.

Vibrapack Notes

1. Use heavy duty leads for the connections between vibrapack and storage battery. No. 14 is really about the smallest advisable. Use larger conductor if you can.

2. Separate leads from battery to pack and to filament circuit are suggested. Break these with a double pole toggle switch.

3. Protect the pack with a fuse, but use a household type (low voltage drop). Voltage drop in the fuse, or for that matter in the on-off switch, may have as much an adverse effect upon proper pack operation as drop in the battery leads.

4. The average vibrapack in use supplies about 250 volts (at the output of a suitable

[*Continued on Page 88*]

TRANSMISSION LINES

As Circuit Elements

While it has been generally accepted that transmission lines offer much higher Q and circuit impedance at ultra-high frequencies than coil-condenser combinations, much doubt has existed as to the optimum ratios of diameter of conductors to spacing for best operation. In this article the subject is clearly and comprehensively covered as is also the problem of tuning a shortened line over a given frequency range.

By E. H. CONKLIN,* W9BNX

During the past two years there has been a growing appreciation of the value of transmission lines as circuit elements at ultra-high frequencies where the usual coil-and-condenser circuits are not very effective.[1,2,3] Up to the present time, however, relatively little has been published on the subject,[4] especially in sources regularly available to amateurs. There is a need for data on the design for best Q and impedance, as well as on the necessary capacity to resonate a short line or to provide a convenient means of varying the resonant frequency. Formulas alone are not sufficient; there should also be charts or tables giving the necessary data for frequencies of interest to amateurs.

Where the object of a tuned circuit is frequency control, a high Q is desirable and the circuit should be loaded as little as possible by the tube. At ultra-high frequencies, the input conductance and capacitance of tubes are such that they load a circuit heavily unless the tube is tapped down on the line. For selectivity, which is not generally a prime requirement of r.f. stages at very high frequencies, a high Q is necessary. But for stage gain a high impedance is desirable, requiring a somewhat different design for optimum performance.

In general, parallel-wire lines are convenient where a push-pull arrangement is used. The ordinary concentric line is most easily adapted to single-ended stages but it can be constructed for use in balanced circuits. The concentric line has the lower attenuation of the two types, giving a higher Q and impedance when used as an anti-resonant circuit. This lower attenuation is due to the relatively low resistance of the outer conductor and the negligible radiation resistance.[4,5,6]

Parallel Wire Lines

In spite of the radiation that takes place from the shorted quarter-wavelength parallel-wire line—obvious from the fact that there is an external field since transmitter power can be coupled out with a "hairpin" coil—this type is widely used. It has generally been supposed that large pipes and a 3.6 to 1 ratio of spacing to radius give the best results. This assumption, however, neglected some rather important factors.[4] Considering radiation resistance and the proximity effect, the

---

* ex-W9FM, Associate Editor, RADIO, 512 N. Main St., Wheaton, Ill.

[1] "Aircraft Radio, 1939," *Electronics*, January, 1939, p. 14, referring to u.h.f. receiver of the Civil Aeronautics Authority.

[2] "High Frequency Receivers—Improving Their Performance," Reber and Conklin, RADIO, January, 1938, p. 112.

[3] "An Improved U.H.F. Receiver," Reber and Conklin, RADIO, January, 1939, p. 17.

[4] "Transmission Lines at Very High Radio Frequencies," Lester E. Reukema, *Electrical Engineering*, August, 1937, p. 1002. See also discussion in February, 1938, issue.

[5] Some controversy exists as to whether there is any radiation at all from a concentric line.

[6] "A Survey of U.H.F. Measurements," L. S. Nergaard, *RCA Review*, October, 1938, p. 165.

Table I

Optimum Design for Quarter-Wave Shorted Parallel-Wire Lines for Maximum Selectivity (max. Q)

Freq. Mc.	D/r	D Spacing between centers (inches)	2r Conductor diameter (inches)	Q
30	6.186	2.14	0.69	1660
60	6.186	1.20	0.39	1317
120	6.186	0.66	0.21	1046
240	6.186	0.38	0.12	830

ratio of center-to-center spacing to conductor *radius, D/R,* has the optimum values of 6.186 to give maximum Q and 20.96 for maximum sending-end impedance, for a quarter-wavelength shorted line. These compare with 2.72 and 8.0 neglecting radiation resistance and proximity effect. The best spacings are thus surprisingly large, especially for maximum impedance.

The optimum spacing between conductor centers, *D,* for a quarter-wave shorted line designed for maximum Q is $0.0172\lambda^{5/6}$ where the wavelength λ and the spacing *D* are in centimeters. The formula becomes $0.00677\lambda^{5/6}$ if the spacing is to be expressed in inches. The Q is then $166\lambda^{1/3}$. For amateur bands, therefore, the design in table I should be followed if the line is to be used for oscillator frequency control or, occasionally, for selectivity; in either case the tube grid and plate should be tapped down from the open end as far as oscillation, or gain, respectively, will permit.

Thus it is seen that the best Q is obtained with sizes that are entirely practical. For five-meter operation, the optimum conductor diameter is only 0.39 inches—just a little larger than ⅜ inch. Several experimenters have increased the pipe size without obtaining any improvement in the frequency stability of a modulated oscillator. The reason for this is now apparent in that the best size is not the largest possible, but a definite one for each frequency.[4]

The Q falls at higher frequencies. Also, if optimum design is not followed, the Q decreases. If the conductor radius is changed from the best value but the spacing recommended for the wavelength is maintained, the Q varies as shown in figure 1. If the

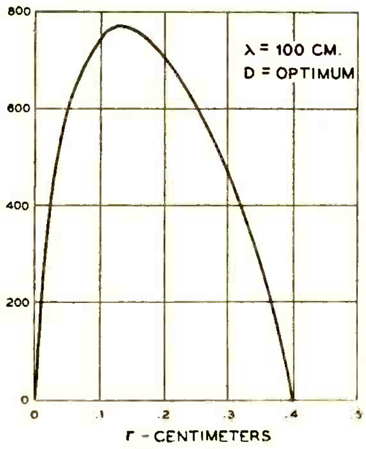


Figure 1.
Variation in Q with conductor radius, at 300 Mc., maintaining optimum spacing.

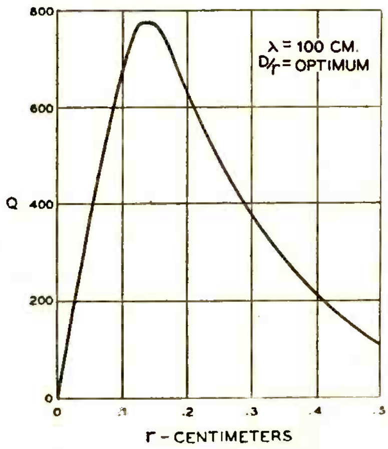


Figure 2.
Variation in Q with conductor radius, at 300 Mc., maintaining the optimum D/r ratio of 6.186.

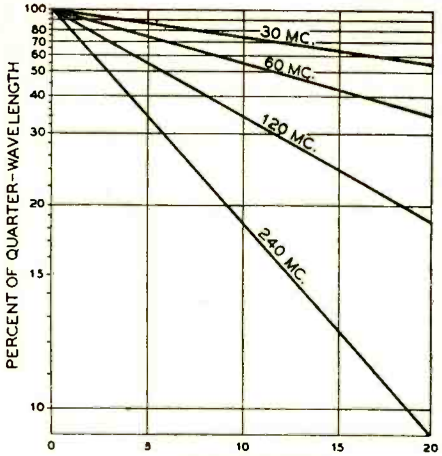


Figure 3.

Capacity required to resonate lines less than ¼ wavelength long, for line of 218.7 ohm surge impedence (6.186 D/r ratio).

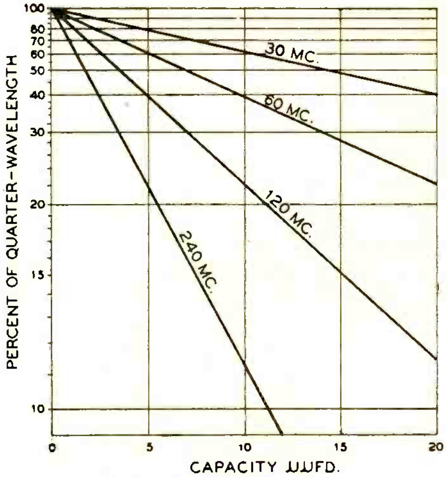


Figure 4.

Capacity required to resonate lines less than ¼ wavelength long, for line of 365.1 ohm surge impedence (20.96 D/r ratio).

spacing is also changed so that the recommended *D/r* ratio is maintained, figure 2 applies. It is seen that it is much better to maintain the recommended spacing, and for a given deviation in conductor radius, it is a little better to have it too large than too small.

Since for optimum design 71.8 per cent of the radiation resistance is due to the shorting bar, Professor Reukema points out[4] that the Q can be increased by almost 50 per cent if the wires are brought together gradually, thus eliminating the shorting bar. This will slightly alter the characteristic impedance to be used in calculating Q, and increases by 50 per cent the optimum spacing to be used.

Design for Maximum Impedance

If the grid circuit of an oscillator is tuned with a high-Q line, the plate circuit should be a high impedance. Likewise, for high stage gain rather than maximum selectivity, lines used as interstage couplers should be designed for maximum open-end impedance and the grid and plate leads can be tapped to the points giving the highest stage gain.

In this case the best spacing between conductor centers is $0.0259\lambda^{5/6}$ where wavelength and spacing are expressed in centimeters, or $0.0102\lambda^{5/6}$ where the spacing is in inches. The open-end impedance Z_s is $60{,}150\lambda^{1/3}$. As already mentioned, the proper ratio of spacing to conductor radius *D/r* is 20.96. Design data are given in table II.

A surprising thing about these data is that the best conductor size for 60 Mc. is just slightly under 3/16 inch, a very inexpensive size compared with the one-inch pipes, and the like, often used.

Here again, for the highest possible impedance, the quarter-wave line can be drawn

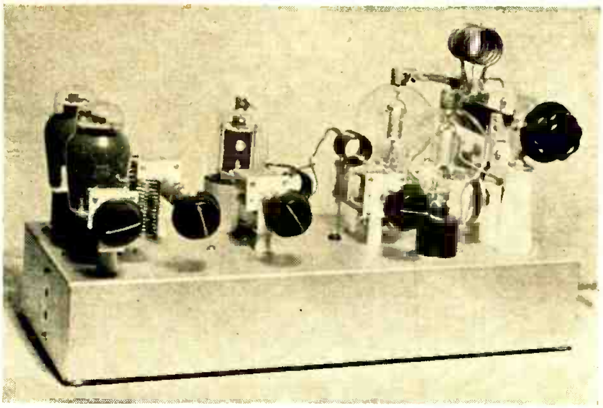
[*Continued on Page 75*]

Table II

Optimum Design for Quarter-Wave Shorted Parallel-Wire Lines for Maximum Impedance

Freq. Mc.	D/r	D Spacing between centers (inches)	2r Conductor diameter (inches)	Input Impedance Z_s
30	20.96	3.22	0.307	601,500
60	20.96	1.81	0.173	477,420
120	20.96	0.99	0.085	378,925
240	20.96	0.57	0.054	300,753

Simplicity at 56 MC.



Front chassis view of the transmitter. Exciter control knobs are placed in one row to facilitate the ultimate installation of the unit in a relay rack behind a standard panel.

By FRANK C. SOUTH,* W3AIR

Until comparatively recently, simplicity of design and construction in a 56-Mc. transmitter has been almost an impossibility. But with the introduction of high-transconductance, high-sensitivity beam tubes and efficient power amplifier tubes the problem has been much simplified. The 56-Mc. exciter described in the January RADIO ("A 56-Mc. Transmitter-Exciter," Rothman, p. 23) is a good example of efficient u.h.f. exciter design. Many excellent arrangements of power amplifiers also have been described in recent issues of RADIO.

The transmitter to be described exemplifies the ideas employed in these designs and has been in use at the author's station for some time for 56-Mc. work. The excellent signal put out by this transmitter can be attested to by many who were worked and who heard the signal W3AIR during the dx spree of 56-Mc. last summer and fall.

Tube Lineup

Beam tetrodes were selected for use in all three of the exciter stages of the transmitter. A 6L6G harmonic crystal oscillator, starting out with a low-drift 7-Mc. crystal, supplies 14-Mc. excitation from its plate circuit to the grid of the following doubler. This stage, another 6L6G, doubles in its plate circuit to 28 Mc. to feed the grid of the 807 doubler to 56 Mc. All three of these stages are capacity coupled through .0001-μfd. mica condensers. The 6L6G's operate at comparatively low plate voltage, 300 volts, while the 807 is supplied with 500 volts and draws approximately 90 milliamperes under full load.

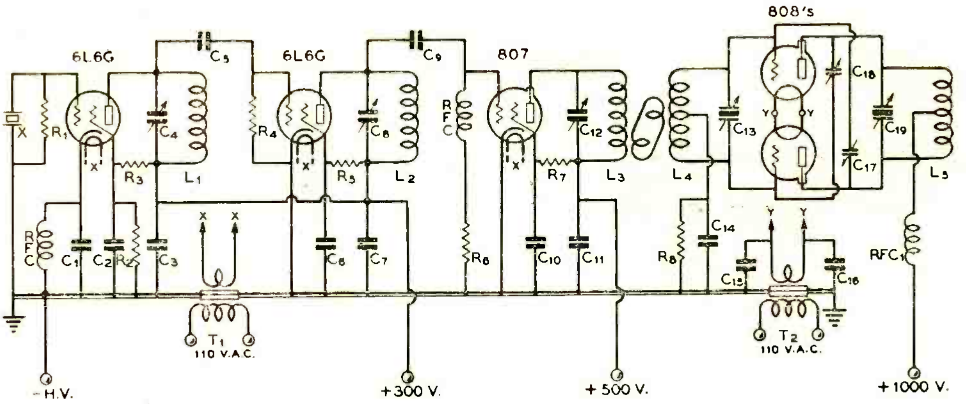
The grid circuit of the push-pull 808 final amplifier is link coupled to the plate tank of the 807. Since comparatively loose coupling is required between these two stages, a link with a single turn at each end is used. The normal excitation to the final grids furnishes 45 ma. of grid current through the 5000-ohm grid leak. This is more than ample excitation for class-C operation of the 808 stage.

Mechanical Design

The transmitter was built upon a standard length chassis, 7 by 17 by 3 inches, so that at some later date the unit could be suspended from a standard panel and installed in a relay rack. Underneath the tray are housed the two filament transformers, 6.3 volts at 3 amperes for the exciter stages and 7.5 volts at 8 amperes for the 808's, and the majority of the low-potential components of the transmitter. All the tuning condensers are mounted above-deck upon isolantite standoff insulators; each of the coils is bolted or soldered to its respective tuning condenser. A cylindrical aluminum shield extends from the chassis upward on the 807 to slightly below the bottom edge of the plate of the tube. This assists in reducing unwanted degeneration in the doubler stage.

---

* 2 Nassau St., Princeton, N. J.



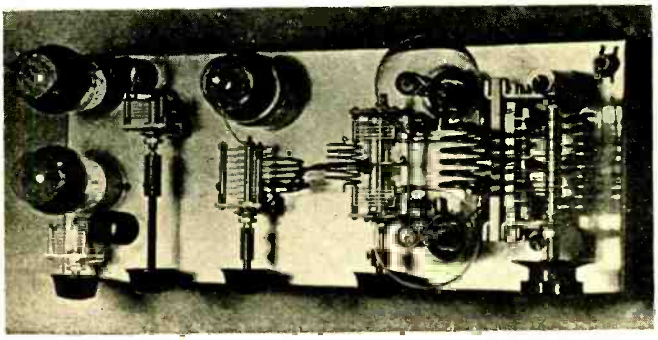
Wiring diagram of the 56-mc. transmitter.

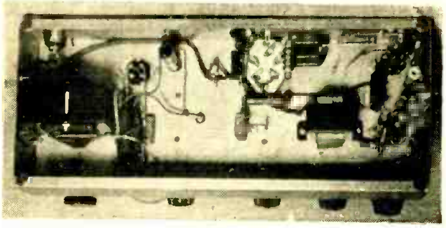
C_1—.00015-μfd. mica
C_2, C_3—.01-μfd. 400-volt tubular
C_4—35-μμfd. midget variable
C_5—.0001-μfd. mica
C_6, C_7—.01μfd. 400-volt tubular
C_8—35-μμfd. midget variable
C_9—.0001-μfd. mica
C_{10}, C_{11}—.01-μfd. mica 1000-volt
C_{12}—30-μμfd. 2000-volt variable
C_{13}—35-μμfd. per section midget
C_{14}—.01-μfd. 400-volt tubular
C_{15}, C_{16}—.01-μfd. 400-volt tubular
C_{17}, C_{18}—808 neut. condensers
C_{19}—35-μμfd. per section 4000-volt variable, u.h.f. type
R_1—100,000 ohms, 1 watt
R_2—35,000 ohms, 2 watts
R_3—10,000 ohms, 10 watts
R_4—50,000 ohms, 2 watts
R_5—25,000 ohms, 10 watts
R_6—50,000 ohms, 2 watts
R_7—35,000 ohms, 10 watts
R_8—5000 ohms, 25 watts
RFC—2½-mh. 125-ma. r.f. choke
RFC_1—5.7-μhy. uhf. choke
T_1—6.3 volts at 3 amps.
T_2—7.5 volts at 8 amps.
L_1—16 turns no. 16, 1" dia. 1⅝" long
L_2—7 turns no. 10 enam., 1" dia., 1¼" long
L_3—5 turns no. 12 enam., 1" dia., 1" long
L_4—6 turns no. 12 enam., 1" dia., 1¼" long
L_5—6 turns ⅛" copper tubing, 1¼" dia., 2" long

It also allows the 807 to operate straight through on 28-Mc. as an amplifier.

The neutralizing condensers for the final stage are of the horizontal circular-plate type and are mounted below the final tuning condenser. The grid leads of the 808's, which come out of the side of the envelope, are faced toward each other and are connected directly to their respective neutralizing condensers. The leads from the other ends of the neutralizing condensers then cross over and connect to the lower stator connections of the final tank condenser. This mounting arrangement provides for very short lead length and good mechanical symmetry in the neutralizing circuit; these are important considerations in an amplifier which is to operate efficiently on the 56-Mc. band.

Top chassis view of the transmitter. Note the straightforward and orderly arrangement of components.





Under-chassis view of the transmitter. The large filament transformer to the left is the 7.5-volt 8-ampere one that supplies the 808's; the other transformer, to the right of the chassis, supplies 6.3 volts to the exciter stages.

The rotors of both the grid and plate tank condensers of the final stage are left floating. Since the stage is mechanically symmetrical with respect to the chassis, this allows the amplifier to determine its own nodal point. However, for coupling to certain types of transmission lines, and to those whose standing waves make them unbalanced to ground, it will be advisable to ground the rotor of the final tank condenser through about a .002-μfd. 5000-volt mica condenser. This will tend to hold the stage down when it is coupled to an unbalanced load.

Operation

The final stage normally is operated at 1000 volts with an input from 250 to 300 watts and is high-level plate modulated for phone. If desired, for c.w. use the full rated plate voltage may be applied to the 808's (1500 volts) and the plate current may be run to 300 ma. for the pair of tubes—450 watts input on the 56-Mc. band. Keying may best be accomplished by means of grid-controlled rectifiers in the final plate supply or by means of primary keying of this supply. If one of the preceding stages is keyed it will be necessary also to key all succeeding stages since all are operating with straight resistor bias. Incorporation of power supply bias on the final, however, will allow one of the preceding stages to be keyed.

See Buyer's Guide, page 98, for parts list.

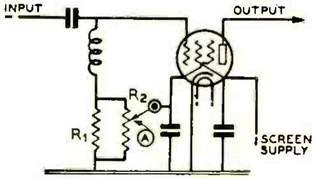
●

Automatic Excitation Control

In line with the article in the December, 1938, issue of RADIO concerning limiting and controlling grid current,[1] Mr. E. W. Johnson, W9RAB*, has submitted a circuit which makes the controlling action entirely automatic.

The chief requirement of this circuit is that the tube in the stage to be controlled must be a pentode which has the suppressor brought out to a separate terminal. Typical tubes which have been used satisfactorily are the 59, 89, RK-25, and 802. Larger pentodes such as the 803 and 804 may also be used.

The circuit diagram is practically self-explanatory. The suppressor of the controlled stage is biased negatively by returning it to a voltage divider which is in parallel with the grid leak. As the excitation to the stage is increased, the current through the grid leak, R_1, and consequently the bias, is increased. The increased negative voltage at point A reduces the output of the pentode and thus holds the excitation to the following stage substantially constant.



Since the suppressor draws no current when biased negatively, the contol-grid bias on the stage is not affected by tapping the suppressor across a portion of the grid leak. The 500,000-ohm control potentiometer across the grid leak allows the suppressor bias to be set conveniently. In low-power stages the separate grid leak could be dispensed with and a small 15,000- to 50,000-ohm receiving type potentiometer could be substituted to act as grid leak. The suppressor would then be connected to the movable contact.

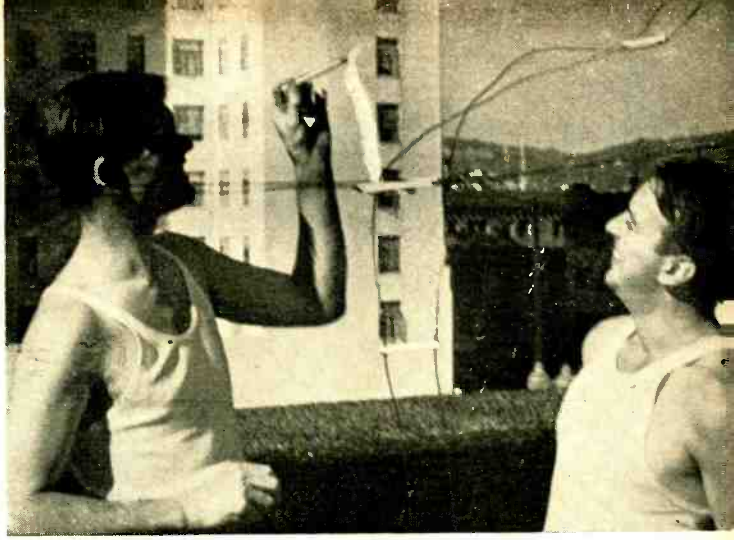
●

W6QX inaugurated the A. R. R. L. standard frequency transmissions.

---

* 2807 Jackson Street, St. Joseph, Mo.

[1] Johnson, "Name Your Grid Current," RADIO, December, 1938, p. 41.



" . . . which generally indicates a mismatch at the termination of the 600-ohm line." W6VX, left, and W6HB, right, observe a standing wave in action.

