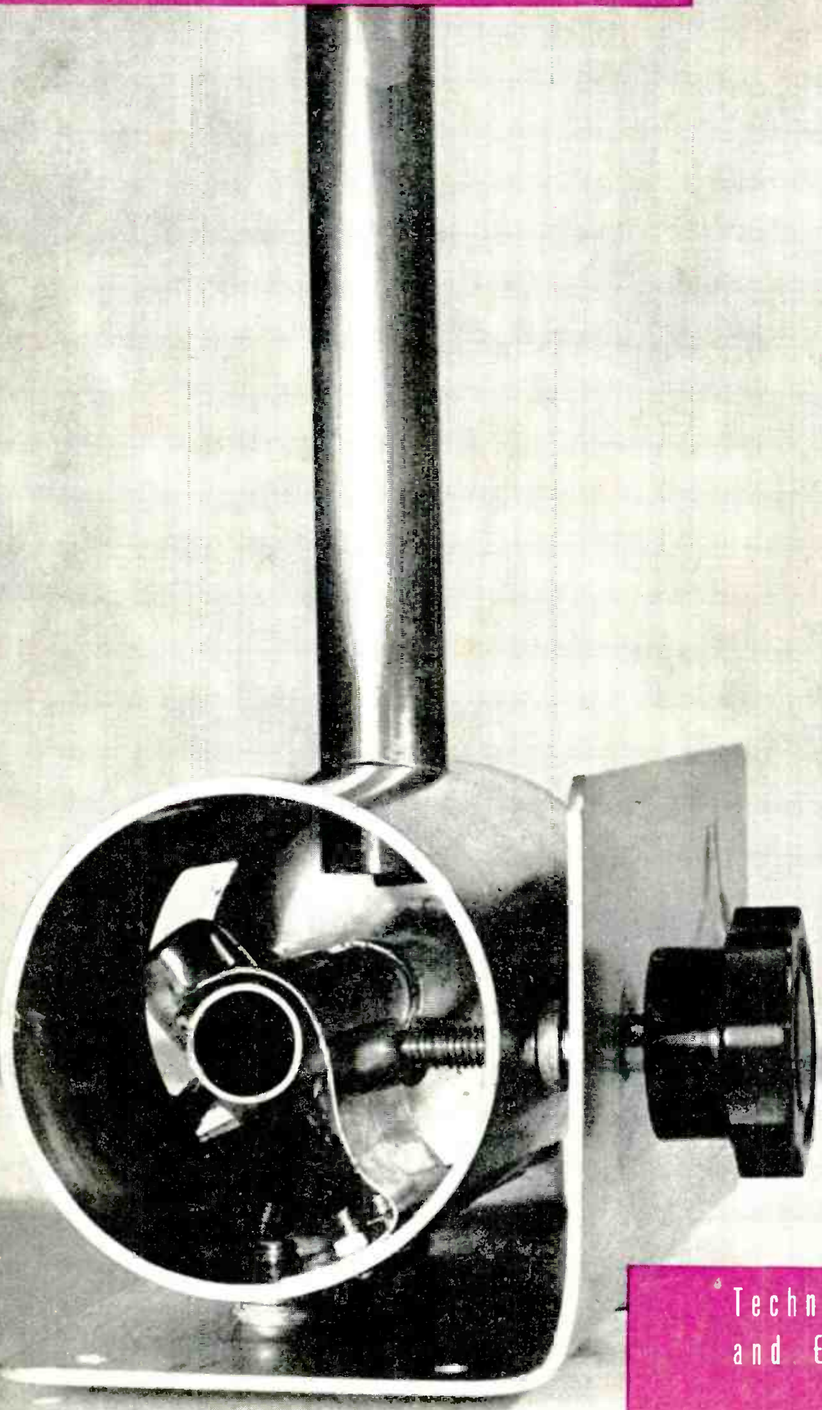
RADIO

ESTABLISHED 1917



Technical Radio and Electronics

★

March 1941

NUMBER 257

30c IN U.S.A.

- 400-MC. RECEIVER
- COMPRESSOR SPEECH AMPLIFIER
- NEW PORTABLE DIATHERMY
- MIDGET F-M CONVERTER

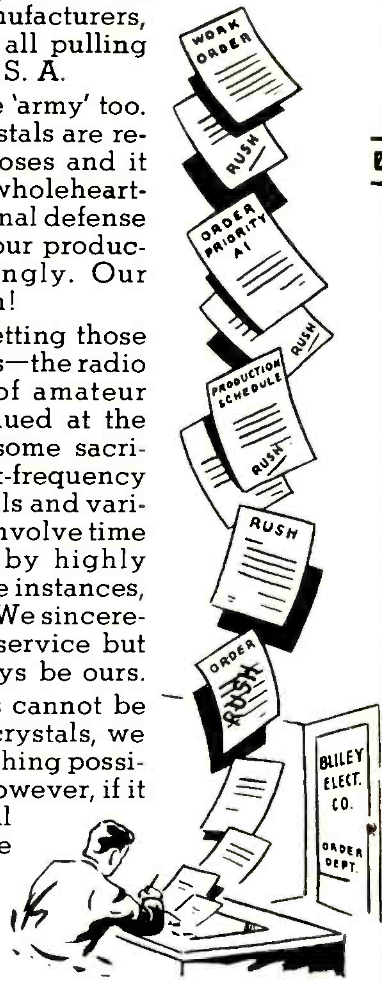
WE'RE IN THE ARMY NOW...

AND who isn't in the 'army' for national defense? Regulars, National Guardsmen, conscripts, manufacturers, taxpayers and amateurs are all pulling together for the good old U. S. A.

We, at BLILEY, are in the 'army' too. Great numbers of quartz crystals are required for military purposes and it is up to us to cooperate wholeheartedly. We're behind national defense 100% and are gearing our production facilities accordingly. Our present motto is: Dig in!

Yet, we are not forgetting those who have been loyal to us—the radio amateurs. Production of amateur crystals is being continued at the best possible rate but some sacrifices must be made. Spot-frequency crystals, ten-meter crystals and variable-frequency crystals involve time consuming operations by highly skilled craftsmen. In some instances, deliveries may be slow. We sincerely want to provide fast service but the choice will not always be ours.

If your requirements cannot be met by selecting stock crystals, we will, as always, do everything possible for you. Be patient, however, if it takes a little time. National defense comes first—there can be no alternative.



BLILEY ELECTRIC CO.

UNION STATION BUILDING ERIE, PA.

Announcement

The Editors of RADIO announce that the 1941 "RADIO" HANDBOOK has been put back on the presses for the second printing.

Because of unprecedented interest and approval among radio amateurs, short wave and electronics experimenters and radio technicians the first printing of this year's edition (calculated to be a year's supply) was completely sold out in three short months.

Copies of the second printing will be available in just a few days.

We will not print any additional copies of this edition after the second printing is exhausted. High unit cost of fine book paper, quality presswork and the cloth cover, coupled with a remarkably low selling price, make a further printing out of the question.

We wish to thank those who have approved the 1941 edition of "RADIO" HANDBOOK, and suggest to those who have not purchased their copies that they do so as soon as possible. Your nearby radio parts dealer will supply you, and if his stock is gone, ask him to order a copy for you. You may also order direct.

The Editors of RADIO.

RADIO

the worldwide authority . . .

Published by EDITORS and ENGINEERS, Ltd.

Home offices: 1300 Kenwood Road, Santa Barbara, California

Telephone: Santa Barbara 4242
Bell System teletype: S BAR 7390
Cables: EDITORSLTD SANTABARBARACALIF

March • 1941

The publishers assume no responsibility for statements made herein by contributors and correspondents, nor does publication indicate approval

No. 257

Table of Contents

Closeup view of the tuning-condenser end of Reed's 400-Mc. receiver as described in the article beginning on page 27.

ARTICLES

MISCELLANEOUS FEATURES

DEPARTMENTS

The Editors of "Radio"

Past • Present and • Prophetic

'Scuse, Please

Now that the clamor has died down to a roar, we can tell the subscribers who didn't write concerning the mysterious absence of wrappers from the February issue that it was all a mistake. The mistake—fortunately for us—was the printer's, but we're sorry it had to happen. This issue and all others will be carefully wrapped, as they have been in the past.

Diathermy Dig

The F.C.C. engineering conference on electro-medical equipment mentioned here in December seems to have resulted in little in the way of definite action. This was to be expected, however, since the conference involved only a preliminary "look see" at the situation, a situation which we are as willing as any to admit is deplorable if not worse. With one phase of the conference, as reported to us, we would like to take issue, however. This concerns the condemnation of the publishing of constructional articles on diathermy equipment. Since the shoe fits as though it were tailor-made for RADIO, we would like to counter with a few pertinent facts and caustic comments.

Every diathermy oscillator shown in this magazine has used a *full-wave rectified plate supply*, and all the later ones have incorporated some power-supply filter. These units consistently have been improvements over their commercial counterparts of the same date. Even now many commercial units use *a.c.* straight from the power transformer as plate supply. The fact that the new 8000 and 8003 triodes are rated for this type of "self rectified" oscillator service attests to the continued commercial use of such circuits. The "better" grade diathermy machines use rectifiers, but filtering is rare.

When you built a diathermy oscillator from constructional material presented in this magazine you not only should have made a small profit on the transaction, but you also provided the purchaser with a *better* unit than he could buy for an equivalent price. We can't quite see any logical basis for condemning

[*Continued on page 94*]

● The f.m. converter described in the article beginning on the opposite page.

AN 8-TUBE CONVERTER *for* F.M. RECEPTION

By ROBERT T. THOMPSON,* W9KNU

The 8-tube f.m. converter to be described in this article is the result of considerable experimentation with various frequency modulation receivers, both commercial and experimental. Of interest to the readers of RADIO is its good performance, simplicity of design, and strict adherence to low cost tubes and components. Its small size (the complete chassis measures only 6″ x 5.5″ x 9.5″) recommends it as a unit to be installed in console a.m. receivers where space is limited. This compactness has been secured at no practical sacrifice in performance or appearance, and the arrangement of parts permits a clean wiring job, as illustrated by the photograph in figure 1, showing the under side of the chassis. The converter is a.c.-d.c. and hence may be used in any of the metropolitan areas where f.m. is most prevalent. The frequency range is from 41.2 to 50.4 Mc. All coils, as well as the special three-gang tuning condenser, are commercially available, although a complete kit of parts is not being offered.

Tube Component

The tube component is as follows:

1—12SK7 R.F. Amplifier
1—12SA7 Mixer
1—12SK7 1st I.F. Amplifier
1—12SK7 2nd I.F. Amplifier
1—12SJ7 Limiter
1—7A6 2nd Detector
1—35Z5GT Rectifier
1—6AB5 Tuning Eye

*402 Poplar St., Mt. Carmel, Ill.

The 150-ma. heaters make it necessary to use one loctal tube, the 7A6. The use of the 150-ma. series of tubes is justified because of the lesser power consumption and corresponding smaller heat dissipation. The constructor can, of course, use the corresponding 0.3 ampere heater tubes by the addition of a ballast tube or other line resistor, provided sufficient ventilation is assured. The circuit diagram, figure 2, clearly shows the relative proximity to ground of the heaters of the various tubes. This sequence should be followed. The small choke inserted between the 7A6 and the 12SK7 consists of eight or ten turns of heater hookup wire and saves a mica by-pass condenser otherwise necessary for hum-modulation reduction.

Antenna, R.F. and Oscillator Circuits

Doublet antenna connections to the converter are made to the outside terminals of the three-terminal strip shown in figure 2. The center terminal is to be connected to a good ground. The antenna coil primary is connected to the doublet terminals through 500 $\mu\mu$fd. coupling condensers. The coil form is grooved for the secondary turns which are closely coupled to the primary and tuned by the front section of the gang condenser. The 12SK7 r.f. amplifier has its cathode grounded, and a.v.c. voltage is applied to this tube.

Trimmers for each tuned circuit are ceramic insulated and are mounted directly on the gang condenser, the center section of which tunes the oscillator coil. All r.f. coils have their low potential end closest to the chassis.

The r.f. and oscillator coils each have but a single winding. In the case of the r.f. coil, the inductance is coupled to the gang condenser and mixer grid by a pair of .004-μfd. mica condensers. Both the screen and plate return of the 12SK7 r.f. tube are provided with a de-coupling condenser and resistor. The oscillator coil is similar in construction to the r.f. coil except that it has a cathode tap one turn up from the low potential end. Leads from the oscillator coil are short and direct, the ground being soldered directly to the socket saddle.

I.F. Amplifier

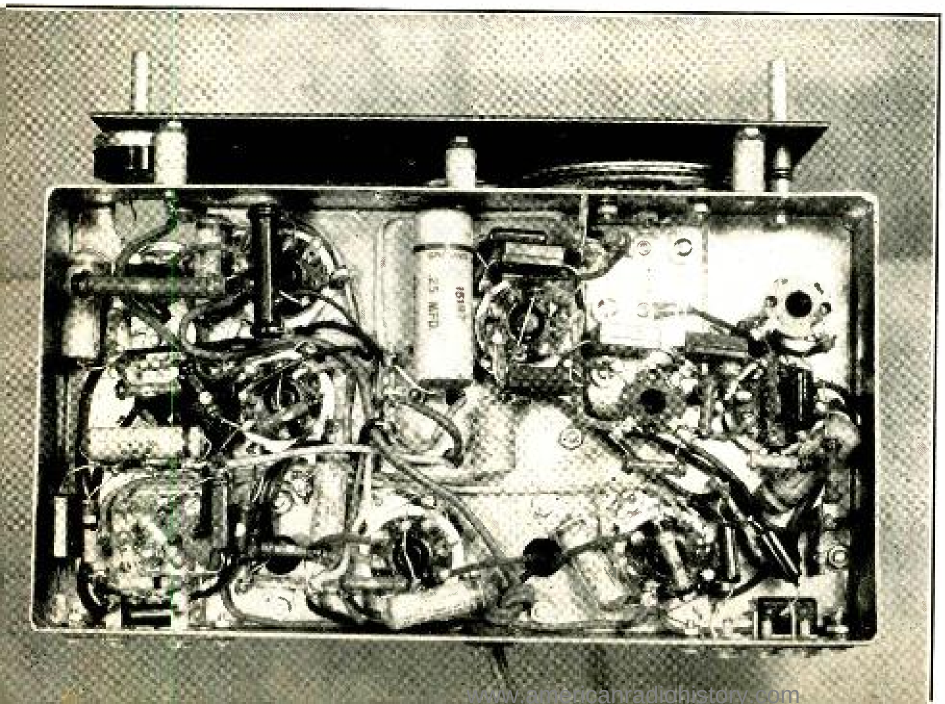
An intermediate frequency of 4.3 Mc. was selected for this converter after testing experimental models using i.f.'s ranging from 2.1 Mc. to 8.6 Mc. In their final form the i.f. transformer windings have a Q in air of about 50 at 4.3 Mc., and are tuned by about 15 μμfd. This gives an overall i.f. response characteristics shown by the curve in figure 3. The band width is seen to be 100 kc. at 70% response. Sensitivity and adjacent channel selectivity compare favorably with four other f.m. converters and receivers of commercial manufacture.

Values of components used in the diagram of figure 2.

C_1, C_2, C_3—Special 3-gang variable
C_4, C_5—.0005-μfd. mica
C_6—.001-μfd. mica
C_7, C_8—.004-μfd. mica
C_9—.00005-μfd. mica
C_{10}—.05-μfd. 200-volt tubular
C_{11}, C_{12}—.01-μfd. 400-volt tubular
C_{13}—.0001-μfd. mica
C_{14}—.01-μfd. 400-volt tubular
C_{15}—.05-μfd. 200-volt tubular
C_{16}—.001-μfd. mica
C_{17}—.0001-μfd. mica
C_{18}—.001-μfd. mica
C_{19}—.01-μfd. 400-volt tubular
C_{20}, C_{21}—30-μfd. 150-volt electrolytic
C_{22}, C_{23}—.0001-μfd. mica
C_{24}—.001-μfd. mica
C_{25}—.02-μfd. 400-volt tubular
C_{26}—3-μfd. 150-volt paper
R_1, R_2—1500 ohms, 1/4 watt
R_3—250,000 ohms, 1/4 watt
R_4—25,000 ohms, 1/4 watt
R_5—1500 ohms, 1/4 watt
R_6—150 ohms, 1/4 watt
R_7—1500 ohms, 1/4 watt
R_8—50,000 ohms, 1/4 watt
R_9—500,000 ohms, 1/4 watt
R_{10}—10,000 ohms, 1/4 watt
R_{11}—50,000 ohms, 1/4 watt
R_{12}—15,000 ohms, 1/4 watt
R_{13}, R_{14}—100,000 ohms, 1/4 watt
R_{15}—50 ohms, 1 watt
R_{16}—250,000 ohms, 1/4 watt
R_{17}—1000 ohms, 1 watt
R_{18}, R_{19}—100,000 ohms, 1/4 watt
R_{20}—50,000 ohms, 1/4 watt
L_1, L_2, L_3—R.f., mixer, and osc. coils, see text
IFT_1, IFT_2, IFT_3—4.3-Mc. i.f. transformers
IFT_4—Discriminator transformer
RFC_1—10 turns of hook-up wire close wound, 1/2" dia.
RFC_2—Included in IFT_4, see coil table
S_1—S.p.s.t., rotary type
P—117-v. pilot light

This particular i.f. amplifier, in addition to being commercially acceptable from the standpoint of selectivity and fidelity, has the further advantage of not requiring loading resistors across the tuned circuits, can be aligned with an unmodulated i.f. signal, and needs no separate screen and plate filters. In the event that i.f. coils of higher Q are substituted, additional by-passing and de-coupling will be found necessary. The only difference between the three

Figure 1. Underchassis view of the f.m. converter



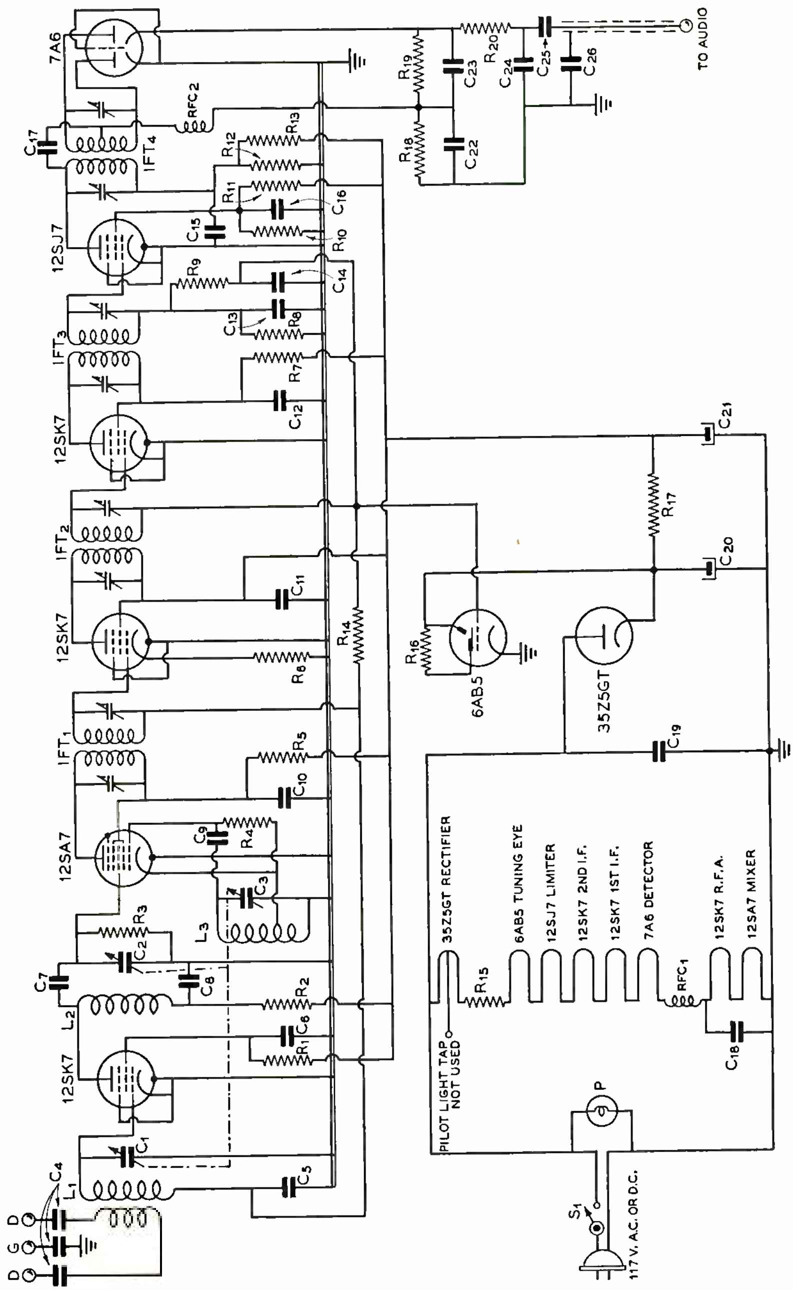


Figure 2. Wiring diagram of the 8-tube a.c.-d.c. f.m. receiver

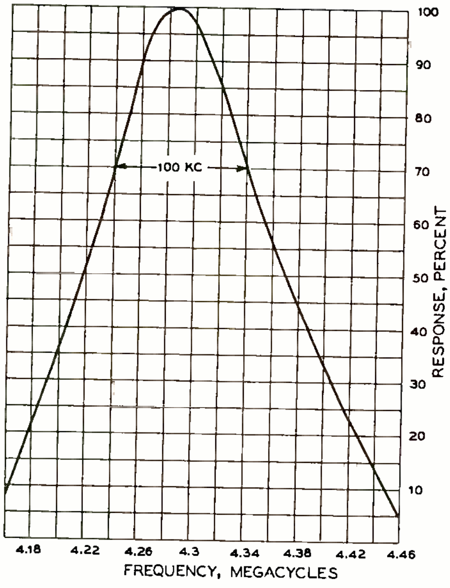


Figure 3. I.f. response characteristic of the FM converter. Output held constant at 20 microamperes in the limiter grid leak.

i.f. transformers is the variation in lead lengths.

Limiter

The limiter utilizes a 12SJ7 at reduced plate and screen potential, the limiting action becoming effective with a signal input of about 100 microvolts. The 12SJ7 also provides a.v.c.

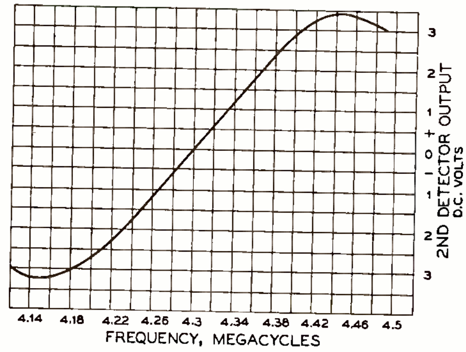


Figure 4. Second detector (discriminator) characteristics of the FM converter. The curve was taken with 2 volts input to the limiter grid.

voltage across the 50,000-ohm load resistor. This voltage is applied at the control grid of the tuning eye as well as to all preceding tubes with the exception of the 12SA7 mixer. Application of a.v.c. to the r.f. tube is of importance in reduction of spurious response in areas of unusually high signal strength. It might be noted here that the grid return of the first i.f. amplifier is by-passed to ground by the 500 $\mu\mu$fd. by-pass of the antenna coil secondary.

Discriminator

The discriminator coil and circuit is conventional except that the r.f. choke is wound on the same dowel which carries the primary and center-tapped secondary. The discriminator characteristic is shown in figure 4. The

FIGURE 5. COIL TABLE

Coil	Coil form dia.	Turns	Wire	Winding pitch	Tap	L	Spacing
I.f. pri.	3/8"	58	36 d. cel. bare	Univ. 1/8" wide		47	15/32" between adj. faces
I.f. sec.	3/8"	58	36 d. cel. bare	Univ. 1/8" wide		47	
Disc. pri.	3/8"	44	36 d. cel. bare	Univ. 1/8" wide		26	9/32" between adj. faces
Disc. sec.	3/8"	56	36 d. cel. bare	Univ. 1/8" wide	31	43.9	
Disc. choke	3/8"	450	37 s.s.e.	Univ. 3/16" wide		2500	
Ant. sec.	.412" (over wire)	5-3/4	26 d. cel. bare	20 turns per inch			
Ant. pri.	At low potential end of sec.	2	30 d.s.e.	Close			
R.F.	.412" (over wire)	4-3/4	26 d. cel. bare	20 turns per inch			
Oscillator	.412" (over wire)	8	26 d. cel. bare	20 turns per inch	1-1/4 turns from ground		

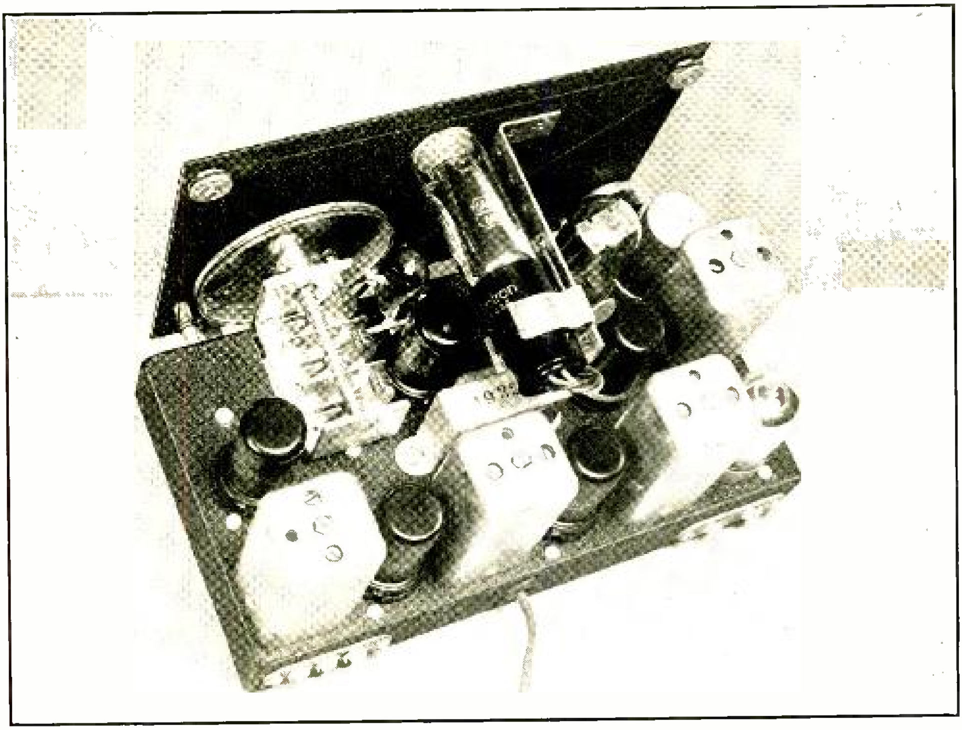


Figure 6. Rear three-quarter view of the chassis of the converter.

straight line portion covers approximately 220 kc., which provides ample tolerance for oscillator drift and mistuning.

Coil Data

Complete coil information may be found in the table, figure 5. It is expected that few constructors will have access to winding machines for winding universal coils, nevertheless essential coil data for these units is included. The antenna, r.f. and oscillator coils, being solenoids, are easy to construct, but any or all of these coils may be found in the Buyer's Guide on page 96.

Audio Output

Since the converter is a.c.-d.c. its chassis must not be directly connected to the radio receiver chassis whether the latter is a.c. or d.c. Hence, the business of getting the converter output to the receiver's audio system becomes a rather vexing problem. If both chassis are to be used on d.c. everything is lovely, but when either or both are used on a.c. the hum is liable to be annoying (to put it mildly) unless certain precautions are observed. Since the constructor may have a preference, two coupling methods will be mentioned.

One method is to use a good audio transformer between the de-emphasis circuit and the converter output terminals. The photograph in figure 6 shows such a transformer mounted on the chassis, and the circuit used when the transformer is employed is shown in figure 7. Since all of the hum cannot usually be removed by the use of the transformer alone, a coupling condenser of about .25 μfd. will probably be needed, connected as shown.

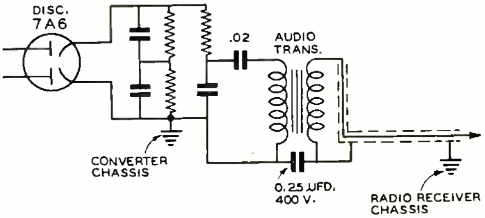
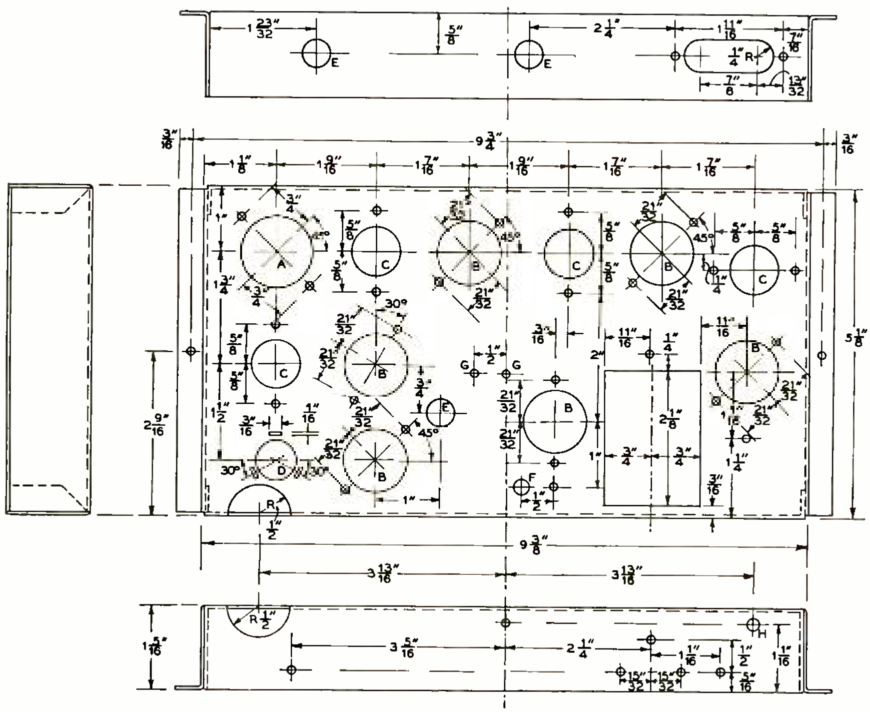


Figure 7. An optional method for coupling the audio output of the converter into the audio power amplifier.

FIGURE 8. CHASSIS LAYOUT DIAGRAM FOR THE FM CONVERTER.



HOLE MARKED	DIAMETER
A	1 1/8"
B	1"
C	3/4"
D	5/8"
E	7/16"
F	1/4"
UNMARKED	#27 (.144)
G	#32 (.116)
H	.187

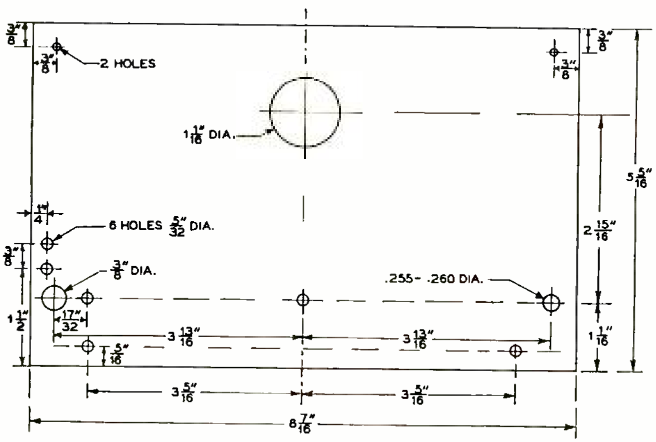
MATERIAL

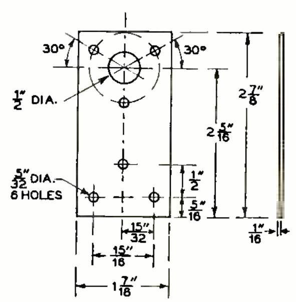
#21 GA. (.0329) AUTO BODY STEEL

FINISH

CADMIUM PLATE THEN BRUSH & COAT WITH CLEAR LACQUER ON OUTSIDE ONLY

FIGURE 9. LAYOUT DIAGRAMS FOR THE FRONT PANEL AND THE TUNING CONDENSER MOUNTING BRACKET.





VARIABLE CONDENSER MOUNTING PLATE

NOTE: TOP EDGE TO BE FREE OF BURRS AND SMOOTH SO THAT POINTER WILL RUN FREELY.

MATERIAL: #16 GA. (.0625) STEEL FINISH; TO BE CADMIUM PLATED

DIAL PLATF

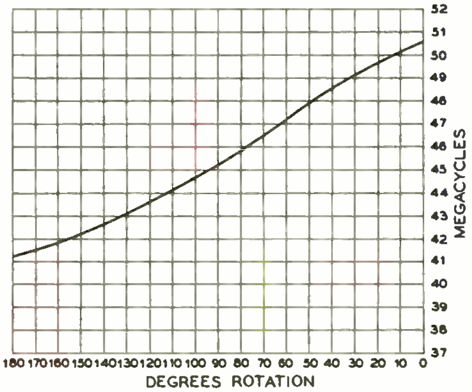


Figure 10. Frequency vs. dial reading calibration curve for the converter.

SOCKET VOLTAGE CHART
TESTS MADE WITH 1000-OHMS-PER-VOLT METER WITH NO SIGNAL INPUT

TUBE	DESCRIPTION	SOCKET CONTACT NUMBER							
		1	2	3	4	5	6	7	8
12SA7	MIXER	0	0	7.5	75	0	0	12.6 A.C.	0
12SK7	R.F. AMPLIFIER	0	25.2 A.C.	0	0	0	80	12.6 A.C.	70
7A6	DETECTOR	31.5 A.C.	0	0	0	0	0	0	25.2 A.C.
12SK7	1ST I.F	0	31.5 A.C.	0	0	1	85	44.1 A.C.	85
12SK7	2ND I.F.	0	44.1 A.C.	0	0	0	70	56.7 A.C.	70
12SJ7	LIMITER	0	56.7 A.C.	0	D	0	12	69.3 A.C.	2
6AB5	TUNING EYE								
35Z5-GT	RECTIFIER	0	81.9 A.C.	88 A.C.	—	117 A.C.	75.6 A.C.	117 A.C.	135

Figure 12.

The simplest coupling method, however, is shown in the circuit diagram, figure 1, where a 2 or 3 μfd. condenser connects the two chassis. In many instances a 1-μfd. 400-volt paper condenser will be sufficient and can occupy little more space than that occupied by the .25 μfd. condenser shown in the chassis wiring. A condenser larger than 1 μfd. will have to be mounted on the chassis. For instance, a 3-μfd. 117-volt a.c. condenser may be mounted directly below the tuning eye. The dimensions of such a unit are about 1¾ x 1¼ x 2¾ inches. Neither the transformer nor the condenser are needed, of course, if both units are used on d.c.

Power Supply

The converter's power supply consists of a single 35Z5-GT half wave rectifier, a 1000-ohm 1-watt resistor, and a dual 30-μfd. 150-volt electrolytic. Target voltage for the tuning eye is taken from the rectifier side of the filter. If the constructor prefers an a.c. operated converter a slightly larger chassis will be needed, but the cost of materials will be only a little more since the large coupling condenser can be omitted.

Mechanical Details

The location of the chassis holes is shown by the drawing in figure 8. The dial plate is shown in figure 9. A piece of felt should be placed between the glass dial scale and the dial plate, these three parts being held in place by soldered tin tabs. Dimensions for the condenser mounting plate are also shown in figure 9. The dial is edge illuminated by a 110-volt candelabra lamp and the dial pointer travel is 4-27/32 inches with the pulley used. The constructor may desire a longer or shorter dial scale and this may be changed, of course, by using a larger or smaller dial drive pulley. The calibration for any desired dial may be plotted from the calibration curve of figure 10. The appearance of a slide rule dial is shown in the illustration on page 8.

Modifications

Instead of the 6AB5 tuning eye which has a 6.3-volt heater, there can be substituted a new tube, the 1629, which has a 12.6-volt heater and the 50-ohm series resistor may be omitted. However, this resistor gives a measure of protection when the converter is turned on. The decision on this choice depends on the line voltage encountered.

Aligning the Converter

Alignment of the converter may be started at the discriminator by applying a 4.3-Mc. signal of 1 volt to the 12SJ7 limiter grid. The indicator may be a high impedance voltmeter connected from ground to the number 7 pin of the 7A6 detector, or a 0-100 microammeter in series with 300,000 ohms connected in the same way. The sensitivity of the 12SJ7 may be temporarily increased by shunting the plate series resistor as well as the screen series resistor with a 2000-ohm resistor. With either polarity of indicator connection a frequency departure in one or the other direction from 4.3 Mc. will give a meter reading in the positive direction. The generator may thus be set to a frequency 100 kc. away from 4.3 Mc. (in the direction which gives the positive meter reading) and the primary coil aligned for max-

[*Continued on Page 72*]

A Highly Effective

COMPRESSION AMPLIFIER

for Communications Work

By W. W. SMITH,* W6BCX

By designing a compression amplifier to have not only a fast "take hold" but also a rapid "let go," a weak voice syllable which immediately follows a loud one does not suffer from compression along with the loud syllable.

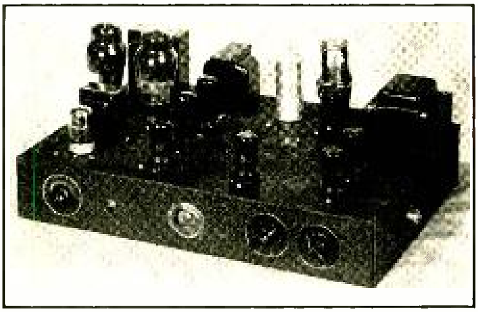
The volume range or "spread" of speech syllables during monotone conversation is from 25 to 30 db. In actual conversation, where no attempt is made to hold the voice at an even intensity, the inflectional accentuations injected for purposes of expression will increase this range somewhat. If the speaker starts throwing his personality around, the syllabic intensity range may exceed 40 db. Moving the position of the head with respect to a microphone will add to the intensity variation as present in the audio channel, especially when the speaker is talking close to the microphone.

In communications work, where it is desired to keep the modulation percentage high at all times, the operator can hold the intensity spread at the output of the microphone to approximately 30 db by talking at an even level, obtaining expression by inflections in pitch only, rather than by inflections in both pitch and volume. This assumes, of course, that the operator maintains a given distance and orientation of his head with respect to the microphone.

Thus, even if the operator deliberately minimizes the intensity spread by careful operating, the weaker consonant *sounds* (not letters), such as *t, k, f, j, etc.,* will be 20 to 30 db weaker than the loudest vowel sounds. If the received signal is weak, or substantial background noise is present, these weaker vowel sounds may be below the threshold of hearing or masked by the background noise. Such masking or omission of the weaker syllables and of the "attack and decay" portions of certain loud syllables results in appreciable impairment of intelligibility.

It is obvious that if the strength of the weaker sounds is raised, so that the intensity spread between the loudest and weakest voice sounds is reduced, the weaker sounds can be made to contribute to the intelligibility where before they were masked or below the

*RADIO



This 15 watt audio amplifier utilizes peak compression to give an equivalent power gain through QRM and QRN. When receiving conditions are good, no compression is used, and the amplifier works as any good a.f. amplifier except that the bass response deliberately has been attenuated to permit maximum intelligibility for a given peak power.

threshold of hearing, assuming no increase in the limiting value of instantaneous peak power.

The Bell Telephone Laboratories accomplish such compression of the volume spread in their "Compandor" system, introduced in 1934. This system utilizes a compression amplifier at the transmitting end, having linear compression at a 22½ degree slope, to squeeze a 30 db volume range into a 15 db volume range. At the receiving end an expander, called an *Expandor,* is used to restore the original characteric of the syllabic variations. However, the *expandor* is used simply to make Uncle Harry sound like Uncle Harry to Aunt Harriet. The *expandor* restores naturalness, but adds virtually nothing to the intelligibility. The equivalent power gain is realized in the compression, and while speech so compressed sounds slightly unnatural when not subjected to complementary expansion, it does not sound objectionable. An equivalent power gain of 5 db, or nearly four times in power, is claimed for such compression.[1]

The Compandor utilizes a fast time constant in the compression circuit. This is important, for reasons which will be apparent later. The most rapid syllabic variations, ignoring the steep wave front of explosive sounds, has been found to correspond to a frequency of about 30 c.p.s. for most persons. The compressor in the Compandor is designed to have a "take hold" and "let go" that will accommodate these rapid changes, yet not be actuated by the lower (fundamental) voice frequencies.

