RADIO

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INDEX TO ADVERTISERS

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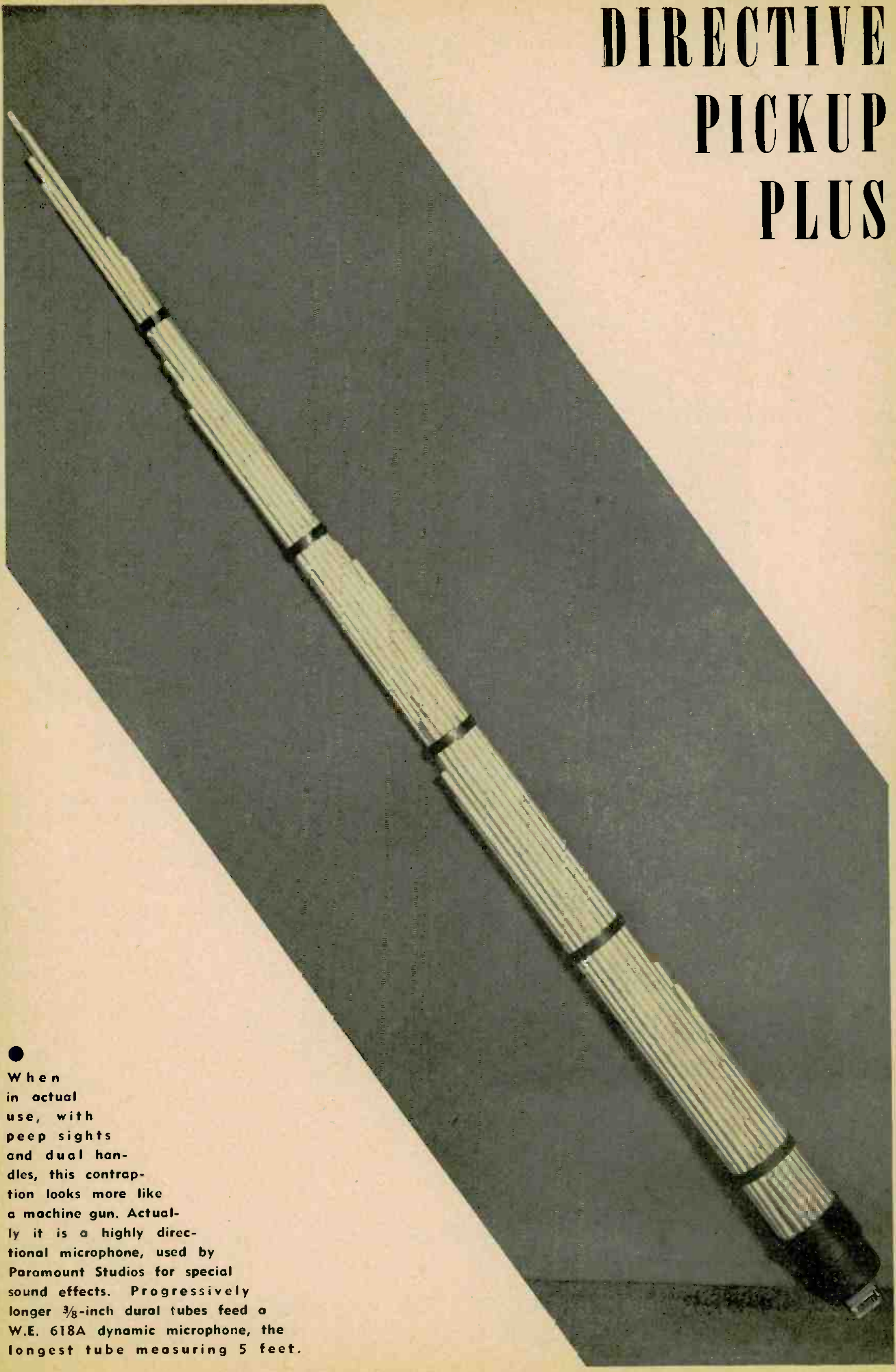
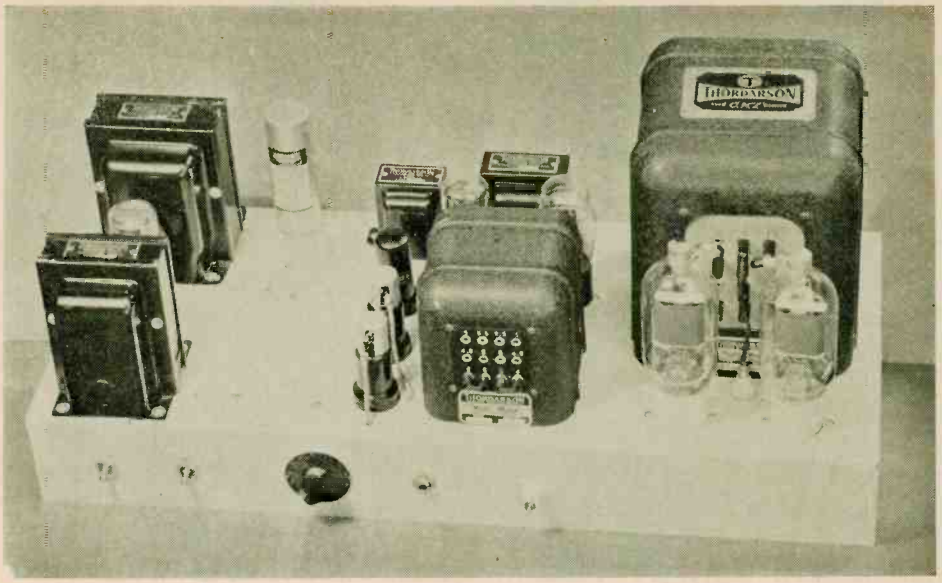


● When in actual use, with peep sights and dual handles, this contraption looks more like a machine gun. Actually it is a highly directional microphone, used by Paramount Studios for special sound effects. Progressively longer ⅜-inch dural tubes feed a W.E. 618A dynamic microphone, the longest tube measuring 5 feet.

● The complete modulator as built upon a 24"x10"x3" chassis.



A SPEECH-MODULATOR of Modern Design

● By RAY L. DAWLEY,* W6DHG

In recent months a number of improved tubes, improved circuit arrangements and new ideas have been published concerning high-level modulators and modulation systems. With these new thoughts in mind it was not a particularly difficult task to design and build a modern-design speech amplifier-modulator to incorporate them.

A.M.C.

First, and perhaps most important of the improved ideas that have been publicized in recent months concerning modulation systems is automatic modulation control[1]. A number of other methods of controlling the peak amplitude of the voltage have been suggested but the one advocated by Waller seems to incorporate the largest number of desirable points. This arrangement *does* effectively hold the modulation percentage below 100% regardless of the modulation waveform, the response characteristics of the complete amplifier and modulator or of its power-handling capabilities. Also, as has been mentioned before in connection with modulation-percentage limiting devices, the actual effective modulation percentage is raised. The gain on the amplifier may be turned up to a higher level than would be possible without a.m.c. Then, due to the limiting characteristics of the circuit, the gain of the amplifier will be raised for low-level voice passages and reduced to an amount which will prevent overmodulation on the high-level ones. All in all, a.m.c. is decidedly a feature to be incorporated in any speech amplifier-modulator of modern design.

Degenerative Feedback

It has been proven by Nalley[2] that degenerative feedback between the grids of the class-B tubes and their drivers in a class-B modulator exerts a definite improvement in the quality of output of the modulator through a reduction in harmonic generation. Hence, feedback between the class-B grids and their drivers has

*Technical Editor, RADIO.

[1]"Automatic Modulation Control," Waller. RADIO, March, 1938, p. 21.

[2]"Negative Feedback Applied to Class-B Audio," Nalley. RADIO, July, 1937, p. 54.

been used in this modulator. The improvement in quality was easily noticeable in a listening test made upon the modulator when it was operating with and without feedback. Of course a portion of the distortion that was apparent when the modulator was operating without feedback was caused by the use of beam tetrodes as drivers for the class-B stage. But when the feedback was cut into the circuit the distortion was considerably lower than that experienced when using low-μ triodes as drivers in the conventional arrangement.

Modulation Capability

Another idea taken into consideration in the design of the amplifier-modulator was that of obtaining the maximum peak power output from the modulator tubes. In an article that appeared in the April RADIO[3] Douglas Fortune, W9UVC, analyzed the now commonly known fact that more class-C input can be modulated 100% by voice waveforms with a certain complement of tubes than can be modulated by a sine wave. His analysis mentioned the fact that an audio amplifier will modulate a class-C input numerically equal to its *peak* audio output. It is well known that the peak power contained in a sine wave is twice its average power. The peak power contained in an ordinary speech waveform is from three to four times its average power. So if we design the class-B amplifier stage so that it is capable of a high ratio of peak-to-average power output, it will be capable of modulating considerably more input to the class-C stage.

It is possible to obtain a high ratio of peak-to-average power from a class-B modulator by working the class-B tubes into a somewhat lower than average plate load impedance, and by proper design of the driver stage. Through these design principles, the modulator described, although only capable of an output of about 175 *average* watts at the plate voltage recommended (1000 volts) it is capable of a *peak* output of approximately 500 watts at this same voltage—and consequently is capable of modulating 100% by voice an input of 500 watts to the class-C stage.

Mechanical Construction

The combined speech amplifier-class-B modulator with the associated power supply for the speech amplifier, is built upon one 24"x10"x3" metal chassis. All the mounting holes for the equipment and the sockets were drilled first. Then the top side of the chassis was painted with aluminum gray lacquer. The under side of the chassis was not painted; the plated cadmium finish on this side facilitated the grounding of the various components.

The power supply for the speech stages is mounted along the left hand side of the chassis. Then there are mounted, in a row, the 6J7 first audio stage, the 6L7 a.m.c. amplifier and the 6F6 last audio. Then, in the next row, in front is the multi-tap driver transformer for the class-B stage, then the two 6V6 drivers, and in back, the coupling transformer between the 6F6 and the two 6V6G's. On the right hand end of the chassis are mounted the two TZ40 modulators and their associated class-B output transformer.

Looking at the front of the chassis can be seen at the extreme right, the on-off switch for all filaments and for the plate supply for the speech amplifier. The plate supply for the TZ40's is controlled at the transmitter proper. The next switch is the on-off switch for the a.m.c. circuit. Then comes the gain control, the microphone input jack and the binding post for connection to the a.m.c. peak rectifier.

The under-chassis view is practically self-explanatory. At the extreme right end of the chassis is the 7.5-volt filament transformer for the TZ40's and to the left of the center of the chassis are mounted the resistor plates. Only the upper one can be seen as the two are mounted one above the other.

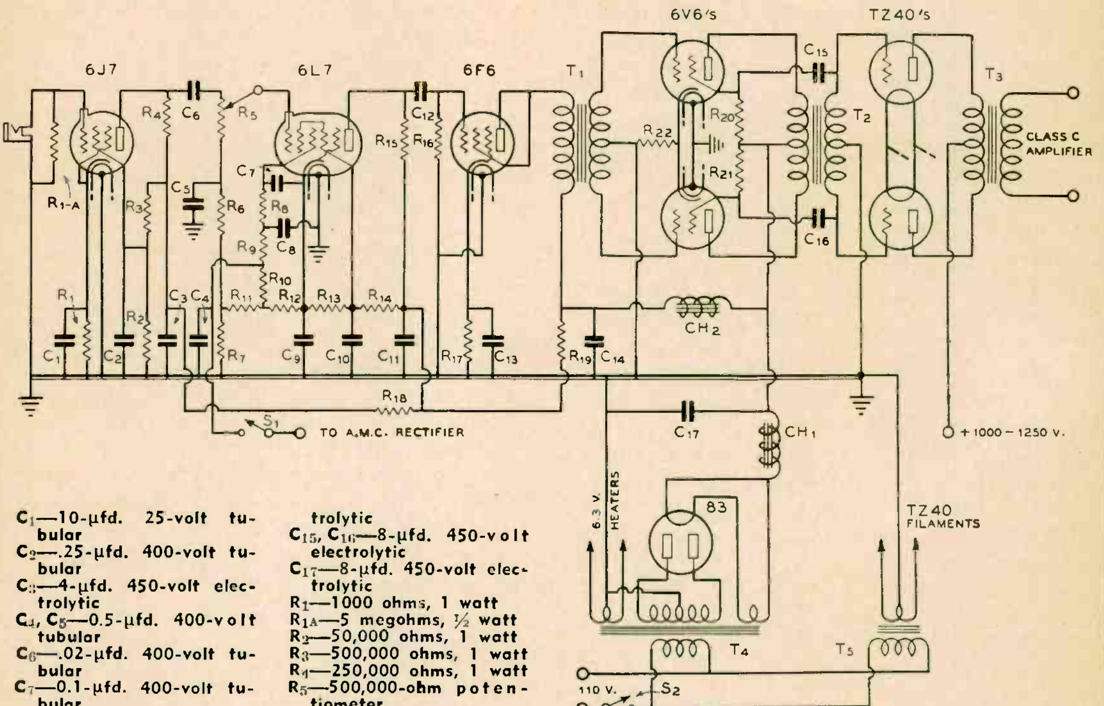
Electrical Design

The speech amplifier uses a 6J7 metal tube connected as a high-gain pentode in the input. The circuit is conventional and the tube is designed to operate from a diaphragm-type crystal microphone. The closed circuit jack on the input of the amplifier is shielded by a small metal can to eliminate any possibility of coupling between the output of the amplifier and the input circuit. Since the large metal spring of the jack is at grid potential it was deemed desirable to shield it from the output circuit of the 6V6G's and from the a.m.c. lead which also runs very close to the jack.

The 6L7 A.M.C. Stage

The second stage of the amplifier—the a.m.c. stage—utilizes a 6L7 tube and is connected essentially the same as the analogous stage in the amplifier described by Waller[1]. The 500,000-

[3]"More Speech Power from Class-B Modulators," Fortune. RADIO, April, 1938, p. 49.



C_1—10-μfd. 25-volt tubular
C_2—.25-μfd. 400-volt tubular
C_3—4-μfd. 450-volt electrolytic
C_4, C_5—0.5-μfd. 400-volt tubular
C_6—.02-μfd. 400-volt tubular
C_7—0.1-μfd. 400-volt tubular
C_8—.002-μfd. 400-volt tubular
C_9—8-μfd. 450-volt electrolytic
C_{10}—0.5-μfd. 400-volt tubular
C_{11}—8-μfd. 450-volt electrolytic
C_{12}—.05-μfd. 400-volt tubular
C_{13}—10-μfd. 25-volt tubular
C_{14}—8-μfd. 450-volt electrolytic
C_{15}, C_{16}—8-μfd. 450-volt electrolytic
C_{17}—8-μfd. 450-volt electrolytic
R_1—1000 ohms, 1 watt
R_{1A}—5 megohms, ½ watt
R_2—50,000 ohms, 1 watt
R_3—500,000 ohms, 1 watt
R_4—250,000 ohms, 1 watt
R_5—500,000-ohm potentiometer
R_6—500,000 ohms, 1 watt
R_7—4500 ohms, 5 watts
R_8—1 megohm, 1 watt
R_9—100,000 ohms, 1 watt
R_{10}—500,000 ohms, 1 watt
R_{11}—350 ohms, 1 watt
R_{12}—150 ohms, 1 watt
R_{13}—5000 ohms, 5 watts
R_{14}—7500 ohms, 5 watts
R_{15}—100,000 ohms, 1 watt
R_{16}—100,000 ohms, 1 watt
R_{17}—750 ohms, 10 watts
R_{18}—10,000 ohms, 5 watts
R_{19}—2000 ohms, 5 watts
R_{20}, R_{21}—5000 ohms, 3 watts
R_{22}—300 ohms, 10 watts
T_1—Triode power tube to p.p. power tube driver transformer
T_2—Multi-match class-B input transformer
T_3—Multi-match class-B output (300 watt)
T_4—745 c.t., 145 ma.; 5 v., 3 a.; 6.3 v., 4.5 a.
T_5—7.5 volts, 4 amperes
CH_1—10-hy., 150-ma. filter choke
CH_2—10-hy., 65-ma. filter choke
S_1—A.m.c. on-off switch
S_2—110-v. a.c. switch

ohm volume control is placed between the plate circuit of the 6J7 and the control grid of the 6L7. It is important that this potentiometer be of the insulated-shaft type since the entire 6L7 circuit operates considerably above ground potential. A complete description of this circuit and of its operation was given in the article previously referred to. One slight change has been made in the RC filter in the injector-grid circuit of the 6L7. It was found that the return-to-normal time constant of the network was, under certain conditions, slightly too long. Changing the value of the condenser from the injector grid to ground from 0.5 μfd. to 0.1 μfd. sufficiently lowered the constant of the network. Aside from this quicker return to normal after an unusually strong signal has passed, the operation of the 6L7 is the same as the one used by Waller.

The 879 reverse peak rectifier should be connected in the conventional manner; the plate of the tube should be connected directly to the a.m.c. binding post on the amplifier, and the filament of the tube should be connected to the lead that goes to the plates of the modulated class-C amplifier. The filament should be lighted from a 2.5-volt filament transformer that is adequately insulated for twice the average plate voltage of the modulated amplifier plus 1000 volts. Also, it is often a good idea to remove the negative peak rectifier as far as conveniently possible both from the speech amplifier and from the class-C final.

Since the injection grid of the 6L7 a.m.c. amplifier is 70 to 90 volts above ground potential (the whole a.m.c. stage is, as mentioned before, at this potential above ground) the 879 peak rectifier will begin to operate when the plate voltage on the class-C amplifier becomes less than 70 or 90 volts, whatever the case may be. Then, as the modulator tends to drive the plate voltage lower than this the gain on the speech amplifier will be reduced as the injector-grid bias on the 6L7 becomes negative. As this negative bias is increased, the signal output of the modulator is reduced. The final result: the output voltage of the modulator is reduced to an amount that will not cut the negative-peak plate voltage on the class-C stage to zero; consequently, there is no overmodulation. And, the gain on the speech amplifier may be run up to an amount which will permit a higher average voice level from the transmitter without any chance of overmodulation under any case. When the resulting signal is heard over the air, the transmitter seems to be modulated at a much higher percentage although there is no tendency toward overmodulation splatter or hash.

The next stage, a 6F6, is connected as a low-μ triode and is transformer coupled to the grids of the 6V6G's used as drivers. The 6F6 is triode connected for two reasons: first, since there is ample gain obtained for any ordinary condition of operation from the cascaded 6J7 and 6L7, the low-μ of the triode-connected 6F6 serves only to step up the power output of the 6L7 to the amount needed by the 6V6G's without greatly increasing the gain; and second, a power triode in this position will have somewhat less distortion than either a pentode or a low-level triode such as a 6C5. The coupling transformer between the plate of the 6F6 is designed to carry the plate current of the 6F6 without saturation of the core. It is designed with a step-down ratio to feed the grids of a pair of power tetrodes or triodes.

The 6V6G Drivers

A pair of 6V6's or 6V6G's are connected as tetrodes with degenerative feedback coupled into their screen circuits. This method of connection for the 6V6G's adapts them very well as drivers for the TZ40's since the plate impedance of the tubes is very considerably lowered by this method of connection.

Beam tetrodes when connected in the conventional manner are not particularly well suited as drivers for a class-B stage unless a considerable amount of swamping is used. The high plate resistance of the tubes in the conventional method of connection causes a large drop in output voltage when any increase in load is placed upon them. But by connecting them in this manner two important advantages are accrued. First, the two resistors, R_{20} and R_{21}, act as swamping resistors for the grid circuit of the TZ40's. Second, since feedback is introduced into the 6V6's, their gain is raised or lowered from the operating value by an amount depending upon the conditions of drive to the modulator.

Operation of the Feedback Circuit

An explanation of the operation of this arrangement for obtaining negative feedback should be of interest. First, if the screen potential is maintained at a constant value with respect to the audio voltage, the tubes will operate as conventional tetrodes with high gain and high plate resistance. Then, if the screens are connected to the plates of their respective tubes, the screens will swing back and forth at an audio voltage of the same phase and magnitude as that of the plates. The tubes then operate as conventional triodes with low gain and low plate resistance, but *without* the ability of adjusting their gain to conform to varying conditions of load. Now, by connecting the screens to a source of voltage of the same *phase* as the plates but of different magnitude (the correct driver transformer ratio is 4 to 1, step down), the gain of the tubes will be reduced to some value between that obtained with tetrode connection and that obtained with triode connection. In other words, with the tubes connected as shown, they will be operating under conditions between those of tetrode and triode operation.

Now, with this thought in mind, consider what happens during an audio cycle when the 6V6G's are driving the TZ40's. As the audio voltage increases, the grids of the TZ40's start to draw grid current and the loading across the secondary of the driver transformer increases. Ordinarily this increased loading would lower the voltage appearing across the winding but another condition comes into play. As this voltage tends to decrease due to increased loading, the amount of voltage that is being fed back to the screens of the 6V6G's tends to decrease. But, as the feedback voltage tends to decrease, the gain of the 6V6G's tends to increase and thus tends to counteract the condition and hold the voltage up to the value that would be obtained if there were no non-linear loading on the secondary.

Thus the use of this system of degenerative feedback greatly reduces any tendency toward distortion in the place where distortion most commonly occurs in a class-B modulator: in the tubes and in the driver transformer.

However, when first placing the amplifier in operation, it is very important that the screens be connected to the proper side of the class-B modulation transformer secondary. The only way of finding out which side is the proper one is to connect up the amplifier and try it out. If you have, by some queer trick of fate (the odds are 1 to 1), connected the proper screens to the proper grid circuits everything will be lovely. If not, the amplifier will leave no doubt in your mind; it will oscillate quite vigorously and with much gusto at about 500 cycles. It is a fine idea not to have the plate voltage on the TZ40's when this test is made—something is liable to flash over. If the 6V6G's do oscillate, reverse the connections between the screen grid coupling condensers and the class-B grids and the correct phase relation between the screen and plate voltages will be obtained.

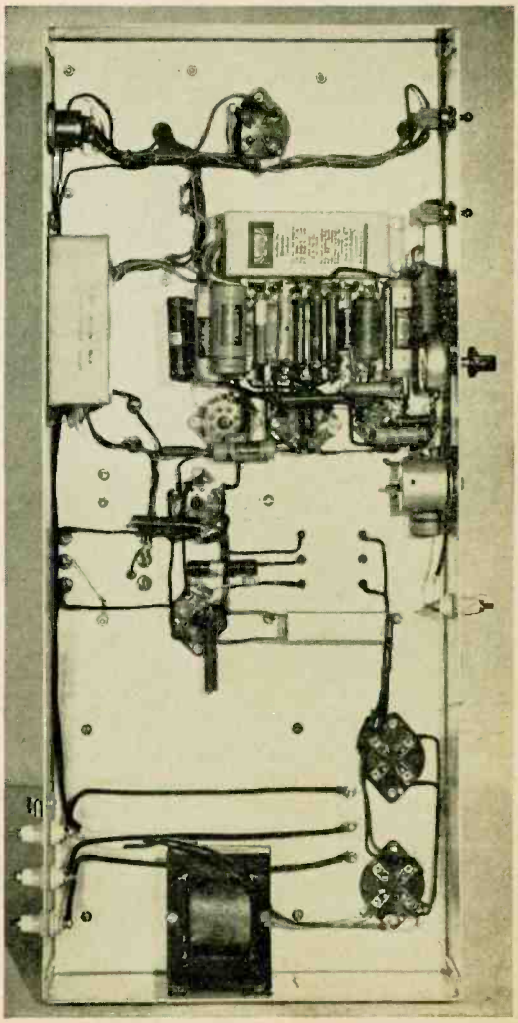
The TZ40 Class-B Stage

The TZ40's operate with zero bias under the conditions recommended by the manufacturers. The standing plate current on the two tubes is approximately 45 ma. with an applied plate voltage of 1000 volts. It will be somewhat higher, in the vicinity of 60 ma., if the full rated plate voltage of 1250 volts is used. Since these values of standing plate current require an appreciable amount of plate dissipation from the tubes, a small amount of grid bias will lower the plate current under no-signal conditions by a considerable amount. It would only be necessary to connect a 4½-volt "C" battery between the center tap of the driver transformer for the 1000-volt conditions; a pair of 4½-volt batteries in series to give 9 volts would be best for 1250-volt operation.

For maximum peak power output from the TZ40's, that is for the adjustment which will modulate the greatest class-C input with voice, the plate-to-plate load impedance for the 1000-volt conditions would be 5100 ohms. Under these conditions of operation the complete modulator would be capable of 100% modulating an input of 500 watts to the class-C stage; the plate current on the TZ40's should kick up to 200 to 250 ma. under normal modulation.

For maximum peak modulating capabilities at 1250 volts the plate-to-plate load value should be 7400 ohms; the unit would be capable of fully modulating 600 watts input and the plate current would kick up to 175 to 225 ma. under full modulation.

If it is desired to operate the class-B stage under the conventional conditions for maximum *sine-wave* audio output, the plate-to-plate load resistance would be 6800 ohms under the 1000-volt conditions; the power output would be 175 rated watts and the plate current would drive up to 250 to 275 ma. on peaks.



In this view, the modulator is standing on end. By comparison with the circuit diagram, placement of parts can be easily figured out.

Band Leader, W2AD

⊙ The candid camera caught Andy Sannella in a moment of great exuberance while conducting his orchestra during a C.B.S. broadcast. (In addition to leading a dance band, W2AD plays several instruments and is one of the best of the electric guitar performers.) He works up as much enthusiasm for amateur radio, in which he has been interested for about 10 years. W2AD started out with a transmitter using a pair of 852's in the final. Now, with a kilowatt phone and c.w. rig, he operates usually on 20 meters, but also likes to hear what the boys are doing on 40, 75, and 160.

Movie Actor, W6OSP

⊙ Movie-going hams have heard Donald Grayson sing in Columbia's musical westerns, as well as talk over the air on 10-meter phone. Before the films found the tenor-voiced radioman, W6OSP was violinist with Henry Busse's orchestra, Harry Sosnick and Johnnie Hamp, here and abroad. W6OSP has had his call about a year now . . . before that, he traveled around so much that nothing but a portable would have done.

Photo by E. Trim & Co. Wimbledon.

Tennis Star, W5VV

⊙ Wilmer Allison, the long-legged Texan on the left, is a champion in two fields: radio and tennis. In spite of a world championship in tennis, he says he is most proud of winning the 1937 dx contest for the fifth district! His tennis titles include: American champion in singles, doubles and mixed doubles, world's champion in doubles, and national intercollegiate champion in singles. He started hamming back in 1919 with the call 5TC, but let the hobby slide until he finished college and received the call W5VV. He's been on the air consistently since then—usually 10- and 20 meter phone and c.w. During his annual tennis trips around the world, he visits fellow radio hams and manages to maintain skeds with W5BB, his brother-in-law.

"It takes all kinds . . ."

Almost every profession and trade in the world will be found among those who are amateur radio operators. Here are representatives from five different activities: radio industry, sports, journalism, motion pictures, entertainment.

Editor

● Jack Clarricoats, G6CL and R.S.G.B. secretary, wonders whether he should make another w.a.c. and w.b.e. or try to snag Nevada, Wyoming and South Dakota for his w.a.s. "Clarry" edits the "T. & R. Bulletin" and "A Guide to Amateur Radio", knows about 2000 of the 3200 R.S.G.B. members, invariably carries a black notebook full of facts and figures pertaining to ham radio, enjoys talking extempore, expects to see at least one of his three youngsters with a call one of these days.

N. A. B. Man

● N.A.B. refers to the fact that Herb Hollister, W9DRD, is on the executive committee of the National Association of Broadcasters board of directors. W9DRD will be remembered by old timers as the maker of many of the first quartz plates used in amateur transmitters. To everyone, he is the man who now general manages KANS Broadcasting Co.

After the "SK"

By ERIC T. LEDIN,* W6MUF

Among the "Q" signals one of the most common is undoubtedly QSL. How it started nobody knows. That it will not end is quite certain. Without benefit of commercialism the custom has become universal among amateurs. Although occasionally a feeble complaint is heard, the growing stack of cards or the spreading "wallpaper" continues to be for many of us the focal point of sleepless hours.

That there are hams so blase as to be bored with foreign cards is hard to believe. At the present time there are roughly 100,000 unclaimed cards in the nine W QSL Bureaus. Visualizing this "mint" in relation to the meagre accumulation on my own desk has speedily deflated the ego.

Curiously, in thirteen years, I have yet to meet a ham who does not hold his QSL's in high esteem. To me they are the top rewards for achievement. They are indisputable proof of accomplishment. No apologies for haywire when XU's and OZ's line the walls. The personality at the other end of the contact is not complete until his card arrives.

It is true that international dx is now taken for granted and contacts rare enough to demand proof are scarce. Naively though, and perhaps with a tincture of sour grapes, I aver that the ten-zone ham is still in the majority. It is to us then, that a survey of what goes on in the QSL Bureaus is a revelation.

During the year 1937 well over 300,000 cards were handled by the nine Bureaus in the United States. Add to this the much greater number of cards exchanged direct, plus those handled by VE and other Bureaus throughout the world and the figure deserves a gasp. Almost all foreign countries now maintain this service, and local QSL's are redistributed in large packets to other Bureaus throughout the world.

It was in 1932 that the idea of the QSL Bureaus originated. Prior to this time cards had been distributed from A.R.R.L. headquarters in Hartford, but for various reasons it became necessary to discontinue the service. Herman Schmidt (W2AEN) of Bronx, New York, took over the first amateur QSL Bureau, and was shortly succeeded by Henry Yahnel (W2SN) who still holds the second district appointment. The experiment was a success in this district, and shortly appointments were made in the other eight districts and Canada.

As an example of the increasing popularity of the QSL card, in 1933, 10,174 cards were handled in the second district and by 1937 the number had increased to 35,716.

The increase is general in all districts. In the eighth, cards have increased by 15,000 in the last two years and so far, 1938 is far ahead of 1937. The number of envelopes handled has likewise increased about five times in as many years, but the chief problem has always been and still is—how to inveigle addressees into collecting their loot. As a general rule about 50% of the cards find envelopes and are promptly forwarded. Of the remainder only about 20% eventually reach the owners.

A number of methods of ridding the files have been tried. It seems that without exception, the sight of all these rare cards has inspired the various managers to rack their brains and raid the bank in philanthropic efforts at distribution with uninspiring results. One-sixty phone, eighty-meter c.w. nets, and printed notices have been tried. W5DKR sent out 2,000 notices and received replies from about one-third. W3CZE has tried the same stunt but is still swamped with unclaimed cards. W2SN printed up 2,000 cards and received about 50% replies.

As is to be expected, about fifty stations in each district lead the list and corner the quantities, but in one district alone there are now 30,000 cards on hand which belong to some 5500 different stations. Cards are on hand which date back to 1929. In January of this year, W1GBY received a consignment from Belgian Congo covering QSO's made in 1934.

As an average, twenty-five to fifty parcels of mail are received daily at each Bureau and in several instances as high as four thousand

[Continued on Page 77]

*244 Excelsior Lane, Sausalito, Calif.

• If desired, the receiver can be altered to accommodate another set of coils for 10-meter phone.

A DIVERSITY RECEIVER

for 20-Meter Phone

By RAYMOND P. ADAMS*

A diversity receiver featuring all-band coverage, single dial control, and metering for full visual indication of gain balance, signal conditions in each channel, and combined output, might be a pretty nice thing to have in the shack and might be as impressive in its operation as in its appearance. But we're somewhat doubtful if any such set-up would be within the financial and constructional reach of the average amateur.

There's not only the enormous cost of the many required parts to consider—there's the question of whether or not some of these components may be conveniently acquired. And then, another consideration, of what practical worth to the amateur is diversity reception on the broadcast band, 160 meters, and other low-frequency signals? If a diversity job is built primarily to eliminate fading 'phones, and if fading is particularly troublesome on say 14 Mc., why an immense, expensive, complex rig which has comparatively little functional value except on these higher frequencies? As a diversity receiver performs best when fed by directional receiving antennas, one spaced to take the valley as the other takes the peak of a fade, and cut to approximate wavelength, what sort of signal collectors would we require to get good diversity action on all bands? How about the antennas for 160-meter reception? Just think of them—spaced the necessary two wavelengths or more. The only practical diversity installation for amateur use would be one built for service on some one or two specific bands,

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● Back view of the receiver proper. The two i.f. channels, second detectors, and the 6B5 power stage are mounted upon the upper chassis while the two r.f. channels and the h.f. oscillator are on the lower one. The two mixer tubes have been removed from the bottom chassis to show the ganged r.f. tuning condensers. The inter-connecting power and i.f. cables also have been removed for the sake of clearness.

preferably in the higher frequency range. The most logical band is 14 Mc., with perhaps 28 Mc. added as the occasion demands. It is possible that a special receiver might be designed for 3.9-Mc. phone—the receiver to be described might even be adapted to it—but that would be another design problem and possibly can be covered at a later date.

The receiver to be described is strictly a 20-meter phone band affair, although it could be altered slightly to accommodate another set of coils for 10-meter phone. The circuit is simple, straightforward and understandable; actually it is very similar to the conventional common high-frequency superhet layout and uses conventional tubes. The two channels are physically and electrically symmetrical, entirely free of cross-coupling and individually stable. The receiver is built upon a two-deck rack with the r.f. parts on the lower and the i.f. and a.f. components on the upper chassis; the power supply is a separate external unit. The main dial tunes the common h.f. oscillator and affords full-scale band spread. R.f. tuning is direct-drive controlled, separately, for each channel.

Layout

On the upper panel are the "R" meter, the diversity switch, the audio and tone controls, and the gain-balance controls for the i.f. circuits. On the lower are the tuning dials to which we have already referred, the r.f. gain control, the common i.f. gain control, pilot indicator lights for each channel, and switches for communications on-off and break-in. Layout for the two chassis is for the most part symmetrical; i.f. transformer cans have the same dimensions as the r.f. shield boxes, the same positions and the same physical relation to associated stage tubes. R.f. stages move back from the lower front panel toward the rear of the bottom chassis; i.f. stages are in line forward, from the rear of the uppermost base toward the upper panel. The 6J7 h.f. oscillator lies between the two 6L7 mixers, directly beneath the output transformer, which is in a horizontal line with the 6B5, 6C5 driver, and R meter (the meter is positioned between the two diode-triode second detectors).

This has been found to be a thoroughly practical layout permitting short-lead wiring with good isolation between stages and a logical sequence of connections between them. The only long leads are those between the chassis, and the only important long ones, those between the 6L7 plates and the input i.f. transformers. But these latter leads have been carefully shielded to reduce the possibility of any bad effects resulting from their length.

The R.F. Circuits

As the two input channels are symmetrical and identical, anything said in description of one is applicable to the other. We shall therefore simply discuss the r.f. circuits as though they were only one channel—the other channel is the same conventional receiver.

Two r.f. stages have been used to afford good r.f. preselection and gain. One stage, with regeneration, will do the trick almost as well but would involve the use of some sort of feedback control and would be more difficult to align properly. The first of these departs from conventionality slightly through its incorporation of a 6J7G, which is neither manually nor automatically gain controlled, and which performs slightly better with weak signal inputs than the remote cut-off "K". The second stage employs a 6S7G, with a.v.c., though a 6K7G may be substituted if filament drain is of no great concern. Small 2.1-mh. pie-wound r.f. chokes have been placed in each of the two plate circuits and the screen circuits are de-coupled with 5,000-ohm resistors.

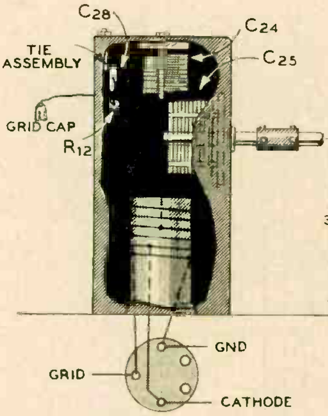
The mixer is the usual 6L7—probably the only tube available to us which provides maximum isolation between two detector circuits working in diversity channels and fed by one common h.f. oscillator. Operating with rather high screen voltage obtained through a dropping resistor from B plus and neither automatically nor manually gain controlled, this tube does its usual excellent job of conversion. We suggest the use of the straight metal type 6L7, due to its efficient self-shielding even though glass tubes may be used elsewhere in the set. A change from a glass 6L7G to a metal one in the receiver shown completely eliminated any tendency toward instability.