DEPARTMENTS

- **Dx**
- **The Amateur Newcomer**
- **U. H. F.**
- **Postscripts and Announcements**
- **Yarn of the Month**
- **Scratchi**
- **Open Forum**
- **What's New in Radio**

"WAZ" HONOR ROLL

CW and PHONE

	Zones	Countries
ON4AU	40	158
G2ZQ	40	143
W8CRA	39	154
G6WY	39	151
W6CXW	39	150
W9TJ	39	144
W6GRL	39	141
W8BTI	39	141
W6ADP	39	140
W6BAX	39	140
W6CUH	39	140
W4CBY	39	138
W6DOB	39	138
W2HHF	39	135
W8OSL	39	133
W3EVT	39	131
W2GWE	39	129
W6KRI	39	129
W4CYU	39	126
W7BB	39	123
W6HX	39	123
G5BJ	39	120
W2GVZ	39	120
G5BD	39	120
W2CYS	39	117
W2IYO	39	116
G2LB	39	115
W6FZL	39	112
ON4FE	39	110
W6FZY	39	109
VE4RO	39	99
XE1BT	39	90
K6AKP	39	67
W2BHW	38	149
W1BUX	38	145
W2GT	38	143
W2GTZ	38	141
W8BKP	38	138
W6KIP	38	137
W2GW	38	137
W5VV	38	132
W5BB	38	132
W8LEC	38	131
VK2EO	38	130
W9FS	38	130
W1ZB	38	129
W8OQF	38	127
ON4EY	38	126
W3EMM	38	124
W6QD	38	124
W3EDP	38	121
W3EPV	38	121
W3EVW	38	120
W8AU	38	120
W8DFH	38	119
W9PST	38	119
W2AAL	38	118
W8DWV	38	118
W6AM	38	117
W1CC	38	116
W3DDM	38	116
W9UQT	38	116
W3GAU	38	115
W5KC	38	115
W8MTY	38	114
W8HWE	38	112
W2BMX	38	112
W2BXA	38	111
W6GRX	38	111
LY1J	38	110
W6HZT	38	110
W1AQT	38	109
W8KWI	38	108
W6VB	38	107
LU7AZ	38	107
W8BOX	38	106
W9ADN	38	106
W9KG	38	106
W8LYQ	38	106
G2QT	38	106
W1BGC	38	106
G2IO	38	103
W8QXT	38	102
W9CWW	38	100
J2KG	38	95
ON4FQ	38	92
G6XL	38	89
W8GBF	38	87
W9VDQ	38	79
W4AJX	38	
W8KKG	37	127
W7AMX	37	122
W6GAL	37	121
W8ZY	37	114
W6LYM	37	111
W8EUY	37	110
W3TR	37	106
W9PTC	37	103
VE2EE	37	102
G6GH	37	102
W6FKZ	37	101
W6JBO	37	101
W8KPB	37	100
W4DMB	37	100
W9AJA	37	99
W4EQK	37	99
W3AYS	37	98
W3EXB	37	98
ZL2CI	37	97
W3AYS	37	97
W1GDY	37	92
W9UBB	37	77
W8AQT	36	118
W2BJ	36	116
W4IO	36	107
W9AFN	36	105
W1RY	36	104
G6CL	36	104
W6BAM	36	103
W3GHD	36	102
W6ITH	36	102
J2JJ	36	100
W8LZK	36	99
G2QT	36	98
VE1DR	36	98
W8JSU	36	98
ON4VU	36	96
W3KT	36	96
ZL1HY	36	95
G6YR	36	94
W7AYO	36	94
W9RBI	36	94
W6KWA	36	92
W9KA	36	92
W9PK	36	92
W5ENE	36	91
W4ADA	36	90
W8JAH	36	89
W1APU	36	89
OK2HX	36	86
VK2NS	36	84
W6NNR	36	84
G2UX	36	83
W6TI	36	80
W6GCX	36	76
W7DSZ	36	73
W2GXH	36	71
W9ARL	36	
W8OXO	35	107
W6GHU	35	103
W8DOD	35	102
W6MVK	35	100
W8CJJ	35	98
W9RCQ	35	97
OK1AW	35	96
W8AAJ	35	96
W3RT	35	95
W9EF	35	94
W6AQJ	35	92
W6DLY	35	92
W9GBJ	35	92
LU3DH	35	89
W8AAT	35	87
G6QX	35	82
ON4NC	35	82
GI6TK	35	80
W6KQK	35	79
W9GNU	35	77
VE5ZM	35	76
W6ONQ	35	73
W9QOE	35	66
W6MCG	35	
SU1WM	34	109
W6HEW	34	103
W8BSF	34	100
VK2AS	34	94
W6HJT	34	94
W8HGA	34	93
W1APA	34	93
W3KT	34	92
W8QDU	34	89
W6CVW	34	84
W8JSU	34	83
W9BCV	34	83
ZS1CN	34	82
VK2TF	34	81
W6MJR	34	81
ON4SS	34	80
W6HIP	34	76
VK2TI	34	75
W7AVL	34	75
W4ELQ	34	74
W6LHN	34	71
VK2EG	34	70
VE5MZ	34	69
VK2VN	34	63
W9QOE	34	56
K6JPD	34	
W8ACY	33	97
W5ASG	33	94
W6GK	33	94
W2BMX	33	90
W6KUT	33	90
ON4HC	33	88
W6CEM	33	88
W2WC	33	83
VE4LX	33	82
W6ANN	33	81
W6GCT	33	79
W6LCF	33	78
W5PJ	33	78
W6MVQ	33	77
W9TJI	33	76
W7AVL	33	71
W6PNO	33	68
W2FAW	33	67
VK2RA	33	65
K6CGK	33	62
W9LBB	33	
VK2VQ	32	99
W6DIO	32	90
G6WB	32	84
W9FLH	32	80
W9PGS	32	78
W6NLZ	32	76
W1AB	32	76
W3CIC	32	75
W6PQZ	32	73
W9GKS	32	71
W3GAP	32	70
W6LPR	32	67
W9DEI	32	66
W6KRM	32	62
W6OAQ	32	56
W4MR	31	92
W6DRE	31	86
W6GNZ	31	85
W8FJN	31	85
W2AOG	31	83
W9LW	31	82
W2FLG	31	80
W6KEV	31	80
W2HVM	31	78
SM6VK	31	76
W2GPF	31	75
W2BZB	31	75
W9YEG	31	75
G5VU	31	73
W6OEG	31	72
W5PJ	31	71
W9VKF	31	68
VK2VA	31	62
W6OFC	31	62
W9VWV	31	60
W9NRB	31	54
VE2GA	30	84
W4DCZ	30	80
W3CDG	30	78
G3BS	30	75
W3GHB	30	73
W3GMS	30	72
W8MFB	30	71
W4DTR	30	68
W8MPD	30	66
W9RXL	30	65
W9VLQ	30	58
W8PHD	30	57
W6AJN	30	56
W8DPY	30	53
W7ENW	30	51

PHONE

W3LE	37	96
W2AZ	37	90
W6OCH	36	92
W3FJU	35	80
W6ITH	35	87
F8UE	35	84
VE1CR	35	79
KA1ME	35	79
W4CYU	34	93
W9NLP	34	84
W6NNR	33	75
W9TIZ	33	72
W6CQI	32	70
W7BVO	32	70
W3FAM	33	68
W6OI	32	68
VE1DR	32	59
W6IKQ	32	52
W6MLG	31	76
F8VC	31	71
W8LFE	31	70
W6LLQ	31	68
W2GW	31	65
F8KI	31	53
W6AM	31	
W6AM	31	60
W9ZTO	31	53
W4AH	31	
W2AOG	30	77
W9QI	30	75
G6BW	30	73
G8MX	30	65
W2IXY	29	86
W3EMM	29	76
W6EJC	29	64
W8QXT	29	63
W2IKV	28	77
W9BCV	28	68
W8AAJ	28	66
VE2EE	28	62
W9RBI	28	58
W8LAC	27	72
W1HKK	27	70
W6FTU	27	62
W8RL	27	58
W6NLS	27	52
W6GCT	27	52
G5ZJ	26	77
W1AKY	26	73
W4BMR	26	67
W2IUV	26	65
W4EQK	26	61
W5DNV	26	60
VK4JP	26	32
W6GAL	26	45
W7EKA	26	45
W2HCE	25	69
W8JK	25	47
W8QDU	25	54
W6PDB	25	44
W7AMQ	25	40
W6LYM	25	39
W6MXD	25	38
W6FKK	25	36
YV5AK	24	59
W8DBC	24	53
W4TS	24	52
W1BLO	24	50
W6LPR	24	45
W6MVK	24	36
W6MVQ	24	32
ON4HS	23	51
W1JCX	23	52
W5ASG	23	46
W6GRX	23	43
W9ORL	23	38
W7ALZ	23	31
W6NCW	23	27
W7ESK	23	
W8DBC	22	46
W1KKP	22	40
W9UYB	22	35
G6DT	21	53
W6NEP	21	53
W8KWI	21	50
W5BB	21	42
W6FZL	21	40
W4MS	21	40
W9VYD	21	36
W7BJS	21	37
W6PNO	21	30
W6OJK	20	37
W3AKX	20	32
VE5FO	20	31
W6LOY	20	29
W6NMI	20	25
W6IWS	20	24
K6KMB	20	23

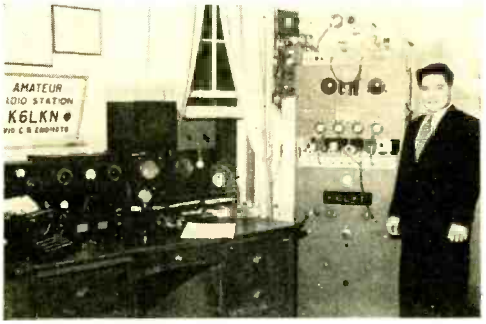
DX AND OVERSEAS NEWS

Herb. Becker, W6QD

Send all contributions to Radio, attention DX Editor, 7460 Beverly Blvd., Los Angeles.

By the time most of you read this, the contest will be history. We hope that everyone comes out of it "unscathed." It has been our contention for a long time that some guy should wise up and put out a special brand of gargle and mouth wash for the phone boys. Just think what a cleanup he would make during the phone contest. Last year during the contest there were a number of phone boys that bogged down during the last two or three days because they lost their voices. Imagine working a dx station and finding yourself getting hoarse . . . you could just tell him to QRX a moment because you want to take a swig of "Elixer of DX" mouth wash.

Along the more serious vein . . . it is good to see the response to the "1939 DX Marathon."



K6KLN, popular phone station on the island of Maui. The transmitter uses a 53 into T20's into T55's, modulated by TZ20's in class B.

Phone Zone Requirements Changed

Effective immediately, all stations in the phone section of the "WAZ Honor Roll" will be required to list and count "two-way" phone contacts only. We have felt for some time that this should be changed but wanted to await reaction from the fellows themselves. This is still your column, and a great many of the boys have expressed their approval of such a change. This will also apply to the "1939 DX Marathon." The "c.w. and phone," or main portion of the list, will remain as is . . . no changes. We will want all those now listed in the phone list to kindly drop us a card stating if this ruling affects your totals, and if so, to list the *new* correct totals. We will check your call as soon as you notify us . . . but we must have an answer from everyone in the phone list. Remember, two-way phone only. The deadline for receipt of all answers will be May 10th. After this date, those not heard from will be omitted from the list until they "check in" with their correct totals. We're sure that this will meet with approval from the whole gang.

"1939 DX Marathon"

The Marathon is under way . . . and how. You will note that a number of fellows have sent in their totals even though the year is still pretty young. How long these fellows will keep their places in the list, or stay in at all, is up to them. Send in your list as soon as you think you have sufficient to get in the running. Don't save up your zones with the idea in mind you're going to spring 'em all of a sudden.

For those who "may have tuned in late" the "1939 DX Marathon" started January 1 and will end December 31, 1939. The 50 highest "c.w. and phone" will be listed, as will the 25 highest for phone only. Phone contacts must be two-way phone. The Marathon gives the newcomer an equal chance with some of the older dx men, and I wouldn't be a bit surprised to see a lot of dark

1939 DX MARATHON

C. W. and PHONE

	Zones	Countries
W9TJ	31	56
W8AU	30	61
W1IED	30	43
W4FIJ	29	55
G6CW	28	60
W8LEC	27	41
G2FT	25	40
W9GKS	25	38
G8JV	24	47
W8OQF	24	37
W5ASG	23	43
G5BD	22	48
W3EPV	22	36
W6TE	22	36
W9CWW	21	23
W1BGC	20	36
W6NLZ	20	24
W2BHW	20	22
G3BS	18	31
W6PNO	16	24
W8JJY	16	24
W6ANN	15	18
W2ICX	13	13
VE5ZM	13	31
W9YXO	12	19
G2QT	12	12
G2IO	11	22
W9WCE	7	9

PHONE

W6ITH	28	36
W8LFE	27	46
W8QXT	26	50
W6OCH	23	41
W1AKY	22	39
W6NNR	21	31
W9RBI	20	31
W2AER	20	27
W6MZD	20	22
W8NYD	19	30
W1QUD	17	29
W8DBC	17	23
W6QLN	17	22
W6PDB	15	19
VE5FO	14	16
W5EDX	13	13
W5ASG	10	16

horses go places. Already there are calls in there that have never been in the "Honor Roll." You must send in a list of the zones claimed, showing a station in each zone. The total number of countries will be sufficient, however. If it so happens that you are on the list of 50 one month and enough men pass you, and eliminate you from the list, you need not send in a complete list again. When you think you have enough for re-entry, just notify us that we have your original list and then show the new ones worked. Please keep your "Honor Roll" scores separate from the "1939 Marathon" scores. The DX contest should really show up to advantage in adding new ones, and right now I can almost feel the sudden surge, which means long and late hours of tabulating.

Brasspounders Gossip

W8AQT chalked up a new country in FP8AA, making 36 and 118. AQT has worked 41 countries on 40 meters since the first of this year. W3EVT, although very busy with college, has found time to add YS2LR, ZD4AB, VU2AN, XZ2LZ and PK4KO, which gives Clem 131 countries. W6EGH is back after dx with what time he has available. I got a laugh out of a story EGH tells . . . it seems that W6FKZ is in charge of a large sound truck at one of our best "movin' pitcher" studios, and EGH in his regular call at the studio tried to find FKZ. He was told to look over at a certain sound truck . . . so Wallie "ankled" over but no FKZ in sight. But there was a lot of hammering going on, and finally EGH located FKZ inside the truck pounding away for all he was worth. Wallie asked FKZ what he was building and Roy retorted, "I'm building the turning gadget for a rotary beam."

W2HHF is still doing business and some of the best of his new business is K7FST and PK4KO. His other new ones are OQ5AV, VU2BG, PK1VX, XU6D, VP8AD, KA1RP, CR7AL, VU2MA, J3DF, VS7AR, VU2FO, XU4XA. W3TR has no fault to find with Friday, January the 13th. He got a raise in pay and worked XU4XA for his 37th zone. Al also has a couple of others that look very good too . . . ZC6EC and HR7WC, making 106 countries. W2GVZ also nabbed PK4KS for his 120th. W3KT can't be denied forever and just for the devil of it he worked CR7AG and VS7RF for new zones, and then to top it off added NY1AB and HI6Q for his 95th and 96th countries.

Operating position at VK2OQ. The final winds up with a pair of 809's, which are plate modulated. A rotary array is used. Superhet receiver and crystal mike are homemade.

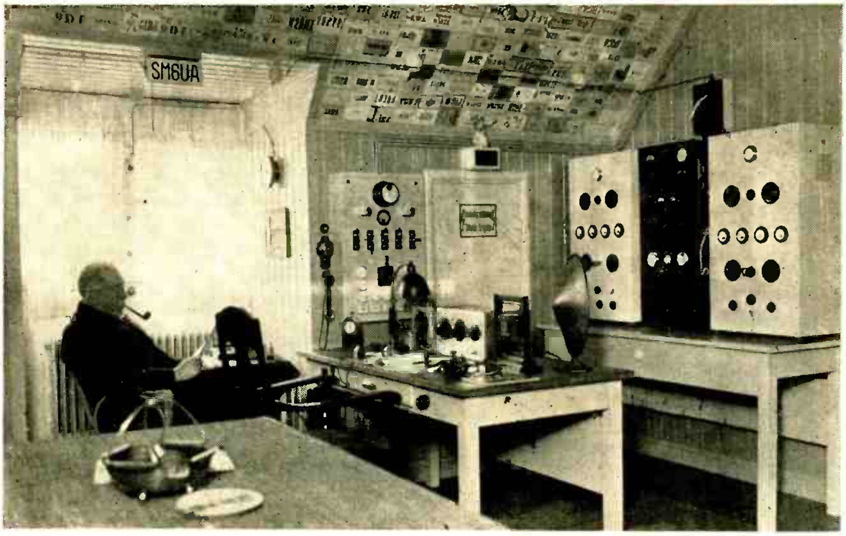
VP4GA was in Trinidad for a year but is back in the States now. He is also ex-W5GA, and for those who want to locate him, his address is Chas. Cowden, 177 N. Hill St., Pasadena, Calif. W6ADP, who was a single man and a dx operator, is still inactive . . . that is, as far as radio is concerned. He took exception to this column's statement in the January issue that he "ended" up with 39 and 140. ADP says he will stage a comeback.

VE4RO is happy these days after hooking CR7AG for his 39th zone, and he also got a couple of new countries in TG9BA and VP3AA. W1DPJ and his dx have picked up a great deal since his new receiver arrived. He has 22 zones so far and is right in there after 'em. Naturally, he feels pretty good because the first night he fired up the receiver he batted off a WAC. W4EPT says he can't find any VP2's listed in the country list as printed in January. I'll bet if he looked under Windward Islands and Leeward Islands he'd find the VP2's. W4EPT has worked HA8G, YR5AR, HB9J, and VK7CM on 7 Mc. recently, with a lot more heard but not worked.

W2BJ has a new ECO so will be doing a little band scooting. Ray is another one who got a raise, and on top of that his y.l. gave him a new receiver for Xmas . . . oh yes, a pair of T-55's too. Nice going, Ray, and do I hear any wedding bells? W2BJ worked OY4C on 7 Mc. for a new one. W3HVH has heard quite a bunch of 40-meter dx and is waiting until he can get his rig going to grab off some of it. W6ONQ was credited with working PA0EA and FA8BG on 7 Mc. in the February issue. This was in error as Johnny didn't work them . . . he just heard 'em. Anyway, Johnny did get CN8AV for his 35th zone and 73rd country.

NEVADA . . . if there is anyone who wants Nevada just take a look for W6QQL. He is running 300 watts into a vertical radiator and will soon have another antenna going soon. W6QQL is ex-W9DFY and is now located at Boulder City, Nevada. The frequencies used are 14,300, 14,322. 14,364 and when on phone 14,230. W4CYU picked off FI8AC for his 39th zone and VQ4KTB and VQ2HC for new countries. W8AQT has a new 250TH and is running 850 watts on it. He worked ST6KR, and he said to send all cards for him to Frank H. Pettit, SU1SG, c/o Catholic Club Mustapha Barracks, Alexandria, Egypt.

SP1AR joins our list with 34 zones and 97 countries. SP1AR used to be SP3AR until the recent change, and then still farther back he was TPAR. W2IYO is in again, and this time to tell the world about zone 19 in the form of K7FST. Gee, FST is giving the boys a treat, isn't he? Also for 2IYO is PK4KS, VP6LN, VQ4RHL, CT3BA, and K7GRF. Here's this W5BB . . . still after it, and by the looks of



SM6UA, the station of J. F. Karlson at Goteborg, Sweden.

things he's getting plenty . . . KG6NVJ, KC6CKM and next on the list is KD6QLS. When he gets through with the Islands, I think he is going to build a few more out there to work. Anyway Tom is up to 38 and 132 with confirmations at 38 and 119. Tom also sneaks on phone once in a while and announces he has 21 and 42 via that method. His relation, W5VV, also seems to horn in on some of that and has KC6CKM for a new one. Those fellows must live right . . . or sumpin. Glad to hear from W3CDZ, and that he is planning to be active again. At least that's what he says. Hank, now don't make me a liar.

K6AMH is new to our gang but has really done all right and we hope he keeps up. AMH says that within the year he expects to be on either Midway or Wake Island. If so, you may look for KD or KC6AMH . . . however, we'll go into that later. But don't forget that "Lem" Hobdy, KD6MV, is on Midway or will be shortly . . . low end of 20.

W1AQT sat down on PK4KS for country no. 109 . . . with zones at 38. K7RT is now W7RT again and is on with 200 watts. W7DL has the old fire in him again and added YL2CM, K6NVJ, K6DSF and OY4C to make 39 and 110. Hoffie has just moved into a "joint" (his word, not mine) with 138 apartments in it. However, the rig is still at the old QRA but is a little too far to travel to operate. My, my, I can think of nothing better than to move the station into the apartment house and give all 138 a treat they have never heard before.

I thought W7AMX had worked all the dx there was when along he comes with OY4C, FA3WW, FA8RY, VQ2JC, CR7AF. Art has taken a crack at 7 Mc. and hauled in VP4TN. He notes several good stations, the frequencies of which will be found in the Frequency List.

G6QX has a couple of new ones in KA1FG and LZ1ID, which makes him 35 and 82. On 14 Mc. he worked CP1AA, ZB2A, CE3BF and U9ML. Bob still wants Nevada and New Mexico. (For Nevada note elsewhere in this column, also back issues.) 6QX has been made a present of a T155 and is figuring to have it in shortly. W8AU hasn't been doing much lately, only worked the following . . . PK4KS, XU8NR, XU2AW, VP8AD, ST6KR, VQ4RHL, KA1AF, KA1JM, VS6AO, FI8AC, VQ2MI, U9ML, YV8AA, PK1RI, PK1TT. Wonder what Lou does in his spare time? Betcha he works dx. While I think of it, this fellow PK4KS is really in there this month, isn't he? He's surely doing his part for QSO's. It is interesting to note what calls are the most reported each month. Once I thought I worked a pretty rare station. In fact I was so convinced that I must have been the first W that I almost had it in print early in the month. However, as the month progressed and the mail came in, I found that there were at least 15 other W's that had hooked the same station *before* I did. There just "ain't" any new dx.

W8QDU got the right combination and has TF5C in his log as worked. A line from OK2HX shows that he has 36 and 86 but at present he is not on the air. Due to the then prevailing conditions, the government suspended all transmitters, but very soon now he expects them to be given back and once again the OK hams will be on the air. W8JSU is all steamed up about conditions on 7 Mc. He has worked around 30 or 35 good dx stations on 40 and they all appear in the Frequency List. Spends most of his time around 7250 kc. Chas is using a pair of T20's and sees no reason to increase power. W9KA raised his power to 700 watts and kept an accurate check in his log. It showed no difference over the period of time when he was using 168 watts; so back to 168 watts he went. Roy has 38 and 114.

VK2EO has just built himself one of the new "4-25" Exciters described in the December issue. He says it is foolproof and surely gives plenty of drive on all four bands. Dave uses the "4-25" to drive his 808 final. He also says that during a QSO with VU2AN, the latter told him that he would remain in Baluchistan until 1941. Other new ones for Dave are VP8AD, U8ID, KF6DHW, VK4HN, VU2AN and VU7BR. W8EMW is the op at W8HJP. HJP is the call of the station at the State Armory at Syracuse. EMW says he is going to get the station dx-minded before long. He says on 80 meters dx is swell, and that he can raise anything he can hear . . . So far, the best contact on 80 has been K6CGK. At EMW's home station he has worked 30 zones and 96 countries. Bob says apparently everyone is considering LX1AO a phoney, but it's funny to him because he has received two QSL cards from him. There must be an LX1AO somewhere as his cards do not lie.

Speaking of LX . . . here is a note from LX1AB. He has been appointed QSL Manager of the "Reseau Luxembourgeois des Amateurs d'Ondes Courtes." I'm not up on my French, but I think you may get the general idea he is the official QSL bureau and you may send all cards for LX to W. Berger, 20, rue Louvigny, Luxembourg (G.D.)

Just received a message from W6PLK, who worked K6MV and was told by MV that he was leaving for Midway on February 6th. By the time you read this, Hobdy should be signing KD6MV. The frequencies will be about 7014 and 14,028 kc. I think.

Now then, from VE5ZM I see he has 35 and 76. Latest include YS2LR, JP1BV, G8MF, ES5C, YL2CD, I1IT, YU7AY, U9ML, SV1KE, HS1BJ, FI8AC, VS2AL, FA8ZZ, SU1WM, CR7AG, VQ3HJP. From VE5AAD it looks as though 36 and 92 is the story . . . with his best including VO6D, YS2LR, HR1UZ, YN1AA, VP3AA, VU2AN, FT4AG, SU1SG, CR7AF, TF3C, UX1CN, ZC6AQ, and many more.

W8ODI and W8OGK both wish we would print more 40-meter dx. That's a tough one to answer, but I might suggest that we surely would if the gang would send it in. Of course, first they would have to get up there again on 40 and work the stuff. If enough 7-Mc. dx is available for publication I would be glad to segregate it into a "paragraph" of its own. W8ODI and W8OGK send in a list of nice 40-meter stations worked, and here are a few of the best . . . CE2BH, EI7L, F8AT, GM6IW, HB9CS, HH2ES, HI2S, LA6U, LY1AD, LU9CK, SP1IH, PA0EA, YR5DG, YU7AY and many more.

Operating position at VK2TR. The transmitter uses a pair of 2A3's to modulate an 809. The receiver is a 7-tube homemade superhet.