Curve B in figure 1 illustrates the normal input-output intensity relationships of a conventional amplifier. The absolute values of db units of course are purely arbitrary; the gain of the stage is not taken into consideration in assigning db units to the ordinate and abscissa. We see that if the input is increased 10 db, the output is increased 10 db, regardless of the starting point on curve B. The input-output relationship is linear, and has a "45 degree slope."

The variable losser employed in the compressor of the Bell Laboratories Compandor alters the slope of the curve to that of D, giving it a 22½ degree slope. Thus we see that the db spread is cut in half. A sound 20 db below peak level is only 10 db below peak level after leaving the compressor. The restoring characteristic of the expandor portion of a compandor circuit is represented by curve A, being the complement of curve D. The

[1] "The Compandor—An Aid Against Static in Radiotelephony," by R. C. Mathes and S. B. Wright, *Bell System Technical Journal,* July, 1934.

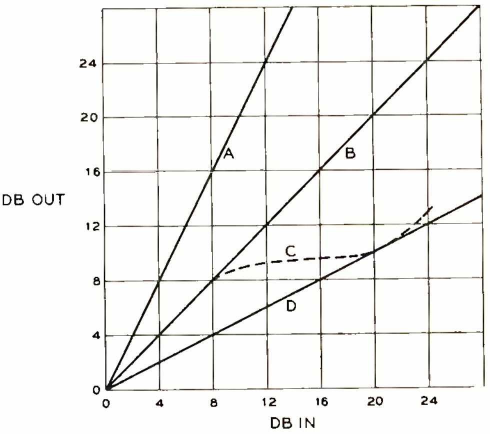


Figure 1.
Illustrating various input-output level amplifier characteristics. Curve B is that of a normal amplifier. Curve C is that of the compression amplifier of figure 2.

overall characteristic of the Compandor is that of curve B, or a normal amplifier.

In broadcasting, the volume range of music, etc. is compressed manually by monitoring operators who "ride the gain" to keep the percentage modulation from falling down into the background noise on weak passages or overloading the transmitter on loud passages. However, it is impossible for the monitoring operator always to anticipate a sudden loud passage or noise unless the program has been carefully rehearsed. This means that even when the program is monitored for gain, the average level cannot be particularly high on programs embracing a large intensity range as picked up by the microphone.

To permit a higher average gain setting by the monitoring operator without danger of overmodulation, the Western Electric Co. in 1937 brought out a program amplifier having a linear input-output level characteristic up to a certain level, but a greatly compressed characteristic above this level. The curve for this amplifier resembles that of curve C except that the horizontal (flattened) portion of the curve embraces a greater range. The normal time constant of the compression circuit of this amplifier is 1/50 second for the "take hold" and ¼ second for the "let go."

The newer versions of this prototype currently offered by several manufacturers have, in general, a faster "take hold" and slower "let go." It has been found that the average program level can be increased approximately

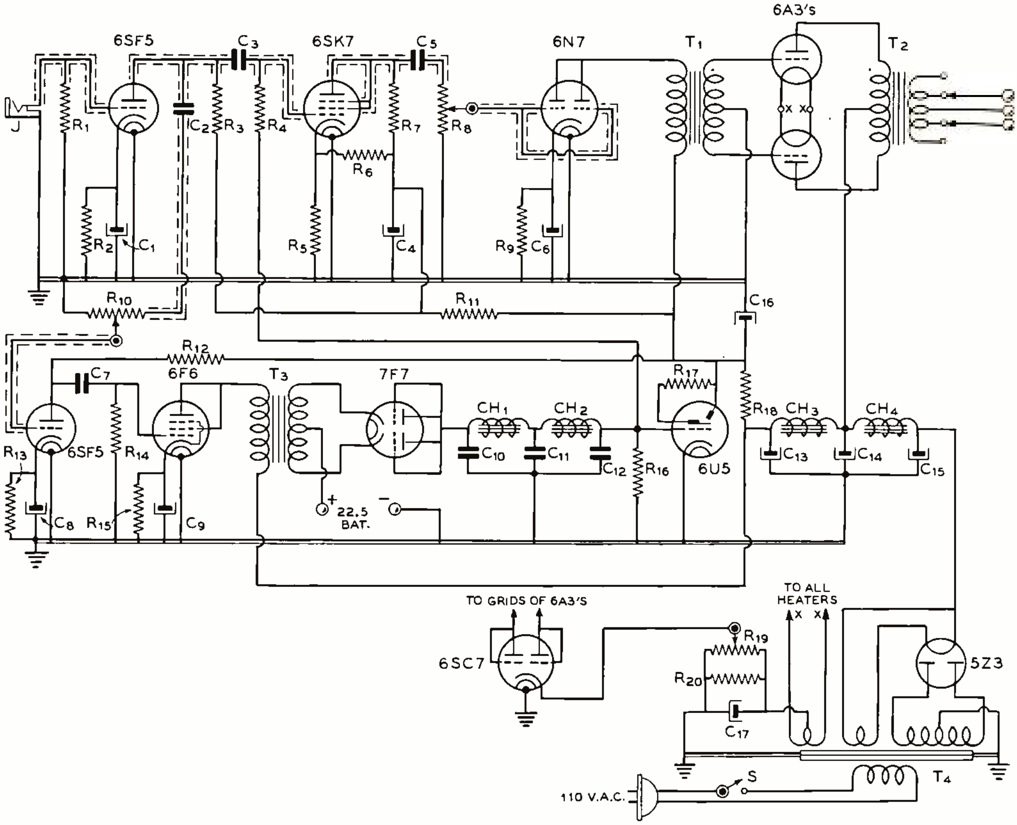
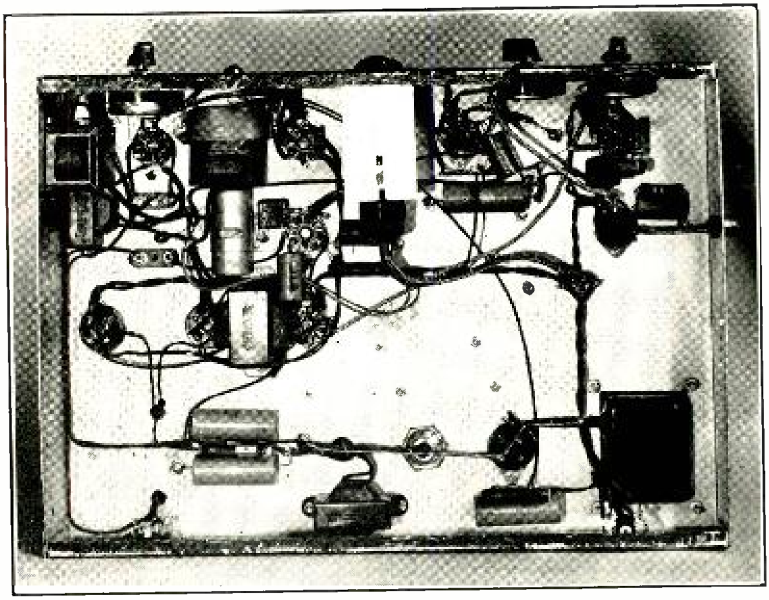


Figure 2.
Schematic Diagram of 15 Watt Compression Amplifier, Suitable Either for Grid Modulation or Driving a Class B Modulator.

R_1—500,000 ohms, 1/2 watt
R_2—1500 ohms, 1/2 watt
R_3—100,000 ohms, 1/2 watt
R_4—1 meg., 1/2 watt
R_5—1,000 ohms, 1/2 watt
R_6—100,000 ohms, 1 watt
R_7—100,000 ohms, 1/2 watt
R_8—500,000 ohm pot., a.f. taper
R_9—1000 ohms, 1/2 watt
R_{10}—500,000 ohm pot., a.f taper
R_{11}—5000 ohms, 1/2 watt
R_{12}—250,000 ohms, 1/2 watt
R_{13}—3500 ohms, 1/2 watt
R_{14}—500,000 ohms, 1/2 watt
R_{15}—750 ohms, 10 watts
R_{16}—3000 ohms, 1/2 watt
R_{17}—1 meg. (part of eye assembly)
R_{18}—3000 ohms, 1 1/2 or 2 watts
R_{19}—3000 ohm wire wound pot.
R_{20}—1000 ohms, 10 watts
C_1—25 µfd. 25 v. electrolytic
C_2—.003 µfd. mica
C_3—.002 µfd. mica
C_4—8 µfd. 450 v. electrolytic
C_5—.005 µfd. mica
C_6—10 µfd. 25 v. electrolytic
C_7—.003 µfd. mica
C_8—10 µfd. 25 v. electrolytic
C_9—10 µfd. 50 v. electrolytic
C_{10}—1 µfd. 200 v. paper
C_{11}—2 µfd. 200 v. paper
C_{12}—1 µfd. 200 v. paper
C_{13}—8 µfd. midget 450 v. electrolytic
C_{14}, C_{15}—Dual 8 µfd. can type electrolytic, 450 w.v.
C_{16}—8 µfd. midget 450 v. electrolytic
C_{17}—8 µfd. 250 v. electrolytic
T_1—1 to 3 (tot. pri. to tot. sec.) ratio p.p. input
T_2—Variable ratio class B input transformer, 15 watt. Should be chosen for particular class B tubes used.
T_3—Driver transformer, 2-1 step down (pri. to 1/2 sec.)
T_4—Power trans., 700 v. c.t. at 120 ma., 5 v. at 4 a., and 6.3 v. at 4.7 a.
CH_1, CH_2—40 ma. 530 ohm filter chokes, 21 hy. at no d.c.
CH_3—10 hy. at 40 ma.
CH_4—12 hy. at 150 ma.

3 db when this type of peak limiting amplifier is employed, without the compression of peak levels being objectionable or even obvious to anyone but the most critical listener.

It should be noted that this type of peak compression does not give an appreciable "equivalent power gain" on *carefully delivered* speech. If the threshold adjustment on the compressor is adjusted so that the loudest syllables receive a worth-while amount of com-



Under chassis view of the 15 watt compression amplifier. Observe that the small chokes CH_1 and CH_2 are mounted as far as possible from the power transformer.

pression, a weak syllable immediately following a loud one will be compressed too, because of the comparatively slow "let go."

For communications work an amplifier having peak compression with both a fast "take hold" and rapid "let go" is desirable if maximum equivalent power gain is to be realized. Such an amplifier is shown schematically in the accompanying diagram. The time constant of the compressor is approximately 1/40 second with a two section compression filter having a cut-off frequency of approximately 50 cycles. Four-fifths of this lag is caused by the 360 degree phase shift through the two section filter (at cut off).

While the ideal characteristic for voice work would be an almost instantaneous "take hold," and a "let go" of perhaps 1/100 second, such a characteristic is difficult to obtain with inexpensive equipment. If an attempt is made to obtain such a characteristic with a skimpy R/C circuit in a peak voltmeter arrangement, the control voltage will contain other than syllabic components, and will cause bad distortion of the voice frequencies when compression is taking place.

With the 1/40 second lag in the amplifier to be described, the initial sharp wave front of loud explosive syllables will cause overmodulation, but for only a short interval. Even so, it is undesirable and is avoided by the incorporation of a peak limiter, the operation of which will be discussed later.

Phase Considerations

Vowel sounds consist of a fundamental frequency (125 to 175 cycles for a typical male voice) and a multitude of harmonics. As the wave form of such a sound depends not only upon the relative amplitude of the various harmonics but upon the phase relationships as well, and as over modulation is a function of peak rather than r.m.s. voltage, it can be seen that phase relationships are of major importance when considering peak modulation percentage.

For instance, if a tone with a strong third harmonic component is fed into a transmitter, the modulation percentage can be varied by as much as two to one simply by shifting the phase of the harmonic, the amplitude of the fundamental and the amplitude of the harmonic remaining constant. In speech the ratio of peak to r.m.s. is generally taken as twice that of a sine wave, but this is simply an empirical rule. Actually the ratio varies considerably with different sounds and different phasing.

From this it follows that the compression rectifier should, under ideal conditions, be fed

[*Continued on Page* 77]

A MODERNIZED DIATHERMY

By ROY H. RAGUSE,* W6FKZ, and BRUCE DENNEY**

It has been several years since Radio has issued an article on the construction of radiotherapy equipment. During that time we have received a large number of requests for a more modern unit than those described in back issues of Radio and the Radio Handbook. This article should answer those requests and satisfy many other persons with the inexpensive, easily constructed, and well designed diathermy described herein.

Since the acceptance of diathermy machines for usage by the general public, many an amateur has taken advantage of the situation and made a few nickels by building these machines for friends.

These self excited oscillators for diathermy or radiotherapy use divide themselves into two broad classes: (1) those using a.c. as a high voltage source, and (2) those using d.c. as plate supply.

There are two good reasons for using d.c. as the plate supply voltage. One of them is of interest to the amateur, and the other is of prime interest, medically, to the person using the diathermy for treatment. Let's take the first reason, which is of interest to the amateur, and the general public as a short wave b.c. listener.

*3518 So. Sycamore Avenue, Los Angeles, Calif.
**2641 So. Greenfield Avenue, West Los Angeles, Calif.

Interference Checks

On an amateur receiver designed for 2½, 5, and 10 meter operation, and located about 300 feet from the diathermy machine, the following checks were made, using the unit described in this article:

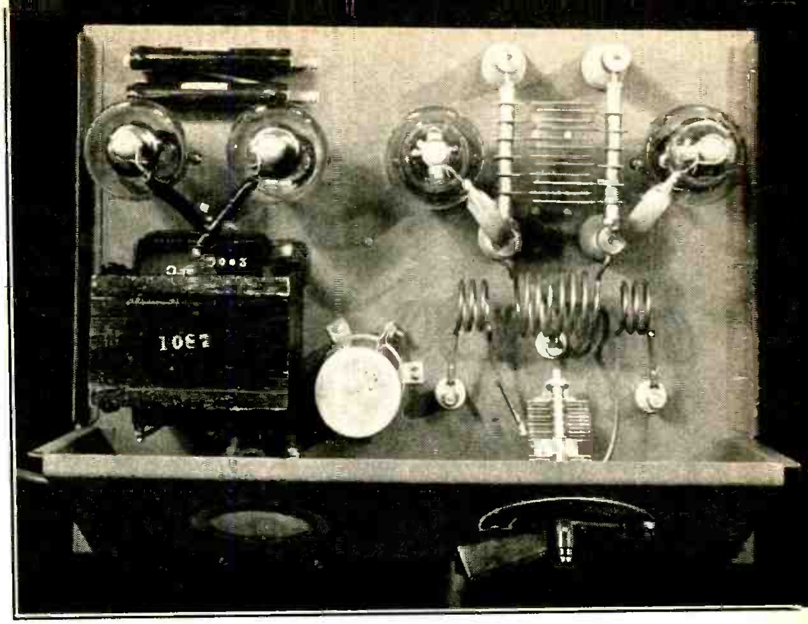
(1) With the pad leads disconnected and the top cover removed, the R meter on the receiver hit the pin on 25 Mc., the operating frequency.

(2) Pad leads disconnected, top cover in place, the 25-Mc. signal could be heard but wouldn't budge the R meter.

(3) Pad leads connected and applied to a patient, with top cover on (normal oper-

The case for the diathermy unit has handles mounted on the side to make for easy portability. Along the front drop of the chasis are the following: overload relay reset, fuse container, filament switch, green (filament) light, plate power switch, red (plate) light, and the two output jacks for the pads.

Top view of the chassis of the unit with the cover to the case removed. Since this photograph is taken dead-on, it gives an excellent idea of the top-chassis layout of components.



ation), the 25-Mc. signal was R5. The second harmonic on 50 Mc. was inaudible with the 3000-ohm bias resistor. With a 5000-ohm bias resistor, 25 Mc. was R5, the second harmonic on 50 Mc. was R3, and the third on 75 Mc. was R2. Under these conditions the effect on the patient was a decrease in the amount of heat produced, and a tingling sensation very similar to that produced when your leg starts to regain circulation after it has been "asleep," as the saying goes. This was interpreted as being the result of applying the ultra high frequencies. So the bias resistor was adjusted for minimum harmonic content.

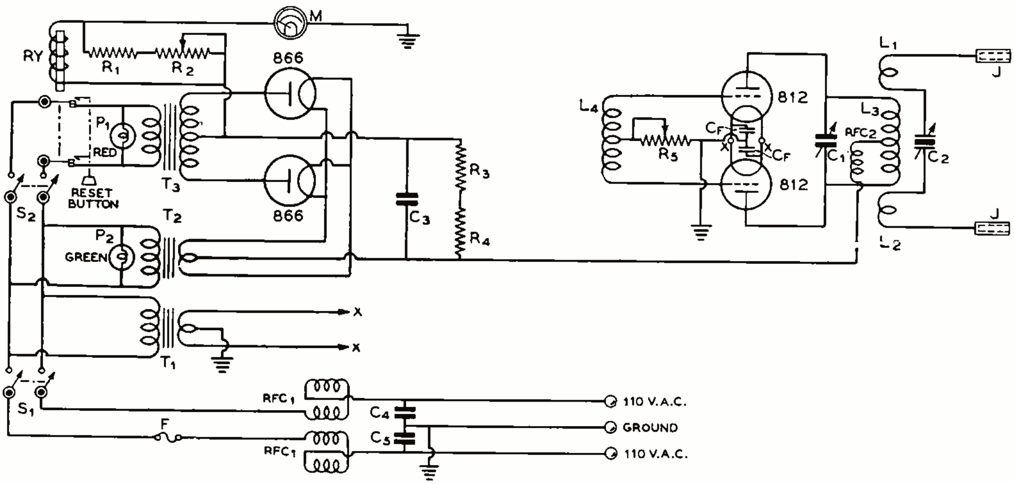
(4) The signal, under all conditions, from no load to full 250 watts input was at all times about T7 and very sharp with no tendency toward splatter. The measured ripple content was 70 volts or 7%. The maximum change in frequency from no pads connected to the full load operating condition was about 50 Kc.

The foregoing covers the QRM angle pretty thoroughly, and we get to the other reason for using a d.c. plate supply. Where a d.c. machine with 1000 volts on the plate will produce a certain amount of heat, it will require a peak a.c. voltage of 2800 volts to produce the same amount of internal heat with the a.c. plate supply. This will subject the patient to a much higher peak r.f. voltage, and will have a tendency to produce a kneading or stimulating action upon the tissue being treated.

Shielding Precautions

It was necessary to devote considerable thought to the matter of shielding to obtain the low values of radiation mentioned in the preceding paragraphs. R.f. chokes

Rear three-quarter view of the chassis with the cover removed. This photograph shows the construction of the homemade plate tank condenser and the method of mounting the pad tuning condenser.



Wiring diagram of the portable diathermy machine:

C_1—Homemade semi-variable condenser, see illustration.
C_2—35-μμfd. per section split stator, double spaced
C_3—2-μfd. 2000-volt filter condenser
C_4, C_5—.005-μfd. midget mica
C_F—.0025-μfd. midget mica
R_1—50 ohms, 1 watt
R_2—Resistor supplied with overload relay
R_3, R_4—100,000 ohms, 50 watts
R_5—5000 ohms, 50 watts (set at 3000 ohms)
M—0-300 d.c. milliammeter
RY—200-500 ma. overload relay
P_1, P_2—110-volt colored pilot lamps
S_1, S_2—D.p.s.t. a.c. line switch
F—5-ampere fuse
RFC_1—Line chokes, see illustrations
RFC_2—250-ma. r.f. choke
L_1, L_2, L_3, L_4—See coil table
J—Jacks for plugs from pads
T_1—6.3-volt 10-ampere transformer
T_2—2.5-volt 10-ampere transformer
T_3—2000 v. c.t., 250 ma.

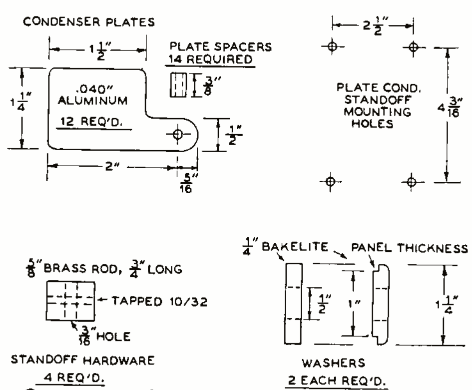
are included in each side of the a.c. line, the a.c. cord from the unit to the wall outlet is shielded and the shield is grounded at one end to the chassis and at the other end by means of a clip which is attached to the metal of the outlet box. Since the unit itself is completely shielded by a metal chassis and shield cover, the shield is not broken from the metal conduit of the house wiring to the chassis of the unit.

The Oscillator

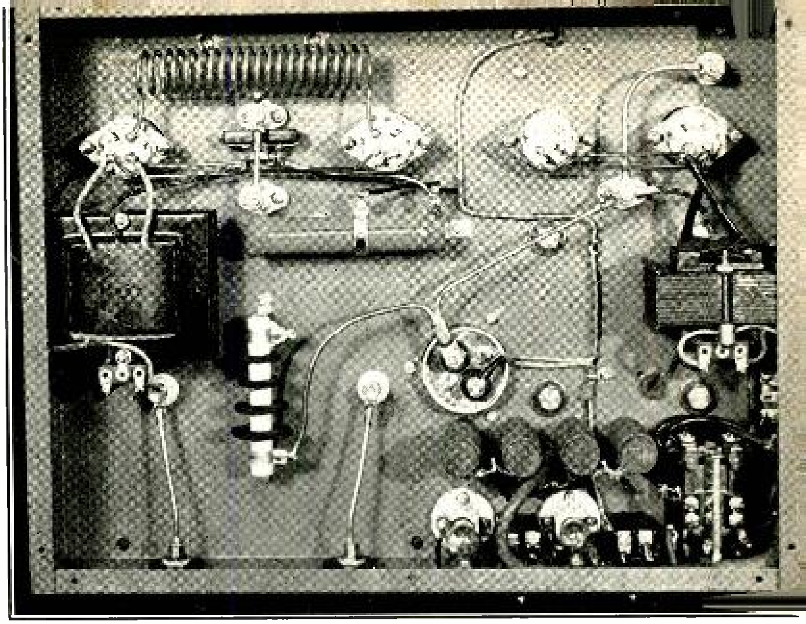
The two circuits most commonly used in diathermy oscillators are the push-pull Hartley and the TNT. The TNT was chosen for this particular unit since experience has shown that this circuit gives the best regulation of excitation to the grids of the oscillator tubes with varying load. The pair of 812's will operate at a maximum input of 250 watts at a plate voltage of 1050 volts. However, the normal operating input is 100

COIL SPECIFICATIONS

L_1, L_2—Pickup coils, two required. Three turns 1/8" copper tubing, one inch inside diameter, spaced 1/4" center-to-center of turns, with four-inch leads.
L_4—Plate coil. Seven turns 1/8" copper tubing, 1 5/16" inside diameter, center tapped, spaced 1/4" center to center of turns, with one-inch leads.
L_3—Grid coil. Twenty turns 1/8" copper tubing, 3/4" inside diameter, center tapped, 5 1/4" long with one-inch leads.



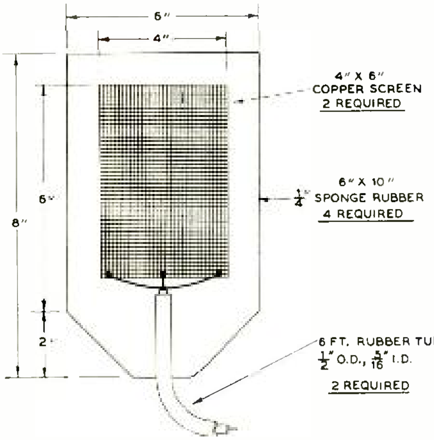
Constructional details for the plate tank condenser and the insulating washers for the pad jacks.



Bottom view of the chassis. The left hand side of the chassis is devoted to the oscillator while the right side accommodates the power supply. Note the line r.f. chokes and the overload relay near the front panel.

watts and the overload relay is set to operate at an input of 200 watts as a safeguard to the tubes.

As an aid to stability of operation everything in the oscillator is rigidly mounted, and all high voltage and r.f. wiring has been done with 1/8" copper tubing and terminal lugs. Cut and try was used on the grid coil until the oscillator operated at 25 Mc. It is strongly advised that both the grid and plate coils and the plate condenser be exactly duplicated in the construction of the unit. The plate condenser is homemade (its construction is shown in an accompanying illustration) and it is mounted so that it is electrically and mechanically balanced with respect to the chassis. Both the grid and plate coils are also mounted so that they are electrically and mechanically balanced with respect to the chassis.



Drawing showing the method of making the diathermy pads.

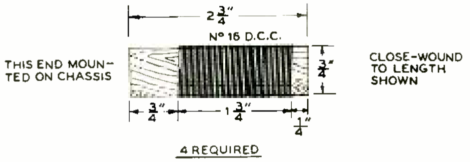
The A.C. Line Cord

The 110-volt a.c. cord is twisted no. 16, shielded and rubber covered. A flexible wire with a clip is soldered to the shield at the plug end. This is used to clip to the outlet plate mounting screw to obtain a ground to the wiring conduit. The 110-volt leads go directly to the two r.f. by-pass condensers and to the line r.f. chokes.

Overload Relay

The overload relay is a stock item for 200 to 500 ma. operating current. At the 200-ma. setting with the 50-ohm variable resistor that comes with the relay, the operation was erratic and the armature chattered. With the 50-ohm 1-watt resistor shown in series, the adjustment was smooth and the action was positive. The balance of the power supply wiring is conventional and can be

[*Continued on Page 80*]



Four a.c. line chokes, made as in the above drawing, are required. All chokes are wound in the same direction on 3/4" round wooden dowel with no. 16 d.c.c.

Self-Excited

OSCILLATOR OPERATION

By WILLIAM H. FREEMAN*

There are several factors which affect the stability of self-excited oscillators, the principle ones being temperature changes and supply voltage changes. This article will cover the stabilization of the oscillator for changes in supply voltage.

Conditions for Oscillation

To begin with, a short review of the "why" of oscillators is in order. In figure 1 is shown the conventional Harley oscillator with all d.c. supplies omitted (the grid biasing resistor is also a d.c. supply). This circuit shows the essential a.c. parts of the oscillator. The usual explanation is that there is feedback from the plate circuit to the grid circuit. This is not enough as it is only one of the three conditions necessary for oscillation. These conditions are:

1. There must be feedback from plate to grid.
2. The voltage at the grid produced by the feedback must be equal to the original grid voltage producing it. That is, from the grid around through the circuit and back to the grid there must be a one to one amplification and no more.
3. The voltage produced by the feedback must be in phase with the original grid voltage.

The first two conditions are generally known but the third and most important consideration is not usually taken into account. It is this necessity of an "in phase" feedback voltage that is the root of most of the frequency changes occurring in self-excited oscillators. In order to stabilize an oscillator it is necessary to hold to condition 3 in spite of changes in the d.c. voltage supplied to the oscillator. Stated in another way, the voltage as measured from cathode to grid, E_{kg}, (see figure 1) and the voltage from plate to cathode, E_{pk}, must remain in phase regardless of supply voltage changes if the oscillator is to hold its frequency.

In figure 2 is shown the same Hartley oscillator as shown in figure 1, but it has been redrawn to show the mutual inductance, $-M$, that exists between the plate and grid parts of the coil. This is the usual convention in representing a transformer. The feedback voltage, E_{kg}, is produced by the summation of the voltage across the negative mutual inductance, $-M$, caused by the plate current, I_p, and the voltage across L_1 caused by I_c. The plate current, I_p, will be in phase with the original grid voltage. I_p flows thru a plate resistance, R_p,

*35 West 96th Street, New York, N.Y.

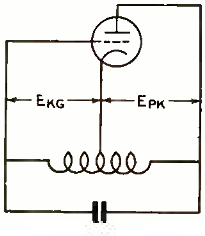
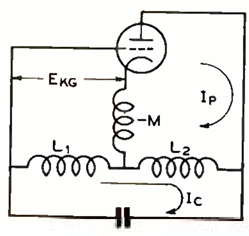


Figure 1. A.c. details of a Hartley oscillator.

Figure 2. Hartley oscillator showing a.c. current flow and mutual inductance between portions of the tank circuit.



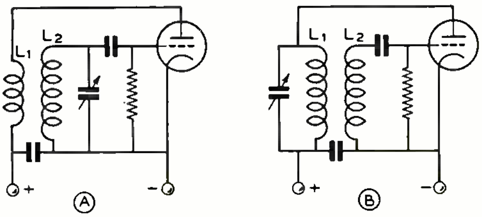


Figure 3. Tickler feedback oscillator. (A) Plate tickler version, (B) grid tickler arrangement.

and a negative inductance, $-M$, and a positive inductance, L_2. I_c flows thru a positive inductance, L_1. This causes a feedback voltage that is out of phase with the original grid voltage. To delve into the complexities of the circuit equations and finally, after much floundering around, arrive at the result would be very uninteresting reading and would be skipped by most readers. Therefore to make a short story of it, the frequency that the oscillator finally works at is not the frequency and is calculated by the formula: $f = \frac{1}{2\pi\sqrt{LC}}$, where L is the total inductance in the coil.

The frequency of oscillation automatically adjusts itself to the frequency at which the original and feedback grid voltages are in phase. It must be pointed out that this difference between the computed frequency and the actual frequency is small. One of the principle reasons for this difference is the production of harmonics due to the drawing of grid current by the oscillator. Oscillators which do not draw grid current (those giving sine-wave output) have much less difficulty in this respect.

Causes of Frequency Shift

Now for the reasons for frequency change when the supply voltage is changed. If the circuit of figure 2 is further broken down, the part that the a.c. plate current I_p flows through consists of the negative mutual inductance, the inductance L_2, and the plate resistance of the oscillator tube, R_p. The magnitude of this plate resistance is determined by two things, the d.c. grid voltage and the d.c. plate voltage. The plate current in flowing through an inductance and a resistance is series. If either of these changes, the phase of the current will change. In actual practice the supply voltage will be subject to change. When it does, the plate resistance of the tube changes causing a shift in the phase of I_p and resulting in a frequency change of the oscillator to correct for this phase change of I_p.

The Plate Tickler Oscillator

Any system which will stabilize the frequency of the oscillator must neutralize the effect of the change in plate resistance or have a circuit or tube in which plate resistance is independent of the plate supply voltage. Let us first examine, on the basis of what has just been stated, the familiar tickler feedback oscillator. In figure 3A is shown the usual circuit. Because of the feedback coil L_1 in the plate circuit, this arrangement is sensitive to supply voltage changes. Any change in the d.c. will cause a frequency shift because the phase of the plate current will shift due to a change in the plate resistance. If we should put the tuned circuit in the plate circuit we will have a parallel resonant circuit in series with the plate resistance. Since this tuned circuit will have a very high impedance at resonance the plate resistance of the triode oscillator is negligible in comparison to it. Normally the plate resistance of the oscillator will be somewhere in the neighborhood of 10,000 ohms while the tuned circuit impedance will be about a megohm depending on the frequency and the Q of the coil. Should the supply voltage change causing a change in plate resistance the result will not be noticed because there will be a change in something which is already $\frac{1}{100}$ of the tuned circuit impedance. This type of circuit will exhibit good stability for voltage changes. It is also a good oscillator at high frequencies (50 to 100 Mc.).

There are other methods of voltage stabilization of oscillators. Once the problem has been recognized, any number of methods of stabilization can be used. Some are clever; others are "brute force" methods. The crystal oscillator is one of these brute force methods. It is simply a very high Q tuned circuit which permits the phase to shift without causing much frequency shift. Another high Q circuit is the resonant line. One of the clever methods has already been discussed. The other method that will be covered is the "electron-coupled" oscillator, more properly called the Dow oscillator. This is the best known of the many voltage stabilized oscillators.

The Dow Oscillator

This much-maligned oscillator is basically a Hartley or a Colpitts oscillator. This much is generally realized. In describing how it works the usual explanation is to say that the screen

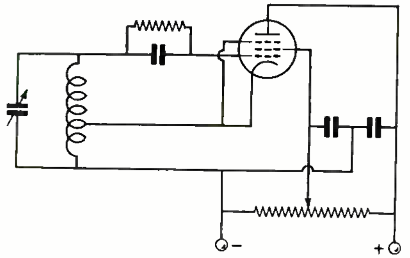


Figure 4. The Dow or electron-coupled oscillator.

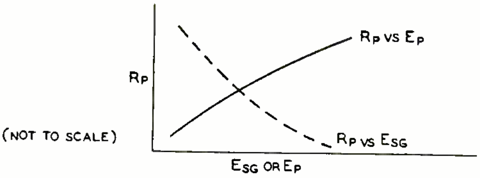


Figure 5. Variation in plate resistance plotted as a function of screen-grid voltage E_{sg} and plate voltage E_p.

forms a plate of the oscillator part and the regular plate is part of the output amplifier that is electronically coupled to the oscillator part. This is not correct for the following reason. The current that flows to the plate must come from the cathode, hence there is both plate and screen current in the cathode circuit. This cathode current flows through part of the tuned circuit. As a consequence thereof the oscillator works against both the plate and screen. The oscillator-amplifier idea is therefore entirely wrong.

The circuit of the Dow oscillator is shown in figure 4. In many cases there is a tuned circuit in the plate. For the purposes of simplicity it is left out since it merely serves as an output circuit. This circuit is the Hartley connection. The tube shown is a pentode but a screen grid (tetrode) would work as well as far as the theory is concerned. There are three things which can control the plate resistance, namely: the plate voltage, the screen voltage and the grid voltage. The first two are the most important.

The secret of the stability lies in the variation of the plate resistance caused by the changes of plate and screen voltages. In figure 5 is shown a representative graph of the variation of R_p with E_{sg} or E_p. It will be noted that plate resistance increases with increasing plate voltage but decreases with increasing screen voltage. It should be possible to find some value of plate voltage and some value of screen voltage at which the same percentage increase or decrease in each would cause the same magnitude of change in the plate resistance. The changes in R_p would be opposite and the net change would be zero. It is this fact that voltage changes on plate and screen affect the plate resistance in opposite directions that makes it possible, *by proper adjustment* of the voltages, to cancel out the net effect of plate and screen resistance changes.

The words "proper adjustment" are written in italics to emphasize the fact that only in this way can an "electron-coupled," or Dow, oscillator be made stable. Merely connecting an oscillator circuit like the one shown in figure 4 and calling it an electron-coupled oscillator will not make it stable. There is no magic in the words "electron-coupled" so that when they are pronounced over an oscillator they make it stable. It takes *proper adjustment* of the plate and screen voltage, particularly the screen voltage, to make the electron-coupled oscillator stable for supply voltage changes.

Determining the Stable Adjustment

Now that this has been discussed we will describe a simple method by which the adjustment can be made. If there is any hum in the supply voltage of an unstabilized oscillator the oscillator will be modulated and the beat note when listened to will be rough. Since most people nowadays have a "good" power supply some hum will have to be introduced. Now refer to figure 4. If we place the secondary of a filament transformer, 5-6 volts, in series with the plus lead we will vary the plate and screen voltage at a 60 cycle rate. The screen voltage must be taken from a bleeder across the plate supply; *a series dropping resistor will not do.* The plate and screen voltages must change in the same percentage. Listen to the oscillator with any kind of a receiver by means of which the beat note can be observed. If the oscillator is not stabilized the note will sound fuzzy or rough. Adjust the screen voltage until the note clears up and becomes clean. When this happens the oscillator is stabilized and will not be affected by supply voltage changes. After finishing the adjustment don't forget to take out the a.c. "modulator."

Now for the usual testimonials. The author hasn't personally tried this on the air because he isn't an amateur, but he has some ham friends who have tried it. One was rather doubtful but thought it was worth a try. When he adjusted the voltages as described and got reports of XPDC about his transmissions he

[*Continued on Page 83*]

A 400-MEGACYCLE RECEIVER

By JOHN C. REED,*
W6IOJ

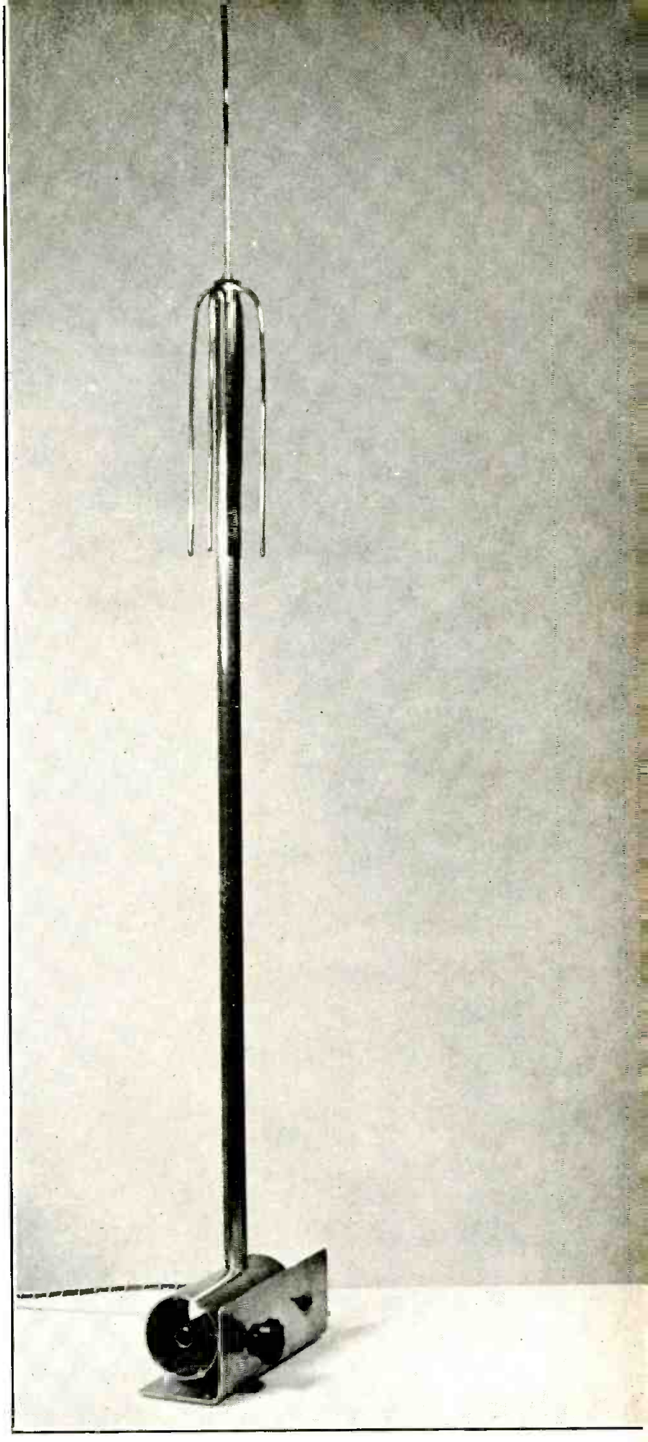


Figure 1. The complete oscillator and antenna.

There is always some question as to what kind of equipment to use when operating on 400 Mc. Herein is described a 400-Mc. receiver that compares in operation in every way to other superregenerative detectors on 2-½ and 1-¼ meters. It seems to be as sensitive to ignition noise as other superregenerators at the lower frequencies, and that is a good general check on u.h.f. sensitivity.

The oscillator is of the cathode-above-ground type using a concentric line. This concentric line is made of a 2-inch copper pipe 4-½ inches long for the outside conductor, and a ½-inch copper pipe of the same length for the inside conductor. Of course it is not necessary to conform to the materials specified. In case the large copper pipe is not available a box made of sheet copper 2 by 2 by 5 inches with one side and one end left open will serve the purpose about as well. The heavy copper pipe was chosen to serve as a basic support for the antenna and the rest of the oscillator.

The diameter of the inner conductor is not critical. For maximum Q the ratio of conductors should be about 3.6, although a much higher value can be used without a noticeable effect. The ½-inch conductor was used to give maximum Q, and also because of its mechanical strength and ease of mounting.

*7521 Lankershim Blvd., North Hollywood, Calif.