The H.F. Oscillator Circuit

The high-frequency oscillator circuit employs a 6J7 in a high-C e.c. hookup, and provides ample output for dual mixer excitation. The coupling condensers have been brought down to 25 μμfd. in value and tie between the mixer injector grids and the oscillator cathode.

R.F. and H.F.O. Coils

All r.f. coils are wound on small isolantite plug-in forms and are specifically for 14-Mc. phone. The L_2, L_4, and L_6 windings are wound



Internal arrangement of the high-frequency oscillator shield can. The main tuning control is the one entering the can from the right.

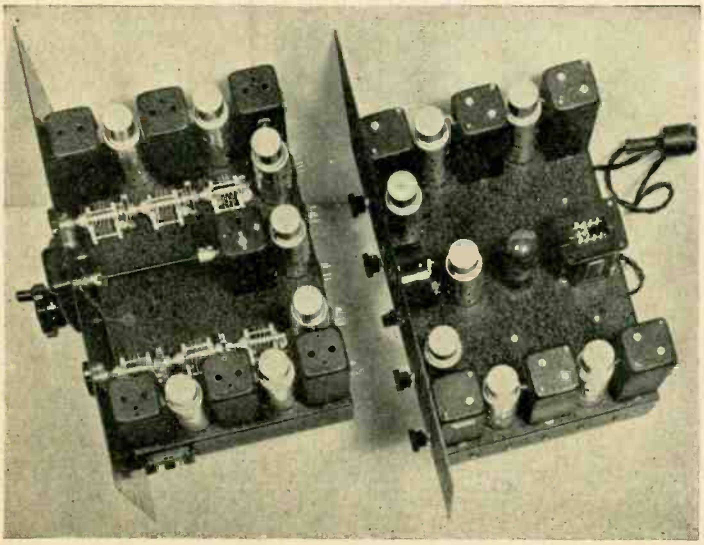
to precise limits and spot pretty close to the high frequency end of the 14-Mc. band, to minimize the necessity for much tank capacity. L_3 and L_5 are interwound with L_4 and L_6.

L_7, the oscillator coil, employs relatively few turns for high-C operation and is tapped for both cathode feedback and bandspread.

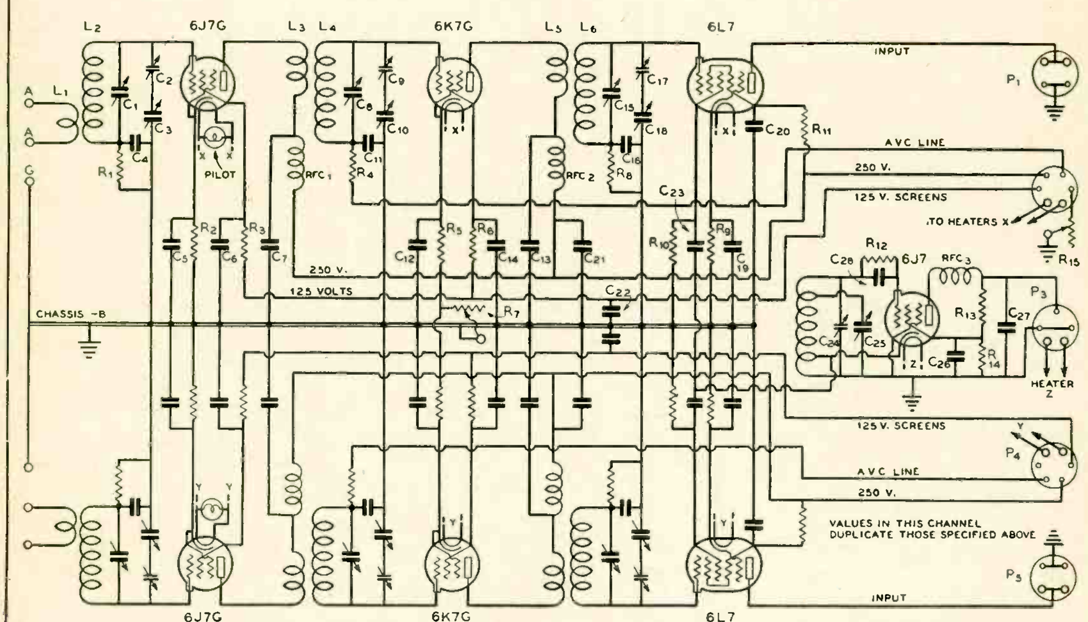
Should it be desired to use the receiver on bands other than 14-Mc. phone, appropriate plug-in coils of similar design may be used.

R.F.-H.F.O. Tuning

The r.f. tank condensers (C_1, C_8 and C_{15}) are 25-μμfd. APC air trimmers, mounted, by the way, below chassis and on the coil socket terminals. They might very well go inside the



● Top view of the two chassis; the r.f. and h.f.o. chassis on the left and the i.f., audio and "R" meter chassis on the right. The various r.f. coils are contained in the shields along each side of the r.f. chassis as shown on the left. The h.f.o. tube and tank circuit are placed in the center of this chassis; the extension shaft going from this shield can to the front panel is the main tuning control.



Complete wiring diagram of the two-channel diversity receiver. The two r.f. channels and the h.f.o. are shown above; the i.f. amplifiers, second detectors and the audio channels are shown on the opposite page.
All values given for the upper channel are duplicated in the lower one.

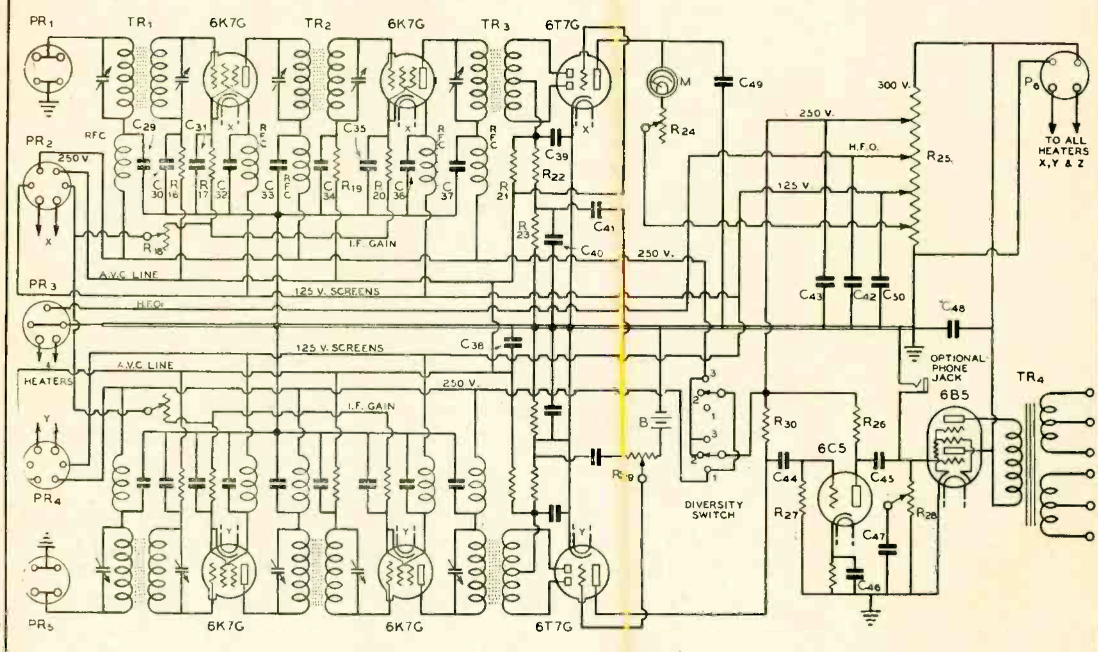
C_1—25-μμfd. r.f. tank condenser
C_2—3-30 μμfd. spread-set trimmers.
C_3—20-μμfd. tuning condenser
C_4, C_5, C_6—.05-μfd. 200-volt tubulars
C_7—.05-μfd. 400-volt tubular
C_8—25-μμfd. r.f. tank condenser
C_9—3-30 μμfd. spread-set trimmer
C_{10}—20-μμfd. tuning condenser
C_{11}, C_{12}, C_{13}, C_{14}—.05-μfd. 400-volt tubulars
C_{15}—25-μμfd. r.f. tank condenser
C_{16}—.05-μfd. 200-volt tubular
C_{17}—3-30 μμfd. spread-set trimmer
C_{18}—20-μμfd. tuning condenser
C_{19}—.05-μfd. 200-volt tubular
C_{20}—0.1-μfd. 400-volt tubular
C_{21}, C_{22}—0.1 μfd. 400-volt tubulars
C_{23}—.000025-μfd. mica condensers
C_{24}—100-μμfd. oscillator tank
C_{25}—15-μμfd. oscillator bandspread
C_{26}, C_{27}—.05-μfd. 400-volt tubulars
C_{28}—.0001-μfd. mica
R_1—100,000 ohms, ½ watt
R_2—1000 ohms, 1 watt
R_3—5000 ohms, ½ watt
R_4—100,000 ohms, ½ watt
R_5—300 ohms, 1 watt
R_6—5000 ohms, ½ watt
R_7—15,000-ohm potentiometer
R_8—100,000 ohms, ½ watt
R_9—600 ohms, 1 watt
R_{10}—50,000 ohms, ½ watt
R_{11}—15,000 ohms, 1 watt
R_{12}—50,000 ohms, ½ watt
R_{13}—100,000 ohms, ½ watt
R_{14}—50,000 ohms, ½ watt
R_{15}—15,000-ohm potentiometer
Coils—See coil table
$RFC_{1, 2, 3}$—2.1 mh., 125-ma. chokes
Plugs—See text

coil shield-cans for more convenient adjustment. C_3, C_{10}, and C_{18} are the ganged r.f. tuning condensers, each 20 μμfd. in capacity. These latter condensers could, of course, bridge directly across L_2, L_4, and L_6, to give about twenty divisions of bandspread; they could be cut down physically through the removal of plates to effect a somewhat greater spread, or they could tap down on the windings for the same purpose. But we have employed series capacities (C_2, C_9, and C_{17}—all 3-30 μμfd. MEX trimmers) so that we might both conveniently adjust the spread to any desired amount and align this spreading accurately, stage by stage.

The 6J7G, in our job, is not regenerative. But, nevertheless, changes in antenna load will upset the first stage alignment to some extent. And, although we haven't yet done it, we plan to substitute—and suggest that the individual builder should do the same—a front-panel-mounted variable condenser for the APC at C_1 to compensate conveniently for these changes in load.

C_{24}, the oscillator-circuit tank condenser, should be about .0001 μfd. in value. It is an adjustable APC mounted either below chassis on the coil socket terminals or in the coil can.

C_{25}, the oscillator tuning condenser, is mounted in the can; it is of 15 μμfd. in capacity (maximum), and when tapped down on L_7 3½ turns from the grid end of the winding,



C_{29}—0.1-µfd. 400-volt tubular
C_{30}—.05-µfd. 200-volt tubular
C_{31}, C_{32}, C_{33}—0.1-µfd. 400-volt tubular
C_{34}—.05-µfd. 200-volt tubular
C_{35}, C_{36}, C_{37}—0.1-µfd. 400-volt tubular
C_{38}—.05-µfd. 200-volt tubular
C_{39}, C_{40}—.0001-µfd. mica
C_{41}—.05-µfd. 200-volt tubular
C_{42}, C_{43}—0.1-µfd. 400-volt tubular
C_{44}, C_{45}—.05-µfd. 400-volt tubular
C_{46}—25-µfd. 25-volt tubular
C_{47}—.05-µfd. 200-volt tubular
C_{48}—8-µfd. 450-volt electrolytic
C_{49}, C_{50}—0.1-µfd. 400-volt tubular
R_{16}—100,000 ohms, ½ watt
R_{17}—300 ohms, 1 watt
R_{18}—5000-ohm potentiometer
R_{19}—100,000 ohms, ½ watt
R_{20}—300 ohms, 1 watt
R_{21}—1 megohm, ½ watt
R_{22}—50,000 ohms, ½ watt
R_{23}—250,000 ohms, ½ watt
R_{24}—250,000-ohm potentiometer
R_{25}—30,000-ohm 75-watt voltage divider
R_{26}—50,000 ohms, ½ watt
R_{27}—500,000 ohms, ½ watt
R_{28}, R_{29}—500,000-ohm potentiometers
R_{30}—250,000 ohms, 1 watt
R_{31}—(Number omitted from diagram; cathode resistor for 6C5) 5000 ohms, 1 watt
RFC—16-mh. shielded r.f. chokes
M—0-1 d.c. milliammeter
TR_1—456-kc. input i.f. trans.
TR_2—456-kc. interstage i.f. trans.
TR_3—456-kc. single-tuned diode-input i.f. trans.
TR_4—Output transformer, 7000 ohms to line and v.c.
Receptacle plugs—See text
B—Midget 3-volt "C" battery

will afford approximately 100 degrees of spread for the phone section of the 20-meter band.

Front Panel Gain Controls

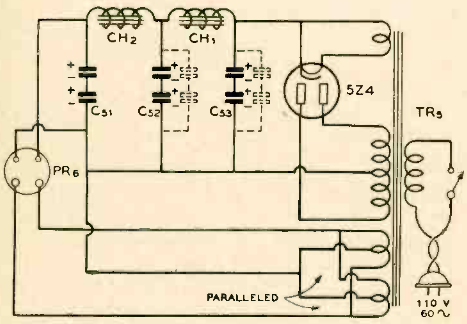
R_7 is the r.f. gain control, adjusting the effective sensitivity of both channels simultaneously. This control varies the conductance of second stage tubes only as the 6J7's work wide open at all times. R_{15} is the i.f. gain control, has nothing to do with the r.f. circuits, and has simply been positioned on the lower panel for convenience of adjustment.

Connections to the I.F.-A.F. Section

$P_{1, 2, 3, 4, 5}$ are all male receptacles. P_1 and P_5 are for mixer output, P_2 for power and a.v.c. connection to one channel and for i.f. gain connection (from R_{18} and R_{18A}) to R_{15}, P_3 for h.f.o. power, P_4 for second channel power and a.v.c. $PR_{1, 2, 3, 4, 5}$ are female receptacles on the "upstairs" chassis and, of course, are related to the P items on the lower. Short lengths of cable, with plug terminations, connect the two sections together between all but P_1 and PR_1 receptacles. The mixer-to-TR_1 leads are single wires, similarly plug terminated, but run through low-C shielded tubing for reasons which have been given.

The I.F. Circuits

Each i.f. channel uses two stages, tubes being 6S7G's or 6K7G's. (They have similar characteristics and simply differ in filament drain.) Both stages are manually and automatically controlled, individually (to assist in channel-balance) by means of the R_{18} and R_{18A} and collectively by means of R_{15}. All screen and plate circuits are very carefully by-passed and r.f.-choke filtered. Cathodes are, similarly, in-



Circuit diagram of the heavy-duty external power supply. The choke, the power transformer and the speaker field all must be able to carry the 165-ma. average drain of the receiver.

C_{51}, C_{52}, C_{53}—Each two 16-µfd. 450-volt electrolytics in series
CH_1—15-hy, 210-ohm, 165-ma. filter choke
CH_2—1000-ohm heavy-duty speaker field to carry 165-ma.
TR_5—425 volts, 165 ma.; 5 volts, 3 amps.; 6.3 volts, 6 amp.
PR_6—Receptacle plug from receiver proper

dividually by-passed, with each stage bias limited.

TR_1 and TR_2 are conventional i.f. transformers for 456 kc. input and interstage service. TR_3, on the other hand, is a single tuned, c.t.-secondary item designed for a.v.c. or noise-suppressor channel diode feed. All these components are Ferrocart (iron-cored) jobs, Alignaire (air) trimmed.

The Second Detector and A.V.C. Circuits

We have used 6T7G (150-ma. filament) tubes as second detectors rather than the 6H6's which the reader might have expected us to employ, and simply so that the overall number of tubes required for the diversity set-up might be cut down to minimum. These tubes, like the equivalent 6Q7's which may be substituted for them, are duo-diode high-mu triodes.

The a.v.c. voltage develops across the R_{22}, R_{23} diode load (total—300,000 ohms) from TR_3 center top to chassis-ground. The total control voltage (R_{21} filtered) for the one channel is impressed in parallel with the voltage developed by the other since the a.v.c. lines are connected together. Thus the channel receiving the strongest signal and producing the strongest a.v.c. voltage, takes control of both channels of the receiver.

The "R" Meter

We use but one meter for visual signal level indication. The meter is in the plate circuit of the triode section of one of the 6T7's, is a one-ma. affair and reads backwards. It should and will eventually be worked into a bridge layout for forward reading but it does a good enough job in its present connection. R_{24} limits the plate current to 1 ma. full deflection (about 135 volts at the plate of the T does the trick).

The Diversity Switch

A two-pole three-way switch, wired so that the B plus connection to the individual channels may be made or broken, permits the use of either channel independently or both channels together and in diversity. It is a very desirable refinement, but we now think that it should have a few more poles so that screen voltage leads will make or break with plate voltage leads and so that when either channel is switched out of service some sort of bleeder will be switched in to compensate for the change in drain on the power supply.

The Audio Circuits

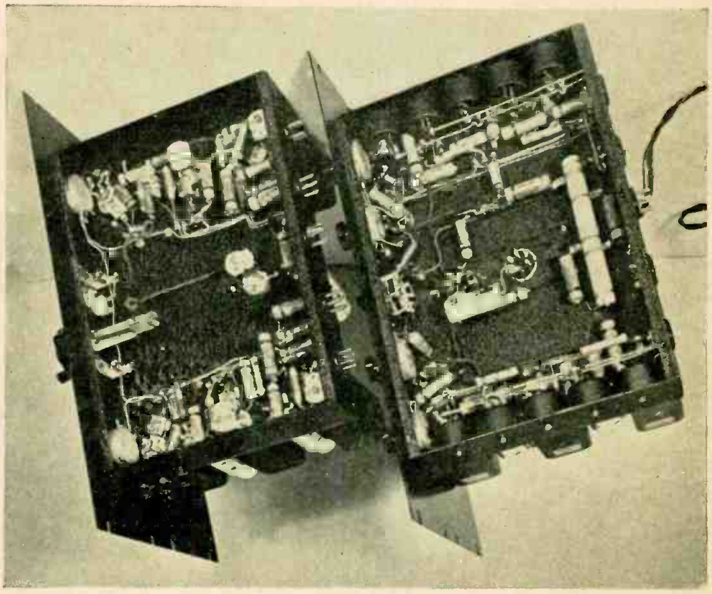
Audio frequency outputs from both second detectors add arithmetically in the grid load resistor of the triode section of the second 6T7G (or 6Q7G), and thus combined are amplified by this tube, by the succeeding 6L5 or 6C5 driver, and by the 6B5 output stage. The 6B5 is well suited to this use but of course a 6F6, a 6L6, a 6V6 or a 42 could be substituted.

Noise Silencers

It will be seen, by looking at the circuit diagram, that there is no noise silencing arrangement incorporated into the circuit. One has not been included since neither the "hole-punching" or "amplitude-limiting" type will operate satisfactorily on the i.f. or audio input circuits of a diversity receiver. However, one of the audio-amplifier amplitude-limiting types might be used in the plate circuit of the 6C5/6J5 audio stage. But the candid opinion of a number of people who have had experience with silencers of this type is that they are scarcely worth the trouble of their installation although they are effective in reducing certain types of local interference..

Power Supply

The power transformer selected for use in this receiver must have quite healthy ratings. It must supply, in the very first place, 4 to 6 amperes at 6.3 volts for filaments—enough to



● **The bottom view of the two units shows the sub-panel wiring of the high-frequency unit at the left and that of the i.f. audio section at the right.**

permit actually the use of .3 amp tubes throughout the line-up if we wish. The high voltage should be rated at about 425 each side at 160 to 170 ma. Under conditions of full receiver B drain and with condenser input in the filter system, the output at the high side of our voltage divider is 300, indicating a drop across CH_1 and the speaker field CH_2 of 125 volts. A heavy-duty speaker is of course necessary, and C_{52} and C_{53} should both be series-parallel electrolytics to assure against breakdown.

The voltage divider is under the r.f.-a.f. chassis and is tapped as follows: full voltage for the 6B5, 250 volts for the plates for all other (except h.f.o. and v.t.v.m.) tubes, about 200 volts for h.f.o. plate, about 135 volts for the v.t.v.m. circuit and slightly more than 100 volts for screens.

Construction

Our photographs should adequately point out correct parts placement on the two chassis. So long as the usual wiring precautions are taken and our layout recommendations are borne in mind, there's no reason why construction should be a difficult business.

All coils (r.f. and h.f.o.) are wound on small plug-in forms and are shielded by individual cans. R.f. cans are drilled on one side to pass the leads from coils to tube grid caps. The oscillator unit, on the other hand, must be subjected to considerable mechanical and wiring attention. The APC condenser (if it is not to go below chassis) must be installed in the top of the box, along with a tie point on which are mounted the grid leak and condenser. A hole for the grid-cap connection from tie point to 6J7 must be made in the side and the HF-15 condenser must be mounted on the front surface and in such a way that its shaft will line up properly with the main tuning dial with which it is coupled. Then all these items must be wired and leads brought down for tap and grid connection to the coil.

With the coils built we may proceed with the construction of the r.f. assembly, the i.f.-a.f. layout, the power supply, and the plug-terminated cables for connection between units. We have found, by the way, that the securing nuts for the various controls will hold chassis and panels together quite securely; no supporting arms should be necessary.

In wiring up the three units, the usual practices should be observed, particularly for the r.f. and i.f. sections. Keep leads short and direct and bring all returns for each stage to one chassis point. Remember that there must be no cross coupling between channels, follow the circuit diagram carefully, and don't stint on the use of tie-points.

Check-Up and Alignment

With the wiring and inter-section cabling carefully checked, the diversity switch in posi-

COIL SPECIFICATIONS FOR 14-Mc. PHONE

Radio-frequency coils: L_3, L_5—10 turns interwound with L_4, L_6 of 12¾ turns, all spaced to one inch.

Antenna coil: L_1—6 turns, close wound; L_2—12¾ turns, spaced to one inch.

Oscillator coil: L_7—6¾ turns, spaced. Cathode tap at 1¾ turns from ground end; bandspread tap at 2½ turns from grid end for 20 divisions of 20-meter phone bandspread, 3½ turns from grid for full dial spread.

tion three for two-channel operation, and the power unit turned on, adjust the sliders on the voltage divider until proper plate and screen potentials are read with all gain controls on full. Check full-gain cathode potentials (–3 for all r.f. and i.f. tubes), readjusting the screen-supply tap until proper limiting voltages are obtained. Vary the adjustment of one or more of the controls with a voltmeter across the B-plus line; if the B voltage shifts to any great extent, indicating poor regulation, remove the C_{53} input filter condenser. Fairly good regulation is quite imperative in a diversity receiver.

With the P_1-to-PR_1 and P_5-to-PR_5 mixer output connectors in place, align both i.f. channels to exactly 456 kc. It is quite important that both i.f. channels be aligned to exactly the same frequency.

Tighten up C_2, C_9, and C_{17} until fully closed, set the ganged r.f. condensers at zero dial reading, and, with the APC tanks, align the r.f. circuits to spot at some frequency slightly higher than the high frequency 20-meter band limit (with antennas connected if the C_1 condensers are not panel mounted). Use the same frequency for the alignment of both channels.

The series trimmers may now be opened up to give maximum desired r.f. bandspread, as the ganged condensers are varied from minimum to maximum, and to afford accurate tracking. Or they may be left "as is" to give about forty divisions of spread over the band.

C_{24}, in the oscillator circuit, is adjusted until with the main tuning dial indicating minimum C_{25} capacity, the desired high frequency oscillator limit is reached. Proper tapping for C_{25} will then bring about a spread meeting individual requirements. If the 6J7 oscillates at more than one frequency, by the way, reduce its plate potential by adjusting the slider on the voltage divider. If it does not produce enough output for optimum dual-mixer conversion, increase the plate potential, or place the cathode tap slightly higher on the coil winding.

Operation

The two antennas should be fairly well separated—by two wavelengths at least. Balanced transmission-line feed is of course suggested between the antennas and the two inputs. Collectors may be directional or non-directional, parallel to each other, at right angles to each other in the horizontal plane, or in a vertical-horizontal relation. The important thing is to have them so situated that the best possible diversity action will result. Remember, the further apart the antennas are placed, the greater will be the effective diversification; the more chance we will have of having a signal at its peak at one antenna when at the depth of its fade at the other. Remember, too, that there is polarity as well as space diversification in the fade, and that the antennas—particularly if they cannot be well separated—should logically not be in the same polarization plane.

If the antennas are directional, by the way, and their collective effectiveness multi-directional, then the assembly has a dual applications value. It not only operates in diversity when we want to hold one particular signal to minimum effective fade, but it provides for optimum pickup conditions when we are scanning the band for CQ's or for a reply to one of our own, working very much as though we were using a single aerial of practically no directional characteristics.

When adjusting the receiver for diversity reception, the gain conditions, channel against channel, should be in approximate balance. Controls R_{18} and R_{18A} are simply varied until a non-fading signal gives the very same R-meter reading when the one set of ganged r.f. condensers is thrown well out of alignment and the other adjusted for maximum level as it does when this input tuning condition is reversed. If both inputs are now brought into

[*Continued on Page 78*]

An Inexpensive Way to

DETERMINE TRANSMITTER OUTPUT

By K. CROMWELL,* VE4KD

Nearly every amateur station is able to determine the input to the final stage but few are able to measure the power output with any degree of accuracy. A method used by some to determine the power output is to use a bank of lamps as dummy load and then by a comparative system to determine the amount of power that was being dissipated by these lamps.

This method is shown schematically in figure 1. A tank circuit, tuned to the operating frequency, is coupled, either by a link or inductively, to the final stage. Then a lamp or lamps are tapped across enough of the turns of this external tank circuit to load the transmitter to normal operating conditions. A photronic cell, at a fixed distance from the lamps, is then used to determine their brilliancy. Then, with the cell and the lamps in the same positions, the lamps are connected to the 110-volt a.c. line. A voltage regulator, either a variable resistor or a tapped autotransformer such as the variac, is then used to light the lamps to the same brilliancy (determined by noting the reading of the photronic cell and its meter) as they had when they were operating from the transmitter. The power being dissipated by the lamps is then determined by noting the current flowing through them and the voltage across them. The product of this voltage and current gives the output of the transmitter directly.

But photronic cells, sensitive meters to go with them, a.c. voltmeters and ammeters, and tapped transformers such as the variac are expensive. Since they were above the budget of this station, one of the principles of photometry was used to achieve the same result.

The Simplified System

The operation of this system of photometrically determining the approximate output power of a transmitter is based upon the fact that

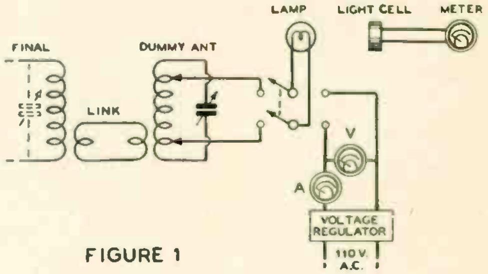


FIGURE 1

translucent materials will integrate the amount of light intensity arriving at their surface and will glow by an amount dependent upon this intensity. Hence, since this is a method of measuring *light* energy and not power directly, it must be assumed that the lamp banks concerned are both operating at the same relative efficiency as far as the conversion of r.f. energy into light energy is concerned. This condition will be approximately met when the two lamp banks are operating at nearly the same brilliancy. When this condition is met, this method of measuring power is quite accurate. But even when it is not met precisely the method will give reasonably accurate results.

The Procedure

Upon a wooden board, approximately 5 feet long, is nailed or bolted a yardstick and another section of one 1-ft. long making a total measuring-stick length of four feet. Then at one end, one or more lamp sockets are mounted so that their centers are lined up with the 4-ft. mark; at the other end of the measuring stick are placed one or more lamp sockets also lined up with their centers exactly at the zero mark of the stick. One set of lamps is connected to the transmitter to act as the dummy antenna; the other set is connected to the 110-volt a.c. line and preferably with an ammeter in series with them and a voltmeter across them. The set-up is graphically indicated in figure 2.

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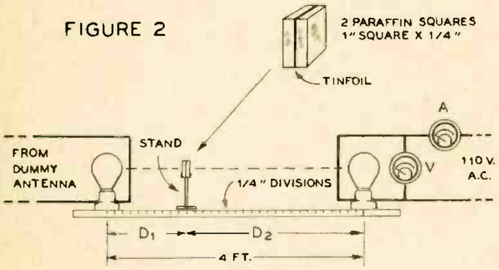
Next comes the device which replaces the photronic cell. Procure a block of paraffin wax, the kind commonly used as a seal for jelly jars. Cut two pieces from the block ⅜" thick and 1-inch square. Next cut a piece of tinfoil (it is important that it is equally bright on both sides) 1-inch square. Gently heat one side of each of the wax squares and press them together on opposite sides of the tinfoil. Then pare down the wax until each side is exactly ¼-inch thick. The next operation is to make a

FIGURE 2



stand from thin sheet metal to hold the wax-and-tinfoil square. This stand should be of such a height that the centers of the two lamps or sets of lamps are lined up with the center of the square, figure 2.

To use the equipment, tune up the rig with enough lamps at one end of the board to take the full output of the transmitter at approximately full brilliancy. Then light up approximately the same amount of lamps at the other end of the board directly from the 110-volt line. Now vary the wax square back and forth between the two sets of lamps until the two sides of the square glow with the same brilliancy. Now determine the power input to the lamp or set of lamps that are operating from the 110-volt line either by taking the product of the line voltmeter and the ammeter in series with them, or by approximating their input from their wattage ratings.

Then the power that is being dissipated in the dummy-antenna set of lamps can be determined from the formula:

$$W_1 = (D_1/D_2)^2 \times W_2$$

where W_1 is the power in the dummy lamp load, D_1 is distance of first lamp from wax, D_2 is distance of second lamp from wax, and W_2 is the a.c. line input to the second lamp.

Practical Example

Suppose we have a transmitter with a pair of 809's in the final stage running at an input of 150 watts. Since the efficiency of the final stage will be approximately 65%, there will be about 100 watts to be dissipated in the dummy load. Consequently it would be best to place a 100-watt lamp in the socket as the load. Then, either a 50-watt or 100-watt lamp may be placed in the other end and operated from the a.c. line. The transmitter is tuned up to the dummy load, the a.c. is turned on in the lamps at the other end and the wax block is moved back and forth until the glow on each side of the tinfoil is the same.

The distances D_1 and D_2 are measured and the wattage input to the lamps that are running from the a.c. line is either measured or approximated. They are found to be: D_1, the distance from the dummy lamp to the block of paraffin, 25"; D_2, the distance from the other lamp to the paraffin, 23"; and W_2, the wattage input to the a.c.-line lamp, 100 watts. Substituting these in the above formula:

$$W_1 = (25/23)^2 \times 100 = 118 \text{ watts}$$

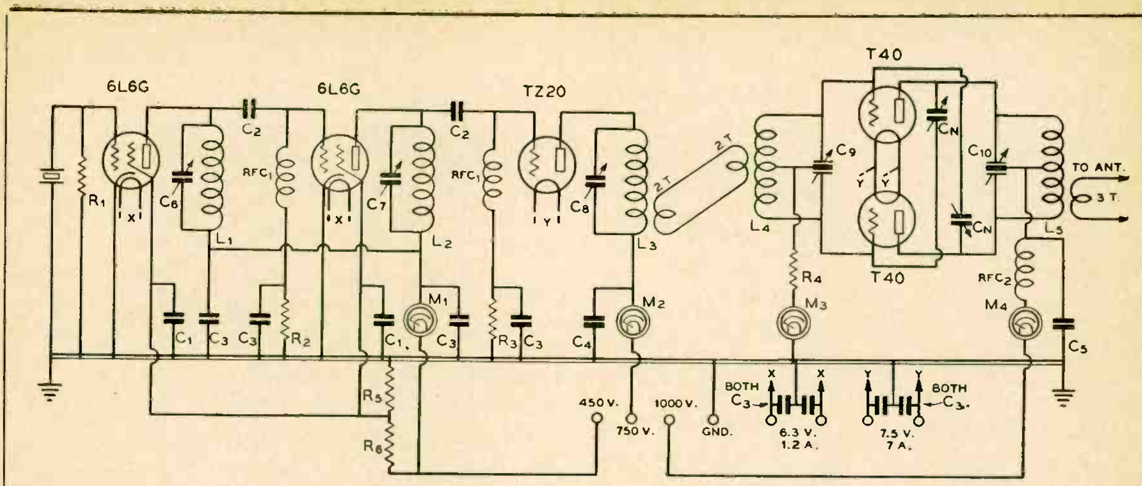
Thus the output of the transmitter into the dummy load is 118 watts. Of course, as mentioned before, this method of measurement is subject to some error since the conversion efficiency of the lamps will vary considerably depending upon their brilliance. The method is quite accurate enough for ordinary determinations, however.

Pick-ups . . .

Have you ever noticed that the VE phones use the names of our States in spelling? Wonder how many W hams know the names of the Canadian provinces as well.

WLW engineers tore their hair for a month to get a pistol-shot sound effect. It seems that the real McCoy does not sound like itself when broadcast.

From a story in *American* magazine: "Her warm loveliness, electric and enigmatic, was like a throbbing radio signal — an exciting 'C.Q.', clearing a short-wave channel from her to me."



C_1—.01-µfd. 600-volt tubular
C_2—.00025-µfd. mica
C_3—.002-µfd. molded-bakelite paper 600-volt
C_4—.002-µfd. molded-bakelite paper 1000-volt
C_5—.002-µfd. 2500-volt mica
C_6—50-µµfd. midget variable
C_7—35-µµfd. midget variable
C_8—50-µµfd., 4000-volt variable
C_9—50 µµfd. per section split stator
C_{10}—100 µµfd. per section, 4000-volt split stator
CN—Low-minimum neutralizing condensers
R_1—100,000 ohms, 1 watt
R_2—20,000 ohms, 5 watts
R_3—25,000 ohms, 5 watts
R_4—3000 ohms, 20 watts
Coils—See text
Meters—See text
RFC_1—2 ½-mh., 125-ma. chokes
RFC_2—2 ½-mh., 500-ma. r.f. choke

A Foolproof 10-METER RIG Using T-40's

By A. S. BAUMANN,* W4AEI

Here is a foolproof 10-meter 250-watt transmitter using the new T-40 tubes. It is a straight forward circuit using a 6L6G 40-meter crystal oscillator, a 6L6G doubler to 20 meters, TZ20 doubler to 10 meters and the T40's in the final. It was built for G. F. Steele, for use in his station, W4EGJ, at Norcross, Ga.

As seen in the accompanying photographs, this is built on one standard rack and panel unit. The chassis is 11″x 17″x 3″, the panel is 19″x 12½″. Reading from left to right the meters are: plate current for the oscillator and 1st doubler, 0-150 ma.; plate current for the 2nd doubler, 0-150 ma.; grid current for final, 0-100 ma., and plate current for final, 0-500 ma. These are all standard 2″ meters.

I have found, from experience, that it is difficult to get maximum efficiency from an all-band transmitter, using plug-in coils or band switching, when operating on the high-frequency bands. This is probably due to the losses in the coil and socket contacts and losses in the coil forms themselves. Another problem with all-band operation is the "Q" of the circuit. Naturally for 160-meter or 80-meter operation, the tank condensers must have large capacity for proper operation, whereas in the minimum capacities these same condensers are decidedly too high for 20 or 10 meters.

Building a transmitter for one-band operation, especially on very high frequencies, makes it a simple matter to get maximum efficiency, because the proper "Q" in each of the tank circuits can be obtained without difficulty.

Coil Specifications

The coils are all wound on a 1″ form and then removed and doped with Duco cement to make them self-supporting. The oscillator coil consists of 26 turns no. 16 enameled single cotton and is close wound. First doubler coil to 20 meters, 20 turns no. 14 enameled and

*568 Winton Ter. N. E., Atlanta, Ga.

spaced the diameter of the wire. Second doubler, 12 turns no. 14 enameled spaced about one and a half times the diameter of the wire. Both final grid and plate coils are wound with no. 12 enameled, 12 turns each and spaced equal to twice the diameter of the wire. All coils are self-supporting as has been mentioned above.