GI6YM passes along a nice piece of information regarding VQ5EJT and VQ5ELD. VQ5EJT is J. Thompson, Post Office, Entebbe, Uganda, B. E. A. He was to be active toward the last of January on 14,140 and 14,046 using both phone and c.w. He is ex-GM8NT, and his rig is a 6K6G crystal oscillator capacity coupled to an LS6A, which gives him about 30 watts on the fundamental, and 15 on 14 Mc. He soon will have a final using a pair of 6L6 tubes. Grid modulation will be used as parts are very expensive in that neck of the woods. The receiver is on the way, an RME for 6-volt operation. The antenna is center fed, four waves long and *168 feet high.*

VQ5ELD is L. Durham, Post Office, Entebbe, Uganda, B. E. A. He will be active on 14,046 kc. His rig is a 6F6 into a 6L6 with about 15 watts out. Both ELD and EJT are great pals and operate at the Aeradio VQD, which is in connection with the British Air Mail Service. VQ5KLB is inactive at present and is away at Butiaba on Lake Albert. He will be back, but it is not known whether he will be back on the air or not. VQ3HJP is H. J. Powell, c/o G.P.O. Das-es-Salaam, Tanganyika. The rig is ECO 59-59-TC04/10 with 20 watts input. Antenna is a 132-foot end-fed Hertz. VQ3HJP is ex-SU6SW. All this from GI6YM, and many thanks. Now then, GI6YM says that 7 Mc. is "looking up." KA1AX has been heard and W4DZO puts in a peach of a signal.

W3FQP is a new one in here with 34 zones and 101 countries. His rig is a pair of 250TH's with 750 watts input. Not much has been heard from W1CH since he acquired an x.y.l. some time ago. However, he assures us that the old war horse isn't dead yet and sends in an imposing list of 38 zones and 150 countries. Joe is smart; his x.y.l. can pound brass too. W6TE, formerly K6TE from Wake Island, has been hard after 'em since returning to the States. He has his 30 and 60 . . . using a Premax vertical radiator on 14 Mc. W8MWL worked his 30th zone and has 81 countries. By the way, 8MWL wonders if he was the first W to contact a G on 10-meter phone . . . two way, of course. The date was Nov. 9, 1935. G5BY was the other end.

W6CEM says that VE5LD has moved to Bathurst Inlet, which seems to be in Zone 1. If this is true it's too bad. Keep your eyes open, because you may still think he is in Zone 2 when you work him. W6HJT is almost a goner . . . outside of the fact that he is going to Stanford, he has gotten himself engaged, and when June rolls around, he'll probably stumble up that middle aisle. Anyway HJT breezed into town for the weekend. It appears that he is on Stanford's rugby team, which was to play U.S.C. Cam plays the position called "scrum" . . . and he politely reminded me that the word was spelled with an "R" in it. While I'm on the subject of all this fancy stuff, I might just as well tell you that "Bill" of W6CD started out the New Year right by getting married. He swears he is not through with brasspounding though. And W6MR is a proud "poppa" of a Jr. op.

K7FST and $50.00 per QSO

I have an interesting letter from Charlie, K7FST. Chas. says that he is nearly broke from all the trips over to East cape. Quoting parts of his letter: "Is it any wonder I'm about broke? With the trips over by plane and the loss of a Super Pro, and two 808's together with the expense for special food, the sum is about $1000. Beside the money, there was 100 hours of hard work in 35 to 45 degrees below zero in 5 to 35 feet of snow, and not much shelter. The first trip over was the worst for getting lined up. We had to keep the plane warmed up to pull out at any moment, for anything might happen. The folks over there don't take the idea lightly. There wasn't even a shelter or cabin where we landed, so we made a tent of the planes engine cover, but the darn thing wouldn't stay put. We had to find some way to tie it down. We finally decided to dig small holes in the ice, lay a rope in the hole and poured water from melted snow in the hole. It froze in four minutes flat. We tied our tent down and felt swell . . . if you can feel swell with an engine pot burning and about ten one-foot draughts all around you. It was 30 below and getting colder. Well, we had to get up the antenna some way, but the large bamboo poles were too weak in the wind . . . they would just belly out, then down they'd come. So, we melted a lot of snow on our fire (charcoal and kerosene) and took this water and poured it into the bamboo poles. Then we put them outside of our tent and they froze solid. We glazed the outside of the poles like they do fish. Boy, howdy, we could hardly lift them. Next we cut three holes 18 inches deep in the ice and put each pole in a hole, filled it up with water, and let it freeze. The poles were still up on our last trip over.

"Then we set up the rig, put the engine outside, and with a table cut from ice and some ice cakes for seats (covered with sealskin) we went on the air. Well, we called CQ and listened for about 5 gallons of gasoline, which was around 20 hours. Couldn't hook a W. . . . but heard hundreds. Froze both ears and left foot, despite our fur pants and Parkas. We wore three pair of heavy wool socks over a pair of silk, over a pair of cotton, and still we couldn't keep warm. To help we drank coffee and cocoa every little while. We had to load up and get out finally at 3 p.m. Sunday afternoon. When we got home, I thought never again, as we had nothing to show for all the trouble and expense. The next four trips were about the same; however, between trips I was working every ham in the country and they were all going to help me.

CM2AZ, operated by James Bourne, has 65 countries and 25 zones. The rig uses a 6A6 oscillator into a 210 doubler into a pair of 801's with 100 watts input.

"Our last trip was fine as far as contacts were concerned. We took 12 sacks of coal, ½ cord of wood, 10 pounds coffee, 4 gallons of seal oil (to drink) and a small tent. We got the tent up, the plane blanketed down with the old pot smoking up the world, and say, we were sitting swell, just ready to call CQ . . . when it hit us.

"The wind was so strong it blew our tent away and we never saw a piece of it again; so there we were out in the world. I'll bet the ice worms around there thought we were a couple of crazy fools. We did, too, but went ahead and CQ'd and worked several stations. But it was too much; so the pilot said we'd better get out while we could. It was 42 below and the wind 38 m.p.h. You fellows sitting there by your warm fires! Well, I made one last CQ and then we folded up. Shin pants, Parkas, and everything, we were nearly frozen.

"We loaded up and had nearly everything on but the engine and receiver, when here came about ten guys that appeared to be armed, and looking for trouble. We got a move on and while the pilot warmed up the motor, I had to finish loading. They were only a hundred yards away, and I had yet to get the Super Pro on. I grabbed it and set it in the door of the Bellanca, got in myself while Jack gunned the engine, and we were rolling. I finished pulling myself in just as we cleared the ground. A stiff wind almost keeled us over on our right wing and out slid the receiver. It had been covered with ice and had melted in the plane, forming a slippery surface. Well, it hit the ground on the soft side of a snow bank and went out of sight. If we didn't have the plane we would have gone back after it, but those fellows might have caused serious complications. They found the receiver. We're going back sometime but to a different location. Next time will work one day c.w. and one day phone. Have been thinking the c.w. boys haven't been getting a break. Don't know when I'll go over again as yet, because I haven't got a receiver to take. Well, guess it's all in a ham's life, so 73, Herb." Signed, *DeRemer*, K7FST.

What do you think of that, gang? Gosh, I get cold thinking about it. W8CRA is working dx for a change and now has his countries up to 154. Will it never cease? Some new ones for Frank are CR4HT 14,430, ZC6EC, G3QF 14,280, FP8AA 14,420, and LZ1AA 14,420. That guy never will give up, I guess.

It is extremely gratifying to see the interest you fellows have shown toward this column during the past three and a half years. When you look back a few years and recall the number of fellows who were on the air just gunning for dx, you will have to admit the number was small compared to the many who go after it with a vengeance today. It is true that conditions are much better today than they were then; we know things about antennas that were not known then, and improvements in tubes as well as parts are all responsible for the better dx. It used to be that a fellow had to sit for hours listening on the 14-Mc. band for something to pop through. Sometimes he would sit so long he would develop a good case of "fanny-itis." With receivers as good as they are nowadays, and all-around operating efficiency higher, most of us work some dx we think just mediocre that a few years ago would have been extremely "choice." Let's just remember this, because conditions will not always stay as they have been, and once more we may have to really sweat and struggle to "pull one through." We hope that it will never be so bad that there won't be anything to write about.

Let's not forget to list the frequencies after all of the rare dx stations that you send in. This may be a means for us all to get an idea where "so-and-so" comes in. The other day a ham in town remarked to me he thought I was getting a swell break in receiving all this advance information from you fellows before the next guy gets it through the magazine. That part is all very fine, but the only sad thing about it is that no one has come forward on how I am going to get the time to use all of this advance "dope." There is no truth to the story that as soon as I read each batch of mail, I sit right down and work 40 zones.

To go on with where we almost left off . . . another thing to remember is always to note the new stations you work when sending in your zone revisions. Don't send in your card saying, "You may now credit me with 36 zones and 87 countries, due to working two new ones." For the newcomers to the Honor Roll, I might say that you must list each of your zones and show the call of at least one station worked in each zone. For your country total you need not itemize them; simply state the total worked. (Refer to the Country List in January RADIO.)

Phone Happenings

It looks like the phone boys have been doing all right during the past month. From the number of reports and the stations reported, I would say conditions had been pretty good. I don't mean excellent . . . just pretty good. The excellent conditions are being saved for the dx contest . . . we hope. Let's see now what's doin'.

W8LFE worked SV1KE and FB8AH for two new zones and this makes him 31 and 70. Higgy is stepping right along. LA1F was a new country for him. 8LFE uses about 400 watts input and has a General rotary beam as his only antenna. He is located near the center of the city and the noise is quite bad there. Judging by his imposing list of dx, I don't think he has any kick coming. Speaking of noise, W6NNR lives right on one of the most heavily traveled boulevards in Los Angeles . . . the ignition noise is just part of his existence. And he's right up with the boys in the list. NNR is going to do a little brass-pounding again very soon we hear. W8QDU nabbed a couple new countries . . . TG9BA and K5AF. He says that the present EL2A is OK as he has been shooting messages back to his old home of Barberton, Ohio. Name is Pete Kondik at Monrovia, Liberia . . . and generally comes through around 7 p.m., e.s.t., signal about T4. Guess this should have been noted in the c.w. section . . . Oh, well. W4CYU added a few during the holidays . . . CP1BA, VP2LC and ZD4AB. Bob said while he was home during the vacation days he heard 33 zones and 72 countries, which was in a two weeks period.

VE5AIK worked K7FST in 19; in fact, I think he was the first one to work him over there. W8NOH advises that XE2DA is on the 10-meter band around 27,980-27,990 kc. CO7VP is with the gang from now on with 20 zones and 47 countries. Hope to hear more from him. His rig uses a pair of 210's with about 65 watts. W6OCH, the "voice of San Leandro," worked SV1KE, which makes 36 zones and 92 countries. Larry, as you may have observed, is getting pretty hot in the Marathon, too. K7GSC wonders if 10-meter mobile stations wandering around the ocean would count as zones. The answer is . . . "no." He worked W6NTU, who was operating 10 mobile, but says NTU faded out . . . probably drove into a tunnel. W6IKQ is another to get K7FST for 19.

W1HKK is still after 'em and a few are PK1RL, YN3DG, TG9BA, VS6AG, PK3WI. W4DRZ is here with 27 zones and 69 countries. W1JCX is up one with VR6AY. K6LKN says he thinks K6 should be better represented; so here he is with 26 and 46. Dave is running 175 watts into a pair of T55's.

G8MX is going up by great leaps. His latest are TF3C and VQ2HC. G8MX has been conducting some ultra-QRP tests. He uses an Alford-type beam and made contacts with a number of W stations when only using an input of 1½ watts . . . 120 volts of battery at 12 mills. The most extraordinary QSO was with W8DST. At that time G8NX was using his usual power of 25 watts and was getting into W so well he cut down the input until he was using *12 volts*, while the current was too low to measure accurately. His report on this power (power???) was Q4R4. Of course, conditions at the moment were exceptional . . . but even so!

VE1CR hasn't been heard from for a long time, but he has not been what you would call idle.

[*Continued on Page 83*]

THE AMATEUR NEWCOMER

A Simple 2-1/2 Meter Transmitter

The newcomer to amateur radio who wants to get on phone can do it with the least difficulty and expense by going on 2½ meters (112 Mc.). Less equipment is required than for a 160-meter phone transmitter, and the antenna problem is much simpler. Also, one need not be concerned with b.c.l. problems, bugaboo of amateurs on the 160-meter phone band. The only disadvantage offered by 2½ meters as compared to 160 meters is the inability to work more than 15 or 20 miles on 2½ meters unless both stations are located at high elevations, with no hills in-between. As 160 meters is used primarily for local rag chewing, this is not such a serious item, and certainly does not offset the many advantages offered by 2½-meter operation.

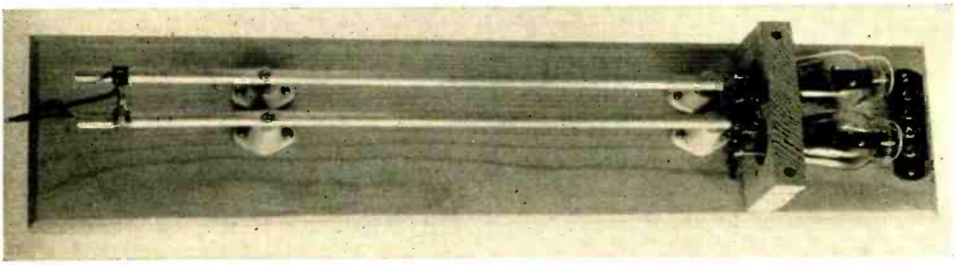
Another advantage offered by 2½ meters, for the present at least, is the lack of QRM. Amateurs who have tried to work 160 meters with low power in metropolitan areas will appreciate the importance of this advantage.

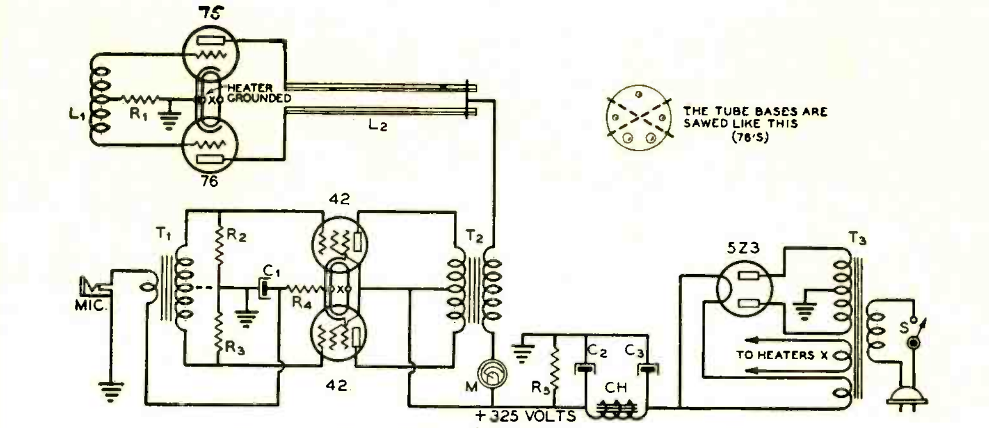
In the March issue of RADIO, Frank C. Jones described an excellent 2½-meter superheterodyne, using resistance coupled i.f. stages and very easy to get working. If used with the 10-watt transmitter described here, the receiver power supply may be omitted and the plate voltage obtained from the power supply for the transmitter. A single-pole double-throw switch may be used to throw the plate voltage from transmitter to receiver, thus acting as a send-receive switch. A common ground should be used for both transmitter and receiver; in other words the B minus for both receiver and transmitter should be permanently connected to the negative of the power supply. This makes it necessary to switch only the positive lead from transmitter to receiver.

The switch should be of the "house" type, available for fifteen cents or twenty cents at Woolworth or Kress stores. The small, radio type toggle switches will not stand up when breaking this much voltage and current, and therefore should not be used. Needless to say, 300 volts is not to be sneezed at, and should be treated with due respect, even when it comes from a source which has not sufficient current delivering capacity to be considered a lethal device.

The simple transmitter diagrammed in figure 2 will deliver approximately 10 watts of carrier, fully modulated. This does not sound like very much power, when compared to the power used on the lower frequency bands. However, there are two reasons why high power is not required on the 2½-meter band. One is that antennas are so small physically at this frequency that it is not at all difficult

The 112-Mc. oscillator is built breadboard fashion, with connections made directly to the tube prongs. The use of the "linear tank" type of plate circuit results in an efficiency of nearly 50 per cent, permitting an output of close to 10 watts.





General wiring diagram of the complete transmitter.

L_1—5 turns no. 14 enameled, ½" dia., spaced to approx. ⅝" (see text)

L_2—Copper or aluminum tubing "linear tank," each element ⅜" dia., 15½" long, spaced 1¼" center to center (see text)

C_1—25-μfd. 25-volt electrolytic

C_2, C_3—Single "dual 8-μfd." electrolytic, 450 w.v.

R_1—7500 ohms, 1 watt

R_2, R_3—200,000 ohms, 1 watt

R_4—400 ohms, 10 watts

R_5—50,000 ohms, 2 watts

T_1—High ratio sing. button mike trans. (see text)

T_2—Class-B output transformer for 6N7, 6A6, 53, etc. to class-C load

T_3—350 v. each side c.t. at 110 ma.; 5 v. at 3 amp.; 6.3 v. at 2 amp.

CH—10 to 30 hy., 110-ma. filter choke

M—0-100-ma. milliammeter

MIC—Closed circuit jack for microphone

to construct rotatable directive antennas giving high power gain, which is equivalent to using a transmitter with many times the power. The other reason is that with a few watts it is possible to transmit as far as one can see, with good signal strength, and impossible to transmit much farther than this regardless of how much power is used. In other words, the waves do not travel very far beyond the horizon, and increasing the transmitter power in an attempt to work farther is rather futile. The antenna efficiency and height are much more important at 2½ meters than the amount of transmitter power used.

Construction

The r.f. section of the transmitter diagrammed in figure 2 is illustrated in figure 1. The 76's deliver approximately 10 watts to the antenna, and the modulator shown has more than sufficient output to modulate the 76's. When a *high ratio* microphone transformer is used, one having a primary of around 50 ohms and a secondary (total) of at least 200,000 ohms, plenty of gain is obtained to work a single-button microphone of the "F" telephone or similar type (such as used in the newer telephone handsets) without need for a speech amplifier stage. This simplifies construction and cuts down the cost of the modulator.

The secondary of the microphone need not be center tapped. The resistors R_2 and R_3, of equal value, divide the voltage evenly and apply an equal voltage to each grid. If the transformer does have a center tap, it can be connected as shown by the dotted line.

The one power supply has sufficient current capacity to supply the whole transmitter, both oscillator and modulator. This results in a saving in components. If the power supply is not used to feed the receiver as mentioned earlier in the article, it will be necessary to make some provision for turning off the plate voltage to the transmitter while receiving. This cannot be done simply by inserting a switch in the 110-volt lead, as this would turn off the filaments, and they take 15 or 20 seconds to reach operating temperature. The best method is to insert a regular 110-volt house type switch in the lead from the center tap of the high-voltage transformer to ground. This will effectively kill the high voltage to the whole transmitter.

The oscillator is built on a baseboard measuring 5 x 23 x ¾ inches. The two rods are each 15½ inches long, of either copper or aluminum ⅜ inch o.d. tubing. They are supported on 1½-inch standoff insulators placed approximately as shown.

The "stock" supporting the tubes is made from a block of wood measuring 4¼ x 2½ x

¾ inch. The grain should run the long way of the block. Holes are drilled just large enough to take the bases of the tubes, their centers 1⅝" apart and ⅞" from one of the 4¼" edges. Now with a rip saw, cut the length of the block parallel to the long edges, through the centers of the two socket holes. The tubes will be held firmly, with a viselike grip, when two screws are run down through the assembly and into the baseboard, 5 inches from one end of the latter.

This method of mounting the tubes, and soldering direct to the tube prongs, permits shorter leads than could be obtained with any type socket, as even socket terminals represent objectionable lead length at this frequency. Also, it solves the problem of insulation, an important factor at this frequency, by eliminating it. There can be no losses in the sockets when there are no sockets.

Unfortunately the composition bases that are used on 76's do not have a very good power factor at 112 Mc., and there is no point in eliminating sockets for the sake of losses if we are going to have high losses in the tube bases themselves. We can very easily reduce these losses to a negligible value by putting two hacksaw slots in each base, as shown in the insert in the upper right corner of figure 2. Be sure to saw all the way through the base (about 1/16"), but don't go any farther or you may saw into the glass tip that seals the stem of the tube.

The grid coil which does not show up very well in the photograph, is soldered directly to the grid prongs of the tubes, which should be mounted with the grid prong (the isolated prong) upward. The coil consists of 5 turns of no. 14 enameled, spaced to approximately ⅝". The exact spacing constitutes tuning of the grid circuit, which will be covered later under tuning of the transmitter. The carbon resistor which serves as a grid leak is mounted vertically between the grid coil and the wood "stock." The top of the resistor is soldered to the center turn of the grid coil (top of the coil) and the other resistor lead is soldered to the jumper which connects the two 76 cathodes.

The sliding jumper for the plate tank is constructed by soldering together two of the older type grid clips which just slip over a ⅜" diameter. These make firm contact to the rods, and can be slid along by pressing upon the two "tongues" while attempting to slide them. The lead from this jumper runs underneath the baseboard *midway between the two tank rods* to prevent unbalancing of the circuit as a result of greater capacity to one rod than to the other. The wire connects to one of the four terminals on the terminal strip at the other end of the board. The other terminals are for the heater leads, and the negative B (ground).

The modulator and power supply can be built either on a metal chassis or upon a breadboard. Parts placement in these units is not at all critical; neither is the lead length or wiring. The only precaution is that the microphone transformer should not be placed closer than about 10 inches from the power transformer. If a wood baseboard is used in preference to a metal chassis, be sure to join all the points indicated by the "ground" symbol.

The microphone jack, MIC, must be of the closed circuit (shorting) type. Otherwise the low voltage by-pass condenser C_1 will be blown when the microphone plug is removed.

Antenna and Coupling

The best all-around antenna for general coverage is a vertical half-wave dipole, fed with a delta-matched two-wire 450- or 500-ohm line. The feed line can consist of no. 14 or no. 16 wire, spaced by means of 2-inch ceramic spreaders. The line should not be spaced much greater than 2 inches. The dipole should be exactly 2 feet long, and the feeders should be fanned out for the last 12 inches so that they tap on to the dipole exactly 5 inches either side of center. The dipole should be placed as high and as much in the clear as possible. The feed line may be any length, and should leave the dipole at right angles for at least two feet.

The transmission line is coupled to the plate tank by means of a one-turn "hairpin" coupling link, a piece of solid, rubber covered wire bent in the form of a "U" with the same separation as the rods. Coupling (loading) is varied by varying the position of the "U" with respect to the shorted end of the linear plate tank. Coupling is increased by slinging the hairpin link along so that it overlaps more of the "U" formed by the shorting bar and plate rods.

If desired, a directive array may be used. As there are many satisfactory types, none will be described here. Suitable arrays are described in the RADIO ANTENNA HANDBOOK. The array should be oriented to give vertical polarization.

Tuning

The oscillator is tuned by placing the shorting bar 14½ inches from the plate end of

[*Continued on Page 89*]

U. H. F. . . .

By E. H. CONKLIN,* W9BNX

56 MC.

More comments on conditions during the January first relay attempt have been received. W8VO in Akron says that he heard some of the Detroit and Cleveland gang at 9:30 a.m., the band seeming to be quite active for that time of day. He has been hearing W8SLU at Auburn Heights, Michigan, just east of Pontiac and forty miles beyond Detroit. Other stations at considerable distances include W8NXB Detroit, W8QKI Ashtabula, W8NQO-FDF New Castle, Penna., and W8CIR-PVC near Pittsburgh. Several more around Detroit have been heard and worked (with 500 watts at W8VO), c.w. being used almost entirely by some and in calling by others.

By eleven o'clock, however, the dx had faded out and except for taking some relay messages from W8CIR near Pittsburgh, nothing was done. W8TT in Painesville was worked but faded out before the messages were given to him. Later in the evening, W8CIR reported similar conditions. W8VO says that he is going to try to organize the Ohio stations for the February 22 relay attempt.

In Ann Arbor, Michigan, W8MDA was unable to assist on January 1 but will be on the air February 22. He can connect with W8CVQ at Kalamazoo usually, and W8IUD in Wyandotte anytime. His help will probably assure the circuit from Illinois across Michigan, assuming that moving W9CLH to a new noise-free location does not disrupt the Illinois end.

In Kalamazoo, W8CVQ says that his new acorn superhet is working excellent with an almost unbelievable sensitivity and very good stability. He had a contact with W8SLU, east of Pontiac, but has not made direct contacts with Detroit stations.