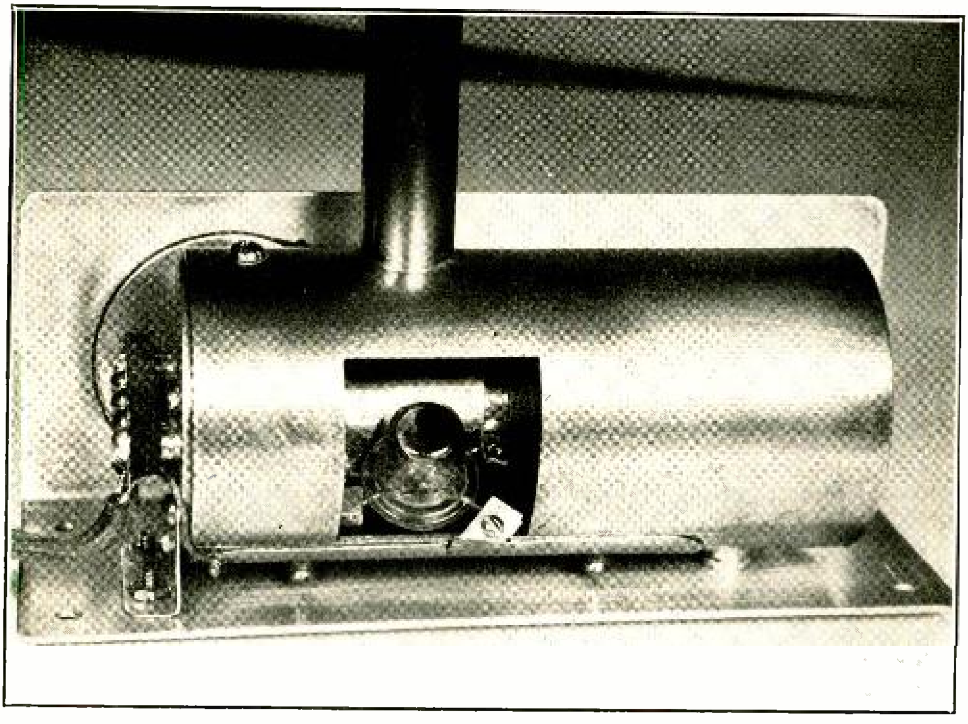


Figure 2. Rear view of the receiver itself showing the cut-away in the outer pipe through which the 955 is inserted, and showing the linear plate by-pass condenser on the outside of the outer conductor.

The Circuit and Construction

The cathode connection and one filament connection are tied together by a copper bar

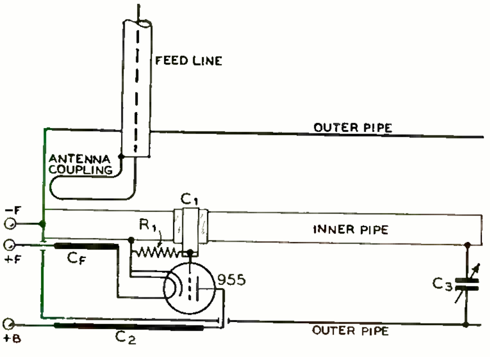


Figure 3. Semi-schematic wiring diagram of the 400-Mc. receiver. The grid-coupling, C_1 filament by-pass, C_F, and plate by-pass condensers, C_2 are described in the text. The grid leak R_1 is 2.0 megohms.

soldered directly to the inner conductor one inch from the end. Grooves are filed in the bar for the cathode and filament leads in such a way that the tube is held into place by a plate held over the two leads, and thereby acting as a support for the tube. A copper strip is connected to the other filament lead and run down along side the inner conductor

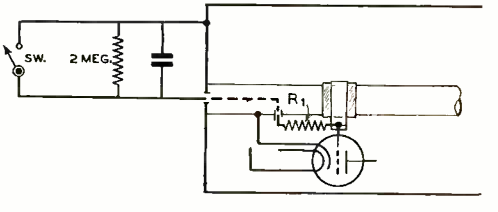


Figure 4. Method of altering the grid leak resistance of the oscillator for using the unit for a transceiver. R_1 is adjusted to the proper value to make the tube draw its rated plate current when feeding the antenna as a transmitter. With the switch opened the tube operates in the conventional manner as a superregenerator.

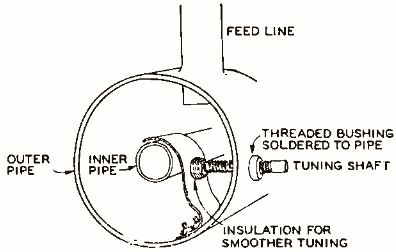


Figure 5. The tuning arrangement for the oscillator. The tuning shaft is connected to a knob, and a cable around the shaft drives an indicator.

to the cold end of the pipe. This filament lead is insulated from the inner conductor by a thin sheet of mica. Equal results can be obtained with the filament lead down through the inside of the inner conductor by drilling a hole in the ½-inch pipe near the cathode connection. If this type of connection is used the filament wire will have to be by-passed to ground at the cold end of the pipe.

The grid is connected approximately half way up the pipe through a mica condenser. The size of this condenser will have to be varied to give the smoothest regeneration for each particular oscillator. The one used in this case is a copper band 3/32 inch wide, insulated by a thin sheet of mica. The band is a tight fit over the mica and the pipe. Larger condensers were tried but they resulted in rough superregeneration. A two-megohm grid resistor is connected from the grid condenser to the inner pipe.

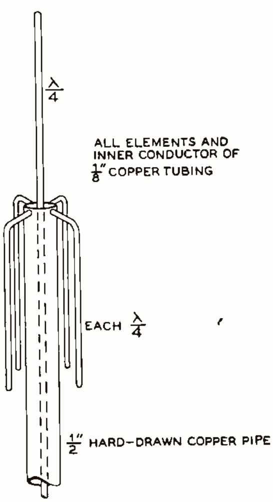


Figure 6. Detail of the radiator at the end of the feed line.

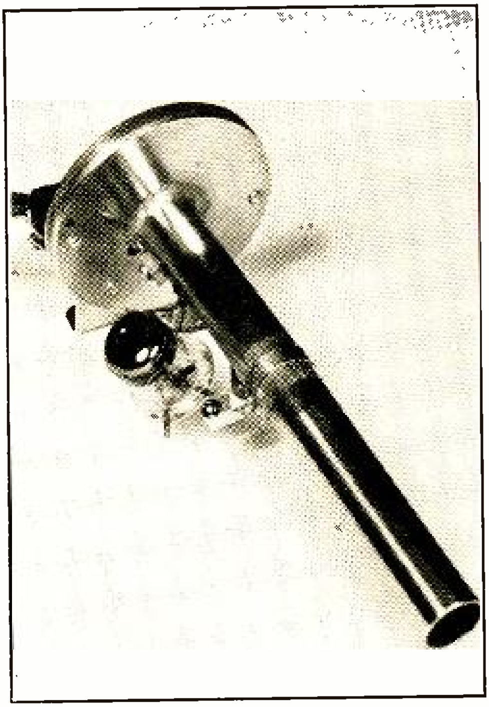


Figure 7. The oscillator with the outer conductor of the concentric line removed; these insides can be removed easily by disconnecting the plate connection and then sliding the works out. Note particularly the grid condenser and the filament-cathode connection.

The plate by-pass to ground is a copper plate 3 by 1-¼ inches, and is insulated from the outer conductor by mica. This by-pass may seem unusually large but in this case the larger condenser produced smoother regeneration.

Tuning

Tuning is accomplished by varying the distance of a copper sheet 1-½ inches wide alongside the end section of the inner conductor. This sheet is of hard-drawn copper so that it will spring back on its own accord, thereby simplifying tuning arrangements. A string belt is run around the tuning shaft to a pulley 1-¾ inches in diameter to act as a tuning indicator. With this size tuning condenser the receiver will tune approximately 75 Mc. each side of the band. A much smaller condenser could be used if the pipes were about

[*Continued on Page 82*]

A PHONE—C.W. R.F. UNIT

for 7, 14 and 28 Mc.

By ELIOT HABERLITZ,[1] W6QZA, and
JACK H. ROTHMAN,[2] W6KFQ

An r.f. unit delivering a good 200 watts on the higher frequency bands, with provision for clickless keying. Adequate excitation is available to the final amplifier for distortionless plate modulation at full input.

At an increase in cost which represents only a small percentage of the total investment in the transmitter, it is possible to construct a 200-watt transmitter with two independent r.f. units, with common power supplies, speech amplifier, and modulator. This greatly minimizes the necessity for changing coils, especially if most work is done on one high frequency band and one low frequency band. Even if one periodically hits all bands from 160 to 10 meters, it still permits a worthwhile reduction in coil changing and retuning.

Another advantage is that it makes it possible to design an r.f. unit for maximum efficiency and low cost for low frequency operation, and another for maximum efficiency and low cost for high frequency operation. No construction compromises are necessary in the interest of all-band operation as so often is the case with a single unit which must cover all bands.

The unit is designed for use with a combined crystal-v.f.o. exciter delivering output on either 160, 80, or 40 meters, the same exciter furnishing excitation for the low frequency r.f. unit. The exciter reposes on the operating desk, and as it is a separate, self-sufficient unit it is not considered a portion of the unit described here. The "Signal Shifter" v.f.o. type exciter offered by one manufacturer also is suitable as an exciter for this unit.

To facilitate changing from one r.f. unit to the other, switch S_1 is connected as shown in figure 4. This switches both 110 a.c. and the v.f.o. excitation from one r.f. unit to the other. If the unit described is not used in conjunction with a low frequency r.f. channel, then S_1 and associated circuits can be omitted.

The unit is constructed on a 19-inch rack panel, 12¼ inches high, and a standard 17 inch chassis, 3 inches high. The arrangement of components is clearly shown in figures 1, 2, and 3. Interstage shield baffles are used both above and below the chassis in order to prevent capacity coupling and consequent instability. Inductive coupling between stages is minimized by spacing the coils well and orienting the coils for minimum coupling.

To permit a pleasing arrangement of the tuning dials, the final tank tuning condenser

[1] 417 Mountain Ave., Santa Barbara, Calif.
[2] Laboratorian, RADIO.

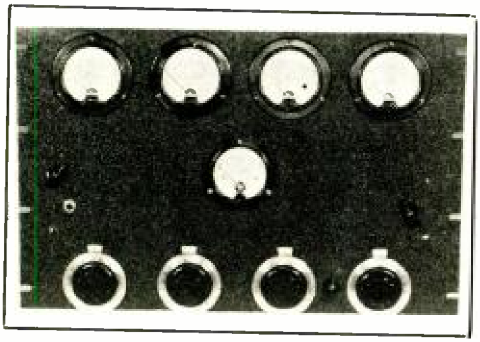


Figure 1.
Front view of the transmitter r.f. section. Meters are provided for buffer and final grid and plate currents, as well as for measuring the supply voltage. The small knob at the left, above the keying jack, moves the variable antenna coupling loop.

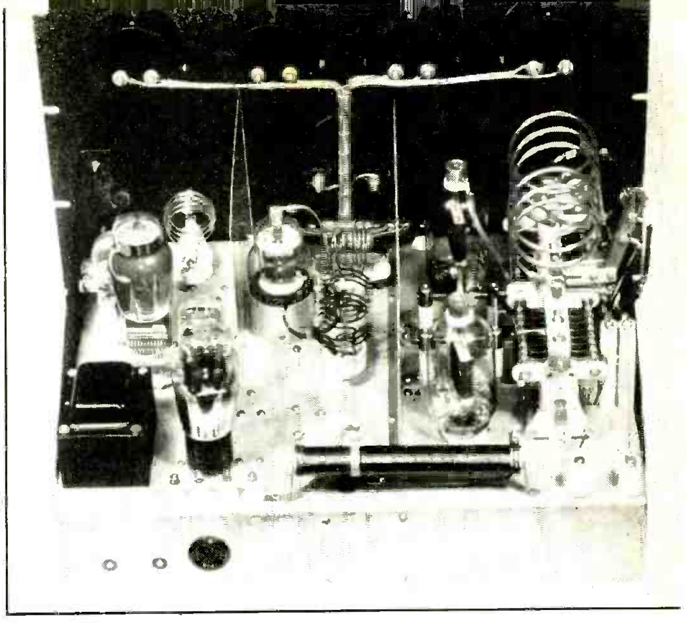


Figure 2.
Adequate shielding above the chassis helps prevent oscillation due to coupling between stages. In this view the input stage is seen at the left, buffer stage at the center and the push-pull final amplifier at the right. The bias pack and the keying tube are located at the left, between the input stage and the rear of the chassis.

is rotated by means of a pulley and dial cable, of the "non-slip" type often used in broadcast sets. Obviously a 1-1 ratio is used.

The final amplifier tank coil jack bar is mounted atop the tank tuning condenser by means of brackets cut and drilled to suit the job. All coils are of standard manufactured type, and are used "as is" except for the 6L6-G plate coil, which must have one turn removed on 10 meters, 2 turns removed on 20 meters, and 4 turns removed on 40 meters. The alteration is required because of the capacity coupling arrangement. All coils are Bud, L_1 being of the OEL type, L_2 of the OEL type (altered as described) with link unused, L_3 of the OEL type, L_4 of the OLS type, and L_5 of the VLS type.

The bias pack and keyer tube may be seen in the lower left corner of figure 2. The fixed bias permits keying of the 6L6-G by providing plate current cut off to the 807 and the T-40's when the key is up. The 6A3 keyer tube prevents objectionable keying thumps. If desired, a pair of 45's in parallel may be substituted for the 6A3 (in case a 2.5 volt filament transformer already is on hand).

The 807 is "underslung" mounted to shorten the plate lead and minimize the external

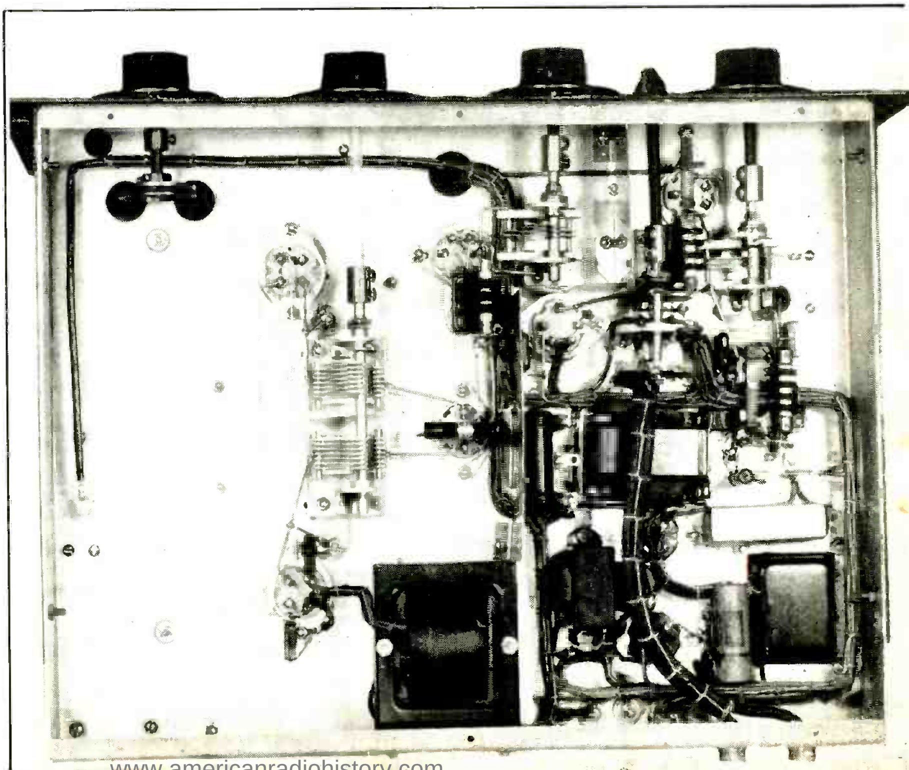


Figure 3.
Underneath the chassis all d.c. and a.c. supply leads are cabled to help in giving the unit a neat appearance. Note the vertical shield partition near the center of the chassis to separate the 807 input and output circuits. The final amplifier plate condenser is operated by means of dial-cord drive from the pulley seen at the upper left of this photograph.

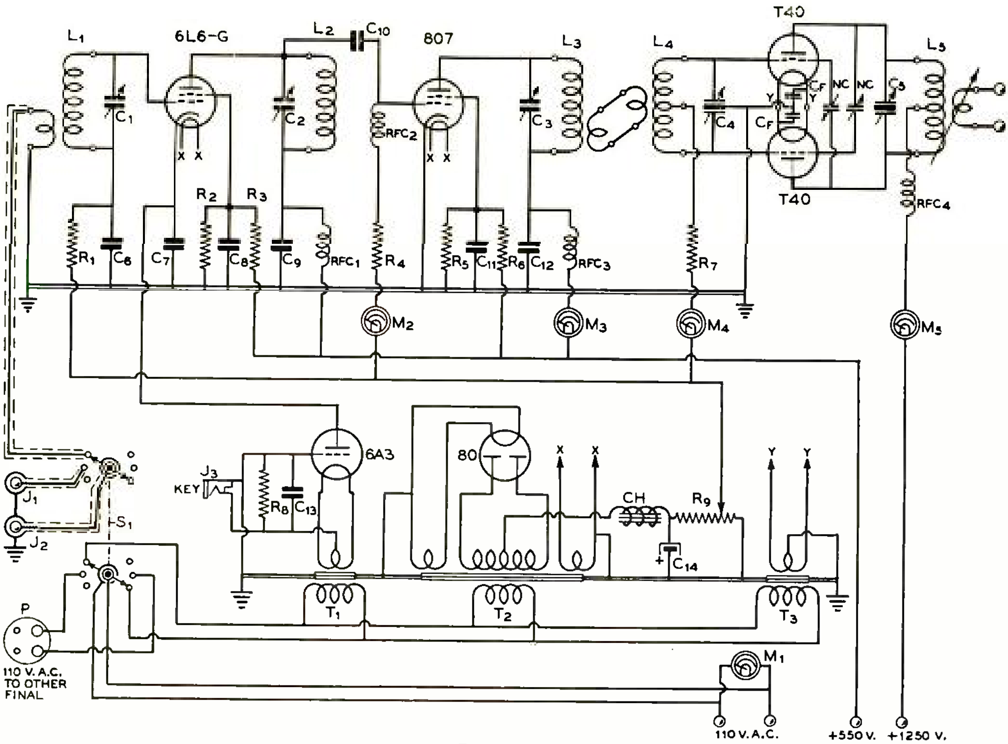


Figure 4.

GENERAL WIRING DIAGRAM.

C_1—50-µµfd. midget variable
C_2, C_3—35-µµfd. midget variable
C_4—Dual midget variable, 100-µµfd. per section
C_5—80-µµfd. per section, .078" spacing
C_6, C_7, C_8, C_9—.003-µfd. mica
C_{10}—.00005-µfd. mica
C_{11}, C_{12}—.003-µfd. mica
C_{13}—.25-µfd. 400-volt tubular
C_{14}—8-µfd. 450-volt electrolytic
C_F—.003-µfd. mica
NC—18-µµfd. neut. condenser
R_1—50,000 ohms, 2 watts
R_2, R_3—100,000 ohms, 2 watts
R_4, R_5—50,000 ohms, 2 watts
R_6—25,000 ohms, 10 watts
R_7—600 ohms, 10 watts
R_8—50,000 ohms, 2 watts
R_9—5000 ohms, 100 watts
L_1, L_2, L_3, L_4, L_5—See text
RFC_1, RFC_2, RFC_3—2.5 mhy., 125 ma.
RFC_4—2.5 mhy., 500 ma.
S_1—Four-pole, 3-position tap switch
M_1—0-150 v., a.c.
M_2—0-25 ma., d.c.
M_3—0-200 ma., d.c.
M_4—0-100 ma., d.c.
M_5—0-300 ma., d.c.
T_1—2.5 v., 3.5 a.
T_2—700 v., c.t., 70 ma.; 5 v., 3 a.; 6.3 v., 2.5 a.
T_3—7.5 v., 8 a.
CH—10 hy., 75 ma.
J_1, J_2—Microphone type connectors for link input.
P—4-prong socket

grid-plate capacity. The latter is further kept to a minimum with the aid of a shield "collar" around the base of the 807 as may be seen in figure 2. The T40 sockets are likewise lowered slightly, in order to shorten the plate leads.

Condensers C_1, C_2, C_3, and C_4 are mounted back from the panel and operated by means of extension shafts. This permits shorter r.f. leads and better isolation of stages.

The variable link coupling of the final tank coil is suitable for a twisted pair or open untuned line. For other types of feed, an external antenna coupler is required.

The slider on the bias tap is adjusted until the bias is at the highest value which will permit full rated grid current on all bands under actual operating conditions.

As the design of the whole unit is straightforward, the tuning adjustments are conventional, and therefore will not be dealt with here. If the final amplifier is neutralized accurately on 20 meters, the adjustment will also hold on 10 and 40 meters.

The transmitter ordinarily is loaded up to 300 watts, the output being approximately 225 watts at this input on 40 and 20 meters, and slightly less on 10 meters.

25 WATTS ON 56 Mc.

A compact and well designed transmitter utilizing crystal control of the oscillator for home station or mobile operation on the five-meter band.

By G. V. DAWSON, Jr.,* W9ZJB

Several years ago I tried an 807 as a doubler to 56 Mc., the output of which was to drive a pair of T-20's as a final amplifier to about 100 watts. The 807 minimum plate dip was about 80 ma. with no load and 500 volts on the plate, parasitics were plentiful, and the output was very low. After experimenting with the stage for about two months I became very discouraged and substituted a triode for the 807 and operated the triode at reduced plate voltage.

This arrangement was satisfactory until it was desired to increase the power of the final stage to about 400 watts input. Knowing that the small triode had insufficient output to excite the larger amplifier, an HK-24 was substituted for it. A common ground system consisting of a piece of bare no. 10 wire was then run the full length of the exciter chassis. All grounds in the exciter were then made to this bus.

After the unit was completely wired the bus was grounded to one point approximately in the center of the chassis. The plate voltages were applied, everything was tuned to resonance, and the plate current readings were noted. To our disappointment the HK-24 was drawing 70 ma. no load and the output was very low. Taking a screwdriver, and watching the plate milliammeter on the HK-24, the common bus was grounded at different points along the chassis. At every point where the plate current dropped, a ground was made from the bus to the chassis. By repeating this process several times the plate current on the HK-24 was lowered to 18 ma. no load as a doubler to 56 Mc., and 8 ma. as an amplifier on 28 Mc. Sometimes a half-inch movement in one of the grounding connections would make a considerable reduction in the plate current of the stage.

Checks upon the output of the doubler stage showed that each time the plate current was lowered by a properly placed ground, the output went up. The result of the properly grounded common bus was an exciter free of parasitics, having a low minimum plate current dip, and capable of delivering plenty of excitation to the final.

*Route No. 1, Gashland, Missouri.

The 25-Watt Mobile Transmitter

Not long after the experiences with the home exciter, it was decided to go mobile on 56 Mc. The result of this urge is the transmitter shown in the accompanying photographs and described in the following paragraphs.

The lineup decided upon for the transmitter was as follows: 6V6-GT regenerative oscillator with a 7.0-Mc. crystal[1] and the output circuit on 14 Mc., another 6V6-GT as a doubler to 28 Mc., an 807 in the modulated final stage operating either as a doubler to 56 Mc. or as a straight amplifier on 28 Mc., and a pair of 6V6-GT's in push-pull as modulators with their grids excited directly through the microphone transformer from a single-button microphone. For home-station use, the output of the speech amplifier is coupled into the microphone transformer in place of the single-button mike.

[1]Jones, "A Regenerative Crystal Oscillator Circuit," RADIO, July 1938.

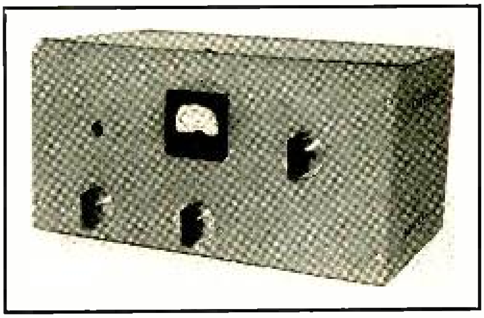


Figure 1. Front view of the 56-Mc. mobile transmitter shown in its case.

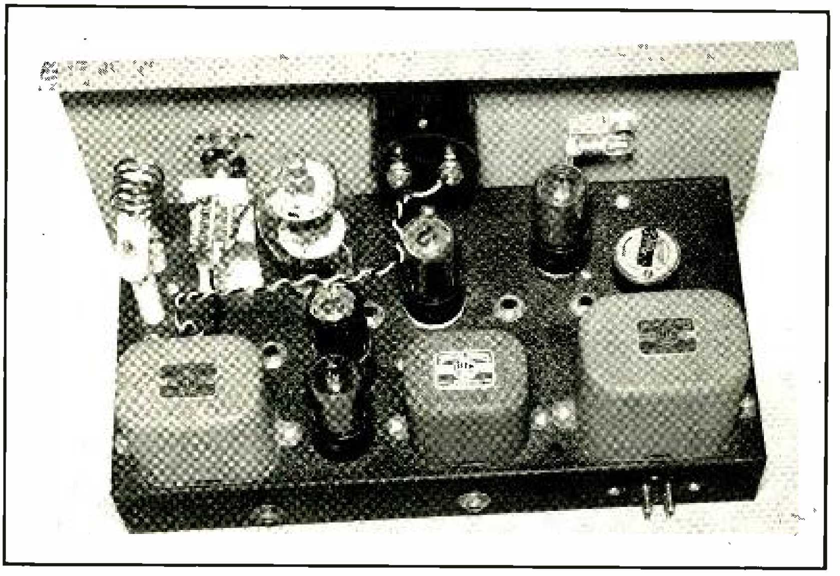


Figure 2. Looking down upon the chassis of the 56-Mc. mobile transmitter. The large case on the right rear of the chassis contains the choke for filtering the output of the vibrator supply. The other two cases on the rear of the chassis house the input and output transformers for the 6V6-GT modulators. The r.f. section mounts along the front of the chassis.

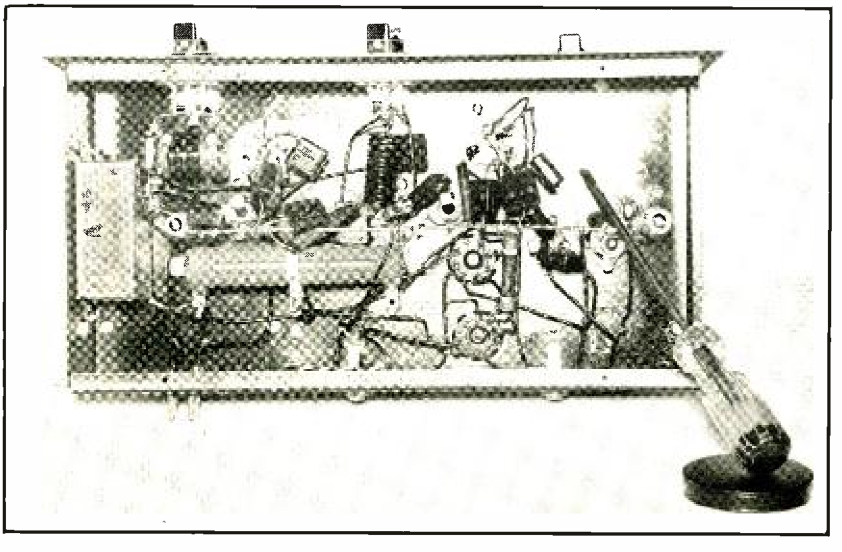
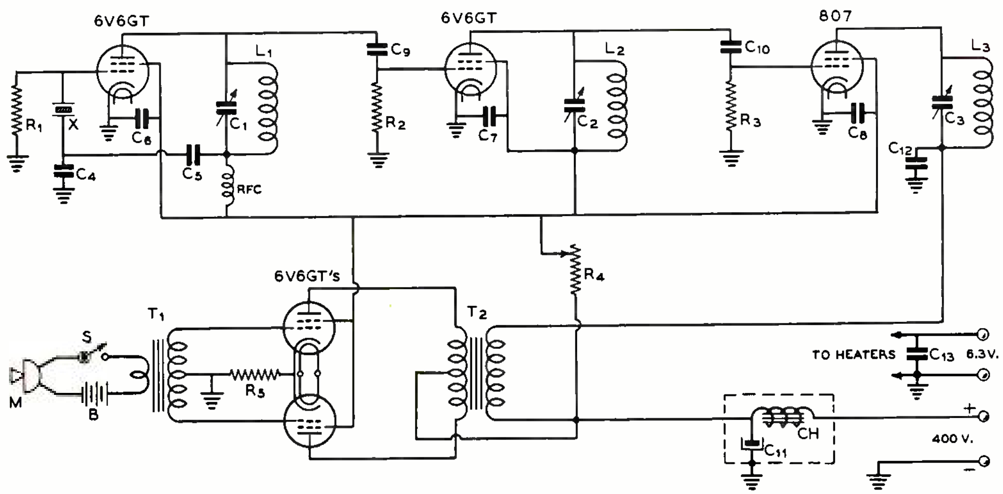


Figure 3. Underchassis view of the transmitter. Notice the common ground bus running down the center of the chassis. The 14- and 28-Mc. coils can be seen mounted upon their respective tuning condensers.



Wiring diagram of the transmitter. It may be used either as a fixed-station transmitter on 28 or 56 Mc., or as a mobile transmitter on 56 Mc.

C_1, C_2—25-μμfd. ultra midget
C_3—25-μμfd. ultra-midget, double spaced
C_4—.0002-μfd. mica (exact value found by adjustment)
C_5, C_6, C_7, C_8—.001-μfd. midget mica
C_9, C_{10}—.0001-μfd. midget mica
C_{11}—16-μfd. 450-volt electrolytic
C_{12}—.001-μfd. midget mica
C_{13}—.001-μfd. mica at 807 socket
R_1—100,000 ohms, ½ watt
R_2—50,000 ohms, ½ watt
R_3—50,000 ohms, 2 watts
R_4—25,000 ohms, 50-watt adjustable
R_5—400 ohms, 2 watts
L_1—16 turns no. 18 enam., 1" dia.
L_2—13 turns no. 14 enam., ½" dia.
L_3—5 turns no. 14 enam., ¾" dia. for 56 Mc.; 8 turns no. 14 enam., ¾" dia. for 28 Mc.
CH—6-hy. 175-ma. filter choke
T_1—Mike to push-pull grids
T_2—12-watt universal output transformer to r.f. load
M—Single-button mike
B—4½-volt mike battery
S—S.p.s.t. mike switch

After the experience of the home transmitter, the common bus system was again installed. Turning everything on and tuning to resonance, the 807 was again full of parasitics and had no appreciable plate dip. But after taking the screwdriver and going to work on the ground bus the r.f. section became tame as a kitten. The 807 dipped to 30 ma. when doubling to 56 Mc. with 425 plate volts, parasitics were absent, and no tendency toward oscillation was noticed even with the crystal removed from the socket.

Some may frown on the appearance of the under-chassis wiring as a result of the ground bus. But he who goes in for nice square turns and longer leads in the interest of appearance is due for trouble when he attempts to get anything operating properly on the ultra highs. For good efficiency and ease in removing parasitics, the common ground bus system is without a doubt the best approach yet run across by the author. The use of the system allows a properly designed ultra-high-frequency transmitter to be "de-bugged" and placed into operation with very little more work than a low-frequency transmitter.

Operation of the Mobile Transmitter

The transmitter is designed to operate from a power supply delivering 350 to 425 volts at 175 ma. for home-station use, and from a motor-generator or vibrapack delivering from 300 volts at 100 ma. to 425 volts at 175 ma. for mobile operation. The heaters of the tubes can be lighted from the 6.3-volt car battery for mobile use, and they can be operated from a 6.3-volt 3-ampere filament transformer for home-station use. One section of filter, consisting of a small 75-ma. choke and an 8-μfd. 450-volt filter condenser should be included in the a.c. power supply for home station use. For mobile operation, the dynamotor or the vibrapack may be operated directly into the transmitter since a small amount of filter (enough for these types of power supply) has been incorporated into the transmitter proper.

It will be noticed that a switch S is shown in the circuit diagram, along with the microphone battery. Actually, neither of these are incorporated into the transmitter unit. The battery can be a small 4½-volt C battery

[*Continued on Page 89*]

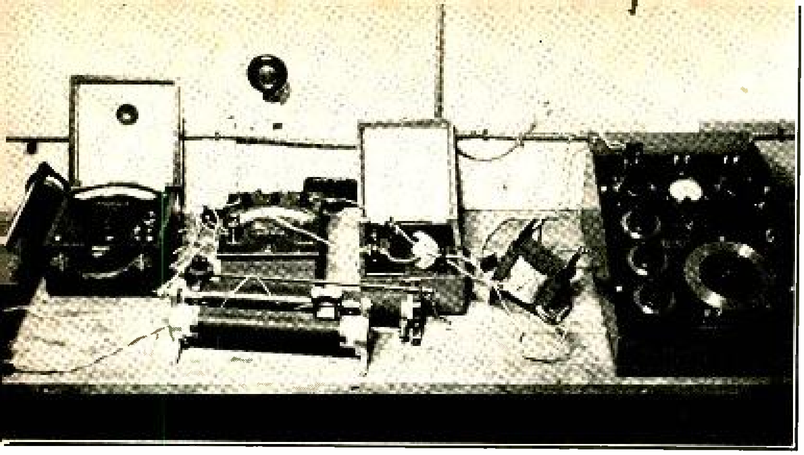


Figure 1.
Laboratory set up to measure effect of flux density upon coil and core loss.

Flux Density and Its Effect Upon TRANSFORMER PERFORMANCE

Design considerations of power transformers having high core flux densities for improved regulation.

By THOMAS A. GROSS,* W1JZM

Transformer regulation (drop in voltage with applied load) is caused by IR drops in the coil windings and incomplete coupling existing between their circuits. These effects may be reduced to negligible values by recourse to oversize conductors and interleaving of the windings, but these expedients are costly. High flux densities in the transformer cores make improved regulation possible without added expense.

Associated with transformer operation are certain constant losses and other losses which vary with the load. If the variable dissipations could be diminished even at the expense of increased fixed losses, it is evident that regulation would be improved. This can be accomplished by increasing the volts per turn ratio. The resistance of the windings is then reduced and hence the variable I^2R dissipation is reduced.

The a.c. flux density in the core obeys the following equation:

$$\text{Flux Density} = KV/N$$

where: K is a constant depending upon core area, stacking factor and frequency of the applied alternating voltage

V is the applied alternating voltage

N is the number of turns.

Core materials lose some of their magnetic properties at high flux densities; hence there must exist a definite maximum volt per turn ratio for each transformer design if the undesirable effects of core saturation are to be avoided.

Power Loss: A Function of Flux Density

In power transformer service, core saturation is important only to the extent that it determines transfer efficiency. A study was made in the laboratory of the effect of high flux densities upon typical core materials and its consequent influence upon transformer efficiency. A special iron core coil was made having pre-calculated flux density/a.c. voltage and core loss characteristics. Sixty cycle a.c. voltages were applied to this coil and readings were taken of the total power dissipation, voltages, and reactive amperes surging through the winding.

The results, charted in figure 2, indicate that the power loss at high flux densities slightly exceeds the I^2R dissipation in the coil winding. Evidently the efficiency of a transformer operating under these conditions of high flux den-

*409 Marlboro Street, Boston, Mass.

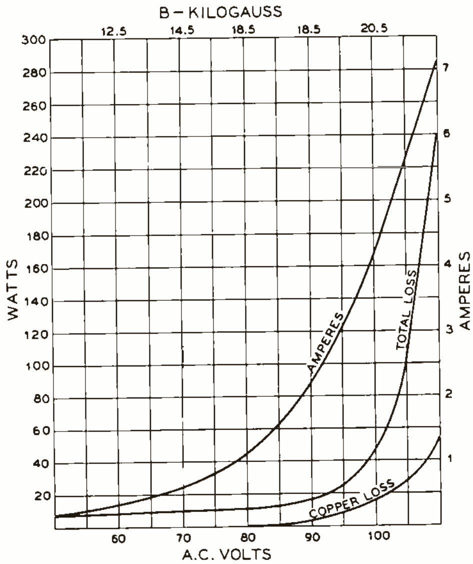


Figure 2.

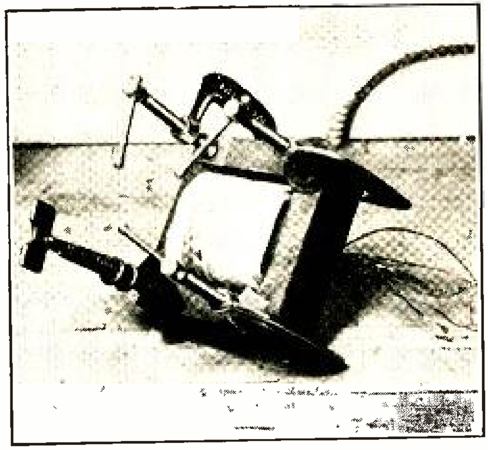


Figure 3.

Iron core reactor used in laboratory experiment. Observe that clamps are used to secure the laminations, making it unnecessary to run bolts through the core. By spacing the metal of the clamp from the outside laminations, calculations for eddy current losses are undisturbed by the presence of the clamps.

sity is determined largely by the reactive currents flowing through the primary and not by hysteresis and eddy current loss in the core. For a given magnitude and frequency of applied voltage, the reactive current can be reduced only by increasing the inductance of the primary, for $I = E/2\pi fL$. More turns could be used but this would defeat our original purpose to improve regulation. Greater core permeance and further reduction of primary resistance by employment of larger wire, however, can hold this I^2R dissipation within tolerable limits. This discussion will be amplified later under *Practical Design Considerations.*

A significant practical result illustrated by figure 2 is the abrupt rise in power dissipation above a flux density of 20 kilogauss. Considerations of efficiency and primary temperature would set this figure as a maximum allowable flux density for this particular transformer design and core material. Most transformers are designed to operate with a flux density around ten kilogauss. In this instance it would be possible to double the flux density with the attendant reduction of IR drops in all windings contributing to a higher transfer efficiency. It is probable that efficiency as well as regulation in many existing transformers would be improved if a greater volt-per-turn ratio were used.

The core material does not have much of a direct effect on transformer losses but its influence on primary "copper loss" is tremendous. This suggests that core materials should be selected more on the basis of permeability rather than hysteresis and eddy current loss.

Behavior of Transformer Cores

The core laminations account for direct power dissipation by hysteresis and eddy current losses. These two effects show up as the difference between the curves representing total losses and the I^2R dissipation (figure 2). This disparity becomes greater with increasing flux density, which would be expected by examining the following formulas:

$$\text{Hysteresis loss} = K_1 f B^{1.6}$$
$$\text{Eddy Current loss} = K_2 f^2 B^2$$

where: K_1 & K_2 are constants

f is the frequency of the applied voltage

B is the a.c. flux density

The eddy current loss, being proportional to B^2, rises more rapidly with increasing flux densities than does the hysteresis loss. Special consideration should be given to eddy current loss whenever high flux densities prevail.

The alternating current permeability is the most important characteristic of the core material. It is strongly affected by the degree of flux density as demonstrated by the curve representing *amperes* in figure 2. Were the permeability constant this line would be linear. The upward concavity of this curve is explained by

[*Continued on Page 88*]

AIDS IN FILTER DESIGNING

By the Engineering Department, Aerovox Corporation

Filter networks may be built up from reactances in different configurations but this article is confined to the well-known "ladder"-networks of the type shown in figure 1. The series impedance Z_1 and the shunt impedance Z_2 may consist of inductive reactances or capacitive reactances or several in combination. They may or may not have appreciable resistance.

Such a ladder network can be considered as built up of several sections either of the "T"-type or the "Pi"-type as illustrated in figure 2. Note that each of the two series arms of the T-section are equal to $Z1/2$, since adding several sections together will put two of these in series, resulting in a full-series impedance Z_1. For a similar reason, the individual Pi-section has shunt arms equal to $2Z_2$, for, when two sections are added together two of these are in parallel and form the full-shunt impedance Z_2.

When a filter ends with half a series-arm it is said to be mid-series terminated. When it ends with the double shunt-arm it is mid-shunt terminated.

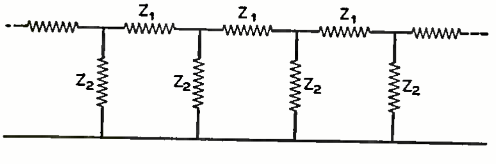
The image impedances of a filter are the two impedances, not necessarily alike, which will simultaneously terminate the filter at its two ends so there will be no reflection loss. This occurs when the image impedance is equal to the impedance looking into the filter at that end.

When the two image impedances are equal, the filter is symmetrical, and they are equal to Z_0, the characteristic impedance.

The characteristic impedance and/or the image impedance may be found by measuring the impedance of the filter at one end with the other end left open and again with the other end shorted. The desired impedance equals the geometric mean of the two values obtained.

The image impedance and characteristic impedance generally vary with frequency so the two measurements must be carried out at the same frequency.

FIGURE 1.



Constant-K Filter

The filters discussed here are of the "constant-k type" which means that the product Z_1Z_2 is constant for all frequencies and equal to k^2. This value k is again equal to the characteristic impedance of the filter over the greater part of the pass band and equal to the value R used in the calculations.

Such a filter, when properly terminated in its image impedance, acts as a resistance load on the generator throughout the passband, but, at the cut-off frequency the load becomes either zero or infinite and thereafter it is imaginary. In other words, in the attenuation band the filter acts as a reactive load, does not take any energy from the generator, and does not transmit any energy to its terminating impedance.

