RADIO

ESTABLISHED 1917

SPECIAL YEARBOOK NUMBER

The Worldwide Authority of Amateur and Shortwave Radio

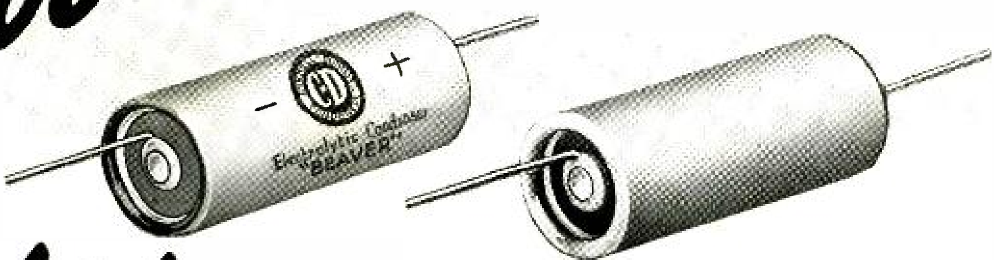
★

Annual Year-Book Number

JANUARY 1940 NUMBER 245

50c IN U.S.A. AND CANADA

both look alike



but . . . that's where the similarity ends. For one of these capacitors was built by Cornell-Dubilier and that means built with greater care —extra quality at no extra cost. Take the C-D Type BR "Blue Beaver." Here's a space-saving unit that offers exclusive electro-chemical* etching — eliminates corrosion; hi-formation process — affords higher voltage breakdown; hi-pressure centrifuge — better impregnation, lower power-factor; hi-purity aluminum foil — better direct current leakage recovery; special C-D super-purity cellulose separator — extra long life; double ageing — stable characteristics; all aluminum tubes and accessories — prevents galvanic corrosion; special vent — safety under all operating conditions; tubular compact construction — allows ease of wiring into circuit.

Amateurs who want the most-for-the-money get it in C-D's. Be specific—order capacitors by name. Your jobber will appreciate it. For he knows the difference. Type BR's described in catalog No. 175A free on request.

Product of the world's largest manufacturer of capacitors

MICA • PAPER • DYKANOL • WET & DRY • ELECTROLYTICS

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CORNELL-DUBILIER

a great name in capacitors

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ELECTRIC CORPORATION
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Back of the Skyrider 23. . .

A communications receiver — no matter how well constructed — is no better than its engineering. Each function in the SKY-RIDER 23 was carefully analyzed from the most scientific approach before it was incorporated into the final circuit. (This page on drift characteristics from the Laboratory Data Book is an interesting example.) That is a vital reason why the "23" is one of the best receivers the Hallicrafters has built. Yet it is available at your Distributors, for only a $23.10 down payment, less speaker. See it today. Try it tonight.

the hallicrafters inc.

CHICAGO, U. S. A.

"LARGEST BUILDERS OF AMATEUR COMMUNICATIONS EQUIPMENT"

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The Editors . . . .

. . . . of "Radio"

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

Correspondence

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

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

IF YOU MOVE notify us in advance. We cannot replace copies send to your old address. See "Changes of Address" notice elsewhere in this issue.
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RESPONSIBILITY will not be accepted for subscriptions placed with unauthorized agents. Prospective subscribers are urged to inspect carefully the credentials of anyone soliciting their business. Agents are never authorized to vary the rates quoted on this page.
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Europe: (Subscription) N. E. Read, 24 Church St., Oswestry, Shropshire, England. **Australia:** "The Bulletin", Box 2521BB, Sydney; McGills, 183 Elizabeth St., Melbourne; Swain & Co., Pitt St., Sydney. **New Zealand:** Te Aro Book Depot, Ltd., 64 Courtenay Place, Wellington. **South America:** F. Stark, Caixa 2786, Sao Paulo; "Revista Telegrafica", Peru 165, Buenos Aires; Editorial Pan American, Peru 677, Buenos Aires. **South Africa:** South African Radio Publications, 40 Trust Buildings, Fox Street, Johannesburg.

PRINTED IN U. S. A.

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

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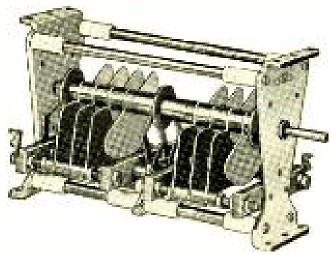
HERE'S THE COMPLETE STORY!

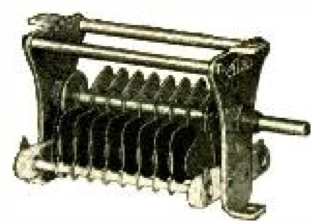
Below are listed the important specifications and characteristics of BUD Variable Condensers. This is only part of the story, however. The *real* story of the superiority of these units is being told by the thousands of BUD Condensers in use in ALL branches of radio throughout the world. When you buy BUD Condensers you buy PROVEN DEPENDABILITY!

Giant and Master Condensers



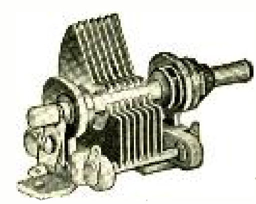
STYLES: Single section, Split Stator, U.H.F.
CAPACITIES: 30 to 530 mmfd, 25 to 340 mmfd.
PLATE DIAMETERS: 6½″, 3¼″.
PLATE SPACINGS: 0.1″ to 1.0″.
PLATE MATERIAL: Polished Aluminum.
INSULATION: Alsimag 196, Mycalex
NET PRICES: $17.00 to $46.00, $4.00 to $12.00.
USES: Tuned circuits handling up to 10 KW for Giants. Tuned circuits handling up to 3 KW for Masters.

Junior Condensers



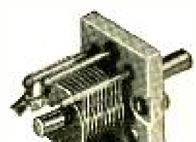
STYLES: Single section, Split Stator, U.H.F.
CAPACITIES: 20 to 340 mmfd.
PLATE DIAMETER: 2¼″.
PLATE SPACINGS: 0.05″ to 0.175″.
PLATE MATERIAL: Cadmium plated brass.
INSULATION: Alsimag 196.
NET PRICES: $1.50 to $5.40.
USES: Tuned circuits handling up to 750 watts.

Midget Condensers



STYLES: Single bearing. Double bearing, Midline or Straight line plates, Single, Dual and Three gang units.
CAPACITIES: 10 to 325 mmfd.
PLATE DIAMETER: 1½″.
PLATE SPACINGS: 0.024″ to 0.095″.
PLATE MATERIAL: Cadmium plated brass.
INSULATION: Alsimag 196.
NET PRICES: $0.51 to $3.14.
USES: Low Power Transmitters, Receivers, etc.

Tiny Mite Condensers



STYLES: Single and double section, Air padder, Balancing (one rotor and two stators).
CAPACITIES: 8 to 140 mmfd.
PLATE DIAMETER: 13/16″.
PLATE SPACINGS: 0.017″ to 0.073″.
PLATE MATERIAL: Cadmium plated brass.
INSULATION: Alsimag 196.
NET PRICES: $0.56 to $1.98.
USES: Regular and U.H.F. Transmitters, Receivers, Coil Padding, Phasing, etc.

Ask your jobber for the latest BUD catalog—just off the press

BUD RADIO, INC.

BUD

CLEVELAND, OHIO

As the spirit moves, we present in this column from time to time a bit of gossip about RADIO, its affiliated publications, and those who produce and distribute them.
—"From the private life of RADIO".

Handbook

The biggest news around these diggings is that the 6th Edition of RADIO *Handbook* has been put to bed (trade slang for "on the press"); in fact, first copies to dealers and direct customers are in transit as this is written (in November). The newspapers report a slight eastern earthquake; nonsense! It's just the backwash from our sigh of relief. It really was some job, especially for our relatively small staff.

This isn't supposed to be an advertising column, but we can't help slipping a word in that anyone who buys this year's 640-page book, will be getting his dollar-and-a-half's worth and then some. In fact, we just heard the boss bemoaning the bill for paper and printing for a book considerably larger than originally contemplated, and laying down the law that it isn't to happen again. But if you fellows will back us up with your purchases we'll promise you "bigger and better than ever" *again* next year—and make him like it!

Back to Normal

It's nice to be back to normal again. We've pretty well dug out from under the load of things which accumulated while the Handbook was being given its finishing touches. And the Managing Editor is back in Santa Barbara after several months in Pennsylvania assisting the Production Manager in the production of the Handbook. Once again said M.E. is wielding the blue pencil on the worst of our off-brand English and punctuation, laying out the monthly issues of RADIO, corresponding with authors (and incidentally authorizing their checks) and most important, bedeviling the editors to get their copy in on time.

Of course, this double-size January issue produces a nice little headache of its own, but after the Handbook we can almost take a mere 200 pages in our stride—we hope!

Club Rates

The circulation department is receiving a growing number of inquiries as to whether or not RADIO has any "club" rates. Yes, a special rate is available to bona fide amateur radio clubs; it's the only permanent special rate which RADIO offers: $2 per one-year subscription in groups of ten or more, sent in at one time and accompanied by remittance in full. If you do not write on a printed club letterhead, please furnish the circulation manager with other evidence that yours is a bona fide amateur radio club, for we have no "club" rates in the sense in which that word is usually used in the publication-subscription trade, meaning any group which subscribes together at one time.

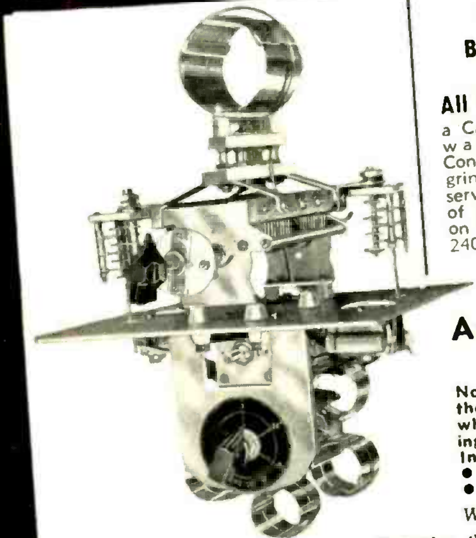
Clubs which cannot gather ten subscriptions at one time should take advantage of the special temporary Christmas season rates advertised elsewhere in this issue; these expire January 15th, and are not limited to amateur radio clubs. Clubs which can gather twelve or more subscriptions before that date will find these rates slightly lower than the permanent club rate.

There are no "club" rates on the "RADIO" HANDBOOK. Unlike RADIO, this book is sold largely through our best friends and yours, the radio parts stores, and we do not consider it a fair or wise business policy to "cut under" them. Please do not embarrass our circulation manager by asking him to do so.

Exaggeration

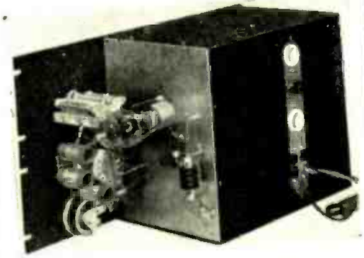
Our apologies to the meticulous soul who "called" us (and to any others who just didn't bother to write) on the ad on page 98 of the December issue. The ad read "RADIO for January—200 pages!!" Actually, of course, this issue has but 196 pages. Since an ordinary issue has 100 pages we fall into the habit of thinking a "double size" issue must have 200, but due to the peculiarities of printing it is actually four pages short of that figure.

CARDWELLS in a few 1940 applications



In Glen Browning's NEW All Band Exciter

a CARDWELL Midway Transmitting Condenser helps grind out a conservative 35 watts of driving power—on 5 bands, for any 240 watt amplifier.



Send for full details with circuit diagrams.

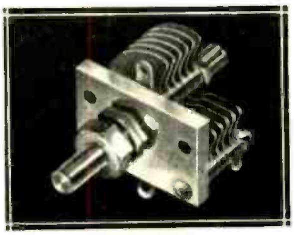
And Here's The 240 WATT 'PHONE OUTPUT FINAL AMPLIFIER

Not a kit we are trying to sell you—just a tested layout for the new RCA 812's, Taylor T-55's, HK-24's or similar tubes, which can be easily driven by such an exciter as the Browning.

Includes: • CARDWELL "AFU" Foundation
• CARDWELL EU-100-AD Trim-air dual
• Barker & Williamson coils and baby turret

Write for free drilling templates and directions.

Transfer this tested layout to your chassis, where you want it.



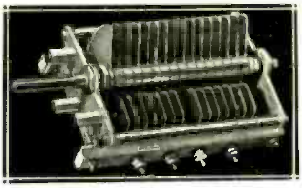
ZR-35-AS

Trim-Air Midget Condensers

Better than ever! New Single Trim-air Condensers with these new worth while features. • Full solid shaft • New locking nut insures positive shaft lock • Improved double lug brings connections out both sides of condenser • Thicker Isolantite plate prevents breakage • New ¼" split collar at rear permits coupling to other units.

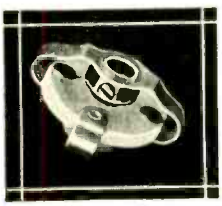
No increase in prices.

Midway Featherweight Xmtg. Condensers



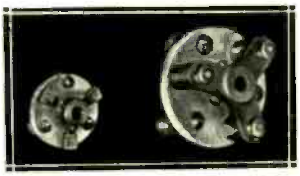
MT-70-GD

CARDWELL Midway Condensers assume the proportion of high power units, when connected a la Ferrill. See the RCA ad on the rear covers of December RADIO and QST, featuring the use of this type of circuit. 240 watts of 'phone output safely handled by the CARDWELL Midway MT-100-GD! Two more Midways and a pair of Trim-air Neutralizers complete the variable air components used.



TYPE "A"

TYPE "FNF"



TYPE "CNF"

TYPE "E"

INSULATED COUPLINGS

Now vitally important with everyone connecting the high voltage to their condenser rotors.

Thanks for your loyalty, gang, and may 1940 bring you complete fulfillment of your most cherished plans!

THE ALLEN D. CARDWELL MANUFACTURING CORPORATION
89 PROSPECT STREET, BROOKLYN, NEW YORK

Past • Present and • Prophetic

As this is being written the atmosphere around RADIO's bailiwick is permeated by a "whew, I'm glad that's over" attitude. What with the 1940 Handbook, the Amateur Newcomer's Handbook and this Yearbook issue of RADIO, things have been whirring in both the word and equipment departments for the past several months. In spite of all this activity we still have a good crop of ideas rattling around which will be passed along as fast as they are put to test.

Whopper

The statistically inclined might be interested to know that this outsize January issue of RADIO contains three times as many pages of editorial material as a regular issue—count it.

Inventors

In spite of last month's mention in this department that we, as well as nearly everyone else, knew that cathode modulation was not new—merely that it was deserving of wider application, letters continue to show up here and elsewhere to the effect that "I invented it 'way back in . . . ." So far none of these "I-done-its" has made claim to any of the years previous to 1934, thus leading one of the members of RADIO's staff to admit blushingly that he had been guilty of connecting a telephone mike into the center-tap keying jack of his 210 Hartley and operating on the old 85-meter phone band with complete satisfaction to himself and his listeners. This was "'way back in 1931." Not only that, but he claims he knew what he was doing and hasn't written a letter to anyone yet. Surely someone else must have done the same trick before he did. Any prior claims?

Asleep at the Mike

Along with much favorable comment on the "Comes the Revolution" article several remarks have been heard from here and there concerning the sleepy individual gracing last month's cover interpretation of the distended peak subject. The individual (no, we won't name him) who "modeled" for this shot is not entirely to blame for the unusual (or is it?) pose of an amateur talking into a microphone. The camera used happened to be an ancient Graflex which has a shutter mechanism that goes off like a four-bit pistol every time the release is pressed. Of seven pictures taken one was a dud and the other six showed said individual with his eyes tightly blinked at the noise of the shutter.

Oops, Sorry about Bloops

Is our face red! Last month under the heading "Keying by Request" this department went so far as to state that we had not yet found a really simple way to oscillator key a conventional v.f. exciter without "bloops." Well, it appears that if the v.f. oscillator is of the *e.c.o.* type and a *good* one (a la Perrine, for instance), all you have to do is stick the key in the screen of the oscillator. All very simple, but one of the things we hadn't heard about or got around to trying yet at the time of writing last month's squib.

Incidentally, the Franklin oscillator shown on page 41 can be keyed satisfactorily. Quite a nifty device, though we frankly admit it isn't as simple as some.

Advertisement

While on the subject of cover pictures, it might be well to mention that this month's cover is not intended as free Chamber of Commerce advertising extolling the advantages of California sunshine for winter mobile work. You will pardon us, however, if we point out that this picture was taken on November 24, with the thermometer resting well above the 70-degree mark. Details of the location and occasion will be found on page 144.