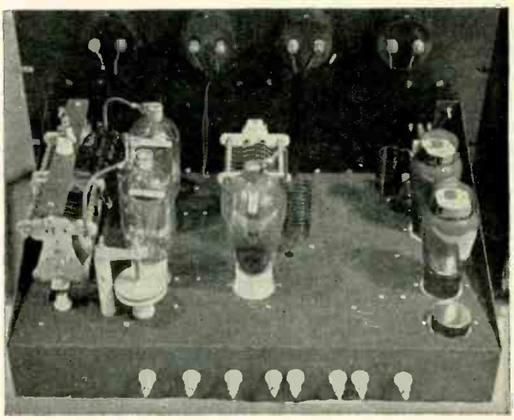
Parts in each circuit are arranged in order to make each lead as direct and short as possible. Tank coils are soldered directly onto the condensers in each case. Each circuit has its individual ground return direct to the chassis. The grounds are not bonded with a common bus at any point to reduce the chance for intercoupling. The ground stand-off on the rear of the chassis is connected by a bus to the center of the chassis. This reduces any tendency for interstage regeneration due to stray circulating ground currents.

Power Supplies

Two power supplies are used; one is a 450-volt 150-ma. supply for the two 6L6G tubes and the other is a 1000-volt 500-ma. supply for the final and doubler. The voltage for the TZ20 power doubler is obtained through a 3000-ohm 75-watt dropping resistor from the 1000-volt supply. This puts about 750 volts on the plate of this tube.

The normal current readings for this rig when operating are: oscillator and 1st doubler 47 ma., 2nd doubler 75 ma., final grid 50 ma., and the final 35 ma. unloaded. The final loaded plate current, of course, will vary due to loading and type of antenna used.

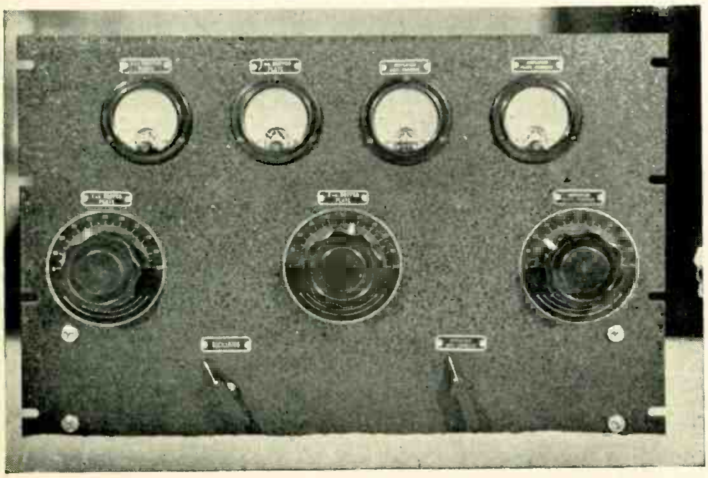
The antenna used on this transmitter is the conventional 4 half-waves in phase with a quarter-wave matching stub. The transmission line to the antenna is fed by means of a three turn pick-up coil loosely coupled to the final tank. The final is normally loaded to 230 ma. at 1000 volts. But the T40's are very easily capable of taking 300 watts input and have been operated at this input for tests.



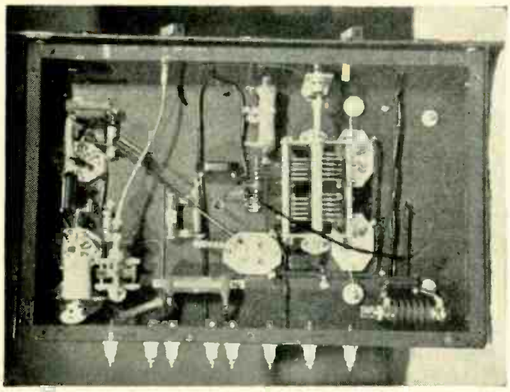
Back view shows layout of the parts in the 10-meter transmitter.

The modulator uses a pair of 6L6G's in class B (triode connected) with about 500 volts on the plates. They do a very nice job of modulating 230 watts input and do so with very little effort.

This unit is later going to be mounted in a standard 6-foot relay rack with two other complete r.f. units, one on 160-meter phone and the other on 20-meter c.w. and phone. Also in this same rack will be the power supplies and modulator. There will be a simple voltage switching arrangement which can be controlled remotely by relays. This will give instantan-



• The transmitter is built on one standard rack and panel unit. Front view of the rig is shown here.



Parts in each circuit are arranged so as to make each lead as direct and short as possible.

eous band switching without losses due to plug-in coils or switches in r.f. sections. Naturally the efficiency should be very good on all bands.

At first this seems to be rather an expensive way to get all-band operation in one transmitter, but with medium-power tubes as efficient and as inexpensive as they are today, one can get a fairly high-powered rig at minimum cost.

●

Noise Damping

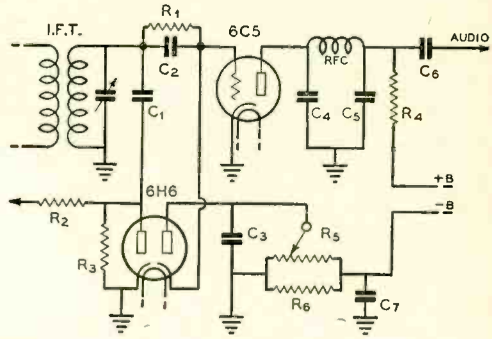
AND A.V.C. WITH GRID-LEAK DETECTION

Ordinarily, when someone mentions a grid-leak detection for the second detector in a superhet you think, "Yes, that should be swell, especially as far as sensitivity is concerned, but what about a.v.c. and some type of noise damping?" And there the discussion stops.

But O. H. Mills, W8NED, in designing a new five- and ten-meter superheterodyne, decided that grid-leak detection would give a worthwhile increase in weak-signal sensitivity and so figured out a method of applying a.v.c. and noise limiting to the grid-leak detector as used in his receiver.

The circuit is shown in the accompanying circuit diagram. It is quite simple, one diode of the 6H6 acts as a carrier rectifier to supply the a.v.c. voltage to the preceding stages, and the other one, reverse connected, acts as a noise limiter. It should be very simple to install such an arrangement in an existing superhet; W8NED states that due to the simplicity of the circuit there are very few, if any, "bugs" to iron out. He also states that the circuit gives as good results on phone signals as on c.w. reception. That does sound encouraging.

The circuit does, however, have one disadvantage. The setting of the noise suppression potentiometer, R_5, is correct for signals of only one level. This potentiometer must be re-adjusted when signals of a much different level are being received. However, due to the



C_1—.00005-µfd. mica
C_2—.00025-µfd. mica
C_3—1.0-µfd. tubular
C_4, C_5—.0005-µfd. mica
C_6—0.1-µfd. tubular
C_7—10-µfd. 50-volt electrolytic
R_1, R_2, R_3—1.0 megohm, ½-watt
R_4—100,000 ohms, 1 watt
R_5—10,000-ohm potentiometer
R_6—500 ohms, 10 watt
IFT—Diode-input i.f. transformer
RFC—10-mh. r.f. choke
Note—There should be enough current flowing through R_6 to develop a voltage of 25 volts across it.

a.v.c. action of the receiver, the variations in signal level, especially when receiving phone signals, should not be particularly great.

The detector tube, shown as a 6C5 in this particular diagram, can be almost any other small triode or pentode as long as it is connected for grid-leak detection.

It should be noted that the negative B supply is not grounded.

Here and There . . .

Miss Nelly Corry, G2YL, has made another trip to the West Indies, stopping at Miami, Florida. Welcome, Nelly, but why make the Southern California Chamber of Commerce fret?

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VE2AJ, located one-thousand miles from the ocean, still is five-hundred miles nearer Liverpool, England, than W2AJ.

●

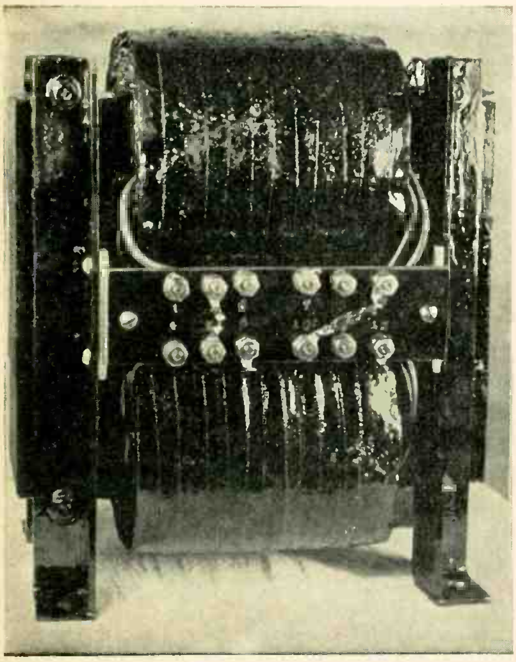
What a governmental coincidence—*Woodrow Wilson,* W3BOX, is located in Federalsburg, Md.

MODULATION-TRANSFORMER DESIGN

By **LLOYD W. ROOT,* W9HA-W9EHD**

This discussion is not intended to be the ultimate in either the theoretical or the practical aspect of transformer design but it is hoped that it will perhaps point the way to a more complete understanding of some of the more puzzling features of transformer characteristics. It is one thing to design a straight power transformer carrying only alternating currents and quite another when one or more windings of the transformer must also carry direct current.

Most experimenters are familiar with the much abused formula for determining the number of turns to be used on a given power transformer but perhaps are not so well acquainted with other formulas dealing with magnetic quantities so that a brief review of those most used might be in order. In this presentation the similarity between the simple electric current and magnetic formulas will be apparent.



A representative 300-watt modulation transformer made from the design data given herein.

Indeed, the equation dealing with magnetic reluctance might be termed the "Ohm's Law" of magnetic circuits.

Laws of Magnetic Circuits

In practical terms the unit of magnetic field strength is the Gauss. It is one line of magnetic force per square centimeter and produces a force of one dyne (approximately .001 gram) on a unit magnetic pole. A current of electricity passing through a coil of wire produces a magnetic field at the center of the coil which is directly proportional to the current strength, the number of turns of wire, the material on which the coil is wound and inversely to the radius of the coil. For a torus or a coil surrounding a closed magnetic path (as would be the case of a transformer carrying direct current),

$$H_o = \frac{4\pi NI}{10L} \text{ where}$$

H_o = direct current magneto-motive-force (MMF) in Gilberts per centimeter (Oersteds)
N = number of turns in winding
I = current strength in amperes
L = length of magnetic circuit in centimeters

One Gilbert per cm. produces one Gauss or one line of force per square cm. of cross-sectional area in a vacuum while in a substance of permeability mu (μ) there will be produced mu lines per sq. cm. That is,

$B = \mu H$ where
B = flux density in Gausses (lines per sq. cm.),
μ = magnetic permeability,
H = magnetic field strength.

The reciprocal of the permeability is called the reluctivity. Thus, $V = 1/\mu$. The magnetic drop across any path is known as the magneto-

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There has been far too little material published in the various radio magazines concerning the proper design of high-level audio transformers, especially those where the secondary must carry the class-C plate current along with the audio current. In this informative article, Mr. Root gives a complete discussion of the conditions existing within a transformer carrying d.c. plate current along with audio, the mathematics necessary for taking into consideration these conditions in making the design, and a number of practical examples for using these formulas in the design of class-B output transformers for high-power use.

It should be pointed out that it will usually be less expensive to purchase complete factory-made transformers for power levels of 100 watts or less; but for high power uses, where special consideration must be made in the design, it is often advantageous to be able to design and have built or build a transformer to the exact specifications of the transmitter.

motive-force (MMF) and is equal to the product of the magnetic potential gradient and the length of path, MMF = H L. The reluctance of any magnetic path equals the product of the reluctivity and path length divided by the cross-sectional area of the path, R = VL/A. When the magnetic path is not homogeneous, that is, consists of more than one kind of material (such as iron plus air), the total path reluctance is the sum of the separate path reluctances. The permeability of a magnetic material is not a constant quantity, however, but varies over rather wide limits depending upon the degree of magnetization. Figure 1 shows the relationship between the permeability of a sample of silicon steel and the magnetizing force. For most common transformer iron the permeability reaches a maximum value of from 5000 to 7000 for magnetic flux densities of from 5000 to 7000 Gausses.[1]

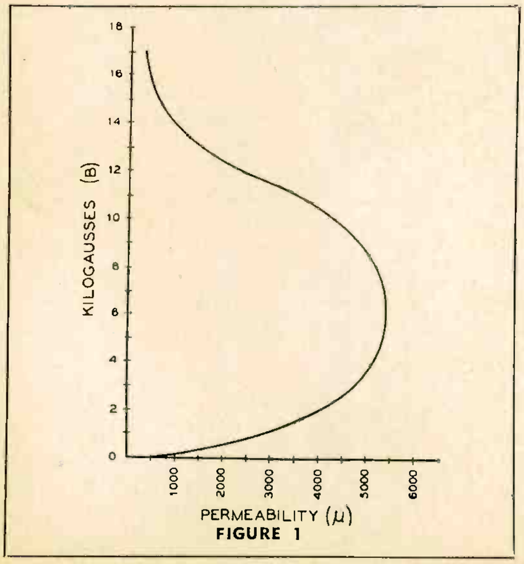
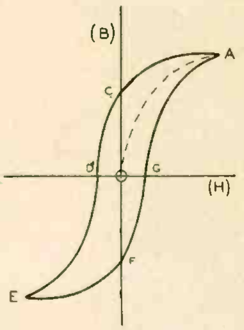


FIGURE 1

FIGURE 2



If the flux density in a given sample of iron is observed while it is carried through one magnetization cycle, results as shown in figure 2 will be obtained. Starting at point O on the curve, the flux density (B) increases as the magnetic field (H) is increased, until eventually a point is reached where the flux density no longer increases with increased field. At this point the iron is said to be saturated, saturation occurring at from 10,000 to 15,000 lines per sq. cm. (63,000 to 94,000 lines per sq. in.). If, at point A on the curve, the field is diminished, the flux in the iron will not fall back along line AO but along AC. When H = O, it will be found that B = OC and that a negative field will have to be applied of mag-

[1]"Magnetic Core Materials Practice," Allegheny Steel Company, Brackenridge, Pa.

Watts loss/lb. at 10000 Gauss	Freq. in c.p.s.	Watts loss/lb. at 60 cycles	Gauss
.4	25	.08	2000
.7	40	.25	4000
1.2	60	.5	6000
1.6	80	.8	8000
4.0	133	1.2	10000
		1.3	10500
		1.65	12000
		2.2	14000
		2.5	15000

FIGURE 3

nitude OD to bring B to zero. The amount of this negative field that has to be applied is called the coercive force and it is proportional to the "hardness" or retentivity of the iron. Permanent magnets having high retentivity are desirable for certain purposes but for transformers, curves showing low coercive forces are to be preferred.

Figure 2 shows the complete cycle of magnetization, commonly called a hysteresis curve, the area ACDEFGA being indicative of the hysteresis loss of the iron sample under test. Magnetic materials also suffer "eddy current" loss which is due to the flow of transverse alternating currents in the core caused by changing flux through it. It can be minimized by laminating the core material, common laminae being from 15 to 25 mils (thousandths of an inch) thick. Both eddy current and hysteresis losses are usually combined and called iron loss in designing transformers. Iron losses increase with increasing magnetization and frequency as shown in the tables of figure 3 based on 26-gauge electric steel (0.0187″ thick, 0.75 lbs. per sq. ft.).

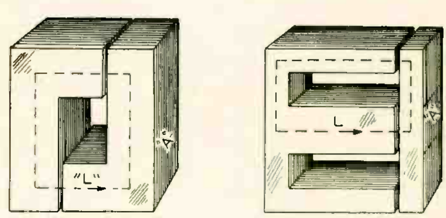
There are two types of cores which are generally available for use in transformers, the core-type and the shell-type. (See figure 4.) The core-type is used by those desiring to cut out their own laminae, while the shell-type is used by those fortunate enough to possess the expensive punches and dies needed or by those able to obtain burned out transformers having the requisite E-shaped laminae. The shell-type gives a more compact design since all windings are on the center leg, while with the core-type the windings are usually split, half going on each of the long legs. The average full-load efficiencies of a representative group of small transformers is shown in figure 5.[2]

When a transformer winding must carry a relatively large direct-current along with the induced alternating-current, the core becomes magnetized by a fairly heavy polarizing magneto-motive-force which establishes a unidirectional magnetic flux (B_o) upon which is superimposed an alternating flux (B_{ac}).[3]

$$(1) \quad B_{ac} = \frac{10^8 E}{\pi\sqrt{2}\, N A K F} \text{Gauss}$$

$$(2) \quad B_o = \frac{4 \pi N I \mu}{10 L} \text{Gauss}$$

Where, E = r.m.s. alternating voltage across winding
N = number of turns in winding
A = cross-sectional area of core in sq. cm.
F = frequency in cycles per second
K = stacking factor = W/V g,



CORE TYPE SHELL TYPE
FIGURE 4

where W = core weight in grams
V = core volume in cc.
g = sp. gravity of core material (7.5-7.7)

(K = .94 for butt-joint core
.88 for 100% interleaved laminae)
I = direct-current in amperes
μ = magnetic permeability
L = length of magnetic circuit in cm.

The actual value of the alternating current permeability (μ_{ac}) of the core material simultaneously subjected to alternating and direct magnetization can be presented through the

[2] "Standard Handbook for Electrical Engineers," McGraw Hill Book Co.

[3] "Alternating Current Phenomena," C. P. Steinmetz.

medium of incremental permeability curves which show the value of (μ) to be lower for larger values of H_0 and, what is most important, "that core materials having the highest values of μ_{ac} when unpolarized are subject to the greatest reduction in the a.c. permeability by a given value of H_0". The introduction of an air-gap into the path of the magnetic core will reduce the degree of direct magnetization established, and, even though the reluctance of the core path to a.c. magnetization is increased by the air-gap, there may be an actual increase in the effective inductance of the reactor as a result of the introduction of the air-gap."[1] Thus it may be of particular advantage to use a poorer grade of silicon steel in a transformer designed to carry direct-current.

The direct-current magneto-motive-force consists of the drop across the reluctance of the iron path plus the drop across the reluctance of the air-gap,[4]

$$MMF = H_1 l_1 + H_2 l_2$$

H_1 = Magnetic potential gradient in iron,
H_2 = Magnetic potential gradient in air,
l_1 = Length of magnetic circuit through iron,
l_2 = Length of magnetic circuit through air.

In air, the magnetic flux density is numerically equal to the magnetizing force, or $H_2 = B_0$. Thus, the above equation becomes

$$(3) \quad MMF = H_1 l_1 + B_0 l_2$$

KVA Capacity	Efficiency Full-Load	Weight Lbs.
.050	89%	3-4
.10	90	8
.15	91	14
.25	92	20
.375	93	30
.50	94	40
1.0	95	70

FIGURE 5

The two unknowns are H_1 and B_0, the relation between which is given on the B-H curve for the particular iron involved. Without attempting to show exact relationships, imagine the solid curve in figure 6 to represent the B-H curve of a silicon-steel sample. Equation (3), above, will be recognized as the equation of a straight line and if plotted on the same axes as figure 6 will intersect the vertical axis of the B-H curve at a point corresponding to H_1 = zero and $B_0 = MMF/l_2$, and also will intersect the horizontal axis at a point corresponding to B_0 = zero and $H_1 = MMF/l_1$. For a given set of conditions the total MMF is known, being equal to $(4\pi NI)/10$ Gilberts, so that both B_0 and H_1 can be computed and the dotted line shown in figure 6 drawn. Thus, the vertical coordinate of the point of intersection of the straight line (3) with the B-H curve determines the value of the d.c. flux density in the core under the conditions as given and the horizontal coordinate gives the magnetic potential gradient in the iron part of the magnetic circuit. It is then possible, knowing H_1 and the value of B at the intersection of (3) with the B-H curve (OC), to make use of incremental permeability curves to determine the apparent (not the a.c.) permeability of the iron under the given operating conditions. It will be found that while the a.c. permeability of the iron under the given conditions may be as high as 5000 to 8000, the apparent permeability has dropped to as low as 150-300 when the core is subjected to a strong direct polarization. Examination of magnetic path reluctance formulas reveals the clue to the method of increasing the apparent permeability (μ_a) for the purpose of increasing the effective inductance of the transformer winding and thus improving the bass-note response. Using the same symbols and terminology as above, the reluctance of the iron path

$$R_1 = V_{ac}\, l_1/A,$$

while the reluctance of the air path

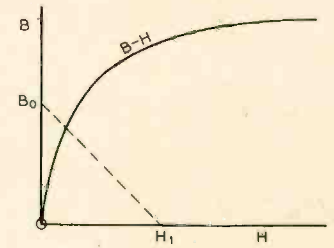


FIGURE 6

[4]"The Magnetic Circuit," Karapetoff.

$R_2 = l_2/A$ (The reluctivity of air being unity).

The total path reluctance is then

$$R_1 + R_2 = V_{ac} \frac{l_1}{l_1 + l_2} + \frac{l_2}{l_1 + l_2}$$

Since, in most cases, the length of the air-gap seldom exceeds 1% of the iron path, $\frac{l_1}{l_1 + l_2}$ is practically unity and $\frac{l_2}{l_1 + l_2} = \frac{l_2}{l_1}$ (approximately) so that

$$(4) \quad V_a = V_{ac} + \frac{l_2}{l_1}.$$

In other words, in most practical cases, the apparent reluctivity is equal to the sum of the a.c. reluctivity and the ratio of the length of the air-gap to the length of the mean iron path.

Substituting $\frac{1}{\mu_{ac}}$ for V_{ac} and $\frac{1}{\mu_a}$ for V_a in equation (4),

$$\frac{1}{\mu_a} = \frac{1}{\mu_{ac}} + \frac{l_2}{l_1} \text{ or,}$$

$$(5) \quad l_2 = \frac{l_1 \, (\mu_{ac} - \mu_a)}{\mu_a \, \mu_{ac}}.$$

Introduction of Air Gap

From equation (5), it is seen that it is possible to effect as much of a change in the permeability of the iron as necessary for best results in the completed transformer. Thus, if $\mu_{ac} = 5500$ and it is desired to have $\mu_a = 400$, the total air-gap should be 0.0023 l_1 cm. Instead of interleaving the transformer laminae, one should provide for a butt-joint to be filled with some non-magnetic material such as fiber, micanite, etc. This can easily be done with most shell-types of cores but is somewhat more difficult with the core-type unless one uses four gaps. Figure 4 suggests a way in which two gaps may be provided in the core-type. The same scheme could, of course, be extended to provide only one gap. In both types of core shown, the gap between the two sections of core should be half the calculated amount since there are effectively two gaps. By the introduction of an air-gap into the magnetic circuit of a poor transformer, one may compensate to some extent for limitations imposed when the unit was manufactured. The bass-response will tend to be increased by such a procedure. It should not be assumed, however, that the use of an air-gap provides a cure-all for core and winding faults.

Some rather interesting conclusions may be drawn by juggling equations (1) and (2), above. If we agree that for flux densities under 14,000 Gauss no serious error is involved in assuming that a sine-wave alternating voltage applied to the transformer winding will produce a sine-wave flux variation in the core material, we may let $B_o + B_{ac} = 14{,}000$. Then, replacing B_o and B_{ac} with their equivalents,

$$\frac{4 \pi I \mu N}{10 \, L} + \frac{10^8 E}{4.442 \, K F A N} = 14{,}000$$

For clarity set $\frac{10^8 \, E}{4.442 \, K F} = \Theta_1$ and $\frac{4 \pi I \mu}{10 \, L} = \Theta_2$

Then $$\frac{\Theta_1}{A N} + \Theta_2 N = 14{,}000$$

or $$(6) \quad A \, \Theta_2 N^2 - 14{,}000 \, A N + \Theta_1 = 0$$

Equation (6) may be solved for maxima and minima by differential calculus or by use of the quadratic formula, either method resulting in the same solution. If we apply the quadratic formula and solve for N,

$$(7)\quad N = \frac{7000 \pm \sqrt{49 \times 10^6 - (\Theta_1\,\Theta_2)/A}}{\Theta_2}$$

There is obviously no real solution for N if $\frac{\Theta_1\,\Theta_2}{A}$ is greater than 49×10^6. On the other hand, if $\frac{\Theta_1\,\Theta_2}{A} = 49 \times 10^6$ i.e.,

(8) $A = \Theta_1\,\Theta_2/49 \times 10^6$ sq. cm., there will be two coincident solutions for N. Thus

(9) $N = 7000/\Theta_2$ turns. By now inserting the values of Θ_1 and Θ_2 and assuming the stacking factor K to be .94 (butt-joint), we have

$$(10)\quad A = .61406\,\mu\,I\,E/L\,F \text{ sq. cm.}$$

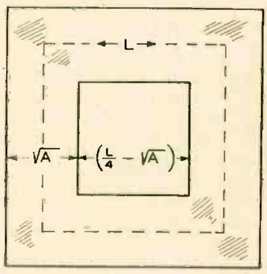
$$(11)\quad N = 5570.4\,L/\mu\,I \text{ turns.}$$

Equations (10) and (11) present what seem like rather contradictory facts, but it must be remembered that the two equations go hand in hand—one is meaningless without the other. As a further check it will be noticed that by eliminating L between the two equations we obtain $N = \frac{3420.6\,E}{A\,F}$ turns, which is perfectly logical. For actual transformer design these equations may be still further simplified by assuming values for μ and F. At least one manufacturer supplies a choice of two modulation transformers, one based on a response of 70 cycles, the other on 35 cycles. The average amateur interested in good intelligible speech could very well use 100 cycles as the basis for computation, but if he is partial to high quality low-note response, he might wish to use F=70.

Permeability Factor

We have avoided dealing with the permeability factor (μ) as long as possible since it is such an extremely variable quantity. From actual experience it may be concluded that values of μ_a ranging from 250 to 500 will prove satisfactory. If some chosen value of μ_a does not lend itself to a satisfactory design

FIGURE 7



for a given available core, the value may be changed slightly to fit the desired conditions and allowance made in the air-gap according to equation (5). Allowing μ_a to be 400 and setting F = 70 in equations (10) and (11),

$$(12)\quad A = \frac{3.51\,E\,I}{L} \text{ sq. cm.}$$

$$(13)\quad N = \frac{13.93\,L}{I} \text{ turns.}$$

When one has on hand core punchings of certain definite size, the length (L) of the magnetic path is pre-determined and the problem resolves itself into stacking the laminae sufficiently deep to obtain the required cross-sectional area. Dimensioning new laminae, however, is somewhat more difficult, but here again there are obviously certain limits. It would appear possible to have a very small cross-sectional area and a long magnetic path or vice versa, resulting in a long, slender core or a short, fat one, but for best efficiency the ratio of L to A should be from 1.5 to 3 (L in cm., A in sq. cm.).

Equations (12) and (13) above can be derived in another way by re-stating equations (1) and (2) thus

$$\text{From (1), } N = \frac{10^8\,E}{\pi\sqrt{2}\,K\,F\,B_{ac}\,A}$$

$$\text{and from (2), } N = \frac{10\,B_o\,L}{4\,\pi\,I\,\mu}$$

If we imagine that we are dealing with the secondary winding of the modulation transformer across the terminals of which is induced an r.m.s. audio potential E while the winding is carrying the class-C plate current I, then obviously the latter two equations refer to the same N. Eliminating N from these two equations, setting $B_0 = B_{ac} = 7000$, $\mu = 400$ and $F = 70$, we have $A\,L = 3.509\,E\,I$, which is the same result as obtained above in equation (12).

Moreover, equation (2) results in $N = (13.926L)/I$. [Same result as (13).] For ease in further computation, let us use the constants appearing in equations (12) and (13), above, to the nearest decimal, thus

$$(12) \quad L = 3.5\ EI/A$$

$$(13) \quad N = 14\ L/I.$$

Now if we could find some other relationship involving the three unknowns L, A and N, it would be possible to design a transformer starting from "scratch". For the purpose of calculation, suppose the core cross-section to be square and that the outline of the core itself is a square as shown in figure 7. Then the winding "window" will be a square having an area of

$(L/4 - \sqrt{A})^2$ sq. cm.,
L = magnetic path length around center of core (Cm.),
A = area of cross-section of core legs. (Sq. cm.).

Let us further suppose that the turns ratio between total primary and total secondary is to be 1 to 1.2. If the number of turns of wire on the secondary be N, the number of turns on the primary will then be N/1.2. If the outside diameter of the wire used on the secondary is d_1, there will be $1/d_1$ turns per unit length or $(1/d_1)^2$ turns per unit of cross-sectional window area. The space required by the secondary turns will then be $N(d_1)^2$. Similarly, if the diameter of the wire used on the primary is d_2, the window area needed by the primary will be $N\,d_2^2/1.2$. Thus, the total window space needed for both windings is

$$N\left(d_1^2 + \frac{d_2^2}{1.2}\right).$$

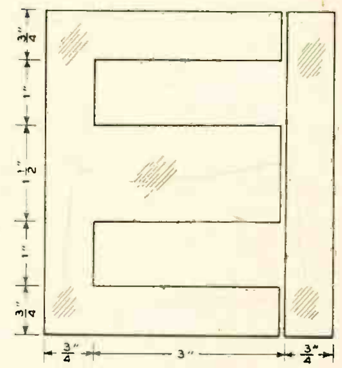


FIGURE 8

For ordinary transformers an allowance of an extra thirty per cent is usually made for insulation but for class-B modulation transformers from eighty to one hundred per cent is not too much. Equating the window area to twice the space required by the wire, we have

$$(14) \quad \left(\frac{L}{4} - \sqrt{A}\right)^2 = 2N\left(d_1^2 + \frac{d_2^2}{1.2}\right)$$

From (12), (13) and (14) it is possible to solve for any of the three unknowns, but the work is simplified somewhat if we solve for A, since it usually has the smallest numerical value. Eliminating L from (12) and (13), (15) $N = 49\ E/A$. Substituting (12) and (15) into (14),

$$\left(\frac{.875\ E\ I}{A} - \sqrt{A}\right)^2 = \frac{98\ E}{A}\left(d_1^2 + \frac{d_2^2}{1.2}\right)$$

Simplifying and rearranging terms in descending powers of A,

$$(16) \quad A^3 + 2\sqrt{98\,E\left(d_1^2 + \frac{d_2^2}{1.2}\right)}\,A^2 + 98\ E\left(d_1^2 + \frac{d_2^2}{1.2}\right)A - (.875\,E\,I)^2 = 0$$

This cubic has only one positive solution for A and may be solved using Horner's Approximation, reference to which may be had in most any standard mathematics text. Knowing A it is then possible to use equations (12) and (15) to find L and N, respectively.

Let us carry through the design of two transformers, one of 100 watts audio handling capacity (to modulate 200 watts input to the class-C amplifier), the other of 250 watts audio capacity. Let us suppose that we have E-shaped punchings available of the size and shape shown in figure 8, which we intend to use for the 100-watt transformer and that we propose designing the 250-watt transformer right from "scratch" using core-type laminae. In both cases there are two things to be decided upon before any design can be started — the maximum r.m.s. voltage to be developed by either primary or secondary and the maximum steady d.c. class-C plate current to be used. As a rule the highest r.m.s. voltage will appear across the modulation transformer secondary, especially if zero-bias modulator tubes are used on the primary. If the low- or medium-mu modulator tubes are used with their attendant high plate voltages, the maximum r.m.s. audio voltage will appear across the total primary winding. In special cases where restricted design is desired one may easily determine which winding requires the greater number of turns of wire. The square root of the product of recommended modulator plate to plate load and audio power output equals the r.m.s. audio voltage developed across the primary, while the secondary r.m.s. voltage will be equal to the class-C plate voltage divided by the square root of 2. Thus,

$$E_p = \sqrt{W\ R_L}$$

$$E_s = \frac{E_b}{\sqrt{2}}$$

where E_p = r.m.s. audio voltage developed from plate to plate of modulator tubes

W = rated audio watts output from pair of modulators

R_L = recommended plate to plate load resistance for modulators

E_s = r.m.s. audio voltage developed across secondary of modulation transformer

E_b = class-C amplifier d.c. plate volts.

Watts Audio	R.M.S. Audio Volts	D.C. Class-C Plate Current
100	1000	.15 amps
175	1500	.20
250	1750	.25
350	2000	.35
500	2500	.50

FIGURE 9

The maximum class-C plate current contemplated should next be noted. Figure 9 shows the maximum r.m.s. audio voltage to be expected as well as the class-C plate current for a group of representative modulators. These values will fit practically all cases found in amateur practice and make the design of a "universal" modulation transformer possible.

Recalling our two design problems and referring to figure 9, the 100-watt transformer will have a maximum r.m.s. audio voltage of 1000 volts on the secondary N turns and will carry a class-C plate current of .15 ampere. Thus, in equations (12) and (13), E = 1000 and I = .15. From figure 8 we determine the length of the magnetic path to be L = 30 cm. Substituting these values in (12) and (13) we have

$$A = \frac{3.5\times1000\times.15}{30} = 17.5 \text{ sq. cm.}$$

$$N = \frac{14\times30}{.15} = 2800 \text{ turns.}$$

Since A = 17.5 sq. cm. = 2.71 sq. inches, the given laminae must be stacked to a depth of 2.71/1.5 = 1.8 inches. We have already assumed that the primary to secondary turns ratio is to be 1 to 1.2 so that the number of turns on the primary will be N/1.2 = 2334 (approx.). The wire sizes are determined from the total amounts of current they will be called upon to handle. Since the audio r.m.s. voltage on the secondary is 1000 at 100 watts, the audio current will be 100/1000 = 0.1 ampere. The total current carried by the secondary wire is then .15 + .1 = .25 amperes. At 1000 circular mils (CM) per ampere this would require no. 26 wire. The primary wire size should be chosen to carry 1.2 times the secondary current or 0.30 amperes, corresponding to size 25 wire. This combination will be found extremely conservative in operating ratings since the audio currents do not flow continuously. As a matter of fact, in case the core window space does not

[*Continued on Page 79*]

An Economical Cathode-Ray

MODULATION INDICATOR

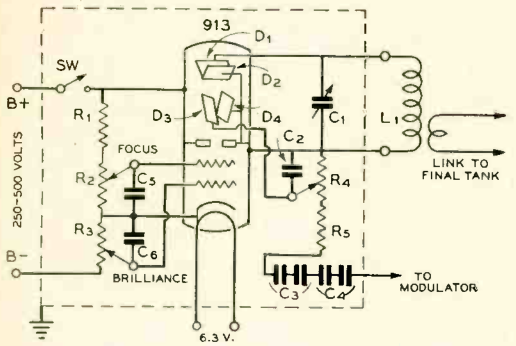


FIGURE 1

C_1 and L_1—Tuned to transmitter frequency
C_2—.0001-μfd. 600-volt tubular
C_3—2 0.1-μfd. 600-volt tubulars in series
C_4—2 0.1-μfd. 600-volt tubulars in series
C_5, C_6—.002-μfd. 400-volt tubulars
R_1—150,000 ohms, 1 watt
R_2—50,000-ohm potentiometer
R_3—25,000-ohm potentiometer
R_4—200,000-ohm potentiometer
R_5—800,000 ohms, 1 watt
SW—S.p.s.t. toggle switch
The insulation on L_1 should be adequate for 500 volts.

By
H. F. FOLKERTS*
W2HFZ

A very simple, economical cathode-ray-tube modulation indicator is shown in figure 1. The principle of operation or the idea itself is not original, but this particular arrangement, considering its performance, is more compact, simple, and inexpensive than similar devices which have previously been described.

No saw-tooth circuit, synchronizing circuit, deflection amplifiers, or additional power supply is required. The unit consists essentially of a 913 cathode-ray tube with a few resistors and condensers. It can be constructed and mounted in a metal box at a cost slightly higher than the price of the cathode-ray tube itself. The exact cost depends upon the contents of the "junk" box.

The power supply may be any of those used in the transmitter or receiver capable of supplying about 250 to 500 volts, since the additional current drain on this supply is in the order of only a few milliamperes. The higher the voltage, providing it is not over 500 volts, the greater will be the detail in the resulting pattern. Naturally, the power supply voltage should be reasonably free from ripple. A separate filament transformer or filament winding is essential to prevent short circuiting the bias supply of the cathode-ray tube. If a separate filament transformer is used, it should be placed far enough away from the cathode-ray tube to prevent beam deflection by the magnetic field. The iron shell of the 913 tube, however, reduces this possibility greatly.