Figure 3 shows the hook-up of four types of filters with the equations for their elements while Tables I and II contain tabulations of these values for different cut-off frequencies.

In general it will be necessary to use filters of more than one section if a sharp enough cut-off is to be obtained and these sections need not necessarily be the same. Other sections, having special attenuation characteristics can be "derived" from the filter sections of the "prototype" described here. These will be dealt with in a later article.

FIGURE 2.

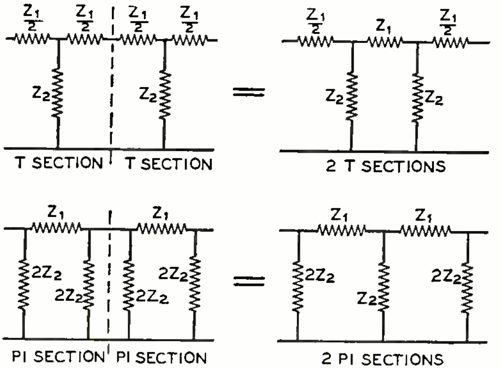


TABLE I LOW-PASS and HIGH-PASS FILTER DATA

	R = 500 ohms				R = 10,000 ohms			
	Low-pass		High-pass		Low-pass		High-Pass	
f^c (cycles)	L^1 (henries)	C^2 (mfds.)	L^2 (henries)	C^1 (mfds.)	L^1 (henries)	C^2 (mfds.)	L^2 (henries)	C^1 (mfds.)
30	5.31	21.2	1.33	5.31	106.	1.06	26.5	.265
100	1.59	6.37	.398	1.59	31.8	.318	7.96	.0796
150	1.06	4.24	.265	1.06	21.2	.212	5.31	.0531
200	.796	3.18	.198	.796	15.9	.159	3.98	.0398
250	.637	2.55	.159	.637	12.7	.127	3.18	.0318
300	.531	2.12	.133	.531	10.6	.106	2.65	.0265
350	.455	1.82	.114	.455	9.09	.0909	2.28	.0228
400	.398	1.59	.0995	.398	7.96	.0796	1.99	.0199
450	.354	1.41	.0884	.354	7.07	.0707	1.77	.0177
500	.318	1.27	.0796	.318	6.37	.0637	1.59	.0159
550	.289	1.16	.0723	.289	5.78	.0578	1.45	.0145
600	.265	1.06	.0663	.265	5.31	.0531	1.33	.0133
650	.245	.979	.0612	.245	4.90	.0490	1.22	.0122
700	.227	.909	.0568	.227	4.54	.0454	1.14	.0114
750	.212	.849	.0531	.212	4.24	.0424	1.06	.0106
800	.199	.796	.0497	.199	3.98	.0398	.995	.00995
850	.187	.749	.0468	.187	3.74	.0374	.936	.00936
900	.177	.707	.0442	.177	3.54	.0354	.884	.00884
950	.168	.670	.0419	.168	3.36	.0336	.839	.00839
1*	.159	.637	.0398	.159	3.18	.0318	.796	.00796
3*	.0531	.212	.0133	.0531	1.06	.0106	.265	.00265
10*	.0159	.0637	.00398	.0159	.318	.00318	.0796	796#
30*	.00531	.0212	.00133	.00531	.106	.00106	.0265	265#
100*	.00159	.00637	398†	.00159	.0318	318#	.00796	79.6#
300*	581†	.00212	133†	531#	.0106	106#	.00265	26.5#
1**	159†	637#	39.8†	159#	.00318	31.8#	796†	7.96#
3**	53.1†	212#	13.3†	53.1#	.00106	10.6#	265†	2.65#
10**	15.9†	63.7#	3.98†	15.9#	318†	3.18#	79.6†	0.796#
30**	5.31†	21.2#	1.33†	5.31#	106†	1.06#	26.5†	0.265#

NOTE: *Kilocycles, **Megacycles, †Microhenries, # Micromicrofarads.

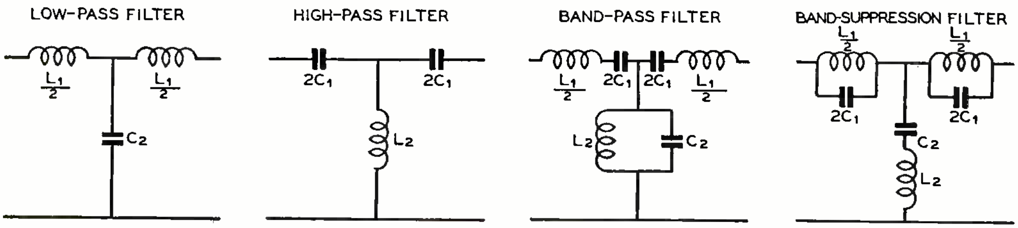
TABLE II BAND-PASS FILTERS ($R = 500$ OHMS)

Band Width	f_m =	100 cycles	1000 cycles	1500 cycles	2000 cycles	2500 cycles	3000 cycles	3500 cycles	4000 cycles	4500 cycles	5000 cycles	5500 cycles	6000 cycles
.05	L_1	31.8	3.18	2.12	1.59	1.27	1.06	.909	.796	.707	.637	.579	.531
	L_2	.0199	.00199	.00133	995m	796m	663m	569m	497m	442m	398m	362m	332m
	C_1	.0796	.00796	.00531	.00398	.00318	.00265	.00227	.00199	.00177	.00159	.00145	.00133
	C_2	127	12.7	8.49	6.37	5.09	4.24	3.64	3.18	2.83	2.55	.232	2.12
.1	L_1	15.9	1.59	1.06	.796	.637	.531	.455	.398	.354	.318	.289	.265
	L_2	.0398	.00398	.00265	.00199	.00159	.00133	.00114	995m	884m	796m	723m	663m
	C_1	.159	.0159	.0106	.00796	.00637	.00531	.00455	.00398	.00354	.00318	.00289	.00265
	C_2	63.7	6.37	4.24	3.18	2.55	2.12	1.82	1.59	1.41	1.27	1.16	1.06
.15	L_1	10.6	1.06	.707	.531	.424	.354	.303	.265	.236	.212	.193	.177
	L_2	.0597	.00597	.00398	.00298	.00239	.00199	.00171	.00149	.00133	.00119	.00109	995m
	C_1	.239	.0239	.0159	.0119	.00955	.00796	.00682	.00597	.00531	.00477	.00434	.00398
	C_2	42.4	4.24	2.83	2.12	1.70	1.41	1.21	1.06	.943	.849	.772	.707
.2	L_1	7.96	.796	.531	.398	.318	.265	.227	.199	.177	.159	.145	.133
	L_2	.0796	.00796	.00531	.00398	.00318	.00265	.00227	.00199	.00177	.00159	.00145	.00133
	C_1	.318	.0318	.0212	.0159	.0127	.0106	.00909	.00796	.00707	.00637	.00579	.00531
	C_2	31.8	3.18	2.12	1.59	1.27	1.06	.909	.796	.707	.637	.579	.531
.25	L_1	6.37	.637	.424	.318	.255	.212	.182	.159	.141	.127	.116	.106
	L_2	.0995	.00995	.00663	.00497	.00398	.00332	.00284	.00249	.00221	.00199	.00181	.00166
	C_1	.398	.0398	.0265	.0199	.0159	.0133	.0114	.00995	.00884	.00796	.00723	.00663
	C_2	25.5	2.55	1.70	1.27	1.01	.849	.728	.637	.566	.509	.463	.424
.3	L_1	5.31	.531	.354	.265	.212	.177	.152	.133	.118	.106	.0965	.0884
	L_2	.119	.0119	.00796	.00597	.00477	.00398	.00341	.00298	.00265	.00239	.00217	.00199
	C_1	.477	.0477	.0318	.0239	.0191	.0159	.0136	.0119	.0106	.00955	.00868	.00796
	C_2	21.2	2.12	1.41	1.06	.849	.707	.606	.531	.472	.424	.386	.354
.4	L_1	3.98	.398	.265	.199	.159	.133	.111	.0995	.0884	.0796	.0723	.0663
	L_2	.159	.0159	.0106	.00796	.00637	.00531	.00455	.00398	.00354	.00318	.00289	.00265
	C_1	.637	.0637	.0424	.0318	.0255	.0212	.0182	.0159	.0141	.0127	.0116	.0106
	C_2	15.9	1.59	1.06	.796	.637	.531	.455	.398	.354	.318	.289	.265
.5	L_1	3.18	.318	.212	.159	.127	.106	.0909	.0796	.0707	.0637	.0479	.0531
	L_2	.199	.0199	.0133	.00995	.00796	.00663	.00568	.00497	.00442	.00398	.00362	.00332
	C_1	.796	.0796	.0531	.0398	.0318	.0265	.0227	.0199	.0177	.0159	.0145	.0133
	C_2	12.7	1.27	.849	.637	.509	.424	.364	.318	.283	.255	.232	.212
.6	L_1	2.65	.265	.177	.133	.106	.0884	.0758	.0663	.0589	.0531	.0482	.0442
	L_2	.239	.0239	.0159	.0119	.00955	.00796	.00682	.00597	.00531	.00477	.00434	.00398
	C_1	.955	.0955	.0637	.0477	.0382	.0318	.0273	.0239	.0212	.0191	.0174	.0159
	C_2	10.6	1.06	.707	.531	.424	.354	.303	.265	.236	.212	.193	.177
.7	L_1	2.27	.227	.152	.114	.0909	.0758	.0650	.0568	.0505	.0455	.0413	.0379
	L_2	.279	.0279	.0186	.0139	.0111	.00928	.00796	.00696	.00619	.00557	.00506	.00464
	C_1	1.11	.111	.0742	.0557	.0446	.0371	.0318	.0279	.0248	.0223	.0203	.0186
	C_2	9.09	.909	.606	.455	.364	.303	.260	.227	.202	.182	.165	.152
.8	L_1	1.99	.199	.133	.0995	.0796	.0663	.0568	.0497	.0442	.0398	.0362	.0332
	L_2	.318	.0318	.0212	.0159	.0127	.0106	.00909	.00796	.00707	.00637	.00579	.00531
	C_1	1.27	.127	.0849	.0637	.0509	.0424	.0364	.0318	.0283	.0255	.0231	.0212
	C_2	7.96	.796	.531	.398	.318	.265	.227	.199	.177	.159	.145	.133
.9	L_1	1.77	.177	.118	.0884	.0707	.0589	.0505	.0442	.0393	.0354	.0322	.0294
	L_2	.358	.0358	.0239	.0179	.0143	.0119	.0102	.00895	.00796	.00716	.00651	.00597
	C_1	1.43	.143	.0955	.0716	.0573	.0477	.0409	.0358	.0318	.0286	.0260	.0239
	C_2	7.07	.707	.472	.354	.283	.236	.202	.177	.157	.141	.129	.118

m = microhenries

TABLE II BAND-PASS FILTERS (R = 500 OHMS)

Band Width	f_m =	6500 cycles	7000 cycles	7500 cycles	8000 cycles	8500 cycles	9000 cycles	9500 cycles	10 kc.	100 kc.	1 mc.	10 mc.
.05	L_1	.490	.455	.424	.398	.374	.354	.335	.318	.0318	.00318	318m
	L_2	306m	284m	265m	249m	234m	221m	209m	199m	19.9m	1.99m	.199m
	C_1	.00122	.00114	.00106	995mmf.	936mmf.	884mmf.	838mmf.	796mmf.	79.6mmf.	7.96mmf.	.796mmf.
	C_2	1.96	1.82	1.70	1.59	1.50	1.41	1.34	1.27	.127	.0127	.00127
.1	L_1	.245	.227	.212	.199	.187	.177	.168	.159	.0159	.00159	159m
	L_2	612m	568m	531m	497m	468m	442m	419m	398m	39.8m	3.98m	.398m
	C_1	.00245	.00227	.00212	.00199	.00187	.00177	.00168	.00159	159mmf.	15.9mmf.	1.59mmf.
	C_2	.979	.909	.849	.796	.749	.707	.670	.637	.0637	.00637	637mmf.
.15	L_1	.163	.152	.141	.133	.125	.118	.112	.106	.0106	.00106	106m
	L_2	918m	852m	796m	746m	702m	663m	628m	597m	59.7m	5.97m	.597m
	C_1	.00367	.00341	.00318	.00298	.00281	.00265	.00251	.00239	239mmf.	23.9mmf.	2.39mmf.
	C_2	.653	.606	.566	.531	.499	.472	.447	.424	.0424	.00424	424mmf.
.2	L_1	.122	.114	.106	.0995	.0936	.0084	.0838	.0796	.00796	796m	79.6m
	L_2	.00122	.00114	.00106	.995m	936m	884m	838m	796m	79.6m	7.96m	.796m
	C_1	.00490	.00455	.00424	.00398	.00374	.00354	.00335	.00318	318mmf.	31.8mmf.	3.18mmf.
	C_2	.490	.455	.424	.398	.374	.354	.335	.318	.0318	.00318	318mmf.
.25	L_1	.0979	.0909	.0849	.0796	.0749	.0707	.0670	.0637	.00637	637m	63.7m
	L_2	.00153	.00142	.00133	.00124	.00117	.00111	.00105	995m	99.5m	9.95m	.995m
	C_1	.00612	.00568	.00531	.00497	.00468	.00442	.00419	.00398	398mmf.	39.8mmf.	3.98mmf.
	C_2	.392	.364	.340	.318	.300	.283	.268	.255	.0255	.00255	255mmf.
.3	L_1	.0816	.0758	.0707	.0663	.0624	.0589	.0558	.0531	.00531	531m	53.1m
	L_2	.00184	.00171	.00159	.00149	.00140	.00133	.00126	.00119	119m	11.9m	1.19m
	C_1	.00735	.00682	.00637	.00597	.00562	.00531	.00503	.00477	477mmf.	47.7mmf.	4.77mmf.
	C_2	.326	.303	.283	.265	.250	.236	.223	.212	.0212	.00212	212mmf.
.4	L_1	.0612	.0568	.0531	.0497	.0468	.0442	.0419	.0398	.00398	398m	39.8m
	L_2	.00245	.00227	.00212	.00199	.00187	.00177	.00168	.00159	159m	15.9m	1.59m
	C_1	.00979	.00909	.00849	.00796	.00749	.00707	.00670	.00637	637mmf.	63.7mmf.	6.37mmf.
	C_2	.245	.227	.212	.199	.187	.177	.168	.159	.0159	.00159	159mmf.
.5	L_1	.0490	.0455	.0424	.0398	.0374	.0354	.0335	.0318	.00318	318m	31.8m
	L_2	.00306	.00284	.00265	.00249	.00234	.00221	.00209	.00199	199m	19.9m	1.99m
	C_1	.0122	.0114	.0106	.00995	.00936	.00884	.00838	.00796	796mmf.	79.6mmf.	7.96mmf.
	C_2	.196	.182	.170	.159	.150	.141	.134	.127	.0127	.00127	127mmf.
.6	L_1	.0408	.0379	.0354	.0332	.0312	.0295	.0279	.0265	.00265	265m	26.5m
	L_2	.00367	.00341	.00318	.00298	.00281	.00265	.00251	.00239	239m	23.9m	2.39m
	C_1	.0147	.0136	.0127	.0119	.0113	.0106	.0101	.00955	955mmf.	95.5mmf.	9.55mmf.
	C_2	.163	.152	.141	.133	.125	.118	.112	.106	.0106	.00106	106mmf.
.7	L_1	.0350	.0325	.0303	.0284	.0267	.0253	.0239	.0227	.00227	227m	22.7m
	L_2	.00429	.00398	.00371	.00348	.00328	.00309	.00293	.00279	279m	27.9m	2.79m
	C_1	.0171	.0159	.0149	.0139	.0131	.0124	.0117	.0111	.00111	111mmf.	11.1mmf.
	C_2	.140	.130	.121	.114	.107	.101	.0957	.0909	.00909	909mmf.	9.09mmf.
.8	L_1	.0306	.0284	.0265	.0249	.0234	.0221	.0209	.0199	.00199	199m	19.9m
	L_2	.00490	.00455	.00424	.00398	.00374	.00254	.00335	.00318	318m	31.8m	3.18m
	C_1	.0196	.0182	.0170	.0159	.0150	.0141	.0134	.0127	.00127	127mmf.	12.7mmf.
	C_2	.122	.113	.106	.0995	.0936	.0884	.0838	.0796	.00796	796mmf.	79.6mmf.
.9	L_1	.0272	.0253	.0236	.0221	.0208	.0196	.0186	.0177	.00177	177m	17.7m
	L_2	.00551	.00512	.00477	.00448	.00421	.00398	.00377	.00358	358m	35.8m	3.58m
	C_1	.0220	.0205	.0191	.0179	.0169	.1059	.0151	.0143	.00143	143mmf.	14.3mmf.
	C_2	.1088	.101	.0943	.0884	.0832	.0786	.0745	.0707	.00707	707mmf.	70.7mmf.



Low-pass filter:

$f_c = \frac{1}{\pi\sqrt{L_1 C_2}}$

$R = \sqrt{\frac{L_1}{C_2}}$

$L_1 = \frac{R}{\pi f_c}$ $C_2 = \frac{1}{\pi f_c R}$

High-pass filter:

$f_c = \frac{1}{4\pi\sqrt{L_2 C_1}}$

$R = \sqrt{\frac{L_2}{C_1}}$

$C_1 = \frac{1}{4\pi f_c R}$ $L_2 = \frac{R}{4\pi f_c}$

Band-pass filter:

$f_M \sqrt{f_1 f_2}$

$f_M = \frac{1}{2\pi\sqrt{L_1 C_1}} = \frac{1}{2\pi\sqrt{L_2 C_2}}$

$R = \sqrt{\frac{L_1}{C_2}} = \sqrt{\frac{L_2}{C_1}}$

$L_1 = \frac{R}{\pi(f_2 - f_1)}$ $C_1 = \frac{f_2 - f_1}{4\pi f_1 f_2 R}$

$L_2 = \frac{(f_2 - f_1)R}{4\pi f_1 f_2}$ $C_2 = \frac{1}{\pi(f_2 - f_1)R}$

Band-suppression filter:

$f_M \sqrt{f_1 f_2}$

$f_M = \frac{1}{2\pi\sqrt{L_1 C_1}} = \frac{1}{2\pi\sqrt{L_2 C_2}}$

$R = \sqrt{\frac{L_1}{C_2}} = \sqrt{\frac{L_2}{C_1}}$

$L_1 = \frac{(f_2 - f_1)R}{\pi f_1 f_2}$ $C_1 = \frac{1}{4\pi(f_2 - f_1)R}$

$L_2 = \frac{R}{4\pi(f_2 - f_1)}$ $C_2 = \frac{f_2 - f_1}{\pi f_1 f_2 R}$

FIGURE 3.

Use of the Tables

Table I lists the element values for low-pass and high-pass filters with 500 ohms and 10,000 ohms characteristic impedance. These are the values for the full series arm and the full shunt arm, Z_1 and Z_2 as in figure 1. They are given in henries and microfarads except in some cases where micro-henries and micro-microfarads are used.

The cut-off frequencies listed were selected to minimize the work to be done by the user. All element values are inversely proportional to the cut-off frequency. This information will serve to find data for filters having a cut-off frequency which may not be listed. For instance: A low-pass filter working out of and into a 500 ohm line and having a cut-off frequency of 150 cycles requires a coil of 1.06 henry inductance and a shunt condenser of 4.24 microfarads. For a cut-off frequency of 1500 cycles these values become .106 henry and .424 μfd. When the cut-off frequency is 15 Mc. the values become 10.6 microhenry and 42.4 $\mu\mu$fd. Note that the figures remain the same but the decimal point only has been moved. A guide to the placing of the decimal point: note that the required values must be between those for 10 and 30 Mc.

When a filter is to be designed for a different characteristic impedance R, find the required data first for a 500 ohm filter. Then multiply the inductance value by R/500 and divide the capacity value by the same factor.

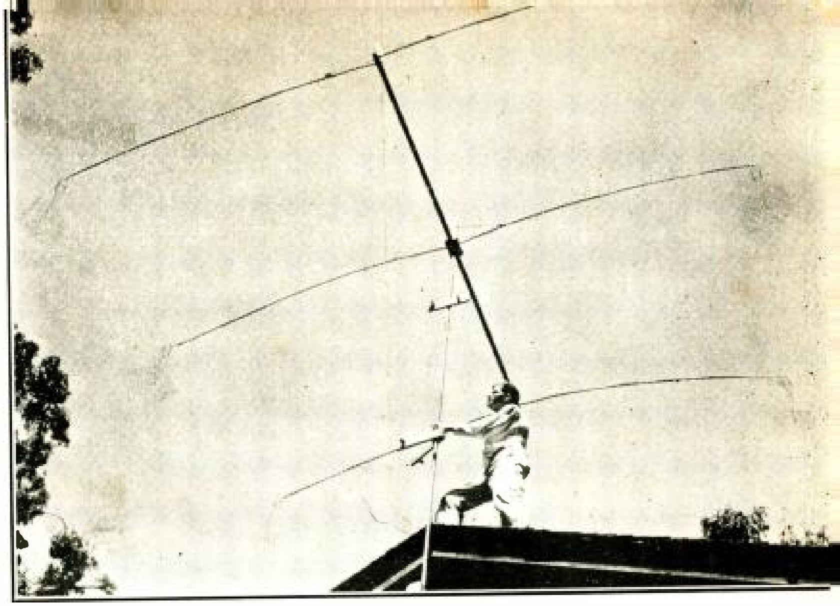
In table II is listed the required data for a band-pass filter of 500 ohms, having different band-widths and different mid-frequencies, f_m. Usually the two cut-off frequencies for the filter are given. Let us call these f_1 and f_2, f_1 being the smaller one. The mid-frequency is then the geometric mean between the two or $f_m^2 = f_1 f_2$. The band-width, for the purpose of this table is defined as $(f_2 - f_1)/f_m$. So, for instance, a filter with a lower cut-off frequency of 625 cycles and an upper cut-off frequency of 1625 cycles has a mid-frequency of 1000 cycles and a band-width of unity. A filter with the same mid-frequency and a band-width of .2 would have cut-off frequencies of 910 and 1110 cycles.

All values are given in henries and microfarads except those marked "m" which are in microhenries and micro-microfarads.

Similar to table I, element values for different mid-frequencies and different characteristic impedances can be obtained by interpolation or displacement of the decimal point, remembering that all element values are inversely proportional to the mid-frequency, the inductances are proportional and the capacities inversely proportional to the characteristic impedance.

When a different band-width is desired, the element values are found from the following rule: L_2 and C_1 are proportional and L_1 and C_2 inversely proportional to the band-width. Element values for a band-width of unity are the same as those given in table I.

To find the values of capacity and inductance of a band-suppression filter with a characteristic impedance of 500 ohms proceed as follows:—L_2 of the shunt arm is equal to $\frac{1}{4}L_1$ of the band-pass filter, and L_1 of the series arm is equal to $4L_2$ of the band-pass filter. C_2 of the shunt arm, in series with L_2, is equal to $4C_1$ of the band-pass filter; and C_1 of the series arm in parallel with L_1 is equal to $\frac{1}{4}C_2$ of band-pass filter.



"Short coupled" 14 Mc. three element array. The end-loaded elements are no longer than for a conventional 28 Mc. array of the same type.

End Loading the Three-Element Beam for Economy and Compactness

By P. L. BOURRET,* W6KNW

Despite the fact that rotatable directional antennas have been available to amateurs for several years, their use is still far from universal. For some, they cost too much; for others, they take too much time to put up. And there are still a large number of amateurs who don't think a rotary offers worthwhile advantages over the simpler antennas. For this last group, there is only one answer. Ask the man who owns one, or better, operate with one yourself.

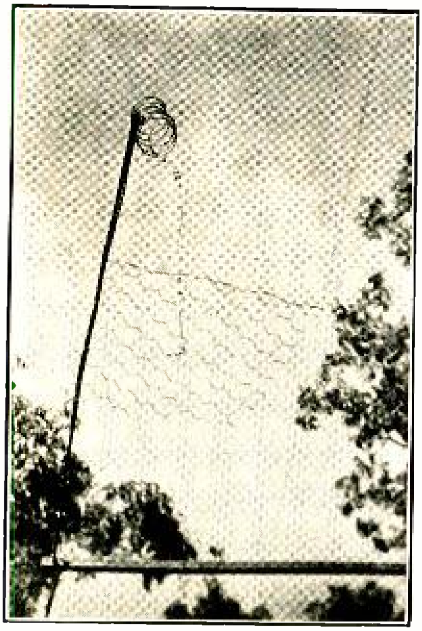
This article attempts a solution for the first two objections by proposing a 14 Mc. beam that ought to set a new standard for low cost and simplicity. Here are some of the claims made for this rotary:

Gain closely approximating that of orthodox three-element beams.
Sharp directivity. Signals drop off at 10° rotation.
30 db. front to back ratio.
Simple to construct. This one took five hours, exclusive of tower and rotator. (These required an additional four or five hours.)
Inexpensive—not more than two or three dollars if you buy everything new.
Light weight (less than twenty pounds).
Easy to feed. Efficient delta match with open wire 600-ohm line.

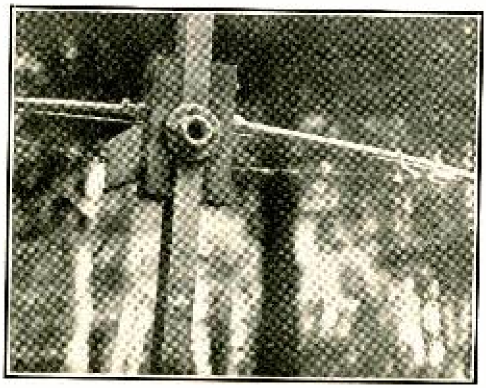
The unorthodox appearance of the beam arises from an attempt to meet several unusual requirements. The antenna was to be used for only two weeks at a summer camp; hence expense and labor had to be at a minimum in order to justify building it at all. At the same time high gain was needed to overcome a combination of low power and a large number of r.f.-absorbing trees surrounding the antenna site.

The materials used and the appearance of the antenna in the different stages of construc-

*Alma, California.



Looking up at one of the director end loading contraptions. All six inductances are the same, and all are spaced 20 inches from their capacity plate.



Detail of center portion of boom, showing reenforcement, method of attaching bamboo elements, and floor flange for fastening to pipe support. With heavier bamboo, the truss wires would not be required.

tion were a constant source of amusement to our fellow-campers. The thirteen foot main supporting boom was taken from under the feet of the chickens in a nearby roost. The element supports are pieces of bamboo trimmed from a small stand of bamboo on the property, and the number 8 copper wire elements are tied to these with string. Iron wire was used for the inductances, since it is more rigid than copper. The loss as compared to copper is negligible, because the impedance is relatively high. We rolled these up for the job, though had there been some old bed springs handy they would have saved us this extra labor. The capacity loading was done with foot square pieces of chicken wire, also "borrowed" from the nearby hen-roost. Because of its rigidity, good conductivity, and lack of wind resistance we think this is an ideal material for the purpose and suggest that supply houses begin handling it in specially prepared and nicely silver-plated sections.

Theory

Before going into the details of construction on this "bed-spring, chicken-wire array," a few remarks on the theory of end-loading will make it clear why this particular method of simplifying the beam was chosen. Any half wave antenna is similar to an ordinary resonant circuit except that its constants are distributed throughout the length of the conductor. The r.f. current flowing in the half wave is always of maximum intensity in the center part, gradually diminishing till it reaches zero at the ends. Maximum radiation takes place where this current is maximum. Any portion of the half wave wire can be replaced by lumped inductance and capacity. This substitution of lumped in place of distributed constants has two effects. The length of the half wave section is shortened (its electrical length remains the same); and the portion replaced by lumped inductance and capacity no longer radiates.

If it is desired to shorten a half wave horizontal radiator to the physical dimensions of a quarter wave this is best done by introducing the lumped constants in the end eighth waves and not in the center. The reason is chiefly the fact that the radiation resistance is lowered more when the loading is done at the current loop. The effectiveness of using end loading when the antenna is shortened has already been demonstrated in practice by the beam with bent down ends of W7GAE[1], and more recently by the experiments with shortened 160 meter verticals of W6KQ[2].

Construction

The main beam support of the antenna was made up of a 13′ 4″ piece of 1½″ by 1¾″

[1]Weagant, "Compacting the 3 Element Rotary," RADIO, July, 1939, p. 34.
[2]Kennedy, "Top Loaded Verticals," RADIO, April, 1940, p. 20.

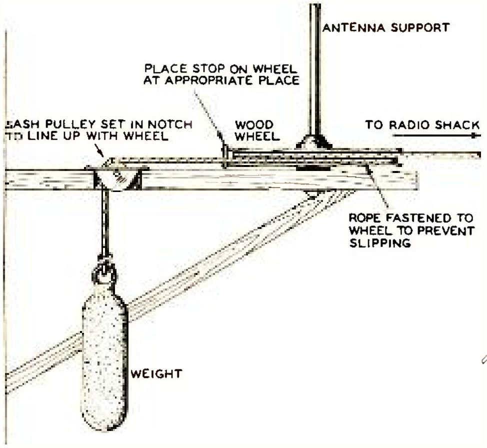
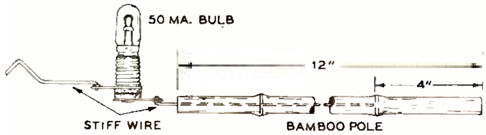


Figure 1.
Detail of simple rotating mechanism. The stop prevents the shaft from being rotated more than 360 degrees and tangling the feeders. A nail through the stop and rope will keep the rope from slipping.

Figure 2.
Standing wave indicator, indicating amplitude of voltage on feed line.



pine. Reinforcement in the center was obtained by bolting two 8" pieces of the same stock to either side with ¼" bolts. Where the beam can easily be lowered and the ends reached for adjustments, there is no need to provide a pivot connection to the supporting pole to permit tilting, and a simple floor flange pipe connection can be fastened with lag screws to screw directly on to the ¾" pipe support. The radiating part of each of the three elements in this antenna was made up of No. 8 copper wire, tied by string to the bamboo supports. Of course for a permanent installation, wire should be used in place of string. Holes about three-sixteenths inches larger than the bamboo were drilled into the boom, and at a slight upward angle in order to balance the sag at the outer ends of the elements. The bamboo poles were inserted in these and small three inch sections of split bamboo hammered in as wedges to produce a tight fit. A small piece of dowel hammered into the hollow end will prevent the bamboo poles from cracking under the pressure of the wedges. If the poles chosen are at least three-quarters of an inch in diameter at the large end, the overhead trusses will be unnecessary.

Although No. 8 copper wire was used for the full length of the radiating portion of each element, it should be noted that the only place where large diameter conductor is needed is the center four or five feet. Copper tubing could be used here with slightly reduced losses, but beyond this center portion there is no reason for using anything heavier than No. 12. Perhaps the best inexpensive elements would be those made from foil covered bamboo as described by W9NWU in a recent issue of RADIO[5]. But then that begins to raise the labor vs. results ratio.

The iron inductances were made from No. 14 galvanized iron wire (same size as No. 12 copper) and are wound on a 2¼ inch form. When taken off the form the free diameter increases to about 2¾". Before winding these coils, it will help to stretch the iron wire a few feet in order to make it absolutely straight and thus insure perfectly uniform coils. After they are wound, if the coils are pulled out to produce about ¾" spacing between turns, slight differences in spacing will have negligible effect on the over-all inductance. However, the tuning will be easier if care is used to make the coils

[*Continued on Page 74*]

---

[5]Murray, "Bamboo Radiator Elements," RADIO, June, 1940, p. 76.

TABLE OF DIMENSIONS

Main Boom: 13' 4" x 1¾" x 1½"

Spacing between elements:
  6' 6" for both director and reflector

Director:
  Horizontal portion: 8'
  Inductance: 6 turns

Radiator:
  Horizontal portion: 8' 4"
  Inductance: 6½ turns

Reflector:
  Horizontal portion 8' 8"
  Inductance: 9 turns

All inductances are wound so as to have a diameter of 2¾", and are pulled out to make a spacing of approximately ¾" between turns.

Distance from bottom end of all inductances to capacity plate: 20"

Calculating Distance and Direction

By E. H. CONKLIN,* W9BNX

Ho hum! With very little dx on the air, why read an article on calculating its distance or direction? Who cares, now, if that nice new great circle map on the wall *is* ten degrees off on the directions of points in India? Well, there is something to be said for such a point of view if you are not concerned with actual distances of five- and ten-meter skip, and are not confused on the actual direction of Boston from San Francisco or the reverse. Few can work Swan Island or some of the other choice tidbits, with so many on the air to be satisfied by the eligible dx stations.

Yet, there is much confusion on this matter of distance, part of it resulting from road mileage, perhaps, or the inadequacy of many maps that cover a large area. Almost everyone will say that Miami is 1500 miles from Chicago, and many will think that it is considerably east.

Two years ago a study of five-meter skip was published[1] indicating that many stations were heard at 1500 miles or more, meaning that signals may have taken two hops of less than 1250 miles—if there is anything to the writer's explanation of the "sporadic E-layer"[2] as the means of producing skip dx on five meters. A careful recheck revealed that all reports were within 1200 miles, after all misread calls were traced to similar calls of stations actually on the band at the time.

Accuracy is Cheap

How much trouble is it to obtain distances and directions accurately? An Atlas or the maps in a banker's directory will yield the latitude and longitude of any place with reasonable accuracy, subject to correction for the part of town in which a station is situated. All commercial (police and broadcast) stations probably have their position accurately stated in their license applications. A local surveyor will also have it. Maps in the hands of the Navy Hydrographic Offices or U.S. Coast and Geodetic Survey will provide accurate data.

After the latitude and longitude of two places have been determined, there remains only to call in the high school mathematics teacher or one of his (or, better, her) trigonometry students—or do it yourself if you have a book of trigonometric tables at hand.

The Z P S Triangle

Now comes a short course in Spherical Trigonometry. The name is big, but don't get scared. Follow the instructions in the front of the book of tables, and all will be hunky dory.

The astronomers use a common equation applied to what they call the Zenith-pole-star triangle. We could call it the transmitter-pole-receiver triangle and forget the astronomy. Also, navigators have use for similar solutions but, in the attempt to speed up the solution to a simple problem, they are inclined to dig up an equation and method that requires more time to learn for occasional use than it does to solve the problem by the direct method. The *ZPS* or *TPR* triangle on a sphere is the one shown in heavy lines in figure 1.

Calculating Distance

The equation to be used for distance is:

$$\cos a = \cos b \cos c + \sin b \sin c \cos A$$

The capital letters represent the angles and the small letters the sides opposite the angles. It is advisable to choose the letters so that a is the distance between the desired points,

*Associate Editor, RADIO, Wheaton, Ill.

[1] J. A. Pierce, "Interpreting 1938's 56-Mc. DX." *QST*, September, 1938, p. 23.

[2] E. H. Conklin, "56 Mc. Reception via Sporadic-Layer Reflections." *I.R.E. Proceedings*, January, 1939, p. 36.

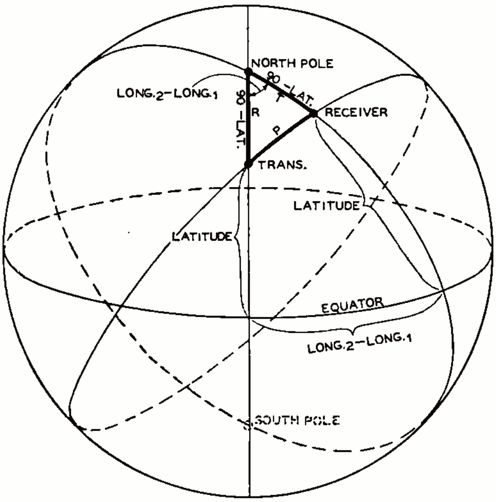


Figure 1.

opposite the angle at the pole, and A is the known angle at the pole, being the difference in longitude between the two points. Using the letters *TPR,* therefore, the equation will read as follows:

$$\cos p = \cos t \cos r + \sin t \sin r \cos P$$

The sides t and r are the distance from the known points to the pole, known as the co-latitude, and are equal to 90 degrees minus the latitude. We need not subtract the latitude from 90, however, but can use the co-function; that is, use the *sine* of the latitude as the same as the *cosine* of 90 degrees minus the latitude. These changes will make the equation read as follows:

$$\cos(\text{distance}) = \sin(\text{lat}_t)\sin(\text{lat}_r) + \cos(\text{lat}_t)\cos(\text{lat}_r)\cos(\text{lon}_r - \text{lon}_t)$$

Example of Distance Formula

Let us illustrate with an example, taking Chicago as 41°53′ N. latitude, 87°40′ W. longitude, and Miami as 25°46′ N. latitude, 80°11′ W. longitude. The first step is to multiply the *sine* of one latitude by that of the other, which can be done easily by adding the logarithms of these functions and taking the *antilog:*

log sin 41°53′	9.82453−10	
log sin 25°46′	9.63820−10	
log of product	9.46273−10	
product	0.29022	(1)

Next we must do the same with the other term of the equation, which includes the difference in longitude, 87°40′ less 80°11′ or 7°29′:

log cos 41°53′	9.87187−10	
log cos 25°46′	9.95452−10	
log cos 7°29′	9.99629−10	
log of product	9.82268−10	
product	0.66478	(2)

The sum of the products (1) and (2), 0.95500, is the *cosine* of the distance, and the tables gives the distance as 17°15′. Converting the degrees to minutes, this is equal to 1020 minutes or nautical miles. To get statute miles, multiply by 1.1516, which can be done by logarithms:

log 1020	3.00860
log 1.1516	0.06130
log distance	3.06990
distance	1,174.6 statute miles

As a second example, let us calculate the distance from Dallas to Boston:

	lat.	lon.
Dallas	32°47′	96°50′
Boston	42°21′	71°03′
Difference in longitude		25°47′

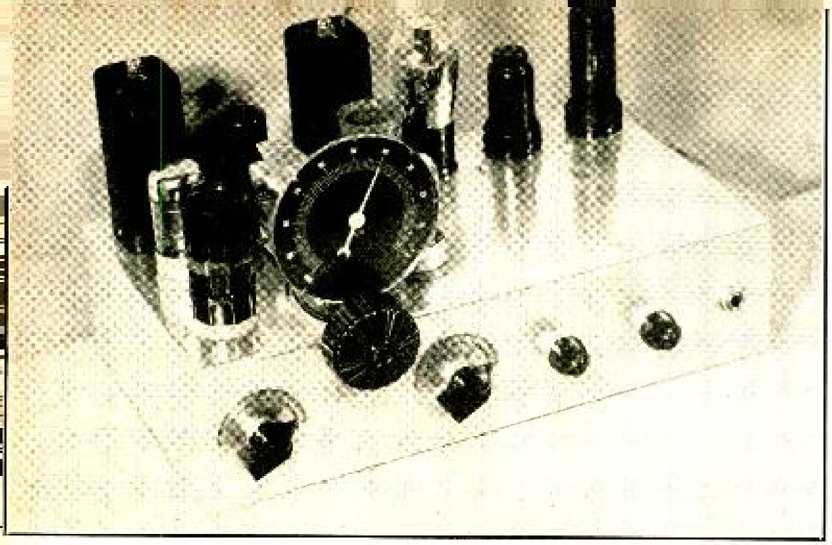
log sin lat.₁	9.73357−10
log sin lat.₂	9.82844−10
log product	9.56201−10
product	0.36476
log cos lat.₁	9.92465−10
log cos lat.₂	9.86867−10
log cos long.	9.95446−10
log product	9.74778−10
product	0.55948
cos distance	.92424
distance	22°27′=1347 naut. mi.
log distance	3.12937
log 1.1516	.06130
log distance	3.19067
distance	1551.2 statute mi.

This distance can be corrected for the location of the actual stations in respect to the point for which the latitude and longitude were selected. This change will amount to but little, as a rule.

While maps are sometimes misleading as to distances in a north and south direction, they are apt to be much more so in an east and west direction, especially in the higher latitudes and for long distances.

Where the difference in longitude between the two places is greater than 90° or where

[*Continued on Page 85*]



By limiting its features to the important items of operation, this superhet was built by the author at an expense of only $20.00 for parts.

A "Bare Essentials" SUPERHET RECEIVER

By EVERETT TAYLOR,* W8NAF

When the newcomer sets out to equip his amateur station for regular operation, the problem of what to use for the station receiver is not an easy one to solve. Inquiries among his friends will indicate that the majority of them are using factory-built jobs retailing from $75.00 to twice this figure. Asked as to what they used before that, they will probably mumble something about a blooper and add that it was fine except when someone else in town was trying to use the same band simultaneously.