Ralph Brockway, W8NXB, says that W8QDU-NKJ-LJP are not on 56 Mc. in Detroit at present. He is sure that W8IUD-MDA-NXB-SLU will be active on February 22. He also reports that W8SLU worked W8CVQ twice recently on c.w. with good signals, but with a super-regen at NXB, CVQ was not heard. With this receiver, however, NXB in Detroit worked W8VO in Akron on January 16 with a Q5 R6-9 report; at this same time, CVQ was hearing NXB off the side of the beam.

W8NBV, who is one of the 56 Mc. men in the Bliley organization, wrote us for rush information on a concentric line receiver, to be built before the February relay. We gave him the particulars of a 954 r.f., 954 mixer job with 28½-inch lines made of 2-inch and ½-inch tubing, tuned with 20-$\mu\mu$fd. condensers. An acorn oscillator has the usual coil instead of a pipe as a tuned circuit. The i.f. is 3.5 Mc. The job is built on an ordinary chassis with the leads hard-soldered (aluminum solder) where they come through two inch holes in the chassis. It is plenty hot—but all that is a separate story which we hope to treat in detail next month. Getting back to Erie, Penna., W8NBV says that W8QKI-GU-GBK-RV will be lined up together with one or two portable rigs in between Ashtabula, Ohio, and Buffalo to make absolutely sure that poor signal strength won't break the circuit.

W8PK is located in East Bloomfield, near Rochester, N. Y. He had to work on January 1, but will be on hand February 22. He and W8AGU provided the regular contacts for that section last year and since they became less active after the summer, five-meter activity took a lapse. At the Rochester hamfest on February 4, W8AGU promised W8PK his support on the 22nd. W8PK said that no other five-meter men were present at the meeting although fifteen were there last year. W8PK uses W.E. 304B's with 200 watts input; W8AGU still puts 250 watts on 35T's.

Fred Merry, W8DSU, writes from Auburn, N. Y., to say that he was out of town on January 1 and will be on the air very little for the next few months but he will be looking for anything that will improve our chances of completing a relay to the east.

W8DSJ-KIU tells us that a W2/8 at West Virginia University, Morgantown, West Virginia, has been working on a rotary array and may fill in between W8CIR and W3GLV as well as helping lots of fellows, near and far, to add that state to their list.

W8JLQ in Holland, Ohio, says that he will be on 56.02 Mc., helping the Toledo gang try for contacts with Detroit and W8VO in Akron in the relay.

---

*ex W9FM; Associate Editor, RADIO, 512 N. Main St., Wheaton, Ill.

W5CSU/1 in Boston promises to be on the air during the February attempt, but says that most of the gang will be found on 122 Mc. now.

W1DEI thinks that we'll need more New England stations than those published (we agree) and suggests using the "Horsetraders" organization. Well, we wrote several asking their help, but the only ones who have replied are W9QDA (an ex W2) in Chicago and those previously mentioned! Frankly, we have not spent much time lining up the New England bunch because we have heard of successful Boston-New York relays and know of the difficulties in working between Syracuse and Schenectady, across Pennsylvania, or on the Maryland route which may require one or more portables.

In Leesburg, Virginia, W3GLV says that our information about his having heard or been heard in Cumberland, Maryland, is incorrect but that he has heard W8CIR, 160 miles away, and by using straight c.w. he believes that it would be possible to work Pittsburgh! That would even eliminate portable operation on the southern route between Chicago and the East.

W3GEJ is in Lemoyne, Penna., one mile west of Harrisburg. He is on 58,498 kc. and wants to help in the relay, being high on a hill where he may be able to help in a route over rough central Pennsylvania. We have never uncovered a sufficient number of five-meter stations from Harrisburg to Pittsburgh even to commence to line up a route.

Equipment

We seem to have succeeded in getting some of the gang interested in concentric lines as inductances in receivers. W9SQE had an acorn r.f. stage that barely needed retuning over the 56-Mc. band. He took 26 inches of 1¼ inch diameter aluminum tubing that was handy, mounted a no. 12 wire in it, shorted the far end. Using this instead of the coil, and with no other change, he claims a three R increase in signals and a definite sharpening of tuning. A line made of the same length of ¾-inch copper tubing was not nearly as good.

W8OKC in Shamokin, Penna., has a new exciter with efficiency just as good as on twenty meters. It uses a 6J5G ten-meter crystal oscillator, a 6L6 doubler, and T40 output on 56.9 Mc.

W8JLQ still uses only 60 to 90 watts on 809's. In addition to his insulatorless beam, described and pictured in RADIO, he now has a 3-element closely spaced rotary, both horizontally polarized.

Mostly this month we have heard from W8's. But here come a few others.

Perry Ferrell, Jr., in Linwood, N. J., says that he still hears W2XMN regularly, and can get better readability on a horizontal antenna although his high vertical picks up more carrier.

W9SQE tuned up a closely spaced Yagi with two directors and found that a fraction of an inch change in wire length was noticeable on the field-strength meter. That's a good argument for using a small coil or short stub in the center to facilitate tuning.

G5BY

Austin Forsyth, G6FO, sent us advance copy of the 56-Mc. column in his *Short Wave Magazine* giving details of the equipment used by Hilton O'Heffernan, G5BY, who, like G6DH, GM6RG and G2MV, has a confirmed report of transatlantic reception. The receiver is an acorn converter working into a t.r.f. receiver. Provision is made to tune the antenna feeders in order to boost the signal input. The transmitter starts with a 53 using an 80-meter crystal and having a 20-meter output. Some pentode doublers and a buffer drive a pair of 35T's in the final.

Antennas include a rhombic aimed west, an 8JK and a Yagi, the latter two being rotatable from the receiving position with an additional provision for swinging them from horizontal to vertical. The beams are provided with two feeders each, one to the attic transmitter and the other to the downstairs receiving position. G5BY should be able to provide some interesting antenna comparisons! So far, the only thing he has said is that while the beams should be pointed the same way for transmitting or receiving, there is occasionally a deviation in the apparent direction of transmission.

A Field Day?

Our G friends still report contacts at distances of 100-130 miles, some of the stations using only 25 watts or so. In order to exploit the possibilities of this extended ground wave or low atmosphere bending type of dx, G6FO has suggested a field day with prearranged short hours over a week-end for stations to be on and try to pick up some dx. A general field day of this sort in the U. S. in May could very well result in working some new distances; we may suggest something next month—not a contest or relay, just a get-together.

R. S. G. B. Contest

In answer to our inquiry about the progress of the R.S.B.G. 1938 56-Mc. contest, G2YL says: "Obviously it's W9NY—there's no one else!" W9NY deserves much credit for constant watch for 56 Mc. dx during the year. Some other stations did good work on c.w. but few have reported to the R.S.G.B. Many phones worked more stations than W9NY but modulated signals were not permitted under the contest rules.

Miscellany

On January 22 at 9:15 a.m., W9SQE logged a W2KU? calling "CQ 5" for a minute or two. There were other carriers on the air fading up and down. W8VO says that he has often heard a W9, W2 or W3 for a few seconds, during the winter, but not well enough to make a contact.

We have received the sporadic-E measurements for January from the National Bureau of Standards and find such reflections were recorded on January 22 from 8 to 11 a.m. e.s.t. inclusive, up to 6, 6, 4.5 and 6 Mc., for each hour. Washington is several hundred miles from the center of the W9SQE-W2 path but it is interesting to note the support given to this reception by ionosphere measurements. There were twelve other hours in the month when such vertical incidence reflections out to 6 Mc. were reported.

Perry Ferrell says that the London television voice channel was logged 13 times in December, the best day being the 15th.

W1DEI in Natick, Mass., says that he worked with Ross Hull on the low atmosphere bending study. Now he wants to study old 400-1200 mile dx reports to see what can be done by way of correlating with other data and establishing a means of predicting the dx. We worked out the connection between the dx and the sporadic-E layer, a National Bureau of Standards theory, and published a paper on the subject in the January, 1939, issue of the *Proceedings* of the Institute of Radio Engineers. The sporadic-E layer has been held to be largely unpredictable except for the greater occurrence from early May to early August, and the prevalence in the late morning and during the evening. Our study also suggested that short skip on 28 Mc. often preceded dx on 56 Mc., and also that considerable sporadic-E reflection which is in evidence when short skip appears on 28 Mc., generally indicates a continuation of favorable conditions. The recent ionosphere articles in RADIO by Professor A. W. Friend were to some extent the result of our idea that a gadget visually indicating sporadic-E reflections would help to determine quickly whether good dx conditions were building up.

In his letter, W1DEI indicates that he has worked 6 districts and 17 states on five meters—which puts him well up in the roll of honor. He is going in for equipment designed for the purpose this year.

Kenneth McAfee, W3HJT, has worked four districts and nine states from Washington, D. C., using his 22-watt W3HJO-type beam oscillator described in RADIO. He now puts 120 watts into the same type "antenna-final" on 56,496 kc.

In Grand Forks, N. D., W9IEZ has an HK54 on 57,024 kc. working into a concentric-line-fed vertical. That will make a nice new state next summer for a lot of fellows within about 1250 miles. Look for him.

Incidentally, we get a lot of complaint about this 1200-1250 mile limit we have placed on one-hop sporadic-E summer dx. While two-hop work has occurred, it is much less frequent. Most objections come from people who have poor maps for measuring distance. The Federal Power Commission made a National Power Survey and produced a nice 4 x 8 foot map of the U. S. showing service areas of the principal public utilities in the country. This is seldom in error as much as ten miles on 56 Mc. dx as compared with spherical trigonometrical calculation of great circle distance from the latitude and longitude of the stations. Often people guess distances several hundred miles too long. For instance, it is only about 715 miles from Chicago to New York, not 900 or 1000.

W8BIQ in Toledo uses 180 watts into 800's on 56,040 kc. He has a 510 receiver. W8DPN is on 59,950 kc., while W8ESN puts 200 watts into T40's on 57.5 Mc., working into a very high dipole. The Fort Wayne gang including W9QCY should be able to work Toledo. Also, W8IUD in Wyandotte and stations in Detroit and Cleveland should be good contacts.

W3KDB says that he has moved to 112 Mc. because, "Five meters is nearly as dead as King Tut."

It is rumored that W8ESN in Toledo worked a Chicago station on Christmas morning—that would be some 300 miles, a long haul for low atmosphere bending and a short one for skip. No Chicago stations have mentioned the contact, however, and only W9SQE and W9MQM have been heard on the air in recent months.

W5CSU/1 tells us that Boston five-meter activity has dropped off again, while 112 Mc. has picked up. Possibly summer activity will cause a lot of stations to stabilize their transmitters and stay on the band through the winter.

W4EDD now has his half kilowatt five-meter transmitter on the air, being on every morning with the beam pointed up the east coast from 8:45 to 9:00 e.s.t. and from 6:45 to as late as 8:00 p.m. These schedules are with W4DRZ. W4DRZ is using 50 watts and will have a beam up which should give him good coverage; at present he is using a straight doublet. It packs a nice wallop in Miami. Early in February, it was expected that a station at Palm Beach would join the circuit. They are trying to put in a relay service around the state of Florida, and results look promising.

About this time of the year, reports of 56-Mc. activity start to hit a very low level; so send in your comments, suggestions, experiences, and whatever you think would be of interest to the gang. This material should be sent to Wheaton, Illinois.

112 MC.

Quite a few cards and letters came in as a result of our first 2½-meter column, mostly giving us calls and operating schedules of active stations. Just how long this column will be continued depends on the support given to it by our readers.

First District

Randolph Neal, W1KIK, writes from Gardner, Mass., to say that he, W1AUN and W1LDI work each other on transceivers. He says that 2½ is better than "five" around town, but he wonders if it is the band or the equipment. Now he is talking about putting in crystal control!

According to Whit Griffith, W5CSU/1, who has 150 watts on a pair of HK24's on 2½ meters, the Boston gang includes W1JLI-LDD - LAT - LAQ - IZH - EYR - HTQ - IMI-JSV-JSM.

W2's

W2KRJ has a 6E6 oscillator with fifteen watts input. He says, "There are not many on 2½ here locally but if the word is passed around I am sure that the band will be occupied like 56 Mc. formerly was. I have operated cross-band with fellows here in Newark."

W2GKX in Woodbridge, N. J., has a pair of W. E. 304A's with 100 watts input, using tuned plate and filament lines. Antennas are a matched J fifty feet high and a three-element rotary thirty feet up. He is on from 8 to 10 every night except Saturday and Sunday. He expects a network extending to Perth Amboy, Elizabeth, Cranford and Westfield to be working by the middle of February.

In Flatbush (Brooklyn), W2LEN has 30 watts on an 809 linear oscillator. The antenna is a Q trimmed down from five meters.

112-Mc. gang at the All American Air Maneuvers in January. Officials were loud in their praise of the invaluable assistance, the transceivers forming important communication circuits around the field. Standing, left to right, are W4PBP, W4FNN, W4EDD, W4AI, and W4BTM. Seated: W4DRR, W4DUW, W4DRD, and W4DUW. W4DNV (not in picture) also aided.

W2LOC says that there is a meeting on the 2½-meter band every Thursday night at 8 p.m. The present network includes W2LOC on 112 Mc., W2HIK on 113.5 and W2IBO on 115.5, all located in the Oranges about four miles from Newark.

In South Ozone Park, N. Y., W2KDB says that in his section of Queens County, New York City (there are five counties in that town), a few amateurs are on 2½ "more or less" while others are standing by to observe the results of the pioneers; in spite of previous activity the present extent is almost zero. W2DGJ, using a t.p.t.g. 6E6 has been heard by W2JMK. The 110-Mc. commercials (some are below 110 Mc. so check your frequencies carefully) come through well but W2JMK-KDB-JRG-KOR-LJM are allegedly on 2½ meters without having been reported by anyone. W2BEW will be on with a 6E6 short line controlled oscillator, while W2HKO-KNV-TY will be on the band if there is any promise of activity. W2KDB expects to call CQ at 7:30 as many evenings as possible on 113 Mc. as indicated on Lecher wires. He says that the gang is waiting for reports of successful QSO's (up to them) and detailed dope on reliable 20-60 watt rigs (up to us).

W3AXC/2 is in New Brunswick, N. J., using a transceiver and rebuilding a stabilized 45 oscillator formerly used on 56 Mc. His schedule is 9:45 to 10:30 p.m. on Tuesday and Thursday; 8 to 10 p.m. Monday and Wednesday and occasionally Friday and Saturday.

[*Continued on Page 89*]

POSTSCRIPTS... and Announcements

Cover

The front cover shows the "Tower of the Sun" on Treasure Island, San Francisco Bay. Over 400 feet high, the tower acts as a support for many of the antennas for W6USA, the transmitter of the amateur exhibit in the International Exhibits Building.

Two glass-enclosed operating rooms permit silence during QSO's at W6USA. Both c.w. and phone equipment, with many new innovations, will be on display. Six complete transmitters and more than a dozen nationally known receivers will be at the disposal of visiting amateurs who have their tickets with them.

Frank C. Jones, W6AJF, is technical adviser. The station is in charge of an executive committee composed of W6GEA, W6TI, W6SG, W6IBQ, W6NYQ, W6HC, W6FBW, andW6NGV.

W6USA will be on the air every day during Fair hours, and will QSL 100% with a very attractive and distinctive card.

28-Mc. Auto-Radio Converter

Here are a few suggestions that may be helpful in eliminating difficulties that may be encountered with certain installations of the ten-meter auto-radio converter as described in the January, 1939, RADIO (p. 52).

Some amateurs have encountered trouble with the oscillator portion of the 6J8G when the battery voltage at the converter was none too high. Under this condition it may require a long period (a minute or two) for the oscillator section to become hot enough so that oscillation will start after the voltage has been applied. Also, when the transmitter has been operated and the battery voltage has fallen during this period of operation, the converter may not come back immediately when it is switched on.

The cure for this condition is either to run a heavier lead to the filament circuit of the converter tube or to replace the 6J8G with a 6K8. If the tube interchange is made it will be best to move the socket upward so that it is flush with the subchassis instead of being below as with the 6J8G. The tube replacement has been the most satisfactory remedy for the trouble when it has been experienced.

In certain other installations, when the regulation of the power supply in the auto set is not so good, the receiver will motorboat when a strong signal is tuned in on the converter. This condition is caused by the reaction of the a.v.c. voltage on the plate supply of the auto set due to the change in plate current of the r.f. and i.f. tubes when a strong signal is being impressed. The best way of reducing this trouble is to install a voltage regulator tube such as the VR-150-30 from the plate return of the oscillator section of the mixer tube to ground.

Addition of the VR-150-30 also cures trouble due to frequency change in the oscillator as the motor is speeded up, an objectionable effect found in certain makes of cars due to increased primary voltage on the auto set when the generator is speeded up. Another cure for the latter is to run the "hot" A lead from the auto set right to the battery terminal rather than to the ammeter, light fuse, or other terminal. The latter cure will not work in all cases. In stubborn cases a VR-150-30 will be required.

Bearings and Gears for Rotary Arrays

Few amateurs realize that inexpensive bearings and gears designed for light-duty intermittent service, such as is required in a rotary array, are available from the Boston Gear Works in an infinite variety of sizes, types, and specifications. These gears and bearings are available from distributors, usually a large wholesale hardware store, in all the larger cities of the country. A catalog, listing all types as well as other machinery, can usually be obtained from the distributor.

As an example of prices and what is available, a single-row radial ball bearing for use near the top of the supporting structure and for use with 1¼-inch outside diameter pipe can be obtained for a list price of $1.30. This is designated by catalog number 420-46. For the bottom support of the tower an excellent ball thrust bearing, also for pipe with an outside diameter of 1¼ inches, can be obtained for a list price of $1.00. This one is designated as 4975. Both of the bearings are made by *Nice* and of course are brand new, not practically worn out and covered with grease and dirt as frequently are the bearings obtained from auto salvage parts yards.

A wide variety of gears are also available, for use in the rotating and direction indicating portions of the array.

YARN of the MONTH

●

TRIBUTE TO A TRANSMITTER

●

Don't ask me how, but after working in a radio store as long as I have you can spot a b.c.l. from a ham without even talking to them. Maybe it's because the hams acquire such a dumb look. Or maybe because the b.c.l.'s look still dumber; I dunno.

Eddie and Bill were busy waiting on customers and I was arguing with a fellow who had brought in an ancient bottle for replacement. I had just about convinced my protagonist that we couldn't do anything for him on his "defective" tube when this bird walks in. He hadn't been in the store two minutes before I could tell that he wasn't a ham. And when I got around to waiting on him I had a feeling I had seen him some place before.

"I'm interested in getting a transmitter on the air," he explained. "If the stuff doesn't come to too much money I'd like to get a 100-watt transmitter going—both c.w. and phone."

"Surely," I replied, wondering if I'd been mistaken in my guess that he wasn't a ham. Sometimes, when they just have received their ticket, I get fooled. I hauled down a handbook and some manuals put out by various manufacturers, still trying to place this fellow. "I imagine that you are interested in building one, rather than a factory built job?"

"Yes, I think I'd like to take a crack at building my own. I left the air in 1926 when I got married, and while I kept up on ham radio till 1928 by reading the mags, I haven't done a thing with it since. Or rather until a couple of months ago when we got a new radio with short-wave bands on it. After tuning around a few evenings and listening to the amateurs I got the bug again. So I brushed up on the laws and went down and took the exam. My code is still pretty good—it came right back to me after listening a couple of evenings on 40 meters—and I figured that Ohm's law is still Ohm's law. So I didn't bother to polish up either my code or theory."

I wondered what would have happened if back in 1927 or '28 a ham were handed a bunch of the questions that they throw at you today. This was worse; the fellow had to go back 12 years in his memory for what knowledge he did have. "I hope you pass all right," I offered in the most cheerful voice I could muster. I figured I'd better sell him all the stuff I could before he got notice of his failure to pass the exam.

"Oh, I passed all right. I got my ticket today, W2XYZ. I figured I'd better wait till I got my ticket so I could get the 40% ham discount. I don't suppose I made 100%, but it was good enough to get by." Proudly he opened his billfold to show me his ticket. "They asked one question on carrier shift that I just had to leave out, but I didn't have much trouble with the rest of them."

I attempted to cover up my amazement with: "Well, that's fine, just fine. Now let's look at some of these transmitters described here and see which seems to be the one best suited to your needs. Here's a nifty little number using a pair of 809's in class B to modulate an 808. It's got a harmonic oscillator, inverse feedback, peak compression,—everything you could want in a rig. Luckily we have all the necessary parts for this job in stock." (That's why I showed it to him first.)

"Well, you see," he offered apologetically, "I sorta would rather build one that I can understand. I don't have much time to study, and I wouldn't be able to get that kind of a rig tuned up without someone to help me, even if I did manage to get the thing built properly by making a Chinese copy of the one shown. I thought I would build the one I drew for my examination. It doesn't use any of these newfangled tubes or circuits but it must be okeh or I wouldn't have passed the exam. And then too I'd have an understanding of the thing."

Out of his pocket he fished a pencil diagram that obviously had been drawn on a street car or bus. Some of the resistors looked like coils and vice versa. But after studying it a minute I had a pretty good idea of the lineup. It was truly a noble rig: a 112-A crystal oscillator into a 45 buffer into a 210 doubler or buffer and a 203-A final, modulated class A by a

[*Continued on Page 94*]

U. S. A.

Dear Hon Ed.

Scratchi are not give you his address this time on account of mite be better to lye low for while on account of reasons which will apeer obvious.

Whooey. Big dx confest are over at last, and in spites of having nerves of steal, Scratchi are have such a strenuous time during confest that cannot yet go to sleeps, mayhap because effeck of last 47 cup of coffees are not wear off yet and also because Scratchi's hand are still jerk in effort to send "599777" even though battle feeld are been cleered for several hour and bands are deader as a doornail.

So instead of counting sheeps I thought I would rite you a letter, hon. ed., which should having the same effeck.

Scratchi are positive he have emerge victorious from international QRM confest with grater score than champeen fish story lyer try to make peoples believe. You are perfeckly safe in printing story in bold face tripe at head of DX Dept. stating that Scratchi are winner of confest, unless you want to be conservative and wait for confirmation. Latter are inadvisable anyhow, on account of there are remote chance that Scratchi will be declaired illegible to win prize on account of off freakency operashon.

You see, I are having sistem which are just as good as making points, and a lot quicker. Are put my transmitter 1 kc. out of edge of band and operate using call of various stations what are likely to make highest scores. This are make them disqualifried, which mean their goose are cooked. It are a fine idear, except Scratchi are forget hisself and sign a couple of times using his own call.

Scratchi are have so many griefs during confest he have sprout a crop of gray hairs. For instance, one fellow are bother me with QRM on account of he only live up the street one blocks. So I just turn him in to the R. I. as running too many inputs. Somehow he are suspeck me of the fowl play and come down to see me with fire in eye and sh rolled up. Scratchi are still got a peeper and soar jaw.

Then there were the fellow in Nigeria w I are work for another multiplier and wh are never heer of confest and come back after I give him my numbers with "Please use old sistem of audiobullity rating, are not knowing these new fangled sistem."

Cannot telling you my score, hon ed., except that it are plenty high and are bound to be the winning points. You see, Scratchi are grate believer in always get the other fellow to tell his score first, on account of it give you a big advantage which even you hon. ed. should not be too dumb to see.

Respectively yours,
HASHAFISTI SCRATCHI

●

The Open Forum

Chicago, Ill.

Sirs:

What's all this fuss about break-in telephony? I have noticed several articles and much interest lately in this new improved method of generating QRM. The worst part of the whole business is that the agitators that advocate break-in contend that it will result in *less* QRM. "Less time wasted signing over, fewer repeats, immediate answers, enabling the operators to say everything they have to say in less time." Phooey.

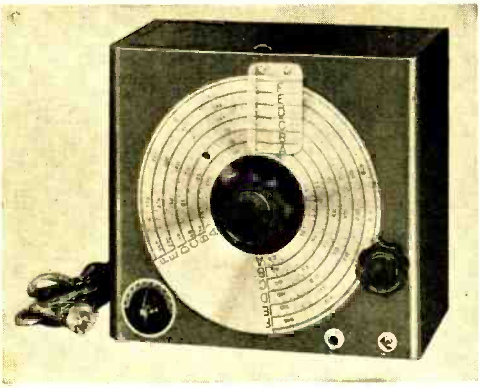
A fellow is going to spend about the same amount of time on the air regardless of whether he works break-in or not. Getting everything he has to say off his chest has nothing to do with it, because few hams have anything to say anyhow. They just talk. Furthermore most hams don't care what the other fellow wants to tell them. They are interested primarily in telling the other fellow about their own rig. They don't care what the other fellow is using or what he has worked. Thank goodness that probably will keep the system from becoming widely popular. Few hams like to be interrupted; they like the idea of being able to tell how good they are without having the other fellow butt in.