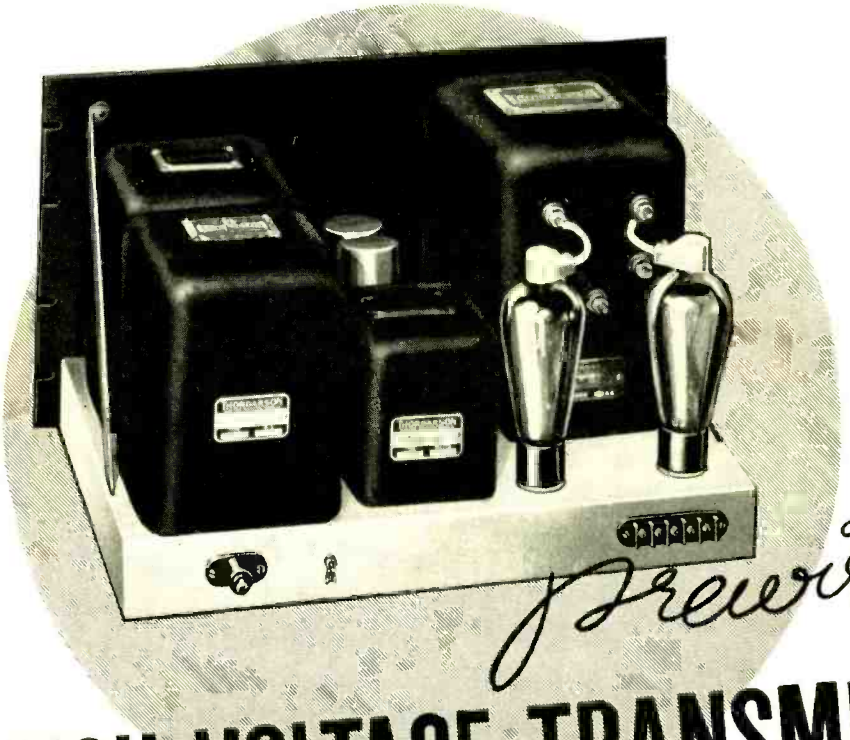
Frequency Modulation

Never was the "when it rains it pours" adage more true than when three frequency modulation articles arrived on the editor's desk in a dead heat. Rather than pass these out installment-style in future issues, the decision was made to publish all three in this issue as a symposium. The Singer and Harrison article is the best non-mathematical description of the subject that we have yet seen; it should be read by every amateur. To complete the picture, the articles by Seiler and Brooks describe transmitting and receiving equipment which should enable the experimentally inclined amateur to do a bit of dabbling in this new field.

Trends on Ten

If the Santa Barbara police radio system can be taken as an example, you can rest assured that George Grening knows whereof

[*Continued on Page 169*]



HIGH VOLTAGE TRANSMITTER POWER SUPPLY

HERE is a Millen transmitter power supply unit that will be a credit to any shack. Heavy steel baffle welded in base isolates input line circuits from high voltage leads. Has insulated safety output terminal, AC input terminal block, tube sockets, safety rectifier caps, etc. All prewired and punched for THORDARSON CHT transformers. Unit complete except for tubes, filter condensers, bleeder, transformers and chokes. Panels are standard fine grain black wrinkle finish in 1/8" steel. Standard relay rack punchings and sizes. The foundation units are made by the JAMES MILLEN MFG. CO. and sold by your Parts Distributor. Engineered to use the following THORDARSON CHT transformers:

FOUNDATION Unit No. 80201 uses T15C37, T15C46 and T11F53 and provides a choice of:

T-15P13 To deliver 750 or 600 volts at 300 ma
or T-15P14 To deliver 1000 or 750 volts at 300 ma
or T-15P15 To deliver 1250 or 1000 volts at 300 ma
or T-15P17 To deliver 1500 or 1250 volts at 300 ma

Foundation Unit No. 80205 uses T15C37, T15C46, T11F53 and T15P19 to deliver 2500 or 2000 volts at 300 ma.

THORDARSON

ELEC. MFG. CO., CHICAGO

"TRANSFORMER SPECIALISTS *45th Anniversary* SINCE 1895"

January · 1940 **No. 245**

RADIO

Table of Contents

ARTICLES

MISCELLANEOUS FEATURES

DEPARTMENTS

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

• Radiomen aboard the U. S. S. Bear on her trial run. From left to right they are: J. A. Daigle, E. L. Lamplugh, Clifford Harvey of the transmitter firm, and W. A. Nylund.

Byrd Antarctic Expedition III

• Left to right, Jerry A. Reece, Elmer L. Lamplugh, (Chief operator at the East Base), Clay Bailey (chief operator at West Base and Director of Communications for the entire Expedition), Joseph Daigle, and Howard T. Odom, all radiomen of the U. S. Antarctic Service Expedition. Lamplugh is W1LWD. Photos by W1BBY.

FREQUENCY MODULATION FUNDAMENTALS

BASIC THEORY OF FREQUENCY MODULATION AS APPLIED TO TRANSMITTERS, RECEIVERS, AND ANTENNA SYSTEMS.

By C. H. SINGER and C. W. HARRISON*

Frequency modulation at the present time is in an introductory state, but its rapid development and pronounced acceptance in broadcasting warrants every radio experimenter's knowledge of its fundamentals. The authors wish to state that no partiality to any particular system will be expressed, but, to the best of their knowledge, a consideration of both good and bad points of the various systems will be pointed out.

The rapid rise in interest of frequency modulation principles makes this subject seem new, but in reality experiments were being conducted with this type of modulation a few years after the close of the World War. It was in 1922 that J. R. Carson published a paper which shattered all hopes of obtaining quality along with narrow sidebands by the frequency modulation principle.[1] Carson's paper did not end all the experimentation that was being carried on, but in most laboratories interest was diverted to other channels which had a more productive outlook. In 1936 Major E. H. Armstrong announced and demonstrated "wide-band" frequency modulation, illustrating its noise suppression and high fidelity characteristics. Major Armstrong should receive due recognition for employing wide radio frequency bands which alone made frequency modulation practical.

A physical picture of frequency modulation as compared to amplitude modulation is illustrated in figure 1. Part (e) illustrates the distortion present over a few cycles. Assume that a 400-cycle sound wave is transmitted by frequency modulation with the carrier at 40,000,000 cycles. This is accomplished by varying the transmitted frequency between 40,100,000 cycles and 39,900,000 cycles, 400 times a second. The number of cycles variation, which is ±100 kc. in the

*WOR Transmitter, Carteret, New Jersey.

Frequency modulation as a means of high-fidelity transmission is rapidly coming into its own. A number of high- and medium-power transmitters are already in service on the east coast and others are projected for the Chicago area and the west coast. For this reason RADIO this month presents a symposium on the subject: an extensive technical article of general coverage, an article discussing demodulator circuits for receivers, and a short article giving a simple method of obtaining a frequency modulated signal for experimental u.h.f. tests with the system.

This, the first of the three articles, should be read by every amateur. To those to whom frequency modulation has just been a word, this article will give a general idea of the theory involved, and an understanding of the operation of frequency modulated transmitters and receivers. To the more advanced amateur this article, once read, can serve as a condensed reference source for information on the general phases of the subject. The complete bibliography will be of assistance in obtaining more extensive information on any branch of frequency modulation.

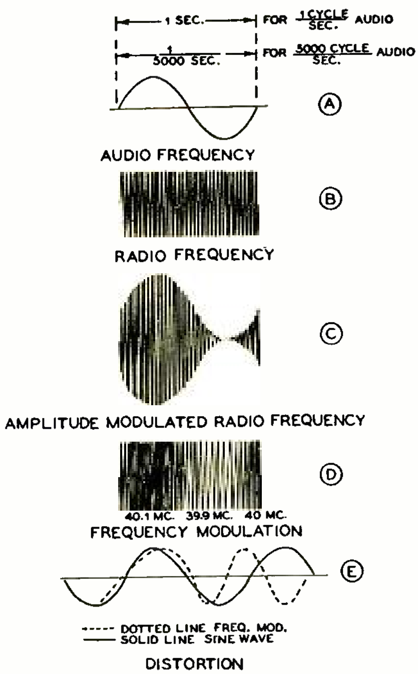


Figure 1. Graphical representation of a comparison between amplitude and frequency modulation.

case illustrated above, is due to the audio amplitude, and the frequency of the carrier variation is determined by the applied audio frequency. This is true when the audio signal is considered to be a sine wave of constant amplitude. The illustration may be carried further to say that, if the audio amplitude is increased to twice the above assumed level, the carrier would vary ±200 kc. This makes the carrier vary within the limits of 40,200,000 and 39,800,000 cycles, according to the audio frequency. If an audio signal of 1000 cycles were applied at a magnitude sufficient to cause the ±200-kc. variation, the carrier frequency would vary between 40.2 Mc. and 39.8 Mc. at the rate of 1000 times a second, or the carrier would continuously change between 40.2 Mc. to 39.8 Mc. and back again to 40.2 Mc. in 1/1000 second. The Federal Communications Commission permits a 100-kc. variation either side of the carrier frequency. The above example using a variation of ±200 kc. is, therefore, only an illustration of the fundamental principle of frequency modulation.

When this system was first investigated, it was believed that very narrow sidebands might result, but it was soon discovered that the higher order sidebands become so great that this would prove impractical. The radio frequency variation at 5000 cycles was insufficient to reduce the magnitude of the higher order of sidebands. When narrow-band variation was used, much distortion occurred, resulting in wider sidebands. Had it been conceived at that time that the variation might have been given 100-kc. limits, as Major E. H. Armstrong advocates, radio might present a different story today.

Summarizing the above discussion and neglecting to elaborate on how such modulation is to be obtained, we may say that frequency modulation consists of varying the carrier between two radio frequency limits at an audio rate. If the variation of carrier is determined solely by the audio level, and the rate that the carrier varies between these two radio frequency limits is the audio frequency, "pure" frequency modulation is the result.

Advantages of Frequency Modulation

The greatest advantage of frequency modulation is the complete absence of noise.[14] Noise may be reduced to the extent of 100 db, depending upon the inherent qualities used in the transmitter. High fidelity properties are more easily obtained by frequency modulation than by amplitude modulation. The overall frequency response of such transmitters has been known to be flat over 30 cycles to 15,000 cycles. The receiver's frequency response variation need not be greater than 2 db between 30 cycles and 15,000 cycles. It seems that frequency modulation offers a solution for high fidelity in radio reception, but to obtain the fine quality available, it is essential to adhere to good acoustical receiver equipment.

Another very popular advantage of frequency modulation is prevalent if the power output is to be increased. To increase the power output of such a transmitter it is only necessary to add radio frequency amplifiers. This makes a simple conversion possible, and the fact that it is a class C amplifier makes the efficiency higher. There seems to be no limit to the number of radio frequency amplifiers that may be added to the same equipment. "Push-pull" class C is used to reduce the capacity effect at this high frequency.

It might be logically questioned what advantages frequency modulation has over amplitude modulation in the ultra-high frequency band. In the ultra-high frequency spectrum, the static level is very low, and other disturbances are not as prevalent as they are at the lower frequencies. It is difficult to differentiate between the two, but such noises as ignition, proximity of nearby man-made electrical devices, and atmospheric disturbances create the greater part of the undesired high-frequency amplitude disturbances in the amplitude modulated receiver. In frequency modulation it might be said that something is being obtained from nothing, as, for example, amplitude disturbances are not heard. This statement is strictly true when the receiver is working properly.

Noise may occur in the transmitter, whereupon it would be picked up in the receiver. If, however, sufficient care is taken at the transmitter to acquire "quiet tubes," and, if the electrical circuits of the transmitter are properly maintained, noise is cut to a minimum. Frequency modulation noise may also occur when the noise-to-signal ratio becomes greater than one. This means that if the radio frequency noise has a field strength that exceeds the field strength of the desired signal, no signal may be heard.

The Masking Effect

This brings out one very interesting feature of frequency modulation; namely, if two stations are on the same frequency, and one has a field strength which is twice that of the other or greater, only the stronger will be heard. The weaker signal is entirely suppressed. This characteristic of frequency modulation may cause considerable difficulty but continued research may find the solution. If a 50,000-watt station is on the same frequency as a 1000-watt station at a reasonably close range, the 50,000-watt signal will practically nullify the 1000-watt transmitter's primary area.

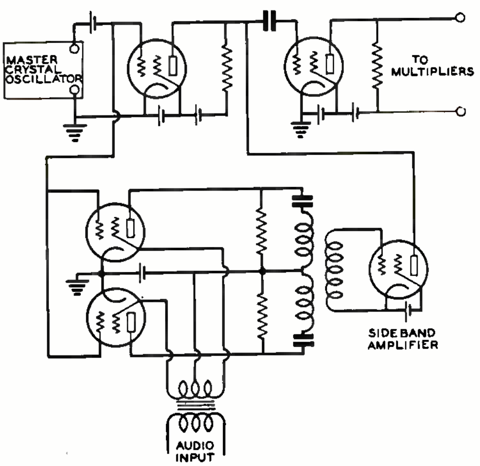
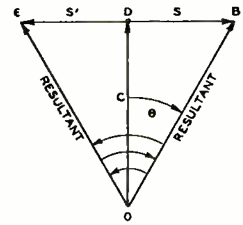


Figure 2. The Armstrong system of frequency modulation.

Figure 3. Vector diagram showing phase modulation as a result of combining sidebands which have been shifted 90° with respect to the carrier, back with the carrier.



VECTOR REPRESENTATION OF HOW A PHASE SHIFT IS OBTAINED BY COMBINING SIDEBANDS S AND S' WITH THE CRYSTAL OSCILLATOR'S AMPLIFIED VOLTAGE C. THE SIDE BANDS VARY OUT FROM THE POINT (D) BETWEEN (B) & (E) AT THE RATE OF THE SIDE BAND FREQUENCY. THE RESULTANT VARIES FROM (O)(B) THROUGH (O)(C) AND BACK AGAIN AS DETERMINED BY THE AUDIO SIGNAL

Experiments have been carried out between two stations to illustrate the above described properties. If two stations are on the same frequency a few miles apart, a portable receiver will receive the stronger signal. Many recent suggestions as to a practical application of this property are being considered by various organizations. To obtain a signal free from noise, the relation, $\frac{\text{signal}}{\text{noise}} > 2$, should be observed. Serious consideration should be given to this effect of signal strength.

Phase Modulation

Before considering how this carrier varies between its two radio frequency limits at an audio rate, the phenomenon of phase modulation should first be explained. Phase modulation consists of nothing more than varying the phase of the radio frequency wave. This type of modulation must invariably be a type of frequency modulation; that is, to vary the phase of one cycle is to vary the frequency of that one cycle. Phase modulation concerns the variation of the phase, but nothing is said about radio frequency varying between two given limits. In other words, the variation of the carrier in frequency modulation is not only determined by the audio level but by the frequency of the audio as well. This alone constitutes the principal difference between phase modulation and frequency modulation.

It is emphasized again that "pure" frequency modulation is defined as varying the carrier between two limits at an audio rate,

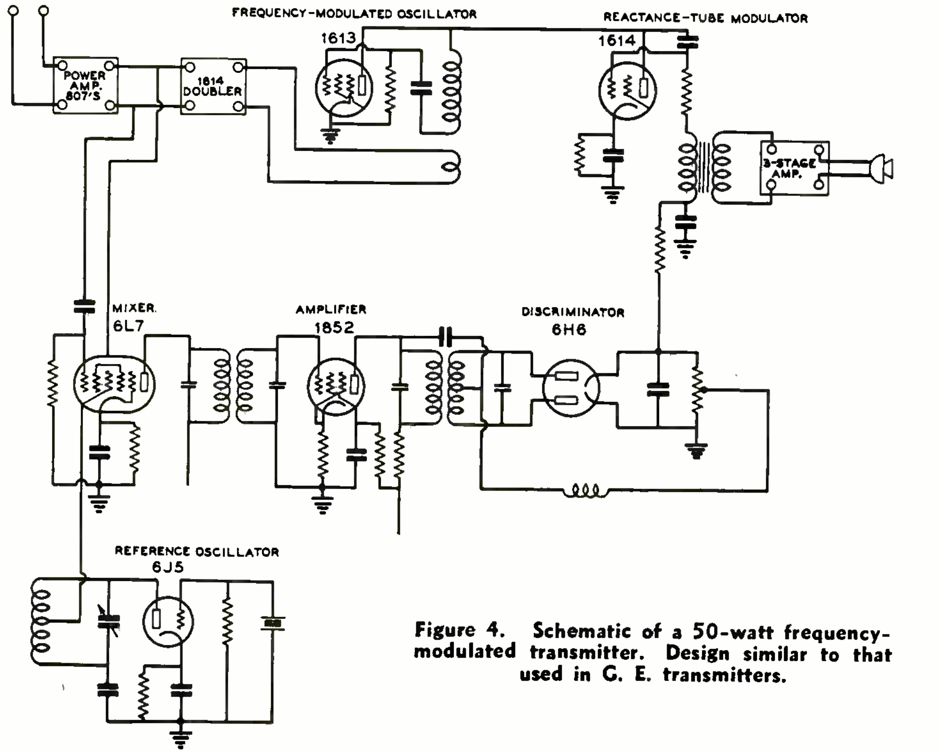


Figure 4. Schematic of a 50-watt frequency-modulated transmitter. Design similar to that used in G. E. transmitters.

the amount of variation of carrier being proportional only to the audio level in the transmitter. The variation between these two limits is directly proportional to the audio frequency applied.