All this is very informative but not very conclusive to one who has but a limited budget allotted to the receiving equipment. A judgment commonly given by persons who have had more experience in such matters is: If you have over about $50.00 to spend, buy the factory-built set which seems to best meet your needs; if you have between $30 and $50 available, there are many good used receivers so priced and obtainable from reputable distributors, and there are several satisfactory new receivers also in this range; but if your cash assets fall very far below the $20.00 mark, you had best dig into past magazine articles, the HANDBOOK, and your ingenuity and see what you can build.

In the author's case, a good receiver for 28, 14 and 7 Mc. was needed, but the budget set $20.00 as the upper limit of expenditure. The requirement was for a good c.w. set which would also deliver good quality and reasonable selectivity for phone.

It is well known that an r.f. stage ahead of the mixer is helpful in sensitivity and image rejection. But in the interests of simplicity and economy it was decided to eliminate the r.f. stage and place the burden of sensitivity on a 1232 loctal as mixer, the burden of image rejection on a 1500-kc. i.f. channel. It was felt that the 1232, with its high transconductance, short leads, and glass base insulation, would make an excellent tube for the input circuit.

Take a look at the construction of the base of a loktal tube and you will see that the elements are welded directly to the external pins, giving low lead inductance. A companion loktal tube is used as h.f. oscillator in preference to a 6C5 or 6J5 in this part of the circuit.

Loktal tubes could have been used throughout, but after consulting a tube characteristic chart, no apparent difference for the lower frequency circuits could be noted in comparing

*611 W. Vine Street, Mount Vernon, New York.

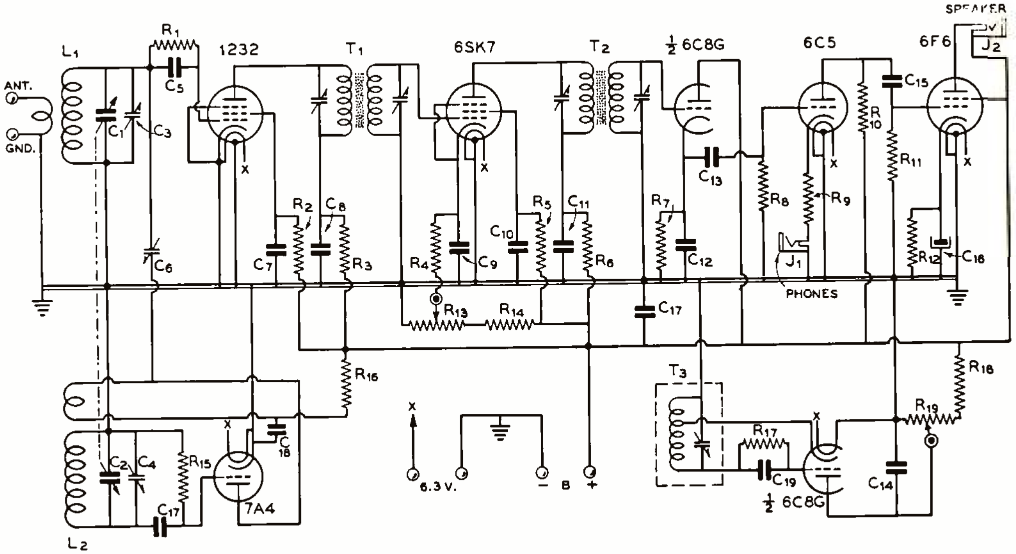


Figure 1.

Receiver wiring diagram.

C_1, C_2—See text
C_3, C_4—100-µµfd. midget variable
C_5—.0001-µfd. mica
C_6—3-30-µµfd. mica trimmer
C_7, C_8, C_9—.05-µfd. 400-volt tubular
C_{10}—.01-µfd. 400-volt tubular
C_{11}—.05-µfd. 400-volt tubular
C_{12}—.00025-µfd. mica
C_{13}, C_{14}, C_{15}—.05-µfd. 400-volt tubular
C_{16}—10-µfd. 50-volt electrolytic
C_{17}—.0001-µfd. mica
C_{18}—.01-µfd. mica
C_{19}—.0001-µfd. mica
R_1—1 megohm, ½ watt
R_2—75,000 ohms, 1 watt
R_3—2000 ohms, ½ watt
R_4—300 ohms, ½ watt
R_5—50,000 ohms, ½ watt
R_6—2000 ohms, ½ watt
R_7—50,000 ohms, ½ watt
R_8—250,000 ohms, ½ watt
R_9—2000 ohms, ½ watt
R_{10}—50,000 ohms, ½ watt
R_{11}—250,000 ohms, ½ watt
R_{12}—400 ohms, 10 watts
R_{13}—10,000-ohm potentiometer
R_{14}—50,000 ohms, 1 watt
R_{15}—70,000 ohms, ½ watt
R_{16}—15,000 ohms, 1 watt
R_{17}—50,000 ohms, ½ watt
R_{18}—1 megohm, ½ watt
R_{19}—200,000-ohm potentiometer
J_1, J_2—Closed-circuit jacks
T_1—1500-kc. input i.f. trans., iron core
T_2—1500-kc. output i.f. trans., iron core
T_3—B.f.o. coil, see text
L_1, L_2—See coil table

them to octal. So the latter were used. A better looking layout could be had by using the loktals throughout, but price decided against this.

The Mechanical Layout

The chassis is 18 gauge, cadmium-plated steel, and the size is 7 x 12 x 3 inches. The mixer tube and grid coil are on the extreme left end. The input i.f. transformer is directly behind the mixer tube socket with the tubes following the first i.f. transformer strung across the back, left to right.

On the front of the chassis, from left to right are: mixer padding condenser, main tuning, oscillator padder, i.f. gain control, b.f.o. output adjustment and the headphone jack.

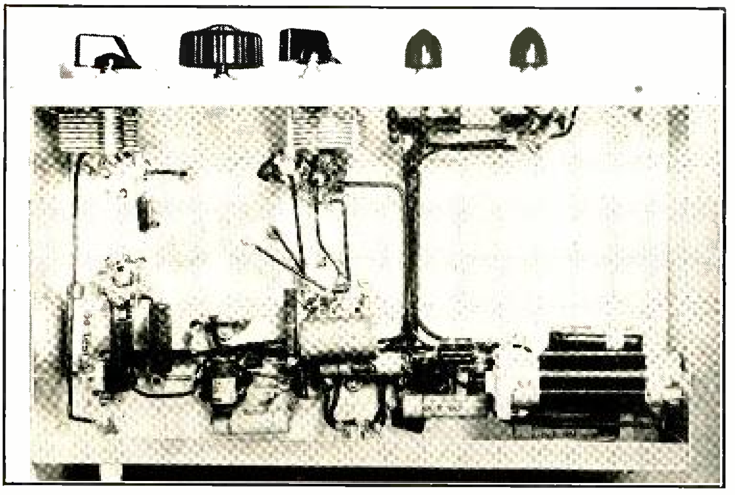
On the rear end of the chassis, directly behind the first i.f. transformer, is a Johnson 44 feed-through insulator for antenna connection. In the center of the drop is a 5-prong socket for power connections and directly behind the 6F6 audio tube is a jack for a loudspeaker.

As can be seen in the photos, plenty of room has been left to build in a power supply, perhaps, at some later date.

The Mixer

Cathode bias on the 1232 was used for a while but it was discarded in favor of a grid leak and condenser combination. The latter seemed to work out better in that it gave greater sensitivity with little difference in sharpness of tuning.

It would be advisable to use the new polystyrene sockets for the 1232 and 7A4 although those in this receiver at the present time are of the mica filled type. While they are satisfactory, it is felt that the polystyrene ones would allow lower losses. This type of socket has been put on the market since this receiver was constructed.



The under-chassis view of the super shows the straight-forward placement of parts, and the neat wiring installation.

The h.f. oscillator-to-mixer coupling condenser is a Meissner 3-35 $\mu\mu$fd. and it is connected from the grid of the 1232 to the plate of the 7A4. By coupling the mixer to the plate of the h.f. oscillator tube the tendency toward pulling is reduced over that which would result from connecting the condenser to the grid of the 7A4.

The H.F. Oscillator

There are a variety of opinions as to what h.f. oscillator circuit is most satisfactory. As for me, I will stick to the old plate tickler. The e.c. type was tried out but the hum on 10-meters was such that c.w. reception was not satisfactory on that band. A Colpitts, such as used in the Browning auto converter, was used for a while but its performance was not all that could be desired.

The Utopia in oscillator circuits would be a plate-tuned arrangement such as used in the RME DM-36 Converter. But this has the disadvantage in this case that one side of the tuning condenser is hot. Hence it is quite easy to get a shock when changing coils.

Back to the tickler type, the first and foremost advantage is the fact that the cathode is grounded. Therefore, there is less chance of hum modulation when using filament power other than d.c. Next, both the stator and rotor of the tuning condensers are at a ground potential (with respect to d.c.). Lastly, one side of the tickler is hot with r.f. voltage. A connection to this results in about the best way to excite the mixer tube with the least pulling and loading effects on the oscillator tuned circuit. A 15,000-ohm resistor is used in the plate lead of the oscillator to drop the voltage to a proper value. This in turn is by-passed to ground by a .01-μfd. paper condenser.

The band spread tuning condenser is made from a Hammarlund MCD-35 dual unit. The number of plates in each section is cut down to four rotors and three stators. The section for the oscillator tuning is the one nearest the rear, to cut down on possible hand capacity effects.

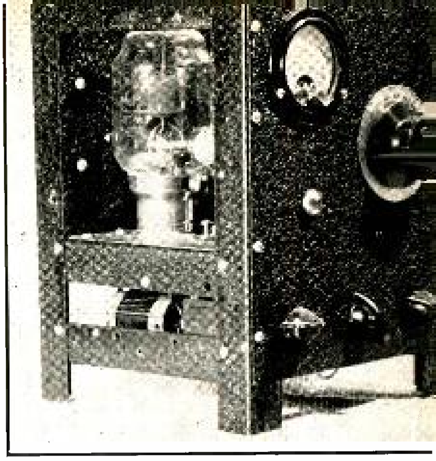
[*Continued on Page 86*]

COIL TABLE

Band	7 Mc.				14 Mc.				28 Mc.			
Coil	L_1	Ant.	L_2	Tickler	L_1	Ant.	L_2	Tickler	L_1	Ant.	L_2	Tickler
Wire Size	22	22	22	22	22	22	22	22	22	22	18	18
Turns	11½	6	12½	3	7½	4	8½	2	4½	3	4½	2
Length	close-wound	close-wound	1"	close-wound	1"	close-wound	1"	close-wound	1"	close-wound	1"	close-wound

All coils wound on 1¼-in. diameter forms.

● Here's a rig to worry the life out of the "so many watts in almost no space" addicts. Built by Howard Burgess, W9TGU, the rig has three stages ending up in a TW-75 at a quarter kilowatt input, the outside dimensions being 7 by 7 by 9 inches. "One Quarter Cubic Foot —One Quarter Kilowatt."



DEPARTMENTS

- **X-DX**
- **The Amateur Newcomer**
- **U. H. F.**
- **With the Experimenter**
- **Yarn of the Month**
- **New Books and Catalogs**
- **What's New in Radio**
- **Postscripts and Announcements**

X-DX AND OVERSEAS NEWS

By Herb Becker, W6QD

Send all contributions to Radio, attention DX Editor
1300 Kenwood Road, Santa Barbara, Calif.

This is about the time of year all the dx men would ordinarily be denying that they intended to enter the dx contest in March. I am wondering just what we'll be denying this year 'cause it's a cinch everyone will believe us when we say, "Nope, not going in the dx brawl this year." Ah, me, isn't it just dandy to look back on those feverish days of preparation, all of us trying to get our stations to the peak for the contest to come. Maybe the following will bring back some memories. Anyway here goes for some rambling thoughts that occur to me of contest during the past five years.

Can you remember around '33 when most of the operating was done of 40, and 20 was having its definite peaks (if any) every day? Can you remember the yeoman's job NY1AB did in grinding out the world high score? You surely remember the way certain stations from overseas would pound through with strength we thought never would be equaled but it was only a couple of years later until almost every peanut whistle over there was as loud. You must remember such guys as G5BY, G6NF, F8EO, F8EX, F8PZ (who could forget PZ's note) . . . and down LU way there was LU3FA, but you could never tell it from what he sent. You heard a noise and called LU3FA, and back he came. It's still a miracle to me how anyone ever got a serial number correct from him. Can't you remember ol' ZS2A who had things his own way, then he hung up the key. Surely would like to know where ol' Pye is now. Long about that time you must remember that ZE tribe coming through such as ol' ZE1JF, ZE1JH and ZE1JG and OA4U, ZL2CI, ZL4AI, ZL4AO. And then there were EA4AO, EA4AV and EA5BE. Surely you remember OH3NP, VU2LZ, OK1AW, OK1BC, ON4AU, ON4UU, ON4FE, and we never will forget sure dxers as OE1ER, J2GX. FM8IH, EA8AH, LY1J, HB9J, PA0LL. PA0XG, PA0QQ, and PA0XF. And how about these: SP1DE, SP1AR, EI8B, EI5F and CT1GU, SU1EC, GI5QX, VS6AG, VS6AE. I1TKM. While they're still popping through my noggin we can't overlook X1AA, X1AM, F3MTA, HP1A, VK3MR, VK3KX, VK3WL (gee, isn't your head swimming?); and then we couldn't get away from the sigs of LU1EP, LU9BV, LU7AZ, PK1HG, OM2AA, K4SA. K4KD.

AROUND 1935, 28-MC. DX STARTED TO COME INTO ITS OWN. W7AMX WORKED 5 CONTINENTS WITHOUT HALF TRYING AND ZS1H WAS ONE OF THE FIRST TO MAKE WAC ON TEN. ALONG ABOUT THIS TIME CAN YOU REMEMBER W1SZ, W1FH, W2UK, W3SI, W4CBY, W6GRL, W6CXW, W7BB, W6AWA W8ZY, W9IJ, W9TB? CAN'T YOU ALSO REMEMBER THE "HARD-TO-GET" BOYS THAT YOU PROBABLY SPENT HOURS TRYING TO LAND . . . SUCH AS CT3AB, ZD2C, FB8C, FM8BG, FF8MQ, LA1G, CT2BK, ZC6FF, YM4ZO, VR2NB, AND VO4Y. A LOT OF YOU MUST REMEMBER THE SWELL OPERATING OF JUDY LEON AT HC1FG. VK'S AND ZL'S WERE IN THERE BY THE ARMFULL . . . GOLLY, HOW MUCH WOULD YOU GIVE TO WORK JUST ONE LITTLE TINY VK OR ZL NOW? REMEMBER THE LARGE CHUNKS OF SCORES THESE FELLOWS WERE TEARING OFF IN '35: EA4AO, EA4AV, EA3EG, F8FC, GI6TK, HAF3D, OK2AK, LY1J (AS USUAL), AND ZE1JB. HOW MANY HEARTACHES DID YOU GUYS HAVE DURING THIS DX CONTEST? TRYING DAY AFTER DAY TO LAND ONE OF THE ABOVE CHOICE ONES AND SOME OTHER "PAL" JUST BEATING YOU OUT AND THEN THE DXER SIGNING OFF FOR THE DAY? YES I GUESS MOST OF US HAVE BEEN THROUGH THAT . . . AND IF WE HAD NOT WE WOULD NOT HAVE ANYTHING TO TALK ABOUT.

While this department is at it, that is, trying to make you feel bad, let's dig into the last couple of years. You know, we might as well shoot the works while we're at it. Remember in '38 and '39 when the phone boys really went to town . . .their scores being as large or larger than the c.w. men's? W2UK threw his kw. into the ozone for plenty of dx both c.w. and phone, while W6GRL and W3EMM doubled up and each scored tops in c.w. and phone.

Surely you remember all the foul e.c.o. sigs on the air this year. This type of control was nothing too new but in previous years they were not so plentiful. But this year, 1938, they really boomed out with everything that would vary. On top of such bad notes as most of them put out, most of us didn't know how to use them properly . . . we abused the privilege. From then until the next year much adverse criticism was given to anything that was a frequency varying device except the variable crystal. BUT . . . the boys weren't through, many went to work to really get a good e.c.o., and many good ones came out. Not until Charlie Perrine, W6CUH, put his device into print in June, 1939, RADIO did the trend of e.c.o's. change. And then they really did with great gusto. This is not especially meant to be orchids to CUH, but he did go about it in the right manner toward eliminating all the bugs from an e.c.o.

Well, anyway the variable frequency oscillator was the beginning of a different type of dx operating. With a good e.c.o. we could save plenty of operating hours, instead of being stuck on a few spots. No use going into it any deeper, you guys know it better than I do, but it did just occur to me that back there in '33 and '34 we sat around with 3 or 4 crystals and mostly working the band edges (yeah, both in and out).

Can you remember the scramble in '38 of the phone boys for such nice ones as YR5AA, VR6AY, EI6G, GM6RG, VU2LL, EA9AH . . . oh, and remember VU2CQ? Such stuff as FR8VX sounds highty sweet nowadays, doesn't it? 28-Mc. phone brought such fellows as VS6AG, SP2LM, I1TKM, ES5D, VP3NV, TG9AA and FA8IH. This all seems long ago with things as they are now, but there's no reason why we can't get into a reminiscent mood once in a while. I just hope I haven't made your mouth water too much for some of the juicy dx recorded in the previous paragraphs. Those were all just passing thoughts that occurred to me while in one of those moods, and we could go on and recall many more very prominent stations who all but rattled the power company's meter off the wall. Ah, those kilowatts, those hours, that boiling pot of java beside the operating desk, that night all Europe was rolling through on 40 like never before, and oh, that day we waited for 10 to open up . . . all in vain. That guy down the street with key clicks or the guy next door with the electric razor that made you miss a sure multiplier; that night you were laying for a certain choice elusive dx station to show up . . . and when he did, you boom out and call him with a satisfaction that you have foxed all the boys, only to find him coming back to your pal across town (the dirty rat).

BOY, THOSE WERE THE DAYS. IN THE MIDDLE OF A CONTEST YOU WONDERED WHO EVER HAD WRITTEN THE STORY ON THE BLANKETY-BLANK ANTENNA YOU WERE USING AND YOU COULDN'T RAISE A K6—THAT NIGHT YOUR ANTENNA HALYARD BROKE—THAT NIGHT YOU BLEW A FILTER CONDENSER TO HALIFAX—OR THE TIME A STRANGE LOOK CREPT OVER YOUR FACE WHEN YOU GLANCED AT YOUR FINAL TO DISCOVER THE FILAMENT OF ONE OF THE TUBES WAS OUT. OR . . . I COULD MENTION THAT NIGHT THE X.Y.L. REMINDED YOU SHE HADN'T BEEN OUT OF THE HOUSE FOR 6 DAYS, SO YOU WENT TO A SHOW. AND THE NEXT DAY YOUR PALS TOLD YOU OF THE SWELL DX THAT CAME THROUGH THE NIGHT BEFORE. (I WOULD LIKE TO ADD THAT ANY SIMILARITY OF THE ABOVE STATEMENT TO EXPERIENCES OF YOURS, OR MINE, IS NOT PURELY COINCIDENTAL). OH YES, WE MUST NOT FORGET HOW THE LIGHTS BLINKED NEXT DOOR SO YOU COULDN'T USE YOUR QRO UNTIL MIDNIGHT, OR JUST THE NIGHT WHEN CONDITIONS WERE SHAPING UP TO BE TOPS . . . THAT GOLDARNED POWER LEAK BREAKS LOOSE AGAIN. NOW GANG, JUST LOOK BACK AT THOSE THINGS THAT HAPPEN TO A DX MAN. I ASK YOU . . . IS IT WORTH IT? YES, YES, YES . . . I'LL SAY IT IS, AND I'LL BET THAT'D BE YOUR UNANIMOUS ANSWER IF WE SUDDENLY HAD THOSE DAYS BACK AGAIN. I HOPE YOU'VE HAD FUN RUNNING OVER THE OLD DX DAYS WITH ME. THIS HASN'T BEEN LEADING UP TO ANYTHING IN PARTICULAR, BUT LISTEN FELLOWS, NO MATTER WHAT HAPPENS LETS TRY AND KEEP SOME OF THESE DX THOUGHTS WITH US UNTIL EVERYTHING SHAPES UP BACK TO NORMAL AGAIN.

Just to show you how an item in this column will stimulate an urge, a couple of months ago X-DX made mention of the fact that W6CHE, the "Mac" half of Eimac, rode to work on a bike, weather permitting. The sequel came to my attention recently. It seems that Jack received a visitor from around the bay area who said he had noted he rode to the plant quite often on his bicycle, and that inasmuch as he was selling motorcycles . . . would he be interested in trading in his bike for a new "sputtercycle."

After all the crabbing trying to get guys like W9TB back on the air, just out of an almost clear sky 9TB pops up on a certain Saturday a.m. just in time to work KD4GYM. Wally has apparently been yelping around on phone for sometime however, so maybe we shouldn't be too hard on him. He made it

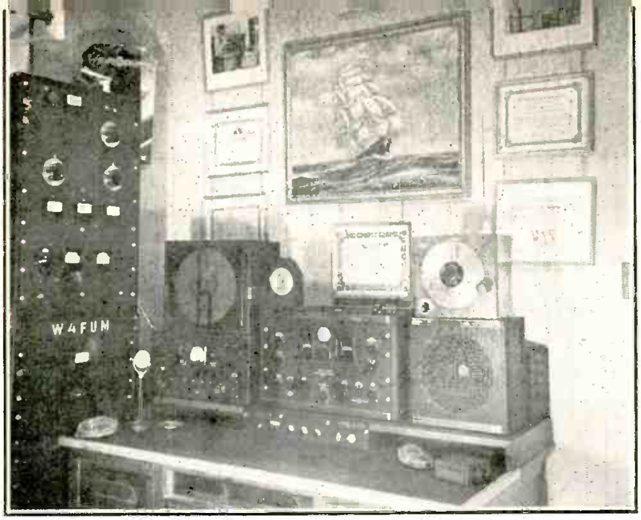
[*Continued on Page 56*]

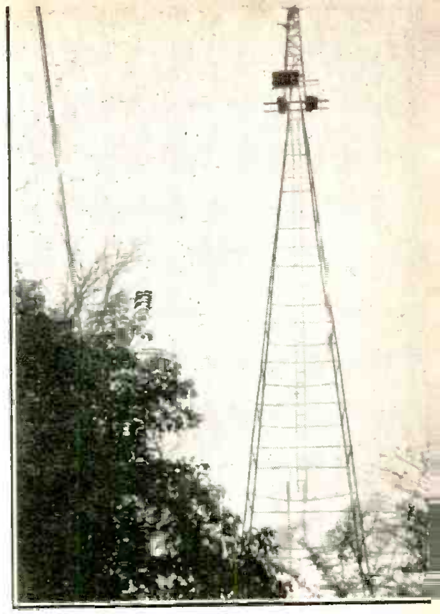
AMATEUR STATIONS

● Here is one of the best 10 meter phone stations on the air. We all know the "Colonel," **W4FUM,** of Montgomery, Alabama, by that fine signal he puts in everywhere. Of course, the Colonel's full name is John D. Cody, Jr. The rig is one of the National-Thordarson jobs slightly revised to use a pair of 250TH tubes in the final. The lineup in front begins with an NTE exciter into a 35T and this drives a single 100TH which in turn excites the final amplifier. On the operating desk we find the NTE exciter on the left, the Super-Pro in the center and its speaker on the right. W4FUM uses a 3-element rotary 99 feet in the air. At this time he is finishing a new 10-meter rotary with reflecting curtain, which is driven by two motors, one to change the direction and the other to change the vertical angle. He and W6KYL expect to conduct some tests in the near future, so by the time this reaches the printer he should know the results. W4FUM has worked 51 countries on 28 mc. phone which, by the way, is all that he has ever heard on 10. He has been interested in ham radio since the end of the last world war and says it is one hobby that he can't lose. ● To the right: The antenna at W4FUM.

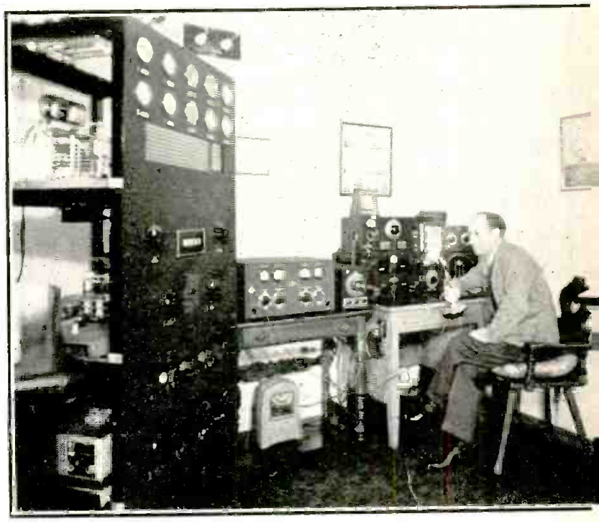
● The signal from **W6RBQ** hardly needs any introduction because of his unusual versatility on operating c.w. and phone and on practically all bands. Anyway, the owner, Wm. A. Ladley—better known as Bill—gets a tremendous boot out of ham radio. He handles traffic, shoots the breeze with anybody, and when it wasn't x-dx he could work that stuff too. Bill's large rig winds up with a pair of 250THs, and next to it you can see his Collins rig on the table. He uses this one on portable, emergency and field trips. Next to the Collins is his X-EC frequency control which he "pipes" into either transmitter. For receivers in this all around station Bill has a Super-Pro, HRO, and an NC-200 which was acquired since the picture was taken. Bill is one of the best liked fellows around the San Francisco area and this same feeling goes for the gang around the country with whom he QSOs. He is a very busy man, owning one of the largest plants in San Francisco, and it is a marvel to see him so active in ham radio. W6RBQ doesn't look as if he has any worries but he told me he really does have them once in a while . . . . and when this time comes he finds a good 3- or 4-way bull session on 40 c.w. a good tonic. RBQ works phone and c.w. Most of the c.w. is now on 40 and 80 meters, and Bill can be found most any evening on the low frequency end of the bands.

● The station of Charles W. Eggenweiler, **W6PMB,** is one that comes as close to being a real "deluxe" ham shack as we have yet seen. Note that Charlie's transmitters are in their own little room opening off the shack proper. The doors to this room are of glass so that he can observe meters at all times. This also allows the transmitters to be operated in complete silence. The final uses a pair of 250THs while the modulator has a pair of 100THs in class B. Direction indicators for each rotary antenna can be seen above the doors leading to the transmitters. ● To the left: W6PMB's operating desk and shack. On the desk you will note two Super-Pro receivers, with a 'scope mounted directly above. On either side of the 'scope may be seen the control panels containing meters and switches. A speaker is mounted in each "wing" of the desk. Charlie is one of the most consistent operators working the 10-meter band, and can generally be counted on to give you the daily lowdown on what is happening on 10 'phone. On just this one band W6PMB has worked 25 zones and 47 countries. Now if you will excuse us, we'll stir up the fire in PMB's fireplace and plop down in that easy chair on the left and watch Charlie blaze away at the poor defenseless mike.



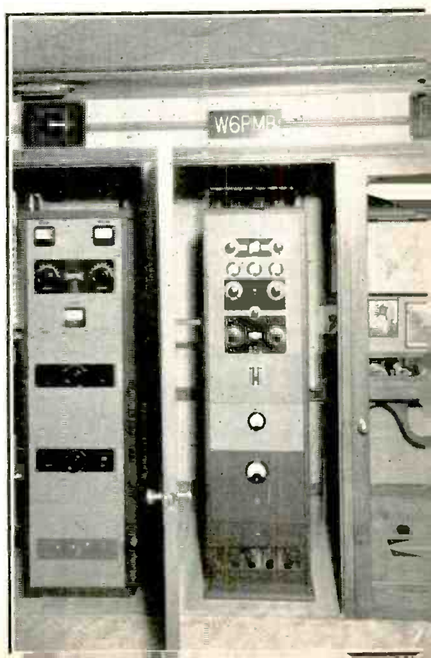


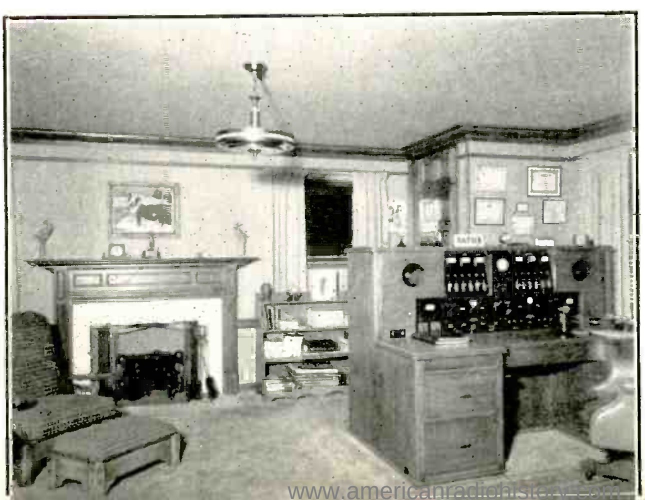
W4FUM



W6RBZ

W6PMB





X-DX

[*Continued from Page 53*]

plain that he had added two countries in the last *year* . . . they being the one above and KC4USA. Says he might move back into Chicago, but doesn't know definitely. Tsk!

Wedding Bells, Etcetera

W5BEN, Wm. Benjamin Wimberly, who will be known to some as the "man of the mike" at W9TB in the past, has "gone and done it." Last summer when yours truly was camping in and around the W9's, it was noticed that a rather balmy look crept over Ben when his y.l. arrived on the scene. Neither at the time would confirm or deny the possibility of what was to happen later. But being a veteran of four summers and winters myself of this married bliss (plus or minus), I could see the handwriting on the wall. So, on that day . . . the 23rd of December 1940, Ben and his y.l. (shhh! . . . the name's Bette) tied the knot that actually untied Ben's future ham activities. Alas! With Ben's story telling ability, since he is now in the same boat as the rest of us, let's see if he can tell a story now about this situation. All joking aside, with such a charming x.y.l. around I wouldn't be a bit surprised if she would spur him on to greater effort and higher power. Our heartiest congratulations, Ben. If my memory doesn't fail me I believe that Bette had the code down pat last summer. Ben is at the transmitter at WBBM. W9TB, who is there too, will no doubt have to awaken him on the job some day and read this epistle to him.

W3AYS SAYS THAT QUITE A NUMBER OF THE LOCAL DX MEN ARE WORKING FOR BENDIX, WESTINGHOUSE AND GLEN MARTIN. ALSO YOU MIGHT GET A KICK OUT OF CHARLIE'S REMARK, "AS ONE WHO HAS WORKED A MEDIUM AMOUNT OF DX, GOING TO 160-METER PHONE SINKS ONE TO A LOW LEVEL, DON'T YOU THINK?" I'LL JUST LEAVE IT LIE WHERE IT FELL. QUOTING FROM W1HIO . . . "AFTER TWO MONTHS OF FRANTIC CALLING I FINALLY RAISED KD4GYM. I MUST ADMIT THOUGH, THAT W8GGQ HELPED ME. HI. OH YES, W8GGQ CONTACTED HIM ALSO."

W2LVF says that W2BHW is about set to go into the service . . . W2GT has moved and is going to try 10 phone . . . W2JT has deserted 20 and is now chewing the rag on the 75-meter phone band . . . and W2CMY has built an e.c.o. 2LVF uses an RK39 with 50 watts input . . . and the following list of calls was received by LVF from ZS1M as being heard between November 21st and December 8th. No mention of the band was made but guess the fellows themselves will know. Here they are: W2CK, W2LDR, W2EIS, W2BXY, W1LSK, W1MTV, W1CJK, W1BJ, W2HKS, W2HFM, W1HQO, W2AEL, W2ARN, W1MBB, W2KJ, W2LTU, W2DUG, W1LYN, W2BZ, W1BGA, W1MQY, W1KNU, W1AXX, W1JVO, W2LSW . . . these were all apparently on c.w. judging by the reports given.

Shame! W6ONQ Busts Up Church Service!

Now we've seen everything! There's a church in the neighborhood of W6ONQ. Said church uses an electric organ. Recently during a service this electric organ was peeling off a hymn with great gusto. At the conclusion of this hymn when things were the utmost in quiet . . . what do you think happened? Well, during this hymn W6ONQ had fired up his rig on phone and apparently had his beam headed toward the church. Yes, yes, go on! Johnnie was just finishing a QSO when this slow deliberate voice came through the speaker system of the organ, with words something to this effect, "Well, you guys, that's the dope on that . . . I've surely enjoyed this session with you lugs, but next time lay off that late night stuff and you won't be late for our sked. Well, solong . . . etc., etc., . . . diddle-de-bump-de-bump."

"WAZ" Honor Roll Suspended

Due to the small number of changes (if any) that we have made in the Honor Roll during the last two months, we feel it better to refrain from publishing it for the time being. We may toss it in every once in a while to give you an idea of how it usta look. No changes were made in February at all so if any of you fellows have any additions please hang on to them for future publication. However, we will continue to publish the WAAP list.

W8PQQ WHO IS A JUNIOR IN E. E. AT WEST VA. UNIV., CAME HOME FOR XMAS AND JUST HAPPENED TO WORK KD4GYM, KG6MV, KC4USA, W2NBP/K4, K4GZR, K5AH AND SEVERAL K6'S. HOMER NOW HAS 134 COUNTRIES. W1APA IS BUILDING A NEW HOME AND FROM THE DESCRIPTION I WOULD SAY IT WILL BE A MIGHTY FINE DX SPOT. IT'LL BE A FINE

[*Continued on Page 84*]

A 112-MC. BANDSPREAD WAVEMETER

By LLOYD V. BRODERSON,* W6CLV

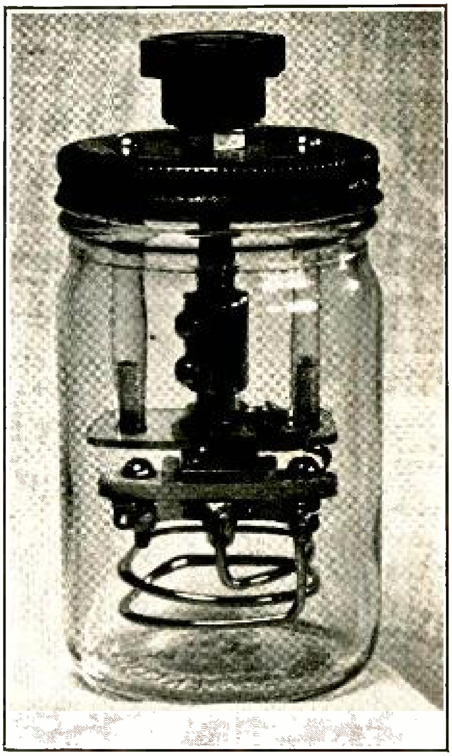
Increased activity on the ultra-high frequencies finds many amateurs including the 112-Mc. band in their field of operation. With but few exceptions, measuring the frequency of transmitters and receivers in this band is confined almost exclusively to the use of lecher wires. This system usually involves a troublesome, temporary installation of parallel wires which, more often than not, must be dismantled at the conclusion of measurements.

The construction and operation of absorption wavemeters is old stuff to most amateurs. However, their use in the past has been confined to measurements at lower frequencies, in most cases the instrument covering a complete amateur band in but three or four dial divisions.

For some time the need has been felt for a simple, efficient meter capable of measuring the frequency of high frequency receivers and transmitters. It should be compact, lightweight and inexpensive. Furthermore, it must be capable of retaining its original calibration under all conditions. The instrument to be described fulfills all of these requirements. With a little judicious planning and a thorough investigation of the proverbial "junk-box," its cost can be kept surprisingly low.

A glance at the circuit diagram (figure 1) shows it to be the usual tuned circuit consisting of a pickup coil and a variable capacity. A small trimmer condenser is shunted across C_1 and used as a band setter. These ceramic trimmer units have a negative temperature coefficient and were recently placed upon the market by a well known manufacturer. They may be obtained in various capacity ranges. The one shown in the model has a range of from three to twelve $\mu\mu$fd. Since this writing, a new zero coefficient condenser has been released, which should be even better.

*515 Salinas Nat'l Bank Bldg., Salinas, Calif.



This 112 Mc. absorption type wavemeter is mounted inside a Mason jar to preserve the accuracy of calibration. There is no danger of getting "bit" when the meter is brought near a high power tank circuit.

Construction

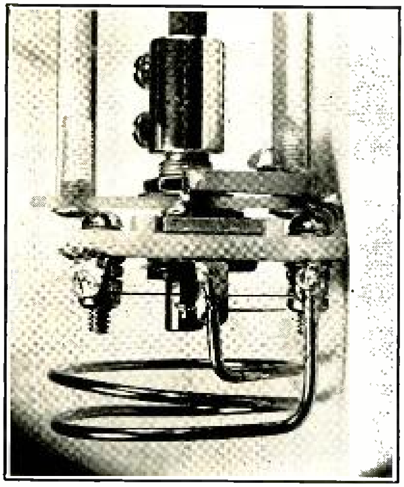
The entire unit is enclosed in a glass jar having a screw type cover. The photographs and drawings (figure 2) clearly illustrate the method of assembly. The two upright lucite bushings are tapped at each end for a 6-32 thread and mounted upon a support also of lucite. The upper support fitting the inside of the jar cover may be fashioned from a piece of Presdwood.

A standard three-plate, midget variable condenser is dismantled and rebuilt to have but two plates, the stator plate being adjustable. This is accomplished by replacing the original stator rods with 6-32 machine screws. When the correct spacing has been found, the single stator plate is held rigidly in place by small hexagonal nuts.

A rubber gasket inside the jar cover makes the unit airtight. The two 6-32 machine screws extending through the dial plate also serve to hold the cover, rubber gasket, Presdwood support and the upright bushings. The panel bearing is mounted in the exact center of the jar cover.

The pickup coil (L_1) consists of two turns of no. 12 wire, one and three quarter inches in diameter and spaced approximately one half inch between the turns.

It is of paramount importance when assembling to make certain that all leads are short and rigid and that the rotor bearing of C_1 is making perfect contact.



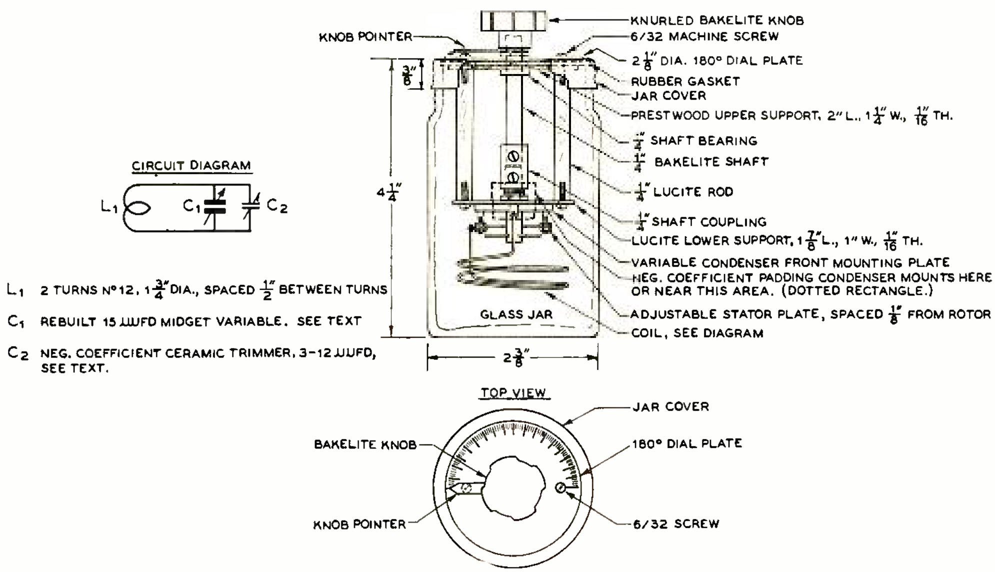
A closeup view of the wavemeter, illustrating detail of construction. Note the lucite posts.

Calibration

Perhaps the most practical means of calibrating the instrument is by a lecher wire meas-

[*Continued on Page 72*]

Mechanical and electrical construction of the wavemeter.



Step Number One:

THEORETICAL.

See past issues of RADIO; these will probably keep you from going completely zany.

Step Number Two:

PRACTICAL

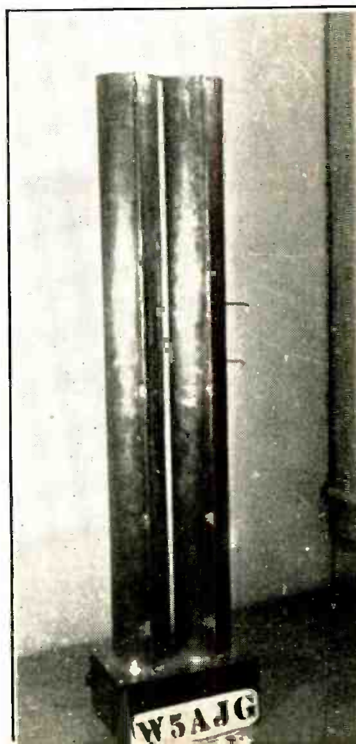
A strong back and a weak mind will be helpful in this step. It is advisable to go to your local labor temple and secure a union plumber's card.