What is my big objection to phone break-in? Just this: I think it is every bit as obnoxious as phone duplex, which most agree is a selfish way of cluttering up the band. I

[*Continued on Page 95*]

What's New . . . .

IN RADIO



FREQUENCY METER-MONITOR

E. I. Guthman & Co. offers the precision frequency meter and amplified monitor illustrated above, and parts for its construction.

This instrument provides features heretofore available only in precision laboratory equipment. Designed for precise measurement, it offers 7¾", 324 degree dial accurately calibrated for 5 to 160 meter bands, zero adjuster for use with 22 precision calibration frequencies regularly available, a.c. or d.c. operation, stabilization of electron-coupled oscillator, and monitor detector-amplifier.

It is styled to "dress up" any station, designed for precision work. For descriptive literature write Edwin I. Guthman & Co., 402 S. Peoria St., Chicago, Ill.

KATOLITE AUTOMOBILE ATTACHMENT

Attachments can be furnished for '37 and '38 Ford V8 automobiles to permit mounting any standard Kato 110-volt a.c. generator, up to and including the 2000-watt size, on the rear bumper. This permits operating when either moving or stationary. For operating stationary, it is only necessary to put a jack under a rear wheel. A variation in generator pulleys permits adjusting engine or driving speed to that most desirable to the user. A welded steel driving pulley is also furnished, which can be attached to the rear wheel in just a few minutes time. No special tools are required.

This means 110 volts a.c. may be had anytime, anywhere for operating sound truck equipment, moving pictures, power saws, drills, amateur transmitters and receivers, flood lights, standard a.c. appliances, etc.

Attachments can be built on special order for cars other than the '37 and '38 Ford V8's. For information write the Kato Engineering Company, Mankato, Minnesota.

NEW BUD ITEMS

Bud Radio, Inc., 5205 Cedar Ave., Cleveland, Ohio, has put on the market several new items, which are illustrated and described in a four-page supplement which is available on request. These items include a 500-watt r.f. amplifier kit; air-wound tank inductances; an auto link control, a device which permits front panel control of the amount of energy to be transferred in a link circuit and eliminates the necessity of mechanically controlled links; "Tiny-Mite" condensers, a line of little condensers to fill the requirements for use in ultra-high-frequency circuits; and a transmitter dolly to set your transmitter on, so that it can be easily moved about when making repairs and adjustments.

NEW TRANSFORMERS

Thordarson units additionally protected by a complete covering of a special transparent and elastic compound which is highly resistant to salt air, high humidity, excessive moisture and other inclement weather conditions which are not especially helpful to the long life of a transformer are now available under the designation, "Tropex."

Complete details regarding this and other new Thordarson developments are contained in Bulletin SD-394, free from the Thordarson Electric Mfg. Co.

Four new replacement filter chokes have just been placed on the market especially for a.c.-d.c. receivers by Thordarson. Designed with specific resistances of 200, 250, 300 and

[*Continued on Page 93*]

Receiving Pulses from the Ionosphere

[*Continued from Page 28*]

truly linear time rate of sweep. In some cases the sweep over a portion of its path may be nearly enough linear to make very little difference when extreme accuracy is not important.

The multivibrator of figure 6 gives a wave form (a representative form is shown in figure 7) which may be used for measuring the degree of linearity of the sweep. If the waves are evenly spaced as measured on the oscilloscope using the sweep in question, the linearity is sufficient for amateur ionosphere investigations. A 60-cycle linear sweep should have enough amplitude to cause only one-third to one-half of the cycle to appear upon the screen, the remainder of the stroke passing off at the ends. The most linear portion of the sweep may be selected by use of the horizontal position control in the oscilloscope. The time rate of sweep in the portion selected for use may be calculated from the distance between points of the timing wave by using the equation, *velocity equals distance divided by time.*

For this purpose the frequency of the timing wave must be quite accurate. If the sweep rate is known to be the same as the power line frequency by synchronization therefrom (checked to show a single cycle of power line frequency per sweep), then it is necessary only to count the *full* number of timing waves produced by the multivibrator in one *complete* sweep and to multiply that number by the power frequency in order to find the frequency of the timing wave. For instance if the power frequency is sixty cycles per second and forty waves are counted in one *complete* sweep, the multivibrator frequency is calculated as 60 times 40 equals 2400 cycles per second. Then the distance between adjacent waves on the expanded sweep for ionosphere measurements are known to represent 1/2400 second each (see figure 8).

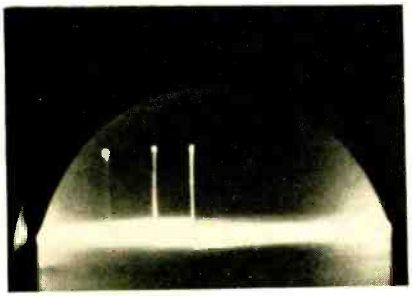


Figure 15. Simultaneous E and F reflections photographed from the cathode-ray screen of the unit shown in figure 14. h_E is 105 km. and h_F is 260 km. (long exposure photograph).

If these 1/2400 second points come at equal intervals the sweep is linear in the range observed, and a calibration chart to show layer height with respect to distance on the screen may be plotted at once. If the waves are nearer together at one end of the screen than at the other end it will be necessary to plot a special curve to correct for the nonlinearity. The direct (ground) pulse must then *always* be set at a fixed point on the sweep.

Assuming the case of the linear sweep, the height of reflection may be determined from the equation h = 150,000 t. Where h is in kilometers layer height and t is in seconds. For instance if the time of one timing wave cycle is used and the equivalent height is to be found, the equation gives

$$h = \frac{150{,}000}{2400} =$$

62.5 kilometers. The distance of two cycles would then be the equivalent of 2 x 62.5 = 125 kilometers, etc. This assumes that the distance between the transmitter and the receiver is not more than ten or fifteen miles (vertical incidence measurements). Using these calculated height values and knowing the distance on the screen between any two points, it is quite easy to plot a curve between distance (on the cathode-ray tube screen) and virtual reflection height. By using calipers on the screen the distance may be found from the chart. It is also possible to make a scale of heights on a straight edge to be held in position on the screen as a direct reading index for layer heights. A transparent celluloid scale is quite convenient (see figure 9).

If the sweep does not happen to be linear the same calibration methods still apply except that the zero point must always be taken at the same place on the sweep, and the scale will not be uniform nor the curve a straight line. It is quite evident that in any case after the calibration is made all adjustments must be maintained in subsequent operation or the timing wave must be used for adjusting the scale before each set of measurements is taken.

Sine-Wave Sweep

To consider an extreme case of nonlinearity, the convenient sine-wave sweep easily provided by the use of a step-up voltage transformer connected to the a.c. power line may be used to provide the horizontal sweep. If the scale is to be calibrated in the same manner as when the nearly linear sweeps are used, it is *most* imperative that means be provided for insuring a constant known position of the direct (ground) pulse on the sweep. Any deviation from this rule will produce very serious errors in height measurements.

One advantage of this sine-wave sweep, however, is that the rate of sweep at any point on the entire sweep line may be quite easily calculated since the sine wave is a form of simple harmonic motion. All that need be known is the maximum amplitude of deflection of the cathode-ray spot from the stationary (no deflection voltage) position and the frequency of the sine-wave deflecting voltage. The calculation is the same as that of the rate of motion of, for instance, a spot on an auto tire *up and down* from the road as the wheel turns. The sweep velocity v at a distance x from the center position is equal to the product $2\pi f\sqrt{r^2 - x^2}$ where:

$\pi = 3.1416$ (a constant)
f = sweep frequency in cycles per second
r = maximum sweep distance from the center (use inches or centimeters)
x = distance to the point at which the velocity of sweep is to be calculated (same units as r)
v = velocity of sweep in inches (or centimeters) per second.

It is quite obvious that the maximum sine-wave sweep velocity will always be at the position where the spot stops when the sweep voltage is turned off ($x = 0$ so that $v = 2\pi fr$). The positions of zero velocity will be at the two ends of the sweep where the spot stops and reverses its direction of motion ($x = r$ so $v = 2\pi\sqrt{r^2 - r^2} = 0$).

No Timing Wave Required

It is evident that if the sweep velocity may thus be easily calculated at any point, a curve of sweep velocity against position on the screen may be plotted for use with any particular values of sweep voltage, accelerating voltage, and cathode-ray tube in use. If the tube happens to give nonuniform deflection to the right and left it may be necessary to make a separate set of calculations for each of the two directions from the zero position. Most good tubes, however, show practically uniform deflection sensitivity across the entire screen so that the curves to the left and right of the zero position become identical and reversed. Thus they form two halves of a sine-wave alternation and the velocity equation may be changed to $v = 2\pi f\ r \cos\ (360\ ft)$ where t is the time in seconds after (or before) passing the zero position, and cos (360 ft) indicates the cosine function of the phase angle (360 ft) which may be found in any table of trigonometric functions. Either this equation or the previous one may be used depending upon whether time or distance from the zero point is considered.

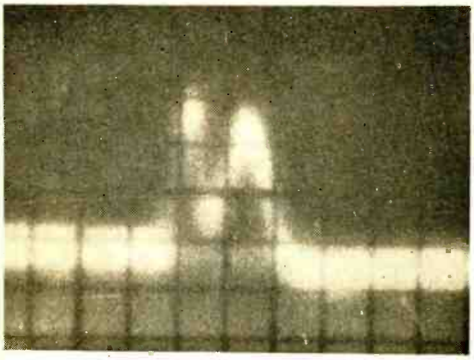


Figure 16. A reflection from 3150 feet above the ground level at the station. This is the so-called C region giving the tropospheric reflections which are so effective in producing u.h.f. wave bending. The only station capable of making these measurements at the present time is this one at West Virginia University. Airplane tests of atmospheric conditions have checked the reflection heights.

Making the Calibration Scale for Sine-Wave Sweep

To make a scale of layer height to be fastened on the cathode-ray screen for the measurements it is first necessary to choose a working position for the direct pulse. A quite acceptable point is where $X = \frac{1}{2}r$, one half of the distance from the center of the sweep to the left end (see figure 10). If the left to right sweep is used the following ionosphere reflection pulses should appear to the right of the direct pulse along the maximum velocity portion of the sweep, where the degree of resolution is most favorable.

The next step is to find the time required for a pulse to be reflected from a number of different ionosphere virtual heights. This has been calculated from the formula

$$t = \frac{2h}{V} = \frac{2h}{300{,}000} = \frac{h}{150{,}000}$$

where: t = time in seconds
h = height in kilometers
v = velocity of wave propagation in free space in kilometers per second,

and the results for a number of values of h appear in Table I.

Table I

h (km)	t (seconds)	h (km)	t (seconds)
50	1/3000	400	1/375
100	1/1500	450	3/1000
150	1/1000	500	1/300
200	1/750	550	11/3000
250	1/600	600	1/250
300	1/500	650	13/3000
350	7/3000	700	7/1500

These time values may be used in calibrating the scale for any type of sweep.

If the sweep is linear with a velocity v (inches per second), the spot position relative to the assumed zero position is x (inches) equals v (inches per second) times t (seconds), or ($x = vt$). For instance, if the total sweep is three inches per 1/60 seconds and is essentially linear the velocity v equals $3/1/60 = 3 \times 60 = 180$ inches per second. Then the distance from the start of the ground pulse to the point representing a layer height of 150 km. will be x = 180 inches per second times 1/1000 second (from Table I) equals 180/1000 or 0.18 inches across the screen.

If the sine-wave sweep is used, an equation for the position of the spot (with reference to a chosen origin point ¼ of the total sweep distance from the left end) may be used. In this case x (the distance from the origin) equals $r\,[\sin(360^\circ\,ft - 30^\circ) + \tfrac{1}{2}]$ where:

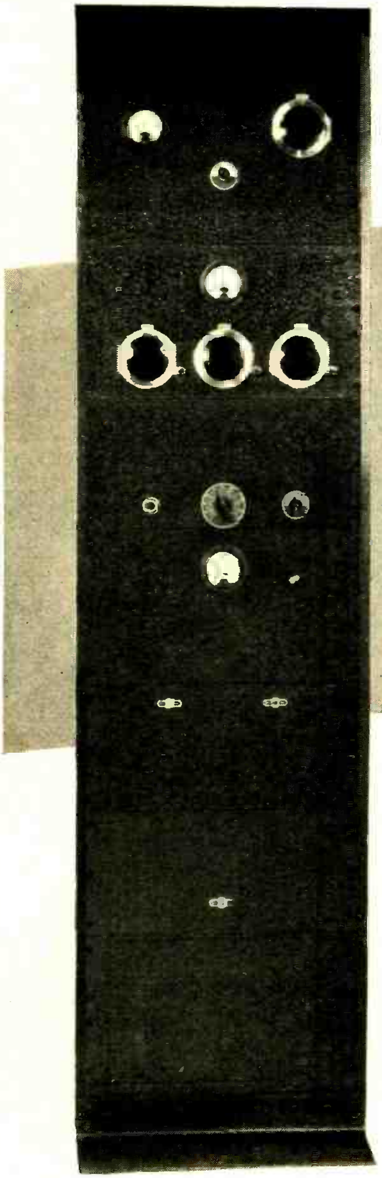
r = *one half* the total sweep distance (end to end),
f = the frequency of the sine-wave sweep, in cycles per second,
t = the time interval in seconds,

and the function $\sin(360^\circ ft - 30^\circ)$ may be found in any set of trigonometric tables.

In order to simplify the process, for those not mathematically inclined, a chart from which the height scale may be very easily constructed by a graphic method is shown in figure 11. All that must be known to make use of the chart is ¼ of the length of the sine-wave sweep from end to end (½r). The direct (or ground) pulse must *always* be set at the point ¼ of the total sweep length from the left end of the sweep (on the left to right trace) when this chart is used. With reduced sweep voltage applied, the pulse may be set at the ¼ point and then the sweep voltage increased until the pulse appears near the left side of the screen.

This procedure gives the maximum usable sweep rate by causing the unused sweep ends to pass off the screen. The distance from the start to the direct pulse to the position of the spot when the sweep is turned off must

AMATEUR RADIO *Gets Its* MAN



John H. Bremer at the operating position of W9CQY

A young Chicagoan, hunting caribou in the wilds of Alaska far beyond the reach of regular communication, recently had amateur radio to thank for calling him to his dying mother's bedside, thus granting one of her last wishes.

Members of his family were put in touch with John H. Bremer, W9CQY, who is in charge of amateur radio activities for the Chicago Park District and director of River Park. Bremer and members of his River Park Radio Club immediately sought contact with Alaskan hams who were nearest the area where the Chicago youth was known to be. Hams all along the line gave aid and arrangements were made for Robert R. Gould, K7ATO, to maintain a regular schedule with W9CQY. Gould located the hunter the following day. An Alaskan patrol boat, a U. S. Coast Guard cutter, and a regular airline plane brought him to Chicago.

W9CQY uses a 1000 watt transmitter completely equipped with Thordarson transformers and chokes. Another example of Thordarson dependability.

THORDARSON ELECTRIC MFG. CO.

500 W. HURON ST., CHICAGO, ILL.

Demand "Power by Thordarson"

be marked on the straight edge or transparent sheet to be used as a scale. The scale end placed at the direct pulse position will represent the zero height point. The blank scale should be placed over the chart of figure 10 with the line along which calibration is to be made parallel to the line AB. *Keeping the scale parallel to line AB with the left* (or zero) *end on the direct pulse line,* slide the scale *along the direct pulse line until the sweep center point* previously marked on the blank scale coincides with the *sweep center line* in the figure. Then the calibration points may be marked on the scale at the intersection points of the scale edge (or line) and the chart layer height lines. A sample scale is indicated in figure 11.

In use, the direct pulse is always placed ¼ of the way from the left end of the sweep (30 degrees phase angle from zero voltage position of the sweep), and then the sweep voltage is increased by means of a Variac or a Varitran variable auto transformer (on primary side of the sweep transformer) until the distance between the left edge of the direct pulse and the zero sweep voltage spot position equals the original distance between the two points marked on the scale when it was first calibrated. This calibration chart is for 60 cycles only. If any other line frequency is used it will be necessary to draw a new "sweep center line" from point C to line AB at a point 60/f times as far from A as the point B is in figure 11. For 50-cycle power this means that AB must be increased to 6/5 of its present value and all other lines must be left in their present positions.

Height Measurements by Phase Shift

As mentioned previously, it is possible to measure the layer heights by finding the phase shift angle required to move the oscilloscope pattern so as to shift the direct (ground) wave pulse from an index line and to move the reflected pulse into position on the index. This is just another method of timing since a phase angle may be used to represent a definite portion of a cycle which has a fixed time duration. The advantage of this method of measuring, over the calibrated sweep arrangement, is its flexibility of application. It may be used with any type sweep circuit whether linear or not. There is almost no limit to the variations in sweep rate which may be used as long as the number of sweeps per second is a multiple or a submultiple of the pulse rate (synchronized with the pulse). The chief disadvantages are that the method does not readily lend itself to continuous measurement by photographic means nor does it enable the operator to note instantly any rapid changes. The only fixed value required is the line frequency.

If two- or three-phase power is available (and finances are not too troublesome) the induction type phase shifter of figure 3 may be employed for this service. It is calibrated in degrees of phase shift. Since 360° equal 1/60 second (one cycle) it is a simple matter to find the time corresponding to any number of degrees by a simple proportion (that is, $180° = 1/120$ second, $36° = 1/600$ second, etc.). Figure 12 is a graph of these values (for 60-cycle power) converted to read in kilometers layer height versus degrees phase shift, by means of the previously used equation $h = 150,000\ t$.

For making measurements, the output from one phase of the phase shifter may be connected through a voltage control to the primary of a voltage step-up transformer to give sine-wave sweep, or to a sweep synchronizing circuit for the linear sweep of any cathode-ray oscilloscope. The phase of the sweep voltage should be shifted until the direct pulse has its leading edge on an index line on the screen. The phase angle dial reading may then be recorded. After that the phase should be shifted until the pulse from the reflected signal lies upon the same index line and the dial reading should again be recorded. The difference between these two readings gives the phase shift angle which may be used with the chart for finding the virtual layer height. It may be more convenient to adjust the dial scale to read from the dial the correct numbers to be used on the figure 12 graph without any calculations. One necessary precaution is an occasional checking of the zero setting. For even more convenience a special dial marking may be provided to read directly in kilometers virtual height.

If limited finances make necessary the phase shifter of figure 4, almost the same conveniences of operation may be provided but a calibration in degrees of phase shift is made necessary. For this purpose the multivibrator calibrator of figure 6 is perhaps the simplest and most convenient device. If a 2400-cycle generator unit is used, each calibrating cycle shift will represent $\frac{60}{2400} \times 360 = 9.0$ degrees of phase shift. A 3600-cycle timing wave will give one cycle per six degrees and 7200 cycles three degrees of 60-cycle phase shift per cycle.

The calibration procedure involves starting at one end of the phase shifter dial and recording the dial reading each time a known number of degrees has been traversed as indicated by the passage of a calibration cycle across the index line on the oscilloscope screen. By plotting the dial reading against the phase shift angle a suitable sequence of points (every five degrees for instance) for marking the dial may be obtained. By cross checking with figure 12 the markings may be converted to read kilometers layer height directly on the dial. An auxiliary zero adjustment phase-shift dial may also be incorporated to make the dial reading correct under all conditions. The two variable resistors of figure 6 produce this effect (either one may be calibrated).

The Results

Using a conventional superhet receiver with a one-stage preselector and a three-inch oscilloscope with the "linear sweep" synchronized from the output of a States phase shifter, the pattern of figure 13 appeared on the screen. The F-region reflection is shown to the left of the direct pulse from a 200-watt transmitter located 200 yards from the receiver. The right to left sweep is characteristic of the oscilloscope used but this causes no inconvenience. Just turn the picture upside down and everything will look quite normal.

The height of the region indicated was 306 kilometers and was checked on the experimental frequency 2398 kc. at about 11:00 p.m. on a December night. An amateur station on about 3500 kc. could have been used to observe about the same reflection conditions. 2000 kc. conditions might have also been checked to see if the E-region critical frequency had fallen below that value.

Figure 14 is a photograph of a relay rack mounted receiving assembly at West Virginia University. The receiver mounted in the top position is a special, wide-band superheterodyne covering the frequencies from 1.5 Mc. to 65 Mc. and utilizing a video frequency amplifier. Below the receiver is a very special high resolution strictly linear sweep circuit for observation of tropospheric (C region) and D region reflections. This unit may also be operated as a sine-wave sweep device for E and F region observations. This panel also contains the cathode-ray oscilloscope power supply and control equipment. Below that is the 110-volt three-phase load center and control panel. It also contains the States induction-type phase shifter, Variac voltage (sweep) regulator and voltmeter. Figure 15 shows simultaneous E and F reflections obtained just as the E region critical frequency was dropping below the 2398 kc. frequency at about 10:40 p.m. on a December evening. Both layers were indicated simultaneously due to the wide frequency band in use. The heights noted were 100 km. and 260 km. for the E and F regions respectively.

Figure 16 shows the direct pulse and C-region pulse reflection received on this equipment on 2398 kc. using a linear sweep rate of 18,000 inches per second. This reflection from 0.95 km. (3150 feet) height (above the station) is probably caused by a discontinuity in the thermal and moisture conditions in the atmosphere.

Your equipment may be made as simple or as complex as desired. Precision is desirable, but in this field the conditions are so variable that five or ten per cent error is not extremely serious.

The most desirable factor in the ionosphere investigation is that we obtain a large volume of reasonably accurate data from many well scattered points over the entire earth. Go to it fellows and work out your own ideas on the subject! Send in your results for publication. Something interesting may come from the correlated information.

An 813 Bandswitching Transmitter

[*Continued from Page 12*]

of these is mounted directly through one of the condenser mounting brackets and thus connected directly to the rotor, while the rear one is supported by a small piece of bakelite which is in turn bolted to the rear condenser mounting bracket. The center-to-center spacing between insulators is 5 inches. All the coils, with the exception of the 10-meter one, are wound to fit between these terminals. The 10-meter coil is wound to the length given in the coil table and a short piece of the coil wire is bent out at right angles and extended to reach the rear jack. The coil is thus close to the front of the condenser where it may be coupled closely to the antenna coil.

Antenna Coupling

Variable antenna coupling is provided by a swinging coil arrangement controlled by a knob on the front panel. A ¼-inch shaft is brought through a compression-type bushing at the top center of the front panel and a small piece of masonite is mounted on the shaft. This piece of masonite supports two jack-top standoff insulators and the insulators in turn support the antenna coil. The same antenna coil is used on all bands except ten meters. On ten meters a coil of smaller diameter is used to correspond with the smaller plate coil.

Panel Controls

Aside from the various knobs, switches and crystals, there are five jacks on the front panel These are used for reading the various plate and grid currents and for keying. By plugging into four of these jacks it is possible to measure either 6F6 cathode current, 6L6 cathode current, 813 grid current, or 813 plate current. Of course, the eight to ten milliamperes of 813 grid current does not greatly excite the 0-250 milliampere meter, but it is possible to get a comparative reading suitable for tuning the exciter stages. If it is desired to read the absolute value of final grid current it is only necessary to plug a 0-25 d.c. milliammeter into the grid-current jack. There seemed to be no good reason for incorporating a relatively expensive meter in the transmitter for this purpose alone, however. The fifth jack on the panel is used for keying. This jack is of the open-circuit type so that the key plug may be removed without closing the circuit.

The final grid and plate current jacks are both insulated from the chassis. The other three jacks are mounted directly against the chassis since their frames are grounded. The final plate current jack is in the negative lead, so the insulation need not be anything but the usual fibre washers.

Coil data will be found in the coil table. The 10- and 20-meter final amplifier coils are wound "on air" as they are sufficiently sturdy to support themselves between the insulators. The usual celluloid strips are used to brace the 40- and 80-meter coils.

Tuning Up

Tuning the transmitter is an extremely simple process. It is merely necessary to set the bandswitch to the proper band, place the correct final plate and antenna coils in place, and tune the exciter stages for maximum grid current to the 813. There will be no grid current on the final stage unless the key is closed, however, as the blocking bias effectively cuts off the grid of the 813. Plate voltage should not be applied to the 813 during the preliminary tuning process, of course. There will, however, be screen voltage on the 813. Ordinarily, operating a tetrode or pentode with screen voltage and no plate voltage is an effective way of ruining the tube. However, it is permissible in this case for short periods of time as the screen is fed through a rather high value of series resistor, which limits the current that the screen may draw.