The Pre-Attenuator

A phase modulation transmitter is transformed into a "pure" frequency modulation transmitter by a pre-attenuator. A pre-attenuator is a simple filter which is inserted in the audio amplifier to give less gain at the higher audio frequencies. The loss is linear with frequency; that is, as the audio frequency increases, the level of the audio input to the transmitter decreases. For example, if the audio frequency is at a level of 1 db, and the audio input frequency is one cycle per second (assume the source of audio to be a beat frequency oscillator), the level of 1 db has the proper magnitude to vary the carrier ±100 kc. (assuming the carrier to be 40 Mc.) from 40.1 Mc. to 39.9 Mc. at the rate of 1 cycle per second. Now apply a 5000-cycle audio signal in place of the 1-cycle audio swing. This will increase the radio frequency variation, and, since in "pure" frequency modulation the variation is independent of the amplitude, something must be done to maintain this variation independent of the audio frequency.

Figure 1 is again helpful in illustrating why the pre-attenuator is a necessity. Part (a) of figure 1 illustrates a 1-cycle audio signal and a 5000-cycle audio signal. Part (d) of figure 1 shows how the carrier changes frequency from 40.1 Mc. to 39.9 Mc. and back, as the 1-cycle audio is applied. The variation of radio frequency would also hold true in figure 1 even if 5000-cycle audio were applied, the only difference being that the time of occurrence for the 1-cycle audio is one second, while the time of the 5000-cycle audio is 1/5000 of a second. Part (d), then, effectively has a greater frequency change if the same change of frequency variation is required in less time. This makes the radio frequency variation greater than ±100 kc. It may also be observed in part (d) how the variation changes (assuming a 40-Mc. carrier) from 40.1 Mc. to 39.9 Mc., etc., at the rate of the audio frequency applied.[15]

A filter (pre-attenuator) is added in the audio circuit to decrease the audio amplitude in such a way that the variation will remain ±100 kc. for all audio frequencies. The present methods of obtaining frequency modulation increase the transmitter's radio frequency variation with increasing audio frequency, but in each case the level is brought down by the pre-attenuator. The variation of radio frequency, therefore, does not take place between greater radio frequency limits at the higher audio frequencies.

Let us suppose that this increase of variation of the radio frequency were allowed to increase with audio frequency. This would make the sidebands greater than their original ±100-kc. swing for the higher audio frequencies. The increase of sideband frequencies is small, but the receiver is dependent on the amount of variation of the radio frequency to determine its volume as originally defined by the term "pure" frequency modulation. Thus, if the sidebands were to increase for the higher audio frequencies, the volume would be greater for these higher frequencies. This effect is undesirable, and the pre-attenuator is, therefore, needed to decrease the level to compensate for the change in amount of the radio frequency variation. It is possible to leave out the pre-attenuator in the transmitter and insert it in the receiver, but this involves a greater expense to the public.

Attaining Frequency Modulation

From the previous discussion it is noted that we require some method for varying the frequency. Any method will be satisfactory as long as our average carrier frequency remains at the same assigned operating frequency. This is usually obtained by phase

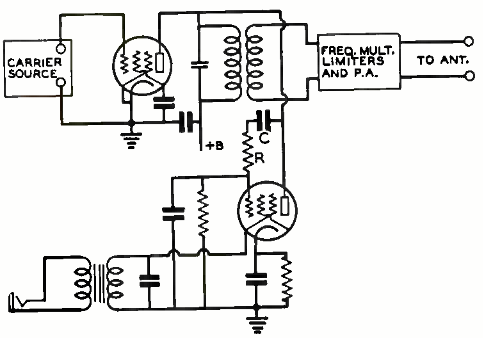


Figure 5. Modulation arrangement similar to figure 4 but using a different method of introducing the audio.

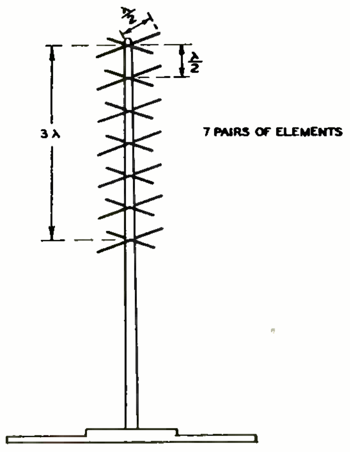


Figure 6. The turnstile antenna.

modulation and converted into frequency modulation by the pre-attenuator.

Major E. H. Armstrong has suggested many methods of producing frequency modulation,[9] but the particular system described here is his original suggestion in 1936. This system today is in use at various localities and produces excellent results. It is interesting to note in figure 2 that amplitude modulation is incorporated in this particular system for producing frequency modulation. Its part is played by adding another voltage, which contains only the sidebands, in such a manner that the net effect will be that of shifting the phase of the carrier.

Figure 3 illustrates the phase shift that results from the addition of the sideband voltage at right angles to the carrier voltage. (C) is the vector representing the carrier signal, while (S) and (S′) are the sideband voltages which are added at right angles to the carrier voltage. The resultants show the variation of phase angle for instantaneous values of sidebands applied. At a particular instant when θ is at a maximum of 30 degrees, the resultant carrier is represented by (O) (B). (O) (B) has a greater magnitude than (O) (D), which means that some amplitude modulation exists in this method. The amplitude is necessarily cut off in the receiver, but this is of no consequence.

The maximum angle is determined by a number of factors, mainly harmonics. It may be noticed that the value of θ could never exceed 90 degrees, and the angular velocity of the vector is linear to approximately 25 or 30 degrees.

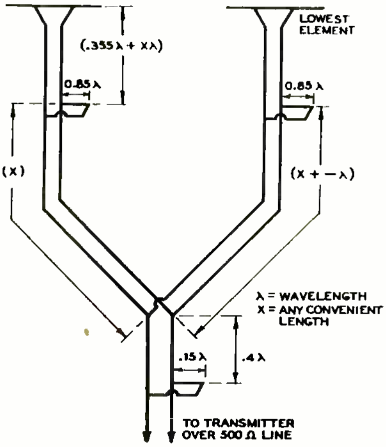


Figure 7. Approximate dimensions for transmission line to feed turnstile antenna array as suggested by G. H. Brown.

A phase shift of 30 degrees is obtained at approximately 200 kc., and the frequency is multiplied to approximately 12 Mc. Insufficient phase shift with straight doubling makes it necessary to add another oscillator at approximately the 12 Mc. point, giving a difference in frequency of approximately .5 Mc. Then again the signal is tripled, until the required carrier frequency is obtained.

From the circuit as shown in figure 2 a voltage from the crystal oscillator is fed to the grids of a push-pull radio frequency amplifier called a balanced modulator. In the two push-pull tubes, the control grids are paralleled and connected to the side of the crystal oscillator tank coil. Both tubes draw plate current at the same time in opposite directions, thus eliminating the carrier.

The audio is fed in a true push-pull fashion to the suppressor grids of this same push-pull stage. When the audio signal impresses a positive voltage on one grid, it is correspondingly impressing a minus voltage on the other, thus unbalancing the system to produce only the sidebands. The sidebands are amplified and combined with the original carrier signal after the first amplifier tube circuit. In this manner it is possible to shift the phase the required 30 degrees.

Various precautions are necessarily observed when using this method to obtain frequency modulation. The first crystal oscillator must maintain its frequency within a few cycles because of the great amount of frequency multiplication. Any variation of phase over 1 cycle, even so little as one-fourth cycle, causes the noise level to rise. The second crystal oscillator gives a beat frequency of a much lower frequency, but many other frequencies are obtained and these make filtering necessary. Transmitters of this type require shock-proof crystal mountings and shielded filters. The authors have attended a number of demonstrations, and in every instance excellent quality and low noise level were self-evident.

Reactance-Tube Phase Modulation

From time to time Murray G. Crosby has suggested many circuits for producing phase modulation.[19] Various developments have been made from Crosby's original suggestions. In the General Electric System, one of his circuits laid the foundation for what has proved a successful system of frequency modulation. Figure 4 illustrates one conception of how this particular system operates. The fundamental oscillator is self-excited, and is made to vary its frequency by effectively adding reactance to the oscillator through the reactance tube. The reactance tube is so named because it adds this reactance to the tuned oscillator. This produces an effective change in frequency. In this way the reactance may add or subtract in accordance with the manner in which the reactance tube is made to act.

The output of the modulated oscillator enters two doublers and is amplified to the desired power. A small voltage is taken from the output amplifier and fed to the converter tube. This voltage is in turn beat against

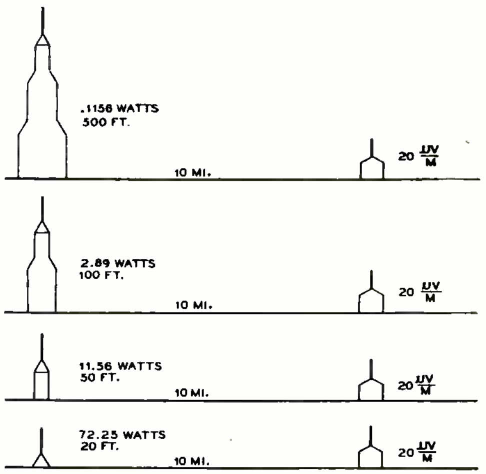


Figure 8. Power required to produce a given signal at the receiving location for different antenna heights.

a crystal oscillator to give a difference frequency of 1500 kc. This signal is again amplified and fed to the discriminator tube.

The discriminator tube is a type of diode rectifier which rectifies the voltage. The slope filter (see receiver section) which supplies the diodes with voltage proportional to the frequency, furnishes bias to the reactance tube. The reactance tube maintains the oscillator frequency. Any change of the average frequency of this oscillator will in turn supply a reactance which tends to counteract the original change in the frequency. The stability of difference frequency is maintained by a crystal oscillator. Figure 4 shows that this control circuit is rather slow-acting, but it will compensate for any average output frequency change. When the average frequency is at 40 Mc., the discriminator feeds the correct amount of bias to the reactance tube. Should the average frequency tend to change, the beat frequency would differ from 1500 kc. resulting in more or less bias being added to the reactance tube as determined by the slope filter. This would in turn add or subtract reactance to bring the average frequency back to 40 Mc. Slope circuits have a few bad inherent qualities. For example, should anything happen to any tube in the control circuit, the average frequency would be thrown to its maximum change as allowed by the reactance tube. Under proper care and operation this disadvantage is easily overcome.

The same holds true in using a reactance tube to induce reactance in a crystal oscillator. The phase of a crystal oscillator may be varied a few degrees, but then doubling presents a problem because of the additional stages to gain a necessary phase shift. Figure 5 gives another method recently suggested by Crosby which is used to obtain phase modulation. This method seems more applicable to portable equipment.[11]

At the present time frequency modulation is in an introductory period, and various experiments are being carried out. Such design features as (1) tubes that may be operated below their normal rating, requiring less care and encouraging longer life; (2) fewer number of tubes; (3) average frequency depending only upon a crystal; (4) a transmitter which is capable of being fully modulated at any audio frequency; and (5) constant frequency for wide fluctuations of line voltage, are among the considerations of future development of frequency modulation transmitters.

Antennas for Frequency Modulation

Antenna design at ultra-high frequencies presents various possibilities. Sky-wave transmission is usually undesirable at these ultra-high frequencies because of the limited amount that returns to the earth. Hence, this discussion will deal only with low angle radiation. Directive arrays or non-directive antennas are not hindered by the wide radio frequency range which frequency modulation necessitates.

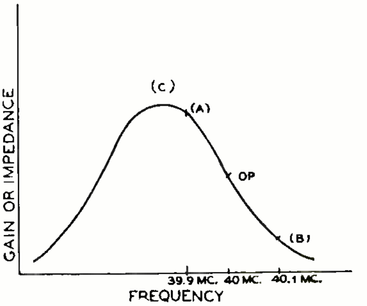


Figure 9.

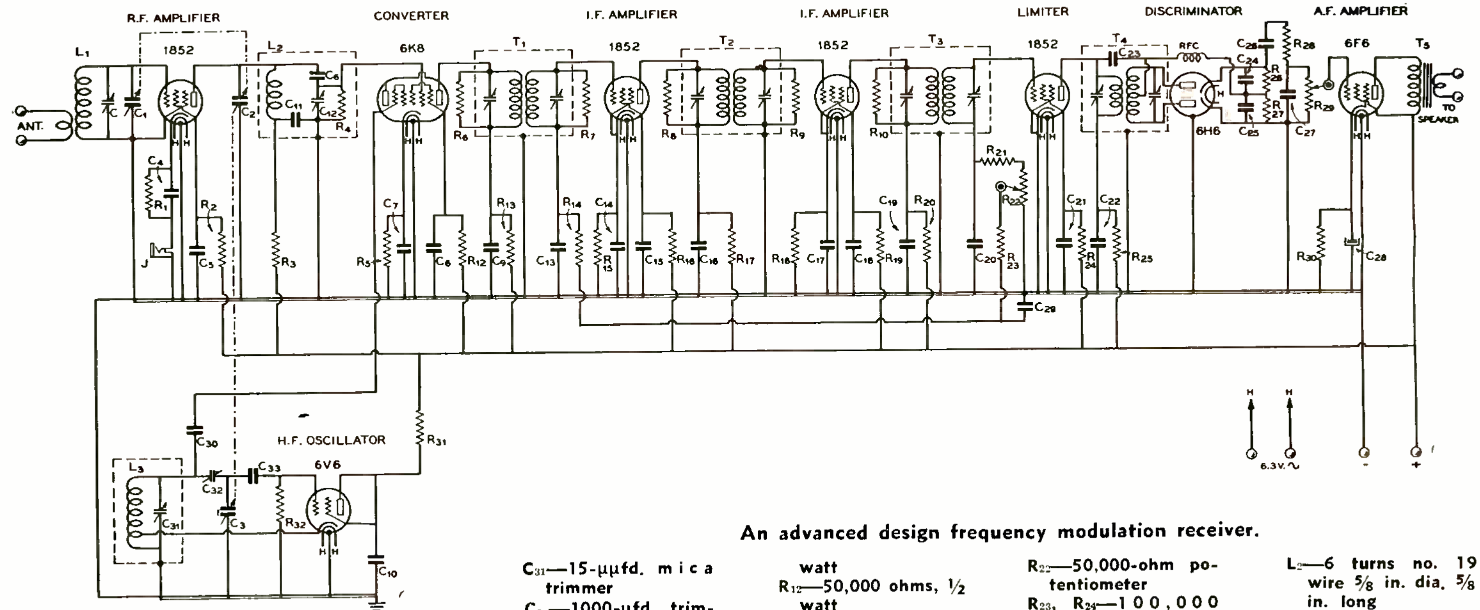
The "turnstile" antenna may be ideally adapted to broadcast on frequencies below 10 meters.[10] Figure 6 illustrates a 7-paired element turnstile antenna. This antenna economizes power by concentrating its energy in the horizontal plane, thus reducing the possible sky-wave radiation losses. To illustrate how this concentration is obtained, Table I gives approximately the relative power gain for various pairs of elements over a single vertical half-wave antenna.

By using the "turnstile" with six pairs of elements, a power gain of approximately 4.25 may be effected in the horizontal plane. The feeders may be of the usual two-wire feed, but care must be taken to feed the one antenna 90 degrees out of phase with respect to the other. Figure 7 suggests a method. The two-wire transmission line will have the usual characteristic impedance of 500 ohms. The lengths given in figure 7 may be increased any additional number of half wavelengths required.

Should it be desirable to make the field pattern oblong rather than circular, the only necessary change in the antenna setup is to

TABLE I

Pairs of Elements	Approximate Power Gain
2	1.25
3	2.00
4	2.75
5	3.50
6	4.25
7	5.00
8	5.75



An advanced design frequency modulation receiver.