The Three Steps Necessary In the Construction of A Conklin

"SEWER-PIPE U.H.F. RECEIVER"

As Discovered By

W5AJG



Step Number Three: THE FINISHED ARTICLE.

Moral: Theory and practice can be made to jibe.

U. H. F. . . .

By E. H. CONKLIN,* W9BNX

In these days of being called to military and naval duty, one hardly knows from one month (or week) to another who will write in with u.h.f. news or, for that matter, who will write the u.h.f. column. Just to be on the safe side, we should like to hear from several hams who might volunteer to do the work, for the good of the cause.

Stretching Skip DX

There has been a bit of discussion in past years as to the probable maximum limit of single-hop five meter dx of the sporadic-E layer reflection variety. Assuming a height of the layer and a minimum vertical angle at which power can be transmitted or received with useful efficiency, it appeared that the effective limit would be around 1200 to 1250 miles, as calculated for a great circle between two stations rather than measured on a distorted map. Actually, these figures appear to have been exceeded by a few outstanding five meter stations (possibly also on ten meters during the summer short skip), at times when there is no evidence at all of double skip to account for the extension of the distance covered. One obvious explanation is that some stations have the power, antenna, or favorable location to transmit or receive effectively down to vertical angles approximately zero—grazing the surface—or in the case of an elevated location, possibly down to an angle slightly below horizontal. The geometry of the skip shows that this will add quite some distance to the one-hop limit, and will nicely account for the fact that only a few good stations generally come through beyond 1250 miles or so, or find the band open at such times as only this type of skip is present.

There is, however, another possibility that deserves consideration—that of covering the extra miles by another means of propagation, such as low atmosphere bending at the ends of the hop. The ordinary skip follows the heavy line of figure 1, but bending at one end would shorten the maximum distance if the signal follows this path. The scale is exaggerated, especially as to the height of the layer, the amount of shortening due to bending in the low atmosphere, and the resulting shortening of the skip.

On the other hand, if there is bending at *both* ends, it appears possible for a signal to leave the transmitter at a normal minimum angle and, in the atmosphere, to be bent horizontal at a point some distance away and sufficiently above the surface of the earth not to be cancelled out by a ground reflection. From this point, then, the maximum skip might take place without a two or three degree limit of the minimum vertical angle of radiation that would be encountered normally. The skip, too, is longer than before. At the receiving end, much the same thing can happen. The resulting longer hop is pictured in figure 2.

W9YKX-W9ZJB Schedules

The pre-skip dx of W9YKX in Iowa and W9ZJB near Kansas City has been repeated regularly. The first contact, as reported last month, was on December 11. Bill Copeland heard ZJB on the following evening but he did not raise Vince. Another contact was made on December 26, for fifty minutes, with R8 signals. They had a schedule on December 30 and another R8 contact just before the band opened west for W6. The next attempt, on January 2, was also successful but signals faded badly. So far, the regular Monday and Thursday schedules have not failed, though this is hardly the time of the year to expect widespread groundwave dx. ZJB heard W9TTL, 230 miles away, on January 2 but could not get through due to a high noise level

*Associate Editor, RADIO, 512 No. Main Street, Wheaton, Illinois.

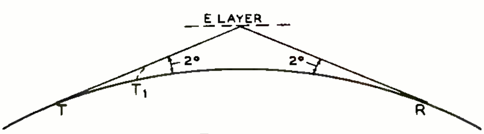


Figure 1.

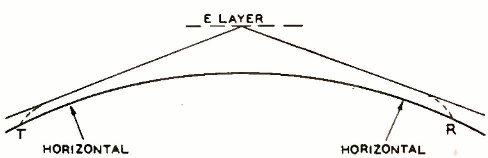


Figure 2.

at TTL. All of these stations seem to be using horizontal antennas as yet but they threaten to give verticals a try too. If TTL or YKX can work W9ZQC in South Dakota and ZJB can get W9GBJ in Springfield, Mo., as interested in five meters as he was in ten a few years ago, they will have themselves a nice relay circuit. W9VWU in Topeka, Kansas, did not go to war with the National Guard so the ZJB-VWU schedules will also probably be repeated. Someone in Lincoln, Nebraska, should also be able to horn in.

Other Pre-Skip DX

Regular contacts between Phoenix and Tucson are continuing. During the dx on December 26 to 28, W6QLZ put his loudest signals into W6OVK. When there is slow fading, OVK gets the fades a minute or so before W6SLO does but OVK's transmitter is more consistent in getting to QLZ than is SLO's.

W9QCY in Fort Wayne read about taking photographs and his first ones were quite good. His antenna includes one horizontal beam and a vertical. He is neutral on comparisons, being able to work across and down the State to W9AQQ in Indianapolis nearly every day and he has worked W9ZHL in Terre Haute and W9BDL in Marshall, Illinois, 175 miles away, on the horizontal beam. We must try to get him to describe his concentric line receiver.

June in January

Perhaps May now comes in December, but whatever it is, those getting on five meters have had a lot of dx to play with. Last month we reviewed the work of early December, to which should be added the information that on December 2, W6QLZ logged W4EDD W5AJG EHM W9ZHB and, on the 13th, the report of W5VV who found the band open from 8 to 9 p.m. during which he worked W6QLZ SLO OVK. Clyde said that OVK was sick in bed, but nothing less than pneumonia seems to keep him off when the band opens. Signals were up to R9 quite a bit.

On December 23, W9ZQC in Brookings, South Dakota, heard W4EQM and five other signals from 5 to 6:30 p.m. but they faded out too quickly to be identified. On the 24th, he heard seven unidentified carriers after 7 p.m., while W5AJG worked W8RUE from 5 to 7 p.m. with no other signals heard. RUE was coming through poorly. Also on this evening W9BJV in South Dakota heard W4EQM.

Bernice May, W5JKM (Mrs. W5AJG).

W5AJG and W9ZQC heard weak carriers on the evening of the 25th. On the next night, AJG worked W8RUE and W9QCY with W9ZHB and a harmonic of W8RJR/8 logged. This time, signals were fairly good for an hour after 5:30 p.m. Also on the 26th,

The operating position at W9QCY showing the concentric-line receiver.

56 Mc. DX HONOR ROLL

Call	D	S
W9ZJB	9	28
W9USI	9	23
W9USH	9	18
W9AHZ	9	16
W5AJG	9	34
W1DEI	8	20
W1EYM	8	20
W1HDQ	8	26
W2GHV	8	24
W3AIR	8	24
W3BZJ	8	27
W3RL	8	29
W6QLZ	8	21
W8CIR	8	32
W8JLQ	8	
W8QDU	8	25
W8QQS	8	17
W8VO	8	
W9ARN	8	17
W9CBJ	8	
W9CLH	8	
W9EET	8	15
W9VHG	8	
W9VWU	8	16
W9ZHB	8	29
W2AMJ	7	22
W2JCY	7	
W2MO	7	25
W3BYF	7	22
W3EZM	7	24
W3HJO	7	
W3HOH	7	17
W4DRZ	7	22
W4EDD	7	
W4FBH	7	17
W4FLH	7	18
W5CSU	7	
W5EHM	7	
W8CVQ	7	
W8PK	7	9
W8RUE	7	17
W9BJV	7	15
W9GGH	7	
W9QCY	7	15
W9IZQ	7	14
W9SQE	7	22
W9WAL	7	
W9YKX	7	13
W9ZQC	7	13
W9ZUL	7	18
W1LLL	6	24
W1CLH	6	13
W1JFF	6	11
W1JJR	6	17
W2KLZ	6	
W2LAH	6	
W5VV	6	18
W8LKD	6	11
W8NKJ	6	16
W8OJF	6	
W9NY	6	13
W1GJZ	5	15
W1HXE	5	18
W1JMT	5	9
W1JNX	5	12
W1JRY	5	
W1LFI	5	
W2LAL	5	11
W3CGV	5	10
W3EIS	5	11
W3GLV	5	
W3HJT	5	
W4EQM	5	8
W6DNS	5	
W6KTJ	5	
W6OVK	5	10
W8EGQ	5	10
W8NOR	5	16
W8OKC	5	10
W8OPO	5	8
W8RVT	5	7
W8TGJ	5	9
W9UOG	5	8
W9WWH	5	
VE3ADO	4	
W1LKM	4	6
W1LPF	4	16
W3FPL	4	8
W4FKN	4	8
W6IOJ	4	7
W7GBI	4	6
W8AGU	4	8
W8NOB	4	
W8NYD	4	
W8TIU	4	8
W1KHL	3	
W6AVR	3	4
W6OIN	3	3
W6PGO	3	6
W6SLO	3	3
W7FDJ	3	3
W8OEP	3	6
W9WYX	3	3

Note: D—Districts; S—States.

W6OVK in Tucson heard harmonics of ten meter signals from W7 and Northern California; he got out to the shack just as W7GBI faded out after a contact with W6QLZ that gave Clyde a new state.

On the 27th, OVK heard more harmonics, including W6PQW, then followed W6QLZ in working W5VV. Weak carriers, mostly from the east, continued to be heard for several hours. This was a good night for W5AJG too, who worked W8SLU W9VHG QCY BDL and heard W6QLZ W9SQE. The latter also heard AJG.

After the five-day run of openings, good and bad, the band appeared to close down except for strong ten meter harmonics for two days, to reopen on the 30th. W6OVK worked W5EHM W9YKX FZN ZQC and heard W9ZJB with a bad flutter on his signal and practically no modulation. Sounds like Pauline was at Vince's house. YKX was raised three times with R9 signals. EHM was a steady R4 on c.w. at OVK with a peculiar hollow sound that was like a VK on 14 megacycles with the band only half open. W9ZQC mentions the W6OVK contact and an uncertain one with W6QLZ, not confirmed in his report. He also heard W5EHM a bit earlier in the evening. W9YKX, after a 200-odd mile contact with W9ZJB, got in on the dx by working W6OVK, and W6QLZ who was R9. QLZ worked W9NFM FZN YKX ZJB and heard W5EHM W9ZQC BJV. W9ZJB called it aurora skip when he worked W6QLZ whose signal was distorted and who went to c.w. to finish the contact. W9BJV (South Dakota) heard W5EHM W6OVK QLZ.

New Year's Day

Then, as if it was not enough for the band to be good nearly every evening in the last week of 1940, it conveniently opened from 4:15 to 6:10 p.m., January 1, 1941, for W9ZQC who worked W9QCY ARN ANH and heard W8CZA. This involved some rather short skip. W9BJV in Watertown, S.D., heard W9HAQ in Davenport and W9ANH in Terre Haute.

The first inkling that W2KLX on Long Island had of anything unusual was when W3HOH came through with good strength (also rather short skip?) around five o'clock eastern time, then W9's began to come in and lasted an hour. Using only an inside antenna and a superregen receiver, KLX heard W9ZHB very well with W9HHT a close second. He heard a W9UGY (QCY?) and some others that were not identified. During this time, the signals from W2MPA, 35 miles away in New Jersey, had a distinct echo. While this was probably due to receiving the signal from two paths, the longer would show up as an echo only if it traveled an appreciable distance. For instance, a delay of a hundredth of a second would result from the second path being 1,860 miles longer than the first, such as might occur if the signal went out 930 miles, hit a vertical layer or was otherwise splattered and returned. Something like this may also explain the hollow sound that W6OVK heard on W5EHM, mentioned two paragraphs before.

2½ METER HONOR ROLL

ELEVATED LOCATIONS

Stations	Miles
W6KIN/6-W6BJI/6 (airplane)	255
W6QZA-MKS	215
W6BKZ-QZA	209
W6QZA-OIN	201
W6BCX-OIN	201
W6NJJ-NJW	175
W1DMV/6-W6HJT (airplane)	165
W9WYX-VTK	160
W6KIN/6-W6OMC/6	140
W6IOJ-OIN	120
W2LBK-W1HDQ	118
W1HDQ-W2JND	105
W6BCX-IOJ	100
W1HDQ-W2IQF	100
W1HDQ-W2GPO	100
W6NCP-OIN	98
W1KXK-MNK/1	81
W6IOJ-OIN	80
W6CPY-IOJ	80

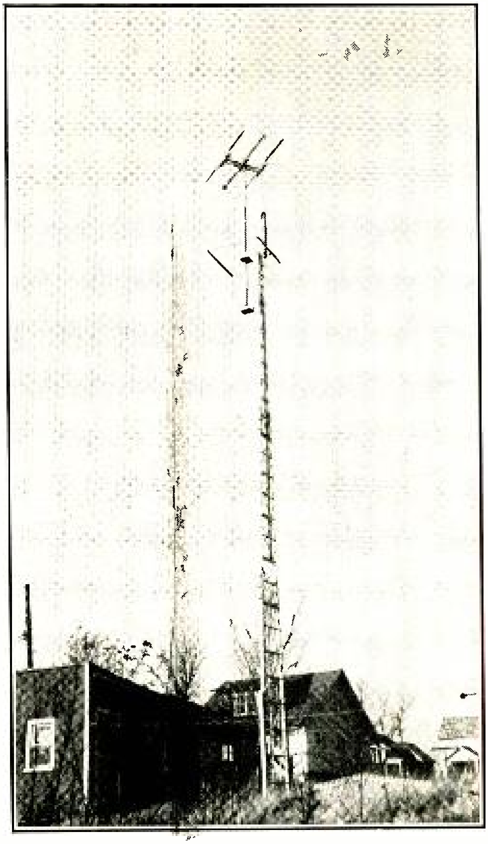
HOME LOCATIONS

Stations	Miles
W1MON-W2LAU	198
W8CVQ-QDU (crossband)	130
W1IJ-W2LAU	105
W2ADW-W2LAU	96
W1HBD-W1XW (1935)	90
W2LBK-W1IJ	76
W2LBK-W3BZJ	76
W1MWN-W2LAU	75
W1SS-BBM	74
W1KXK-IZY	73
W1MRF-W2LAU	68
W2GPO-LAU	50
W1LAS-W2LAU	45
W1LEA-BHL	45
W2JND-LAU	44
W2MLO-HNY	40
W3CGU-W2HGU	40

1¼ METER HONOR ROLL

ELEVATED LOCATIONS

Stations	Miles
W6IOJ-LFN	135
W1AJJ-COO (crossband)	93



The 56-Mc. horizontal and vertical 56-Mc. antennas in use at W9QCY.

That W5TW Beam

Did you ever get *very* disgusted with some troublesome bit of radio gear that baffled you —and then after a good sleep, did you wake up with the answer? Well, it seems to work about the same way with the *Question and Answer* section of this column. Several of the questions raised were solved before more than a few days had passed. The W9ZJB beam was one, and now W5TW's is another. Ed Harris got up early one morning with considerable determination to tune it or bust. He set up the plumber's delight ten feet off the ground and put the field strength meter a city block away. When the radiator length was checked, he found it to resonate 13 inches longer than the formulas for 29,216 kc. Then he adjusted the director and reflector, and rechecked everything. The result was a 72 db signal in front, 6 db off the sides and 16 db in back. That meant a 56 db front-to-back ratio. He thought that it was too

[*Continued on Page 70*]

With the Experimenter

56 Mc. EXCITER or TRANSMITTER

By Theodore Fabian,* W8RUE

When the regulation calling for stabilized 56 Mc. transmitters was passed in 1938, it meant that I would have to make some drastic changes in the rig if I were to stay on the air, as 56 Mc. seemed to be the only band I enjoyed working. The only equipment I had was a self excited rig, which got out pretty well but fell far short of complying with the new regs.

Like lots of others who are more interested in operating than in the technical side of radio, I had not at that time ever built a crystal controlled or even an m.o.p.a. transmitter. It looked as though the only thing for me to do was to cut my 56 Mc. coils to 112 Mc. but unfortunately there was little activity on 112 Mc. in the Pittsburgh area at that time; so 112 Mc. was not the answer.

Then arrived the January, 1939, issue of RADIO, and the article on a low powered 56 Mc. exciter or transmitter by Rothman. With no little trepidation I purchased the necessary parts and built it up. With little difficulty I got it perking and I was back on my pet band, where I got out with the best of them.

Later I made a few modifications in the rig which hopped it up a little. The oscillator was changed over to a Tritet, as shown in the accompanying diagram. This permitted operation of the following stage as a doubler rather than a quadrupler, which gave a boost in grid current to the final stage. This allowed heavier loading of the final stage without the modulation being distorted.

Using this transmitter, with less than 30 watts input, I have worked 7 districts and 18 states on 56 Mc. via the skywave route, and numerous stations from 50 to 190 miles from Pittsburgh on the groundwave.

*3036 Churchview Ave., Brentwood, Pa.

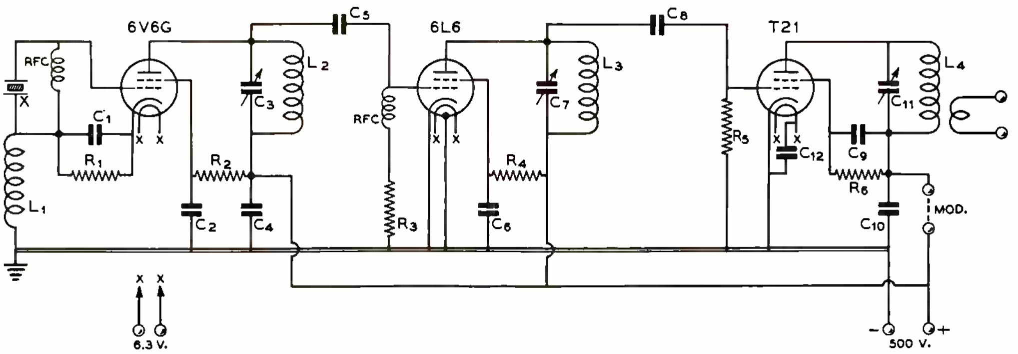
●

SOUND KINKS

By W. W. Blair*

There are undoubtedly a large number of readers of RADIO who are sound men of one classification or another. Some may be broadcast men, others theater or motion picture sound men, and others may fall into the public address group. But all have at one time or another run up against some simple problem that defied rational solution. Maybe the

*Keystone Theatre Service, Harrisburg, Penna.



Wiring Diagram of Modified Rothman 56 Mc. Transmitter

C_1—.00025 µfd. mica
C_2—.01 µfd. mica or paper
C_3—50 µµfd. midget
C_4—.005 µfd. mica or .01 µfd. paper
C_5—.0001 µfd. mica
C_6—.004 µfd. mica
C_7—15 µµfd. midget
C_8—.0001 µfd. mica
C_9—.002 µfd. mica
C_{10}—.001 µfd. mica
C_{11}—15 µµfd. double spaced midget
R_1—400 ohms, 10 watts
R_2—20,000 ohms, 10 watts
R_3—50.000 ohms, 2 watts
R_4—20,000 ohms, 10 watts
R_5—150,000 ohms, 2 watts
R_6—20,000 ohms, 10 watts
RFC—2.5 mh. r.f. choke
X—40 m. crystal
L—60 ma. pilot bulb
L_1—10 turns no. 14 enam., ¾ in. dia.
L_2—13 turns same, 1 in. dia., space wound
L_3—Same as L_2 only 6 turns
L_4—Same only 3 turns

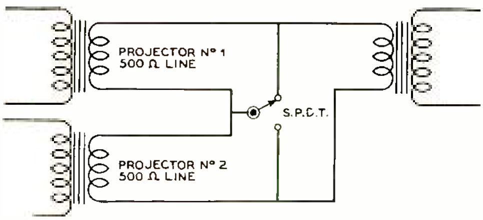


Figure 1. Clickless projector switching kink.

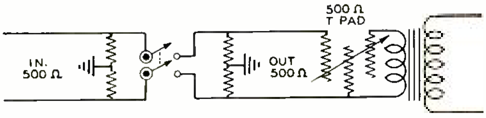


Figure 2. Clickless program line switching.

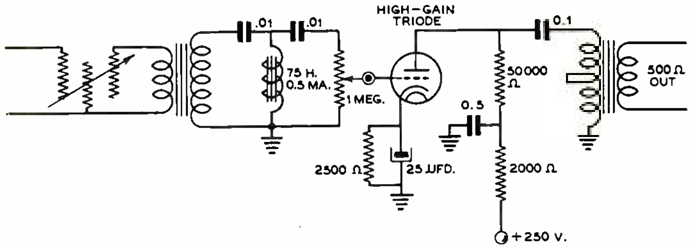


Figure 3.
Simple "telephone effect" filter.

three suggestions herein will allow some individual to regain his self respect by surmounting these should-be simple problems.

Number one is for the theater sound man. Many of you have encountered a noisy changeover switching system. I ran across a Photophone PB59X system employing a low-impedance input circuit which was particularly bad in this respect. The changeover switch would leave one circuit and make another, thereby causing quite a click in the sound. The trouble was remedied by connecting the two projector inputs in series and shorting the one which was not being used. The simple connection for accomplishing this is illustrated in figure 1.

Kink number two is for the benefit of the man at the control panel of the bc station. If you have trouble with clicking noises when you close the various channel switches, do this. Make up an x network of four one-megohm resistors, strap them across the four points of the channel switch, and ground the center of the x network as indicated in figure 2.

Number three is also for the broadcast sound man. You have probably been called upon quite frequently for a telephone filter. If you don't have one, figure three illustrates an easy way of making up such a gadget. Build a straight-forward single-stage amplifier, and design it so that it can be inserted between the microphone pre-amplifier and the main program amplifier. Then insert a simple high-pass filter between the microphone transformer and the grid of the tube. It is possible to get a very satisfactory telephone effect through proper adjustment.

INSTANT ACTION NEGATIVE PEAK OVER-MODULATION INDICATOR

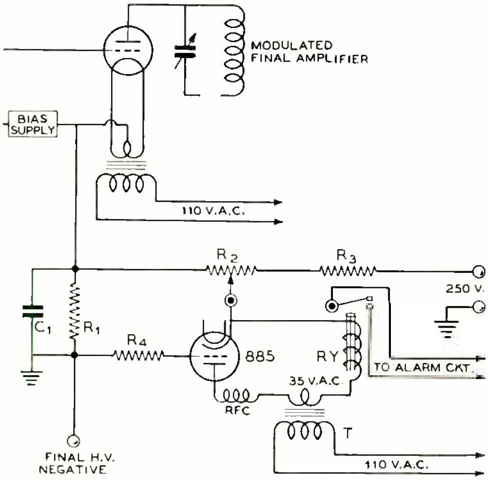
By Orbra Harrell,* W4BIN

Here is a negative-peak modulation indicator that goes to the extreme in simplicity yet does the job of indicating negative-peak overmodulation to a "T". Since the negative peaks of modulation are the ones that cause the damage by splattering the signal all over the band they should be very closely watched. Actually the carrier is cut off on negative overmodulation peaks and consequently the modulated tube is drawing no plate current at that instant. So by making use of this result of overmodulation we can make a very effective negative-peak overmodulation indicator.

If a resistor is placed in the return circuit of the modulated tube the voltage drop across this resistor will remain constant with no modulation (as far as audio frequencies are concerned). When the tube is modulated the current drawn by the tube varies above and below the average current drawn by the tube. At 100% modulation this current increases to twice this average value and then drops to zero in one complete cycle of the audio modulating voltage. Consequently the voltage drop across this resistor is proportional to the current at any instant.

Now if the cathode of a tube is connected to the positive end of the resistor and the grid to the negative end, this effectively puts

*1013 Blue Ridge Avenue, NE, Atlanta, Ga.



Schematic of the Negative-peak Overmodulation Indicator

C_1—0.01-µfd. mica or tubular
R_1—30 ohms, 10 watts
R_2—5000-ohm 2-watt potentiometer
R_3—250,000 ohms, 2 watts
R_4—50,000 ohms, 1 watt
T—Tube tester trans.
RY—Vacuum-tube relay
RFC—2.5-mh. r.f. choke

a negative voltage on the grid of the tube by the amount of drop in the resistor. On a negative modulation peak, when the tube decreases its current, less voltage drop is across the resistor thus lowering the bias on the tube. By connecting a "trigger tube" (gaseous triode) as shown in the diagram we can cause this tube to draw current when the bias is lowered to the critical point. This current change can be made to operate a relay in its plate circuit.

With plate voltage on the gaseous triode it will draw current unless it is biased to its critical cut off point. This bias can be obtained from bias cells if preferred but a more flexible arrangement is shown in the diagram, making it an easy matter to adjust the bias to the exact value. The whole thing works on the principle that when the bias on the triode is reduced to its critical point the tube will draw current, and due to its sharp cut off characteristic will be approaching maximum at the instant it begins to draw current at all. By putting a relay in the plate circuit it can be made to operate some sort of alarm system. This relay will then operate when 100% negative modulation is reached, thus giving the operator a warning that the transmitter is being overmodulated.

The instantaneous change in the plate current during the r.f. cycle will not affect the trigger tube because the voltage change across the resistor due to r.f. is effectively nil because of the condenser placed across this resistor. This condenser has a low reactance at the carrier frequency and a very high reactance at the modulation frequencies. With no modulation this leaves only a d.c. drop across this resistor.

The adjustment of this indicator is extremely simple and does not require additional equipment. It will hold its accuracy extremely well, varying only as the variation of the characteristics of the gaseous tube due to age. This can be taken care of by adjustment of the bias on the tube. The indicator requires no adjustment, or just a minor one, for change in power or external coupling to the transmitter.

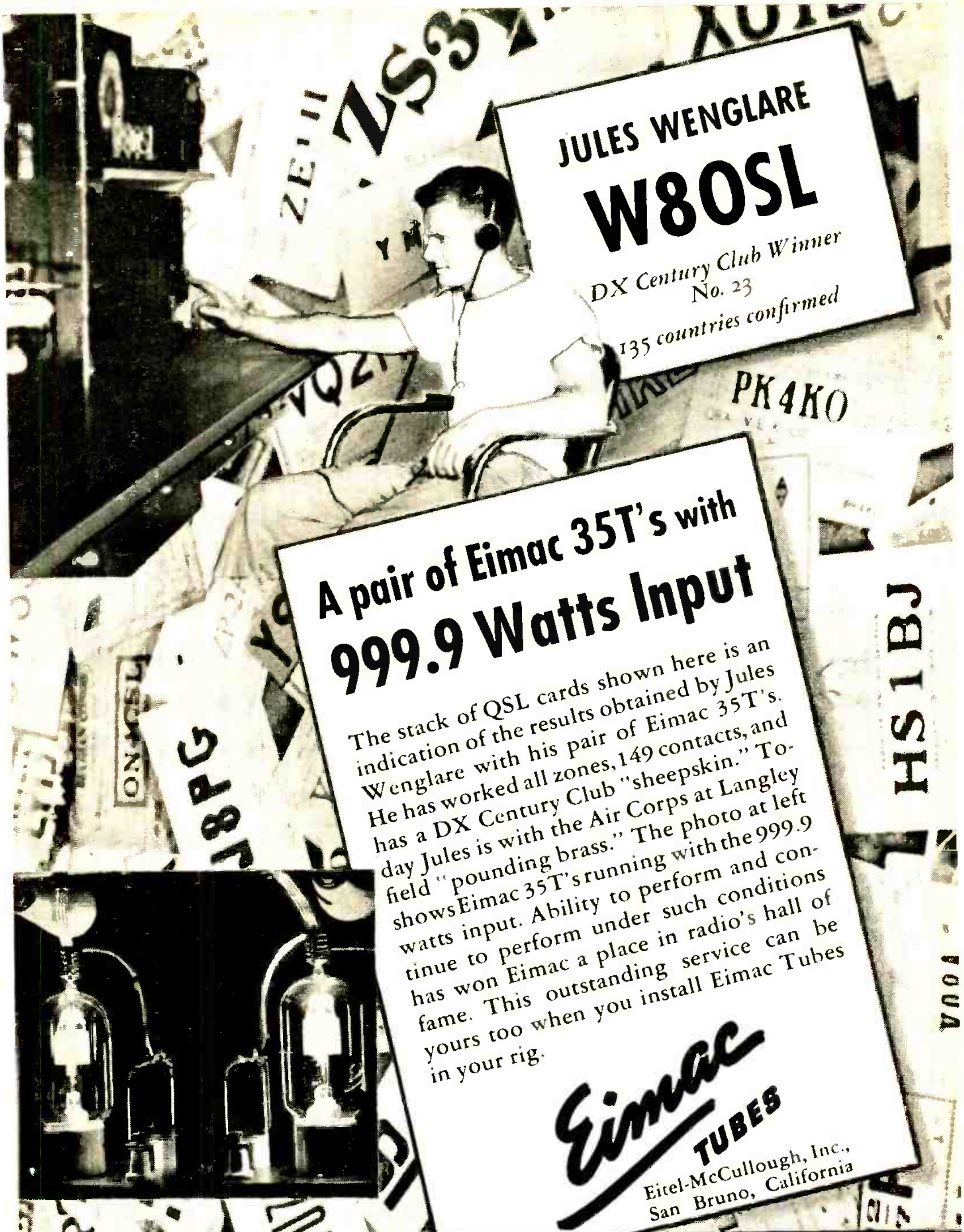
Adjustment Procedure

To adjust the indicator it is necessary only to adjust the bias on the trigger tube to a point *just* enough to make the tube draw current with the final amplifier turned off. This biases the tube only by the external voltage. Now when the final is turned on this will put an additional negative bias on the tube, biasing it beyond cut off. But when the final is modulated 100% on negative peaks the drop across the resistor due to the modulated stage is zero (instantaneously). Hence the only bias on the trigger tube is that of the external source which is just enough below the critical point to make the trigger tube draw current. Thus a succession of negative overmodulation peaks in a single syllable will cause the tube to draw current, working the relay and the alarm signal connected to it.

It might be suggested that a door bell or buzzer be used as a warning alarm and placed near the operating position so as to make it rather annoying for the operator if overmodulation should occur. The annoyance of this noise going out over the air would surely make the operator watch the gain more closely. It is believed that such an alarm would tend to make the operator more careful in his operation than would a visual indication that isn't quite so noticeable.

This indicator can easily be made a part of the transmitter. It need have no attention other than an occasional check of the external bias on the trigger tube to be sure that it is at the proper value to work on overmodulation peaks. This bias can also be adjusted so that the alarm will work before the final is overmodulated, if desired. But this provision would require some additional equipment to determine at just what percentage the alarm

[*Continued on Page 89*]



EIMAC REPRESENTATIVES

California, Nevada
HEEB BECKER, 1530 W. 104th St., Los Angeles, Cal.

N. Y., N. J., Penn., Md., Del., Dist. of Col., Maine, N. H. R. I., Conn., Mass.
ADOLPH SCHWARTZ, 14726 Elm Ave., Flushing, New York.

Wash., Ore., Idaho, Mont.
GENERAL SALES CO., Verner O. Jensen, 2605-07 Second Ave., Seattle, Wash.

Colo., Wyo., New Mexico, Arizona, Utah
RICHARD A. HYDE, 4253 Quitman St., Denver, Colo.

Chicago, Illinois, Wisconsin
G. G. RYAN, 549 W. Washington Blvd., Chicago, Ill.

N. Caro., S. Caro., Georgia, Tenn., Flor., Ala., Miss.
JAMES MILLAR, 316 Ninth St. N. E., Atlanta, Georgia.

Texas, La., Okla., Ark.
J. EARL SMITH, 2821 Live Oak St., Dallas, Texas.

Ohio, Mich., Ky., Ind., Minn., Mo., Kan., Neb., Iowa
PEEL SALES ENGINEERING CO., E. R. Peel 154 E. Erie St., Chicago, Ill.

YARN *of the* MONTH

PSE QSP

If you cud go 'way up yonder where five meter & other sigs go and don't cum back, and if you cud kinda gander sorta omnippytent like and see & hear & know everything that went on, and not miss a thing, you would see a lot of carrying on's such as follows.

Way down in the deep south is a ham who's got a messy pile of junk which hums & groans, smells & smokes, and arcs & sputters. But he messes up the ether with it very little these days, happily, because he's a dx hound and there ain't any, & because he's got a bad case of YL-itis which will last 'til the dx comes back again.

Course under such circumstances he ain't wht one would cal ackerate or effishent, so he is partly responsibul for what happened. He is sitting in revery one fine day when the fone rings. He answers and sez, "Yes, this is doubleyew five xxx." It is a lady which he told he would send a hamgram for once when he weren't so very sharp. He scribbles it down on an old discrepancy report so that when he decifers it three days later he has this, to wit:

```
MSG NR 1 W5XXX
                          PLACE TEX DATE
MRS Y E HUDI
5071 S ELM ST
BEARSKIN ME
FLOSSIE HAD FINE LETTER STOP
WILL BE THERE SEE YOU IN TWO
WEEKS STOP LOVE
                                    NELL
```

Which ain't so very bad on accounta all he left out wuz the words *the dog* following *Flossie,* besides substituting *letter* for *litter.*

Now let's follow this hamgram through its hamchannel and see what happens.

Doubleyew five xxx first dilly dallies around fer three days doping on YL's in general, and his'n in partickuler. Then one night he fires up his rig on 40 and kinda listens around on 7001 kc., which is his frequency and there ain't no use these days looking elsewhere. Natcherly there is plenty to listen to on 7001 kc. any night so he sits there and eggs on his temper trying to deduece whut all the gibberish means. Finally a slew of 'em get tired of it all and things kinda quiet down a mite & he begins to hear a few 9's and 8's whose calls are almost possible to get. But of course, being a dx hound, he has to putter around until he hears a 2, by which time it is either awful late or awful early. So he calls.

"W2XXX W2XXX W2XXX DE W5XXX DAH-DIT-DAAAAH."

Well, he raised him, but look what he got:

"DAAH-DIT-DAAAH-DIT-DAAAAH DAAAH-DIT-DAAAH-DIT-DAAAH W5XXX W5XXX W5XXX W5XXX DE W2XXX W2XXX W2XXX DIT-DAAAAAAAAH-DIT, DIT-DAAAAAAAAAH- DIT GE OB TNX FER CLG DAH-DIT-DIT-DIT-DAH DAH-DIT-DIT-DIT-DAH, UR SIGS RST RST 589X 589X RST 589X HR IS KEWPIE, DAH-DAH-DIT-DIT-DAH-DAH NJ DIT-DIT-DAH-DAH-DIT-DIT KEWPIE DAH-DAH-DIT-DIT-DAH-DAH NJ DAH-DIT-DIT-DIT-DAH-DAH-DIT-DIT-DIT-DAH THE RIG HR IS MOPA WID 45 AND 10 RUNNING ABOUT 15 DIT-DIT-DAH-DAH-DIT-DIT 15 WATTS TO A 40 MTR ZEPP DAH-DIT-DIT-DIT-DAH DAAAAH-DIT-DIT-DIT-DAAAAH. BEEN USING IT FER ABT EIGHT DIT-DIT-DAH-DAH-DIT-DIT-DIT EIGHT YEARS BUT I BEEN THINKING ABT PUTTING ON A KW THIS SUMMER DAH-DIT-DIT-DIT-DAH DAH-DIT-DIT-DIT-DAAAAAH. I DON'T HAVE . . . BLAH, BLAH. *(Hr Abt 1 Page Has Been Deleted—Ed.)* . . . SO

[*Continued on Page 82*]

By THE OLD TIMER

Complete
NET
only
$10.56

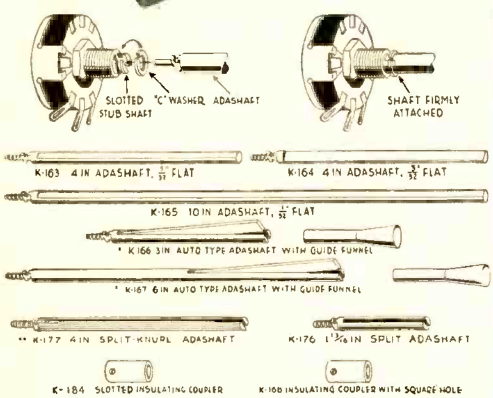
Always THE RIGHT REPLACEMENT CONTROL WITH THIS Centralab PORTABLE *Adashaft Kit*

You name the set and it's a hundred to one that you can do a replacement job right out of our PORTABLE Adashaft Kit . . . mighty good business sense . . . owning one of these kits . . . The strong steel case is 12"x5"x1½" . . . you can even carry it in your coat pocket (note Old Man Centralab above) and you pay for the controls only . . . we give you the case "FREE".

Any shaft and control can be combined in a moment without special tools. Yet the RESULT is just as STRONG and RELIABLE as a ONE PIECE SHAFT.

Then replace the controls from your jobbers stock as they are used. Buy that ADASHAFT KIT today . . . you need it.

CENTRALAB Div. of Globe-Union Inc., Milwaukee
Cable Address — Centralab



INCLUDED IN THIS ADASHAFT KIT ARE THE FOLLOWING CONTROLS:

1 EACH OF		CURVE
10,000	ohms	3
25,000	ohms	3
50,000	ohms	6
250,000	ohms	6
500,000	ohms	6
1 MEG	ohms	6
2 MEG	ohms	6
3 MEG	ohms	6
250,000	ohms	tapped
500,000	ohms	tapped
1 MEG	ohms	tapped
2 MEG	ohms	tapped

SHAFTS

3	K163
2	K164
1	K165
1	K166
1	K167
1	K176
3	K177

COUPLERS

1	K184
1	K168

SWITCH COVERS

5	K155	SPST
1	K157	DPST

Centralab

U. H. F.

[*Continued from Page 63*]

sharp but he likes to cut out W1-2 QRM when trying to work a W6 on a wide-open band. He raised the pipes to the top of a 42 foot telephone pole, and arranged slip rings at the bottom of the delta. These rings are made of pieces of old brass water pump lining, 6 inches in diameter. The brushes are 1940 Chevrolet ground straps held in place by a rack and supported by small springs. The field strength meter read the same with the antenna in its final position.

Ed is proud of his matching job, because the final will load up from 50 to 500 mills without any need for retuning. He turns the array with a half-inch pipe coming down the pole and terminating on the top of a 1928 Chevrolet steering mechanism. The steering shaft was lengthened four feet and brought to a standard steering wheel mounted under the operating table in the shack. Twelve Christmas tree lights (not Chevrolet) mounted in a circle provide a direction indicator. Ed is happy that he went to all the work for he finds that it pays in signal strength reports.

Blocking R. F. Tubes

Recently, W9YKX raised a question on the matter of blocking receiving tubes while transmitting, inasmuch as he found that his acorn r.f. tube had a cathode current of 20 ma. even with the plate voltage off. He tried the grid leak idea, replacing the shorting disk on the grid coaxial line with an .001 $\mu\mu$fd. by-pass condenser, and put a one-megohm resistor across it. This builds up a grid voltage that almost cuts the cathode current to zero when the receiver is picking up r.f. from the transmitter. He still removes the plate voltage during transmission though it seems unnecessary from the standpoint of protecting the tube. If he is going to do that, he could put a switch between cathode resistor and ground to prevent cathode current from flowing, and not bother with the high resistance grid leak.

Five Meter Miscellany

Ed McMahon, W2KLX, would like to see a discussion of the relative merits of various converter tubes such as 6J8G, 6K8, loctal types, 6J7, etc., for those who cannot afford the acorn types. It is admitted that the 955 (which can be used as a converter) sells for more than standard tubes, and this subject should be of interest. Factors to consider are the input resistance, conversion transconductance, and also noise where no high gain acorn r.f. stage is used ahead of it to produce a good signal-to-set-noise ratio and to boost the signal over the converter noise. That would be a nice assignment for the editor to do during his Easter (?) vacation (?). Let's see if he can take a hint.

After eleven years of married life and several of phoning W5AJG at work when the band opened, Leroy's wife, Bernice, studied up on theory and took her license exam. The result is that she is now W5JKM. She is interested enough to keep the receiver on and check the band occasionally. Leroy hopes that her voice may attract some dx when the band would not open for him.

AJG went out to the junk yard in Dallas and found some four inch copper pipe, in good shape, that sells for *one cent an inch.* That makes 80 cents for two nice big 40 inch lines. He wishes that they had acorn tubes too! Now all the hams at the police transmitter are walking around with copper pipe in one hand and a slide rule in the other.

W5BYV has moved from McCamey to Lubbock, Texas, 200 miles north. He wants to make use of the flat country if he can find some other ham around who is interested in 5 or 2½, f.m. or a.m. His RC superhet is bringing in plenty of ignition noise on 2½, especially since he put a resonant line in the grid circuit which helped it a lot.

Wilmer Allison, W5VV, says that every time he goes down to the Mexican border for some hunting, five meters opens up. Someone ought to bribe him with a crate of shells.