After the exciter stages are tuned, lowered plate voltage may be applied to the 813 and its tank circuit tuned to resonance. When the resonant point in this circuit is found, full plate voltage may be applied and the antenna coupling may be adjusted until the final plate current is approximately 180 milliamperes. Once the dial settings have been found for the various bands, the band changing process becomes a matter of but a few seconds' work.

With the coil sizes given in the table it is possible to tune the transmitter to approximately 13 meters instead of 10. This will occur when the 6L6 plate circuit is tuned the third instead of the fourth harmonic of the crystal oscillator. The final amplifier may then be operated straight through on 13 meters. This condition should be readily apparent, however, as the 6L6 tuning condenser will then be set with its plates approximately half meshed instead of at nearly minimum capacity, as it should be for 10-meter operation. A simple absorption type wavemeter may be used to give positive assurance that the 6L6 stage is tuned to the proper harmonic.

See Buyer's Guide, page 98 for parts list.

●

While 73 means *best regards* in the symbols used by the press associations on their wires, *CQ* means *correct,* and *FB* is an abbreviation of *football.*

Transmission Lines as Circuit Elements

[*Continued from Page 45*]

together gradually at the shorted end to eliminate the shorting bar. This will increase the open-end impedance about one-third, requiring a 50 percent increase in both the spacing and conductor radius, maintaining the same ratio between the two.

Capacity Loading

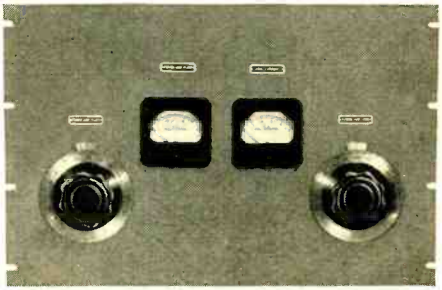
For a circuit in which the tubes are tapped down substantially from the open end of a line, such as in the grid circuit of an oscillator, the values given above are applicable. If a capacity is hung across the open end, a shorter line will be needed to obtain resonance, but the Q, Z_s and even the optimum dimensions may be altered. Nevertheless, knowledge of the results of capacity loading is important because tubes hung across the line alter its length, also because of the convenience of using a small variable condenser to provide tuning and in some cases to shorten the necessary line length.

We have calculated the effects of such capacity upon line lengths expressed in per cent of a quarter wavelength. These are shown in figures 3 and 4. Figure 3 is based upon a 6.186 ratio and figure 4 on a 20.96 ratio. It is seen that the loading effect of a given capacity is much less for a line of low characteristic impedance (that is, small ratios of spacing to conductor radius). There may be some reason, then, to deviate from optimum design by using closer spacing or larger conductors to avoid too much shortening, if a large capacity must be hung across the end. For a given line length, though, the D/r ratio should be maintained but the conductor size and spacing, for the maximum impedance design, should be increased slightly. For a $1/8$ wavelength (50%) line, the Z_s design figures must be increased 16 per cent.

The charts are drawn so that the curves are plotted as straight lines. To obtain data for larger capacities on the longer wavelengths, it is necessary only to extend the lines and the horizontal scale. For other frequencies, it is apparent that the capacity varies directly with wavelength, provided that the line length is expressed in per cent of a quarter wave.

Actual quarter wavelengths, for the edges of several bands, have the values given in table III.

There is some inductance in the shorting bar which slightly reduces the length of an unloaded quarter-wave shorted parallel-wire line. This has not been included in the table, nor in the line lengths given by figures 3 and 4. A small amount of adjustment by moving the



shorting bar or the tuning condenser, if used, will compensate for this.

Table III

Quarter Wavelengths

Megacycles	Length
28	8′ 9.4″
30	8′ 2.4″
56	4′ 4.7″
60	4′ 1.2″
112	2′ 2.3″
224	1′ 1.1″

Transmission Line Constants

We give below the equations for calculating the constants for parallel-wire transmission lines, at commercial power frequencies, with wide spacing and nonmagnetic material:

$$L_o = 4 \log_e \frac{D}{r} \times 10^{-9} \text{ henries per cm. of 2-wire line,}$$

$$C_o = \frac{1.111 \times 10^{-12}}{4 \log_e \frac{D}{r}} \text{ farads per cm. line to line.}$$

In the above, the logarithm to the base *e* can be obtained by multiplying the common logarithm (to the base 10) by 2.30258. To take into consideration the proximity and skin effects,[4] the above are changed as follows:

$$L_o = 10^{-9} \times 4 \log_e \left[\frac{D}{2r} + \sqrt{\left(\frac{D}{2r}\right)^2 - 1}\right]$$

$$C_o = \frac{1.111 \times 10^{-12}}{4 \log_e \left[\frac{D}{2r} + \sqrt{\left(\frac{D}{2r}\right)^2 - 1}\right]}$$

The characteristic impedance Z_o is generally taken as $\sqrt{L/C}$, neglecting the quadrature term which on very short lines may result in an error on the order of 50 per cent.[6] For power frequencies:

$$Z_o = 120 \log_e \frac{D}{r} = 276.3 \log_{10} \frac{D}{r} \text{ ohms.}$$

For high radio frequencies, but still neglecting the quadrature term, the equation takes this form:

$$Z_o = 120 \log_e \left[\frac{D}{2r} + \sqrt{\left(\frac{D}{2r}\right)^2 - 1}\right] \text{ ohms.}$$

The two equations for Z_o give 218.7 ohms for the simpler, and 211.35 for the latter form, using a 6.186 ratio of spacing to radius. The difference will be greater for a smaller spacing ratio and, consequently, for a lower Z_o.

In order to calculate the shortening effect of capacity at the open end, it is first necessary to calculate the reactance of the condenser which is $1/(2\pi f c)$. This must be equaled by the inductive reactance of a shortened line, as follows:

$$\frac{1}{2\pi fc} = \sqrt{\frac{L_o}{C_o}} \tan \frac{360\,l}{\lambda}$$

$$= Z_o \tan \frac{360\,l}{\lambda}, \text{ where}$$

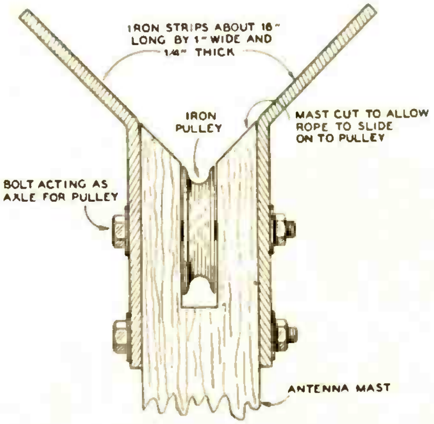
$$\tan \frac{360\,l}{\lambda} = \frac{1}{2\pi fc \times 120 \log_e \frac{D}{r}}$$

This expression gives the line length *l* in electrical degrees which, multiplied by 1.111 gives the length in per cent of a quarter wavelength.

The case of the concentric line will be treated in a forthcoming article.

EASY REPLACEMENT OF
ANTENNA HALYARDS

It is often quite a difficult job to replace the rope halyard on an antenna-mast pulley without lowering the pole and re-stringing it. Methods of accomplishing the replacing of the halyard have been suggested in the past but all have required the placing of a new pulley and halyard at the top of the pole. The accompanying diagram shows a method of fixing the pulley to the mast to obviate the difficulty.



The pulley is fitted into a slot at the top of the mast that is just large enough to clear the pulley without leaving any space at either side. Two iron straps are then fitted to the top of the mast in the manner shown. If the need arises, a small pilot rope with a doorknob on the end may be thrown over the mast and between the iron struts. Then the main halyard may be pulled over by the pilot rope. But be careful of the neighbor's windows when attempting to put the doorknob (or other such convenient object for throwing), with pilot rope attached, over the appropriate location at the top of the pole.

—*The Bulletin*, Sydney

●

Undertaker's Delight

Hams who are motorists would shudder at the suggestion they drive 80 m.p.h. on the wrong side of the road on a Sunday drive. Yet many of these same hams think nothing of it when they do the *equally hazardous* by puttering around the high-voltage end of their rigs while the power is on. Unfortunately, the ham game has no "highway patrol" to curb its more reckless participants.

High Efficiency Frequency Doubling

[*Continued from Page 16*]

oscillator has its main plate circuit tuned to 80 meters for use with 80-meter crystals. A center-tapped "3f" circuit was added and tuned to about 11 Mc. (about 27 meters). This increased the 809 output on the second harmonic in the 40-meter band and raised it from about 5 watts on the fourth harmonic (20 meters) to a value of about 20 watts. This makes a 20-, 40-, 80-meter exciter having an output of from 20 to 30 watts with just a single coil to change and one condenser dial to reset.

The "3f" circuit does no harm in the exciter when the 809 is operated as a neutralized buffer amplifier on 80 meters. The "3f" circuit can be set so it covers a wide range of crystal frequencies without any re-adjustments. A small mica trimmer condenser (3-to-30 $\mu\mu$fd. size) is adjusted with a screw driver until a small 2-volt 60-ma. pilot lamp and loop of wire show an indication of r.f. resonance at the third harmonic. The lamp will light up brilliantly if a 60-ma. size is coupled to the "3f" coil. An absorption wave-meter should be available to be sure that this circuit is tuned to the third harmonic of the crystal oscillator.

The 809 plate or cathode current will show a much better dip while tuning the 809 tank circuit when the "3f" circuit is tuned properly. The r.f. output of the 809 will also show an increase on 40 meters and a very great increase on 20 meters. The cathode current of the 809 runs, under load, at from 75 to 100 ma. and that of the 6L6G at from 30 to 40 ma. A 2-volt, 60-ma. pilot lamp in the 6L6G cathode and a 6.3-volt 150-ma. lamp in the 809 cathode provide cheap tuning indicators in this exciter. These lamps extend through the front panel and are connected across the current measuring jacks.

The 80-meter oscillator coil has 28 turns 1¼" diam. 1½" long. The "3f" tank has 20 turns 1¼" diam. 1½" long. The 809 plate coils are standard commercial plug-in coils about 1½" diam. and 1½" long. The 80-meter coil has 40 turns, the 40-meter coil has 24 turns, and the 20-meter coil has 12 turns in the exciter shown in the photographs.

This exciter is not shown as an ideal application of this new frequency generator circuit but rather as a typical illustration of how the idea can be applied to nearly any exciter. The third-harmonic tank coil can be wired into any doubler grid circuit which is capacitively coupled to the driver stage. Another example would be a 40-meter driver circuit with a "3f" tank tuned to 14 meters and the doubler plate tuned to 20 meters. The same idea has been tested with a 20-meter driver, a 7-meter "3f" circuit and a 10-meter doubler. The "3f" circuit can be tuned to the third harmonic of the highest "fundamental" frequency (3/2 of the final output frequency) and left in the circuit when operating on the lower frequency bands.

It should be possible to apply this "3f" circuit idea to a class-C modulated amplifier in which the grid excitation has been found insufficient by a small amount. The peaked grid voltage wave form can be used to increase the plate circuit efficiency of any class-C amplifier or frequency doubler stage in which there has been insufficient grid excitation.

See Buyer's Guide, page 98, for parts list.

Compact All-Band Portable Transmitter

[*Continued from Page 23*]

brought the harmonic up to a high percentage, it is well to shun this particular length of sky-wire most religiously.

The five-meter final coil would have been more efficient if an isolantite coil form had been available. Losses unquestionably are high in the base that was used, a 5-prong tube base with the sides cut off. Probably, with the new regulations making the five-meter band more attractive, manufacturers will present the amateur fraternity with efficient plug-in coils for this band in the near future.

Capacity Switch

The sketch shows clearly how S_2 is mounted by soldering it to the stator lugs on C_3, the final tuning condenser. The little knife switch is quite rigid after transplanting it from its original base.

Operation

Operation is perfectly straightforward. The proper coils are selected by reference to the chart. The only chance of error comes when trying ten meters for the first time. This calls for adjustment of the regeneration control condenser, C_4, and the opening of S_1. The screw adjustment on the little mica trimmer condenser is first closed tightly, then opened just enough to allow doubling from the 40-meter crystal to 20 meters in the oscillator tank circuit. To be certain of crystal control, it is good practice previously to check the harmonics of the crystal when working on its fundamental frequency. If, when doubling, the signal is tuned in at the same point on the receiver and does not leap away from that point when the oscillator tuning condenser is rotated, you may be sure you are crystal controlled, and not free-wheeling.

When crystal-controlled doubling is established, open C_4 as far as is possible without self-oscillation checking stability by starting and stopping the oscillator. Back off from the point that promotes self-oscillation, far enough to have good stability. Further notes on tuning this circuit can be found in the April, 1938, issue of RADIO under the heading of "A Sure-Fire Crystal Oscillator."

Coupling to the antenna is accomplished by means of a link wound around each of the final tank coils. An external antenna-tuning circuit may be used if desired.

Five-Meter Operation

In testing the transmitter for five-meter operation, you will find that very exact tuning will be necessary to bring forth upward modulation. A little practice on other bands will make the trick easier. The actual output on this frequency is quite low, but is ample to work as far as you can see from the tallest available mountain, and perhaps more. A complete log of the five-meter operations of W6LCL with this rig can be written on a couple of air-mail stamps, but if u.h.f. crystal-controlled operation is what it's cracked up to be, a few watts output from a rig of this sort should go at least as far as the same power sprayed into the ether by one of the wobbulated oscillators of earlier vintage.

Not being the possessor of a 10- or 20-meter crystal, no experimenting was done with higher-frequency coils in the exciter portion. But it seems logical that with a 20-meter rock one might expect almost as much output on five as it is possible to attain on ten from the 40-meter crystal.

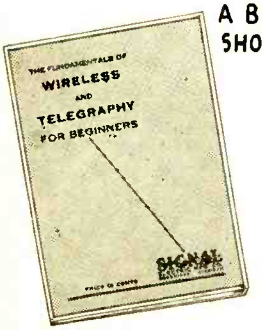
Reports have been very satisfactory with this little pint-sized handful. Barring QRM, which seems to bother even the high-power boys, we have been able to cover nearly as much territory as with the home station, which uses ten times the power.

So, it seems we have achieved our pet ambition. We have our complete, self-contained portable radiophone transmitter all enclosed in a carrying-case cabinet, the whole measuring eight by twelve by nine inches, rubber feet included. Our frequency coverage is complete; stability is a matter of present adjustments, not available to the exploring hand of curious visitors. Though for my own use in emergencies there is a kilowatt of a.c. power in the form of a belted alternator under the hood of my car, others might want to adapt this layout to battery power. This also can be done with no great difficulty. But, even with the a.c. power supply on the chassis, the total weight is just 28 pounds. It comes pretty close to a watt per pound.

Cabinet

A number of the manufacturers are offering streamlined cabinets in several sizes, but for the benefit of those who choose to roll their own the following instructions will be of interest.

After the chassis, with its bottom and front panel, has been assembled, make a full size drawing of the front elevation, with the curve you wish at the top corners. Measure from the lower left corner up and around the bend to the center line of the panel. Double this measurement and add an inch for safety. Fold two angles of ½-inch by ½-inch by 1.0-mm. terneplate this length, which should be a little less than 30 inches. Measure from center line of the panel to the start of the bend, as per sketch, and cut out a section of the web of the angle. Bend this around a piece of pipe of appropriate size, flattening the edge against the pipe as you bend by striking it with a flat face hammer. Check finished bend against the panel and adjust to fit. Cut off extra length of angle to fit flush with bottom of panel. Stand the two angle frames at the corners of the chassis so they outline the cabinet, and measure the width of the whole to determine the width of your top and ends.



As ventilation is necessary, get a piece of perforated metal from your local cornice works large enough to make the two ends and the back. Cut the two pieces for the ends so that they just meet the beginning of the bend. Rivet them to the angles, using the ⅛-inch rivets used for holding sockets in chassis. The back is then measured and cut, riveting it in the same way. It is well to cut your metal so that the bottom edge is solid, which can be done by cutting between the lines of perforations. Round the corners by peaning with a hammer and filing smooth.

The top is of solid terneplate of the same gauge as the angles. It is made long enough to overlap the ends at least one half inch and is riveted to them. Completely assembled the cabinet should lift smoothly from the chassis. A spacer is necessary between the front panel and the chassis to allow for the thickness of the angle frames. If this is not desirable, the edge of the frame can be cut away where it would interfere with the fit of the panel.

Drill the ends and chassis for two screws at each end to hold the cabinet to the chassis, attach a handle to the top, which can be purchased under the queer name of "Lift-bar" at your local hardware store, and you are nearly finished.

The panel, as previously mentioned, has been cut across at the chassis line and hinged to open outward. Catches can be made up very easily by following the construction shown in the sketch. The thumb pieces are cut from a piece of brass bar, ½ inch wide and ⅛ inch thick. Bevel the edges for a more pleasing effect. The small washers were from an old tuning condenser and the lugs are from an ordinary 110-volt lamp plug. They are cut off ⅝ inch from the rounded end and drilled to pass the 6-32 brass screw. The edge of the angle frame is cut out as per sketch to allow the dogs to clear in the released position. Turning the thumb pieces down to the closed position turns the dogs in so that they catch behind the angle, holding the panel firmly in place.

By removing the four screws in the ends, and releasing the panel catches, the whole cabinet lifts off, which is only necessary when changing tubes or making possible repairs. All band changing is done from the front; the bottom, being attached to the chassis, can be removed separately for inspection or adjustment of the innards.

It is sometimes a problem to get dials that match for a job of this kind. After much shopping around we finally found them all of the same diameter. The meter switch dial had no border, but by scratching the paint away a passable match resulted.

See Buyer's Guide, page 98, for parts list.

Rebuilding Collins 32-B's and 32-F's

(Continued from Page 34)

The Rewired Antenna Tuner

There is no need to change the original pi-network (standard on the 32-F; available as an accessory for 32-B) if you like this type of antenna coupler. The owner preferred the more conventional arrangement, though; so it was rewired as shown in the diagram. Flexible leads are provided on the pick-up coil so they may be clipped onto either the rotor or stator plates for series or parallel feeder tuning. The baby knife switch S_4 is opened for the former and closed for the latter method of operation. As the condenser spacing was rather close it was desirable to have both condensers in series with each other when placing them in parallel with the coupling coil. This doubles their breakdown voltage and halves their capacity, but since they are rather large this reduction in capacity is no disadvantage.

If you have a 32-B and did not purchase the antenna coupler, the coupler in figure 3 may be built by purchasing the required components and mounting them external to the 32-B.

Operation

If you've studied the diagram and read thus far you should have a pretty good idea of the rig's operating procedure. After wiring is completed a low-scale (0-10 or 0-25 ma.) milliammeter should be temporarily placed in the buffer grid return lead to facilitate neutralizing. With a 40-meter crystal, and oscillator and buffer coils for this band in place, and with buffer plate voltage off, screw the neutralizing condenser in until there is no flick of the temporarily inserted meter when tuning the buffer through resonance. Turn the thumbscrew a little farther until the meter barely begins to flick again, noting how much leeway there is between points where meter movement is noticeable. Then back off half this distance so as to be neutralized as perfectly as possible. This same setting should hold sufficiently for all bands if the circuit is properly balanced.

For 20, 40, 80 and 160 meters throw S_2 to take excitation from the oscillator plate. S_1 is left open, causing blocking of the doubler grid. For 10-meter operation, close this switch and throw S_2 to the doubler plate coil. A 160-meter crystal is used for the two lower frequency bands and a 40-meter crystal for the higher frequencies. The buffer works as a doubler for 10-, 20- and 80-meter operation and straight through on the other bands.

Upon tuning the buffer to resonance, grid current should appear on the final grid meter. With S_3 open, adjust the gauged neutralizer until there is no flick of grid current when tuning the final amplifier through resonance. 15 ma. final grid current through the grid leak shown is sufficient for linear modulation, but if everything is OK you probably will have closer to 20 ma.

In the original circuit the modulator B-plus was taken from "above" the final amplifier meter, thereby indicating the sum of final and modulator plate currents. The idea was to estimate modulation percentage by how far the meter bounced. As it is now necessary to add a negative-peak modulation indicator or keep a small 'scope permanently connected, to be in compliance with the new FCC regulations, the modulator lead was placed below the meter, so that the latter reads final amplifier plate current only.

The "revised" transmitter performs quite nobly on all bands, getting good reports for both quality and quantity of signal, despite its comparatively low power. Easy band changing makes all-band operation a pleasure.

See Buyer's Guide, page 98, for parts list.

●

"Famous Last Words"

Now watch what it does at 3000 volts. . . .

The Quadrectional Rhombic

[*Continued from Page 40*]

as to be objectionable, it can be corrected by adding to the lengths of the various feeders until they load the transmitter uniformly. It is not necessary that the feeders be of the same length; it is only necessary that they be of the same amount too long or too short of an integral number of half waves. Thus it can be seen that adding a few feet at most will result in equal loading in spite of the presence of moderate standing waves.

Adjustment of the terminating resistor is made easy by its location at the operating position. It will be somewhere between 700 and 1000 ohms. The best way to determine the correct value is to run low power to the transmitter, 10 or 15 watts, and then with a handful of carbon resistors try different combinations until the best value is found. Measure the resistance with an accurate ohmmeter (don't rely upon the resistor marking; they may be off 10 per cent) and then duplicate this value of resistance with a non-inductive resistor of sufficient wattage to dissipate approximately half the maximum transmitter output. Suitable terminating resistors are commercially available, or may be made up as has been covered many times in various past discussions of rhombic antennas. (See RADIO ANTENNA HANDBOOK.)

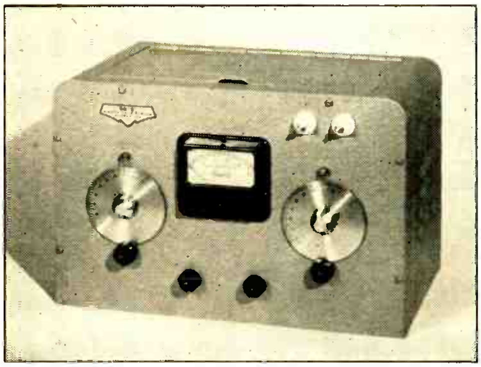
The determination of the best value of terminating resistor must be made while *transmitting*, as the input impedance of the average receiver is considerably lower than 800 ohms. This mismatch will *not* impair the *effectiveness* of the array on *reception*, but as a result the value of resistor which gives the best directivity on reception will not give the most gain when transmitting. It is preferable to adjust the resistor for maximum gain when transmitting, even though there will be but little difference between the two conditions.

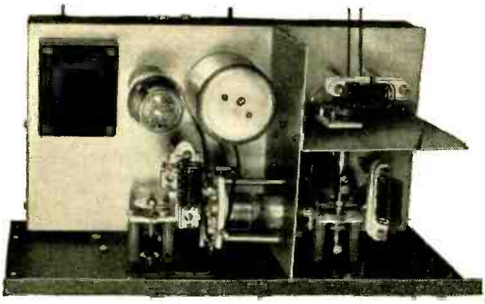
See Buyer's Guide, page 98, for parts list.