Regarding the 913 tube, the constructor should bear in mind that the negative side of his power supply is usually grounded, whereas the shell of the cathode-ray tube must be positive. Thus, the shell should be carefully insulated from ground by bakelite tubing or by some other suitable means. A piece of bakelite tubing about two inches longer than the tube itself is to be preferred, since the extended portion helps shield the screen from the room light (and from inquiring fingers).

Adjustment

The adjustment of this unit is very simple and may be completed in a few moments. After the heaters have warmed up, close the switch (SW) and adjust R_2 for the proper focus and then R_3 for suitable brilliance. With no deflection voltages applied as yet, the resulting pattern should be a luminous spot at the center of the screen. The switch (SW) should not be closed until the heater of the 913 tube and the cathode of the rectifier have reached operating temperature. Failure to exercise this care, especially at low anode voltages, may result in a negatively charged screen which will not fluoresce properly. This charged-screen condition is due to a low-velocity electron beam. Another preventive measure would be to adjust the bias control R_3 for maximum bias before the heater supply has been turned on.

*200 Jackson Ave., Jersey City, N. J.

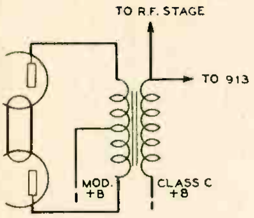


FIGURE 2

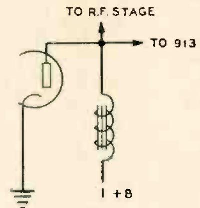


FIGURE 3

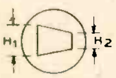


FIGURE 4


FIGURE 5


FIGURE 6

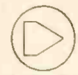


FIGURE 7

Next, by means of a tuned pick-up coil and twisted-pair transmission leads, unmodulated r.f. voltage from the final tank or antenna circuit is coupled to plates D_1 and D_2. This coupling is varied until the electron beam in the cathode-ray tube traces a vertical line approximately one-half the diameter of the tube screen. The audio modulating voltage is then coupled to plates D_3 and D_4 as shown in the diagram. Proper precautions should be taken by the constructor to insulate the r.f. leads from ground to prevent shorts or possible shock, since they are at high potential. The transmitter is now modulated with a convenient tone, such as that from an audio oscillator, and resistor R_4 varied until the horizontal dimensions of the pattern are approximately ¾ of the diameter of the tube screen. That's all there is!

The purpose of C_4 is merely to increase the voltage breakdown point of coupling condenser C_3 and should be necessary only where the d.c. plate voltage to the final r.f. stage is greater than 650 volts. With C_4 in series with C_3 this unit may be used on transmitters employing 1250 volts on the plate of the final r.f. stage. C_2 should be mounted directly at the socket of the 913 tube and serves as an r.f. by-pass condenser. Without this condenser, the r.f. energy "floating" around the unit might be sufficient to deflect the electron beam horizontally, resulting in a distorted pattern. Condensers C_5 and C_6 likewise serve as r.f. by-pass condensers, preventing defocusing and pattern distortion. Using the voltage and wattage ratings shown for all parts in this circuit, the amateur can measure percentage modulation on any transmitter having up to 1250 volts applied to the plate of the final r.f. stage.

Figures 2 and 3 indicate the proper method of connecting the modulator to the 913 tube. Regardless of whether the transmitter is grid, screen, suppressor, or plate modulated, the connections shown still apply. If a class-B r.f. stage follows the modulated stage, the link circuit should be coupled to the output of the class-B stage.

Interpretation of Figures

To determine the exact modulation percentage, as in figure 4, substitute the maximum and minimum vertical dimensions of the pattern in the formula:

$$\% \text{ Modulation} = \frac{H_1 - H_2}{H_1 + H_2} \times (100).$$

From this equation it is obvious that the pattern resulting from a 100% modulated carrier is a true isosceles triangle, as shown by figure 5.

If the transmitter has been improperly adjusted or modulated, various other patterns will result when modulation is attempted. Two of these patterns are shown in figures 6 and 7. Figure 6 indicates that the modulated carrier voltage has reached zero before the modulating voltage has reached its peak value on the negative portion of the a.f. cycle. To put it more clearly, overmodulation has taken place. Figure 7 indicates that the modulated carrier voltage does not continually increase with a corresponding increase in the positive half cycle of the audio modulating voltage. This condition may be due to insufficient r.f. grid excitation, poor regulation of a common r.f. and modulator power supply, or low emission r.f. tubes. Various other possible patterns and their causes are explained in detail in the article "Let's See," by Jay C. Boyd, in the April issue of RADIO; 1938 RADIO *Handbook; R/9* for September and November, 1935; *QST* for March and April, 1934; "RCA Cathode-Ray Tubes and Allied Types," and Rider's "The Cathode-Ray Tube at Work."

The author wishes to thank Melvin A. Lewis (W2HEJ) for his cooperation in the use of his amateur radio station.

●

Kunio Shiba, J2HJ, died in April, 1936. Just recently, his brother, Baron Masao Shiba, sent us a copy of a 172-page memorial book edited by friends, including J2IS. The book contains reproduced articles, copies of his 28 Mc. w.a.c. cards in color, and other material. In all it is quite an unusual memorial, and one which impresses the reader with the value of amateur radio in international friendship.

A Five-Meter

SUPER GAINER RECEIVER

A five-meter superheterodyne receiver suitable for c.w. or phone reception in the u.h.f. region and incorporating a simple and new noise-limiting circuit.

By FRANK C. JONES,* W6AJF

Line-stabilized and crystal-controlled transmitters in the u.h.f. region have made it possible to use fairly selective superheterodyne receivers with as much success as on the lower frequencies. A good noise limiter system to suppress automobile ignition interference makes this type of receiver considerably more desirable than a super-regenerative type because of better selectivity. A superheterodyne receiver can easily be made which is less subject to auto ignition QRM than in the case of a good super-regenerative receiver. The latter has an objectionable hiss which is not present in the superheterodyne receiver. The main disadvantage of the superheterodyne heretofore has been the large number of tubes and the complicated circuits required. The set illustrated here has only three tubes in the radio receiver proper and an extra tube for noise limiting or suppression.

The Circuit

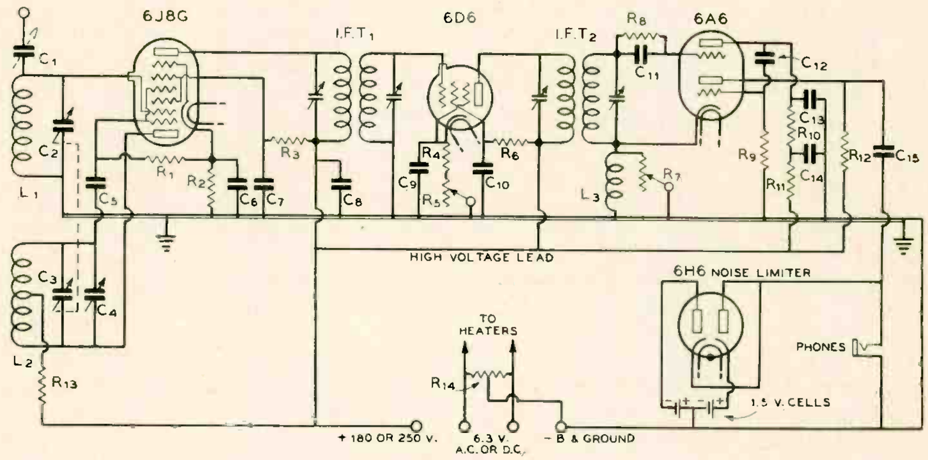
The circuit utilizes a new hexode converter tube, the 6J8G, which is apparently far superior to any previous tubes or combinations of tubes such as the 6A8 or 6L7-6C5 detector-oscillator systems. Electron mixing takes place through an extra grid connected inside of the tube to the oscillator triode section of the 6J8G. This triode has a high transconductance and oscillates vigorously even below five meters in the circuit shown. The oscillator circuit requires a tuning condenser which isn't grounded or by-passed to ground for u.h.f. operation. This is easily accomplished by mounting this condenser on a small porcelain stand-off insulator and connecting the rotor to the dial and detector tuning condenser through insulated shaft couplings. A high-C oscillator circuit gives good frequency stability and can be made to track easily with the low-C detector circuit for single dial tuning. Good oscillator stability is especially needed for c.w. reception of long distance 5-meter signals. These signals occasionally reach long distances when the ionized air layers are such as to reflect these very high frequencies back to earth.

Regeneration in the detector circuit was tried by tapping the cathode lead to a point near the grounded end of the detector tuned circuit. Variable screen voltage was obtained through a potentiometer but little benefit seemed to result—possibly due to the oscillator circuit arrangement. The sensitivity was so much greater than expected with the circuit shown that additional regeneration was left out. An i.f. sensitivity control was needed due to overloading from any nearby 5-meter phone station signals.

One stage of 1600 kc. i.f. was sufficient since a regenerative second detector adds to the gain and selectivity in the intermediate-frequency amplifier. A 6A6 acts as a regenerative second detector and one stage of audio amplification as in the super-gainer receivers illustrated in various editions of the RADIO *Handbook*. The 6A6 has two triodes, one of which acts as a grid-leak detector connected to the second 1600 kc. i.f. transformer. Regeneration, or oscillation for c.w. reception, is controlled by a 1000-ohm variable resistor connected across a cathode r.f. coil. This coil consists of approximately 40 turns of small wire such as no. 28 d.s.c. jumble wound on a ½"-diameter porcelain or bakelite rod. It is not coupled to the i.f. transformer but is mounted underneath the chassis near the 6A6 tube socket. The best number of turns depends upon the type of i.f. transformer and degree of coupling. Loose coupling between the coils of the second i.f. transformer is best for smooth control of regeneration by means of the cathode circuit.

The second triode in the 6A6 is resistance coupled to the detector and to the headphones.

*Engineering Editor, RADIO.



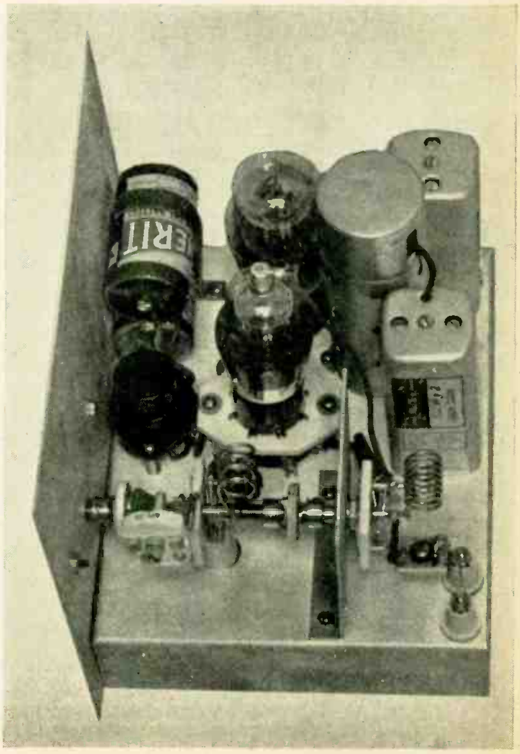
C_1—3-30-μμfd. coupling condenser
C_2—8-μμfd. tuning condenser. Revamped 15-μμfd. midget
C_3—15-μμfd. midget tuning
C_4—50-μμfd. osc. tank condenser
C_5—.0001-μfd. mica coupling
C_6, C_7—.005-μfd. mica by-pass
C_8, C_9—0.1-μfd. 400-volt tubular
C_{10}—.01-μfd. mica by-pass
C_{11}—.0001-μfd. mica coupling
C_{12}—.01-μfd. 400-volt tubular
C_{13}—.002-μfd. 400-volt tubular
C_{14}—0.5-μfd. 400-volt tubular
C_{15}—.25-μfd. 400-volt tubular
R_1—50,000 ohms, ½ watt
R_2—300 ohms, ½ watt
R_3—100,000 ohms, ½ watt
R_4—300 ohms, ½ watt
R_5—50,000-ohm rheostat
R_6—100,000 ohms, ½ watt
R_7—1000-ohm rheostat
R_8—5 megohms, ½ watt
R_9—500,000 ohms, ½ watt
R_{10}—50,000 ohms, ½ watt
R_{11}—20,000 ohms, ½ watt
R_{12}—50,000 ohms, ½ watt
R_{13}—25,000 ohms, ½ watt
R_{14}—50-ohm c.t. resistor
$IFT_{1, 2}$—Midget 1600-kc. iron-core i.f. transformer
L_1, L_2—See text
L_3—40 turns, ½" dia., no. 28 d.s.c. jumble wound

The plate circuit of the second detector has an RC filter, an extra condenser and resistor, in order to reduce hum and any possible motorboating trouble. A second audio stage consisting of a high-gain interstage audio transformer and a pentode amplifier tube can be added for loudspeaker output.

Noise Limiting

The new noise-limiting circuit is of particular interest because it can be added to any short-wave or u.h.f. receiver. It is very effective in leveling off the terrific popping or crackling of auto ignition noise. Weak phone signals can clearly be understood through very bad auto ignition interference.

This limiter has a 6H6 twin diode connected in push-pull across the audio amplifier. The plate of one diode connects to the ungrounded end of the headphones and the cathode of the other diode to this same point. The remaining cathode and opposite plate connect through bias delay batteries to the grounded side of the headphones. A negative bias of 1½ volts is applied to each diode plate to act as a delay voltage in order not to attenuate the desired phone or c.w. signals. However, the ignition noise voltage may be as high as 10



or 15 volts on peaks and the limiter levels these off, in fact short circuits the output for the short duration of the noise-voltage peak. These noise peaks, in a receiver that isn't too selective, have a very short period and the receiver output can be automatically short-circuited for a 1/1000 to 1/100 of a second without appreciably affecting the audio quality on phone reception.

The push-pull diode circuit is necessary in order to short-circuit both positive and negative a.f. noise peaks. A single diode would only suppress approximately half of the noise. Whenever a noise peak develops more than 1½ volts (either positive or negative) one diode or the other begins to conduct and acts as a short circuit of fairly low resistance across the headphones. The delay voltage can be made any value; however, two small 1½-volt dry cells connected as shown provide about optimum delay voltage for average headphone reception. This type of noise limiter in any of its several possible forms has proven to be extremely effective. The simplicity of the circuit and ease with which it can be applied to any audio amplifier should make it very popular.

In adapting it to any audio amplifier, it should never be connected across a transformer, choke or pair of phones which has d.c. plate current flowing through the winding. The phones, choke or transformer should be isolated from d.c. as shown in this circuit. The relatively low d.c. resistance of the phones or transformer acts as a current path for the diode return circuit. The delay bias limits the noise voltage to the same approximate level as that of a moderate signal which means that the noise is no longer objectionable.

Other Tube Combinations

Other tube combinations may be used in the five-meter receiver illustrated here. A 6K7 or 6K7G may be substituted for the 6D6 i.f. stage. A 6N7 metal tube usually has a little less hum level than a 6A6 or 6N7G in the second detector-audio circuit due to its better shielding. Any two triodes connected as diodes can be substituted for the 6H6 noise limiter, but the 6H6 is so compact that it is highly recommended. There seems to be no present substitute for the new 6J8G hexode mixer tube.

The receiver was built on a 14-ga. aluminum chassis 6″x8″x1¾″ with 12-ga. front panel 7″x8½″. A vernier or slow motion dial is necessary and it must be insulated from the oscillator tuning condenser which it drives. The latter is mounted on a porcelain insulator and the detector tuning condenser is mounted on a 3″x3″ 14-ga. aluminum bracket which acts as a shield between the oscillator and detector coils and condensers. The 6J8G tube is mounted up above the chassis on a porcelain socket in order to have short r.f. leads to the triode oscillator section. The 6D6 is shielded and the 6A6 should also be shielded. The 6H6 was mounted above the chassis simply because it was added to the receiver at a later date. Ordinary iron-cored air or mica-tuned i.f. transformers are satisfactory.

Single-Dial Control

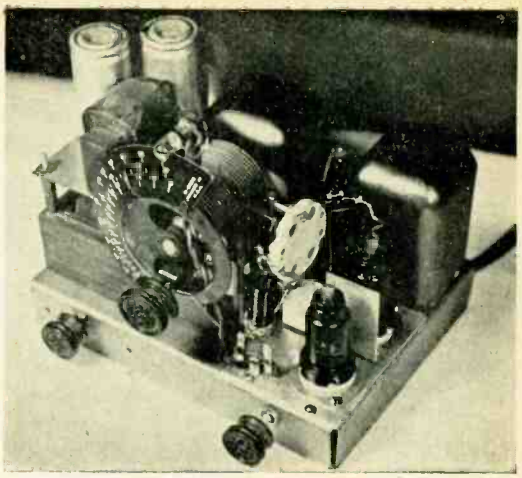
Two Hammarlund type HF-15 condensers were ganged for single-dial tuning control. An ordinary ⅝″-long brass spacer tube was carefully soldered to the shaft nubbin at the rear of the oscillator tuning condenser. This must be "sweated" on carefully with a soldering iron as too much heat will loosen the rotor plates. This hollow shaft extension can be easily soldered on over the nubbin by clamping the front end of the condenser shaft in a vise and holding the brass sleeve in line with a pair of pliers and a steady hand. The shaft extension provides a ¼″-diameter shaft for the rear insulated coupling and also spaces the tuning condensers farther apart. The rear or detector tuning condenser has one rotor and one stator plate removed, leaving only three plates. This leaves a tuning condenser with a maximum capacity of about 8 μμfd. The oscillator condenser has a maximum capacity of about 17 μμfd. and by choosing the proper coils and oscillator trimmer condenser, the two circuits can be made to track 1600 kc. apart. A 50-μμfd. midget condenser set at about three-quarters of its full capacity acts as a fixed "tank" condenser across the oscillator coil and provides a high-C oscillator circuit. The detector has no trimmer condenser as it should have as low C-to-L ratio as possible for maximum signal sensitivity. The oscillator should always be tuned to 1600 kc. higher in frequency than the detector.

Coils

The coils are soldered to the tuning condenser terminals. The oscillator coil has 4 turns of no. 14 wire wound on ½″ diameter and the turns spaced enough to make the coil about ¾″ long. The coil is center-tapped and the resistor is soldered directly to the coil with a lead about ⅜″ long since this resistor must also serve as an r.f. choke in the oscillator circuit. The trimmer condenser is soldered to the

[*Continued on Page 85*]

● **This is a re-built commercially-manufactured converter from a few years back, but it can also be constructed either from the junk box or new parts.**



A 28-Mc. Converter

By **RUSSELL H. FRANKE*, W8GNJ**

The writer, having been bitten by the species of radio bug known as u.h.f., recently spent several sleepless nights trying to decide whether to tear down a perfectly good nine-tube super and rebuild it for 28 Mc. and higher or build a u.h.f. converter to hook on ahead of this already proven, but decidedly low-frequency, receiver.

There was only one way to decide. The family pocketbook was carefully emptied into the center of a large sheet and its contents as carefully counted, but alas! there was not even one cent among the few that was willing to leave its companions and be a martyr to the most worthy cause.

The case seemed hopeless and one was likened to a person cast upon a desert island without food or drink. But after this period of extreme dejection had passed, a new thought began to dawn! There was plenty of junk lying around so why not put together a converter and just see what it would do, if anything, without the fancy trimmings and high class insulation that are usually associated with high frequency equipment?

Something to Start on

A hasty inventory of the top layer on the top shelf disclosed a shortwave converter which had been designed for use with a standard b.c. receiver and which was sold very widely throughout the U.S. by one of the leading mail order houses a few years ago. This contained its own power supply and produced an intermediate frequency of about 1000 kilocycles.

This seemed to be a good beginning so it was completely dismantled and was found to yield many parts that were later to be useful. As the power supply was of the conventional type and occupied but a small amount of space, little was changed here except to rewind the filament winding of the transformer for 6.3 volts, it being originally designed for 2.5. This, however, was merely a time consuming chore and required but little skill. Since the two small metal electrolytics which, in the photos, are clearly visible just above the transformer, were only 6 μfd. each, another 8 μfd. section was added which accounts for the extra unit which may be seen beneath the chassis. The old reliable type 80 was retained as the rectifier as there seemed to be no reason why anything different should be used.

The Tuned Circuits

The problem of suitable tuned circuits next presented itself. It was decided to use the two-gang condenser which originally tuned the unit;

*508 State St., Hart, Michigan.

hence, some means had to be devised to reduce the capacity and also to give a reasonable degree of spread to the amateur band.

The idea of series condensers seemed fairly good and so a dual intermediate transformer trimmer was hooked into the circuit with one section in series with each section of the variable. This turned out to be very effective as it not only gave the necessary reduction in capacity and an acceptable band spread but it also provided a very nice adjustment for tracking the oscillator properly. It has been said that this tracking is not important at these frequencies but on the contrary it was found to be quite necessary in this case.

As it was only desired to use the unit on ten meters, some very sturdy coils were wound with 20 turns of no. 14 wire on a one-half inch form with no spacing between turns. The coils were then soldered right into the circuit. The oscillator coil is tapped about one third of the length from the cold end, this being not at all critical. The cold ends of both coils and also the two spring rotor contacts of the variable condensers were brought to a common ground. All of the high-frequency by-pass condensers were also brought to this point. This bonding was found to be very important since at this high frequency stray circuits are easily formed when the chassis or the shielding forms a part of one of the tuned circuits.

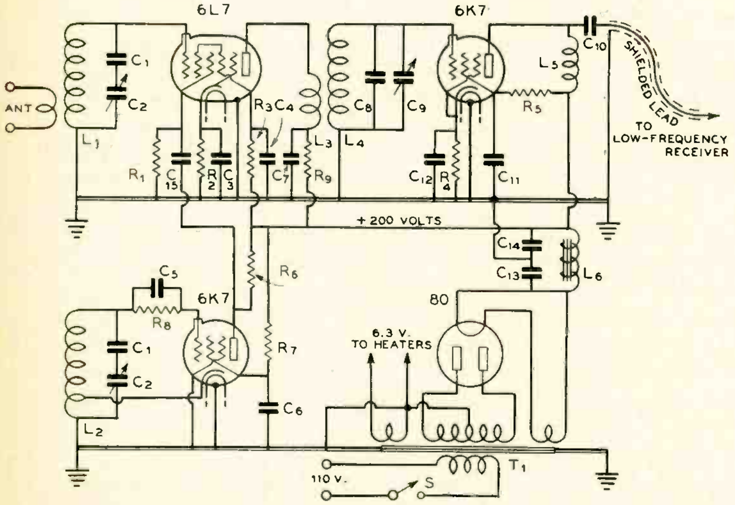
A 6L7 was chosen as the mixer tube because of its good reputation as such and a 6K7 was used as the oscillator because one happened to be handy. This combination proved to be a wise choice as the coupling can easily be controlled between the two stages because of the complete isolation of each tube from its tuned circuits. While this coupling is not at all critical, a capacity of about .0001 μfd. seemed to be best in this case. Probably a fixed mica condenser of this value could as well be used instead of the variable padder which may be seen at the upper right in the bottom view of the chassis.

At this point it might be well to mention that if a metal panel is not used on the unit, as was the case here, the oscillator stage must be placed well back on the chassis to prevent body-capacity effects when tuning. This is the reason for the small shield between the mixer and oscillator tubes. Another reason is that it helps to isolate the two circuits.

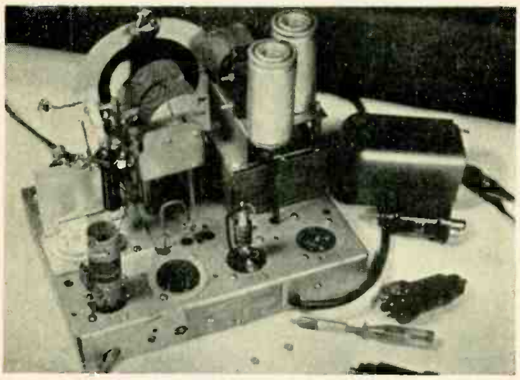
Reason For an I.F. Tube

The failing of most superhet converters lies in the fact that the output is usually taken directly from the plate circuit of the mixer tube and fed into a very uncertain load depending on the input arrangement of the receiver with which it is being used. More for this reason than for anything else, an i.f. amplifier was used as a coupling stage and was found to be well worth

SCHEMATIC DESIGN OF THE 28-MEGACYCLE CONVERTER



- C_1, C_2—Tuning condensers, see text
- C_3, C_4—.01-μfd. 400-volt tubulars
- C_5—.0001-μfd. mica
- C_6, C_7—.01-μfd. 400-volt tubular
- C_8—.0001-μfd. mica
- C_9—Small trimmer condenser
- C_{10}—0.1-μfd. 400-volt tubular
- C_{11}, C_{12}—.01-μfd. 400-volt tubular
- C_{13}—6-μfd. 450-volt electrolytic
- C_{14}—14-μfd. 450-volt electrolytic
- C_{15}—.0001-μfd. mica
- R_1—50,000 ohms, ½ watt
- R_2—400 ohms, 1 watt
- R_3—5000 ohms, 1 watt
- R_4—300 ohms, 1 watt
- R_5—100,000 ohms, 1 watt
- R_6—50,000 ohms, 1 watt
- R_7—100,000 ohms, 1 watt
- R_8—50,000 ohms, 1 watt
- R_9—5000 ohms, 1 watt
- T_1—Power transformer from old unit rewound for 6.3-volt fils.
- Coils—See text
- L_5—2.5-mh. r.f. choke
- L_6—20-hy. 50-ma. filter choke
- S—A.c. line switch



Almost everything may be seen in this view. The uncovered i.f. transformer is at the left foreground.

the few extra parts it takes. The conventional 6K7 fills the bill perfectly.

The coupling transformer between the mixer and the i.f. tube is merely an old interstage coil from a midget t.r.f. b.c. receiver with a few turns removed from the secondary and shunted with a small .0001-μfd. condenser and a variable trimmer for the purpose of dodging any strong broadcast signals that might get into the circuit. This transformer, with the shield cans removed, shows very clearly in the photo.

Choice of an I. F.

An i.f. of 2000 kc. was chosen for two reasons. First, it gives complete freedom from image interference. Second, because in the set-up used here it is very desirable occasionally to stand by on the high frequency end of the 160-phone band at the same time that the receiver is being used on ten and this i.f. makes this conveniently possible without the necessity for two complete receivers. The low-frequency receiver can be tuned to as low as 1900 kc. without materially affecting the operation of the converter even though its i.f. stage is permanently tuned to 2000 kc.

It was originally intended to provide a tuned output transformer in the plate of the 6K7 i.f. tube which accounts for the second copper shield can at the rear center of the chassis, but in the usual haste to get the thing working to see what it would do, r.f. choke and condenser output were used instead and the results were so satisfactory that the coupling system has not been changed. Possibly a tuned coupling transformer at this point and better high-frequency parts would improve the operation of the unit considerably, but that is doubtful because it really gives excellent results. Ten-meter phone stations have been heard from all over the world with tremendous volume and good consistency when using either an all-wave table-model b.c. receiver or the ham-made 9-tube super in conjunction with the converter.

Noise Level and Antennas

When the converter was first put into operation, the noise level and auto ignition racket seemed to be quite high. An ordinary b.c. antenna was being used and so a regular 10-meter doublet with a two-wire low-impedance twisted line was tried. The improvement was positively amazing! Signals came up to R7 out of an apparently dead band and those that were R8 or 9 before were so loud that the volume control would not completely cut them off.

Perhaps the writer is overly enthusiastic about this performance as it is the first experience of any consequence with a 10-meter converter. However, the unit operates so much better than several standard all-wave communications receivers with which it was compared, that it is felt that we really have something to crow about—considering the junk that was used in its construction.

The writer wishes to give a great amount of credit to W8NFM who did much to hasten the design and construction of the above very successful converter.

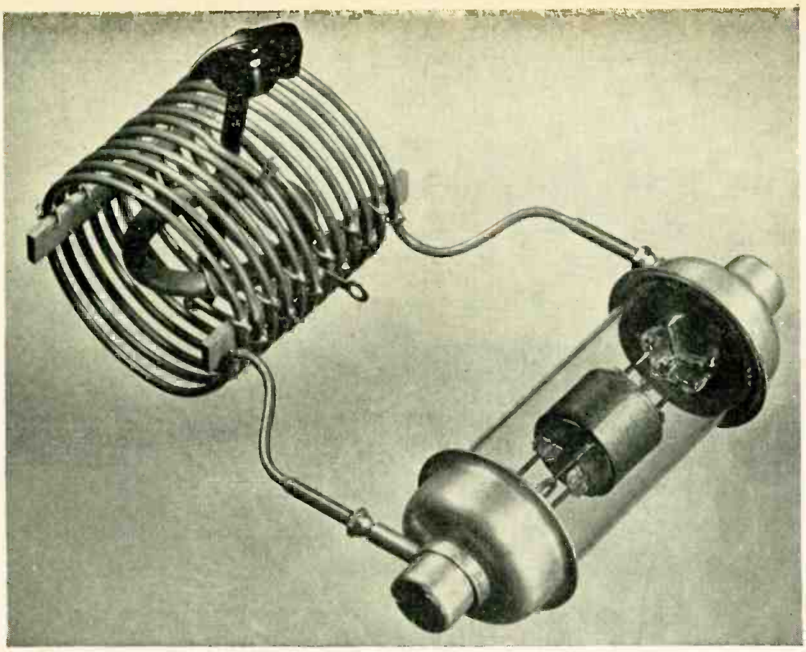
Ten Years Ago
. . . IN MAY

The yacht "Carnegie," signing WSBS, leaves Newport News, Va. for Plymouth, England, on the first leg of a projected three-and-a-half-year world cruise. L. A. Jones ships as operator.

W9AFA most consistent May contact for the "Bowdoin," WNP, frozen in at the North Pole.

W. D. Terrell, chief of the radio division, department of commerce, congratulates Twin City Vigilance committee on its outstanding work in cleaning up b.c.l. QRM.

Objections raised to the use of amateur calls for obvious commercial communications by the "New York Times" (2UO) and the "San Francisco Examiner" (6ARD). Pressure brought to bear results in the two newspapers taking out limited commercial licenses.



VACUUM CONDENSERS

for Fixed-Capacity Finals

In the article on inductive tuning by Chas. D. Perrine, Jr. in the February issue, mention was made of the fact that small vacuum tank condensers would soon be commercially available. We have been informed by the manufacturer that within a very short time condensers similar to that shown in the accompanying photograph will be offered on the market.

Tentative specifications call for four sizes: 6½, 12, 25, and 50 μμfd. for 10, 20, 40, and 80 meters respectively. Two 50-μμfd. units may be paralleled for 160-meter operation. The "Q" represented by these values is about optimum for high-power operation with tubes normally used by amateurs, and this works out very nicely inasmuch as the use of these condensers will probably be confined to amplifiers of 500 watts and over.

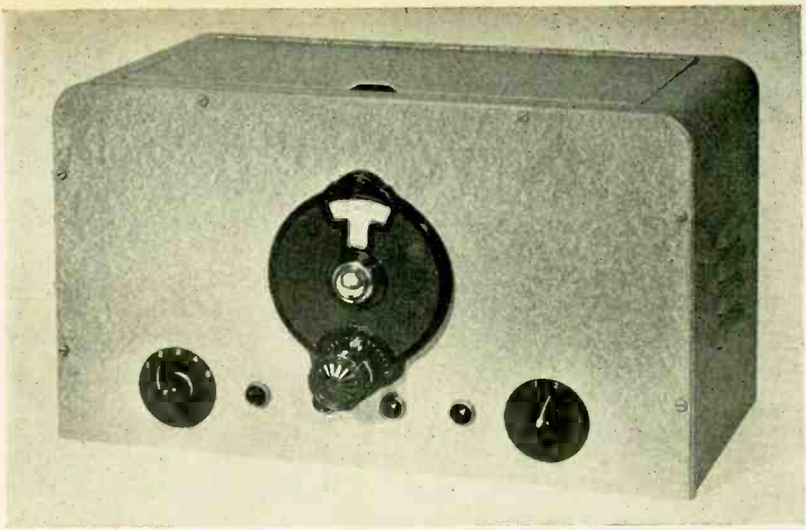
The condensers are all the same size physically, and fit into heavy cartridge fuse clips, which can be mounted on ceramic insulators having a long leakage path.

Because of the small spacing between electrodes, the static stress is sufficient at d.c. potentials of over 9000 volts to drag electrons from the negative electrode even though cold. However, at radio frequencies the condenser will stand any potential that will not arc between the outside corona shields (3½-inch spacing) or more than 30,000 peak volts. In common tank circuits, where no d.c. appears *across* the tank condenser, the condensers will easily withstand 4000 volts on a plate-modulated amplifier or 5500 volts on c.w.

The fact that one of the vacuum tank condensers cannot be used in a "split stator" arrangement is no drawback in a push-pull amplifier which uses a *split grid condenser with grounded rotor*. Inspection of high-power push-pull amplifiers in recent issues of RADIO will in many instances show the rotor of the plate tank condenser to be "floating" instead of connected to ground. Such an arrangement actually has several advantages if the *load on the two tubes is not unbalanced.*

On the higher-frequency bands a single, heavy, shorted turn may be rotated within the tank coil to vary the resonant frequency over the band. This, of course, requires that the coil be initially "pruned" to just the right amount of inductance, because it is possible to

[*Continued on Page 86*]



THE "FLEXTAL" EXCITER

By LEIGH NORTON,* W6CEM

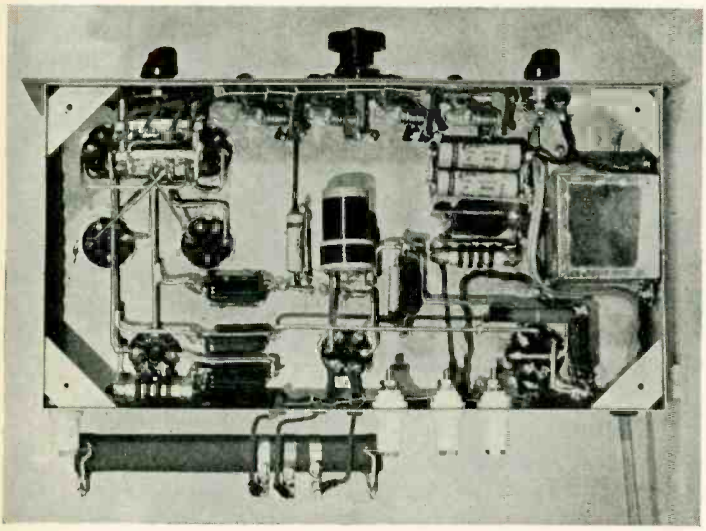
One of the results of the recent dx contest which will not appear in the logs of the contestants was the discovery by numerous operators that operation could have been far more enjoyable and much more productive if some sort of continuously variable frequency control had been employed. It was disheartening, to say the least, to listen to some choice dx station making one contact after another while his receiver stayed tuned to a frequency about 5 kc. from the new crystal purchased just before the contest to "get down in the band a ways." To provide a shining example of "locking the stable after the horse was stolen," it was decided, after the contest was over, to see what could be done to enable W6CEM to be placed *anywhere* in the 7, 14 and 28 Mc. bands.

Three solutions to the problem presented themselves. A large supply of variable crystals would do the job, but to cover the c.w. section of the 14 Mc. band at least twelve crystal units would be necessary. For complete coverage of both 7 and 14 Mc. no less than 24 would be required. The cost of these crystal units made this solution highly impractical in the writer's case.