W9BJV will be on five from somewhere near Alexandria, Louisiana, after February 1, where he is going with the 34th Division Signal Company. Yeah, and your conductor may be somewhere near Alexandria, Virginia, with the Navy at the same time. But send in the u.h.f. news anyway because an arrangement will be made to carry on.

According to W9SQE, his club in Chicago is encouraging five meter work one night a week. W9MXK and W9EMF are supporting this movement; the night is Monday.

Now that Vince has given Pauline a ring, W9ZJB may or may not be as active. The usual practice, Vince, is to lay off radio for about six months, then to devote full time to it. This might be termed an "escape mechanism." Some wives, however, call it grounds for divorce.

After the January 1 band opening, W9ZQC lost his antenna in an ice storm. He promises that another will be up soon. This would be a good time for W9YKX to take a hand in the polarization so that the YKX-ZJB circuit can extend another 200 miles or so north. ZQC thanks us for bringing back his January issues of RADIO for him, as a result of the recent note in this column. Did anybody else lose anything?

W9YKX was curious as to the sensitivity of his coaxial-line-tuned converter until he started to work W9ZJB, some 200 miles away, without benefit of summer weather. Then W9HAQ of Davenport and W9NFM of Solon, Iowa, came over for a week-end and brought a DM36. The concentric line job was thought to be only slightly better than the DM36, on W9TTL's relatively loud ground wave signal. No test on a weak signal or relative noise was made, which would give a more interesting comparison. YKX does not use any tuned circuit between his acorn r.f. stage and 6K8 mixer-oscillator. He is now planning a new pipe job with coaxial tuned r.f. and mixer, using acorns both places. We look forward to receiving his observations on any improvement noted when he compares the new with the old.

Although YKX has worked only W9ZJB well out of direct ground wave range, he knows of only five stations within 200 miles of Woodbine, Iowa—W9TTL FZN ZJB CHI ZQC. Are there any more? He is working on someone in Des Moines (OLY and CXL), who should provide all the help that is needed to extend the relay from the east right up to the edge of Nebraska and Kansas. He thinks that he heard the carriers of W9NFM and W9HAQ on one schedule. Apparently c.w. was not used to make sure. Bill is putting up a stacked beam to try to improve on his present three-element horizontal.

ABOVE 112 MEGACYCLES

A. J. Van der Staay, W2JAB, has sent in a summary of 2½ meter work around Plainfield. New Jersey, where about 14 stations are on the band. The local Club meets on the air every Tuesday at 9 o'clock for a round table which generally is attended by seven or eight who can make themselves heard. All use modulated oscillators and superregens except W2HNY who has a converter. Several have acorn type 955 triodes in their receivers but the QRM from the hash has caused several to threaten to install r.f. stages ahead of their detectors. The antennas are mostly extended zepps, presumably vertical.

Most of the dx work in the Plainfield area is done by W2KP using a pair of HK24's, a 955 acorn superregen, and an extended zepp antenna. He works W3BZJ and stations in the New York area consistently. He has logged W1MRS and others in the first district. In December he heard a W8 too.

Around Chicago, W9VHG in Glenview heard W9PNV in Riverside. The latter also worked W9RQG in Park Ridge. VHG has had some trouble with a local church, the address system of which seems to want to call "CQ 2½ meters de W9VHG" during services. The Club in Aurora has decided on a 2½ meter equipment contest to stir up interest; they should have some outside dx to work now that W9WZO in Naperville has worked W9PQH in Batavia, and other stations are strung out east all the way to East Gary and north up the lake.

8-Tube FM Converter

[*Continued from Page 15*]

imum output, a value to be recorded. Then the generator may be returned to 4.3 Mc. and the secondary coil tuned to give zero output. The meter connections may then be reversed, the generator set to an equal frequency deviation in the other direction and the peak output reading compared to the previously recorded value. Repetition of this procedure and the attendant "touching up" of each trimmer will give a good "S" curve, which should be plotted to give a final assurance of the extent and linearity of the straight portion of the curve.

Having centered the "S" curve about the 4.3-Mc. axis, the i.f. alignment may proceed. In this case a microammeter may be inserted in the ground side of the 50,000-ohm grid load resistor of the 12SJ7 tube, or a v.t. voltmeter placed across this resistor. Each transformer is then aligned for maximum response in exactly the procedure used at lower i.f. frequencies.

Finally, the r.f. alignment may be performed at the middle of the band, by applying an unmodulated 45-Mc. signal to the antenna terminal and using the tuning eye or the microammeter as an output indicator. Overall sensitivity is such that 15 micro-volts of r.f. signal input produces a limiter grid current of 40 microamperes.

The oscillator trimmer should be set about ¼ turn from maximum capacity. At this value there will be no difficulty in finding the signal and little possibility of getting the image. The antenna coil trims near maximum, the r.f. near minimum capacity.

Tuning the Converter

The tuning eye has some shortcomings when compared to a dual shadow tuning eye operated by a twin triode to show exact discriminator tuning. However, the saving of one tube justifies the slight additional tuning care involved. In actual use the tuning eye shows i.f. resonance; the user then swings the tuning knob slightly either side of this indicated resonance point until the reception is most satisfactory. Any other tuning position will then be quickly recognized as lacking in fidelity of reception or quietness of operation.

The Amateur Newcomer

[*Continued from Page 58*]

uring system coupled to a 112-Mc. receiver or transmitter, unless a pre-calibrated piece of equipment is already at hand. In either case, at least three readings should be taken identifying the center, low and high frequency limits of the 112-Mc. band. Other points may readily be found by interpolation.

Wavemeter calibration and lecher wire systems have been adequately covered in numerous radio publications and current handbooks and need not be elaborated upon here.

If a receiver is used as the calibrating standard, resonance with the wavemeter will be indicated by either a loss of super-regeneration or a complete cessation of oscillation.

Should a transmitter be employed as the standard, a change in plate or grid current will occur when the wavemeter is tuned to resonance.

If, during calibration, it is found that more bandspread will be required, the distance between the stator and rotor plate of C_1 may be increased. Ordinarily, this spacing will be approximately one eighth of an inch. This adjustment enables the entire 112-Mc. channel to be spread over a 180 degree arc or any position thereof.

It should be borne in mind that the accuracy of any absorption type wavemeter is limited by the fact that reactance is coupled into the wavemeter when it is brought near another tuned circuit, and also that the resonance peak covers quite a few kilocycles on the flat portion of the "nose." For this reason frequency measuring equipment of the heterodyne oscillator type should be used when a high degree of accuracy is required, the absorption meter being used simply to identify harmonics. In the latter case the absorption wavemeter can be designed so that the band covers only a small portion of the dial. Then, when a new oscillator is being fired up for the first time, it is possible not only to tell if it is out of the band, but in which direction and approximately how much.

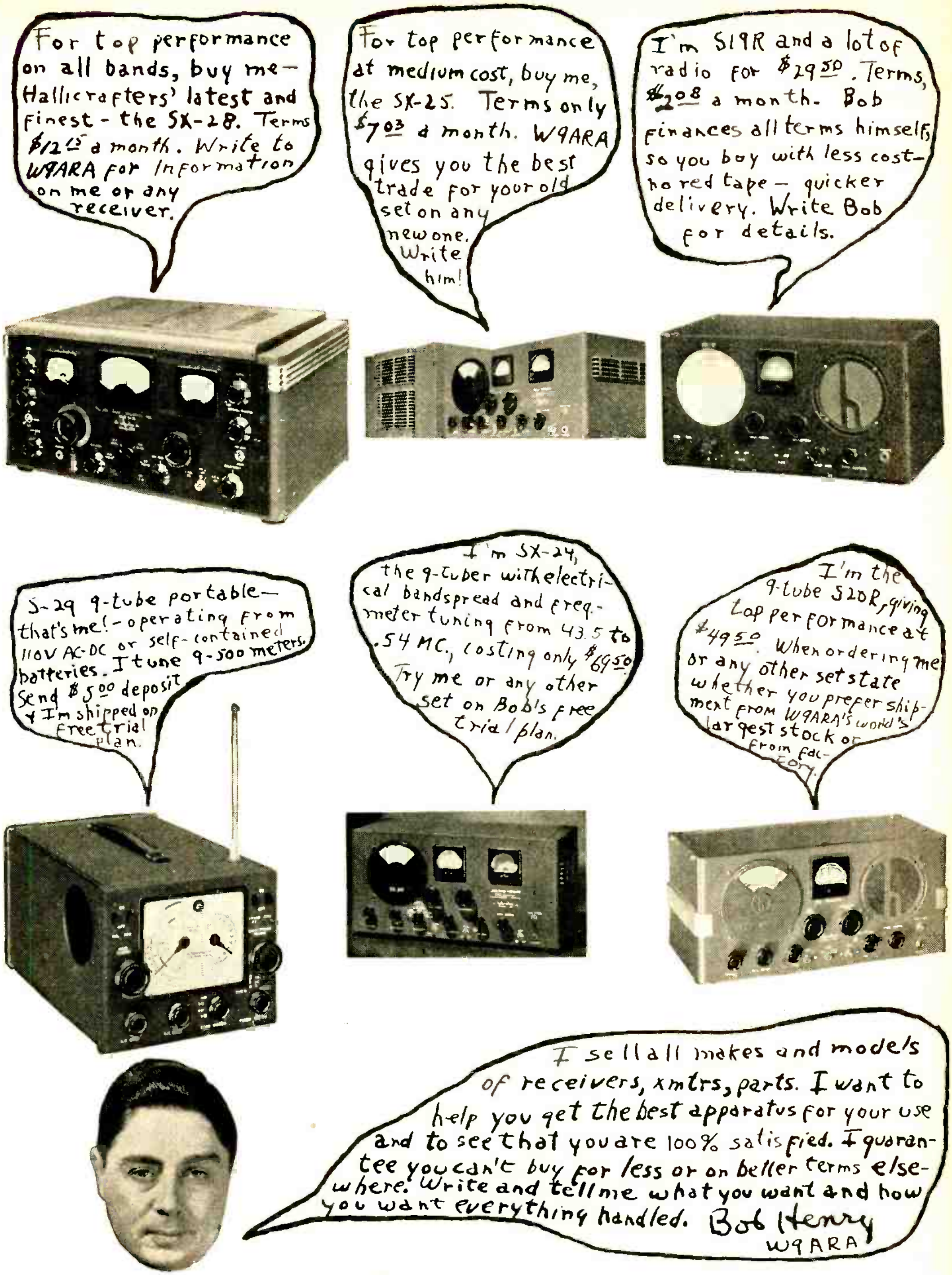
See Buyer's Guide, page 96, for parts list.

●

Radioddities

An attempt to catch electricity in a bottle and there to keep it for future consumption resulted in the 18th century discovery of the condenser.

More methods are made available for the variation of condenser capacitance than for the adjustment of any other device used in radio transmitters and receivers.



HENRY RADIO SHOP

BUTLER, MISSOURI

End-Loading the 3-Element Beam

[*Continued from Page 45*]

uniform. Connection to the ends of the copper wire can be made by means of solder or brass nuts and bolts, though in this antenna a tight twisted connection was relied upon. Chicken wire for the capacity plates should be of a fairly heavy gauge so that it will keep its shape when supported only at the center. The pieces used were each one foot square and have 1½ inch mesh.

The length of the elements must of course be adjusted if the beam is expected to give satisfactory results. This may be done by making the inductances three or four turns too long and then cutting them into two pieces. They are then "screwed together" and adjustments are made by screwing the bottom half in or out as though it were the cover of a mason jar. During the process of determining the correct setting, the two parts of the coil can be held together by two short wrappings of No. 16 copper wire. The permanent connection should be soldered in order to prevent later development of a high resistance joint.

The completed array weighs only about twenty pounds, and hence requires little in the way of a supporting structure. A twenty foot section of ¾" pipe will support it on top of a roof or tower with no need for guys any higher than about ten feet from the top. By studying the roof or tower facilities at a given station, it should be possible to devise a method of lowering or raising the beam so that tuning adjustments can be made from the roof or tower without use of extension ladders. The installation here was such as to make it particularly easy to lower the entire twenty-two foot supporting pipe so that the inductances could be reached from the roof, as shown in one of the accompanying illustrations. All the tuning was done with it at this height and then the pipe was raised again. This added ten feet did not seem to affect the tuning noticeably.

Electrical or mechanical rotating devices are left to the ingenuity of the individual constructor, though because of the lightness of the beam, ruggedness should not have to be an important consideration. The mechanism used by the author was built and completely installed in less than three hours. The wheel is the end of an old boiler that happened to be available. If this method of rotating is employed, care should be taken to keep friction at a minimum in the thrust bearing on which the pole rests, and likewise in the pulleys. Otherwise the counter balance weight which must return the beam to 0° after it has been pulled around will need to be quite heavy, and pulling the beam will require too much force. The pieces of wood fastened to the pipe support are used to keep the 600 ohm line clear of the metal pipe. Enough slack is left in the feeders as they come away from the pipe to allow them to remain free through a 360° rotation.

Before describing the tuning procedure, a few suggestions might be in order for amateurs who may have more severe weather to deal with. If sleet is likely to form on the elements and loaded sections, bamboo poles of perhaps seven-eighths to one inch diameter should be used to give added strength. The thirteen foot boom is quite strong and would need to be heavier only if there were danger of weakening it too much by larger holes for the heavier bamboo. Hanging the chicken wire from one corner would lessen the likelihood of snow piling up (and also of birds nesting there). If the pieces are fastened this way the length of the connecting wire should be reduced from 20" to about 12".

Tuning

Coupling and feeding are accomplished with a delta match and a 600 ohm line. This type of line has proved easy to construct and adjust, and at the same time it is highly efficient. No great care is needed either in the construction or insulation of the feeders, since coupling to the antenna can be made in a way to remove practically all standing waves. A one turn fixed link on the tank coil of the transmitter is a satisfactory termination at the transmitting end during the tuning up. The approximate delta distance is twenty inches either side of center.[6] The clips can be left at these points until all other parts of the tuning procedure have been completed.

Tuning is done by using an electron coupled oscillator in the transmitter and coupling the feeders with a one turn link to the first buffer stage that has its plate at 20 meters. If no electron coupled oscillator is available, a coil can be substituted for the crystal and the crystal stage used as a v.f.o. The tuning procedure consists of varying the frequency throughout the entire amateur band of 14,000 to 14,400 kc., and watching the plate meter of the stage feeding the antenna for maximum current. As the resonant point is passed the current drain will be greatest with a notable dropping off on either side. Of course the tank circuit of this stage must be kept at resonance while the frequency is being changed, and its grid drive must not be allowed to drop off too much.

It is easy to keep track of the change in frequency by starting at the known crystal frequency and then following along with the re-

[6] This shorter than normal delta is a result of the lowered loop radiation resistance caused by shortening the elements. With the degree of loading used, this resistance is only about 70% of the value for full length elements (Brown, *loc. cit.*).

ceiver or a frequency monitor. Caution is needed in approaching the ends of the band so as not to go outside. The frequency at which resonance occurs will indicate whether the length of the radiator must be increased or decreased, the final adjustment being for resonance at the crystal frequency. It is possible that no resonance point will occur, indicating that the radiator element is so far out of tune as to be out of the band, and then it must be adjusted by as much as two or three turns on the end inductances to bring it within the amateur band.

Tuning of reflector and director is best done with a field strength antenna several wavelengths removed from the beam and mounted in a horizontal plane. The one used here was a center fed half wave, one quarter wave off ground, with a twisted pair feeder link coupled to a 0-500 micrommeter. Rectification was secured with a crystal detector. This meter was not sufficiently sensitive to give any reading off sides and back; so the antenna was tuned for maximum forward gain only. Unless high power is used to feed the beam, a microammeter or galvanometer will be needed to indicate at the very slight signals received off the back, and thus make it possible to tune for maximum front to back ratio. However, the former method of tuning is considered by many to be the best for the receiving and transmitting conditions at the average station, and for this, even a one ma. meter is sufficiently sensitive. Tuning the inductances by screwing them in and out already has been described. A little less than a quarter turn change on the two ends is enough to produce a change in signal strength.

After the tuning of the elements, the delta distance can be checked for minimum standing waves. First, however, the length of the radiator should be readjusted for exact resonance as before. A simple indicator for checking the current on the feeders can be made by connecting a twelve inch piece of heavy wire to one side of a 60 ma. pilot light. A piece of bamboo is slipped over this wire so that when the bamboo is held in the hand a capacity coupling is made to the wire. By varying the grip of the hand, the amount of coupling to the wire can be varied so as to produce a satisfactory brilliance in the globe when it is moved along the feeders. The power consumed by this type of indicator is not sufficient to cause any notable unbalance when it is touched to one side of the feeders. The check is made by following one of the wires down the delta section from the point where it is attached to the antenna. If the indicator light becomes brighter as you leave the antenna, the delta distance is too small. If the light is brightest at the point of attachment and becomes dimmer coming away, the delta is too large. If it is impossible to get very close to the antenna while power is being fed to it, the check can be made on any part of the feeders and adjustment made for uniform current.

Results

The beam has good front-to-back ratio even though tuned for maximum forward gain. Checks made on a Hallicrafters SX-16 at two miles showed a ratio of R2 to R8 plus; and on a Howard receiver approximately the same distance away, a difference of R1 to R9. W6CKD and W6CME, who made these checks, as well as W6DSZ estimated the ratio as about 30 db and said this ratio was as good as that of any of the orthodox beams they had checked. Signal strength on the field strength meter began to drop off at about ten degrees of rotation either side of "head on," which seems to indicate that the slight widening of the radiation pattern in each element due to end-loading has not materially affected the sharpness of the beam as a whole. The extent to which front to back ratio, forward gain, and sharpness of radiation pattern differ from these characteristics in an ordinary three element beam could be determined only through a side by side comparison of the two under identical conditions. Such a comparison was impossible in the present instance.

Results of actual operation may not seem too impressive unless it is remembered that the antenna was in a small clearing surrounded on all sides for several hundred feet by a grove of trees that towered sixty or seventy feet above the antenna. In addition, the transmitter used had an input of only sixty watts, with a single frequency in the middle of the 14 Mc. phone band available. However, a good number of contacts was had with practically all parts of the U.S., including the Atlantic coast. Contacts with Hawaii were quite easily made. The average report was R8.

In conclusion, it is suggested that the type of design and construction utilized in this antenna is easily applicable to forty meter rotaries. By using tenth wave spacing and eighth wave loading on each end of the elements, the over-all size of the beam would be only slightly greater than the average twenty meter beam, and its gain and directivity as compared with a twenty meter rotary need be limited only by the problem of attaining a height in wavelengths comparable to that of most twenty meter beams.

Radioddities

Archie J. Weith, a Bloomfield, N. J. chemist told the American Chemical Society how he manufactures synthetic rubies, amethysts, and aquamarines from our polystyrene insulator.

Highly Effective Compression Amplifier

[*Continued from Page 19*]

the same a.f. waveform as is represented by the modulated r.f. carrier envelope. However, it is virtually impossible to maintain exactly the same phase shift through the side amplifier as there is through the entire main a.f. channel. Fortunately, however, the phase shift disparity was found by test not to affect the operation of the amplifier adversely. The phase shift bogy proved to be more of a paper hazard than an actual one.

Peak Rectification

More important to the operation of the compressor circuit than its phase characteristics is its ability to respond to *peak* waveforms. If the compression rectifier and filter circuit do not follow the *crest* of the a.f. waveform, but either the average or something between crest and average, then two sounds with different waveform but producing the same peak voltage might produce substantially different amounts of compression.

In the amplifier to be described, the resistance of the compression rectifier, its driving transformer, and its driver tube have all been kept low in proportion to the resistance in which the filter is terminated. While there is sufficient resistance that there is a slight clipping of peaks, it is virtually a peak voltmeter at voice frequencies. By using a higher value of resistance at R_{16}, the voltage developed across C_{10} would correspond more nearly to the crest of the exciting voltage. However, a high terminating impedance would call for high inductance chokes (assuming the same filter cut off frequency) and the 60 cycle a.c. picked up inductively by CH_1 would be sufficient to produce bad hum when compression was taking place. If heavily shielded chokes of humbucking construction were employed (unfortunately quite expensive) the filter could be advantageously designed for around 20,000 ohms, R_{16} being changed accordingly. In this event the lead from R_4 to R_{16} and to the 6U5 grid should be shielded to minimize electrostatic pickup of hum. With R_{16} only 3000 ohms such shielding is not required.

Because the voltage developed across C_{10} with the values specified in the diagram is *not quite* the full crest voltage, different sounds of the same peak amplitude will produce *slightly* different amounts of compression. This slight difference is not serious. It simply means that 100 per cent modulation *may* be determined by different vowel sounds than would be the case were no compression used.

A question arose as to the practicability of injecting the control voltage directly into the control (signal) grid of the compressor stage, and of using a single-ended compressor stage rather than a push-pull (balanced modulator) arrangement. As syllabic injection will mix with the voice frequencies regardless of whether a single-ended or push-pull arrangement is used, the only reason for using a balanced affair would be to avoid "wows" coming from the syllabic variations of the control voltage. However, with limited bass response of succeeding amplifier stages, these wows cannot get through the amplifier in sufficient amplitude to be noticeable. Hence, to simplify the amplifier, a single-ended compressor stage was used.

Getting the compressor to "track" properly was somewhat of a problem, and the characteristic represented by curve C of figure 1 was obtained only after laborious "cut and try."

With a "backward acting" circuit, such as is used for a.v.c. in b.c.l. sets, a characteristic such as curve C is not difficult to obtain. However, a backward acting arrangement proved impractical in this case because of a tendency to motorboat unless the time constant of the compression filter was increased considerably (by designing it for a much lower cut off frequency). The "loop" was eliminated, and with it the tendency toward motorboating, by changing to a forwarding acting circuit (one in which the input voltage for the compressor rectifier is taken ahead of the controlled tube rather than after it).

The 6U5 "eye" tube not only gives an indication of when and how much compression is taking place, but also serves as an overmodulation indicator when once the various controls are properly adjusted for a given transmitter.

Construction

No particular care need be taken in the construction of the amplifier except to use the exact specified values, which in some instances are critical, and to keep CH_1 and CH_2 as far as possible from the power transformer. All high impedance, low level leads should be shielded as indicated in the diagram in order to minimize hum pickup and feedback. Not only should CH_1 and CH_2 be spaced as far as possible from the power transformer, but CH_2, which has the least shunt capacity following it, should be oriented so that the axis of the winding is at right angles to that of the power transformer T_1. If these precautions are taken, the hum level of the amplifier will be gratifyingly low.

The specified chokes, besides having the desired inductance at zero or low values of current, are very small physically, which tends to minimize hum pickup.

Adjustment

Proper adjustment of the amplifier when used in conjunction with a phone transmitter is a simple matter, and when once adjusted the controls need not be touched unless it is desired to talk at a different distance from the microphone and maintain the same modulation percentage and the same degree of compression.

First, make sure the amplifier is operating properly as a straight amplifier. The compression gain control R_{10} should be turned off, and the limiter control R_{19} opened full on so that the cathode of the 6SC7 is at the same potential as the heaters of the 6A3's. Under these conditions neither the compressor nor the limiter has any effect upon the operation of the amplifier.

After the amplifier has been checked in this manner, the compressor and limiter can be adjusted.

With the main gain control off, assume what will be your normal position with respect to the microphone (preferably from 4 to 12 inches from the lips) and make sustained vowel sounds at normal speaking level. Then advance the compressor gain (R_{10}) until on the loudest vowels the magic eye just does close completely

but does not "overlap" (zero shadow angle).

Now run up the a.f. gain control until, on these sounds, a peak type modulation meter indicates 100 per cent modulation. The modulation meter need only be capable of indicating when 100 per cent modulation is reached, and need not be capable of indicating various levels up to 100 per cent. However, it must be of the *peak* type, such as a negative peak clipping indicator or flasher type instrument.

Next, gradually back off the limiter control (while attempting to hold the eye just barely shut by means of a prolonged "aaaaahhhhh") until the point is found where it *just begins* to clip the peaks and prevent 100 per cent modulation. If the limiter adjustment is too "tight," distortion will be present on modulation peaks. If the limiter adjustment is too "loose," it will not prevent "thumps" from the initial surges on explosive sounds (syllables with fast attack) when full compression is being utilized.

After these adjustments have been made, do not touch any of the three controls unless the transmitter input is changed. In this case, you must go through the whole procedure again. For less compression, talk more softly or farther from the mike. Do not attempt to change the gain or compression or limiting without readjusting all three.

The eye will just begin to flicker on an 80 per cent modulation peak. To hit 100 per cent modulation, which is indicated by the eye closing completely (but not overlapping) a peak 12 db higher in level is required, which represents about 10 db of compression at 100 per cent modulation.

When using the full 10 db of compression, which will be indicated by the eye closing almost completely on most every loud syllable and occasionally closing completely, the voice will sound somewhat flat and expressionless. For this reason the operator probably will desire to take advantage of the full compression only when competing with bad QRM or QRN. At other times, when the fellow at the other end is having no difficulty getting you, there is no point in attempting to raise your effective power, and you can back off from the mike until the eye just barely flickers on the louder syllables. Under these conditions the peak modulation will be approximately 85 per cent and the compression insufficient to be noticed even by the most critical listener.

The amplifier is designed for close talking (not over 12 in.) with a diaphragm type crystal microphone having an output level rating in the neighborhood of minus 50 db (1 bar rating).

For parts list refer to Buyer's guide on page 96.

●

A Modernized Diathermy

[*Continued from Page 23*]

determined from the circuit diagram and photographs. The plate milliameter is wired in the negative high-voltage lead as a safety precaution to protect the operator from any possible contact with the high voltage.

The filament circuit of the oscillator is also conventional, the center tap of the by-pass condensers being the common ground point for the oscillator. The four tube sockets are mounted 1″ below the chassis to shorten the plate leads. The grid coil is mounted upon them and half way between the chassis and bottom cover. The plate coil is rigidly mounted on the standoff feed-through insulator with its center tap lug, and the ends are soldered directly on the condenser end mounts. The pickup coils are spaced ⅝″ from the plate coil. With this adjustment, a normal person between the pads can put up to a 200-ma. load on the oscillator. The pad tuning condenser is a split-stator 35μμfd. per section variable, thus placing the dial handle on the rotor shaft at zero r.f. potential, and eliminating hand capacity. A ¾″ hole was drilled through the panel, and the condenser was mounted on a strip of bakelite which mounted over this hole in the panel. This insulates the rotor of the pad resonating condenser from ground.

Output Termination

The r.f. output connections on the front lip of the chassis were each mounted in two homemade bakelite washers. These washers are described in an accompanying drawing. The washers are mounted in a one inch hole made in the chassis. This gives ¼″ clearance all around to the chassis from the pad jacks.

Pads

The length of the pad leads is critical, and should be 6′ 9″ from the pickup coil to the farther edge of the pad screen. The construction of the pads is shown in the drawing. The pad leads are made from shielded twisted pair no. 18 stranded wire, both wire and shield being used to carry the r.f. These leads are covered with 5/16″ i.d., ½″ o.d. rubber tubing. At the pad end the wiring is fanned out and soldered to the screen at 3 points. The screen itself is soldered all around the four edges. The screen is insulated with two pieces of high grade sponge rubber 8″ x 10″ x ¼″ and cemented together with rubber cement.

Usage

Due to the nature of the beast, a few words of caution should be in order on the operation of the diathermy. *First and foremost a diathermy is not a cure-all, and should be used for specific applications under a doctor's direction.* By having a machine of his own, the patient who would normally have to go to a doctor's office, or rent a machine for treatment, would more than pay for the cost (about $55.00 for all components) by the reduction in bills or rent. For sciatica, arthritis, neuritis, etc., diathermy is one of the best treatments. But for specific applications see your doctor for the amount and time of application. The plate supply voltage is 1050 volts, so the milliampere reading is approximately the wattage input reading (100 ma. is 105 watts input.)

The filament switch, or green light, should be turned on for about a minute before applying plate voltage, which is the red-light switch. Do not place the machine on a metal table during treatment. Keep all metal objects such as buttons, tie clasps, etc., out of the field of the pads. Keep the pad leads separated as far as possible. Preferred practice is to form a circle with the pad leads instead of running them parallel to each other. One other word—it is a subject of controversy in medical circles, but we feel *it is not wise* to apply the pads to the heart or to the head.

New Books

The new RCA Receiving Tube Characteristics Chart (1275-B) is just off the press. This new chart, which now covers 309 types of receiving tubes, retains the convenient booklet form of the preceding edition. Included are data on all RCA glass and metal receiving types arranged in numerical-alphabetical order.

The first two pages show a classification of the types according to their cathode voltages and their functions. Types having similar electrical characteristics are grouped in parentheses. This classification will assist the tube user in identifying type numbers and in choosing a tube type for an application. The last two pages show socket connections with RMA designations (4AD, 4B, 4C, etc.).

Interested persons can obtain a copy of the Chart 1275-B on request from Commercial Engineering Section, RCA Manufacturing Company, Inc., Harrison, N. J.

●

The average error of the time signals sent out on 113 kc. by NAA is slightly in excess of one-hundredth of a second.

Yarn of the Month

[*Continued from Page 68*]

YOU WILL BE HEARING ME ON HI POWER SOON HI HI DAH-DIT-DIT-DIT-DAH DAH-DIT-DIT-DIT-DAH. WL OM HANDLE HR IS ALFONSO DIT-DIT-DAH-DAH-DIT-DIT ALFONSO OR AL FOR SHORT DAH-DIT-DIT-DIT-DAH WL OM WAT SA? W5XXX W5XXX W5XXX DE W2XXX W2XXX W2XXX DAAAAAAAAH DIT DAAAAAAAH."

Natcherly after that *somebody* is bound to be tired and irritated. And somebody is. Poor W5XXX wearily gives a brief return of necessaries and asks "PSE QSP? ANI QRM?"

Then W2XXX comes back with a string of R's two feet long and chirpy and sez he is sorry abt the QRM & so he repeats all of his first transmission.

W5XXX steels himself and beats out in QSZ after it is all over "WILL YOU TAKE A MSG? QSP?" Then W2XXX comes back with a glimmer of intelligence and sez, "SURE QSP GLADLY GA."

It is enough for one guy to suffer so much, so let's just skip over about an hour of misery and stoopidness and "RRRRRRR PSE REPEAT SIG, RRRRRRRRRRRRRR PSE REPT TEXT AGN," etc, and let poor W5XXX get some shut-eye.

Whut is left of the msg lays around W2XXX's shack for a week before he is able to get his mopey MOPA into a semi-useful condition again. This is whut he has, to wit:

```
NR 1 W5XXX
                         PLACE TEX DATE
MR SY E HUDI
471 HELM ST
BURVAIN, ME, (FEDOSSIE)
HAD FINE LETTER STOP ILL, BE
HERE IN TWO WEEKS
                              SIGNAL (?)
```

That isn't whut I wud call ideel copy, what do you think? W5XXX sent it purty near right, I reckon. The main trouble waz in New Joisey. That there lid W2XXX first off made some errors in copy. Also he is one of them dopes who know so much that they hafta change what they get, anyhow. Look what he did to *Bearskin*. I gess if you were to make a *very very* strong effort to read it *Burvain* you could do it, on account of not counting spaces they are the same. It waz easy for W2XXX because it seems he knew there waz a Burvain in Maine, because he'd been there. In fact he waz so sure that he changed *Flossie* and also made it *Fedossie* on accounta that is the county which Burvain is in, being an old Injun name. As fer the rest, especially the sig, you can see that there were some other serious errors made.

Well, then W2XXX lissens around one PM and hears W1XXX who the call book sez is in Burvain, so he raises him somehow. W1XXX is one of them hot-shot ops with a bug which sounds like a Judas Berry Locust or certin other obknockous insects & he is so danged fast that he trips himself up.

W2XXX beats out the msg in QSZ, sending creepy capitol letters. W1XXX is so dern fast he pounds it out on the mill by the touch system while he reads HOW to WIND FRIENDS AND INFLUENCE PEEPUL, cuz he is one of them smart young squirts with ideers too big fer their britches. He rattles off sum hash which is meant to be "W2XXX W1XXX R SK." Very snappy, as you can plainly see. W2XXX cudn't read it but since he never heard no more out of W1XXX he figgered that the msg waz across OK.

W1XXX is so engrossed in his rise to fame that he fergits the msg and spends something like a week working toward his future—which means he waz jist loafing and daydreaming, laying in the park and looking up at the sky & the like. After his pa wakes him up by tanning his hide good he remembers the msg and starts looking for it. There really weren't much chance of his finding it, cuz like half the hams he kept his log on scratch paper, which same is scattered everywhere. After two days he gives up, natcherly.

Come on up hyar whar the air is pure and clean and you is away from it all & lets air all this out. I tell you, this here stoopidness oughta be stopped. It ain't only frequent, it's habitual.

A 400-Mc. Receiver

[*Continued from Page 29*]

¾ inch longer. Of course this would decrease the tuning range considerably.

The Antenna

In mounting the concentric feed line for the antenna, a ½-inch hole is cut in the 2-inch pipe near the closed end so that the ½-inch pipe can be soldered directly to the oscillator. The inner conductor of the concentric feed line is connected to a ¼ by 1-½ inch copper strip. The other end of this strip is connected to the 2-inch pipe in such a manner that the antenna coupling can be varied by sliding the feed line closer to or farther from the inner conductor of the oscillator. The diagram shows the antenna clearly so no further explanation is necessary. This type antenna has proven to be very satisfactory. The losses are low, it is easy to couple to the oscillator, and it lends itself aptly for the mounting of reflectors.

●

CQ was a distress call before CQD and SOS.

Self-Excited Oscillator Operation

[*Continued from Page 26*]

was converted. Another got good results and a third wasn't able to find much improvement. It should be emphasized that this stabilization is for *voltage* only and does not apply for temperature stabilization.

Other Causes of Instability

If the problem of temperature is troublesome the trick of putting the oscillator in an oven or some kind of a box where drafts cannot reach it will work. As long as cooling drafts that are irregular do not come in contact with the oscillator it will take only two hours for the thing to reach its final temperature. At the end of that time all the parts will have that final temperature even on the inside of them. However, most of the temperature rise takes place in the first half hour. If the reader doesn't like this idea he can try negative temperature coefficient condensers. These can be made to correct exactly for the temperature drift but it will take almost an hour to do so. The maximum drift from cold to hot will not be as great as in the case of no compensation.

Another cause of frequency drift is due to the aging of parts, coils particularly, and also condensers. The only cure for this is to use solidly constructed parts of good quality. This type of frequency drift is of small importance in v.f.o.'s where the operator is mainly interested in a particular frequency for only a short time.

To summarize: it has been pointed out that the main cause for frequency variation because of supply voltage changes is due to the phase change in the feedback voltage caused by the change of plate resistance. Any method of minimizing the change in plate resistance or cancelling it out will diminish the frequency change and stabilize the oscillator. Two possible methods were described with a method of adjusting the electron-coupled oscillator which was given as one of the examples. The reader may think of other methods that are possible of achievement. To repeat, it is the adjustment of the plate and screen voltages that results in the stabilization of the electron-coupled oscillator and not its "magic name."

●

"Oh, Mr. Fadiman!"

There are only four states in the Union in which NBC outlets are not indicated.

X-DX

[*Continued from Page 56*]

SPOT EVEN THOUGH NO DX. THIS JERNT IS GOING TO HAVE 4 BEDROOMS AND ABOUT 8 OTHER ROOMS OF VARIOUS TYPES INCLUDING A RUMPUS ROOM. HE'LL NEED IT PADDED IF HE ENTERTAINS MORE THAN FIVE DX MEN AT A TIME. W2BJ WHO TOSSED IN HIS CHIPS NOVEMBER 9TH AND GOT MARRIED, SAYS THAT HB9J PASSES ALONG HIS 73 TO THE GANG . . . OH, AND HE TOO HAS BEEN IN THIS MARRIAGE WHIRL SINCE LAST AUGUST. NOW, I'M BEGINNING TO SEE THAT THIS THING GOES ON YEAR AFTER YEAR.

No Swan Song for Swan Island

Steve Paull who has been doing a good job at KD4GYM, left Swan Island on Friday, February 7th, for the mainland. All is not lost though, for you fellows who did not get to work it for a new country because the new man to take Steve's place has taken the exam. for a ham ticket. By the time this paragraph reaches your eyes the new op, whose name is George Grover, should be punching out a few QSO's via c.w. and phone. For the information of the boys who have worked KD4GYM, it will be good to know that George will operate the rig on the same frequencies, at least to start with. Steve was to have left two rocks for him: 14240 kc. for phone and 14280 kc. for the c.w. end of it. Naturally George will have a different call so don't look for KD4GYM anymore. Before Steve left he told me that he heard that a whole batch of mail had been lost, and this contained a flock of QSL cards for the gang around the country. He says not to be alarmed because if it is not located shortly after he returns to the States he will grind out new cards to the same gang. It may take a while but Steve guarantees everyone he worked will receive a card. In the meantime, if you intend to send him a card, and of course you should, you may send them to me and I'll see that he gets them, wherever he may be.

If any of your time is spent in the movies . . . you may be interested to know that every now and then hams (the radio kind) show up on the screen. One of the pictures that sprung two of them loose at once is "Play Girl" with Kay Francis. First thing you know, about a third through the picture, enters ham no. 1, who is none other than Tim Huntley, W6LIP. While the celluloid is unwinding we find Tim and a very charming y.l. attending a broadcast, and who should pop up at the BC station's mike but Doug Evans, W6QUW. Tim, or George P. Huntley as he's known on the screen, has quite an amount of film footage and does a good job. Oh yes, the picture is a good piece of entertainment.

While we're still on the subject of pictures I might mention that the epic made by Columbia called "Arizona" involved another ham. The sound recording was done by George Cooper, W6PKK. Fun was had by about a dozen of us, including Geo. and his x.y.l., when we went to see the picture. The moment various screen credits started to unfold at the beginning of the picture we anxiously awaited George's name to appear. When it did we all stood up and cheered . . . the 12 of us. Naturally the rest of the audience consisting of about 2000 thought we were slightly nuts. And quite naturally as I guess we were . . . or we wouldn't have pulled it. Still about pictures in "Flight Command" did you see the big rig used in the control tower . . . it had a pair of 750T's in it . . . and of course running at 999.9 watts. And it looked like the same piece of equipment that showed up in the ship "wireless shack" at the beginning of "It Must Be Love" with Mel Douglas and Rossy Russell.

W2MNF IS TRYING FOR WAAP AND IS BUILDING AN 80-METER RIG. W3LE BREAKS LOOSE AGAIN AND RELATES HOW HE HAS MOST OF HIS LARGE TRANSFORMERS MOUNTED IN OIL. LOU ALSO SAYS THAT HE HAS HEARD FROM HIS FRIEND W6QIV WAY OUT HERE IN CULVER CITY THAT HE "DONE GOT HITCHED" JANUARY 1ST, '41. RECEIVED AN INVITE TO THE ANNUAL GATHERING OF W9PSP, JACK STANTON, IN CHICAGO. BUT UNFORTUNATELY THE DISTANCE WAS TOO GREAT TO HOP IN ONE WEEKEND, SO WITH REGRETS . . . COULD NOT DO. THANKS ANIHOO, BUT WAIT 'TIL JUNE! ALSO RECEIVED AN XMAS GREETING CARD FROM ENZO, CX2AJ. AT THE TIME HE WAS ON A VACATION IN BUENOS AIRES. W6DIX, WHO IS EX-OH6BHW AND EX-W3GT IS NOW LOCATED IN SALT LAKE CITY, UTAH—THE EXACT ADDRESS IS 331 DENVER ST. FOR THOSE WHO NEED UTAH W6DIX HAS A COUPLE OF SPOTS ON 20 AND 40, NAMELY 14396-14068 AND 7198-7034 KC. YEAH, HE'LL QSL.

You guys who would like a good belly laugh and who missed that "screwball" story of Tom Caswell's, W5BB, in February RADIO . . . get that issue out and turn to the "Yarn Of The Month". I understand some manufacturer is going to put out one of those "Dialogue Meters." But what I'm wondering now is whether or not W5BB uses one himself? W3GAU surprised us a bit when we received a note from him written

[*Continued on Page 92*]

Calculating Distance and Direction

[*Continued from Page 47*]

the places are on opposite sides of the equator, rules given in the book of trigonometric tables must be followed in order to obtain the correct results. See figure 2.