DX

[*Continued from Page 56*]

New ones for him are K7ETI, SV1KE, VJ2JL, VJ4CRE and ZS6BW, making him 35 and 79. Nice going. W7BVO had a pain in the neck when he was visiting W6OI a while back because while he was there OI worked a few stations that he could have used, too. However, all is not too gloomy, as when Rollie returned home he did hook K7FST in 19 and FB8AH,





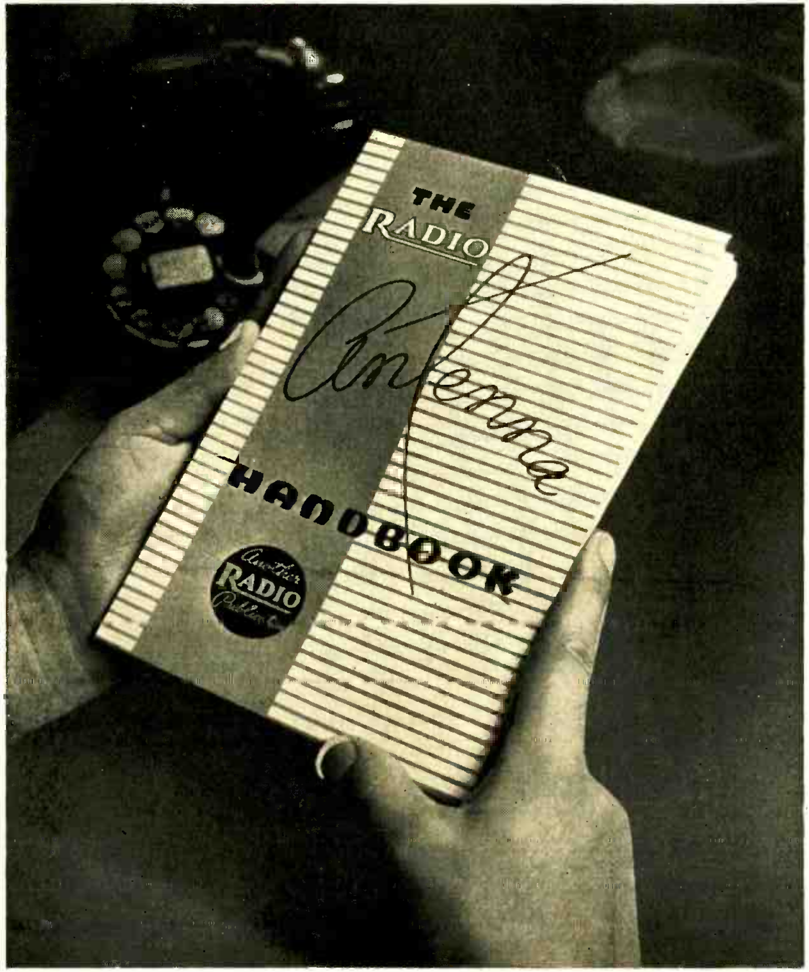
giving him 32 and 70. However, he has reason to shed some tears: he had the misfortune to have a fire in his transmitting room on the wall containing most of his rare QSL cards. He had the cards tacked around one of the zone maps. He is going to have a tough time getting all of them, but if any of the dx gang overseas read this, you might help him if he asks for a duplicate.

W6ITH worked KF6DHW on Canton Island. He told Reg not to worry if he was a little slow in coming back once in a while because when his starting battery is a bit low he has to do a 100-yard sprint to crank the gas-driven generator. New ones worked by ITH are I1TKM on 28-Mc. phone, VP4TK, VK7CL, XZ2EX who gave his address as P.O. Box 380, Rangoon, Burma. Another he has been chasing for a couple of years and finally hooked is FB8AH. ITH says that FB8AH runs either 40 or 900 watts and likes to make comparisons with both powers. OX7ZL was also worked and is supposed to be in East Greenland. If it proved okay, that's a good one. Says to QSL via E. D. R. in Copenhagen. For another new country Reg has CT1AY safely tucked away, also says PK6XX is on again and has a complete set of variable crystals to cover 14,000 to 14,400. Good dx worked at W6ITH recently include ES5D, KA1FH, VJ3AA, F8XT, ON4JN, PA0FB, HH2PB, I1TKM, G6LK, ZE1JX, VK6MU.

F8VC is going right up the line and the late countries for Jean are OH2OI, VP9G, ZC6EC, YL2CG, G6IA and, probably best of all, K6OQE, which gives him 31 zones and 71 countries. Oh yes, should have mentioned TF3C for one of the new zones, too. Jean points out that W6OI and W6EJC were both coming in well on January 2, while they were QSO FB8AH at 6 p.m. G.m.t. W5EDX is a new one with us with his 20 zones and 35 countries. He hails from San Antonio and is practically the only one from South Texas. W5EDX uses a pair of T55's with 130 watts input. Another new one is W1KJJ from "way down east" in Kennebunk, Maine . . . and his claim is 20 and 47.

W6PDB has a rather imposing list of dx worked on 10 phone entirely. Consists of about 25 G's, 4 ON's, F, PA, CN, and the usual run of ZL's, VK's, etc. W9ZTO now is up to 31 and 62, and now is going after his verifications.

F8UE has two new zones in U8IB and ZD2I. This makes 35 zones and 84. His new countries are, in addition to the above, ZC6EC, VP9L, VP7NS, K4DDH, ES5D, ZA1CC, MX2C, CN1AF, OQ5AU and VQ5ELD. F8UE has a new receiver, which probably has helped grabbing off these new ones. W3LE informs us that W3FAM has built a new kw. phone rig for 75 meters, W3CDZ is rebuilding, W3GNB has been on 40 quite a bit, W3AIB is on phone once in a while. W3LE has not been asleep at the mike as these will show. . . . new zones: UK3AA, YI5KG, K7AOC and U9AB. For countries Lou has the above, plus EI6G, ES7D, ZB1P, CT2AH and ZE1JP. Lou noticed that on the afternoon of February 6 the 20-meter band was acting screwy, hearing W, VE 1, 2, 3, G, F, CO, VP9, YV, ZS and a K6. . . . all this in 45 minutes. Another note from Lou says that after all this time he has picked off CE1AH for no. 37 and



one of a kind!

The "NEW" RADIO ANTENNA HANDBOOK is the first—foremost—and ONLY book written exclusively on the subject of Antennas. Containing everything that is worth telling about this important subject, it is invaluable to you regardless of what books you already possess.

Profusely illustrated, the new book features many diagrams, tables of dimensions for all frequencies (no calculations necessary), dope on all practical arrays and directive antennas, and feeders of all types. In addition, several practical multi-band antennas are fully described.

Be sure to order your copy-Today!

Seventy-five cents

(In Continental U. S. A. Elsewhere 85c or 3s 6d)

RADIO Limited
Technical Publishers
7460 Beverly Boulevard
Los Angeles

96th country. W3LE says he has a heck of a time working W stations and can work dx much easier than he can raise a W. W9NLP gets VU2CQ and now has 34 and 83. Guess that's about all from the phone gang.

A letter from ON4EY, who by the way is a stamp collector, notes a little project he has in the making. It's called the "300 District Club." The general idea is that he believes there is a place for another type of dx club. He has taken the number of districts in the world, such as in CE there is 1 to 7 or a total of 7 to be worked in Chile. Other examples are OH, 1 to 9, total 9; SM, 1 to 7, total 7; XE, 1 to 3, etc. By totaling up all the districts in the world we find 505. The object is to work as many of these districts as possible and when you have reached 300 you are in the Club. Example would be. . . . ON4EY has a score of 286. I have on hand a complete list of the districts of all the countries set forth by ON4EY. If there is sufficient interest RADIO will be glad to print the entire list. Any further information may be obtained from ON4EY, Marcel Dupuis, 46 rue du Velodrome, Ostende, Belgium, or through this department.

A couple of notes from here and there prove interesting. . . . LU7AZ during a QSO the other night, said, "Did you know that I am to marry on March 18, but this is after the Contest, hi" Guess Milo has his ideas for March all right. . . . and to LU7AZ, our congratulations. Here is G2IO with a new zone in the form of K7HCX, and now has 37 and 101. W1APU hooked up with XU2AW who gave his address as Box 45, Peking, China. Another new one was PK1TT and with the XU he has 36 and 89. W9GBJ got a strangle hold on TF5C boosting him to 35 and 92. His rig is a 100TH with 300 watts. W1APA worked ZD4AB for 34 and 93. He says that W2UK has put up two new Premax beams, one for 10 and the other for 20.

Last night after pounding the "mill" on this stuff until around 1:30 a.m. thought I'd take a listen before hitting the hay. The band sounded wide open, and sure enough there were European stations all over the band. To those of you who do not know what dx is like around here, it is very unusual to hear Europeans at that time. Especially, after the band has been folding about 8:30 every night. Naturally there weren't any W6's up at that time on 20 so QD just couldn't leave the band completely deserted.

It was an odd feeling to have the tables turned and have the European stations call, instead of the other way around, as is usual on 20 meters. I didn't even hear a W9. For those who might be interested to know what's going on at this new "spot" I can say the pole raising bee was a success, and at present a Lazy H hangs between the two poles. The pole raising crew really knew how to stand up those 70 footers as well as drink me entirely out of "milk and stuff."

With such talent as W6VB, OEG, EGH, LS, RP, BUO, NSA, OAQ, OJ, and the neighborhood kids, you couldn't go wrong.

So far the neighbors don't seem to know there is a "wireless station" in their midst. But I'm afraid they will. The lazy H is pointed for Europe but it also is good for the 9th district. . . . W9FS said so. By the time this is in your hands I should have a couple more up in the air. . . . if I don't run out of land.

I might mention W6CXW has up a rotary two element for 20 and he likes it much better than the other antennas he has tried. Of course he has issued his usual annual denial that he is going into the contest. Of course we all know better. Well, fellows, keep things moving and I'll see you next month if you survive the contest.

DX FREQUENCY LIST

C.W.—14 Mc.

AC4YN 14,140; CN1AA 14,408; CP1AA 14.415; CR4HT 14,425, 14,470; CR6AI 14,100, 14,400; CR7AF 14,275; CR7AY 14,100; EA7AN 14.418; EL2A 14.275; FA8ZZ 14,405; FI8AC 14.410; FM8AD 14,290; G6IA 14.050; HR7WC 14.404; HS1CK 14,020; KC6CKM 14.295; KD6QLS 14,040; KF6DSF 14,395; KG6NVJ 14,365; K7FST 14,395; J8CG 14.410; J2KG 14,410; LZ1AA 14,450; LZ1ID 14,400: LZ3AB 14,405; OQ5AV 14,028; PJ1BV 14,410; PK1TT 14,250; PK4KO 14,120; PK4KS 14,320; ST6KR 14,310. 14,375; TF3C 14.420; TF5M 14,310; TG9BA 14.005; TI2LC 14,420; U8ID 14,378; U9AB 14.450; VK9BW 14.380; VK9JG 14,100; VP2AT 14.437; VP2ZA 14.312; VP5SB 14,300; VP7NU 14,300; VP8AD 14,380. 14,410; VP9X 14,300; VQ2MI 14.330; VQ2PL 14,425; VQ3HJP 14.405; VQ4RHL 14,350; VQ5EJT 14.046, 14.140; VQ5ELD 14.045; VQ8AI 14,320; VQ8AS 14,290; VS4JS 14,050; VS6AG

14,385; VS6AS 14,130; VU2AN 14,055, 14,350; VU2F0 14,340; VU2LK 14,001; VU7BR 14,310, 14,345; XU0A 14,340; XU2AW 14,320; XU3AA 14,075; XU4XA 14,270; XU6D 14,410; XU9NT 14,240; XU9FS 14,210; YI5KG 14,410; YS2LR 14,412; ZB1R 14,306; ZC3D 14,370, 14,420; ZC6EC 14,316, 14,410; ZD2H 14,100, 14,312; ZD4AB 14,350.

C.W.—7 Mc.

D4CGK 7190; EA6BA 7312; HA8G 7260; HB9CS 7170: HB9J 7310; HP1X 7115; HR7WC 7310; I1TL 7190; J3FJ 7053; KA1AX 7160; KD6MV 7014; OZ2FY 7168; SM5XW 7173; SP1CF 7174; YR5AR 7305; YR5FD 7180; YR5MI 7230.

Phone—14 Mc.

CN1AF 14,110; CT1AY 14,016; ES5D 14,050; FB8AH 14,350; FI8AC 14,410; FN1C 14,040. 14,212; I1MY 14,020: K7FST 14,160, 14,200, 14.208. 14.219; KA1CS 14.130. 14,265; KA1ME 14.260; KF6DHW 14,378; LX1SI 14.035; OH2OI 14,188; OX7ZL 14,023; OZ5CN 14,270; PK4KS 14,310; SP1QE 14.030; SU1RD 14.300; SU1MW 14.100: SU1AX 14.010; SV1KE 14.000; TF3C 14,100; TG9BA 14.005; VK4HN 14,300; VK6KW 14.068; VK6WS 14,065; VK9BG 14.100; VP9L 14.050; VQ5EJT 14,046. 14,140; VS6AG 14.126; XZ2DX 14.000; XZ2EZ 14,300; YI5KG 14.410; ZB1L 14,040; ZC6EC 14,315; ZD4AB 14,395; ZL2JQ 14,248.

Phone—28 Mc.

CN8BA 28.100: I1KN 27,990; I1TKM 28,080, 28,600; I1TT 27,990; KA1ER 28,200; KA1ME 28.250; PK6XX 28.400; SU1JN 28.100; SU1MW 28.490; VS2AS 28,070; VS6AF 28,645; VU2FU 28,038; YI2BA 28,050.

●

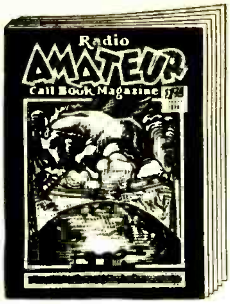
Tubes? Nuts

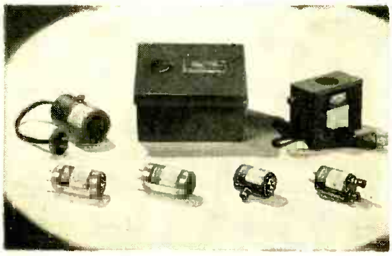
In twenty years we have seen radio progress from "peanut" tubes through tetrodes, pentodes, duo-diode-pentodes, heptodes, hexodes, etc., and now—"acorn" tubes.

MORE ON THE
New Regulations

Several new FCC rulings should be of interest to amateurs. One of the new rulings concerns changes in the International Morse Code. Although these changes are part of the revisions made at Cairo, which have not as yet been ratified by the United States, it is expected that the new comma and period signs will be universally adopted. The new period is (. — . — . —) and the new comma (— — . . — —).

Other action by the Commission of interest to amateurs is the amendment of Rule 225. This rule concerns the classification of various forms of emission and specifies the bandwidth which each may occupy. New emission classifications are types A-O, A-4, and A-5. A-O emission covers continuous-wave transmissions, such as standard-frequency broadcasts, of which the successive waves are identical under fixed conditions. A-4 emission now covers only facsimile transmission instead of both television and facsimile. Television is now designated as type A-5 emission.





So You're Going Mobile!

[*Continued from Page 42*]

chosen filter system) under rated maximum drain of 100 ma. Though overloads as great as 30% are quite in order providing they are *intermittent,* it's nevertheless good policy to stick well within the prescribed current limit. Remember, by the way, that the vibrapack makes the best possible receiver power supply and that it will be perfectly satisfactory for the powering of certain transmitters. But a good dynamotor has better regulation and will very probably be the more satisfactory assembly to use should the total plate current vary greatly during set operation.

Transmitters

A few brief remarks of interest primarily to the amateur beginner contemplating construction and use of a low or medium powered phone follow:

1. You can purchase dynamotors supplying up to 350 volts at 100 ma. These are just the thing, by the way, for a phone running from fifteen to twenty watts input into the final. Remember that a good dynamotor will run under *continuous* 30% overload.

2. Don't let anyone tell you that you can't purchase dynamotors of greater output. There are dual and triple unit jobs on the market which will supply as much as 600 volts at 300 ma. (just the thing for a transmitter with push-pull 809's in the output stage). Outputs of units can be paralleled or series connected to give any desired voltage at any specific drain within reason.

3. Whatever we have said about the better regulation of the dynamotor, it's perhaps wise business to stick to the vibrapack when and if the transmitter to be powered does not call for more than 250 volts at 100 ma. The pack is really the ideal unit for the "typical" u.h.f. mobile-portable whose plate input to the final is something on the order of 8 watts, 100% modulated by a 6N7 or, better still, by a pair of 6V6's or 6F6's running strictly class A to minimize variation in drain with modulation. It's small, compact, self-shielded, and may be conveniently mounted in the smallest of transmitter cabinets.

4. Remember—the self-excited job is no more. Read Turner's article in December RADIO if you don't believe us. Whether you're going on 5, on 10, or on 160 makes no difference. The set must be either a crystal-controlled or m.o.p.a. job.

That doesn't end the story by a long shot. There's a lot more to be said about mobile transmitters and transmitter powering—and certainly something to be said about antennas. But we'll have to leave further remarks for another time.

The Amateur Newcomer

[*Continued from Page 59*]

the plate tank rods. With the antenna disconnected, squeeze the grid coil in and out until the oscillator draws 50 ma. It should be possible to draw small sparks from the plate end of the rods with the tip of a lead pencil, indicating oscillation. The antenna is now coupled to the plate tank by means of the hairpin link, the coupling being adjusted until the oscillator draws 60 ma. Tighter coupling should not be used, as the life of the 76's will be greatly shortened if they are allowed to draw over 60 ma. for any length of time. The output under these conditions will be very close to 10 watts.

Adjust the distance between your lips and the microphone, and also the level of your voice, so that there is just a perceptible upward kick of the plate milliammeter as you talk. A greater variation in plate current to the oscillator as you talk indicates objectionable overmodulation.

The first thing to do is to check with other amateurs or by means of Lecher wires to see if your frequency is too high or too low. If you have followed constructional details closely you should be within the band, but if a check reveals that you are not, you may raise your frequency by sliding the shorting bar towards the tubes a slight distance, and lower it by the opposite procedure. After you are in the band it is well to readjust the grid coil spacing, spreading or compressing the coil until the oscillator draws 50 ma. with the antenna disconnected.

See Buyer's Guide, page 98, for parts list

U.H.F.

[*Continued from Page 63*]

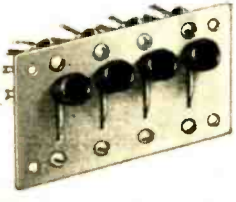
There seem to be a lot of New Jersey-New York stations getting on the band. If they can get together, it should add up to a lot of activity.

Washington, D. C.

According to W3HJT in Washington, 2½-meter activity is very low, but W3HBP-DBC-HJT all planned to be ready by March 1.

W4's

The South Florida Radio Association took it upon themselves to have a little fun during the All American Air Maneuvers on January 6, 7 and 8 and to do something that apparently had never been done before. So after a couple of weeks of conversation, the committee decided to put on a five-meter phone transmission between all the principal points on the field, there being six stations.



Because of the new regulations that went into effect it was impossible (legally) to use modulated oscillators or transceivers for 56-Mc. work and they did not have time to build crystal controlled outfits. The only answer was to rebuild all the transceivers for 2½ meters. A committee was appointed immediately to rebuild the sets, the committee being headed by Dick Smith, W4DRD. He and his committee did a swell job with the time that they had and considering the equipment. They turned out on the day of the meet with six complete outfits that worked like a charm on 2½ meters. Much could be said about the headaches but that would take up too much space.

Arriving at the air meet, the officials immediately advised where they wanted the outfits placed. One was set up in connection with the Department of Commerce for opening and closing the field. This gave complete break-in coverage over the entire field which is about a mile and a half square. In every instance 2½-meter work was better than "five" because it got away from all the motor noise which accompanies more than 700 airplanes within a radius of a mile and a half. Practically all of these little outfits had no more than about an eighth of a watt output but they sounded like a kilowatt over the complete field.

Those who participated included W4PBP, W4FNN, W4EDD, W4AII, W4BTM, W4DRR, W4DUW, W4DRD, W4DNV.

In a great many cases the 2½-meter transmitters outperformed the few telephone lines and the officials of the air meet were loud in their praise for the work the boys did. Next year special arrangements will be made to use 2½ meters for complete communication at the air meet, with special equipment being built to handle it.

The boys deserve a lot of credit for this work.

Even In Texas!

J. F. Towler, W5BYV, says that he and W5DB in McCamey, Texas, are on 2½ meters with 3-element closely spaced arrays fed with delta-matched lines. The location is half way between Ft. Worth and El Paso. Hams are few and far between out that way but they would like to see some interest aroused on 112 Mc.

The Nines

We are told that W9PEI will be on the air in the spring. W9ZEO in Chicago has 50 watts xtal (!) ready.

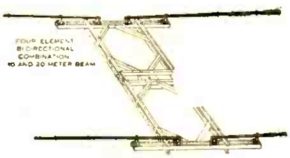
In Milwaukee, W9ZGD reports little progress recently with W9ANA and YYY, the best equipped locals, off the air. ZGD has a schedule at 6:30 every night with SYT and MZZ, sometimes with CCD. Quite a few of the others have talked about getting on. So far, ZGD has worked seven stations, receiving reports from nine others. He added three miles to his dx by getting a report from Grafton, Wisc., 17 miles away. He is still trying to get into Port Washington. His tape is still running on 114 Mc. evenings and weekends. All the Milwaukee stations are said to use horizontal antennas, 45 oscillators, and 76 detectors with separate quench oscillators.

W9ZAC-W8QUR in Fort Wayne, Indiana, has a stabilized 6L6 with eight watts input, 6J7-6L6 modulator. His receiver lineup is 955-6C5-25L6 which gave a good account of itself on 56 Mc. last summer when he was operating portable with the Cole Brothers Circus.

Sixth District

We haven't even had any five-meter news from way out west for months, and someone called this a western magazine! We shall quote a letter from Dick Sampson, W60FU, who is located in Colton, California:

> "Just a few lines with dope about 112 out here in our portion of Sunny Southern California (you can tell these Californians a mile off—W9BNX). I don't know if it is any help, but here it is.
>
> "Most of the five-meter transceiver gang moved down on 2½ around December 1. Those active at present include W6HDY-QQP in Riverside; W6EAR-QUF-NCP-OFU in Colton; W6DMQ-PPJ-QUK in San Bernardino. QUF-DMQ-OFU are also portable-mobile.
>
> "Transmitters are about as follows: QQP-QUK-QUF mobile use t.n.t. 6A6's. HDY has a pair of HK24's long lines. OFU uses a single 45 concentric line oscillator, while AVR is whipping up a pair of 45's in a "trick" long lines circuit and will be on the air as soon as he gets his antenna system up. Receivers are mostly superregens although OFU is working on a superhet with an 1851 autodyne first detector and concentric line grid circuit.
>
> "The Southern California Gas Co. club has fourteen members studying for the exam. W6QUF is one of the 'top men' in the San Bernardino-Riverside district. W6EAR is teaching the code and W6OFU is handling the theory. Each member is building a transceiver for 2½; some are already finished. The fellows are using them for i.c.w. code practice on various nights on schedule by W6EAR-QUF-OFU.
>
> "The dx so far has been between W6EAR in a truck in the San Bernardino mountains and W6QUF near Brea for a distance of about 46 miles. There seems to be very little, if any, activity around Los Angeles as yet but we hope to work the distance when the fellows there get going.
>
> "I have been down on 2½ for the last year, taking time out once in a while for



> a little 7 Mc. c.w. or a chat on 56 or 28 Mc. The only activity here for some time was between W6AVR and myself cross band as he has a 1-10 receiver. We could find little difference between 5 and 2½ meters. We now find that 2½ seems to work *better* than 5. W6DMQ-PPJ-QUK work into Riverside over hills where it was impossible on five meters. This is done with transceivers.
>
> "Congratulations on the 112-Mc. department in RADIO, Bill. Some of us 'old timers' who were complaining about the lack of QRM now may have to move to 224 Mc. soon for lack of elbow room."

So, W2KDB, *there* is a report of a 46-mile QSO with a transceiver. Much longer distances than that have been worked fairly consistently using home stations and beams, as reported in past years. Transmitters are but little different on 2½ except that the tube filaments are more separated in terms of wavelength and may require either chokes or tuned lines. The latter are quite easy to handle. Parallel wire or concentric line oscillators are not at all tricky—an untuned coil in the grid and a line in the plate generally being sufficient.

Receivers are inclined to be insensitive unless they are carefully adjusted. Straight regenerative receivers are a possibility if the voltage is stabilized, such as by using a small battery on the detector screen. Superregenerative sets should be adjusted carefully for good sensitivity with little hiss, and are probably more apt to be good if a separate quench oscillator is used; see the articles on that subject in RADIO. Receivers can be tested and adjusted by setting up an oscillator somewhere far enough away to get a weak signal. Care should be taken to get enough antenna coupling — sometimes self-quenched detectors are used with less than optimum antenna coupling because tighter coupling stops the oscillation.

Concentric lines as tuned circuits are without question an improvement over coils of vanishing size; the lines can be something over a foot long, depending on the circuit capacity tied across them. An outer conductor diameter of 1½ to 2 inches and an inner conductor a tenth of that size will give good results. A larger inner conductor will increase the Q, decrease the gain, and require more tuning condenser (or, better, more line) to restore resonance. Acorn tubes should, by all means, be given preference in the first circuit. Beware of cathode bias in r.f. stages because it is difficult to by-pass the resistor effectively.