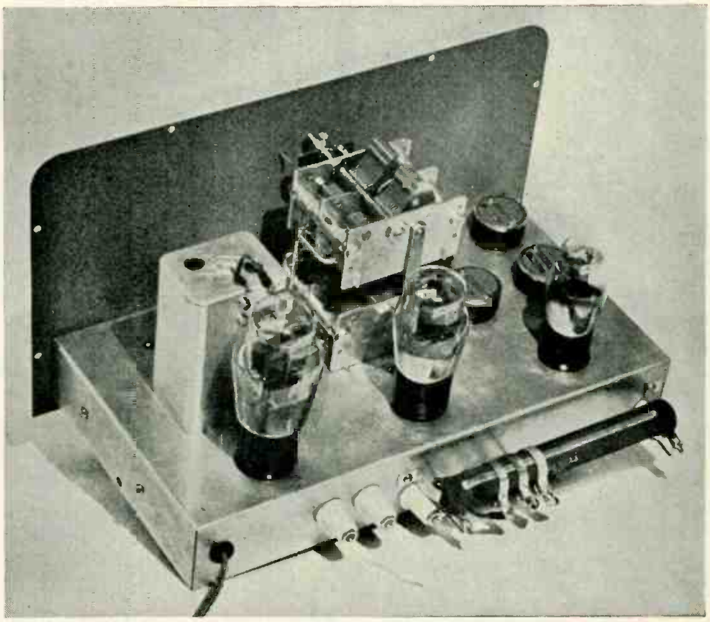
*921 Maltman Avenue, Los Angeles.

Another method was to replace the present crystal stage with a self-controlled oscillator of the electron coupled type. The electron-coupled oscillator, however, leaves much to be desired in the way of stability, quality of signal, and simple foolproof construction. To be really stable, an electron-coupled oscillator should be operated at a very low power level, making several buffer stages necessary to bring its output up to the level of the average crystal oscillator. The theoretical high degree of voltage-frequency compensation obtainable in this type of oscillator requires critical and interlocking adjustments of screen voltage, plate voltage, and excitation. Even when an elaborate voltage regulated power supply is used, its operation is not always entirely satisfactory. These disadvantages ruled out the electron-coupled oscillator principally from a standpoint of simplicity and ruggedness.

The third solution to the problem was to follow in the footsteps of W6BC and W7GAE and attack the variable frequency control problem from the frequency conversion angle. In this type of control unit, a variable output frequency is obtained by mixing the output of a variable low-frequency oscillator with that of a relatively high-frequency crystal oscillator. The output is taken from the plate circuit of a



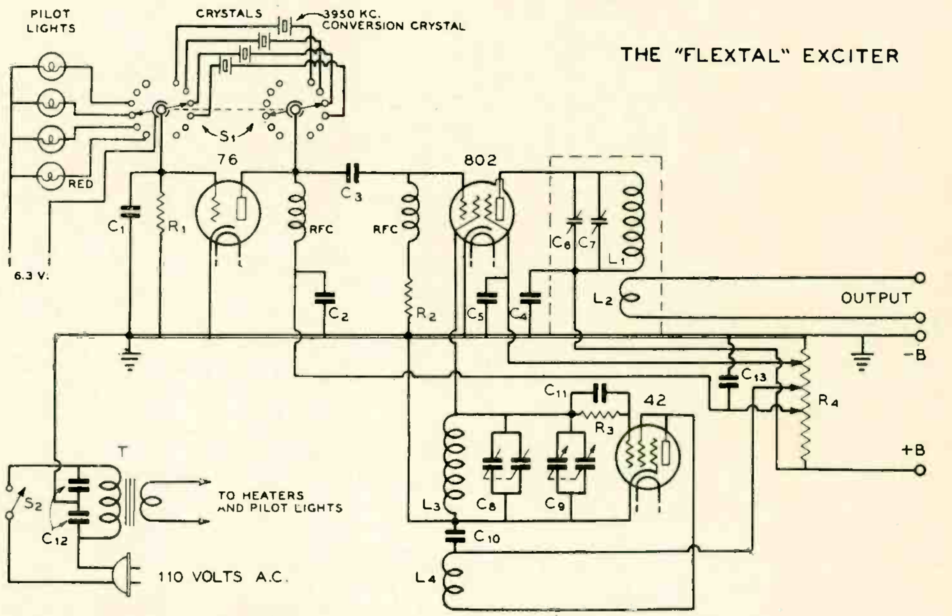
• In this bottom view the pilot lights may be seen at the top, the crystal switch top left, the low-frequency coil at the center, and at right center, the filament transformer.



• The tubes from left to right are 802 mixer, 42 l.f. oscillator and 76 crystal oscillator. The voltage divider is outside-mounted to avoid heating effects on the stability.

mixer stage which may be tuned to either the sum or difference of the two applied frequencies.

The theoretical frequency stability obtainable from this type of unit is very high. To provide a highly exaggerated example: If a 3600-kc. self-controlled oscillator had a 1% frequency shift due to a certain change in plate voltage, the change in frequency would amount to 36 kc. Comparing this shift with that of a conversion unit, assuming a similar set of conditions as applied to a low-frequency oscillator on 350 kc. which is mixed with a crystal oscillator on 3950 kc. to obtain the same 3600-kc. output frequency, we find that the same voltage change would have a negligible effect on the 3950-kc. crystal oscillator and would cause a frequency change of but 3.5 kc. in the 350 kc. oscillator. Since the output frequency is simply the difference between these frequencies (the l.f. and crystal oscillators), the shift in resultant frequency would only be that of the low frequency oscillator, or 3.5 kc. The conversion



THE "FLEXTAL" EXCITER

- C_1—.0001-μfd. mica
- C_2, C_3, C_4, C_5—.002-μfd. mica
- C_6, C_7—25 μμfd. each, in tank unit
- C_8, C_9—2-gang b.c.l. condensers, 350 to 365 μμfd. per section
- C_{10}—.01-μfd. 400-volt tubular
- C_{11}—.0005-μfd. mica.
- C_{12}—0.1-μfd. 400-volt tubular
- C_{13}—4-μfd. 450-volt electrolytic
- R_1—50,000 ohms, 1 watt
- R_2—3000 ohms, 2 watt
- R_3—30,000 ohms, 1 watt
- R_4—25,000-ohms 100-watt voltage divider
- L_1—48 turns no. 22 enam. close wound on 1" dia. form
- L_2—8 turns no. 22 enam. wound over cold end of L_1 and insulated from it by strips of celluloid
- L_3, L_4—Broadcast receiver coil, see text
- S_1—4-pole, 2-gang 6-position tap switch
- S_2—110-volt a.c. on-off switch
- T—6.3-volt 3 amp. filament transformer

unit is, therefore, inherently over 1000% more stable than the self-controlled oscillator, regardless of the actual percentage of frequency change considered.

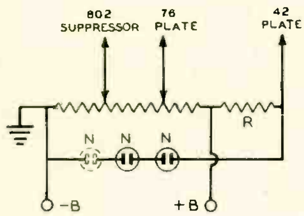
In at least two other ways the conversion unit has a definite advantage in regard to stability over the self-controlled oscillator. A certain amount of compensating action is provided by the high frequency crystal oscillator itself. This will be discussed later in connection with the choice of crystal frequency. The effect of changes in element spacing due to tube heating again shows the conversion unit to be definitely superior.

All in all, the conversion unit presents a very rosy picture as to inherent frequency stability from a theoretical standpoint. This theory is well borne out in practice; listeners are unable to notice any difference between conventional crystal control and control by the conversion unit.

With the conversion type frequency control showing such marked theoretical advantages it was decided to see what could be done to simplify its utilization.

It was decided that to provide a really satisfactory frequency control the following requirements must be met: (1) It must be stable to the highest possible degree; (2) it must have a reasonable amount of output—enough to excite the rig in place of the present crystal stage; (3) it must be inexpensive to construct. Parts must be easily obtainable through the usual channels; (4) it must be of simple design, with no critical adjustments or "tricky" circuits; (5) it must be flexible—operate either as a conversion unit or straight crystal oscillator and buffer merely by selecting the proper crystal with a tap switch.

The aforementioned theoretical advantages seemed to satisfy requirement (1); so with the other four requirements firmly in mind and the ever present junk box close at hand the prob-



Voltage Stabilization Circuit

R—5000 to 15,000 ohms, 10 watts
N—2-watt neon lamps

lem was attacked in earnest. The unit to be described is the result of many hours spent in trying various combinations of coils, resistors, condensers, and tubes. It resembles its predecessor of the junk box in circuit and operation only, a new set of parts having replaced the time worn ones used in the original model.

Several of the local ham fraternity with a bent toward coining words who have built similar units or seen them in operation have dubbed it the "Flextal" exciter. "Flextal" is fairly descriptive of the unit's operation; so "Flextal" it remains.

The "Flextal" conversion exciter is probably far from the ultimate in frequency control. No piece of radio equipment worthy of the name should ever be considered as not subject to improvement. However, it does answer all the requirements originally set up. It provides an abundance of extremely stable, easily obtainable, low cost r.f., the frequency of which is controllable by "a twist of the wrist".

The "Flextal" consists essentially of a crystal oscillator, a pentode amplifier, and a low frequency oscillator modulating the pentode stage, which thence becomes the "mixer". As the heart of this type of unit is the mixer stage, it was decided to employ the largest moderate-voltage tube that could be used. The only practical tube proved to be the 802; it has effective shielding and a sufficient number of elements to handle the job—not perfectly, but adequately.

Two simple methods of modulation, or injection, suggested themselves. Either screen or suppressor modulation could be used. Of the two, screen modulation proved to be the more satisfactory, giving slightly greater conversion output, and having the distinct advantage of being much less critical in adjustment.

The 802 is used as a straight single-ended mixer, in contrast to the balanced modulator used in previous units of this type. This proved to be no disadvantage, in spite of the fact that three frequencies appear in the output tank: (1) the crystal frequency, (2) the sum of the crystal and the low frequency, and, (3) the difference between the crystal and the low frequency. These three are easily separable by the use of a moderate value of C in the tank circuit. In practice, with the 802 plate circuit tuned to the desired peak, it is impossible to get enough energy through on the two unwanted frequencies to be measurable on the grid of the stage following the "Flextal" unit. The screen of the 802 is directly connected to the "hot" end of the low frequency oscillator tank circuit. This places it at ground potential for d.c. and also at ground for *high frequency* r.f. due to the by-passing effect of the high-capacity oscillator tank condenser.

The crystal oscillator is a simple Pierce affair, used because of its simplicity and because of the fact that it will operate with crystals of widely differing frequencies, there being no tuned circuits.

The low frequency oscillator uses a 42, triode connected. The 42 was selected because of its ruggedness and large power handling capability (allowing it to "loaf" at low voltages) and its wide element spacing. This choice has been fully justified; the 42 leaves nothing to be desired in output and frequency stability.

The choice of a frequency for the low frequency oscillator involves several considerations. An output range from the "Flextal" unit of from 3500 to 3650 kc. will provide complete coverage of the 7 and 14 Mc. bands and the c.w. section of the 28 Mc. band together with the most-used portion of the 28 Mc. phone band. To achieve a 3500- to 3650-kc. output range, the low frequency oscillator must have a range of 150 kc. In order to keep the l.f. oscillator out of the 465-kc. i.f. amplifier in the neighbors' b.c. sets, it should tune no higher than 450 kc. A frequency range of from 300 to 450 kc. seems to be the logical answer.

An "interstage" broadcast coil tuned by a regular four-section b.c. condenser with its sections in parallel will cover from approximately 250 to 750 kc. By splitting the condenser in two parts and using two paralleled sections for padding, or band setting, and two for tuning, it is possible to obtain a spread of approximately 75 divisions on an ordinary 100-division dial for the 300 to 450 kc. range.

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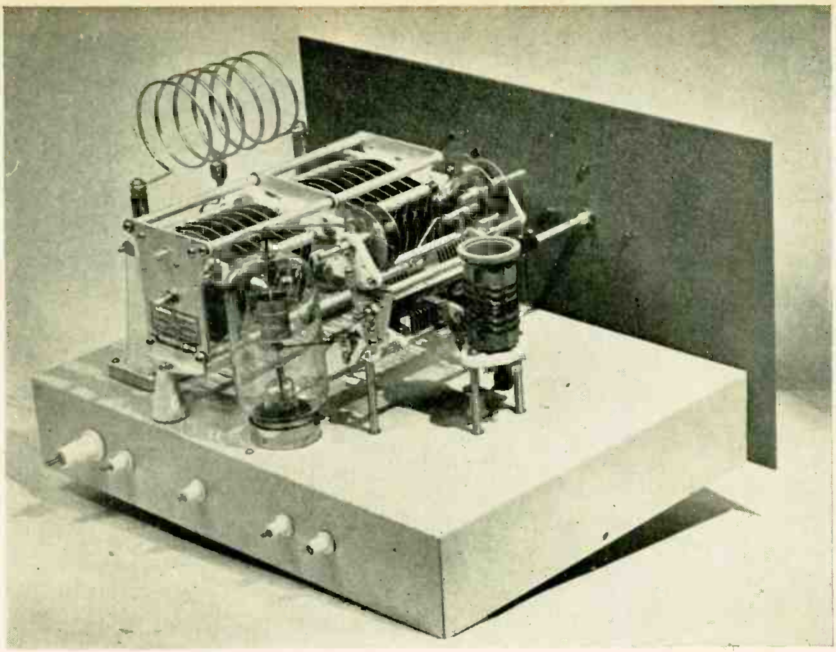


A Neat H.F. KW. AMPLIFIER

By FAUST R. GONSETT,* W6VR

The problem of laying out a kilowatt amplifier so as to have short leads and take up but little space is a rather difficult one because of the necessarily large size of the components. The problem is a strictly mechanical one, and not insurmountable. By shoving parts around in different positions and combinations it is usually possible to hit upon one that permits of a very compact and efficient layout. One such arrangement of a kilowatt amplifier is illustrated in the accompanying photographs. It takes up but little room, and r.f. leads are all less than two inches long; in fact the average length is about one inch.

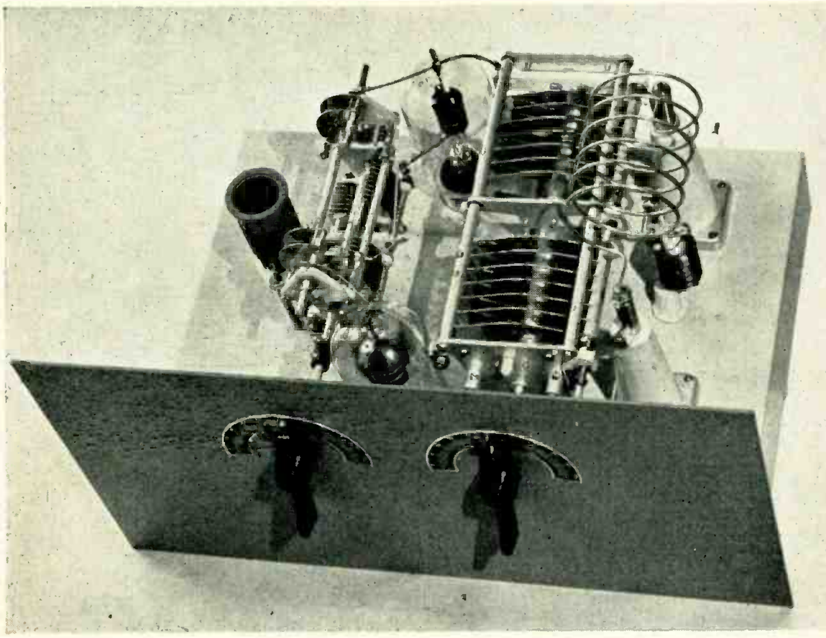
The amplifier consists of standard, readily available components, including a pair of the new HK-254 Gammatrons. The short leads are accomplished by "underslinging" the HK-254's and mounting the other components either on ceramic standoff insulators or on brass rods or bushings of such heights that lead lengths are kept to a minimum.

*Laboratorian, RADIO.

The amplifier is constructed on a standard rack size panel and chassis, the panel measuring 19x10½ inches and the chassis 17x13x3 inches. If used in a rack, especially one with a dust cover, a narrow "meter panel" with a cut-out and snap-on door can be used above the amplifier panel to reach the coils from the front of the transmitter.

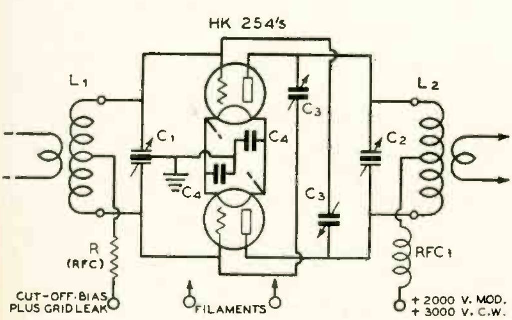
The two variable condensers are so placed that the shaft holes divide the front panel into three equal sections. The appearance would probably be improved slightly if the condensers were spaced a little wider apart, but this would require longer r.f. leads and would place the plate tank coil too close to the dust cover if one is used.

The "50-watt" sockets for the HK-254's are supported below the chassis by means of one-inch bushings. This puts the grid and plate leads at just the right height. The grid condenser and coil socket are both raised from the chassis by means of 2¼-inch brass rods or bushings. This permits short leads and places the shaft of the grid condenser at the same



height as the plate condenser if the latter is supported on the 1½-inch ceramic cones shown in the illustration.

Because the rotor of the grid tank condenser is grounded, the shaft coupling need not be of the insulated type. However, the rotor of the plate tank condenser is left "floating" in order to increase the allowable plate voltage, and an insulated shaft coupling is therefore required. It will be necessary to saw the rather long shaft of the plate tank condenser in order to accommodate placement of the insulated coupling between the condenser and front panel.



L_1, L_2—See coil table
C_1—100 μμfd. per section, 2000 volt spacing
C_2—100 μμfd. per section, 7000 volt spacing
C_3—5 or 6 μμfd. max. 7500 volt spacing
C_4—.002 μfd., 500 volt mica
R—400-ohm 10-watt resistor
RFC_1—2.5 mh. 500 ma. r.f. choke

The 7000-volts-per-section plate tank condenser allows the use of 2000 volts with plate modulation or 3000 volts on c.w. Thus it is possible to run 1 kw. input on c.w. or 800 watts on phone without exceeding the 200 ma. per tube rating on the HK-254's. If sufficient audio power is available, trouble may be experienced with arcing of the neutralizing condensers on occasional (unintentional) peaks of overmodulation. This is easily remedied by placing in series with each lead from plate to neutralizing condenser a 100-μμfd. 5000-volt mica fixed condenser.

No bias provision is made in the amplifier itself. It is desirable to use fixed bias equal to cutoff (1/25th the plate voltage) and a grid leak for the balance. A 3500-ohm 100-watt grid leak with adjustable slider connected so as to short out part of the resistor may be considered as part of the bias unit rather than part of the transmitter. The slider should be adjusted so that 80-ma. grid current flows when maximum driver output is being obtained. While more drive will permit greater efficiency, 50 watts output from the driver will be sufficient for phone operation and about 30 watts will be sufficient for c.w. operation. More drive permits the use of higher bias, which results in slightly greater efficiency. Regardless of the amount of drive available, the grid leak should be adjusted to allow 80 ma. of grid current.

COIL TABLE

Band	Turns	L_1 Length	L_2 Length
10 M	6 T	1½″	4″
20 M	12 T	2″	5″
40 M	24 T	2″	5″

All L_1 are 1½″ dia.; all L_2 are 2½″ dia.

The 400-ohm 10-watt resistor in the grid lead is used as an r.f. choke rather than to provide bias, the small amount of bias resulting from the voltage drop being incidental. A regular r.f. choke used at this point might resonate with the r.f. choke in the plate circuit and cause a bad, low-frequency parasitic oscillation. There is little r.f. voltage present, and the 400-ohm resistor serves the purpose nicely.

The filament transformer should be capable of putting out nearly six volts and have an adjustable primary if it is not placed on the chassis, and heavy wire (no. 10) used for the connecting leads. There is room on the chassis for such a transformer, however, and its inclusion will make it unnecessary to allow for the voltage drop in long filament leads. If the amplifier is to be used in a rack, the transformer should be mounted towards the front panel to minimize the pull on the panel and chassis.

The Coils

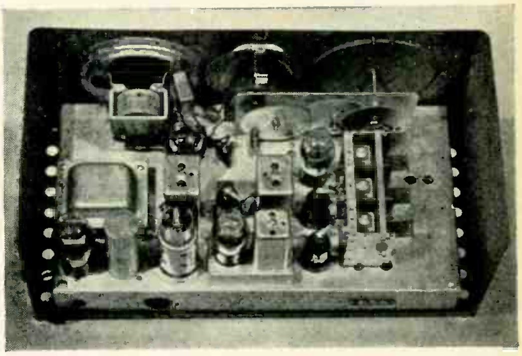
The coils are supported on large, jack-type stand-off insulators with heavy jacks and plugs spaced 6½″. The 10- and 20-meter plate coils are wound from no. 8 bare or enameled wire and are self-supporting. The 40-meter plate coil is wound of no. 12 wire, and supported by means of celluloid strips held in place with Duco cement. If no. 8 wire is not available, no. 10 may be used for the 10- and 20-meter coils, though the coils will "shimmy" a bit. If bare wire is used, it should be shined first with steel wool and then painted with Duco cement or clear lacquer after the coils are wound. No. 18 enameled is used for the grid coils.

The approximate dimensions for the coils are given in the table. The turns should be squeezed together or pulled apart a bit as the case may be until the coils resonate with the condensers nearly out on 10 meters, about half way meshed on 20 meters, and nearly all the way meshed on 40 meters. It is possible to get the unloaded minimum plate current lower by using lower "C" in the plate tank, but the "Q" will not be sufficient for proper operation when the amplifier is loaded. If the amplifier is to be used only on c.w., one extra turn may be used on 10 meters and two extra turns may be used on the 20-meter coil.

The Tubes

The HK-254's, newest addition to the Gammatron line, are rated (each) at 100-watts plate dissipation, 40-ma. maximum grid current, and 200-ma. maximum plate current. The μ is 25, the interelectrode capacities very low, and the tubes require a standard 50-watt socket.

●



A New Receiver

A new Hallicrafters communications receiver has been received at RADIO's laboratory. It is in the medium-low price range and possesses most of the features found on expensive "precision" receivers. A descendant of the familiar "Sky Chief", the new "Sky Champion" is an eight-tube superheterodyne covering the range of 545 kc. to 44 Mc. in four bands. The dial is similar to those used on the more expensive Hallicrafters receivers last year, rather than the b.c.l. airplane-type found on the Sky Chief. Possessing a high degree of bandspread, the receiver tunes very nicely over the amateur bands.

Eight tubes are used as follows: 6K7 r.f. (preselector), 6L7 first detector, 6J5-G h.f. oscillator, 6K7 intermediate frequency amplifier, 6Q7-G second detector and a.v.c., 6J5-G beat oscillator, 6F6-G audio amplifier, and 80 rectifier. The use of a preselector stage and separate beat and h.f. oscillator tubes contributes much toward the excellent operation of the receiver. The use of 455 kc. (free channel) for the in-

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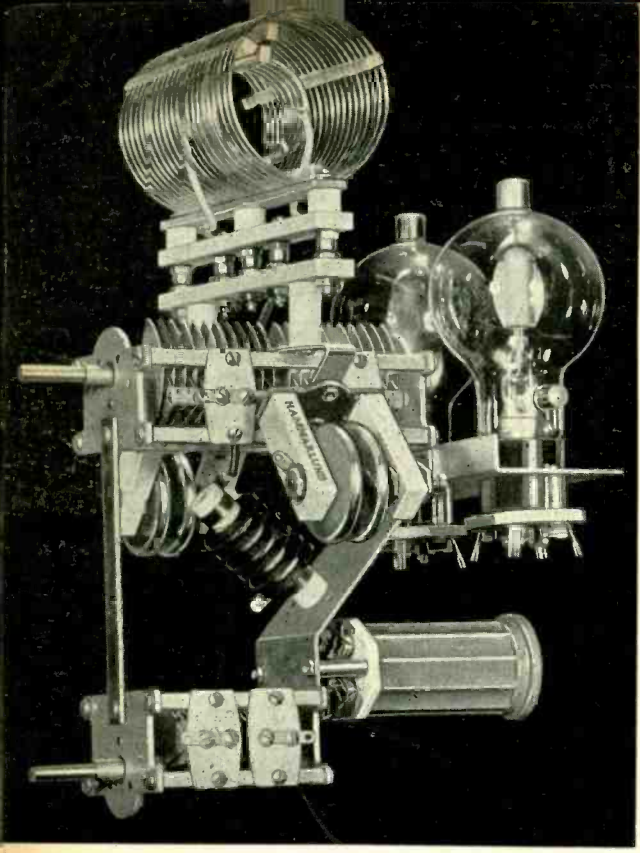

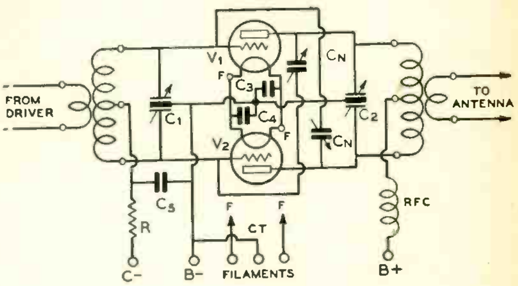

C_1—100 μμfd. per section, 1000-volt spacing
C_2—100 μμfd. per section, 3000-volt spacing
C_3,C_4—.001 μfd. mica
C_5—.001 μfd. (optional). Try with and without
C_N—2-10 μμfd. neutralizing condensers
R—Appropriate gridleak for tubes used
V_1 V_2—See text
RFC—2½ mh., 500-ma. r.f. choke

"UNIT-CONSTRUCTION" *Final Amplifier*

The majority of medium-power amateur rigs being constructed at the present time are using a pair of tubes of the 35T, 808, 54 or T55 class operating as a push-pull amplifier with 150 to 500 watts input. A number of excellent layout arrangements have been shown in past issue of RADIO. But all these involve considerable mechanical construction, and in some cases considerable reassembling is necessary before the various components will fit together in the prescribed manner. Also, they were either breadboard mounted with its attendant disadvantages, or they were panel and sub-chassis mounted with its necessarily large mounting space requirements.

Some sort of unit construction for the entire final stage would be very desirable to those desiring to build a compact and efficient final stage. Such an arrangement, one involving little labor for assembly, is shown in the accompanying photograph and circuit diagram.

The arrangement is very rigid, is compact and self-contained, and features very short interconnecting leads between the various tube elements and the tank and neutralizing circuits. This is conducive to the elimination of parasitics and to high efficiency on the higher frequencies. Also, due to the unusually short neutralizing leads, neutralization is quite easily and completely obtained regardless of frequency.

Much time has been spent in the design and arrangement of this unit. All parts associated with the amplifier proper are joined together with brackets of various shapes. This hardware is available, if desired, in kit form and the only tools necessary for assembling and wiring are a screw-driver and a soldering iron. When finished, it is a self-supporting unit which can be bolted to the panel with the mounting screws furnished with the variable condensers; no chassis is necessary.

Mounted upon the two side bars of the large variable condenser are the two brackets which

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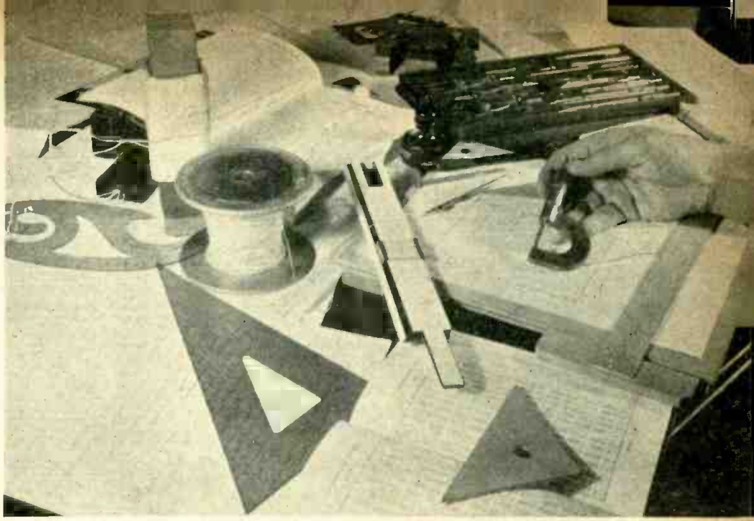


W9HA - W9EHD

DEPARTMENTS

- Dx
- Open Forum
- Postscripts and Announcements
- 56 Megacycles
- Yarn of the Month

DX

HERB. BECKER, W6QD

Readers are invited to send monthly contributions for publication in these columns direct to Mr. Becker, 1117 West 45th Street, Los Angeles, Calif.

I thought the dx contests were over. However, one wouldn't think so the way the mail has been pouring in. Here we are, living the contest all over again . . . it makes me sleepy and tired to think about it. Anyway, I guess both the c.w. and phone portions were a huge success. I believe the phone boys got a little tougher break on conditions than the c.w. gang did during their nine-day stretch. However, the following paragraphs will bring out a surprise or two. Here's the first one.

W2UK Scores Again
176,000 C.W. . . . 68,000 Phone

This fellow Tommy "In-the-bushes" Thomas, W2UK to you, finally found an adding machine that would cover his score. I can imagine poor Tommy after running up 176 grand needing a few weeks to recuperate. W2UK made 329 contacts in 76 different countries and had a multiplier of 179, using the 10-, 20-, 40-, and 80-meter bands. That's what I call going places. There is more to Tommy's success than we probably imagine because only a short time ago he stepped off that well-known plank and now has an x.y.l. Our operative no. 1492 tells us that Tommy's "better half" kept the coffee pot sizzling the last few days of the contest, and supplied him with extra heavy toothpicks to prop his eyes open. A double congratulation to you, Tommy: one for joining the benedicts and the other for that string of points in the contest.

The transmitter at W2UK seemed to be instilled with the spirit of scoring points, so when the phone contest began, Matty Rehm, W2HNY took over the driver's seat and proceeded to run up about 68,000 points. Although not the highest, it was mighty good. Matty made 296 contacts in 54 countries with a multiplier of 78.

W6GRL Repeats in Phone Contest
82,000 points

W6GRL, who has been known as one of the best c.w. dx men in the business, upset all pre-season dope, formulas, or what have you, by entering the phone dx contest. He not only entered it but scored more points than any other west coast station, much to everyone's surprise including his own.

Before going further I should tell you that Doc Stuart turned his station over to Dave Evans for the phone contest, "just to see what he could do on phone". Doc spent his "two-bits worth" in the c.w. contest and had to get busy again yanking molars. Anyway, almost over night a perfectly good c.w. station turns into a first-class phone station. As far as we can determine this is the first time any station on the Pacific coast has been "tops" in both the c.w. and phone contests in the same year. W6GRL made 318 contacts in 56 countries with a multiplier of 87. To refresh your memory GRL scored 140,000 points in the c.w. brawl.

Here are a few other phone scores that have trickled through, although they seem to have a flavor of W6: W9ARA, 80,000; W2UK, 68,000; W3GCR, 50,000; W6ITH, 51,240; W9YGC, 45,-000; VK2GU, 42,000; W6OCH, 37,700; W6CQI, 57,000; W2JMI, 30,000; W6AM, 29,000; W6NNR, 18,000; W6GRX, 17,000; W6GCX, 14,478; W9QI, 12,267; W6QD, 105; W4CYU, 96,000; W3ANH, 56,000; W2DC, 100,000; W3EMM, 98,000.

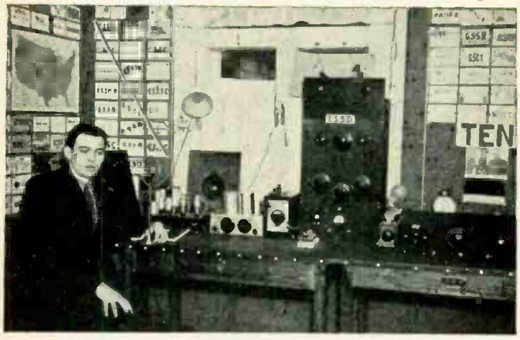
Here are a few more scores from the c.w. marathon: GI6TK, 81,000; G6NF, 91,784; W1ME, 65,670; W2BJ, 40,300; W4ELQ, 44,226. Others who probably have swell scores are W3ANH, W3PC, CO2JJ, W4DSY, W4AH, J2MI, VS6AG, YR5AA, KA1ZL, KA1ME. 10-meter phone brought out such stations as OK1FF, ES5D, I1TKM, SP2LM, FA8IH, VP3NV, TG9AA. More c.w. scores are W3EMM, 156,000; G6WY, 75,000; G6QX, 57,700.

VK2ADE made 104,000 on c.w.—probably the highest score ever made by a VK in any contest.

W9CVL, looking at the whole thing from a Kansan's viewpoint, thinks the phone boys got the best break in conditions, that there were plenty of variable crystals or e.c. units used, and that they should tune up on dummy antennas. Milt also passes along the word that VR6AY (have you ever heard of him?) worked his first G station on March 27th. It was G2TR on 20, of course. W6OCH nabbed 7 new countries out of the phone 'test: YR5AA, VR6AY, K6BAZ, PA0UN, EI6G, GM6RG, VU2LL. All of those are darn good contacts but it just so happens that K6BAZ, who is on Howland Island all right, cannot be considered as a country, at least not yet. For you fellows who have been counting Howland and Baker . . . just take a slant at the Official Country List and you will notice that they are not there. W9QI got himself three new zones out of it, FB8AH, SV1KE, and KA1ME. This makes 28 zones but don't know how many countries.

W6ITH worked K6BAZ, ES7X, and YR5AA on 28 Mc., K6CGK, K7PQ, XE2HN on 1.8 Mc., and K6CGK, K7PQ, XE2FY, K6LKN, K4SA, K7DWH on 3.9 Mc. K7PQ and K6CGK were contacted on four bands. Hal Palin, W9YGC, upped his zones two and now has 29. His best catches in the "mike derby" were VR6AY, J2MI, J2NF, KA1ZL, KA1ME, KA1CS, OZ5BW, SP1DC, ES5D, CN8MU, LA1F, PK3DG, PK2AY, CE1AH and on 28 Mc., VU2CQ. His score, 45,000. It took a lot of warbling to haul in that bunch of points in Indiana.

W1HKK of Boston writes that he hopes the following dx he has worked on phone meets with the approval of a c.w. man . . . hi. It does and here it is: SU2TW, YR5AA, YR5CF, I1IT, VR6AY, ZS3F, ZE1JR, OZ9Q, YI2BA, VK5BF, FA3HC, EA9AH. He wants us to know he actually has a card from YI2BA. His rig is p.p. RK20's with 200 watts input and two beam antennas. Now W8QDU pops up with his new stuff: KA1ZL, ES5D, YR5AA, FA3HC, YN1OP. Zones now 22 and 47 countries for him. W9JOL is using a Vee beam on 28 Mc.



ES5D Estonia
K. Kollemaa, Operator

which is 248 feet long on each leg, fed with Q bars and a 600-ohm line. His transmitter ends up with a pair of T125's running around 500-watts input. During a recent QSO he had with VK5QR, the VK told him he was using only 7.5 watts. His little rig was a 6D6 osc. and a 6L6 final with 190 volts on the plate.

Mutiny on the Bounty

Is there anyone who hasn't heard VR6AY? Is there anyone who wants to work him? Well . . . I was just a wonderin', thasall. You certainly hear all sorts of stories about VR6AY; that he won't answer unless you're in the family, or unless a sked can be cooked up by someone "in on the ground floor" with nightly contacts, etc., etc.

Then, too, there is his side of it. For the first few days he was on the air and was overly anxious to contact his home QTH, every time he would blast out a call for a certain W1— station, well, the whole band would be filled with the gang calling him from every district, both phone and c.w. Imagine the possibility of VR6AY picking out this W1 from that mob. Anyway this went on night after night so I guess he finally got pretty well disgusted.

On the other hand, how was the poor dx man to know the importance and personal "tie-up" of VR6AY's call to the W1 district. It's about even anyway you look at it. Ol' Lou Bellem, W1BES, is usually at the mike or key, and he really did give plenty of the boys a new country, for which they should be grateful. I was glad to see Lou get on c.w. and give that gang a break, too.

Chatter

Now for a little c.w. chatter from here, there, and up yonder. First I might mention that you had better get ready to dig for this news, because there's a lot of it and it's going to be squeezed down. If I didn't it would fill the book and we would have to change the name from Radio to "*Dx*". Boss says 'twould never do.

We are glad to see Lindy, W2BHW, shoot us a line. In the contest he got 103 grand, has worked 38 zones and 122 countries, rig uses a T200 in the final with from 500 to 850 watts input. His receiver is an HRO, antenna is a Yagi with three reflectors and two directors, other antennas include a Vee and a couple of zepps. Lindy did all those points without getting on 80 meters . . . purty good I'd say.