Calculating Direction

Several years ago the expert of a large map publishing company was demonstrating a new globe that gave great circle distances and directions rather easily. He made the statement that it is necessary first to calculate the distance between two places before being able to find the direction of one from the other. The map expert probably had in mind using the following relationship, which is also given with the letters of figure 1:

$$\sin a \sin B = \sin b \sin A$$
$$\sin p \sin T = \sin t \sin P$$

The direct method, however, uses another basic formula for the general spherical triangle, which is given below with the letters of figure 1 and in revised form to facilitate making the calculation:

$$\sin A \cot B = \cot b \sin c - \cos c \cos A$$
$$\sin P \cot T = \cot t \sin r - \cos r \cos P$$

$$\text{Cot } T = \frac{\tan(\text{lat}_t)\cos(\text{lat}_r) - \sin(\text{lat}_r)\cos(\text{lon}_t - \text{lon}_r)}{\sin(\text{lon}_t - \text{lon}_r)}$$

Example of Direction Formula

Let us apply this formula by finding the direction of Boston (lat. 42°21′, lon. 71°03′) from San Francisco (lat. 37°49′, lon. 122° 29′). In this case, P, the difference in longitude, is 51°26′. Let us proceed.

log tan 37°49′	9.88994—10	
log cos 42°21′	9.86867—10	
log product	9.75861—10	
product	0.57360	(1)
log sin 42°21′	9.82844—10	
log cos 51°26′	9.79478—10	
log product	9.62312—10	
product	0.41987	(2)
(1)—(2)	0.15373	
log (1)—(2)	9.18675—10	
—log sin 51°26′	—9.89314—10	
log cot T	9.29361—10	
T	78°52′32″	

This angle is measured clockwise from the pole. It falls in the first quadrant—between 0° and 90°—because the latitude of Boston is north of San Francisco and the longitude is east. In the next example, the latitude and longitude of Miami indicate that it is east and south of Chicago, and the angle must be between 90° and 180°.

In looking up the *log cotangent T*, therefore (which appears only once in the tables), the angle must be selected for the correct quadrant, using the angle at the top or bottom of the page that will give the *cotangent* rather than the *tangent*, for the quadrant into which the angle must fall as determined from the latitude and longitude as explained above.

Figure 2.

Angle	Sine	Cosine	Tangent	Cotangent
x	+ sin x	+ cos x	+ tan x	+ cot x
90° + x	+ cos x	— sin x	— cot x	— tan x
180° + x	— sin x	— cos x	+ tan x	+ cot x
270° + x	— cos x	+ sin x	— cot x	— tan x

	lat.	lon.
Chicago	41°53′	87°40′
Miami	25°46′	80°11′
		7°29′

log tan 41°53′	9.95266—10
log cos 25°46′	9.95452—10
log product	9.90718—10
product	0.80757
log sin 25°46′	9.63820—10
log cos 7°29′	9.99629—10
log product	9.63449—10
product	0.43101
(1) — (2)	0.37656
log (1) — (2)	9.57583—10
—log sin 7°29′	—9.11474—10
log cot T	0.46109
T	160°55′

The third example, involving the direction of New Orleans from Boston, falls between 180° and 270° (third quadrant) as measured clockwise from the north.

	lat.	lon.
Boston	42°21′	71°03′
New Orleans	29° 0′	89°10′
		18°07′

log tan 42°21′	9.95977—10
log cos 29° 0′	9.94182—10
log product	9.90159—10
product	0.79724
log sin 29° 0′	9.68557—10
log cos 18°07′	9.97792—10
log product	9.66349—10
product	0.46078
(1) — (2)	.33646
log (1) — (2)	9.52694—10
—log sin 18° 07′	—9.49269—10
log cot T	0.03425
T	222° 45′

To assist in obtaining trogonometric functions of angles larger than 90° we quote in figure 2 a table that appears in *Hussey's Mathematical Tables* and other similar works.

A "Bare Essentials" Superhet

[*Continued from Page 50*]

The wires from the stators are fed through the chassis by miniature polystyrene bushings. An eyelet type of soldering lug is fastened to the rear of the main oscillator tuning condenser to permit shorter leads to the coil.

The I.F. Stage

1500-kc. i.f. transformers are used in preference to 456 kc. units as the lower intermediate frequency is more likely to give images when used without an r.f. stage ahead of the mixer. We had some fear at first of oscillation in the single ended 6SK7 tube when used as an i.f. amplifier. But we used 2000-ohm resistors in the primary leads of the i.f. transformers and bypassed them to ground with paper condensers. No trouble was experienced.

The mounting of the .01-μfd. screen bypass condenser at right angles between the input and output circuits of the tube helped materially in reducing chances of oscillation. Small rubber grommets were used to lessen the chance of insulation breakdown on the wires from the i.f. transformers through the chassis.

The Second Detector

Having read about, discussed and just cussed the various types of second detectors and their qualifications, the infinite impedance type seemed the most logical choice. It is simple and requires few parts, has very low distortion, and does not load the i.f. transformer secondary.

The Beat Oscillator

The potentiometer in the plate voltage lead of the b.f.o. is used as a control for adjusting the voltage to the b.f.o. section of the 6C8G. This adjusts the b.f.o. injection to the detector to assist in receiving weak c.w. signals. Its action brings back memories of the not too far gone past—with the old two tube blooper.

The b.f.o. coil is home made and consists of 80 turns of no. 22 enameled wire on a one inch diameter coil form, three inches long. The padding condenser is made from an old dual trimmer from an i.f. transformer, the capacity being .00015 μfd. max. One section of the padder is removed from the isolantite bar and a bolt, nut and an angle are used to mount the remaining condenser on the b.f.o. coil form. Inspection of the photo will show the assembly. It is rather awkward to adjust the condenser in its location under the chassis, but once it is set it does not need to be changed.

Audio

The first audio stage may appear rather unorthodox in that it has no cathode by-pass condenser. But no apparent difference in either volume or quality was noted without it. Furthermore, its omission seemed to reduce the hum level. A closed circuit jack is used in series with the cathode. The phones serving as additional bias for the 6C5 when they are plugged in. The 6C5 stage delivers ample volume for satisfactory headphone reception.

The 6F6 stage is wired in the conventional manner with another closed circuit phone jack for the speaker connection. A 400-ohm, 10-watt resistor is used as cathode bias for the output tube and it is bypassed by a 10-μfd. 50-volt condenser.

As mentioned above, a closed circuit jack is used for the speaker connection. In the event of the speaker's being disconnected, the plate circuit will still be closed, and the screen current will be prevented from exceeding a safe value.

It is recommended that at least 250 volts be used as plate supply for this receiver. Voltages around 300 are not too much, and yet it can be operated, if necessary, on 135 volts of B batteries.

All wiring is done with Belden No. 20 pushback wire. It is advisable to use a good quality wire such as the above since it permits a much neater wiring job. Care should be taken in soldering—poor joints have been the reason for the downfall of many otherwise good homemade receivers.

●

Didjano — — ?

Polystyrene, high-efficiency r. f. insulator, is derived indirectly from coatl, a resistive conductor.

The substance *willemite* with which the business end of a cathode ray tube is coated was named in honor of a Dutch king.

Transformer Performance

[*Continued from Page 37*]

saturation of the core on the peaks of the current cycle, thus reducing the average of the alternating current permeability.

The silicon content of the laminations has a marked effect upon the amount of flux density required for saturation. The silicon may be considered as a diluent reducing the concentration of magnetic material. In general, laminations having a low silicon content will have a greater average a.c. permeability at high flux densities.

Most silicon steels display their best magnetic performance at flux densities ranging from six to twelve kilogauss. However, in view of the foregoing discussion, it does not necessarily follow that the best overall transformer performance will be obtained under the same conditions.

Practical Design Considerations

Transformer regulation may be improved by increasing the volt-per-turn ratio but special considerations must be made to hold insertion loss within reasonable bounds. The optimum location of windings, selection of core materials, proportion of iron and copper, etc., for orthodox transformers are not necessarily ideal for those operating at high flux densities.

The primary winding should be located next to the core so that its resistance will be as low as possible. Resistance and temperature can be further reduced if the coil is wound with oversize wire. Secondary windings do not present any new design problems other than a high volt-per-turn ratio. Loss in efficiency caused by energizing of the core and resulting from the reactive current in the primary can be at least *in part* compensated by reduced I^2R loss in the secondary.

The high silicon steels used in the orthodox power transformers generally are not as satisfactory as the cheaper, low silicon grades. The experimental coil described previously used a core fabricated from no. 26 Allegheny Dynamo Special grade steel having a 3.25% silicon content. U. S. S. Motor Grade, Allegheny Dynamo and Super Dynamo, and others having about 2.5% silicon should be more satisfactory, because it is expected that their average alternating current permeability at high flux densities would be greater.

Eddy current loss is particularly important at high flux densities, because it is proportional to B^2. The low electrical resistance characteristic of low silicon steels aggravates the problem. Cost makes it impractical to use electrical sheet steels thinner than no. 29 gauge (.014″). It has been our experience that 29 gauge core plated laminations A.A.S. (annealled after stamping) is the best compromise between eddy current loss and cost for high flux density operation and all high grade transformers.

The laminations should be interleaved 100% to insure the lowest possible core reluctance. The core permeance drops quite rapidly when the degree of interleave is reduced.

High flux density operation should be particularly attractive to the transformer manufacturer, because production costs are lower. Core materials having a low silicon content are much cheaper and more easily stamped into laminations. Reduction of the number of turns per volt is accompanied by lower wire expense and lower winding expense. These savings greatly offset the cost of the oversize wire in the primary and the extra care necessary to prevent eddy current loss in the core.

Conclusion

Power transformers are generally designed so that the core material operates under conditions conducive to its best performance. This involves a superfluous amount of winding, contributing to excessive copper loss which impairs regulation and full load efficiency.

The volt per turn ratio usually can be doubled on existing transformer designs without serious loss of efficiency if care is taken to reduce reactive currents in the primary and eddy current loss in the core. This is done by proper selection and stacking of the core laminations.

The number of primary turns generally has been calculated to obtain a desired flux density. It is more logical to design it for a minimum required inductance. Thus the length of the magnetic path and the degree of lamination interleave should enter into the calculation of the volt-per-turn ratio.

Electrical sheet steels should be graded for alternating current permeability in addition to core loss characteristics. It is hoped that producers of core materials will supply extrapolations of their a.c. permeability curves into the high flux density region to facilitate the design of these transformers.

With the Experimenter

[*Continued from Page 66*]

would work. The only care required in the construction of this indicator is to have the trigger tube and the leads to it fairly well shielded, to prevent any r.f. from the transmitter from getting to the elements of the tube. If r.f. is present, it may ionize the gas in the tube causing it to operate other than in the manner for which the indicator is designed. The voltage on the plate of the tube should be arranged so that it is disconnected when the transmitter is standing by, or the alarm will work during this time.

25 Watts on 56 Mc.

[*Continued from Page 35*]

mounted external to the transmitter, and the switch can be mounted upon the microphone. These two items have not been incorporated into the transmitter since their placement there would interfere with the operation of the unit from the home-station speech amplifier. It is only necessary to connect the 200- or 500-ohm output of the station speech amplifier into the input of the transmitter, after the single-button microphone and speech amplifier have been removed, to operate the transmitter from the home-station speech equipment.

See Buyer's Guide, page 96, for parts list.

What's New . . . .

IN RADIO

OHMITE GENERATOR FIELD RHEOSTATS

Smooth, close, gradual control of generator voltage is provided by generator field control rheostats produced by the Ohmite Manufacturing Company, Chicago.

Ohmite compact, vitreous enameled construction insures permanently smooth operation and exact control—and simplifies design problems for generator and switchboard designers. By providing practically continuous variation of resistance in even the smallest sizes, they effect considerable saving in control-panel space. This economy in space and weight makes them particularly useful on portable equipment, such as welding generators, home lighting plant generators, etc., also on shipboard, on trains, airplanes, and automotive equipment.

Ohmite field rheostats are tapered or uniformly wound, as required, designed to provide control for separately or self-excited generators. They are available in a series of ten wattage sizes, from 25 to 1000 watts. Thus, there is a rheostat suitable for every size generator—from the smallest to units of several kilowatts.

Hundreds of standard size units are listed in Ohmite catalog 40 according to the field voltage, and cover the range from 24-32 volts to 320-400 volts. Write to Ohmite Manufacturing Company, 4835 Flournoy Street, Chicago, Illinois.

HALLICRAFTERS FM/AM TUNER

The Hallicrafters Model S-31 FM/AM Tuner offers special advantages to those who already possess high-fidelity audio equipment, providing full facilities for FM, and for broadcast reception of unusual quality, without the necessity for duplication of audio equipment. Its undistorted output of 130 milliwatts is ample for any standard amplifier, including those in existing broadcast receivers.

The S-31 provides a dual i.f. system, the 4.3 mc. FM channel utilizing 1852 and 1853 tubes in its two 4.3-Mc. stages, a 6SJ7 limiter and 6H6 discriminator. The 455-kc. AM channel includes a single 6SK7 with special band-pass input circuit, and a 6SR7 which serves as detector and a.v.c. and its triode section as the output stage for both AM and FM channels and also for phono. A 6SK7 t.r.f. stage and 6SA7 converter provide the r.f. input to both channels.

The two tuning ranges are 540 to 1650 kc. and 40 to 51 Mc. These are selected by a panel switch which also automatically selects the appropriate i.f. channel. Terminals are provided for standard and doublet antennas, and for phono input. The two scales on the "slide-rule" dial are fully calibrated in kc. and Mc. Other controls include a radio-phono switch, a.f. gain, tone control, and "S"-meter adjustment. This meter, mounted on the panel beside the tuning dial, serves as a conventional tuning and signal strength meter for AM reception and as a carrier-centering indicator for FM tuning.

Outputs of 500 and 5000 ohms are provided, plus a headphone jack for monitoring purposes. The panel is the standard rack-mounting type 19″ x 8¾″ and suitable for rack or cabinet mounting.

LAFAYETTE AMPLIFIER FOR LOW-POWER SOUND JOBS

Although public address men like to think in terms of installations running into higher power and therefore carrying larger contract value, the possibilities afforded for the sale of low-power restaurant order systems, call systems, etc., are not to be overlooked. What they lack in unit sales value can often be made up in quantity sales.

Typical of the better equipment of this type is the Model 406-T amplifier offered by the Lafayette Radio Corporation, 100 Sixth Avenue, New York City. Only 6½″ high, 9″ wide and 7″ deep, this amplifier is enclosed in a gray, wrinkle finished metal cabinet, fully louvred for ventilation. Its output is 6 watts continuous, 8 watts on peaks. One microphone and one phono channel are provided with gain of 105 and 62 db. respectively. Frequency response is 50 to 8000 c.p.s. but a tone control is provided to adapt the output to the acoustic requirements of each location. All parts employed in its construction are husky to insure long, dependable service.

This amplifier is also available as a part of a completely coordinated indoor system, or of a portable system in a compact carrying case with built-in 8″ PM speaker, crystal microphone and 9″ banquet stand.

NEW TURNER VIBRATORS

The Turner Company of Cedar Rapids, Iowa, long accepted in the microphone industry, is announcing a new product to their line of radio components: the Turner Push-pull Vibrator. These new vibrators offer several engineering improvements which should tend to eliminate the vibrator as a source of trouble in the replacement field.

In the first place these new vibrators employ an equal amount of magnetic power to push, then to pull, the reed and its contacts, rather than relying on the springing action of the steel reed. The more positive reed swing insures better contact every time with a reduction of chattering and r.f. hash. Several other improvements in the new vibrators such as a micro contact adjustment and a fully closed dual magnetic path are influential in obtaining the improved performance and reliability claimed for the units.

Persons wishing a free manual or further information may write the Turner Company, Cedar Rapids, Iowa.

X-DX

[*Continued from Page 84*]

from Brazil . . . Rio, to be specific. Joe says he has been studying Portuguese in order to help plow his way around down there. W2GTZ has a new workshop and has been making a lot of new knotty pine furniture for their recreation room. I can see he got that way after his recent trip to Hollywood. Reeve also mentions that XU6D was in NYC over the holidays then to U. of Mich., and that XU4XA is in Philadelphia.

Here's a yarn that rather appealed to several of us and I think this is a good spot to spring on you . . . the mob. It's a tale about NY4AD and written by Bob Ebenreiter, W9LXC, Sheboygan, Wisc. (The fact that it's by a W9 has nothing to do with my selecting it . . . honest it didn't.) Well, here 'tis:

AMBITION REALIZED

Without a doubt all of you ten-meter phone boys know NY4AD of Guantanamo Bay, Cuba who is one of the most consistent performers on ten phone. Well, I know him too —finally!

You see, it's like this. Since the first day I began working ten-meter phone about one year ago I've been hearing NY4AD pounding in here daily like a ton of bricks. As often as I would hear him I would call him. Betcha that if I had buck for every call I've given him I could buy a California kilowatt with all the trimmings!

Well, about three weeks ago I happened to be down in Guantanamo Bay on a Navy Reserve shakedown cruise. While on shore leave I was sitting on the back of an old Army supply truck wondering just how in the dickens anyone could live on the sweet Cuban beer they dish out down there. While steeped in those beery thoughts of better binges in better days I suddenly spotted a three-element beam!! Zippp! I jumped off of that moving truck like a gazelle (that's pronounced gaa-zell not ga-zel-lee) and whipped over to that neat little bungalow parked below the beam. A most attractive xyl opened the door and sed "Yep, this is NY4AD and the OM is at home!"

Well, doggone, I certainly never expected to find NY4AD because Guantanamo Bay is so widely-spread out. But there he was, just one of the most fb guys you'd ever want to meet. He held out his mitt in greeting, and I stuck mine out to him with the old familiar "take five." We shook, and that started us off on a two hour visit.

I told Tom (that's NY4AD's first name for some of you fellows who don't know him) that I had been hearing and calling him for one year without any results. Furthermore, I explained that I had joined the Navy Reserve just so that I could get a free trip down there to talk to him, seeing as how I couldn't raise him nohow on the air. Well, he didn't believe that story and now that I think it all over I guess I don't have too much faith in it either!

Anyhow—I left a message with Tom at the end of our visit. It was for my folks up here in Sheboygan to be handled by my good pal W9POS who is another ham in this town. Tom said he had heard W9POS often and wouldn't have any trouble in giving him the message. So I left everything up to Tom, bid him adieu, stopped in a beer joint, had three more Cuban beers (this time I closed my eyes while I drank and concentrated on the name *Budweiser*, and the stuff didn't taste so bad) and then returned to my ship.

I arrived home here a few days ago. Naturally, the first thing I did was to check the band. Of all things—the first station I heard was NY4AD!! He was calling Bud Asher (W6OZH down there in San Diego) for a schedule but was having a little trouble in raising him due to bad skip conditions. Well, I had it figured out that Bud's frequency was pretty close to mine so I thought I'd give NY4AD a call just for the heck of it, feeling that my sig probably wouldn't get down there anyway. I threw the rig on the air, briefly called "Hello NY4AD—this is Sheboygan calling you" and stood by.

Believe it or not, you could have knocked me over with that proverbial feather when NY4AD boomed right back, "Hello Sheboygan, hello Sheboygan—hello Sheboygan! Stand by! I have a message for you!" in rather an excited voice. In a happy daze, realizing that I finally had contacted NY4AD over the air (that's how this story "Ambition Realized" got its name), I went right back to him and said, "Take her easy, Tom! I'M the guy who gave you the message!"

Well, Tom and I had a good laugh over that unusual little incident and we both agreed that maybe my personal visit to him finally brought me enough luck to make my signals heard down in Cuba. Well, that might have been what did it, but I just wrote down in my log, "Finally! After one year of trying I finally hook NY4AD who gives me a message for myself which I had given to him two weeks previous down in Cuba. Ain't life and ham radio wonderful though???"—*Signed:* BOB EBENREITER—*W9LXC*—Sheyboygan, Wis.

On the last trip north I had occasion to visit the radio station of the Sheriff's Department of a certain county. This should give you a snicker or two. Anyway, the chief op took me to the transmitter house to look at the rig. Once inside the little room I spied one of those sprays such as is used to kill bugs, etc. Upon inquiring what part that played in the life of the station the op replied, "Well, you see, every once in a while we notice something goes wrong with the rig while we're operating it from the station a few blocks away. So we dash down here to discover various spiders and bugs have crawled in the condensers. This of course, is not very beneficial to their health, but that doesn't worry us as much as the fact that the condenser spacing is reduced causing arc-overs. So we grab the spray gun and kill any other bugs in the transmitter." He then added, "It may seem funny but this is a case where the transmitter hasn't any 'bugs' and yet it has." Quick Henry, the Flit!

THIS WINDS UP OUR LITTLE SESSION FELLOWS AND HOPE IT HASN'T BEEN TOO BORING. I'D PERSONALLY LIKE EACH AND EVERYONE OF YOU TO SEND IN A SMALL ITEM FOR THE COLUMN. IT DOESN'T HAVE TO BE ABOUT DX (GUESS WHY), BUT SOME INTERESTING THING THAT MAY HAVE TAKEN PLACE IN YOUR NECK OF THE WOODS. ALSO SEND IN ANY PHOTOS THAT YOU CAN. OF COURSE THEY TOO, SHOULD HAVE A CERTAIN AMOUNT OF GENERAL INTEREST, SUCH AS HAM-SHACK PHOTOS, SMALL GROUP PICTURES THAT HAVE SOME SIGNIFICANCE, ETC. COME ON NOW GANG, SCRATCH AROUND AND SEE IF YOU CAN'T DIG UP AN ITEM OR TWO. THEY CAN BE HUMOROUS . . . OR OTHERWISE. BY THE WAY, HOW DO YOU LIKE THE NEW STYLE OF TYPOGRAPHY AS ADOPTED IN THIS COLUMN FOR THE FIRST TIME? I'LL SEE YOU NEXT MONTH, BUT DON'T FORGET I REALLY DON'T HAVE A PRIVATE LINE INTO THE W9'S . . . BUT I SHOULD HAVE!

Our closing poem:

Ode to Ye Never-Known

No more about ye DX bands
  Do wild men push and pulle
Or brag of J's, VJ's, PK's,
  And toss about ye bulle.
Ye long-haired law hath gummed ye game,
  Ye bands are dry as snuffe.
And many souls, no doubt,
Do find it hard to do without
Excepting thee and me, Old Scout,
  Who never worked Ye Stuffe.

—W3EYY

Past, Present and Prophetic

[*Continued from page 6*]

this improvement from the established state of things. Maybe it's done with mirrors.

Of course there is still room for improvement in diathermy equipment, and we have mentioned that fact before. But there is room for improvement in a great many things. We would hesitate to hold ourselves up as the acme of purity and virtue and condemn a contemporary because they once published a "How-to-build-it" on a modulated self-excited oscillator. It was probably a better rig than many that were being used at the time; it was a step in the right direction. Would *witholding* the publication of that article have improved the state of the art? Of course not! We could show you a crystal-controlled diathermy; and they could have shown a crystal-controlled 'phone. But no one would build or use the crystal diathermy unless forced to, and probably no amateur would have built the crystal 'phone at that time.

On page 20 will be found another diathermy oscillator. This one, like its predecessors, is an improvement over those previously shown. It is reasonably stable, and precautions have been taken to reduce radiation. It operates on a "fixed" frequency. It isn't a crystal-controlled transmitter, but we think it is a good job—as good as or better than any semi-portable unit you can buy. Maybe it will serve as an example to the manufacturers of some of the horrible things we have heard on 20, 10 and 5.

Below 1 Meter

When John Reed, W6IOJ, submitted the picture seen on the cover this month and asked if a story on his 400-Mc. rig could be used, the answer was an immediate "Yes." The full story will be found on page 27. It is our hope that every amateur will familiarize himself with the principle, if not the actual construction and operation, of the pipe-and-blowtorch type of u.h.f. apparatus. With the armed forces using u.h.f. in many ways, a thorough understanding of modern u.h.f. equipment by all amateurs will certainly provide an excellent argument for the amateur's worth in time of emergency.

As the ultra-highs go these days, 400-Mc. is a rather low frequency. Unfortunately, apparatus for the still higher frequencies can be described only in the most general terms, since its actual design is a matter of great military importance. The enterprising experimenter should be able to glean enough information on the subject from material published before the present emergency to get a basic understanding of the methods used. We can not stress too strongly the desirability of u.h.f. "savvy" by all amateurs—for their own and their country's good.

Converter for FM

With Perry Ferrell giving all the qualitative dope on f.m. reception in the past few issues, you may be interested in an f.m. broadcast receiver to check up on his observations. If so, page 9 is the place to find an f.m. converter to use with any suitable audio amplifier. Thompson's unit is relatively inexpensive to build and seems to be well designed for the purpose of forming a useful attachment for the family b.c. set.

●

More than thirty of the U.S. frequency assignments lie in the *audio* spectrum.

POSTSCRIPTS... *and Announcements*

Triodes as Class C Amplifiers

There were several typographical errors in the article with the above title which appeared in the January, 1941, issue of RADIO beginning on page 49. The first error appeared in the familiar equation

$$i_p = K(e_g + e_p/\mu)^x$$

Throughout the article this equation appeared with a minus sign between the first and second factors inside the parenthesis (page 49, column 2; footnote 3 on page 50; and in the caption for figure 4), instead of the plus sign as given above. Then in figure 2 on page 50 under curve B the 2θ should refer to the total plate current pulse instead of to one half cycle of the I_p wave. The last error appeared on page 54 in the determination of the cosine of the angle of plate current flow—this equation should read

$$\cos\,\theta = 0.948 - 175/208.8 = 0.11.$$

Peaked Audio Speaker

When using the tuned audio amplifier described in the February issue it is important that the speaker does not have a "null" at or near the filter frequency. A speaker placed in a small, symmetrical box or cabinet, or placed in the center of a small square baffle, can have a sharp "null" of 15 db or more in the vicinity of 600 cycles, the filter frequency.

To check, tune a beat note from about 200 to 1000 cycles with the filter cut out, and notice if there is an appreciable "dip" in volume at or near the filter frequency. If so, it will be necessary to change the size of the speaker baffle or box, or to use a different resonant frequency for the filter.

●

Glass blowing, brought to a high state of perfection in the radio tube industry, is one of the world's oldest arts.

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.

THOMPSON FM CONVERTER

Page 9

Tuning Condenser—Meissner 18153
All coils—Meissner Mfg. Co.
Chassis and cabinet—Meissner Mfg. Co.
Dial drum—Amer. Radio Hdw. 3"
Tuning eye bracket—Amphenol
Tubes—RCA

●

SMITH 2A3 COMPRESSION AMPLIFIER

Page 16

T_1—Thordarson 33A91
T_2—Thordarson 19D01, 2, 3, or 4 (depending upon class B tubes)
T_3—Thordarson 67D50
T_4—Thordarson 13R14
CH_1, CH_2—Thordarson 13C26
CH_3—Thordarson 13C27
CH_4—Thordarson 17C00-B
R_1, R_2, R_3, R_4, R_5, R_7, R_9, R_{11}, R_{12}, R_{13}, R_{14}, R_{16}—Centralab 710
R_{18}—Centralab 516
R_8, R_{10}—Centralab 72-105
R_{19}—Centralab VF-133

●

RAGUSE AND DENNEY DIATHERMY

Page 20

Complete parts list for the unit.

1—0-300 d.c. milliammeter
2—Cutler-Hammer d.p.s.t switches
4—Large grid clips (for plates)
2—Ohmite 0442, 100,000 ohm 50-watt resistors
1—Ohmite 0578, 5000 ohms 50 watts with slider
1—Ohmite 50 ohm wirewatt
2—Bud PL-977 diathermy plugs
2—Bud PJ-963 jacks for above
1—Mallory-Yaxley 311-R jewel
1—Mallory-Yaxley 311-G jewel
2—GE 6-watt candelabra lamps
2—Candelabra sockets
1—Littelfuse 1075 mount
1—3AG 5-ampere fuse
1—Advance 700-A relay
1—Johnson 204 indicator and dial
4—Johnson 22 standoff insulators
3—Johnson 603 standoff insulators
4—Johnson 42 feed-through insulators
1—Cornell-Dubilier TQ-20020 filter
4—Amphenol RSS-4 steatite sockets
2—RCA or GE 812 tubes
2—RCA or GE 866A/866 tubes
1—Thordarson T-19F90 transformer
1—Thordarson T-19F99 transformer
1—Peerless 1087-F1 transformer
1—Bud CH-876S r.f. choke or similar
1—Bud MC-913 condenser or similar
2—Aerovox 1467 .005 mica
2—Aerovox 1467 .0025 mica
17 feet 1/8" copper tubing
1—Par Metal F-13170 chassis (grey crackle with chrome trim)
Tank condenser, pads, wiring, and miscellaneous components as described in text.

●

PHONE—C.W. R.F. UNIT

Page 30

C_1—Bud 903
C_2, C_3—Bud 902
C_4—Bud 911
C_5—Bud 1560
C_6, C_7, C_8, C_9, C_{11}, C_{12}—Cornell-Dubilier 1W-5D3
C_{10}—Cornell-Dubilier 5W-5Q5
C_{13}—Cornell-Dubilier DT-4P25
C_{14}—Cornell-Dubilier EH-9800L
C_F—Cornell-Dubilier 1W-5D3
NC—Bud 1000
R_1, R_2, R_3, R_4, R_6, R_8—Centralab 516
R_6, R_7—Ohmite Brown Devil
RFC_1, RFC_2, RFC_3—Bud 920
RFC_4—Hammarlund CH-500
S_1—Centralab 2515
T_1—Thordarson T-50F61
T_2—Thordarson T-13R12
T_3—Thordarson T-19F94
CH—Thordarson T-43C92
T-40's—Taylor
Other tubes—RCA

●

DAWSON 56-MC. TRANSMITTER

Page 33

C_1, C_2—Bud LC-1642
C_3—Bud LC-1650
C_4—C_{10}, C_{12}, C_{13}—Aerovox 1467
C_{11}—Mallory CS-136
Resistors—IRC BT-1/2, BT-2
R_1—IRC EPA-25,000

[Continued on next Page]

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; minimum, 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 Santa Barbara accompanied by remittance in full, payable to the order of Radio, Ltd.

[*Continued on next Page*]

Buyer's Guide

[*Continued from Page 96*]

Dawson 56-Mc. Transmitter

CH—UTC S-29
T_1—UTC S-7
T_2—UTC S-18

TAYLOR RECEIVER
Page 48

C_1, C_2—Altered Hammarlund MCD-35-MX. See text.
C_3, C_4—Bud MC-321
C_5, C_{17}, C_{19}—Aerovox 1460
C_6—Meissner 22-5255
C_7, C_8, C_9, C_{10}, C_{11}, C_{13}, C_{14}, C_{16}—Aerovox 484
C_{12}, C_{18}—Aerovox 1467
R_1, R_3 to R_{11}, inclusive, R_{17}, R_{18}—I.R.C. BT-½
R_2, R_{14}, R_{16}—I.R.C. BT-1
R_{15}—I.R.C. F-½
R_{12}—Ohmite Brown Devil
R_{13}—Centralab 72-113
R_{19}—Centralab 72-120
T_1—Meissner 16-8091
T_2—Meissner 16-8099
Coil forms—Bud CF-595
Tubes—RCA

BRODERSON 112 Mc. WAVEMETER
Page 57

1 Midget variable 3-plate condenser (rebuilt)
1 Negative or zero temperature coefficient ceramic trimmer condenser, (Centralab, type B, 3-12 $\mu\mu$fd.)
1 2⅛" diameter dial plate
1 ¼" panel bearing
1 ¼" rigid coupling
1 Insulated extension shaft
Misc.: Lucite, Presdwood, 6-32 machine screws, lugs, washers, etc.

The Marketplace

[*Continued from Page 97*]

SELL—1600V, 600V power supply, plus breadboard 35T rig. Complete $45 plus freight, details. Write W6BLZ. Box 44, Sendover, Utah.

BATTERY POWERED CONVERTER, 10-80 meters, described on page 144 of 1941 Radio Handbook, complete with tubes and coils but less batteries. $15. f.o.b., The Editors of RADIO, Santa Barbara, Calif.

813 C.W. TRANSMITTER, 250 watts, described in chapter 16 of 1941 Radio Handbook. $75 less tubes, f.o.b. The Editors of Radio, Santa Barbara, Calif.

PUSH-PULL 35TG AMPLIFIER for rack mounting, described in chapter 13 of 1941 Radio Handbook, including 10 meter coils but less tubes. $16.00, f.o.b.. The Editors of RADIO, Santa Barbara, Calif.

•

160 METER DX WITH 3 WATTS

Oklahoma City, Okla.

Sirs:

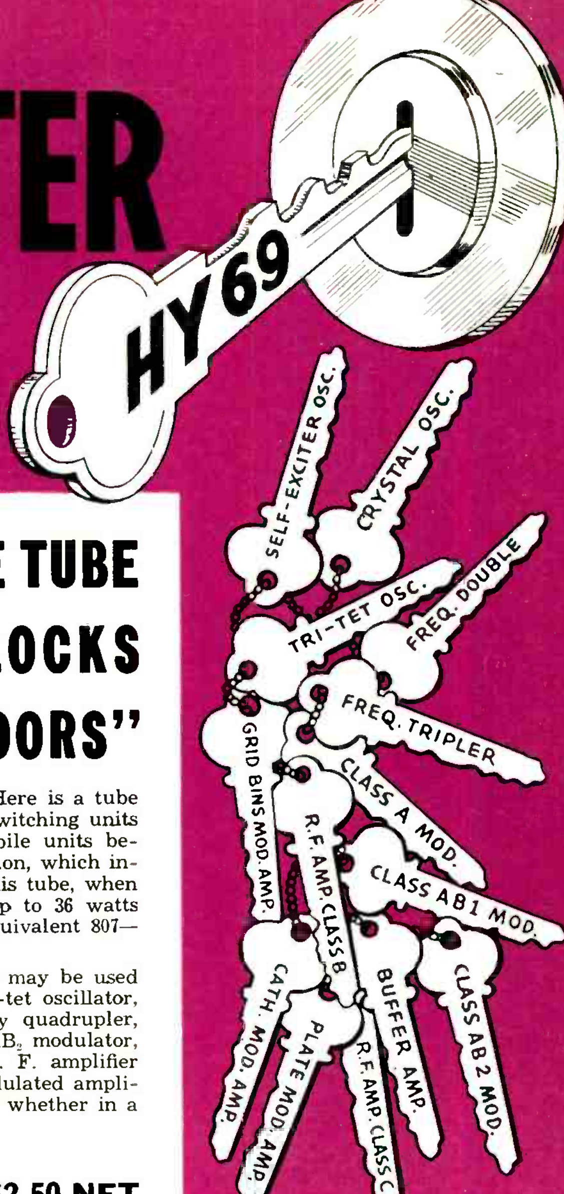
Something that might be of interest to the readers of RADIO is the performance of the flea-power 3-watt 160-meter phone rig that was described in the October issue. The rig was described as being ideal for local contacts, but under good conditions it has proven itself to be quite capable of good 160-meter dx. It might even have set some kind of record for this power. Following is a list of contacts made with this rig running from 1½ to 2 watts input. All reports were Q5 and the strength reports varied from R5 to R9.

W5HUY, Wynsboro, La.
W5ZS, Shreveport, La.
W5AAN, Denton, Tex.
W2KYH, Ridgewood, N.J.
W3IIZ, Morristown, N.J.
W8LII, Nitro, West Va.
W8EQP, Covington, Ky.
W9DMO, Louisburg, Kan.
W9TUG, Great Bend, Kan.
W9RUJ, Auburn, Neb.

In addition, many more or less local QSO's were had with amateurs in Kansas, Texas, Arkansas, and Oklahoma. The antenna in use was a Marconi operating against a counterpoise. Who said that power was necessary for anything more than local work on 160?

JOHNNY SASSER, W5HQV.

LIKE A MASTER KEY



HY69
$3.50 NET

HERE'S THE TUBE THAT UNLOCKS MORE "DOORS"

The Hytron HY69 is your best buy in R. F. beam tetrodes! Here is a tube which is ideally suited for multi-band transmitters or band-switching units because it's so easy to drive. Also, it's first choice for mobile units because of its instant-heating filament, and its rugged construction, which insures reliability. On the basis of continuous-service ratings this tube, when used as a plate-modulated R. F. power amplifier, delivers up to 36 watts R. F. carrier output as compared with 24 for the cathode-equivalent 807—without one cent additional cost.

Get acquainted with this amazingly versatile tube, which may be used as a (1) self-excited oscillator, (2) crystal oscillator, (3) tri-tet oscillator, (4) frequency doubler, (5) frequency tripler, (6) frequency quadrupler, (7) Class A modulator, (8) Class AB_1 modulator, (9) Class AB_2 modulator, (10) buffer amplifier, (11) R. F. amplifier Class C, (12) R. F. amplifier Class B, (13) grid-bias modulated amplifier, (14) cathode-modulated amplifier and (15) plate modulated amplifier. All these applications whether in a fixed station or mobile installation.

What more can you ask for an investment of only $3.50?

HY61/807 — $3.50 NET

The original R. F. beam amplifier (cathode-type). Shielded for R. F. applications and requires no neutralizing.

Plate voltage 600 V. Class C output 37.5 watts.
Plate dissipation 25 watts.
Filament 6.3 volts at 0.9 amperes.

Recommended for use in existing equipment where change-over to HY69 tubes is not possible or not practical.

HY60 — $2.50 NET

The HY60 has a lower power drain than the HY61/807 and is also smaller in size, making it possible to utilize it in compact mobile units without sacrificing performance.

Plate voltage 425 V. Class C output 16 watts.
Plate dissipation 15 watts.
Filament 6.3 volts at 0.5 amperes.

Delivers 30 watts of audio with only 400 volts on the plate, as a Class AB_2 modulator.

No neutralizing required—full ratings to 60 megacycles—less than ½ watt R. F. driving power—40 watt plate dissipation.

HYTRONIC LABS.

23 New Darby St., Salem, Mass.

HYTRON TRADE MARK REG.

A DIVISION OF HYTRON CORP.

Manufacturers of Radio Tubes Since 1921

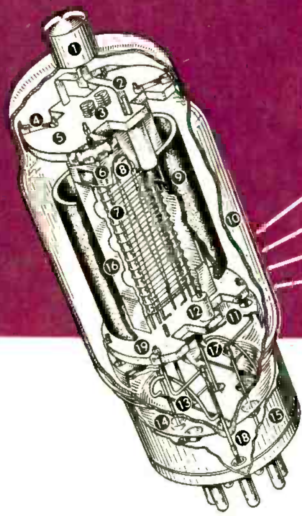
RCA-813

BEAM POWER AMPLIFIER

360 Watts Input with Less Than 1 Watt Driving Power!

Amateur Net $22.00

(Reduced from $28.50, April 1, 1940)



Note These Features

1. Medium Metal Cap
2. Short Ribbon Plate Connector
3. Filament Support Springs
4. Mount Support
5. Top Ceramic Mount Support
6. Top Shield
7. Aligned-Turn Control and Screen Grids
8. Heavy-Duty Thoriated-Tungsten Filament
9. Large Sturdy Graphite Plate
10. Hard Glass Bulb with Mount-Aligning Dome
11. Bottom Shield Disc
12. Ceramic Plate-Support Spacer
13. Directive-Type Getter Container
14. Dish Type of Stem
15. Ceramic-Insert Giant Base
16. Beam-Forming Plate
17. Filament Connector
18. Tungsten-to-Glass Seal
19. Bottom Ceramic Mount Support

BIG-TIME MAGICIAN

OF THE BEAM TUBE LINE!

For high-power transmitters requiring exceptional overall efficiency—for ultra-modern rigs that need no neutralizing adjustments, rigs that can switch bands in a flash—for high-power gear with few tuning controls, requiring a minimum of driver equipment—use the RCA-813. It's the largest of the amateur "beams", big-brother magician of the famous RCA-807. It can handle a greater variety of big-time jobs than any other tube of its size or class.

As a final in c-w service RCA-813 takes 360 watts (CCS) with less than a watt of drive. As a final in plate-modulated service, it takes 240 watts with only 1.2 watts of drive. Moreover, it doubles, triples and quadruples with unusually high efficiency and high harmonic output. It can be operated at full ratings up to 30 Mc—at reduced ratings up to 60 Mc. Power sensitivity of the RCA-813 is extremely high. Screen current requirements are very low.

In brief, the RCA-813 gives you *real* power—*real* circuit simplification—*real* economy. And it makes possible a flexible, high-power rig at a cost comparable with that of equipment using ordinary tube combinations.

Typical (Class "C" Telegraphy) CCS (Continuous Commercial Service) Ratings

Filament voltage, 10 volts (a.c. or d.c.); filament current, 5 a.; D-C plate volts, 2,000; D-C screen volts, 400; D-C grid volts, —90; D-C plate current, 180 ma.; D-C screen current, 15 ma.; driving power, 0.5 watt; power output, 260 watts.

COMPLETE DOPE ON THE NEW RCA-866-A/866 RECTIFIER...

...is contained in the January, 1941 issue of RCA HAM TIPS. Full technical details, typical circuit applications, etc. Ask your RCA Amateur Equipment Distributor for a copy.

RCA *Transmitting Tubes*

RCA BROADCAST EQUIPMENT — From microphone to antenna

RCA MANUFACTURING CO., INC., CAMDEN, N. J. • A Service of The Radio Corporation of America

In Canada: RCA Victor Company Limited, Montreal