C—15-μμfd. mica trimmer

C_1, C_2, C_3—20-μμfd. variable

C_4, C_5, C_6, C_7, C_8, C_9, C_{10} — .002-μfd. mica

C_{11}—.01-μfd. mica

C_{12}—15-μμfd. mica trimmer

C_{13}, C_{14}, C_{15}, C_{16}, C_{17}, C_{18}, C_{19}, C_{20} — .01-μfd. 400-volt tubular

C_{21}—0.1-μfd. 400-volt tubular

C_{22}—.05-μfd. 400-volt tubular

C_{23}—.002-μfd. mica

C_{24}, C_{25}—.00005-μfd. mica

C_{26}—.05-μfd. 200-volt tubular

C_{27}—.001-μfd. mica

C_{28}—25-μfd. 25-volt electrolytic

C_{29}—.01-μfd. 400-volt tubular

C_{30}—.00001-μfd. mica

C_{31}—15-μμfd. mica trimmer

C_{32}—1000-μfd. trimmer

C_{33}—.00005-μfd. mica

R_1—250 ohms, ½ watt

R_2—15,000 ohms, ½ watt

R_3—1000 ohms, ½ watt

R_4—1 megohm, ½ watt

R_5—250 ohms, ½ watt

R_6, R_7, R_8, R_9, R_{10}—15,000 ohms, ½ watt

R_{12}—50,000 ohms, ½ watt

R_{13}—1000 ohms, ½ watt

R_{14}—1000 ohms, ½ watt

R_{15}—200 ohms, ½ watt

R_{16}—50,000 ohms, ½ watt

R_{17}—1000 ohms, ½ watt

R_{18}—200 ohms, ½ watt

R_{19}—50,000 ohms, ½ watt

R_{20}, R_{21}—1000 ohms, ½ watt

R_{22}—50,000-ohm potentiometer

R_{23}, R_{24}—100,000 ohms, ½ watt

R_{25}—20,000 ohms, ½ watt

R_{26}, R_{27}, R_{28}—100,000 ohms, ½ watt

R_{29}—500,000-ohm potentiometer

R_{30}—500 ohms, 10 watts

R_{31}—40,000 ohms, 2 watts

R_{32}—100,000 ohms, ½ watt

L_1—7 turns no. 19 wire ⅝ in. dia. ⅞ in. long

L_2—6 turns no. 19 wire ⅝ in. dia. ⅝ in. long

L_3—12 turns no. 19 wire closewound ⅝ in. dia. Tap at 4 turns from ground end

Antenna Coil — Two turns no. 14 wire wound over ground end of L_1

T_1, T_2, T_3—5000-kc. interstage transformer

T_4—5000-kc. diode-output transformer

T_5—Pentode-to-voice coil transformer

J—Circuit-closing jack

feed one antenna more current than is fed to the other antenna.

Figure 8 illustrates the effect that height has upon the field strength. For purposes of calculation, the following formula will approximate the field strength from the output of a single radiator.[18]

$$E = \frac{.01052\sqrt{P}.H.A.F}{d^2}$$

P = Power Radiated in Watts
H = Height of Transmitter Antenna in Feet
A = Height of Receiver Antenna in Feet
F = Frequency in Mc.
D = Distance in Miles
E = Microvolts per Meter

The distance that can possibly be covered may be calculated from:

$S = 1.63\ (\sqrt{T} + \sqrt{R})$
T = Transmitter Height in Feet
R = Receiver Height in Feet
S = Miles Possible

The latter formula is the optical distance and is the maximum practical distance obtainable for all ultra-high frequencies. The field strength possible may then be calculated by the first formula. The effective power radiated is proportional to the square of the altitude of the antenna. Thus, the greater the antenna height, the less power required. If a turnstile antenna is used, a greater effective power can be obtained. It may be noted that horizontal polarization of the antenna is preferable.

RECEIVER CONSIDERATIONS AS APPLIED TO FREQUENCY MODULATION

The frequency modulated receiver compares favorably with the standard broadcast receiver. The received signal will have some amplitude properties, but the desired signal is to be interpreted only through its frequency variation. It is independent of the amplitude of the incoming carrier. To receive a 40-Mc. signal, the signal is first amplified and then converted into an intermediate frequency by the first detector, just as it would be in any receiver. The intermediate frequency is then amplified in a normal fashion, but at the point where it usually enters the second detector, its amplitude is trimmed down by the limiter.[21]

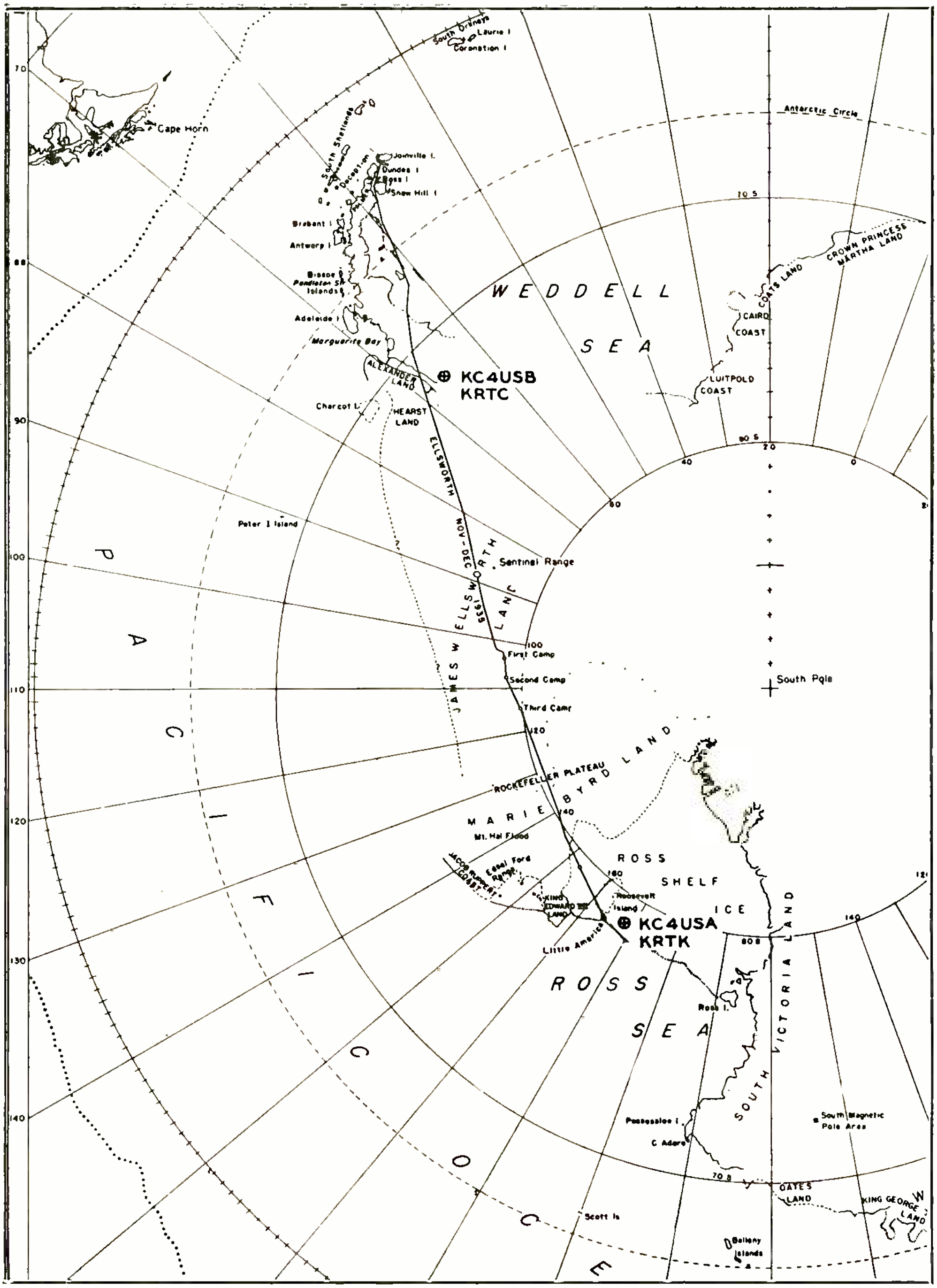
The limiting stage is commonly called the current limiter amplifier. The tube is regulated so that it will begin to limit at 3 volts peak and is completely levelled off at 5 volts. The tube, as operated, is a grid-controlled cathode rectifier and develops a negative bias voltage to ground on a resistor in the grid circuit. This results in a decreased gain of the stage for increasing amplitudes. The greater the amplitude, the greater the negative bias applied, thus resulting in a constant output amplitude. Any amplitude noise is cut off by the action of this limiter. In particular instances where the field strength is too weak to operate this limiter, noise may be very noticeable. The trimming action of the limiter cuts deep into the amplitude of the carrier to insure proper action at all times. Although the limiter distorts the amplitude to a great extent, the frequency is not varied. Since the "intelligence" is being carried through by frequency changes, no harm is done by the limiter.

After it passes through the limiter, the signal has a constant amplitude. It enters the slope filter to be converted into amplitude and audio frequency. The slope filter has two functions to perform: (1) to convert the amount of transmitter radio frequency deviation into audio amplitude, and (2) to convert the radio frequency variation of ±100 kc. into a given amplitude, the rate of change of variation being automatically converted into audio frequency.

The entire action of the slope filter depends on the inherent action of the intermediate frequency transformer. The magnitude of voltage, as taken from the intermediate frequency transformer, determines the receiver's audio level and is proportional to the impedance of the transformer. The impedance of the intermediate frequency transformer is a function of frequency, and, since it was previously stated that the audio level was proportional to impedance, by the simple action of an intermediate transformer alone, the audio level is a function of frequency.

Figure 9 illustrates how the action of this transformer transfers the frequency variation into amplitude variations. A portion of this characteristic permits the amplitude to be a linear function of the amount of radio frequency variation. This portion is represented between points (a) and (b). It may be seen that the impedance of an intermediate frequency transformer rises as the frequency approaches the resonant frequency until a maximum occurs, and then the impedance decreases as the frequency passes on by the resonant frequency. The sides of this characteristic are reasonably straight up to the resonant point, (c), sloping down again to make the curve symmetrical. The sides are appreciably straight and will give a decreased gain for increasing frequency, provided only that part of the curve illustrated by (a)-(b) is used.

[*Continued on Page 163*]



Section of a U. S. Government map of Antarctica showing the projected location of the West Base, KC4USA-KRTK, and of the East Base, KC4USB-KRTC. The snow-cruiser, KC4USC-KRTA, may be located somewhere along the 2600-mile wilderness of ice and snow between the two bases.

Amateur Radio and the

BYRD ANTARCTIC EXPEDITION III

Amateur radio will once again play an important part in the communications plan of the U. S. Antarctic Expedition, now being led into the icy wastes of Antarctica by America's renowned explorer-scientist, Admiral Richard E. Byrd.

From Boston, in mid-November, sailed the two ships of the expedition, the *North Star* and the *Bear of Oakland,* carrying supplies and equipment sufficient to last the crew of approximately sixty men something like two years.

The *North Star* carries the main party, headed by Admiral R. E. Byrd, which is to be based at what will be known as the West Base, located at approximately the same spot as "Little America," on the Ice Shelf of the Ross Sea, south of New Zealand. Also aboard the *North Star* is the famous snow cruiser, *Penguin I,* which is expected to be of great value to the expedition in aiding the exploration of many parts of the vast 2600-mile icy wilderness which stretches between the West Base and the East Base.

On board the ship *Bear of Oakland* are men, equipment and supplies for the East Base, which will be established at a point on the Antarctic continent at the base of the South Atlantic Ocean, south of Argentina and the Falkland Islands.

This expedition differs from previous ones in Antarctica in that it is mostly government-financed and is under the joint jurisdiction of the Department of the Interior and the Navy Department of the United States.

Whereas regular news dispatches and similar traffic were handled entirely by commercial communication systems for the last Byrd Expedition, the present expedition will utilize regular Navy communication channels for official dispatches; press will be handled by commercial communication companies, and unofficial traffic will be sent through amateur contacts, both U. S. and international.

All operators on the expedition are understood to be class A amateur operators, and all were drawn from the Navy.

Approximately 22 men will be based at each of the two main bases West and East, and the balance will be used to man the snow-cruiser, and outposts.

Amateur call letters assigned to the bases are: KC4USA for the West Base, KC4USB for the East Base, and KC4USC for the snow-cruiser. Clay W. Bailey is Chief Radioman for the expedition, and is a veteran in the work, having been in charge of communication on Admiral Byrd's last venture into Antarctica. He will be at the West Base, and while not an amateur himself, will have some amateur operators with him and is intensely interested in determining how effective amateur communication can be. At the East Base is Elmer L. Lamplugh, W1LWD, ex-W6CTV, who will be in charge of communications from that base.

Personnel for the snow-cruiser is not known at this writing but will most certainly include amateurs as it is definitely scheduled to maintain contact with amateurs direct. It carries a 125-watt Harvey transmitter, supplemented by a 30-watt rig and one or more portable transmitters of about 12 watts power. All but the latter will be equipped for phone as well as c.w. transmission, the "trail sets" being c.w. only.

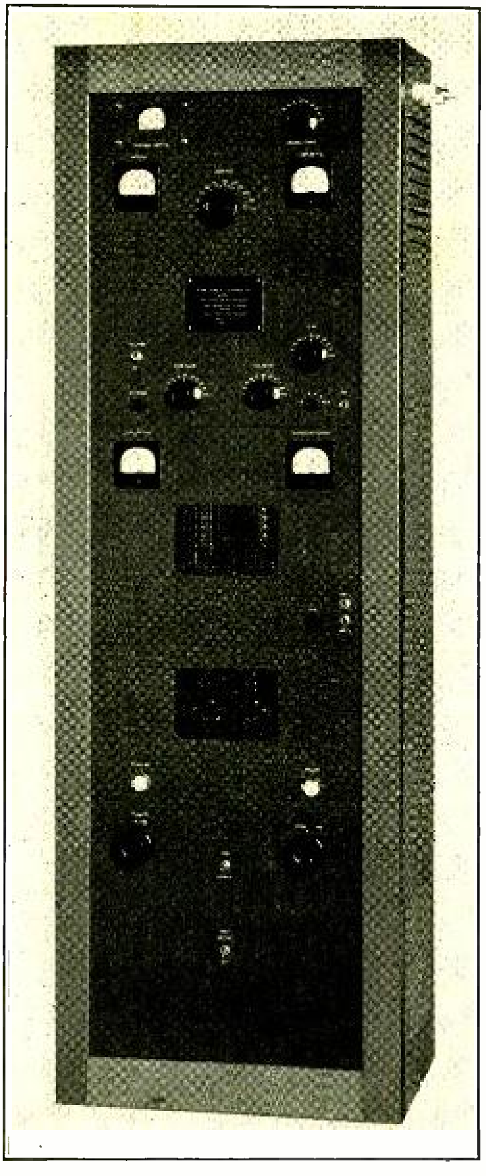
Transmitters at the main bases will include a 500-watt phone c.w. unit, a 125-watt phone-c.w. rig, a 30-watt phone-c.w. transmitter, and one or more portable "trail sets" of 12 wats power.

It is not anticipated that any of these transmitters will be actually on the air until sometime in February. Much work is necessary beforehand in the setting up of the longwire beams and harmonic operated antennas.

At the East Base will be 15,900 feet of wire in various arrays, such as "V" beams, rhombics and long-wire antennas. All antennas were designed by E. L. Lamplugh and are intended to throw intensive signals into the United States on both coasts.

It is interesting to note that these antennas can be laid down on the snow and operated with very high efficiency, due to the fact that the snow is not usually very moist and its surface is a good many feet off of the actual ground. In fact, the tractor parties and sleds will trail their antennas in making contacts with the main bases. The tractor parties and outposts will have transmitters of 30 watts power and 12 watts power, but will not use them for "outside" contacts, being intended for interbase communication only.

Power plants at both bases are to be Diesel engined generators, and a three-kilowatt Diesel driven generator is included in the snow-cruiser as well as auxiliary battery banks, and a rotary converter.



One of the 500-watt push-pull 813 transmitters to be used as the main communications unit both at the East and West Base.

Frequencies of operation on the amateur channels will vary, as all transmitters are capable of "v.f." operation, but regular American amateur regulations will prevail, requiring the use of A-3 emission only in the sections of the various ham bands allotted for that purpose, and c.w. in the regular A-1 sections. Most operation is anticipated in the frequency range from 7 to 30 megacycles. Twenty-meter phone will be heard from KC4USA on 14,150 kc., according to present plans. Schedules have been made in advance with W6KW on the California coast. Other schedules will be made as desired, and as found feasible.

Further information on the expedition schedules will be forthcoming as soon as available.

Shortwave broadcasts are to be handled by RCA Communications System from both East and West Bases, and will be heard over the usual networks, such as NBC, CBS and MBS. Commercial call letters assigned to the West Base are KRTK and to the East Base, KRTC, these calls being used for the shortwave broadcasts and for commercial traffic, such as press.

Radiophoto equipment for the first time will be included in the expedition, using the facilities of World-Wide Pictures, Inc. Another unusual feature of the expedition is that automatic transmitting and recording machines for tape operation will be in use.

QSL cards, showing a map of Antarctica and the locations of the West and East Bases, as well as the probable location of the snow-cruiser, have already been prepared, but plans as to their distribution to stations contacted have not yet been worked out.