Another new one is W2HVM with his 30 and 74. Says he's been after that 30th zone for a long time. W2GTZ now has 124 countries by getting VR6AY and K6TE. Wilmer Allison, W5VV, says the contest is over and he and the x.y.l. are speaking again. Also that queer ringing sensation has left his ears, and the light meter has stopped whirring.

W6DRE in Arizona was running 100 watts to an 808 but after about 24 hours he QRO'd to an old 852. W6DRE has a house trailer that he runs around in, so whenever he decides to put up new antennas he drives out in the wide open spaces outside of Phoenix, puts up a rhombic, a couple of Vee's and then sets his "shack" right in the middle of it all. Tough part is getting near a power line with any kind of regulation.

Another W9, this time W9PK, is never lonesome. At W9PK he has W9TOK 150 feet way 300 watts, W9PST 3 blocks 500 watts, W9UKU 4 blocks 300 watts, W9UIG 6 blocks 750 watts, W9TKN 4 blocks 400 watts, and W9TRH 6 blocks with 600 watts to say nothing of others just a little farther away. Real sport in a dx contest. Aw heck, why don't ya go back to spark and put 'em all to bed.

W8PCU put up a beam from January Radio, got on the air for 13 hours, 28-Mc. c.w. and worked 41 stations in 22 countries. W8LAC made his w.a.c. on phone by getting VU2CQ on 10 meters, and now has 25 zones and 64 countries. W9PGS has 32 and 77 with these as new for him: FT4AG, HH4AS, VP9L, GM6NX, FY8Q, CT2BO, YN1AA, HI2BA, FM8AD, YT7MT, FB8AB, CN8AV, VP6YB, and CR7AC. W9WCE says he worked nine new countries during March.

Most of us have heard or worked ZB1H in Malta, but few of us have seen a picture of his station. We are presenting also a description of ZB1H.

ES5C Estonia
R. W. Palde, Operator

ZB1H, Malta

ZB1H is owned and operated by E. Montanaro Gauci. Although Mr. Gauci has been interested in radio since the early days of broadcasting, ZB1H wasn't licensed until 1935. The station is operated mostly on 14 Mc. as this band has been found to be the best for dx. The power input is normally 250 watts but can be increased to 400 watts by throwing a switch. The lineup of the rig is as follows: 47 c.c. oscillator, 46 doubler, RK20 second doubler, and two Ediswan ES501 in push-pull for the final amplifier. The second doubler is used as a p.a. when operating on 7 Mc. The antenna is a full wave Windom. Inasmuch as ZB1H is located in a residential district, the erection of antennas becomes quite a problem.

Two power packs are used: one of 450 volts for the exciter, and the other 1500 volts for the 2nd doubler and p.a. Rectifiers are 5Z3 and two 866A's. Two receivers are used, a PR-16 and a home-built job which is invariably used when on c.w. The PR-16 is used when on phone. The modulator consists of four RK31's in p.p. parallel, and the mike is a double-button Phillips. In Malta a separate license is required to work phone and the applicant must have at least one year of experience on c.w. ZB1H was the first station authorized to work phone.

That old timer OK1AW adds another one to his standing and now registers at 33 zones and 90 countries. Alois is building a new rig and when it is finished we hope to be able to show you what it looks like. Bob Everard of SWL fame in England has a total of 1788 verifications of phone reception and over 1600 of these are more than 3000 miles in distance. You will remember in this column a couple of months ago mention was made of VK3UN on his way to England. Well, he arrived OK—in fact he has already made plans to get on the air very shortly. Of course he will need a ticket first. Magee is with the Royal Signal Mess, and who should he bump into but that old time SU1EC who is in the same outfit. Between the two of them they should have a great time. We'll be anxious to learn that G call.

Now back to USA for a minute. W1HSX, who is mostly on 80 meters, says that during the contest he called FM8AD every time he tossed out a CQ for about an hour and then gave it up as a hopeless job. Said everyone else in W called him at the same time and that was probably the trouble. FM8AD undoubtedly thought it was static. Hi.

Here's a sort of an endurance QSO or 'sumpin'. W7BSJ had a QSO with W9AGO on 28 Mc. which started at 11:06 a.m. p.s.t. and finished at 5:09 p.m. Both transmitters were on the entire time although they stood by for chow for about an hour and twenty minutes.

This seems to be about as good a spot for this next splash as anywhere else, so pull up a chair and gather 'round. G6QX, who needs no introduction, writes a few pages on how the whole contest looked to him. We think it is very good and without going into a lengthy build-up, here 'tis—by Bob Jardine, G6QX:

"Impressions of the Tenth DX Contest"

"Well, another dx contest has come and gone, and many amateurs are sitting back nursing tin ears and sprained wrists, having caught up on lost sleep and regained a little brightness of the eye and a little color in the cheek.

ZB1H—E. Montanaro Gauci

Looking back, it was a hectic nine days, and we can now reckon up where we failed to achieve our heart's desire, i. e. to be top for our country.

Prior to the starting gun, we made a list of all the little jobs we thought should be done, such as

1. Calibrate Bi-Push for 9 xtals, 4 bands and type an 8" x 5" record card.
2. Rebuild four 150-watt final amplifiers for 28, 14, 7 and 3.5 Mc.
3. Install three switch boards for quick QSY of the four finals, one for filaments, which were 6v., 6v., 7.5v. and 8 volt, one for the "B" minus, one for "B" plus, isolating each final and making it a separate unit.
4. Install four tuned antenna tanks, one to each final, with a quick release chuck for attaching the antenna wire, each tank sliding in runners out of the plate tank field.
5. Check the two antennas, one 137 feet and fed 46 feet high, one 33 foot Windom 46 feet high.
6. Check the lightning switches and earth system to the power plant for continuity.
7. Check the monitor, and have the "A" and "B" batteries all renewed.
8. Prepare a 15 QSO per page foolscap log book, with the code numbers 733 all ready, enough for 600 QSO's.
9. Check the Comet Pro and Peak preselector.
10. Adjust the straight key.
11. Fix the dial setting chart for finals and antennas right on the eye line.
12. Hang the high voltage gloves on a nice hook on eye level just in case we get sleepy and have another jolt like the last one.

Having done these chores, we are all set. We could change from 3.5 to 28 in less than 2 minutes, we could change from 7022 to 7268 in one and a half, boy! did we fancy our chance!

What staff work—look out G6NF and G6WY, we are on our way.

Zero hour draws near. Yes! we'll go to bed, not much use starting before 0600 Gmt, remember last time, we wasted time at zero hour trying to raise W on 7 Mc.

We set two alarm clocks, one for 0530, one for 0535, and sure enough we are in the shack with a flask of coffee at 0545. We are set for 3.5 Mc., so off we go.

Gee whiz, but 3.5 is slow, NF and WY block the receiver, reduce-volume, ah, here's no. 1. Yes! we click, but oh boy! 3.5 is slow.

Check frequency on receiver. Yes! we thought so, 3634 is QRM—a quick change to 3522. Can't see ourselves averaging 6 an hour, and that's what we have to do, QX old

The station at ZB1H. A complete description is to be found on the opposite page.

man, to be up with the G aces. Work four W1's one zone, boy what a score so far. NF must be 80 by now and Ham Whyte is sure 80 also. Let's get on 7 Mc. Yes! that's better, we are doing six an hour now and 7268 is clear for a solid two hours. Getting slower and F fone boys splashing the band and eliminating dx every second. Don't these guys know it's a c.w. contest? My hat! one guy in Paris talks to another in Paris for half-an hour on end at full speaker strength.

We think of 20 years ago, and wonder why we did not pinch an SE5 fighter with two nice Vickers guns plus a Lewis on the top plane with a full drum of 96 in it. Handy thing to have right now and do a bit of straffing. Yes! old man, but these boys are hams like yourself, and have their own ideas of radio, and who wants to use c.w. anyway but those dx cranks.

No, it's no good, let's breakfast now. So off go the switches, but we are disappointed so far. Not much good going on again until 28 is live. So at 1310, we go on 28, Oh boy! oh boy! what a difference, one after the other, one every two or three minutes, nice solid R8 sigs, tuned nice and sharp on the old Pro, no need to tune over more than 100 kc. on the Pro. We are on 28088 and they are queuing up. Here's three at one time. Sorry OM's but only one at a time.

Well, I guess we are holding our own with NF and WY on this band anyhow. Hullo, here's G6RB coming up, but where's Pete Pennell, 2PL and Johnny Hunter, 2ZQ?

Perhaps it won't be so tough after all, with these two aces resting, because Pete certainly put up a grand show last year, averaging 8.65 QSO's per hour, and so we go on.

The days pass, the rig is sure fb and standing up ok, but 3.5 is still dead slow. Work W6QD on 28 and 14, and we fix a sked for 0700 on 7 Mc. h.f. Sure enough, dead on the dot we hear an unmistakable W6, putting the key down with single dots at 5-second intervals, and in comes Herb dead to sked and 599X. Oh boy! what a sweet signal.

More days pass, we have 13 zones on 28, 13 on 14, want VE3 only, 9 on 7 Mc., no VE's yet, 3 on 3.5, W1,2,3, only, total 38 and our hopes begin to dwindle. Why, NF had 47 zones last year. No, we knock 'em up, 400, 450 QSO's, 475, let's make it 500 QSO's and call it a day. 493 now, and about 45 minutes to go. Ah! here's VE3GT, call him on 14 and by heck, got him, good old GT, could give you a real double strength handshake right now. 39 zones now, about ten minutes to go. Click another W then by the living Harry VE3KC at 2348. What do you know about that, wait nine days for a VE3 on 14 Mc., and click two on the post.

2359 Sunday, March 13th, send a slow "G6QX qrt GN all" and at 2400 or 0000 GMT electrical time, a great stillness comes over the air, and we very reluctantly take off the cans, although our ears are blistered. There has been a peculiar hum in our ears all the week, never have they been subjected to nearly ten hours a day concentrated listening. Without the cans on, everything sounds different. the cat engine seems to have a different note, certain notes from the broadcast receiver start beat peep peeps in our ears, and we feel like we were coming out an anesthetic. We have a deep blister under the hard skin on our keying forefinger despite the fact that we wore two finger shields. We feel very tired, just a little disappointed, why didn't we have ear pads made, the cotton wool we tried gave the signals a different note, and why didn't we give 3.5 a miss early on, build up a nice quota on 7, and leave 3.5 to the last two days. 28 was the berries—this, the band shrouded in mystery by the old hands for years was in every way the most rapid means of communication between two continents 3000 miles apart. Louder and sharper signals, snappier operators, rarely a signal which wasn't 100% readable even with another smack on top of it. There must be a solution to the 56-Mc. dx somewhere, and it will not be on antennas either.

A plain honest-to-goodness 33-ft. level Windom, 46-ft. high cut dead to formula for 28088 smacked the numbers across, and had enough leeway for QSY to 28044 and 28712 without any falling off in S, whilst the Comet Pro roped them in every 2 or 3 minutes switched in to the 137 feet end on.

Boy! did we hear some dx on 28; we heard PY, CM, HH, YV, K5, K6, K7, PK, VK, ZL, ZS, ZU, FB, LU and all but VE5, and we guess VE5 was there just the same.

Since the tests we clicked ZL4AO, R6 both ways for 28-Mc. WAC, WBE, which makes us WAC, WBE on 28, 14 and 7.

14 was not so hot, too many fones butting in, and some of the offenders were G's talking across town at that.

7 was good, nearly as good as 28 if you had a clear frequency, fones a little troublesome, but tuning with the xtal in got over that most of the time.

3.5 was poor, the blanketing of large patches of the band by strong transmitters up to 700 miles distance made dx a bit tough, but we believe we heard Henry Sasaki, W6CXW, once at R5.

We didn't try 1.7 as we had no 10-watt final available and driving a 10-watt final with a 40-watt Bi-push exciter was not conforming to the licensing rules for G anyhow.

Well, on Monday following, 6NF calls us on the landline and "breaks the news to Mother". 92,000 odd points, 700 odd QSO's on 44 zones, with Ham Whyte, 6WY, 75,000 odd points, 44 zones. Boy oh Boy! are these two red hot. NF whispered that he and WY were settling a little private affair. Ham had been chipping Gay that anybody could knock up a high score and Gay took him on, and it speaks well for these two boys that they both clicked 44 zones. Well, maybe we are third for G although 6RB is a good boy and may be in place number 3.

QX finished with 57,000 odd points and a lot of resolutions for next time, one of which has taken shape in the advent of a McElroy bug into the shack. Maybe our code number in the next test will be 555, we haven't quite decided, but there's some darned funny attempts at Morse emanating from the shack on a buzzer these days, dx gang please note.

To all the boys who gave QX points we say "thanks old man", to G6NF and G6WY we say "Well done old timers, you sure set the pace", to G2PL and G2ZQ we say "What about it next year, speed aces!" and to G6RB or any others with more than 57,000 points we say "Congratulations old man, we had hoped we were third for G".

Roll on Dx Contest Number 11, we hope we can get a week off for that too, and in closing, a tribute to all those XYL's

Al Weirauch, OK1AW, and his 56 Mc. portable transceiver. OK1AW is a watchmaker and jeweler by trade.

who bit their lips, and were very patient with haggard looking husbands whose fingers made Morse passes at the eating tools, who crept surreptitiously from bed at unearthly hours, and whose principal topic of conversation had to do with numbers, and points, and zones and call signs, all of which bored them intensely. To them we say 'God bless 'em, every one.' "

A few months ago something was said about W9EUZ working HS1EL on 7 Mc. At the time it sounded a little funny. And now W9EUZ writes that he has heard from HS1BJ saying that there never was a station with that call, and that it would be impossible for one to operate there without them finding it out. So I guess that just about squelches that bird. Might be tough for two or three other W's who worked him to learn the news but it's better to find it out than to keep wondering why you never get a card. W8CRA has his plate transformer rewound and is now back on the air—that is once in awhile. His yl keeps him on the jump, must be love or maybe it's just astronomy.

W8JK informs us that a friend of his, John DeMyer, SWL, is in receipt of a letter from Fanning Island explaining about VQ1AB. Fred Harry who operates the cable station on Fanning Island says that a number of years ago there was someone there signing that call but at the present time there is definitely no one on the island operating a station. They have been receiving many letters to the supposedly legitimate VQ1AB and have had to return them all. Someone, a yl, was evidently having a lot of fun at the expense of the hams. Instead of being on Fanning I imagine the station better located in Texas . . . and I'll bet I'm not far off at that.

W8EUY dug up a couple of new zones and countries and now has 37 and 95 although he only spent seven hours calling VR6AY. W1HTP has changed his location and since moving he can't seem to work anything but VK and ZL. He's been wondering if Australia is in the Atlantic??? Incidentally, W1HTP is the brother of W6KIP 'way out here in L. A. W3TR grabbed off VP7NT and G8MF (Channel Islands) and now has 34 and 90.

Zone List

No changes whatever are made in the Honor Roll this month, so don't be disappointed if your standings are not quite up to date. They were revised last month and will be again in the June issue. Remember, we do not require that you send in cards as proof of the zones but we do ask that you send a list of the zones worked and a station or two you have contacted in these zones. The countries should be counted as per the list in January, 1938, RADIO.

Frequency List

Thinking that the dx men had seen enough dx frequencies in both the dx contests, none were printed last month or this. Next month, however, there should be some new stuff popping through and I will endeavor to corral a list just in case some of you have renewed your interest. I must ask a little help from you. When you send in a few stations worked and they seem like extra good dx, please don't forget to list the frequency of said station also. It isn't necessary to do this on every type of station, but just use your own judgment on what would be worth while to the next guy.

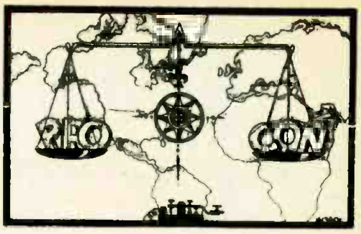
I notice my friend W6CQI, Dick Segerstrom did a fine job in the phone contest. He finally wound up second high out here with 57,000 points multiplier of 82. Dick lives in Sonora, California, which is in the heart of the old gold mining country. You might say his station is located "on a gold mine". W6CQI uses three rhombics and two separate transmitters. By the way, W6CQI and VK2GU are running phone tests every Sunday on 5 meters at 4 p.m. p.st. VK2GU with 500 watts and W6CQI with 1000 watts xtal controlled.

W2HAE used to be on 160 but has got the "bug" and you couldn't hire him to go back. He has a couple of ideas. One is for diathermy machines to go crystal controlled so their QRM will stay in one spot, and the other is a pet peeve on the guy who CQ's so long that he is ashamed to sign his call. Eric Trebilcock, BERS 195, has logged 150 countries and has QSL's from 119 of them. He has still to hear zones 2 and 40 before he is "HAZ". Eric is known to have a stage of r.f. in his ears, as he surely hears 'em. He is wondering why CO2JJ was on c.w.; thought CO was for fone in Cuba. W7AYO thinks he will increase power and chase after a couple of new zones. Stan now has 35 and 81. George Vandekamp, W6GCX, put his 150T on 28 Mc. for the phone contest and ran up 14,500 points, using only that band . . . 127 stations and 38 countries. Karl Duerk, W8ZY, is not a phone any more. He was trying tricks with his phone job and in some way got across his 3000 volts which knocked him cold for five minutes. He's ok now but has converted his phone rig into a 28-Mc. c.w. job.

Don't know what's the matter with W2BJ . . . he runs up 40,000 in the c.w. brawl and now gives his intentions of taking up phone. Ray says that LU7AZ, and CX1CG were tops for SA but he couldn't raise CN8AV. Oh my??? W1ME used four bands and got 65,670 points out of it—199 contacts in 49 countries. He's still using 852's with 500 watts. W4ELQ one of the BirmingHAMS got a big kick out of the dx melle. He started out with 30 zones and ended up with 34 zones and 74 countries, to say nothing of 44,226 points. Norman worked a flock of new ones and he takes it all back about 40 meters being no good. He made 165 contacts with a multiplier of 91. W4ELQ is the first one in town to hook an XU. Other BirmingHAMS who are doing something are W4APU who scored around 30,000

[*Continued on Page 92*]

The . . . OPEN FORUM



Endurance Test

New Westminster, B. C.

Sirs:

Reading the letter in the March issue regarding the 24 hour duplex QSO gives one the impression that we Canadians make a practice of holding endurance contests on the air. Nothing could be further from the truth, as most of us have more respect for the other fellow's rights than to go needlessly jamming up our already over-crowded bands, working duplex for any length of time, and especially when the stations are less than a mile apart.

And as far as this being an endurance test—Humph! Anybody could leave their transmitter running for 24 hours while they go about their regular home chores as they did.

I can't quite see that these chaps have anything to brag about; rather I should think they would be ashamed to let anyone know they carried out such an unsportsmanlike act in creating so much interference.

FRED TAYLOR, VE5HA
President Royal City Amateur Radio Assn.

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Present Examination OK

West Lafayette, Ind.

Sirs:

After seeing many letters similar to that of Mr. Poland's in the January *Forum,* advocating all kinds of special licenses, exemptions, and what not, I think a few things should be said in support of the other side of the question.

If Mr. Poland does not have the necessary time to master the "thirteen per", referred to in his letter as "schoolboy mummery", when is he going to operate that kilowatt phone he contemplates? If he isn't interested enough in amateur radio to bother with learning to handle the code at the slow speed required, he shouldn't have a ticket. And surely Mr. Poland has not thought of the time required to review all of the equations relating to vacuum tube operation, so he will be able to pass the rigorous technical examination he intends to require.

Although I failed the license exam because of the code test, I still think it should be required. If a fellow has to put himself to some extra effort to get into the game, he will have a much greater appreciation for its opportunities, and, of course, those who do not have a real interest in it will be eliminated.

Why tax the hams with a license fee to pay for "proper authoritative supervision"? The hams already have enough supervision.

Of course Mr. Poland will be glad to give us the details of a beam to be erected in an apartment window if he is going to require all phone stations on the high frequency bands to use beams. Or does he consider a horizontal half-wave a beam?

Why not keep things as they are? If the examinations were made any easier, the bands would be crowded worse than they are now. If changed to all-code or to all-technical questions, a particular class would be favored. As it is, we have a balanced examination that gives everyone an equal chance, not too much code nor too much technical knowledge being required.

ALBERT D. M. LEWIS.

•

W4-BT6

Sirs:

Quite a few of the fellows in the east often wonder why the "California Kilowatts" never are able to snag high score in the dx contests. Even those in the east that understand the reason do not fully appreciate the handicap the west coast fellows have chalked up against them.

Having "looked in" on dx contests from both coasts in addition to doing considerable regular operating from both coasts, and knowing the ops very well at many of the high scoring stations on both coasts, I feel competent to shed a little light on the subject of geographical disadvantage as pertains to the annual dx contest.

Before getting along too far and to put things on a more equal basis, it might be a good idea to blast the "California Kilowatt" myth. I am convinced after visiting many of the higher-powered stations both in the east and on the west coast that the large majority of super-powered stations will be

[*Continued on Page 86*]

POSTSCRIPTS...

and Announcements

Conventions—Hamfests

Wichita, Kans.

Kansas members of the American Radio Relay League will hold their state convention on May 7 and 8 in Hotel Lassen, Wichita, Kans., with the Wichita Amateur Radio club as host. C. R. Werner, W9MFH, heads the committee in charge of the affair.

Burlington, Iowa

About 400 amateur radiomen are expected to attend the annual hamfest of the Iowa-Illinois Amateur Radio club, when the meeting takes place on June 12 in Hotel Burlington, Burlington, Iowa. L. B. Vennard, W9PJR, secretary, can furnish details.

Milwaukee, Wis.

Sixteenth annual QSO party of the Milwaukee Radio Amateurs' club will be given on May 14 in the Milwaukee Athletic club. The event always attracts amateurs from about eight different states in the middlewest. The attendance of last year—330 persons—is expected to be equaled and perhaps bettered at the coming affair. Write to W9EFX for details.

Jenny Lake Hamfest

Sixth annual WIMU hamfest will be held August 6, 7 and 8 at Jenny Lake near Moose, Wyo., approximately 50 miles south of West Thumb, Yellowstone National park. Jenny Lake is situated at the foot of the Teton mountains in the Teton National park where there is plenty motor boating, swimming, horseback riding and fishing.

Even though there are cabin facilities, nearly all who attend the meeting come prepared to camp, and a section of the park is set aside each year for the WIMU hamfest.

Any amateur may attend and should feel free to bring his or her family; entertainment is provided for the women and children. Further details may be obtained from Henry D. McCuistion, W7AYG, or Leslie E. Crouter, W7CT.

Fargo, N. D., Hamfest

Fargo, N. D., radio amateurs will be hosts to fellow hams from the neighboring territory at a two-day funfest May 28 to May 30.

The committee in charge is composed of W9EIG, W9LHS, W9RPJ, W9SHI and W9ZVE.

●

"The Why of Harmonics"

Through an error on the part of C. B. Stafford, and an error on our part in not noticing it, the resolution of the harmonics under the heading "Practical Application" in the article "The Why of Harmonics" beginning on page 32 of the April issue of RADIO was incorrectly done. We are indebted to R. A. Kirkman, W2DSY, and W. L. Stahl, W2KGC, for calling this error to our attention.

The resolution of the harmonics by the network shown in figure 5 of this article should be expressed as follows:

$$E_{out} = E_{in} \frac{-j X_c}{R - j X_c} \quad \text{or}$$

$$E_{out} = E_{in} \frac{X_c}{\sqrt{R^2 + X_c^2}}$$

Thus, in figure 5, with 39 volts impressed across the input and with R equal to X_c, the output voltage would be 0.707 times the input voltage or 27.6 volts. The voltage across the resistor would also be 27.6 volts but there would be a difference in phase existing between them; the voltage appearing across the condenser would be lagging approximately 90° *behind* that appearing across the resistor, the exact value being dependent upon the power factor of the condenser.

Then, substituting the decreasing values of the reactance of condenser C in the equations given above to determine the attenuation at the harmonics of the fundamental of 60 cycles, we find that the second harmonic output would be 0.447 times the input and that the third harmonic would be 0.316 times the input. Thus we find that the harmonic attenuation is slightly less than would be supposed from the original article although the ratios are approximately the same. The same calculations could be applied to the 10-μfd. condenser to determine the harmonic output voltages with the larger condenser.

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Cat. No.	Cap. Mfd.		Your Cost
		600 V. D.C.	
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TJ-U 6020	2		2.06
TJ-U 6040	4		2.65
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TJ-U 10010	1		1.76
TJ-U 10020	2		2.35
TJ-U 10040	4		2.94
		1500 V. D.C.	
TJ-U 15010	1		2.06
TJ-U 15020	2		2.94
TJ-U 15040	4		4.12
		2000 V. D.C.	
TJ-U 20010	1		2.65
TJ-U 20020	2		3.23
TJ-U 20040	4		5.29
		3000 V. D.C.	
TJ-U 30010	1		7.06
TJ-U 30020	2		8.82
TJ-U 30040	4		12.94
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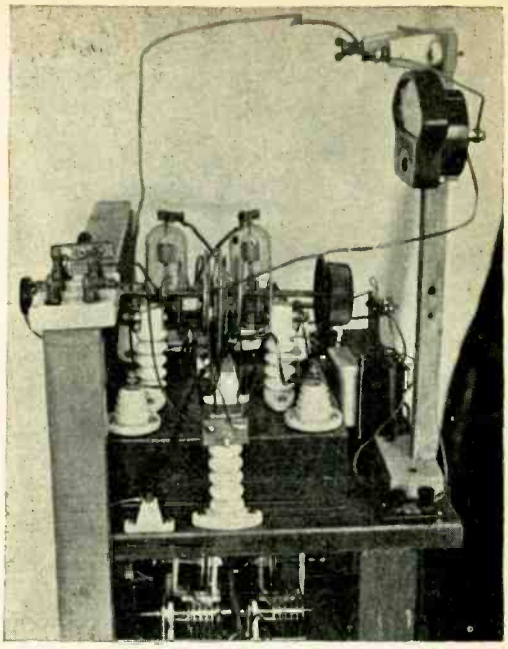
56 MC. . . .

Summer DX is Due

By E. H. CONKLIN*



A view of the final stage of the VK2NO five-meter transmitter responsible for world records. The condensers tuning the output "tank" are made in the form of disks on screw threads.

Now that May is here, sporadic E-layer reflections should bring about quite a lot of five-meter dx at 500 to 1200 miles, just as during the last four summers. Let's get all set with good receivers and antennas to snare a lot of points for the 1938 R.S.G.B. 56-Mc. contest, the rules for which appeared in this column in January.

The International tests that we proposed did not result in any two-way work, as far as we know. Conditions for F_2-layer transmission were not as good after January first as they were during the last few months of 1937 when numerous transatlantic signals were reported. Still, there have been some good cases of transatlantic reception on 56 Mc.

GM6RG Transmission Confirmed

On February 22, GM6RG in Scotland was heard on 28 Mc., telling W2JCY about being heard in the U.S., while using his 500- to 900-watt crystal-controlled rig on 57,016 kilocycles. He writes us as follows:

"The position regarding 56 Mc. with me so far is that I have been able to confirm reports from W2JCY, W2KHR and W1KTF. The first two on fone and W1KTF on c.w. The latter was able to tell me word perfect the call I was making, and which I have cut on a tape, and repeated for ten minutes at a time. I would add that the wording on the tape is changed every week, so I have the means to check every report exactly."

*Assistant Editor, RADIO.

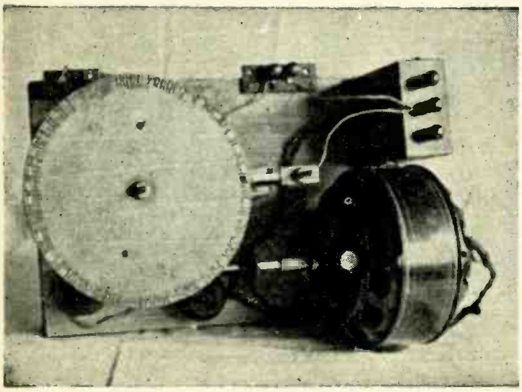
GM6RG also wrote this to G2HG:

"Where W2JCY did come into the picture again recently was to tell me that W1KTF had heard me on 56 Mc., and would like a contact on 28 Mc. I listened for him and made contact OK. W1KTF was able to tell me word perfect what is cut on the tape of the automatic machine I am using for the calling on 56 Mc., and of course also the exact time of the transmission. There is thus no possible doubt that he heard me, as also have W2JCY and W2KHR. I have no information to give of other stations who claim to have heard me, for the reason that they have not offered time and date. I am thus doubtful. Of the three I give, though, there is complete confirmation."

The dates of the above reports were not given.

VK2HL Heard in Wales

Don Knock, VK2NO, received a letter from Cecil Mellanby of North Wales, British Isles, in further regard to five-meter reception. He mentioned having heard VK2HL on phone, this apparently having been in December. Don was interested in our comment about the best location being on top of a hill above sea water or salt marsh. He says that his location is right on the coast on a hill about 380 feet above sea-level, overlooking the wide Pacific from the north to the east and southeast. This kind of a



The automatic telegraphy device in use at VK2NO, for 56-Mc. long-distance test transmissions. It is made up from a fan motor and a double-reduction worm drive. The disc is of three-ply with saw cuts and interleaved copper foil to make up the Morse code characters. It sends "CQ FIVE DX DE VK2NO" at 12 words per minute.

location should be a great help when low-angle radiation is necessary, even if the ocean surface is not tilted! Don sent us a picture of his 35T transmitter and automatic CQ machine. The code disk on the latter is made of three-ply with saw cuts inward from the edge to enable a thin copper strip to be woven in and out to make the code characters. Ingenious, what?

VK2AZ and VK2NO heard an unmodulated carrier R3 to R7 on January 23 at 7:45 a.m., Sydney time, about right for a signal from the U.S. It sounded like a dx signal but it was still unidentified when it passed out.

E. H. Swain, G2HG, has had no luck at all during recent months except on February 13th at 1945 G.m.t., when he heard, "CQ REF de ??EV," on a weak and fading signal, possibly a harmonic of a French station such as F8EV.

42 Mc. Passing Out

Clyde Criswell in Phoenix, Arizona, heard mobile W1XOU on 39,700 kc., driving near Bloomfield, Conn., on March 8. He believed the 2200-mile reception to be a record for mobile operation at seven meters. However, police cars across the country have been heard in the past, and ZS2A in South Africa heard one of the eastern cars. Criswell says that March 11 and 12 were good above 40 Mc., when W2XHG and Alexandra Palace, London, were heard. He reports no reception above 40 Mc., on March 3, 4, 5, 9, 14, 15, 16 and 17. Of course, summer conditions may put a stop to 40-Mc. reception beyond 1200 miles or so.

More Activity in Australia

A move is on foot in Australia to start a live-wire 56-Mc. dx group, to include VK2MQ, VK2EM, VK2NO, and all others who will co-operate by "taking the pledge" for consistent five-meter work, dx or otherwise. During the coming Australian winter, long F_2-layer dx in the east-west direction across their continent and to Africa and South America should be favored. VK2NO thought that our idea of watching for 300-400 mile 28-Mc. signals, to indicate when 800-1200 mile summer sporadic E-layer five-meter work is possible, isn't much help to him. The southern coastline is about 500 miles away and the only other direction would be somewhere in North Queensland or in the heart of Australia where there are very few amateur radio stations. You might try New Zealand again next summer, Don, but a 28-Mc. signal half way between, as a dx indicator, would be difficult to obtain there too!

W4DRZ Looking For DX

In March we called on the "one man Chamber of Commerce," Bud Haskins, W4DRZ, in Fort Lauderdale, Florida. He is going ahead with the construction of a concentric-line tuned converter using acorn tubes, and promises to look for 56-Mc. dx this spring and summer. He is ideally situated for hearing the sporadic E-layer type of dx from the well-populated areas of New England over to Chicago, and on down to Dallas. He plans at first to double in his T-155 28-Mc. final.

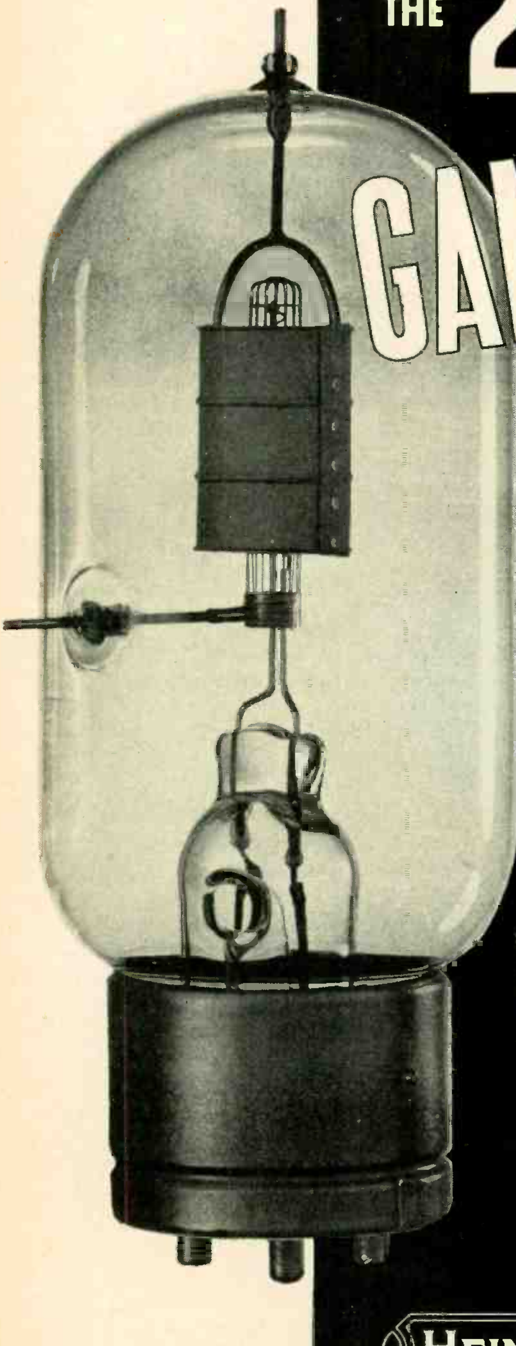
We also saw W4EDD in Coral Gables, who is still looking for the perfect 56-Mc. receiver. He has decided definitely on a horizontal Yagi array, using a reflector and several directors, all spaced one-quarter wavelength and properly tuned. Robbie plans to organize a bunch of the boys to take turns listening for five-meter dx.

In Lakeland, W4TZ, who was one of the 28-Mc. pioneers, told us that there are a number of active 56-Mc. stations on the Florida west coast including W4AKA, W4BRY, W4AJX, Marion Gulick of the Tampa Police, and Julian Betts of WDAE in Tampa. W5EHM reported working W4AKA on "five" last summer, so we look for some real activity in Florida

[Continued on Page 78]

THE **254** A NEW MEDIUM PRICE TRIODE

GAMMATRON



100 Watt Plate
MU = 25
Tantalum Grid and plate
NONEX envelope
No "Getter"
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MAX. plate volts = 3000

A NEW TUBE VALUE
$12 50
AT YOUR DEALER

HEINTZ AND KAUFMAN LTD

SOUTH SAN FRANCISCO CALIFORNIA U. S. A.

YARN *of the* MONTH

"YEARN OF THE WEAK"

June 1, 1937.

Dear Bill:

I started out on a new job this morning. The chief engineer and a lot of important-looking men came into the station and said that they wanted to talk to me for a few minutes. I turned the station over to one of the relief operators, who was about to come on duty anyhow, and went out into the office with them. After a round of introductions and small talk, they said they were planning on moving the station. Yes, sir, they're going to put the little signal pusher out into the country. They threw around a lot of terms like Sommerfeld's Integral, ground conductivity, etc., and everybody looked wise, including yours truly, but I don't think any of them knew what they were talking about.

After more baloney, they finally got down to business and said they wanted me to build a little five-watt transmitter to use for testing out the new location. Apparently nobody knows what I'll have to use, so they said to write to the Commission. Among other things, they want me to fix up a trailer upon which to use the field strength set. That f.s. meter gets the jitters every time a fly lights on it, so you can imagine the fun we are going to have when we start bouncing it around on a one-wheeled trailer.

Well, Bill, I must stop to keep a schedule. I'll write more later.

73, Cy.

•

June 5, 1937.