End fed antennas often have a splattering effect due to power radiated from the feed line as a result of space coupling to the antenna. The Wheaton (Ill.) police checked Western Electric's claim of an 8 db gain for a "folded back" concentric line antenna compared with a concentric line fed J or end-fed Q and found it to be correct. This antenna was described in RADIO some two years ago; it involves use of a pipe as the lower half of the half-wave radiator, with a concentric feed line going up inside it. The outer sheath of the line is connected to the top of the surrounding pipe but it is insulated from the bottom of the surrounding pipe. The upper half of the antenna is a quarter-wave continuation of the inner conductor. Beams can be built up on this antenna simply by sticking additional wires through a horizontal crosspiece of wood, pivoted on the center of the antenna.

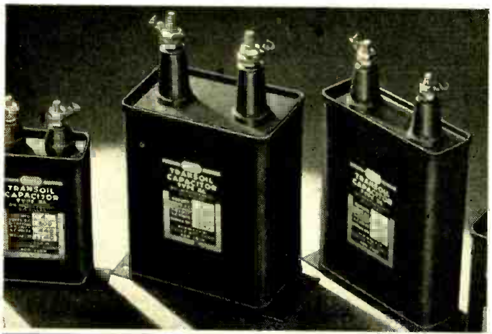
●

"Clothes Beam"

Now comes the yarn of the latest ham-b.c.l. conflict. Upon going to the roof of the apartment house, where his new 3-element beam stands within easy reach for adjustments, Mr. Ham finds his signal-aimer gaily bedecked with the various unmentionables of neighbor Mrs. BCL, who hastens to explain that she had no idea "you would mind my using your empty clothes drier!"

●

W8TAD was a "ham" before he ever got his license. His name is *Hamm*.



What's New

[*Continued from Page 67*]

COIL REPAIR AND REWINDING SERVICE

The Meissner Mfg. Company of Mt. Carmel, Illinois, announces the institution of a new coil repair and rewinding service.

Prompt and efficient service is guaranteed under this new policy. A flat rate of $1.00 per unit is made to the old coil wherever possible, but if this is impractical, a new coil will be made at the same price.

In all cases, the defective coil must be sent in accompanied by as much pertinent information as possible in order to facilitate turning out the job with minimum delay.

NEW RCA TUBES AND CONDENSERS

RCA recently made available through their transmitting-tube distributors three special purpose tubes as follows:

RCA-1620 Triple-grid detector amplifier
RCA-1621 Power amplifier pentode
RCA-1622 Beam power amplifier

The 1620 is a triple-grid metal tube recommended especially for applications requiring very low microphonic and noise response. The physical and electrical characteristics of the 1620 are similar to those of the RCA-6J7.

The 1621 is a power amplifier pentode of the metal type recommended especially for applications where extremely low distortion and continuity of service are of prime importance. This tube has physical and electrical characteristics similar to those of the RCA-6F6.

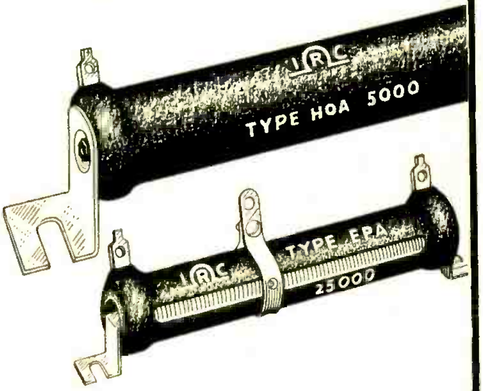
The 1622 is a beam power amplifier of the metal type intended especially for applications where extremely low distortion and continuity of service are of prime importance. Its physical and electrical characteristics are similar to those of the RCA-6L6.

RCA is also offering a new line of receiving tubes, similar to the octal metal types except that they have small, tubular "T9" glass bulbs. These tubes are numbered the same as the corresponding metal types with the addition of the suffix "GT."

Also released are several new single-ended metal tubes, which have all leads coming out the bottom yet have the input effectively shielded from the output in the screen grid types.

Data on these new receiving tubes may be obtained from RCA dealers.

RCA also announces that their extensive line of Faradon fixed mica capacitors, widely used in commercial transmitters since 1920, are now available to amateurs and experimenters through RCA amateur equipment distributors. Specifications are given in the RCA Faradon condenser catalog.



Yarn of the Month

[*Continued from Page 65*]

pair of 845's in parallel which were driven by an impedance-coupled 210. The speech consisted of a double-button mike and a pair of 27's. The whole r.f. section was capacitively coupled, and the 210 and 203-A were neutralized by virtue of a tap placed about a quarter of the way up from one end of their plate coils.

No, there wasn't anything *wrong* with the rig. I'd like to have seen the expression on the face of the fellow who corrected the exam paper when he came to the diagram of that museum piece and tried to find something actually wrong with it.

As tactfully as possible I tried to show him why he should build a more modern rig. I tried to explain the advantages of link coupling, split stator condensers, low-C tubes, class-B audio, peak compression, pentode crystal oscillators. I could see that my suggestions were falling on deaf ears. I thought maybe I could reach him through his pocketbook, not that I wouldn't just as soon sell him a more expensive article, but I figured that he had just about so much to spend and that we would get that and that that was that.

"Look. 845's cost $10 each; 809's cost $2.50 each. And a pair of 809's in class B will put out twice as much audio as a pair of paralleled 845's in class A." Certainly he couldn't ignore such a convincing argument as that.

"Only $10 for an 845?" His face lit up. "Gee, that's swell. I can remember when those tubes cost real dough. That's just dandy. And I suppose 203-A's are cheaper now too."

I gave up, and decided to humor any whim he might have. "Yep, they are only 10 bucks now too."

"That's fine. Only 10 bucks! I paid over $30 for the last one I bought, and it certainly wasn't built like these new ones you have here." He gazed fondly at a couple of graphite plate 203-A's in the display case.

"Of course I appreciate your efforts to help me," he went on. "But it's just that I'd have more *confidence* in this rig I've planned on. I guess this new stuff is all right if you have kept up on things and know what it's all about, though.

"When I sold my c.w. junk in '26 when I got married it was partly with the idea that when the honeymoon was over and we got settled around in a permanent location I'd build a better rig, one that would also work phone.

"But I guess you know how that is." He laughed. "I guess lots of other fellows have found that's not so easy to get on the air right after you're married. But during '27 and '28 I would spend odd moments studying the various mags and designing the transmitter that I wanted. The rig I evolved was the one I have drawn here, and I had my heart set on it to the extent that nothing less would do.

"Well, in '29 I lost everything but my shirt and couldn't have afforded even a 10-watt c.w. rig. So far as I was concerned ham radio was not for me. But now that I can afford it there's nothing against my getting interested again, and danged if I'm not going to have the exact rig I used to lie awake scheming about. I remember one night I didn't get to sleep till 2 a.m., trying to decide whether a single 212D modulator would be better than a pair of 845's in parallel."

I was beginning to understand the fellow better. It didn't seem so crazy after all. And I figured the rig probably would work all right—after a fashion. I spent the rest of the afternoon picking out the necessary stuff for him to put his baby on 40-meter c.w. and 160-meter phone.

I stayed 10 minutes past closing time to get him every last thing he needed, except the copper tubing he insisted upon for the 40-meter tank coil.

After he left I locked up and walked down to the corner to catch an "R" car. My customer pulled up in his sedan to wait for the signal to change, and saw me waiting.

"Get in," he offered. "I live out near the end of the "R" line. I'll take you home." Thankful for the chance to ride home sitting down for a change, I hopped in.

"Where 'bouts do you live?" he inquired.

"Near Lincoln and 37th," I replied.

"Say, I *thought* I'd seen you some place," he exclaimed. "We live in the same neighborhood." Then I realized why his face had looked familiar.

When he let me out at my house I thanked him and offered to help him if he should run into any trouble with the rig. I figured that I was sticking my nose out for sure with the offer, but after all we had sold him nearly $300 worth of parts, and besides I had come to like the fellow.

"Thanks," he offered, "I don't think I'll have any trouble. But I'd like to have you come over and see me some time anyway; I live up the street at 3859. My friends call me Speck."

About a week later Speck called me on the phone. "Aha," I thought, "I knew he would need some help with that antique nightmare." But it wasn't that kind of assistance he wanted; he needed someone to help him raise his poles.

I consented to give him a hand come Saturday morning, and when the time rolled around

I was amazed to find stretched out in the lot next to his house two neatly painted sticks, one about 60 feet and the other around 80, with a trick arrangement of pulleys and tackle which he claimed would permit the two of us to "raise them in a jiffy."

Somewhat skeptical, I followed his directions, and darned if we didn't have the two poles up inside an hour. We could have had them up in even less time except for the presence of a fan counterpoise. (I guessed that's what it was by recalling illustrations I had seen in old books.) Stretching out over most of the lot, it hampered our operations a little.

I wanted to stick around and help him haul up the four-wire flat top he had all rigged up in the back yard ready for raising, but his wife reminded him in no uncertain terms about then that it wouldn't be a good idea for him to forget that he had promised to take her over to visit her mother. So home I went to do a little more pruning on the element lengths of my new rotary.

Well, Speck finished the antenna job himself, and got the rig all finished and tuned up by himself, though I tried to convince him that he shouldn't put so much stock in the antenna ammeter that I tried to dissuade him from buying. But how can you argue with a guy that works more dx with 200 watts on 40 meters than I do with a rosy cheeked kilowatt on 20? He uses that flat top and fan counterpoise contraption on a harmonic on 40 and boy do the J's and PK's and such know when he is on the air!

On 160 the W6's all report him as having about the best east coast signal, and all accuse him of running more than the 150 watts he uses on phone. His quality is about the crispest and his signal about the cleanest on the band. The highest form of compliment on your quality if you live around here is: "You really sound swell, o.m., almost as good as W2XYZ."

One ham who spent two years and close to $1000 trying to get a high-powered 160-meter phone rig to sound right and get out the way it should threw the whole mess out and built an exact duplicate of W2XYZ's rig, right down to the last by-pass condenser, after listening to Speck's signal a few times and to some of the reports Speck got from California.

In fact, one of these days I'm going to put Speck's rig on 20 for him and see if it perks as well as it does on 40 and 160. If it does I'm going to build one too; Speck generously has offered to help me.

You see, I've lately been receiving some unappreciated compliments on my signals when I go up on 160. They tell me I sound almost as good as W2XYZ, and almost as loud, too.

Open Forum

[*Continued from Page 66*]

would just as soon have some bird on my frequency continuously as to have him come on and go off every few seconds. In fact, QRM from a steady carrier, such as in phone duplex, is to be preferred, because it doesn't keep the a.v.c. jumping around. The good old fashioned system of monolog, in which the operator talks for from 1 to 10 minutes and then is off for a comparable period, permits someone else to make some use of that frequency by sandwiching transmissions in between. Did you ever try to get a word in edgewise when one of two break-in stations is smack dab on your frequency?

Phone break-in? There oughtta be a law agin' it!

HARRY BLAIN

EDITOR'S NOTE—*Of course there is something to be said in favor of phone break-in. But rather than enter into the argument ourselves, we would prefer to let some of you break-in enthusiasts present the other side of the question in the Forum.*

NEW JERSEY HAMFEST

The Union County Amateur Radio Association, Inc., will hold another gigantic hamfest at Kreuger's Auditorium, Belmont and Springfield Avenues, Newark, New Jersey, on April 22, 1939. The official starting time for the session is 8 P.M.

In addition to technical presentations by several well known speakers, the program for the evening includes demonstrations, entertainment and awarding of prizes. Light-footed hams and their fair ones will find QLF practice available in the form of dancing. Refreshments are also scheduled for the evening.

The prize-list is imposing, with featured items such as *two* RME-70 receivers, complete, a gross of Taylor and Eimac tubes, and 25 Weston type 301 meters.

As in previous hamfests, the Association is planning to accommodate 2500 persons. The price of admission, including refreshments, is one dollar.

●

"Alsifilm," a new material developed by the Massachusetts Institute of Technology, bids fair to become popular in the radio field. Manufactured from clay which costs about a cent a pound, it can be made transparent, like cellophane. It is pliable, can be made into sheets of any thickness, and its discoverers claim its insulating properties are comparable to those of mica, which has a similar structure.

We don't know just how good the power factor is at high frequencies, but if it is as good as appears very likely from the preliminary data available, it should find wide usage for flexible concentric feed line and other such applications.

Changes of Address

To become effective with
The Next Issue
must be RECEIVED at Los Angeles
by the 10th of this month

●

Address labels are shipped to our mailers on that date. Remember: under U. S. postal laws, magazines sent to an old address are junked unless forwarding postage has been left **in advance** with the postmaster; unlike letters and cards, magazines are not forwarded either free or collect (except to addresses in the same city).

RADIO ***Circulation Department***

The Marketplace

Classified Advertising

(a) Commercial rate 10c per word, cash with order; minimum, $1.00. Capitals: 13c per word. For consecutive advertising, 15% discount for 3d, 4th, and 5th insertions; 25% thereafter. Break in continuity restores full rate. Copy may be changed as often as desired.

(b) Non-commercial rate: 5c per word, cash with order; mimimum, 50c. Available only to licensed amateurs not trading for profit; our judgment as to character of advertisement must be accepted as final.

(c) Closing date (for classified forms only): 25th of month; e.g., forms for March issue, published in February, close January 25th.

(d) No display permitted except capitals.

(e) Used, reclaimed, defective, surplus, and like material must be so described.

(f) Ads not relating to radio or radiomen are acceptable but will be grouped separately.

(g) No commissions nor further discounts allowed. No proofs, free copies, nor reprints sent.

(h) Send all Marketplace ads direct to Los Angeles accompanied by remittance in full payable to the order of Radio, Ltd.

FOR SALE: Norton 813 bandswitching rig described in this issue. Complete with Weston meter. 10- and 20-meter coils for final, less tubes: $36.50 f.o.b. Radio, Ltd., 7460 Beverly Blvd., Los Angeles, Calif.

SERVICEMEN: Radio cartoons enliven advertising, boost business. Cut catalogue. 10c. Radiolabs, Winnipeg.

YOUR sigs recvd hr.. phone CQ's, etc.. on guaranteed phonograph records, special 35c. Brown's Radio Laboratory, Dolgeville, New York.

RECONDITIONED guaranteed receivers. Practically all models cheap. Shipped on ten day trial. Terms. List free. W9ARA. Butler, Missouri.

LISTEN for High Frequency Broadcast Station, W9XA, 26,450 Kilocycles, Kansas City, Missouri.

SELL: Latest Harvey 200-R transmitter complete ready to operate all bands from ten meters up. W9ZUZ, Hopkinsville, Ky.

WANT Edison storage batteries, WE316A. Trade 852. power supply, dynamotor or what? W9GFZ, Grote Reber, Wheaton, Illinois.

SELL: Candler code course, $10. Harold Martin, Mentone, Texas.

ONE Only: 14" rack with two crackled panels. two plated chassis. No cover. $3.75. R. H. Lynch, 970 Camulos, Los Angeles.

RECEIVER Hallicrafter SX17 tubes crystal less speaker. Used five months. Cost $137.50. Guaranteed perfect. Price $87.50 cash. Buying Super Pro. Clifford T. Lee, c/o WAPI Transmitter. Route #3. Box 125, Birmingham, Alabama.

CRYSTALS AIRMAILED: 160-80 AT, 40 X $1.95. 80M Varifrequency. 100 kc. Bars and 20M crystals mounted. $4.50. Large stock. C.O.D.'s accepted. COMMERCIAL CRYSTALS QUOTED. C-W Mfg. Co., 1170 Esperanza, Los Angeles.

ANY radio circuit diagram 25c. Order mentioning manufacturer's name, model. Catalog free. Supreme Publications, 3727 West 13th. Chicago.

CRYSTALS IN HOLDERS: 40 X $1.60: 160-80M $1.25: C.O.D.'s Accepted. Pacific Laboratories, 344 Fetterly, Los Angeles.

HAVE 100 w. — 350 w. — 750 w. phone transmitters. Want to sell two. Also spare RF units, modulators. power supplies, microphones, etc. W9UFD. 3176 So. 13th. Omaha, Nebraska.

USED 20-watt modulator: Other transmitting radio parts. W6KUW, 934 N. Third St., San Jose, Cailf.

WANTED: January. 1936, RADIO. W1BQU, 22 Ames Street, West Warwick. R. I.

FOR Sale: Late model RME 69, $95.00. Patterson PR-10, $25.00. W6CUU.

QSL's—SWL's—RAINBO EFFECTS! Stamps! FRITZ—455 Mason—Joliet. Illinois.

W6KX prints QSL's. Keith LaBar, 1123 North Bronson, Hollywood, California

Advertising Index

Buyer's Guide

Where to Buy It

PARTS REQUIRED FOR BUILDING EQUIPMENT SHOWN IN THIS ISSUE

The parts listed are the components of the models built by the author or by "Radio's" Laboratory staff. Other parts of equal merit and equivalent electrical characteristics usually may be substituted without materially affecting the performance of the unit.

813 TRANSMITTER
Page 9

C_1, C_3, C_5, C_6, C_8, C_{10}, C_{11}, C_{12}, C_{13}—Aerovox 1467
C_2, C_7—Cornell-Dubilier DT-4S1
C_4, C_9—Bud 907
C_{14}—Aerovox 1457
C_{15}—Bud 1540
C_{16}—Aerovox 600
R_1, R_2, R_3—Ohmite Brown Devil
R_4—Centralab 516
R_5 to R_8, inclusive—Ohmite Brown Devil
R_9, R_{10}—Centralab 516
S_1—Centralab 2544 rebuilt (see text)
RFC, RFC_1—Bud 920
X_1, X_2—Bliley BC3

●

JONES PEAKED-WAVE FORM EXCITER
Page 13

C, C_1, C_2, C_6, C_7—Cornell-Dubilier type DT
C_{10}—Cornell-Dubilier type 4-12D6
C_{11}, C_{12}—Cornell-Dubilier type TQ
R_2, R_3, R_4, R_6—Ohmite "Brown Devil"
R_5—Ohmite vitreous enameled
RFC—Bud no. 920 r.f. choke
C_3—Bud no. 321 condenser
C_9—Bud no. 898 condenser
C_8—Bud no. 564 condenser
Tubes—RCA
Crystal—Bliley VF1

●

REED PORTABLE TRANSMITER
Page 17

C_1, C_2—Cardwell Trim-Air ZR-50-AS
C_3—Bud type 913
C_4—Bud type 828
C_5, C_6, C_7, C_8, C_{10}, C_{11}—Solar type MW
C_{12}—Solar type XM-6-45
C_{13}—Solar type DT-879
C_{14}, C_{15}, C_{16}, C_{17}—Solar "Sealdtite"
C_{18}, C_{19}—Solar type DT-875
C_{20}, C_{21}—Solar type D-800
R_{13}, R_{14}—Ohmite "Brown Devil"
Meter Switch—Centralab 2511
Coil forms—Bud type 595
T21 coils—Decker Series M
Microphone—Astatic D-2

BOYD REBUILT COLLINS TRANSMITTER
Page 30

C_6—Cardwell ZR-25-AS
C_{16}—Cardwell ET-15-ADI
C_{17}—Cardwell MO-180-BD
Mica condensers—Aerovox types 1467, 1450 and 1455
L_2 form—Bud 594

●

EVANS RHOMBIC ANTENNA
Page 38

Control Switch—Centralab 2546 or Yaxley 165-C
Relays—Guardian, Leach, or Gordon d.p.d.t. "send-receive" type

●

SOUTH 56-MC. TRANSMITTER
Page 46

C_1, C_5, C_9—Cornell-Dubilier type 1-W
C_2, C_3, C_6, C_7, C_{14}, C_{15}, C_{16}—Cornell-Dubilier type DT-4S1
C_4, C_8—Cardwell ZR-35-AS
C_{12}—Cardwell ZT-30-AS
C_{13}—Cardwell ER-35-AD
C_{10}—Cardwell NP-35-ND
T_1—Thordarson 19F97
T_2—Thordarson 19F94
Tubes—RCA
Isolantite pillar insulators—Bud
Carbon resistors—Centralab 514 and 516
Wire wound resistors—Ohmite "Brown Devil"
X—Bliley type B-5

●

2½-METER TRANSMITTER
Page 57

T_1—Thordarson type T-86A02
T_2—Thordarson T-17M59
T_3—Thordarson T-70R62
CH—Thordarson T-57C53
C_1—Cornell-Dubilier type EDJ2250
C_2, C_3—Cornell-Dubilier EH9808 (one)
R_1, R_2, R_3—Centralab 514
R_4, R_5—Centralab 516
Tubes—RCA

Taylor HEAVY CUSTOM BUILT DUTY Tubes

IT'S HERE!!!

NEW HEAVY DUTY SHIELDED 866

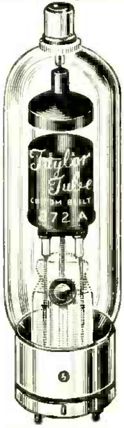
HALF WAVE MERCURY VAPOR *RECTIFIER*

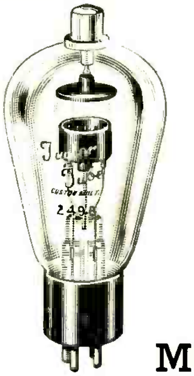
$1.50

Actual Size
New shielded 866

PEAK INVERSE 10,000 VOLTS MAX.

The new, fully shielded, Taylor 866, sets a new standard of rectifier tube performance by delivering all the characteristics of an 866-A in an 866. Here is tube value that will set the pace for 1939. We are again passing on to radio amateurs a price advantage, by calling this new rectifier an 866 instead of an 866-A. Every dollar we save you allows you to buy better gear, and keep your station up to the minute. Instead of selling this new tube for $2.50 and calling it an 866-A, we are selling it to you for $1.50—giving you the performance of an 866-A in an 866. Use this *new mercury vapor rectifier* in any power supply that calls for an 866 or 866-A. Ask your favorite parts distributor.





MERCURY VAPOR RECTIFIERS FOR EVERY PURPOSE

872-A. A heavy duty rectifier that has already scored a big hit in scores of large stations. Carbon anode and shield. Will handle 3,500 Volts D.C. at 2.5 amps. **$10.50**

249-B. Used widely in commercial transmitters. Carbon anode and shield. For power supplies up to 3,300 Volts D.C. at 1.25 amps....**$5.00**

866 Jr. Popular as well as efficient. Used in thousands of rigs. Half Wave delivers up to 250 MA at 1000 Volts D. C. **$1.00**

"More Watts Per Dollar"

TAYLOR TUBES, INC., 2341 WABANSIA AVE., CHICAGO, ILLINOIS

RCA Beam Power Tubes Give You

LOWER DRIVING POWER PER WATT OUTPUT

OUTSTANDING PERFORMANCE AT LOW COST!

Compare these RCA Transmitting Beam Power Amplifiers against all others for low driving power in relation to high output power. You'll find their power sensitivity cannot be matched. Offering you unusual versatility of application and high circuit efficiency, these RCA transmitting tubes are noted for their modern design, rugged construction, uniform characteristics, reliable performance, and long life.

RCA-813 . . . A real "r-f factory" . . . 260 watts output at 2000 volts with less than 1 watt of driving power . . . Makes high-power band-switching transmitters easy . . . Delivers 150 watts as a crystal oscillator for c.w. and 100 watts plate-modulated . . . No neutralization. *Amateur net* **$28.50**

RCA-807 . . . The multi-purpose tube . . . Your logical choice for crystal-oscillator, buffer, doubler, and low-power final amplifier stages . . . Two 807's in push-pull provide 75 watts output at 600 volts with less than ½ watt of driving power . . . No neutralization required up to 30 Mc. *Amateur net* **$3.50**

RCA-814 . . . Delivers 130 watts output at 1250 volts with only 1¼ watts driving power . . . A fine medium-power final amplifier or driver for a one-kilowatt stage . . . Simplifies exciter-unit design for band switching . . . Does away with neutralization problems. *Amateur net* **$17.50**

RCA presents Magic Key Sundays, 2 to 3 p.m., E.S.T., on NBC Blue Network • **For Full Details about these Tubes, Write to the Address Below**

RCA Radio Tubes

FIRST IN METAL
FOREMOST IN GLASS
FINEST IN PERFORMANCE

RCA Manufacturing Co., Inc., Camden, N. J. • A Service of the Radio Corporation of America