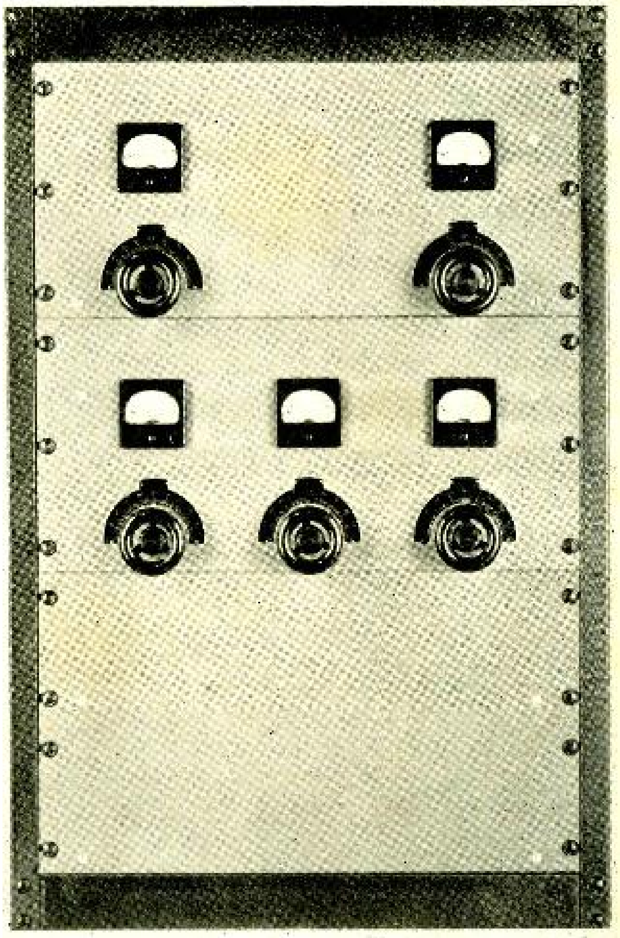
Tests have been made on the transmitters to be used, these tests having been made in the vicinity of Boston, Mass. And as Elmer Lamplugh put it, "Putting up a beam in a blizzard is no joke, but thank God, when we get to the South Pole we will have no next door neighbors to squawk about key clicks or unsightly antenna wires running across their beautiful vacant lots!"

• • •

"Signs of the Times"

Union Telefonica in Argentina has placed on the market an attachment for dial telephones which allows a person automatically to dial any one of a large selection of commonly used numbers merely by setting a pointer to the name of the desired firm or party and pressing a small handle. When the handle is released the attachment automatically dials the desired number.

75T'S Cathode Modulated Phone or C. W.



By GENE TURNEY,* W2APT, and F. RALPH KENYON**

A transmitter giving an output of over 150 watts with cathode modulation or 400 watts on c.w. The quality on phone approaches that obtainable with high quality plate modulation

The revolutionary new method of cathode modulation as described by Mr. Frank C. Jones in the October issue of RADIO will have far-reaching effects upon those amateurs who have long desired to operate on phone and who, because of lean pocketbooks or other circumstances, have hesitated to invest in the equipment necessary for plate modulation. Any system of modulation wherein the audio power required for full modulation of the final stage is only 1/10th that of the class C input becomes extremely attractive from an economical standpoint, providing of course that voice quality is satisfactory. Cathode modulation is a method which combines the advantages of plate modulation with the advantages of grid modulation, and under correct operating conditions will give voice quality that closely approaches that obtainable with plate modulation.

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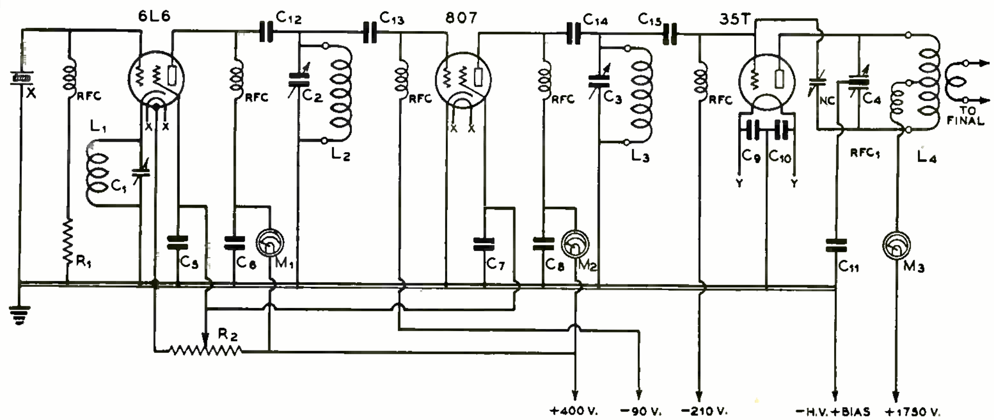
**Chief Engineer, Kenyon Transformer Co., Inc.

Design Considerations

In this particular instance the design is simple and straightforward. It resembles a well designed c.w. transmitter except for the insertion of a suitable transformer in the filament center tap of the final stage. The bias supply for the final amplifier may be taken either from a grid leak, battery, or bias pack. It is *not* extremely important that the bias pack have excellent voltage regulation so long as the bias (with normal grid current flowing) is somewhere near the specified value of 360 volts. Any value between 350 and 450 volts will be satisfactory. If a grid leak is used for bias, it should have a value of 30,000 ohms and a wattage rating of 10 watts. Just connect it from the bias terminal to *ground* (not to filament center



Wiring diagram of the exciter chassis.

C_1—100-μμfd. midget variable
C_2, C_3 — 50-μμfd. midget variable
C_{13} — 50-μμfd. per section, .084" spacing
C_5, C_6, C_7, C_8, C_9, C_{10}—.002-μfd. mica
C_{11}—.001-μfd. 5000-volt mica
C_{12}—.001-μfd. 1000-volt mica
C_{13}—.00005-μfd. 1000-volt mica "micrometer" type
C_{11}, C_{15} — .001-μfd. 1000-volt mica
CN—2-12-μμfd.
R_1—75,000 ohms, 1 watt
R_2—20,000 ohms, 25 watts
RFC—2½-mh., 150-ma. r.f. choke
RFC_1—8 mh., 125-ma. r.f. choke
L_1, L_2, L_3, L_4—Manufactured coils for band in use
M_1—0-100 milliammeter
M_2—0-150 milliammeter
M_3—0-200 milliammeter

tap). C_{18} provides the necessary a.f. by-pass for the grid leak. If grid leak bias is used, care must be taken to prevent loss of excitation, as the tubes may be damaged by the excessive plate current and dissipation.

In this transmitter a 5000-ohm bleeder across the bias supply is tapped to deliver the correct grid bias to the 75T's. The adjustable tap on the bleeder provides the necessary flexibility of adjustment. A choke by-passed on both sides with an 8-μfd. condenser provides a well filtered supply.

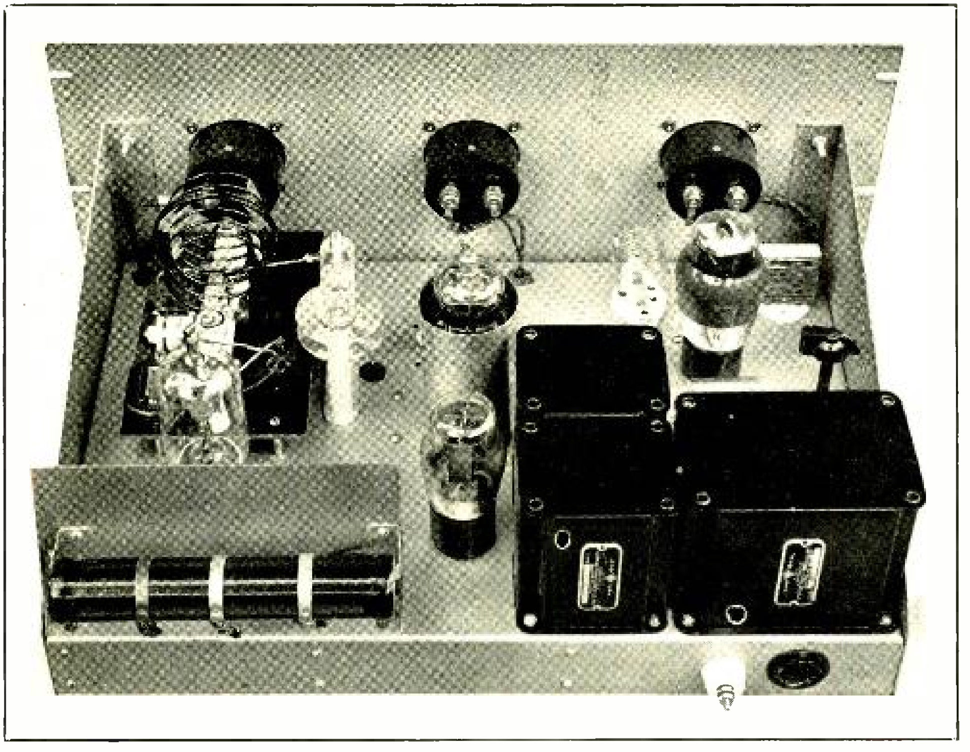
Some trouble was experienced when an r.f. choke in the grid lead of the 75T's acquired a nasty habit of allowing the circuit to start off all by itself in a low frequency parasitic. This caused the plate meter of the final amplifier to run off scale and the tank condenser to arc across. Even after the excitation was removed and shorting stubs were plugged into the jacks that normally would hold the inductances, the choke would still continue to oscillate. The final circuit as illustrated omits the choke in question. No other difficulties were experienced in setting up and adjusting the transmitter. All stages neutralized perfectly when a shield was placed over the 807.

Adjustments

The transmitter is simple to adjust. It is only necessary to set the grid bias to the correct value and vary the amount of excitation furnished to the final stage until 100 per cent modulation is reached. In this instance a 'scope is a very handy accessory. Overmodulation is reached almost as quickly as 100 per cent modulation; so it will be necessary to have some sort of device which will indicate when 100 per cent modulation peaks are reached. In every instance a simple diode type monitor should be used to check the quality. This particular transmitter was set up with the aid of a five-inch 'scope and it was found that the amount of excitation furnished the final stage was quite critical if a perfect trapezoid is to be obtained. The amount of excitation which may be run depends upon the amount of loading (antenna coupling). The tighter the loading, the more excitation may be run and the greater the plate dissipation. When correctly adjusted, with the 75T's running at maximum rated dissipation, the plate current will be around 200 ma.

Cathode modulation permits a theoretical operating efficiency ranging between 50 and 60 per cent under "paper conditions." The efficiency depends a lot on the ratio of plate modulation to grid modulation. Upon measuring the actual *overall* plate efficiency (actual output in a dummy load) it came out 49 per cent under operating conditions.

The cathode impedance was not critical



The exciter chassis of the cathode modulated transmitter. A fixed link is used on the plate coil of the 35T stage; excitation to the final amplifier is adjusted by varying the coupling to the grid coil of the final by means of the swinging link on the grid coil. The knob and shaft showing above the transformer at the right end of the chassis controls the condenser across the cathode coil of the tritet crystal oscillator. The grid bias pack with its associated bleeder-divider resistor (behind the shield on the left rear of the chassis) is also mounted upon this chassis.

but there is an optimum point around 800 ohms. Grid excitation is set at some intermediate point between that which is correct for grid modulation and for plate modulation (about 12 ma. grid current).

Remote Control

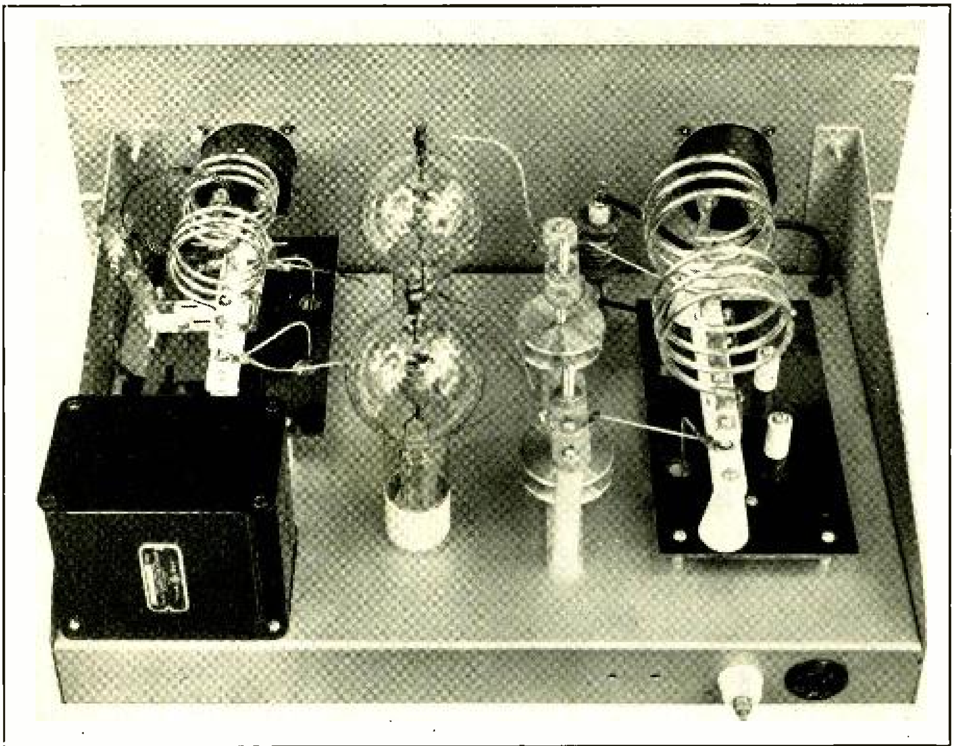
In the transmitter herein described it will be noticed that there is a separate control unit having a green pilot with switch for all filaments and bias supply, and a red pilot with switch for plate supply. These switches are connected in a manner which makes it impossible to turn the plate switch on until the filaments have been lighted. A gain control is mounted on the lower center of the panel while a jack in the back provides for microphone input.

The a.c. line supplying the transmitter is brought directly into the control unit and placed at the opposite end of the high level stage thereby minimizing any a.c. pickup. A six-foot cable carrying 12 wires plugs into the transmitter proper. This cable may be of any reasonable length. The cable carries plate supply for the speech equipment, modulation for the final stage, a.c. for the transmitter proper, a ground connection and filament power for the speech amplifier. The entire unit is housed in a sloping-front cabinet.

The r.f. units and power supply are housed in an upright open rack as will be seen from the accompanying photographs. It might be suggested that this rack be mounted on small rollers in order that the entire unit may be swung around for convenience of operation and adjustments, or, in case of necessity, for repair.

Power Supply

The lower deck carries all the power supplies with the exception of the bias, which



The cathode modulated push-pull 75T final amplifier. Note the swinging link used for varying the coupling to the grid coil and hence the excitation to the amplifier.

is placed on the exciter deck. Two six-prong sockets will be noticed on the left side of the chassis which are for the control cable to plug into as it comes from the control box housing the speech amplifier. The other socket on the right side carries all power leads up to the exciter deck and from there on up to the final deck. It will be noticed that all high voltage leads are brought out through the chassis on insulated feed-through bushings or "buttons."

Underneath the power supply deck are two filament transformers, one for the 866 rectifier tubes and one for the two 80's which furnish power to the crystal oscillator, 807 and speech. Also underneath are two 2-μfd. condensers which are connected in parallel and used as filters in the high voltage plate supply. A single 4-μfd. unit would do as well.

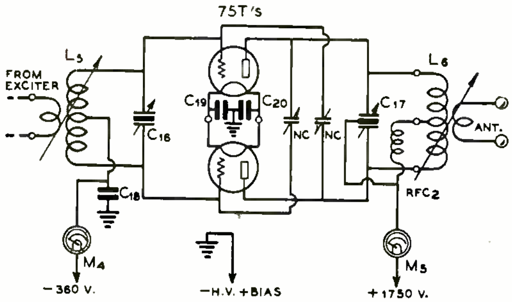
On the top side of the power supply section will be seen a plate transformer for the driver and final stages; choke for same; a power transformer and two chokes for oscillator, doubler, and speech; a pair of 80's and a pair of 866's. On the back bracket of the power supply deck there are two filter condensers, a bleeder for the low power stage and a suitable fuse.

Exciter and Final

The second deck carries the r.f. equipment which is as follows: 6L6 oscillator; 807 or RK39 doubler; 35T driver; bias supply with choke and suitable bleeder resistor. The filter condensers are fastened to the back of the chassis on the outer side. The final deck carries a filament transformer for the 75T's, and the rest of the conventional gear. There is nothing new or startling in the construction of the final amplifier. It is of the conventional type, cross-neutralized, and excited from the previous stage by link coupling which is *adjustable.*

Construction

A few words about some of the features of construction might well be in order. As will be noticed from the accompanying circuit diagram, the rotors of the oscillator and doubler condensers are at ground potential.



Schematic of the cathode modulated 75T amplifier.

- C_{16}, C_{17} — 50-μμfd. per section, .084" spacing
- C_{18}—.002-μfd. mica (paralleled with 2-μfd. 600-volt paper for gridleak bias)
- C_{19}, C_{20}—.001-μfd. mica
- CN—2-12 μμfd. "micrometer" type
- L_5, L_6—Manufactured coils for band in use
- RFC_2—2½ mh., 500-ma. r.f. choke
- M_4—0-100 milliammeter
- M_5—0-500 milliammeter

This method greatly facilitates mounting the condensers. It will be noticed that the control for the cathode circuit of the oscillator is projected through the chassis with a knob at the top so that it is convenient for adjustment. Inasmuch as it seldom has to be changed, it was not brought out through the front panel. When operating straight through the crystal oscillator cathode coil is shorted out. On the front panel the controls reading left to right are as follows: (Exciter deck) oscillator plate tuning condenser, 807 plate tuning condenser, 35T plate tuning condenser. (Final deck) 75T plate tuning condenser, 75T grid condenser.