Dear Bill:

Oh, me! What fun. The F.C.C. wanted blueprints on the proposed test transmitter and nobody even knew what we were going to use in it. After much argument, I finally just copied a circuit out of the handbook, estimated power capabilities and other things, and gave it to the boss. He then wanted to know what it would cost to build. I gingerly estimated it at $150 and held my breath. His eyebrows raised up to where his hair used to be before he worried it away on radio problems, and I knew I had overdrawn. You can guess the rest of the story. By rebuilding an old antenna test oscillator we have here, using parts out of the station, swiping a few from my transmitter, and putting a fan on the entire works to keep it from melting down, I'll be able to build the test rig for about twenty rocks. I have yet to figure out how to put up a 100-foot vertical radiator for ten bucks, but I guess I can do it. Maybe I'll tie a wire onto a carrier pigeon, or hang it from a sky hook. I'll probably end up by using some nearby farmer's barbed-wire fence.

That problem is simple compared to the trailer business. I can get everything from garbage carts to house trailers, but they all have one thing wrong—the price. One man manufactures trailers and I spent two hours learning the intricacies of operation of his spring-contained, built-in shock absorber. Another dealer says that unless I use a trailer with his style of hitch (the gadget they tie the things onto your car with) that my car's rear end will waddle like an overgrown duck! Also, if you don't use super left-handed, double-twisted, ingrown fiber tires, you're liable to have your tires go bad every 356 miles. I asked him for the limits of accuracy on the 356, but he didn't seem to know what I was talking about. After hearing all of the warnings that each dealer made to boost his product, I'm beginning to think that no trailer is a safe investment.

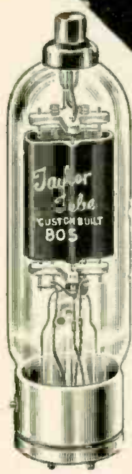
We finally settled on a little steel job with a canvas cover. It looks like a covered wagon made out of a sardine tin. I have three inches of head-room when I sit on the floor. (Did I tell you! The boss is going to let me ride in

***By* Cy Stafford, W9KWP**

MORE WATTS PER DOLLAR

in *Audio-* FREQUENCY TUBES

as well as in R.F.



New 805 Zero Bias
up to
450 WATTS
Class B Audio Output
$13.50
CLASS B AUDIO OPERATION
(value for 2 tubes)

MAX. RATINGS

D.C. Plate Volts	1750
Bias	-22½
Peak AF Grid to Grid Voltage	250
Zero Sig. D.C. Plate Cur. MA	60
Max. Sig. D.C. Plate Cur. MA	390
Plate to Plate, Ohms	10,000
Driving Power, Watts	8.0
Power Output, Watts	450

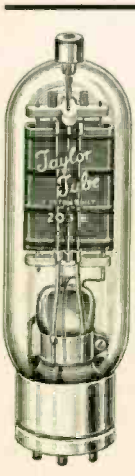
The 805 operates at zero bias at lower plate voltages. The 805 is also a fine RF Tube. ..Insist on Taylor 805's. EXCLUSIVE FEATURES—Processed Carbon Anodes—Floating Anode. Complete technical bulletin free for the asking.

TZ-40 Zero Bias
up to
175 WATTS
Class B Audio Output
$3.50
CLASS B AUDIO OPERATION
(value for 2 tubes)

MAX. RATINGS

D.C. Plate Voltage	1000
Bias	0
Peak AF Grid to Grid Volts	200
Zero Sig. D.C. Plate Cur. MA	44
Max. Sig. Plate Cur. MA	280
Plate to Plate Load, Ohms	6900
Av. Driving Power, Watts	3
Power Output, Watts	175

The leading transformer manufacturers recognized the unusual value of this WONDER TUBE and are announcing special Class B Output units to match. Thordarson T-14-M-49 and Stancor A 3829 transformers are already in your distributors stock. General, Utah, Kenyon, UTC, Inca and others will announce their units soon. Listen on the Ham Bands for real testimonials.



203Z Zero Bias
up to
300 WATTS
Class B Audio Output
$8.00
CLASS B AUDIO OPERATION
(value for 2 tubes)

MAX. RATINGS

D.C. Plate Voltage	1250
Bias	0
Peak AF Grid to Grid Voltage	220
Zero Sig. D.C. Plate Cur. MA	90
Max. Sig. Plate Cur. MA	350
Plate to Plate Load, Ohms	7900
Average Driving Power, Watts	8
Power Output, Watts	300

822
up to
700 WATTS
Class B Audio Output
$18.50
CLASS B AUDIO OPERATION
(value for 2 tubes)

MAX. RATINGS

Plate Volts	2000
Bias	-67
Peak AF Grid to Grid Volts	345
Zero Sig. Plate Cur. MA	60
Max. Sig. Plate Cur. MA	545
Plate to Plate, Ohms	8000
Driving Power, Watts	12
Power Output, Watts	700

"More Watts Per Dollar"

TAYLOR TUBES, INC., 2341 WABANSIA AVE., CHICAGO, ILLINOIS

the trailer continuously and take readings, while he drives over country roads at 80 miles per!) The dealer says that it rides remarkably well, the wheel rarely bouncing more than a *foot or two* off of the pavement.

I'm not going to tempt you with any more of the details, as you might give up your grocery business and get into field strength measurements.

As ever, Cy.

•

June 6, 1937.

Bill OM:

Today is Sunday, day of rest. I should say it is the day when I do the rest of the things I couldn't do during the past week. I had just finished making drawings on all of the special fittings I would need for the trailer's spring suspension of the f.s. set when the boss came in. I didn't like the look in his eye, but I didn't shoot. He looked positively wild. Without going into all of the details involved in the production of a blue haze of profanity around the room, I'll just mention the result. Someone over the boss' head has decided to junk the test transmitter idea and to run the trailer suggestion into the nearest river. Instead of this, we are first going to run a series of tests on the existing station to determine the present coverage area more accurately.

The boss says we are going to start out tomorrow morning, so I had better knock off and hit the hay. After we take a pile of readings, I have to locate them on a map and jot down the field strength at these points in millivolts per meter. This should be fairly simple with the road maps they give out at service stations.

73,

Cy.

P.S.—Just heard the wx forecast for tomorrow—RAIN!

•

June 7, 1937.

Bill:

I know I wrote to you yesterday, but I'm so mad I must blow off to someone. As usual, the weather man was wrong. He said it was going to rain, but he didn't mention anything about being practically flooded. No kidding, it was one cloudburst after another for the better part of the day. And what a wind! The boss opened the car door to get out, and enough rain blew into the car in those few seconds to form an inch deep puddle on the floor. These new cars have a water-proof bottom to keep water from splashing into them from below, but the darned things ought to have drain holes in them too. We carried a sloshing puddle of cold water around, off and on for most of the afternoon.

The field-strength set seems to be ok. We took about ten readings today, and nothing went wrong with the equipment. Of course, we tried to keep the loop contacts dry with little success, but it didn't seem to impair the set's operation any. The loop is detachable from the set and sits on sliding contacts.

But the hardest job was trying to navigate, and I mean that word in its full watery significance. The boss says that reënforcing in concrete, wire fences, power lines, and telephone lines makes any reading taken in their vicinity somewhat questionable. So we had to find places where there were none of these.

I thought I was lost in the wilds of Illinois, but I realize now that there isn't a spot in the state without some of the aforementioned obstacles. We drove off the state road at one point to get rid of the reënforcing, two fences, a high-tension line, and a telephone cable. After about a mile of gravel road, the rural telephone line stopped, leaving us with just two fences to contend with. A mile further, one of the fences dropped out, but we began to get into a heavily wooded section. We turned to the right onto a dirt road and got away from the woods, but picked up another fence. A quarter of a mile farther, we made a series of turns onto various dirt roads and we were able to eliminate all of the fences and telephone lines, but we were in a hollow. So we drove to the top of the next hill in high spirits. Just over the brow of the hill was a high-tension line, two fences, a railroad, a steel-frame building, and a bunch of telegraph lines.

Well, it was that way all day, plus rain. We had water-logged sandwiches for lunch, got mired down four times, and every time we moved water oozed out of our clothes and our shoes just went "squish, squish."

A few minutes before sundown we stopped taking readings to avoid night effect. Just as we took the last reading, the rain stopped, the wind died, and the sun came out in a last blaze of glory. It was almost impossible after we got home to locate some of the readings on the map. I don't know much about the station's field strength, but I know that mine is miserably low just now.

With a "code in my nodes,"

73,

Cy.

•

June 10, 1938.

Dear Bill:

Do I have fun? No doubt you haven't yet recovered from my last display of field strength. You hams don't know how lucky you are. When you want to move the station, you fill in a couple of pages for the F.C.C. and that is that. If you want to change power, you don't even have to fill in anything but the hole in your pocket-book. But b.c. radio is surely different.

I sat down this morning to plot the readings which we took on Saturday. By the time I got them all plotted, the map looked like an ink-footed hen had run across it. After this, I calculated the field strengths at these points and found that all of the readings had been taken too close to the station. We were looking for the 1 millivolt and the ½ millivolt contours, and we found only the 5! Apparently we shall have to calculate the f.s. after each reading so that we may know where to take the next one. I can see myself reading a slide-rule at 80 miles per hour.

I've been plotting and calculating all day, and I think it about time to get a little sleep. It looks like a long hard grind ahead.

73,

Cy.

•

June 28, 1937

Bill Ol' Top:

I haven't been home long enough to write to you for what seems like years. I'm therefore full of all sorts of things. We've been making f.s. measurements all over the state for the past two weeks. Woe is me. I'll just name the happy little incidents in the order in which they occurred.

We went twenty miles out the first morning and were sitting in a field waiting for the station to come on the air when we realized that we had forgotten the earphones. You can get along without them until you get some distance from the station, and then its field strength isn't sufficiently strong to allow you to keep it accurately tuned in with the output meter. This occurred at Hoopleburg, and we tried to find earphones there. One service man said that he had never seen a pair! Another said that he sent his to his ham nephew in Chicago and seemed surprised when he heard that I wasn't a personal friend of this young man. The third serviceman we visited, who runs an undertaking establishment, yielded the very vital information that there was a ham in town. This ham works in a canning factory, which was closed. The factory manager gave us the ham's address, and we went out to his house. He wasn't home, so we adjourned for lunch. We found him after lunch and he loaned us his featherweights. We left the boss' $100 camera for security. When we brought the cans back that night, the ham had a list of questions which would reach from here to there, so we spent most of the evening explaining why antennas didn't radiate, etc.

After the second trip, it was apparent that the sliding contacts on the loop would have to be rebuilt. The instrument cost $945.07. The 7 cents must be the cost of the loop contacts, although I doubt if they are worth that much. I replaced them with solid brass slugs, held in place with massive steel springs. We shall have no more trouble from contact resistance variation.

The next day, we took the set out for more readings. It went dead on the second one, so I took it out of its case and started trouble-shooting. All of the screws were loose as they weren't equipped with lock-washers. Replacing a few cable leads and tightening things up fixed the set. About an hour later, the battery cable broke. More corn-field repairs followed. Then the set got as noisy as your receiver would if you tied the antenna to an arc light. Everything inside the set is double-shielded, and the shields rub together with intermittent contact. Some adhesive tape insulated the two chief offenders and we went on our way. An hour later, she died again. A tube had jarred out of its socket. After that we gave up and came back home.

I spent most of the night servicing the darned f.s. meter, and we started out again the following morning. We headed for a wild, isolated section over on the state line. Just as we got there, the car radiator boiled dry. The air temperature was about 106, and we had to walk about two miles to get water. After we got moving again, the loop broke. It is made in two pieces, joined together by a spring arrangement. We borrowed some bailing twine from a farmer and asked him where we were. He wouldn't commit himself as his farm was half in one state and half in the other. He had been having trouble with taxes, and wasn't sure from what state we hailed. After nearly backing off a cliff into the river, we again went to work.

The next day found us in the northern part of the state. When we plotted the readings, we found that the signal strength increased past a certain point as we drove away from the station!

The northwest portion was really the most fun. As usual, we got lost. Then we mired down in sand. The battery later tipped over, spilling all of the electrolyte. When we finished the day's readings, we went into a nearby town for supper. Somebody let the air out of one of our tires while we were eating.

We finished the northwest portion the next day. Everything went well until the last reading was taken. We were tearing down a steep hill at about 70 (a Model A will do that when it is on a downhill stretch and headed for the barn). Just as we got to the bottom, the right rear tire blew. The boss stepped on the brake, and the pedal went right down to the floor with no resistance, as the pin had fallen out! We came to a stop at the top of the hill and got out of the car. When the boss stepped out, he stepped near a stake with a nail sticking out of the side. Said nail caught his new pants and ripped them up to the knee. Then I put the jack under the rear axle. Just as I got the wheel off the ground, the jack collapsed. It was just as well, though, as we remembered that we didn't have the spare tire with us, having taken it off to facilitate moving the f.s. set in and out of the back end of the car. I went to a nearby house and discovered the nearest phone to be three miles down the road. We got home about midnight.

Taking the readings was easy compared to finding where they had been taken and plotting them on the map. After a week's work, I completed this on a service-station road map. Then I started to transfer them to a big state map which didn't show the roads. Imagine my surprise to find that the road map was not a scale map!

I suppose by now you have a clear idea of the fun involved in a field strength survey. So I shall trundle off to bed. I start back to work at the station tomorrow, and I hope I never see anything more of field strength surveys.

73,

Cy.

•

July 4, 1937

Dear Bill:

Fireworks aren't half the noise around this house. I've been raving for hours. The boss got back from the hearings this morning and called me up as soon as he got in town. He said that the F.C.C. wanted a survey showing our interference area with a station on an adjacent channel and wanted us to check most of our previous readings. The boss said that in view of my previous experience, he was going to let me do the job alone!

Oh, oh—the doorbell. Sounds like the boss. I'll write more later.

73,

Cy.

•

Telegram received by Bill the following day:

HAVE PURCHASED MY OLD FARM STOP ARRIVE SUNDAY STOP
SIG CY

After the "SK"

[*Continued from Page 20*]

---

cards have been received in a single delivery. The largest percentage of cards is still sent by parcel post from A.R.R.L. headquarters but many countries, especially Germany, England, Russia, and Austria send cards direct in large quantities.

At one time s.w.l. cards constituted about one-half the receipts but they have fallen off sharply and now represent only about 10% of the total. Phone stations garner one out of every four cards.

How the Bureau managers contrive to sort this avalanche of cards, earn a living, and pound brass in a respectable fashion is a mystery, but without exception they are well up in the ranks of dx men. Frank Pratt of the seventh district has a long-suffering x.y.l. who acts as "Bureau-Secretary" and he admits that without her the job would be a nightmare. W2SN spent 1586 hours in the shack during 1937 sorting and mailing cards.

There are postage dues—often as high as twenty cents on a single envelope. Sealed envelopes arrive with no return address and a one-cent stamp as a starter. Ten-cent duty stamps are common on mail from one particular country although postal officials cannot explain the reason. The incoming envelopes must be dated and mailed in rotation. It's a full time job and one that pays in a rather indefineable satisfaction.

With only one minor exception, not a card has been destroyed because of non-delivery, no matter how old. It smacks of sacrilege to destroy them (and why not!). They're all there waiting for a stamped envelope and the chances are better than good that if you've been on the air during the last five years there's a foreign QSL—or more—waiting for you at your district Bureau.

A Diversity Receiver

[*Continued from Page 28*]

action, both r.f. circuits lined up to signal frequency, we will note a marked increase in output.

As we have indicated before, use of the three dial controls will not involve difficulties in tuning, particularly if the r.f. bandspread is limited and service coverage is confined to the 14- or 28-Mc. bands or the phone portions of those bands. At least that is our experience. Nor will it be difficult to bring both channels into precise alignment on a desired signal.

56 Megacycles

[*Continued from Page 70*]

this year, and hope that the boys will knock off the dx like W5EHM did in 1937.

W8CVQ in Kalamazoo, Michigan, received a telegram from W9CLH in Elgin, Illinois, in February asking for a signal on which to test some receivers. The signal strength was low on that day so that the whole story of the tests was not mentioned to us but we think that George Lang was testing out a new converter against his old receiver. With WGN about to move to a new location where a tall vertical radiator is being installed, George may not find time to put W9CLH's signals all over the east coast as he did last summer.

W8CVQ has been reported frequently by W8NKJ in Detroit, and is looking forward to numerous contacts over that distance when the band isn't open for "real dx."

Modulation-Transformer Design

[*Continued from Page 41*]

permit the use of the recommended wire sizes as well as sufficient insulation for 4000 volts, one may very well base calculations on 500 CM per ampere in determining wire sizes. In the proposed 100-watt transformer, computations disclose that there will be just sufficient window space for the use of nos. 25 and 26 wire with enamel insulation. Equation (5) above may be used to calculate the airgap needed for $\mu_a = 400$ assuming $\mu_{ac} = 5500$. It is found that $l_2 = 0.0023 \times 30 = 0.069$ cm. or 0.027 inches. Thus each gap in figure 8 should be 0.0135 inches.

Problem number two for the 250-watt transformer should prove of interest since each of the three variables (A, L and N) is to be computed, rather than assuming one of them to be known. From figure 9 we allow E to be 1750 and I to be 0.25. The audio current in the secondary will then be $250/1750 = 0.143$ amperes. Therefore, the total current handled by the secondary wire will be $0.25 + 0.143 = 0.393$ amperes necessitating the choice (at 1000 CM per ampere) of number 24 wire for the secondary and one size larger, number 23, for the primary. Figuring on plain enamel for insulation, the diameters of these two wire sizes will be, secondary $d_1 = 0.054$ cm., primary $d_2 = 0.060$ cm. Substituting these values

$$E = 1750$$
$$I = 0.25$$
$$d_1 = 0.054$$
$$d_2 = 0.060$$

in equation (16) we obtain:

$$A^3 + 63.7A^2 + 1014.6A - 146550 = 0.$$

$A = 33.9$ sq. cm. (5.25 sq. inches) is a solution of this equation. Then, from equations (12) and (15) we find $L = 45.17$ cm. (17.8 inches) and $N = 2530$ turns. The total number of turns of wire on the primary will be $N/1.2 = 2108$ turns.

A slight advantage in window area can be gained by stacking the core laminae somewhat thicker than their width. By having the core laminae two inches wide and stacking them two and five-eighths inches deep we acquire the necessary 5.25 sq. inches of cross-section. To meet the requirement of $L = 17.8$ inches the core may have the dimensions shown in figure 10. If two air-gaps are to be used as shown, each will be one-half the amount calculated from equation (5), above. Thus the proper air-gap length would be $l_2 = 0.0023 \times 17.8 = 0.041$ in. Each gap is therefore 0.0205 inches and may be filled with paper, mica, etc.

In any transformer the most flexible design

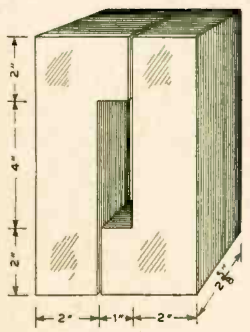


FIGURE 10

sistance and r.f. load impedance. Suppose, for example, one had a modulator using tubes operated so as to require a plate-to-plate load impedance of 6700 ohms and the plates were connected to terminals 8 and 11, B+ being connected to 9 and 10. (See portion of left-hand column in figure 12 labeled 8-9-10-11.) If r.f. load terminals 9 and 10 were connected together with the class-C plate current flowing from terminals 7 to 11, the proper r.f. load would be 0.9 × 6700 ohms or approximately 6000 ohms. The second column in figure 12 shows the maximum recommended plate to plate resistance that should be used for the various input connections. Obviously one may use just so much audio voltage on a given number of turns for a certain low-frequency response although over a range of perhaps two to one the loss in speech intelligibility is slight. It is better, in case of doubt, to use impedances lower than those recommended for any particular connection for best results. While the table in figure 12 shows 48 fundamental impedance terminations, there are almost an infinite number of terminations available by permitting various input impedances to exist. Figure 13 gives tabulations correct to one per cent or better on a few of the more

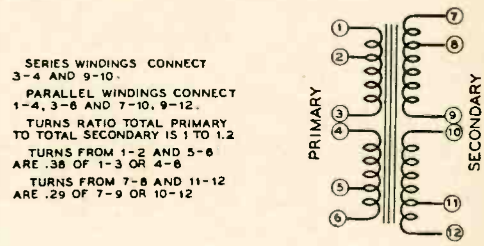


FIGURE 11

dictates a unit having split primaries and secondaries, each half being tapped off center so as to provide the largest possible number of impedance matches. The windings must be balanced electrically with respect to each other and to the core so that two "pies" are required, each containing half the total primary and half the total secondary. These "pies" are placed side by side if on a shell-type core or on opposite legs of a core-type core. Figure 11 illustrates a design worked out after many hours of "cut and try" to determine the best possible ratio of turns. The turns ratio between total primary and total secondary is step-up 1 to 1.2, while the half-primary and half-secondary taps are taken out .38 and .29 of the half-primary and half-secondary turns, respectively. This will be clear by referring to figure 11. Care must be taken in the direction of winding so that terminals 3 and 4 may be connected together as the center-tap for the total primary and terminals 9 and 10 connected together as the center-tap for the total secondary.

The chart in figure 12 will hold for all transformers whose winding ratios are made according to figure 11 and shows under the various r.f. load connections the impedance ratios between modulator tube plate to plate load re-

Connect Mod. to P-B-B-P	Max. P-P Load (Ohms)									
		Connect	7-11 8-12	8-11	8-10 9-11	7-10 9-12	9-11	9-10	9-10	9-10
		Load to	7-8	7-12	8-9	7-9	7-12	8-11	7-11	7-12
1-2-5-6	1500		.21	.84	1.25	2.5	4.15	5.0	7.3	10.0
2-3-4-5	3000		.079	.315	.47	.94	1.56	1.89	2.74	3.75
1-3-4-6	12500		.03	.12	.18	.36	.59	.726	1.05	1.44
		Connect	1-5 2-6	2-4 3-5	2-5	1-4 3-6	3-4	3-5	3-4	3-4
P-B-B-P		Load to	1-2	2-3	1-6	1-3	2-5	1-6	1-5	1-6
7-8-11-12	1250		.3	.8	1.2	2.06	3.2	3.93	5.42	8.26
8-9-10-11	7500		.05	.132	.2	.344	.53	.656	.90	1.38
7-9-10-12	20000		.025	.067	.1	.174	.267	.33	.456	.694

Figure 12. Load Impedance Matching Chart: Impedance Ratio.

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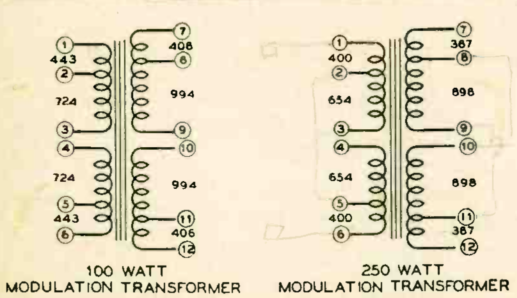
Connect Mod. to P-B-B-P	P-P Mod. Ohms	Connect 7-11 8-12	8-11	8-10 9-11	7-10 9-12	9-11	9-10	9-10	9-10
		Load to 7-8	7-12	8-9	7-9	7-12	8-11	7-11	7-12
1-2-5-6	2000	420	1680	2500	5000	8300	10000	14600	20000
"	3000	630	2520	3750	7500	12450	15000	21900	30000
"	3800	800	3190	4750	9500	15750	19000	27700	38000
2-3-4-5	3000	237	945	1410	2820	4680	5670	8220	11250
"	3800	300	1200	1785	3570	5925	7200	10400	14250
"	5000	395	1575	2350	4700	7800	9450	13700	18750
1-3-4-6	5000	150	600	900	1800	2950	3630	5250	7200
"	6000	180	720	1080	2160	3540	4360	6300	8640
"	6700	200	800	1200	2400	3950	4870	7030	9650
"	8000	240	960	1440	2880	4720	5800	8400	11520
"	10000	300	1200	1800	3600	5900	7260	10500	14400
"	12500	375	1500	2250	4500	7375	9075	13100	18000
		Connect 1-5 2-6	2-4 3-5	2-5	1-4 3-6	3-4	3-5	3-4	3-4
		Load to 1-2	2-3	1-6	1-3	2-5	1-6	1-5	1-6
7-8-11-12	1000	300	800	1200	2060	3200	3930	5420	8260
"	1500	450	1200	1800	3090	4800	5900	8120	12400
"	2000	600	1600	2400	4120	6400	7860	10840	16520
8-9-10-11	3800	190	500	760	1310	2020	2500	3420	5250
"	5000	250	660	1000	1720	2650	3280	4500	6900
"	6700	385	885	1340	2310	3550	4400	6030	9250
"	8000	400	1050	1600	2750	4240	5250	7200	11040
"	10000	500	1320	2000	3440	5300	6560	9000	13800
7-9-10-12	6700	168	450	670	1165	1790	2210	3050	4650
"	8000	200	535	800	1392	2135	2640	3650	5550
"	10000	250	670	1000	1740	2670	3300	4560	6940
"	12500	362	825	1250	2175	3340	4125	5700	8675
"	15000	375	1000	1500	2610	4000	4950	6850	10400
"	17500	438	1170	1750	3040	4670	5770	7970	12150
"	20000	500	1340	2000	3480	5340	6600	9120	13880

Figure 13. R.F. Load Terminations: Actual Impedance Values.

common impedances terminated to various r.f. loads, all of which (and more) are possible with a transformer tapped according to figure 11.

For our 100-watt transformer having 2800 turns on the secondary and 2334 turns on the primary, each half of the primary will be 1167 turns tapped at $0.38 \times 1167 = 443$ turns from the outside or $1167 - 443 = 724$ turns from the center and each half of the secondary will have 1400 turns tapped at $0.29 \times 1400 = 406$ turns from the outside or $1400 - 406 = 994$ turns from the center. This is shown in figure 14. The winding taps for the 250-watt unit are taken out similarly and are shown in figure 15.



NUMBERS BETWEEN TAPS INDICATE TURNS OF WIRE

FIGURES 14 and 15

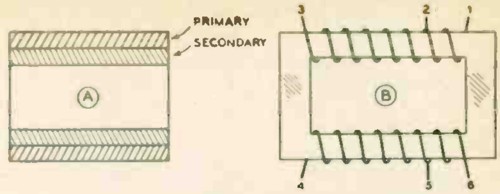
There are advantages to having both primary and secondary windings of the same resistance, and this can be accomplished by winding the secondary next to the core with the primary over it, as shown at A in figure 16. With a shell-type core it is necessary to wind the coils on a form into which are slipped the core laminae, while with the core-type it is usually possible to wind the coils directly upon the core which has been tightly taped. The latter method tends to minimize "back talk" although by careful clamping and wedging the shell-type may be made fairly quiet. In severe cases mounting in oil becomes necessary. Figure 16B also shows clearly the method of winding so as to insure proper coil continuity in the finished transformer.

A representative group of modulation transformers have been designed based on two separate low-frequency responses, one group based on 70 cycles, the other on 100 cycles and the design data presented in figures 17 and 18, respectively. In most cases, the amateur experimenter will find figure 18 good enough for the transmission of speech, and the better fidelity gained through the use of figure 17 seems hardly worth the extra expense. The data based on 70 cycles were included, though, for those who might care for it.

To clarify the question that usually arises as to the amount of class-C plate current that can be allowed in the secondary under various conditions, simply remember that it is the number of "ampere-turns" that is effective in causing core saturation and, therefore, if the secondaries are used in parallel the amount of plate current will be twice that used with them in series. Similarly, for any number of turns of wire used on the secondary, the product of the number of turns and the proposed class-C plate current should not exceed the total secondary turns times the value of current used in computing the transformer design (N I).

Insulation

Many excellent treatises are available on the actual process of transformer winding, so that it is unnecessary to dwell upon that phase of the subject here. Insulation of a class-B transformer should be regarded above everything else, for of what use is a nicely constructed unit that has blown through to the core or to the other winding? Empire cloth is excellent for insulation and has a break-down test of about 600 volts per mil. An allowance of 100 volts per mil is a reasonable factor in design. Actual tapping of the winding should be done with heavily insulated wire such as "brush cable" or its equivalent and ample room should be left on the ends of each layer of wire to prevent leakage of current to the core ends. Of course, the windings will be put on in layers with thin bond paper between.



TERMINALS 3 & 4 ARE BEGINNINGS OF "PIES"
TERMINALS 1 & 6 ARE ENDS OF "PIES"
ONLY PRIMARY WINDINGS ARE SHOWN. SECONDARY IS WOUND SIMILARLY PREFERABLY NEXT TO CORE AS AT (A)

FIGURE 16.

Audio Watts	Core Area (Sq. in.)	Core Length (Inches)	Primary Total Turns	Secondary Total Turns	Primary Wire Size	Secondary Wire Size	Approx. Core Wt. (Lbs.)	Insulate for (Volts)	Total Air-Gap (In.)
100	2.3	14.0	2750	3300	25	26	8	5000	.032
175	4.0	16.2	2392	2870	24	25	16	7500	.037
250	5.25	17.8	2108	2530	23	24	24	8750	.041
350	7.6	19.6	1658	1990	22	23	38	10000	.045
500	11.9	22.4	1327	1592	21	22	67	12500	.052

Figure 17. Tabulations Based on Core Permeability of 400 and Audio Response from 70 Cycles. (See also figure 18.)

For air insulation between ends of windings and core or case, allow 20,000 volts per inch and wherever possible use micanite "flash strips" between the ends of the finished coils and the assembled core.

As to wire, enameled insulation will usually prove sufficient but if the window space permits, use single cotton enamel. Baking and dipping in insulating varnish is fine but not an absolute necessity if care is used otherwise. Some builders may wish to suspend the completed unit in transformer oil; this procedure is to be recommended highly.

To-Specification Transformer Design

The two transformers that have been designed in the earlier part of this article were necessarily universal-impedance units. For this reason it has been assumed (from practical experience in this respect) that the secondary-to-primary turns ratio would be 1.2/1. Of course when a special transformer is being designed for a particular application, it will be necessary to calculate the turns ratio from the familiar equation:

$$\frac{Z_p}{Z_s} = \left(\frac{N_p}{N_s}\right)^2,$$

where Z_p and Z_s are the primary and secondary impedances and N_p and N_s are the number of turns for primary and secondary respectively.

Then, knowing the primary turns (from the equations that have been given) the number to be placed upon the secondary can be determined.

Summary of Computation

1. Determine the maximum r.m.s. audio voltage appearing across the transformer windings. This can be determined from the tube characteristics if the transformer is to be used with specific tubes, or it can be approximated from figure 9 if the transformer is to be a multi-usage unit.

2. Determine the maximum unmodulated class-C plate current that the secondary will be called upon to handle.

3. Determine the wire sizes necessary to handle both audio and class-C currents (d_1 and d_2 in cm.).

4. Apply equation (16) (if 70-cycle response is desired) and solve for the cross-sectional area of the core.

5. Compute L and N from equations (12) and (15). Or, if an available core is to be used, apply equations (12) and (13) to find A and N directly.

6. If the transformer is to be a universal unit, compute the winding-tap locations from figure 11.

7. Proportion dimensions of the core to fit the calculated dimensions and compute the air gap needed from equation (5).

8. Finally, check window space to insure ample room for all the required wire and insulation. Always insulate for four times peak E.

●

W8OMM is named *Bonadio*. He thinks we forgot him when we regretted that no English word rhymed with radio. We said English, o.m.!

Audio Watts	Core Area (Sq. in.)	Core Length (Inches)	Primary Total Turns	Secondary Total Turns	Primary Wire Size	Secondary Wire Size	Approx. Core Wt. (Lbs.)	Total Air-Gap (Inches)
100	1.75	12.8	2524	3028	25 E.	26 E.	6	.030
175	3.0	14.8	2182	2618	24 E.	25 E.	12	.034
250	4.0	16.3	1912	2294	23 E.	24 E.	18	.038
350	5.9	17.8	1500	1800	22 E.	23 E.	28	.041
500	9.0	20.3	1200	1440	21 E.	22 E.	49	.047

Figure 18. Tabulations Based on a Core Permeability of 400 and Audio Response from 100 Cycles.

5-Meter Super-Gainer Receiver

[*Continued from Page 46*]

tuning condenser with short heavy leads. The detector coil is similar except that it has 8 turns. The antenna is coupled to the detector through a mica trimmer condenser having a range of 3 to 30 μμfd. It is set at a fairly low capacity—the two plates well separated.

The total minimum capacity (with an average antenna) in the detector circuit is about 14 μμfd. The revised tuning condenser has a range of about 5 μμfd. so the detector circuit capacity ranges from approximately 14 up to 19 μμfd., enough to more than cover the amateur five-meter band. The oscillator minimum circuit capacity, trimmer, tube and other stray capacities should total 45 μμfd. to track with the detector with the two coils shown. The oscillator tuning condenser, having 5 plates, has a capacity variation of about 14 μμfd., which gives a maximum circuit capacity of 59 μμfd. and a minimum of 45.

Alignment

An all-wave test oscillator is a great aid in lining up even a simple superheterodyne receiver. The i.f. can be aligned to 1600 kc., and harmonics of the signal generator can supply 5-meter signals to check for detector-oscillator tracking. However, it is possible to line up the whole receiver on stray noise or signals in the 5-meter band.

3-Mc. I.F. Channel Operation

The 1600-kc. i.f. provides about the proper degree of selectivity for reception of crystal-controlled or stabilized modulated-oscillator phone signals. Badly overmodulated or frequency-modulated signals are nearly unintelligible on this receiver. If reception of that type of signal is desired, the single stage of 1600-kc. i.f. should be replaced with two stages of 3 or 5-Mc. i.f. which would have less selectivity. The oscillator tracking would have to be changed to make the oscillator tune 3 or 5 Mc. higher in frequency than the detector. The oscillator coil could be stretched out to be a little longer, and the trimmer condenser should be set at a little less capacity for a 3-Mc. or 3000-kc. i.f. system.

Vacuum Condensers

[*Continued from Page 50*]

cover only a rather limited range in frequency by this method.

On 160 meters, and on 80 meters if it is desired to cover the whole band, a single shorted tuning loop will not suffice. For full coverage of these two bands, one or more turns may be rotated within the coil in a variometer arrangement; in other words, the coil conductor is opened at the center of the coil and one or two rotatable turns connected in series by means of heavy pigtail leads.

Another method of tuning a 10-, 20-, or 40-meter tank utilizing a fixed vacuum condenser is to connect either a commercially-built high voltage neutralizing condenser or homemade affair across the tank, tuning it by means of an extended insulated shaft to minimize body capacity. The shorted turn arrangement is somewhat simpler, however, and just as satisfactory.

Open Forum

[*Continued from Page 65*]

found *east* of the Rockies. The number of super-powered stations is roughly proportional to the population in both cases. This is not just my opinion, but also that of several other fellows who have had an opportunity to view the situation first hand on both sides of the continent.

Anyhow, the number of active "5 kw." stations in the whole country could probably be counted on one hand. Most of the offenders run between 1600 and 2000 watts, and while they are undeniably breaking, the law it makes one laugh to hear, "No *wonder* he got nearly twice as many points; he was running *1700 watts*". The difference in signal strength between that power and an even kilowatt is just *barely* perceptible.

The W6's on the whole *do* pack more of a wallop than the eastern stations (making allowances for the difference in population) but it is not due to any great difference in power; it is because the W6's put up antennas with a vengeance.

And why do the W6's come out on the little end of the horn when they poke such a hole in the ether? It might be because they are poorer operators, but it isn't. The W6's are just as good operators as their eastern brethren, and possible just a little bit better. They have to be, because of their geographical handicap.

The reason the W6's don't roll up more points is because of the difficulty in working Europe. The path is nearly all over land, while from the east it not only is much shorter but is nearly all over water. Easterners can get an idea of what the W6 boys have to buck by sitting down and trying to work a few Asians. Supposing just China were divided into a bunch of little countries averaging less area than California, and supposing there were lots of active amateurs in these hypothetical countries on all bands from 10 to 160 meters? The W6 boys could be able to work them like locals on 10, 20, and 40, and with little trouble could hook them on 80 and 160. I have a hunch there would be about twice the usual number of points rolled up by the west coast participants.