An adjustable "swinging" link couples the output of the 35T to the grid of the 75T's. This swinging link is very important, for by this method grid current may be adjusted to an optimum value.

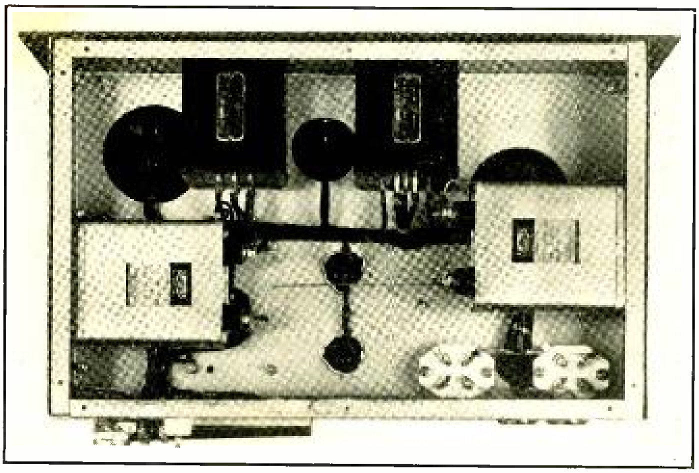
It will be noticed also that the bleeder resistor on the exciter deck is mounted in a convenient position, so that grid bias on the 75T stages may be adjusted with a minimum amount of effort. Once it has been set there is no need of further adjustment. It will also be noticed from the circuit diagram that the condenser in the plate circuit of the final stage has B plus connected right to the rotor. Be sure that the bushing or flexible coupler which connects the shaft of the condenser to the panel bearing is a good one and can withstand a 5000-volt flash-over test.

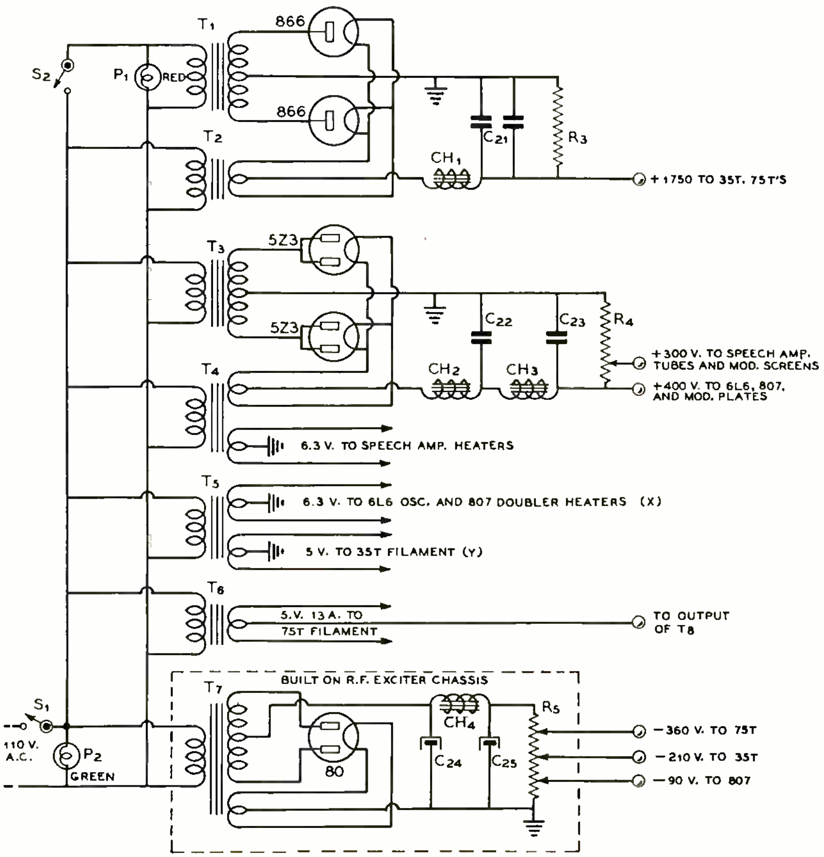
A common bus-bar is run through center of each chassis before wiring begins and to this common bus all ground returns are securely fastened. The chassis are thus connected from a single point to the six-wire cable in the back.

Antenna Loading

Antenna loading in this system of modulation is quite important. For maximum output the antenna coupling is increased to a point where the tubes are operating at their normal plate dissipation when the excitation is adjusted to the optimum value for best modulation. Too little antenna loading causes downward modulation unless the excitation is reduced to a low value, and will be so indi-

Bottom view of the power supply deck.





The power supply chassis.

C_{21}—2-µfd. 2500-volt oil filled

C_{22}, C_{23}—8-µfd. 400-volt paper

C_{24}, C_{25}—8-µfd. 450-volt electrolytic

R_3—100,000 ohms, 200 watts

R_4—20,000 ohms, 100 watts

R_5—5000 ohms, 100 watts

T —3520 v. c.t., 450 ma.

T_2—2.5 v., 10 a.; 5000-volt insulation

T_3—1150 v. ct., 250 ma.

T_4, T_5—6.3 v., 3 a.; 5 v., 4 a.

T_6—5.25 v., 12 a.

T_7—700 v. c.t., 75 ma.; 5 v., 2 a.; 6.3 v., 3 a.

CH_1—10 h., 400 ma.

CH_2 CH_3—10 h., 250 ma.

CH_4—30 h., 90 ma.

S_1, S_2—S.p.s.t. heavy-duty toggle switches

P_1—Red 115-volt pilot light

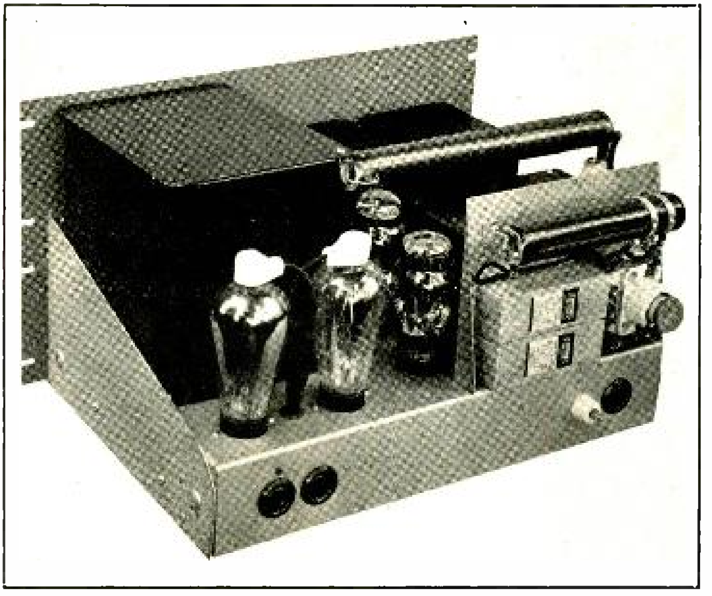
P_2—Green 115-volt pilot light

cated by an indicator bulb or lamp becoming dimmer instead of brighter when modulation is applied.

Modulator Coupling

Of prime requisite in cathode modulation is the necessity of connecting between cathode and ground in the class C stage a modulation transformer having the correct impedance in both primary and secondary winding. In every instance the bias supply (whether C pack or grid leak) must be by-passed for audio frequency by a suitable condenser.

The critical amateur who wishes to obtain the most efficient operation consistent with good quality modulation will need an oscilloscope and an audio oscillator for making exact adjustments. However, they may be made fairly accurately in the usual manner utilizing a monitor and an overmodulation indicator as previously described. The quality thus obtained is better than that of most



The lower deck of the transmitter containing the two plate power supplies for the transmitter.

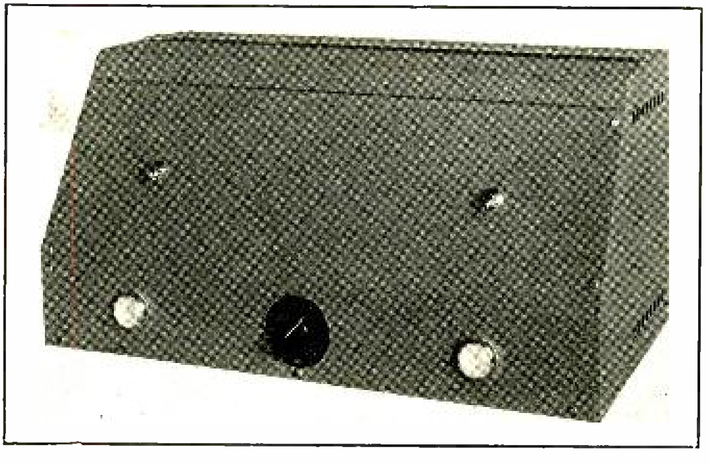
grid modulated phones and as good as that of many plate modulated transmitters.

The transmitter has been tried over a period of several weeks and reports from other stations would indicate that it is very difficult to tell the difference between cathode modulation and plate modulation as far as the human ear is concerned. Certainly one outstanding fact seems to be apparent and that is that from the economical standpoint cathode modulation deserves serious consideration.

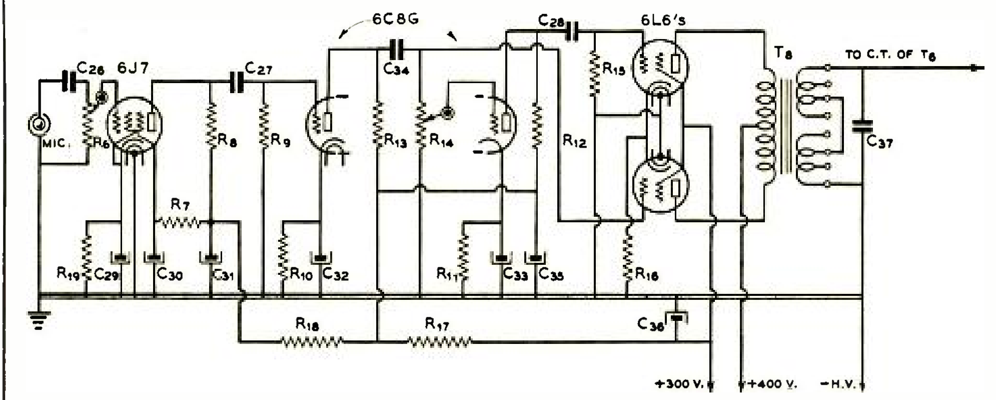
C. W. Operation

If a transmitter of this type were analyzed from a cost-vs.-power output basis upon the standpoint that it was to be used only as a phone transmitter, it would be found that the cost in dollars per watt would be no less than it would be if a plate-modulated transmitter using smaller tubes were employed. However, the big advantage of a rig of this type is that it also can be used on c.w. with a rather healthy input to the final.

In this particular case, with full excitation to the final and proper loading, an input up to about 600 watts can easily be handled by the 75T's. An input of this magnitude would be virtually impossible using the smaller type tube that would be employed for plate modulation of an input of 200 watts.



The complete speech amplifier-modulator for the cathode modulated 75T transmitter.



Schematic of the speech amplifier modulator.

C_{26}—.01-µfd. 400-volt tubular
C_{27}, C_{28} — .25-µfd. 400-volt tubular
C_{29}—25-µfd. 25-volt electrolytic
C_{30}, C_{31}—8-µfd. 450-volt electrolytic
C_{32}, C_{33}—10-µfd. 25-volt electrolytic
C_{34}—.25-µfd. 400-tubular
C_{35}, C_{36}—4-µfd. 450-volt electrolytic
C_{37}—.001-µfd. 1000-volt mica
R_6—2-megohm potentiometer
R_7—500,000 ohms, 1 watt
R_8, R_9 — 100,000 ohms, ½ watt
R_{19}, R_{11}—3000 ohms, 1 watt
R_{12}, R_{13} — 50,000 ohms, 1 watt
R_{14}—100,000-ohm potentiometer
R_{15}—100,000 ohms, 1 watt
R_{16}—200 ohms, 10 watts
R_{17}, R_{18} — 10,000 ohms 2 watts

Keying

Keying can be accomplished by any of the conventional methods, either in the final or in any of the preceding stages since power supply bias is used on all stages. Probably the most satisfactory method would be primary keying of the plate transformer to the final and buffer stages. For cleanest keying it would be best to remove the second 2-µfd. 2500-volt filter condenser across the final power supply. The condenser could be reconnected by means of a switch when phone operation was again desired.

See Buyer's Guide, page 192 for parts list.

The Good Old Days

By PAUL V. TRICE, W8QHS

Of all the hams I've ever met,
I still am looking for one yet
Who doesn't always heave a sigh
When someone mentions "days gone by."

"Why I remember ten years back,"
Someone will say, just reminiscing;
And then proceed to tell us of
The swell things that we've all been missing.

How back in nineteen twenty-eight
With just an "old two ten"
He worked most everything he heard
And didn't think much of it then.

And now he raves and tears his hair
Because with one full kilowatt,
He doesn't work all that dx
He really thinks that he should ought.

He moans about the long "CQ's"
The crowded bands, the so-called lid;
I sometimes wonder if he thinks
Way back, when he was just a kid.

I wish I had a record of
His peanut-whistle "way back when"
So I could play it back for him
To show him how he sounded then.

I really like to hear old hams,
Describe the days of long ago;
But I cannot quite figure out
Why in this day they feel so low.

I suppose it's human nature
And not mine to question why
They groan about the present
When they talk of "days gone by."

U. H. F. *and the* WEATHER

By M. S. WILSON,* W1DEI

By combining an understanding of the mechanics of refraction of ultra-high-frequency waves in the lower atmosphere with a knowledge of meteorology, one can determine in advance the probability of ground-wave or semi-dx. The accuracy of such predictions is a direct function of the completeness of available weather data.

The following is an outcome of several years' study of the phenomena of ground-wave semi-dx. Although the conclusions are true specifically for the northeast corner of the United States, the general conditions necessary for bending to take place and the approach to the problem of prediction would seem to be basic. Although the mechanics of bending of u.h.f. radiation in the lower atmosphere were carefully shown by Ross Hull a number of years ago[1] few operators seem to have a clear concept of the phenomena, and thus are unable to realize the advantage such information offers.

Mechanics of Bending

As most people know, electromagnetic waves are bent farther from the normal whenever the radiation enters a rarer medium obliquely. In the case of u.h.f. bending, the medium, of course, is air, and the question arises as to just how air alone could cause our signals to be refracted. We know that the air density becomes less with altitude, and it might seem that this would bend our signals. Perhaps it does very slightly, but the amount of bending is not as great as the curvature of the earth, and is thus of no value to us.

What does bend our signals a useful amount is the stratification of different types of air masses. When a relatively warm moist air mass touches a cooler mass, the resulting meeting plane acts to u.h.f. waves as different media, and the waves are bent probably by the same mechanics as light refractions. Refraction due to a temperature gradient is nothing new to us, since probably all have noticed the effect with light waves. The classical example is the mirage of the mudpuddle in the street on a very hot day, the extremely hot surface of the street maintaining a very steep gradient a few inches in height. In the case of u.h.f. bending the gradient is tipped upside down in order that the bending be downward and thus of use to us, and consequently this phenomenon might be visualized as the "inverted radio mirage." It is much like the case of seeing the setting sun due to refraction after it is actually beyond the horizon.

With an idea of what could cause the bending of u.h.f. waves in the atmosphere, one needs to know about what the atmosphere is like and in what part this bending takes place. Atmosphere is too broad a term to denote much meaning, and more precise definition of what part of space this discussion covers is necessary.

The Layers of the Atmosphere

As we know, the characteristic layers surrounding the earth are called troposphere, stratosphere, and ionosphere, in that order. The ionosphere is familiar to every radio amateur. The troposphere is the nearest to the earth of all the shells and extends upward from the earth to about an average of eight or nine miles. The stratosphere thus fills in between the others. The troposphere contains practically all the air as we ordinarily think of it, and the outside surface of this sphere (tropopause) represents the area ot practically zero pressure and lowest temperature. All the weather with its storms, clouds, different air masses, etc., is contained within this nearest shell or troposphere and it is this space which is of interest to us when considering this type of refraction. Ross Hull showed that

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*131 Bacon St., Natick, Mass.

[1] Ross Hull, "Air Mass Bending of U.H.F. Waves," *QST*, June, 1935, p. 13.

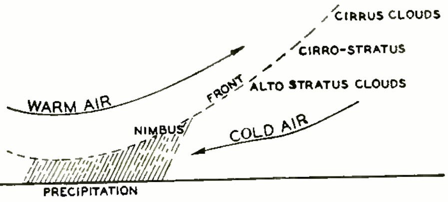


Figure 1. An illustration of the type of air-mass movement which can cause an inversion which will be favorable to u.h.f. bending

signal strength over a long indirect path follows the existing lapse rate anywhere in the region of 300 to 2500 meters altitude, and thus we can further limit ourselves to the extreme low portion of the troposphere. Technically, therefore, u.h.f. bending takes place in the lower troposphere.

The stratification of warmer air riding over relatively cooler air is called a temperature inversion or positive lapse rate. This lapse rate (or rate of falling off of temperature per unit of altitude) is normally negative, but under certain conditions this becomes upset.

To the u.h.f. worker the two most important types of temperature inversion are those caused by contact of two air masses differing in temperature and humidity, and by subsidence and nocturnal radiation. The first of these types is theoretically represented in cross section by figure 1 in which one mass is of polar origin and the other tropical. The former is cool air and thus has the tendency to sink and spread out over the surface of the earth. The latter is relatively warm and moist, and being thus of low pressure and hence "lighter" has the tendency to rise and spread over the heavier air mass. This condition obviously brings about a temperature inversion between the respective centers of the two air masses. Although air masses may become greatly modified as they proceed along their paths, they seldom mix with other masses except where they contact.

The second type of inversion may take place even within an air mass which would seem to be homogeneous. For example, consider a mass of polar continental air which might be shown on a weather map by a high pressure area. This air is clear and, especially during the summer months, the rays of the sun pass through it without much relative loss of heat. Such a day will be very hot on the surface of the earth, and if clouds are present, they assume the appearance of fluffy cotton balls and usually dissipate by late afternoon. The air directly above the ground becomes warmed by convection and rises, and under such a condition increases its moisture content. When the sun sets, the earth cools faster than the air, and thus cools the air in direct contact with it. This condition results in a low altitude inversion. Often a more marked inversion takes place after such a hot day when the rising air "pulls in" underneath it air from a cooler region. This type is very complete when the cooler region is a large body of water, such as the Atlantic Ocean for the east coast. When both air mass stratification and substance are present usually at two distinct levels, tremendous bending takes place and often the low (altitude) stations exceed in signal strength at a distance of 200 to 400 miles the more fortunately located stations.

Weather Behavior

A knowledge of general weather behavior is absolutely necessary for any prediction of probable u.h.f. bending. It is impossible to give but an outline of the approach to such a study here, and it is hoped that the serious u.h.f. worked will turn to the many available sources on the subject found in most libraries and in publications of the U. S. Weather Bureau. The most obvious fact about air mass movement in the U. S. is that due to the prevailing westerly winds which follow a path from the west to the east coast.

The atmosphere slips as it rotates with the earth. The slippage results in the formation of a never-ending series of two types of whirls, one called cyclones (anticlockwise rotation in northern hemisphere) and the other called anticyclones (clockwise). The former are usually of tropical origin and are relatively warm and moist, and since the barometric pressure of such an air mass is less than average they are usually referred to as *lows*. The latter are usually of polar origin and are relatively cool and dry. Such an air mass is "heavy" and since the barometric pressure is higher they are referred to as *highs*. Although it is impossible to determine the exact type of air represented by these *highs* and *lows* by observing them on a weather map, the weather bureau usually mentions the type if known when summarizing general conditions.

The speed of these air masses across the continent varies with the season but their average is about 10 degrees (3 to 20) a day. Anticyclones first appearing over Oregon or southern Alberta usually pursue either a southeasterly course to Florida or an easterly one along the northern border of the country. During the first day it is very difficult to

[*Continued on Page 160*]

A 1623 TRANSMITTER-EXCITER

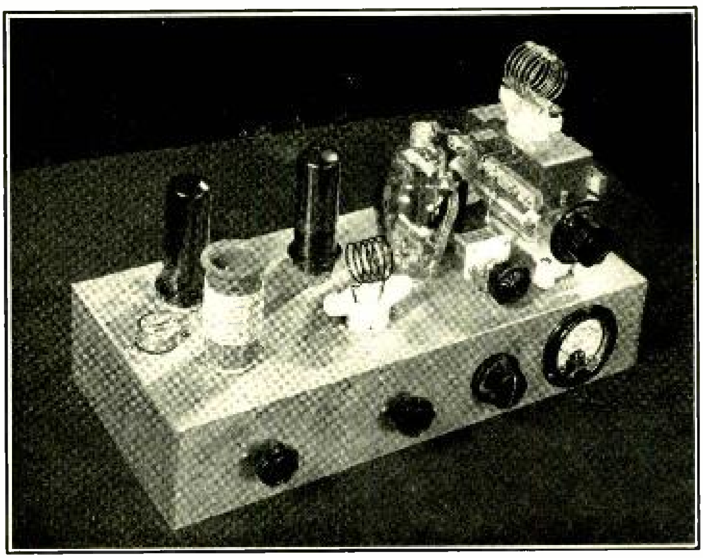
By JACK ROTHMAN,* W6KFQ

A cleverly designed transmitter or exciter using an inexpensive new tube and capable of being keyed or modulated at 35 to 50 watts output on all bands from 10 through 160, a unit well suited to use as the auxiliary transmitter, as exciter for the new rig, or as a complete r.f. unit for those with less pretentious ideas—such is described herein.

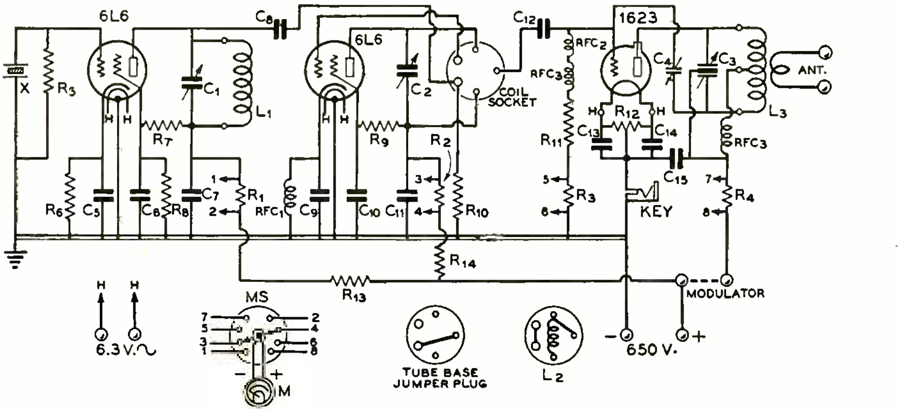
It is quite probable that there are still a few amateurs left who, in spite of the feeling of doing something that couldn't be done that creaking plates and a rosy glow on the wall behind the transmitter bring, still have a desire to run their tubes within shouting distance of the manufacturers' ratings. It is for such "reactionary" souls that the transmitter-exciter to be described was designed. While the tubes in it will not have the longevity of Methuselah they will undoubtedly last long enough to make the constructor feel that he has obtained his money's worth.

As the diagram shows, there is nothing startlingly new about this unit, the circuit is a strictly conventional oscillator-multiplier-final affair with capacity coupling between stages. To begin at the beginning, a 6L6 is used as a conventional tetrode crystal oscillator. The output from the oscillator is capacity coupled through C_8 to one terminal on doubler-quadrupler plate coil socket. The grid lead to the second stage also terminates at this socket. By means of jumpers in the coil form or by the use of a dummy plug the excitation from the crystal stage may be applied either to the doubler-quadrupler or to the output stage. The proper method of jumpering the sockets for this purpose is shown at the bottom of the circuit diagram. The jumper plug, which is used when it is desired to operate the output stage on the same frequency as the crystal oscillator, may be a base from a defunct 5-prong tube with a lead connected between two of its terminals, as shown in the diagram. Two jumpers are

*Laboratorian, RADIO



Top front view of the exciter-transmitter. Note the sheet-iron bracket supporting the 1623 plate coil above the tank condenser.



General wiring diagram of the exciter.

C_1—50-μμfd. midget
C_2—100-μμfd. midget
C_3—260-μμfd. per section, .030" spacing
C_4—15-μμfd. midget, .070" spacing
C_5, C_6—.01-μfd. 400-volt tubular
C_7—.005-μfd. 400-volt mica
C_8—.0002-μfd. mica
C_9—.0001-μfd. mica
C_{10}—.01-μfd. 400-volt tubular
C_{11}—.005-μfd. mica
C_{12}—.0001-μfd. mica
C_{13}, C_{14} — .005-μfd. mica
C_{15}—.004-μfd. 2500-volt vica
R_1, R_2, R_3, R_4 — 50 ohms, 2 watts
R_5—50,000 ohms, 1 watt
R_6—400 ohms, 10 watts
R_7—50,000 ohms, 2 watts
R_8, R_9—50,000 ohms, 2 watts
R_{10}—25,000 ohms, 2 watts
R_{11}—5000 ohms, 10 watts
R_{12}—50 ohms c.t., 10 watts
R_{13}—5000 ohms, 10 watts
R_{14}—2000 ohms, 10 watts
MS — Single-section two-pole five-position selector switch
M — 0-150 milliamperes
L_1, L_2, L_3 — See coil table
RFC_1—2½-mh., 125-ma. choke
RFC_2 — Midget u.h.f. choke
RFC_3—5.5-mh., 125-ma. choke

needed in each of the coil forms used in this stage. One of these jumpers connects the excitation from the crystal stage to the grid of the doubler-quadrupler and the other completes the connection between the plate of the doubler-quadrupler and the coupling condenser to the grid of the output stage.

Frequency Multiplier

The 6L6 frequency multiplier stage has an r.f. choke and .0001-μfd. condenser combination in its cathode lead. This arrangement does not greatly increase the power output when doubling, but, as the second-harmonic output is more than sufficient to excite the next stage, this is of small concern. However, when the 6L6 stage is quadrupling the use of this combination in the cathode raises the efficiency considerably. In other words, the output is held constant while the plate current is reduced to about two-thirds of what it would be without the r.f. choke and condenser in the cathode, thus allowing the efficiency when quadrupling to approach that obtained when doubling.

Note that when the jumper plug is placed in the frequency multiplier coil socket, both the plate and grid leads to the tube are dead ended at the socket, so far as d.c. is concerned. The screen voltage is still applied, however, and it might be thought that this would damage the tube from excessive screen dissipation. Actually, the relatively high value of screen resistor used (50,000 ohms) limits the screen current to approximately 5 milliamperes and thus prevents the screen from becoming overheated. As there is an excessive amount of excitation available from the frequency multiplier when it is doubling to 20 meters with an ordinary low-C plate tank, a 100-μμfd, tank condenser is used at this point to permit a high-C plate tank and reduce the excitation. This condenser will be at nearly full capacity on 20 meters when used with the coil specified in the coil table.

1623 Stage

The output stage of the unit is an RCA-1623, a tube which up to the present time has received little or no notice in amateur publications. The 1623 is essentially a low-μ version of the well known 809, and as such it shows several advantages over its high-μ companion for r.f. work. The advantages of the 1623 show up particularly when a comparison of the class C telephony ratings of the two tubes is made. For this type of service the 1623 requires one-third less driving power than the 809. This saving in driving power is obtained through a reduction in the r.f. grid voltage, d.c. grid current, and bias requirements. The proof of a tube is in its operation, however, since you can't make contacts on the ratings alone. After comparing the two tubes in operation one gets the feeling that the 1623 is somewhat more easy to handle than the 809, that is it allows a wider variation in operating conditions. For those who are not familiar with the tube, the important CCS ratings of the 1623 are as follows:

Filament voltage	6.3 volts
Filament current	2.5 amperes
Amplification factor	20
Interelectrode Capacitances	
Grid to Plate	6.7 $\mu\mu$fd.
Grid to Filament	5.7 $\mu\mu$fd.
Plate to Filament	0.9 $\mu\mu$fd.

Plate Modulated R.F. Amplifier Class C

Typical Operation		
D.C. Plate voltage	500	600 volts
D.C. Grid voltage	-125	-125 volts
or grid leak of	5000	5000 ohms
Peak R.F. Grid voltage	200	200 volts
D.C. Plate current	83	83 ma.
D.C. Grid current	25	25 ma.
Driving power	5	5 watts
Power output	30	38 watts

Maximum Ratings	
D.C. Plate voltage	750 volts
D.C. Plate current	100 ma.
D.C. Grid current	25 ma.
Plate dissipation	25 watts

Unfortunately the 1623 has been placed in the "limited sale" class by the manufacturer and for this reason it is not stocked by most parts dealers. However, it can be obtained on special order by dealers normally handling RCA tubes.

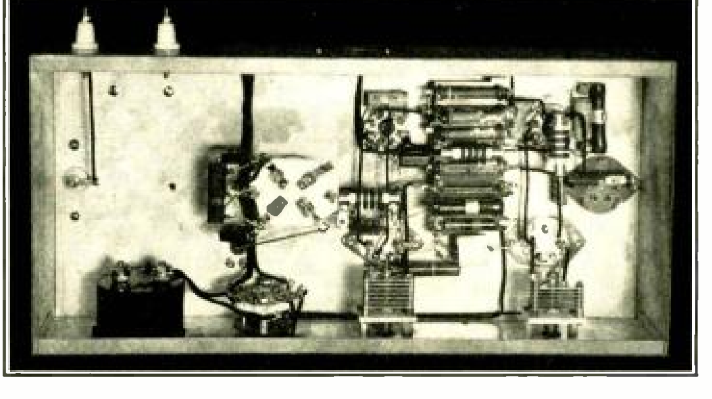
Grid R.F. Chokes

The use of two r.f. chokes in series in the grid of the 1623 stage was made necessary because 160-meter operation was desired. The ordinary 2½-millihenry r.f. choke has insufficient inductance for 160 meters and loads the crystal stage to such an extent that it will not oscillate. Using a larger choke alone in the 1623 grid reduces the excitation available on 10 meters, hence two chokes in series are used. The choke nearest the grid is one designed for u.h.f. work and is somewhat superior to the usual 2½-millihenry choke at ten meters. The lower choke is a 5½-millihenry unit designed for maximum impedance at the lower frequencies.

Neutralization

Plate neutralization is used on the output stage with the rotor of the plate condenser being connected directly to the positive voltage and by-passed to ground from this point. The plate voltage is fed to the coil through an r.f. choke to allow the split-stator condenser to establish balance in the circuit. With the circuit arranged in this manner the setting of the neutralizing condenser need not be changed when changing bands. The plate condenser is large enough to give a reasonably high Q tank on 160 meters and at the same time has a low enough minimum capacity to permit efficient 10-meter operation. It was necessary to remove some turns from the manufactured 160-meter coil to allow the full

Most of the under-chassis components are visible in this view. The mounting strip slightly right of the center of the chassis is used to support most of the resistors.



COIL TABLE

	OSCILLATOR				FREQUENCY MULTIPLIER				1623 STAGE
Band	Turns	Diameter	Spaced to occupy	Wire size	Turns	Diameter	Spaced to occupy	Wire size	
160	65	1½"	close-wound (2¼")	#22 d.c.c.		jumper plug			The 1623 coils are standard manufactured units. See Buyer's Guide for details. The 160-meter coil has four turns removed from each end.
80	31	1½"	close-wound (1")	#22 d.c.c.		jumper plug			
40	17	1½"	1½"	#22 d.c.c.		jumper plug			
20	Use 40-meter coil				5	1½" (self-supported)	1"	#18 E	
10	Use 40-meter coil				5	1¼" (self-supported)	1"	#16 E	

condenser capacity to be used on this band; the details of this alteration will be found in the coil table.

Four 50-ohm resistors, R_1, R_2, R_3 and R_4, are used to allow metering of the various circuits with a single 0-150 milliammeter. The meter is connected to the two contact arms of a two-pole five-position selector switch and is cut in across the resistors by merely turning the switch to the proper position.

Construction

The exciter-transmitter chassis measures 15" x 7" x 3" and is of the usual cadmium-plated iron construction. As may be seen in the top-view photograph, the two 6L6's are located near the rear edge of the chassis with their respective coil sockets directly in front of them. The 1623 is located on the center of the chassis width and somewhat to the right of the length center. The neutralizing condenser, C_4, is located on a line with the 6L6 coils and between the 1623 and the plate tank condenser, which is near the right-hand edge of the chassis. A sheet-iron bracket surmounts the 1623 plate condenser and serves to support the plate coil socket. Link or antenna leads are brought down from this coil socket to a pair of short standoff insulators at the extreme right edge of the chassis.

The oscillator and frequency multiplier tank condensers are mounted on the front drop of the chassis directly in front of their respective coils. Short hollow brass spacers are used to hold the condensers back away from the chassis. The meter is located below the 1623 plate condenser at the right edge of the front drop, and the meter switch is between the meter and the multiplier plate condenser.

Underneath the chassis the majority of the resistors are mounted on a resistor mounting strip between the oscillator and frequency multiplier stages. The various by-pass and blocking condensers are supported from their leads in such a way that the shortest possible connection is made between the point to be by-passed and ground. On the rear drop of the chassis are located the two through-type standoff insulators for the positive and modulator connections and a wafer socket for filament and negative connections.