It is a rare occasion indeed to work a European on 80 meters from W6 land. The Easterners will say, "How about Asia and Australia from here?" Well, Asia is hard, but Australia is much easier to work from the east than Europe is from the west. The *big* item is the fact that Europe represents *so many countries*. I know the W6 boys would be only too willing to throw out their Australasian contacts if the east coast boys would throw out their Europeans. Boy, what a difference there would be when scores were figured on this basis!

I thought the static was bad at home on the lower frequency bands, but after listening from California I decided that I was pretty well off. And Georgia is no peach when compared to the eastern seaboard.

Of course the rules stipulate that a station actually is competing only with stations in his own section or area, but most dx-ers are after the high score for the U.S.A. I will not say that it is impossible to make the high score from the sixth district, but it is highly improbable.

What I would like to see in preference to By Goodman's expedition would be a "Sand Bowl" dx

[*Continued on Page 97*]

"Unit-Construction" Final Amplifier

[*Continued from Page 58*]

support the plug-in plate coil and the two neutralizing condensers. The lower condenser, for tuning the grid circuit, is fastened to the large condenser with an angular-shaped back plate. At the top of this plate is bolted the horizontal bracket which serves as the mounting for the two tubes. At the lower edge of the back plate is mounted the plug-in grid coil. This plate is also drilled for mounting the plate r.f. choke and the two filament by-pass condensers. All brackets come completely drilled, machined and finished if the kit is purchased. The overall dimensions of the completed unit are 13" high, 8½" wide and 8" deep.

With the plate tank condenser shown, the full rating of the tubes, 1500 volts at about 300 ma., may be run to them on c.w. For phone, the plate voltage will have to be cut down to about 1000 to eliminate the danger of condenser flash-over.

The "Flextal" Exciter

[*Continued from Page 54*]

A few simple precautions will provide stable operation of the oscillator. All low frequency r.f. leads and leads connected to the tuned circuit as well as any leads that fall in the field of the oscillator coil should be of heavy bus and firmly anchored at both ends. The mica trimmers on the b.c. condensers should have their set screws removed and the movable plates bent out at right angles to their normal positions to eliminate the possibility of drift from this cause. The b.c. condensers used should be of good quality, with heavy, wiping rotor contacts.

It should not ordinarily be necessary to use any type of voltage stabilization on the l.f. oscillator but if it is desired to do so because of excessive line voltage variation the circuit of figure 2 may be employed. Each neon bulb maintains a constant voltage drop of approximately 70 volts across its terminals, two providing 140 volts and three 210 volts for the plate of the oscillator. It will be necessary to remove the resistors in the base of the bulbs before they can be used for this purpose.

The series resistor R will have a value of between 5000 and 15,000 ohms, depending upon the power supply voltage and the number of neon lamps used. The resistor should be rated at 15 watts and have a slider so that it may be adjusted for best operation.

With the frequency range of the low frequency oscillator fixed at 300 to 450 kc. and the output range fixed at 3500 to 3650 kc. the choice of frequency for the crystal oscillator is limited. Either the sum or the difference of the two oscillator frequencies may be used to give the desired range in resultant frequency. Use of the sum of the frequencies places the high frequency (crystal) oscillator at 3250 kc., while the use of the difference frequency calls for a 3950-kc. crystal. The 3950-kc. frequency has two distinct advantages. It allows an easily obtainable crystal to be used, without resorting to "rolling your own" or having one ground to special order as would be the case with the 3250-kc. frequency. Also, as was mentioned earlier, by utilizing the difference in frequencies a certain amount of compensating action is obtained. This is due to the fact that an increase of frequency of the low frequency oscillator causes a *decrease* in output frequency from the unit, while an increase in frequency of the high frequency, or crystal, oscillator causes an *increase* in output frequency and vice-versa. Thus, if the crystal oscillator is made approximately ten times more stable than the low frequency oscillator as regards changes in voltage (proportionately to the frequencies involved), then the compensating action is nearly perfect. In practice, the ten to one ratio of stability between the crystal and l.f. oscillators may or may not actually be the case, as no tests have been conducted along this line. But whatever the actual ratio may be, the theoretical advantage due to the use of the difference frequency is there, and is thrown in without extra charge.

It is not necessary, of course, that the crystal used for conversion be exactly on 3950 kc. Any frequency from 3925 to 3975 kc. will be satisfactory.

The pictures and diagram are nearly self-explanatory as far as the actual construction of the unit is concerned. The whole unit is built on a 2"x 7"x 13" steel chassis and housed in a 7"x 8"x 14" ventilated steel cabinet. It is inadvisable to try and squeeze the parts into a smaller cabinet. The "two story" low-frequency oscillator tuning condenser is made by mounting the two b.c. condensers one above the other on long angle brackets. The top condenser is used as the fixed padder and, when its proper setting has been found, is locked in position with a rotor lock. The only other part mounted above the chassis is the 802 shielded plate tank circuit. This tank circuit contains a small coil form and two 25-μμfd. midget condensers, which are used in parallel across the coil. The condensers are set for the middle of the 3500- to 3650-kc. range and the circuit is sufficiently broad to cover the 150-kc. range without retuning.

The tube sockets are evenly spaced along the rear of the chassis, with the 76 at the left, the 42 in the center, directly behind its tuning condenser, and the 802 at the right, behind its tank circuit. Four, five-prong crystal sockets are provided in front of the 76 socket. It should be emphasized that four crystals are extremely desirable, if not absolutely necessary, in the "Flextal" unit. One is needed near 3950 kc. for conversion use; one on or slightly higher than 3500 kc. to provide an accurate "spot frequency" on the low frequency end of all bands; a crystal on or slightly lower in frequency than 3600 kc. to use on the high frequency edge of the 14 Mc. band; and another similar crystal near 3650 kc. for the high frequency edge of 7 Mc. For the exclusively phone man these crystals could be replaced with crystals near 3537.5 and 3562.5 to provide both edges of the 14-Mc. phone band and a marker for the low frequency end of the 28-Mc. phone band.

Under the sub panel, parts are mounted where convenience dictates. The crystal switch, an Isolantite tap switch, is on the left, directly under the crystal sockets. This switch is a two-gang, four-pole, six-position affair and switches both sides of the crystals along with the jeweled pilot lights on the panel. Three green jewels indicate each of the three spot frequencies available with straight crystal control. The fourth jewel is red and comes on when the 3950-kc. crystal is in the circuit, indicating that the unit is "ready to go" with variable frequency output.

The filament switch is on the opposite side of the panel from the crystal switch, with the filament transformer behind it and mounted to the side of the chassis. The transformer is mechanically insulated from the rest of the unit by four rubber grommets placed between it and the chassis. The grommets are held in place by a spot of Duco cement on each. This prevents 60-cycle mechanical vibration of the low frequency oscillator, which would result in frequency modulation.

The b.c. coil is easily obtainable at radio parts houses. It is of the variety commonly known as an "inter-stage" coil and has a sliding primary, which is used as a conveniently adjustable tickler.

Filter Condenser

The only other parts deserving of individual mention are the low frequency oscillator filter condenser C_{13}, the line by-pass condensers C_{12}, and the voltage divider. The filter condenser on the low frequency oscillator voltage tap may or may not be necessary, depending upon the particular power supply used; it is good insurance to include it, however. *Under no circumstance should the voltage divider be mounted under the chassis or inside the cabinet,* as the intermittent heating and cooling of the divider as the transmitter is turned off and on will have a very detrimental effect on the frequency stability. It is not absolutely necessary that the voltage divider be mounted on the unit at all; it may be located at the power supply and the various voltages brought to the unit through a five wire cable and plug. Likewise, the filament transformer may be external to the unit, or the filament voltage may be taken from the receiver or transmitter filament supply.

The line by-pass condensers will probably not be necessary in most cases. In one case they were found to be absolutely indispensable, however. In this particular case, operation of the "Flextal" unit was perfectly normal until the key was pressed. When this was done the frequency began to crawl steadily. When the key was released the unit slowly returned to its original frequency. The trouble was finally traced to a large amount of r.f. finding its way into the filaments through the 110 v. line and causing a gradual increase and decrease of cathode temperature. The line by-pass condensers quickly cured the trouble. They can probably be omitted in the majority of cases.

To make sure that the operation of the original "Flextal" unit was not just a lucky "freak" condition, similar units were built by W6QD and W6ADP, a couple of the local low power dx boys. The operation of these units was identical with that of the original model, and Herb and Glenn can now be heard, like the man on the flying trapeze, "swinging through the band with the greatest of ease."

Initial Tuning

The initial tuning of the unit is best done in the following manner: After the filaments have been lighted, the plate voltage of from 350 to 500 volts should be applied to the unit and the voltage divider taps set to the proper points. Approximate voltages taken from the divider are: 802 suppressor, 50 volts; 42 plate, 175 volts; 76 plate, 250 volts. The total voltage across the divider may be anything from 350 to 500 volts, or even higher if it is desired to exceed the ratings on the 802 slightly. None of the voltage adjustments is extremely critical and wide variations from the above figures will not seriously affect the output. Do not, however, exceed 300 volts on the crystal stage.

After the voltages have been adjusted, the 42 should be removed from its socket and a crystal somewhere between 3500 and 3650 kc. (preferably near 3575) switched into the crystal oscillator circuit. The unit should then have plate voltage applied again and the 802 plate circuit tuned to resonance as indicated by a neon bulb touched to the 802 plate or a flashlight bulb connected across the link terminals. Next, link leads from the transmitter itself should be connected to the "Flextal" unit and the grid circuit of the first stage in the transmitter tuned to resonance and the 802 plate tank condenser retuned slightly if necessary.

With these adjustments completed, the plate voltage should again be removed from the unit and the 802 and 76 removed from their sockets. From this point an ordinary amateur band super will be very helpful. Replace the 42 in its socket and set the low frequency oscillator tuning condenser at minimum capacity. Slide the tickler coil along the grid winding until its positive end is above the ground end of the grid winding and again apply the voltage. Rotate the l.f. oscillator padding condenser until a strong, pure, signal is heard, one which cannot be tuned out on the receiver. This should occur at about 2/3 maximum capacity of the padding condenser. The oscillator is now tuned to the receiver i.f. frequency, which will be somewhere between 456 and 470 kc. depending on the make of the receiver. Replace the 802 and 76 in their sockets, turn the crystal switch to the 3950 kc. crystal and check the output frequency in the receiver. It should be near 3485 kc. If the receiver used will not tune far enough out of the band to pick up the signal from the unit, tune the receiver to 3500 kc. and increase the capacity of the l.f. oscillator tuning condenser until the signal is heard crossing the receiver frequency.

Check the band spread for the 3500 to 3650 kc. range and center it on the dial by readjusting the l.f. padder, remembering that, due to the use of the difference frequency beat, the unit tunes "backward"; that is, an *increase* in capacity causes an *increase* in output *frequency* and vice-versa. With the band properly set, lock the rotor of the padding condenser in position and tune the output to the center of the 3500-3650 range and retrim the 802 plate circuit for maximum output. The quality of the signal from the unit should now be checked in the receiver. It should be impossible to notice any difference in the tone of the signal when switching from straight crystal control to control by conversion. Adjust the oscillator feedback by sliding the tickler along the grid winding until the quality of the output is uniformly good over the range of the unit. A small amount of adjustment of the taps on the voltage divider for best output, and the tuning is completed. The tuning adjustments are actually much less complicated than they sound; the whole job can be done in 15 minutes.

Ready to Drive

The unit is now ready to drive the transmitter either with straight crystal control or on any frequency between crystals merely by setting S_1 to the proper position. The link to the transmitter may be any reasonable length without sacrificing a great deal of output. Twisted lines of widely differing characteristics will affect the tuning range of the 802 plate tank circuit, so the number of turns on L_1 may have to be changed to suit individual cases.

The output to be expected from the "Flextal" unit is on the order of five to ten watts, depending upon the supply voltage, and it will replace the present crystal stage in a majority of cases. Where a 40-meter crystal is being used at present, a simple conversion of the crystal oscillator into a doubler by the addition of an 80-meter grid tank will solve the problem. If a tri-tet oscillator is being used with an 80-meter crystal and the plate circuit on 40, it likewise can be converted into a doubler by using the cathode tank circuit as an 80-meter grid circuit. The only case where an additional stage should be required is where a 40-meter crystal is used in a tri-tet oscillator with 20 meter output or where 20- or 10-meter crystals are used.

Two last precautions: *always make all major tuning adjustments of the 802 plate circuit with the 42 removed and the unit operating on a crystal between 3500 and 3650 kc.* This will eliminate all possibility of tuning the transmitter to the wrong output peak. Final minor adjustments of this tank circuit may be made with the 3950 kc. crystal and the 42 both in the circuit, and the output set near 3575 kc. If you care to flirt dangerously with the edges of the bands, *use crystals which are known to be safely in for edge of band operation* and then *keep inside of them* when using the variable frequency control.

The "Flextal" type unit, having again made operating a pleasure for one ham and having received favorable comment from others who have used it or seen it in operation, is offered to those who care to try it for what it may be worth.

DX

[*Continued from Page 64*]

and W4ECI started out well but got sick during the middle of the stretch. W4EHH was in there for new countries mostly and W4BOE didn't quite get his new kw. rig finished in time.

"Ma" Mayer, K4KD, in scoring his 131,895 points really tore 'em apart. He had 977 QSO's and used four bands. Mayer says everything went off slick until the last few days when he had trouble responding to the alarm clock although the xyl came through with hot coffee and midnight lunches which were very welcome. K4KD wants to tell the gang that if they don't get their cards right away not to give up as he is having a new batch printed and everyone will get one. Gil Williams now has his 30th zone. He has been hunting for Asians for years then works four of them in a month. W6MVQ got himself 8 new countries during the contest and now his total is 71. He was on 57 hours and made about 20,000 points. Says he isn't using a "California Kw". Incidentally, MVQ, who is 16 years old, has had his license only two years and has made WAC over 60 times.

W3EVT ran up 150,000 points and earned a few new countries some of which are XU6MK, ZC6AQ, U8ID, VP2LB, W1OXAB, VQ4KTF, YV2CU. Clem now has 37 and 110. W1ZB worked PJ4F in Saba (wherever that is) and FG8AH in Guadelupe for his 129th country. PJ4F, 7000 kc., and FG8AH, 7120 kc., T5. W8DWV says the QRA for ZU9K on the island of Tristan de Cunha is Kenneth Stevens, Anspike British Postal Dock, Tristan de Cunha.

ES7D has worked a few of the boys on 40, W1BYI, W2BHD, W2UK, W3CHH. ES7D says dx on 7 Mc. is quite rare. His rig uses a 310 final with 50 watts input. ON4AU now has 151 countries, and contacted the following on 7 Mc. during the contest: W6CD, W6CIS, W6GNS, W6QD, W6GRL, W6KUT, W6HX, W6ITY, W6CII, W6BIP, W7AJN, VE5OJ. W6BAM snags FU8AA in New Hebrides and VP2LB for new ones.

GI6TK did a noble job in rounding up 81,000 points. He worked 53 districts and hooked W6GRL on 3.5 Mc. Frank has 31 zones and 76 countries to his credit so far. He is much in need of contacts with hams in Arizona, Utah, Nevada, New Mexico, Mississippi, So. Carolina and So. Dakota. Frank will seek anybody in any of these states at any time. His usual operating time is as follows: Week days, 14 Mc. 0700 to 1000 G.m.t. Sundays and week days, 28 Mc. 1500 to 2000 G.m.t. There you are boys, go get him. More on GI6TK later.

VP9L C.W. Station Doubtful

During the phone contest while W6GRL was QSO VP9L in Bermuda Dave mentioned he was glad to hook him on phone after working him on c.w. VP9L said that he had been getting all kinds of cards all over the world for c.w. contacts but he had never been on c.w. Apparently the true VP9L is the phone station and if this information is correct there will be plenty of fellows losing points from that VP9 contact in the c.w. contest and not only that but a country from their list as well to say nothing of coining a flock of words that won't fit into any dictionary. This is one of the lowest of the low in tricks.

Bill Breuer, K6TE, is back on Wake Island for awhile 14350 kc. K6BAZ has a new load of gas and is at it again on Howland, 14390 and 7190; K6DSF on Baker Island, 7080 kc., using 3 watts (dig for him boys), K6GNW on Enderbury Island in the Phoenix Group, 7185 kc., K6HCO on Canton Island, Phoenix Group, 8429 kc. (no, I didn't slip); K6NVJ on Jarvis, 7190 kc.—all of these boys are T9.

Charlie Perrine didn't wait for the dx cycle to roll around, he just went out and worked the above mentioned countries, plus a couple of VP7's. Charlie now has 136 with 39 zones. Come you zone no. 23. CUH has a new final with a pair of 250TH's, but using no tank condensers . . . tunes the coils "accordion fashion". I guess that's low C. The rig was in the March issue.

I must mention something about the gadget called the "Flextal" Conversion Exciter described by Leigh Norton, W6CEM, in the front part of this issue. This seems to be quite a good unit and the one I have built up for use at W6QD has been like a new toy. As far as I can tell it has the clear tone and stability of crystal-control, and the flexibility of an electron coupled oscillator. It has been great sport "skooting" around the band with it setting on any spot desired. Hope I don't forget and skoot the wrong way.

W8RL is a new one to the phone section of the zone list with 21 zones and 49 countries. G2QT has 34 zones and 88 countries. OK1AW now has 33 and 90 and ON4AU finally writes in with the total of his countries worked placed at 148. Here's an item of interest, from OK2BR. He says that our old friend OK2AK who used to put out such a potent signal is now with the Telefunken Laboratories in Berlin. Therefore his OK2AK license was revoked and being a foreigner he cannot, as yet, hold a license in Germany. OK2BR also adds that OK2PN, who is a good dx man, needs cards very badly from stations worked by him up to 1937. He is trying to get enough to get into the Zone list and WAS. He has worked Arizona, New Mexico and Colorado but no cards as yet . . . so, come on and kick through.

W1DKD worked a nice one on 7 Mc. It was ZD1Z in Gambia, and he said he was operating portable and to QSL to G8DF. The funny part of it was that W1DK didn't give it much thought but when he came to look up G8DF in the call book, he wasn't listed. However, a few days later he was put at ease when QSO G5FA. He asked G5FA if he had ever heard of G8DF and 5FA told him they were good friends, and then went on further to say that ZD1Z was operating about 200 miles inland in Gambia and running 25 watts to a single ten. That's a good one to get and I wouldn't be a bit surprised if he was the first W to land one of 'em.

XE1BT who paid us a visit a short time ago is back home now. In fact when he reached San Francisco on his trip he was suddenly called back, so as it happened he got on in the phone contest and made 780 contacts. He didn't say what the multiplier was so I have no way of knowing the score. On his way home from San Francisco, XE1BT met a number of hams in New Mexico and Arizona.

While I think of it, KA1ZL scored 17,200 points in the phone contest, and it was entirely handled by the xyl . . . . . as you will recall KA1ZL is ex-W6BAY, Ted Curnett. 320 contacts were made during the session.

Speaking of traveling hams . . . . . . some of you dx men scattered throughout the world, keep an eye open for W6JWQ, Larry Sorensen. He has just left on a trip around the world and will not return until September first, which should give him a fair amount of time in each country visited. His itinerary briefly is this: Tokyo, Yokohama, Shanghai, Hongkong, Manila, Java, Bali, India, Suez, Athens, Turkey, Italy, Germany, France, Denmark, Moscow, Leningrad, Belgium, Norway, Sweden, England and home. He's a lucky guy, this W6JWQ, and if he locates any of you, don't lead him astray.

We're just full of it this month . . . . . maybe I should have a "visitors and travelers" section. Anyway, G5SA, Price Jones, is now located in Hollywood. He expects to be here for a few months. I hate to think what a few months in Hollywood *might* do to him . . . . . of course, he has his charming xyl with him, so everything will be all right. G5SA is doing a little work in one of the "movie" studios, in the sound end of it, I think. Price says for the past year or so he has been on phone, although he is still a c.w. man, too. Hi. He has gotten the itch to get on the air while here so is assembling a Bi-Push in his spare time. You might hear G5SA/W6 any day now.

Here's something from New Guinea: VK9DM on 14,410 kc. with a T6 note. Claims that he has difficulties hearing W stations at the present time because he is shielded by 10,000 foot mountains. That apparently doesn't affect his signal in getting out for he has the whole band calling him. VK9DM expects to have a new receiver in a short time and so the W's will be given a better break.

Just a few closing thoughts from here and there. A couple of laughs were had during the contest when out of a clear sky a W2 was heard sending a mile a minute on his bug "CQ SS CQ SS de W2—" and then about ten minutes after the contest closed a W9 was heard exchanging numbers with an FY8 . . .

and a loud snicker was had late that night when a certain station in South America was still passing out numbers . . . habit I guess. I had a good laugh on myself when one night on 7 Mc. the gang of 689 hams were calling CN8AV and I was one of them. This was about 9 p.m. and I was pretty groggy that p.m., but every time this CN8 would sign off I would automatically call him anyway . . . thinking I would have one chance in 689. When I finally awoke it was 1:15 a.m. . . . still had the cans on with two cramps in my neck. Anyway the payoff came when W6GRL breezed into town after the contest and asked why I didn't go back to CN8AV after I had raised him. Aw shucks, I'd rather sleep anyway.

Activity around Manhattan Beach hasn't gotten into the summer dx season yet but I am looking forward to it. Any day now the yl's will begin flocking to the beaches to drape themselves over the sand in order to show off their nice new shiny satin, or rubber bathing suits—bathing suits that will never see the water. Anyway, they like to be looked at, so you see, gang, dx in the summer takes somewhat of a slump, that is, if you get what I mean. Our "shack" is only three steps and a stumble from the ocean, so we haven't far to go to demonstrate our ability to "sink or swim".

If any of you fellows are still reading, you deserve a medal, but in the absence of a medal suppose you dig in there and find out where some of those "foney" stations are coming from. Keep up the swell work, gang, fire in all of that dx news and we'll put it in print if we have to run a special edition. I'll do my part . . . in fact I've started already getting back to normal . . . just the other night I worked three W9's in a row. For me, that's something. Next month watch out. That's it.

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.

T-40 TEN-METER PHONE RIG

C_3, C_4—Solar "Domino's"
C_8—Bud no. 898 condenser
C_9—Cardwell MT50GD
C_{10}—Bud no. 92 condenser
RFC_1—Hammarlund CH-X
RFC_2—Hammarlund CH-500
Sockets—Hammarlund
Insulators—Johnson

HK-254 AMPLIFIER

Johnson parts as follows:
C_1—100FD20
C_2—100DD70
C_3—6G70
Two 204 dials
Two 211 sockets
One 225 socket
One 252 coupling
One 258 coupling
Two 602 insulators
Two 67 insulators
Two 76-A jacks
Six 77-A plugs
Two 40 Insulators
Five 40 insulators

JONES 56-Mc. SUPERHET

C_1—Hammarlund MEX trimmer
C_2, C_3—Hammarlund HF-15
C_4—Hammarlund APC 50 μμfd.
Tubulars and mica by-passes—Cornell-Dubilier
Flexible shaft couplings—Bud
R_5—Centralab 72-103
R_7—Centralab 72-107

"UNIT-CONSTRUCTION" AMPLIFIER

Complete kit of hardware, brackets and screws—Hammarlund
C_1—Hammarlund MTCD-100-B
C_2—Hammarlund MTCD-100-C
C_N—Hammarlund N-10 condensers
RFC—Hammarlund CH-500
Tube sockets—Hammarlund S-4
Coil socket—Hammarlund S-5
Grid coil form—Hammarlund XP-53

DAWLEY SPEECH MODULATOR

T_1—Thordarson 81D42
T_2—Thordarson 15D79
T_3—Thordarson 11M77
T_4—Thordarson 70R62
T_5—Thordarson 16F13
CH_1—Thordarson 74C29
CH_2—Thordarson 13C28
All tubular condensers—Cornell-Dubilier
All filter and coupling condensers—Cornell-Dubilier

ADAMS DIVERSITY RECEIVER

Tubular condensers—Aerovox 284 and 484
Mica condensers—Aerovox 1468
C_{48}—Aerovox PR5 8 μfd.
C_{51}, C_{52}, C_{53}—Aerovox PBS 58-8 μfd. in series
C_1, C_8, C_{15}, C_{24}—Hammarlund APC 25 and 100 μμfd.
C_{25}—Hammarlund HF15
C_2, C_9, C_{17}—Hammarlund MEX
C_3, C_{10}, C_{18}—Ganged Hammarlund MC20MX
$RFC_{1, 2, 3}$—Hammarlund CH-X
Coil forms—Hammarlund CF-M
TR_1—Meissner 6643
TR_2—Meissner 6123
TR_3—Meissner 6869
I.F. chokes—Meissner 5590
R.F. coil cans—Meissner 8281
R_7—Yaxley H control
R_{15}—Yaxley H control
R_{18}—Yaxley E control
R_{24}—Yaxley M control
R_{28}, R_{29}—Yaxley N controls
Diversity switch—Meissner 18254
Plugs, connectors, sockets—Amphenol

Open Forum

[Continued from Page 87]

contest here in Calif. Let each section select two operators who are its pride and joy and pay their expenses to California to enter the melee. The juice ordinarily burned during the contest would pay for it. Instead of cluttering up the air, the rest of the operators could stay home and be spectators, rooting for their own entry.

Oh—oh. I think the same man is looking for me—you know, the one with the blue coat and brass buttons.

DAVE EVANS,* W4DHZ

*Winner for U.S.A., 1936 dx contest.

A New Receiver

[Continued from Page 57]

termediate frequency eliminates the possibility of low frequency QRM sneaking into the second detector when one is located near low-frequency commercial stations or shipping lanes.

The controls on the front panel include r.f. gain, band switch, audio gain, a.v.c. switch, main tuning, b.f.o. switch, tone control and power switch, pitch control, and communications (standby) switch. A headphone jack is also located on the front panel.

Both main dial and auxiliary band-spread dial are actuated by the same tuning knob, the tuning mechanism incorporating a weighted wheel which permits one to "spin" the main dial across the scale quickly when going from one frequency to a widely different one.

The loudspeaker, which is self-contained, is well made and provides surprisingly good quality for a 5-inch speaker. While it leaves something to be desired in the way of bass response for broadcast reception of music, the quality is better than the majority of midget b.c.l. sets and insofar as voice intelligibility is concerned, which is the important consideration in communications work, the small speaker seems to be actually superior to a big "boomy" speaker in a large cabinet.

The receiver has provision for balanced (doublet) antenna input, and while best results were obtained with a resonant antenna and balanced two-wire transmission line, good results were also obtained with a 40-foot wire used as a regular untuned Marconi. Good performance on both phone and c.w. on all bands was experienced on the model under test—especially good when the very moderate price of the receiver is considered.

The Marketplace

(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 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 Los Angeles accompanied by remittance in full payable to the order of Radio, Ltd.
(i) We reserve the right to reject part or all of any ad without assigning reasons therefor. Rates and conditions are subject to change without notice.

VERNIER drive for metal disc dials; one-hole panel mounting. INTRODUCTORY, 35c coin, postpaid. New England RADIOCRAFTERS, 1156 Commonwealth Ave., Brookline, Mass.

WANTED: Best transmitter that $100 to $150 cash will buy. Craig, W7ALO, First National Bank Building, Salem, Oregon.

DOUGLAS Universal Class B transformers of quality. Designed by W8UD. Sold exclusively by W9IXR. 50 watts audio $4.95 pair, 100 watts audio $7.75 pair. Postpaid in U. S. A. Guaranteed. To promote faster service we have moved. Write W9IXR, 17 West Knapp Street, RICE LAKE, WISCONSIN.

WANTED: 100-watt, factory-built transmitter for 10, 20, 40 and 80 meter c.w. and phone. Will consider Temco, Harvey, etc. Also want Harvey UHX-10 for mobile use. Give full particulars. C. J. Clark, 925 Montrose Ave., Chicago.

PANELS, chassis, racks, portable cases, specials. R. H. Lynch, 970 Camulos, Los Angeles, Calif.

QSL'S—HIGHEST QUALITY—LOWEST PRICES. RADIO HEADQUARTERS, FT. WAYNE, INDIANA.

RECEIVERS: Sell or trade for test equipment: S. W. 3, like new—power—with 59 output, 20-10 meter coils. S.W.5—Velvet B, 40 meter coils. Motor generator, 110 a.c. input, 400 V. D.C. 250 mils. output, $6.00, W6BTL.

FOR SALE: New 600-watt, c.w., 150-watt phone in relay rack with 250TH final amplifier from 10 to 80 meters. Tube keying and built-in power supplies in silver and grey panels. Price complete with tubes and coils $215, f.o.b. Berkeley. New six-band, plate-modulated phone with four HK54 tubes. Input approx. 1/4 kw. Relay rack and panel of silver and grey finish. Complete with all tubes and coils for $260 f.o.b. Berkeley. F. C. Jones, 2037 Durant Avenue, Berkeley, Calif.

WANTED: Power supply or odd parts. 3/4000 volt, 500/1000 mil; modulator or parts 700/1000 watts audio. Cash. W6OCH.

CASH for modern super with xtal. Must be perfect. W6HEZ, Laguna Beach, Calif.

W6KX QSL's, like the YL's in RADIO's office, are fb. Estimates on special cards furnished. Suggestions for card layout appreciated. How abt ur QSL for a change . . . Hi! Keith LaBar, W6KX, 1123 North Bronson Ave., Hollywood, Calif.

HK-254 AMPLIFIER described in this issue, laboratory model, less tubes and coils, $26.00 f.o.b. RADIO, Ltd., 7460 Beverly Blvd., Los Angeles.

TZ-40 MODULATOR described in this issue, laboratory model, $60 complete with tubes, f.o.b. RADIO, Ltd., 7460 Beverly Blvd., Los Angeles.

METER Repair—Accurate and dependable service. Standard types of meters repaired in 24 hours. Repairs priced so that anyone can afford them. Write for price quotations. Braden Engineering Company, 305 Park Drive, Dayton, Ohio.

HAVE you seen Fritz's newest QSL's—SWL's? They're different! 455 Mason Ave., Joliet, Illinois.

FABERADIO, after years of successful manufacturing, still sells "Y" 160 and 80 meter crystals for 75c each. More than 5000 users are satisfied. "X" cut $2.25. "A" cut $2.75. Molded holders $1.00. Variable frequency holders $4.95. Commercial crystals a specialty. FABERADIO, Sandwich, Illinois.

METERS repaired, Ham's prices, W9GIN, 2829 Cypress, Kansas City, Mo.

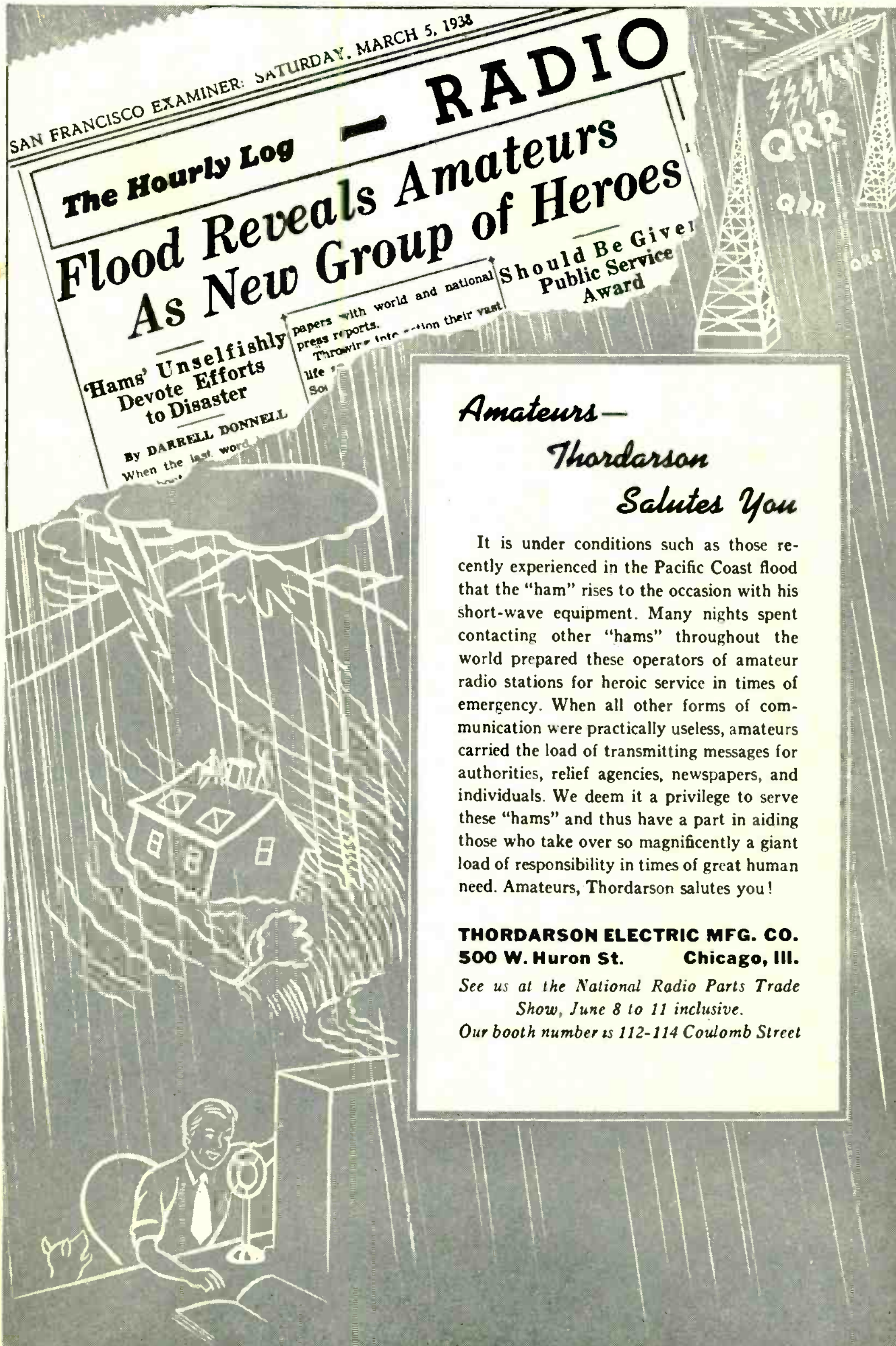
METER Repair—D.C. Milliammeters, springs repaired $1.75. Change range, new scale $1.75. Thermocouples 1 to 5 amperes, $2.50. Change thermocouple range add 25c. All repairs reasonable. Braden Engineering Co., 305 Park Dr., Dayton, Ohio.

BLUE Print (dime) and Photostat (quarter) International "Q" Signals—convenient size. W9OC, Spencer, Iowa.

TRANSMITTER: built by Frank C. Jones, pictured and described in February, 1938, RADIO. 600 watts c.w., grid-modulated phone. Complete with all tubes and coils for ten and twenty meter bands. Broadcast quality, R9 reports from nearly everywhere. Reason for selling: installing more powerful transmitter. $155 f.o.b. Hopkinsville, Kentucky, which is less than cost of parts. W9WOI, A. W. Wood, Jr., Hopkinsville, Ky.

GUARANTEED "PRECISION TRANSFORMER" PIE WOUND, 1790-760-0-760-1790. 450 milliamperes. $16.50. All types power equipment, request prices. Michigan Electrical Laboratory, Muskegon, Michigan.

QSL'S—The Best. W8NOS, 27 Houston, Buffalo.


SAN FRANCISCO EXAMINER: SATURDAY, MARCH 5, 1938
— RADIO
The Hourly Log
Flood Reveals Amateurs As New Group of Heroes
'Hams' Unselfishly Devote Efforts to Disaster
By DARRELL DONNELL
Should Be Given Public Service Award
QRR
Amateurs—
Thordarson
Salutes You
It is under conditions such as those recently experienced in the Pacific Coast flood that the "ham" rises to the occasion with his short-wave equipment. Many nights spent contacting other "hams" throughout the world prepared these operators of amateur radio stations for heroic service in times of emergency. When all other forms of communication were practically useless, amateurs carried the load of transmitting messages for authorities, relief agencies, newspapers, and individuals. We deem it a privilege to serve these "hams" and thus have a part in aiding those who take over so magnificently a giant load of responsibility in times of great human need. Amateurs, Thordarson salutes you!
THORDARSON ELECTRIC MFG. CO.
500 W. Huron St. Chicago, Ill.
See us at the National Radio Parts Trade Show, June 8 to 11 inclusive.
Our booth number is 112-114 Coulomb Street