Operation

For 160-, 80- or 40-meter operation crystals having fundamental frequencies in these bands are used, the jumper plug being placed in the frequency multiplier coil socket. If it is desired to economize on crystals, the 1623 can be used as a doubler to either 80 or 40 meters, the output when doubling to these bands being nearly as great as when amplifying. On 20 or 10 meters a 40-meter crystal is used and the appropriate coil placed in the frequency multiplier plate circuit.

Keying for c.w. operation is accomplished in the filament center tap of the 1623. No key-click filter is shown since the proper constants will depend upon loading, type of power supply, plate voltage, etc. In most cases clicks can be eliminated by the use of a .25 to 1 μfd. condenser in series with a 200 or 300 ohm resistor across the key. Stubborn clicks at the "make" of the code characters may require the addition of a small iron-core choke in series with the key.

Plate modulation to the 1623 may be applied across the modulator terminals at the rear of the chassis. Plenty of excitation is available for extended positive peak voice modulation.[1] For this type of operation a modulator capable of delivering approximately 35 watts of *sine-wave* audio should be used.

[*Continued on Page 170*]

U.H.F. RADIO THERAPY

By WILLIAM REAGH HUTCHINS,* W2JTR

Recent medical research has shown that radio waves from two to five meters in length produce beneficial effects not obtainable with longer waves. Specific new reactions are obtained with the ultra-short wavelengths.

As a result of this, progressive physicians are beginning to require therapy machines capable of producing these ultra-short waves with ease. The desirable effects appear to be unrelated, at least directly, to the heating properties of the wave. Since the heating effects are due entirely to the dissipation of radio-frequency power in the tissues, only relatively low power is necessary.

The machine about to be described has an excess of power for most local treatments. Though it has not been measured exactly the output is about 20 watts maximum. Because of their small power output these machines are doubtless safer to use than those of several hundred watts' output commonly employed on the lower frequencies.

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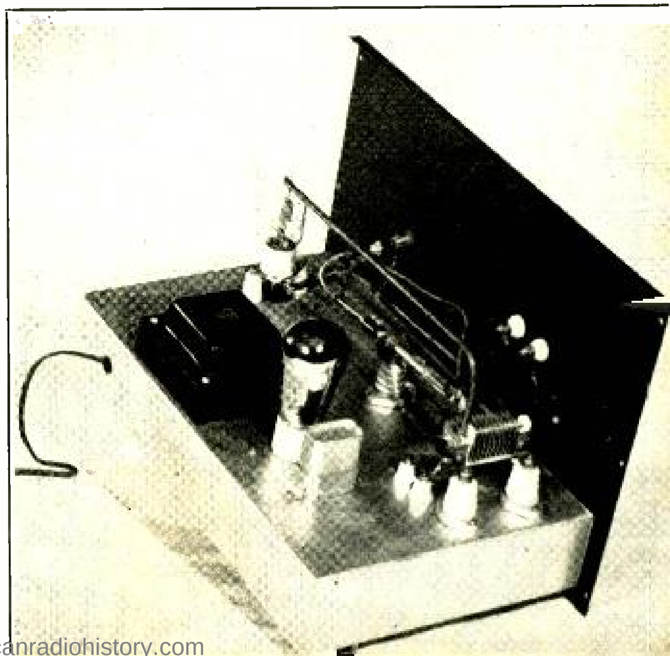
The circuit finally used for the oscillator is of the well-known split-coil feedback type, but employing linear circuit elements rather than the usual coil and condenser. Tuning is accomplished by varying the capacity of the "shorting" condenser, thus changing the effective length of the line.

Most conventional tubes are very inefficient at the 100-Mc frequency used. Until recently there has been no small, inexpensive tube which would do the job. The HK24, however, is about perfect. No trouble was had with it, and it seemed impossible to make it cease oscillating by heavy loading, although, of course, the overload caused it to overheat.

The grid leak was adjusted to give 20 ma. of grid current under normal conditions. The chokes in the plate and grid leads are not uniformly effective over the entire frequency range. Better efficiency could probably be obtained by pruning these somewhat. The filament chokes add to the ease of oscillation but are not very critical.

The output coupling consists of a modified variable link arrangement. A rectangular

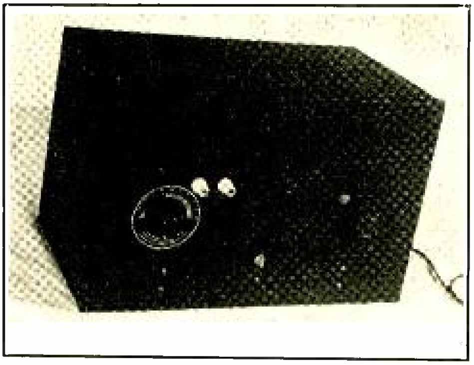


Rear three-quarter view of the miniature u.h.f. radiotherapy machine. The placement of the various components and the mechanical construction of the variable coupling link may be determined from this photograph.

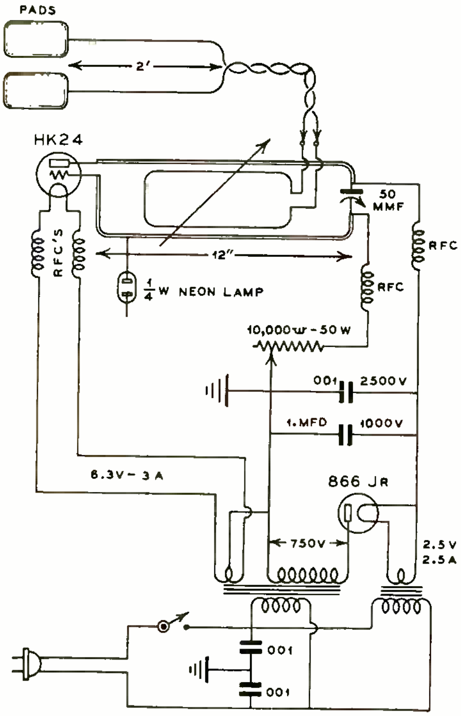
single-turn coil is pivoted in the plane of the tank circuit. It can be turned to a position almost at right angles to the tank by a knob on the panel and a flexible shaft which is coupled to the coil shaft. The latter consists of a panel bearing coupled to a small polystyrene rod, on which the coupling coil is mounted. The two ends of the coil are brought to feed through insulators on the panel.

The pads are connected to the panel terminals by a short length of twisted pair, the last two feet of which are fanned out. This forms a roughly resonant center-fed dipole antenna, with the patient placed between pads at the ends of the radiator. Such an arrangement insures maximum voltage at the pads, and makes output adjustment simple.

The high voltage supply consists of an ordinary 375-0-375 volt, 120-ma. power transformer. The entire 750 volts is half-wave rectified by a single 866 jr. A separate filament transformer is used for the rectifier. It



Front panel view of the HK-24 u.h.f. diathermy. The dial on the left varies the frequency of oscillation and the knob on the right, through a flexible coupling, varies the coupling of the external circuit to the oscillator by varying the angle of the one-turn coupling link.



Wiring diagram of the HK-24 u.h.f. radiotherapy machine. A 150-ma. b.c.l. power transformer is used for plate supply and for the filament of the 24. The filament chokes consist of 55 turns of no. 20 d.s.c. spaced the diameter of the wire on a ½-inch form.

was feared that the insulation of the windings on the b.c.l. transformer might not be safe for the high voltage used, and also it was desired to permit preheating the rectifier filament.

A single 1 μfd., 1000-volt paper condenser is used in parallel with a .001-μfd., 2500-volt mica for the filter. One .001-μfd. mica condenser is connected from each side of the line to ground as a precaution against r.f. power being lost in the lighting circuit.

The neon-bulb indicator tied to the grid line of the tank shows when the circuit is oscillating, and also, by the amount it dims under load, indicates the relative output.

No meters are used, as their cost did not seem justified. An r.f. milliammeter in the output circuit might be useful. A plate milliammeter would probably be cheaper and would tell about as much. The real purpose of meters in such an instrument is more to impress the patient than to show anything to the operator.

To operate, the filament switch is thrown on, lighting the 866 jr. After 30 seconds the plate switch is turned on, and the pads adjusted on the patient. The specific frequency is selected by the tuning knob, and the output knob is adjusted for proper excitation to the patient. The wavelength of this machine is from about 2½ to 4 meters. As physicians differ as to how the frequency and output should be adjusted for best physiologic effect, this will not be discussed here.

No trouble was had at any time with this machine once the maximum coupling was adjusted so that the tube dissipation could not go too high.

The FRANKLIN OSCILLATOR *Circuit*

By LEIGH NORTON,* W6CEM

The history of stable variable-frequency oscillators for service as transmitter controls or as frequency standards has been marked by various methods of removing the effect of oscillator-tube electrode loading on the tuned circuit. The actual electrode loading is in itself of small import except where it becomes great enough to lower the Q of the tank considerably; it is the *variation* in loading as seen from the tank circuit that is the important factor.

Of course, the ideal type of oscillator would be a simple tuned circuit oscillating by itself without loading of any kind. Unfortunately, this type of circuit is a practical impossibility. However, methods have been devised both to reduce the effects of loading variations and to reduce the variations themselves. A typical method is the use of a high C/L ratio tank circuit wherein a large fixed capacity across the tank circuit makes element capacities a smaller proportion of the total tank capacity. Hence their changes will make a proportionately smaller change in frequency. The electron-coupled circuit is an example of another method in which proportionate voltage changes on two tube elements cause opposite and cancelling effects upon the frequency of oscillation. These systems are both helpful but there is still room for improvement in eliminating the effects of input capacity changes caused by heating within the tube.

The obvious remedy for the temperature-capacity variations (and for that matter, for all other variations) is to reduce the coupling between the tube and the tank circuit. Unfortunately, this has its limitations when the frequency-controlling tank also must serve as a common impedance between two of the oscillator electrodes for the purpose of maintaining oscillation. However, one oscillator circuit in which the coupling between the tubes and the controlling tank circuit is reduced to an absolute minimum has long been hiding its light. This circuit is the Franklin, an oscillator which is probably familiar to only a few amateurs. A description of a frequency control utilizing this circuit which appeared in the *T. & R. Bulletin*[1] was the inspiration for some experimental work along similar lines with the result that the unit shown in the photographs was built.

The basic Franklin circuit is shown in figure 1. The resemblance to the common multivibrator is obvious. The tubes may be triodes, tetrodes or pentodes, depending upon the use to be made of the oscillator. The circuit oscillation depends upon coupling from the plate of the second tube back to the tank circuit and from the tank circuit back to the grid of the first tube through condensers C and C_1.

With the tank circuit removed and with a small amount of coupling capacity it is possible to cause the circuit to break into rough oscillation at a frequency determined largely by the resistance and capacity in the coupling circuits. When the tank circuit is added, however, the frequency of oscillation becomes that to which the tank circuit is tuned since the tank "shorts" all frequencies except the one to which it is resonant. This oscillation takes place with extremely small feedback capacity, 2 to 10 μμfd. being sufficient for stable operation. The advantage of the Franklin lies in this small amount of capacity coupling between the tank circuit and the tubes. Variations in amount of interelectrode capacity

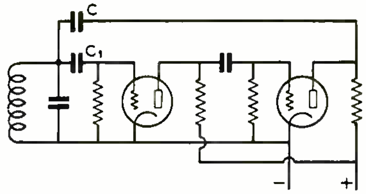


Figure 1. Basic Franklin oscillator circuit.

[1] E. L. Gardiner, "The Franklin Master Oscillator in Amateur Transmission," *T. & R. Bulletin,* July, 1939, p. 13.

* Associate Editor, RADIO.

caused by heating or electrode voltage changes affect the frequency but slightly when coupled through such a small capacity. Also, there is a definite compensating effect with the correct values of coupling capacity which tends to reduce frequency changes still further.

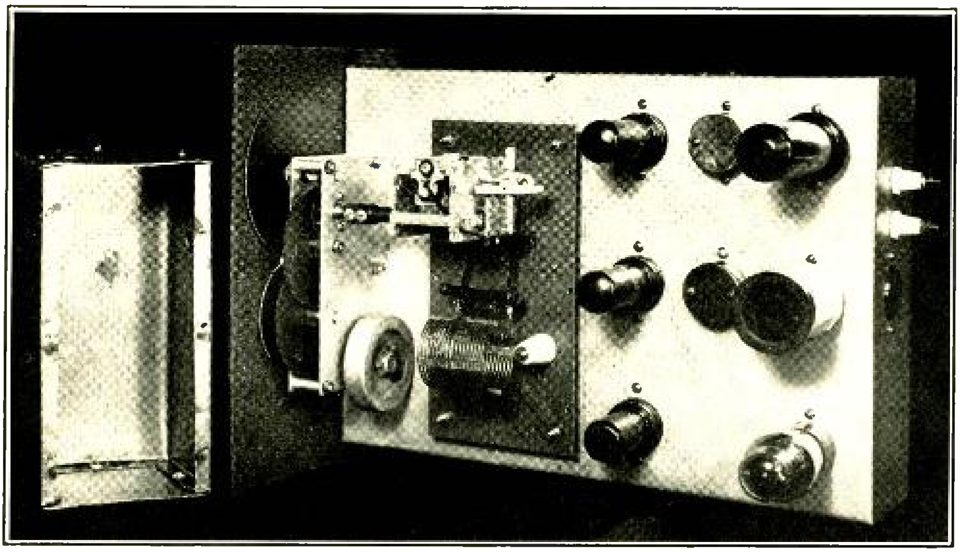
In this type of oscillator the output is usually taken from the grid of the second tube. For this reason a pentode is often used in the first stage and a triode in the second. The larger amount of grid swing required by the triode allows a greater voltage to be developed at this point and, consequently, a larger amount of grid voltage swing to be applied to the tube following the oscillator. In an effort to eliminate the frequency changes resulting when the load on the following amplifier was varied with the output being taken from this point several other arrangements were tried. The circuit shown in figure 2 proved to be the best of several which were used at one time or another. In this arrangement the second tube is used as a sort of "electron-coupled" output stage. The screen grid is used as the plate for the oscillator circuit and the output is taken from the plate through the electron-stream coupling, the suppressor providing electrostatic shielding between the oscillating circuit and the grid of the following tube.

A Practical Exciter

The Franklin oscillator shown in the photograph is built on a 14" x 10" x 3" chassis. Since the loading on the oscillator tank circuit is so slight as to be negligible, the tank Q is retained with the oscillator connected to it, making it possible to design a high Q circuit with reasonable assurance that the Q will not be lowered greatly by tube loading. The tank circuit is a unit in itself, mounted on a piece of ⅛-inch brass to give it a more sturdy base than the chassis would provide and at the same time to act as a fairly large mass for temperature stabilization.

To allow full coverage of the 80-meter band, as well as all the higher frequency bands, a rather large tuning condenser is used. With this condenser the useful tank frequency range is 1750 to 2000 kc. Actually the coverage is slightly greater than this so that there is a small amount of leeway on each end. With the dial shown tuning is quite smooth and precise even on the 14- and 28-Mc. bands, in spite of the extremely large coverage available at these frequencies.

The tank circuit is supported approximately ⅜ inch above the chassis on brass spacers to allow the condenser to line up with the dial shaft. A shield over the complete tank as-



Top view of the Franklin variable-frequency oscillator with the cover removed from the frequency controlling circuit. In the rear row are the VR-150-30, the output tank coil and the 6L6 output amplifier. Ahead of these are the two crystals, then the two 6F6's and the 1852. The dial is an inertia-tuning type having 500 dial divisions to make calibration easier and more accurate. The sheet metal shield can which is bolted over the frequency determining tank is shown to the left of the front panel.

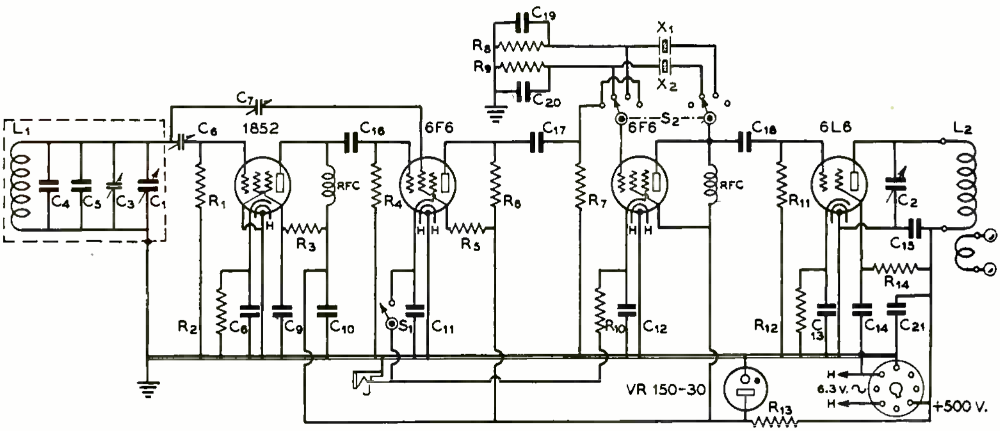


Figure 2. Wiring diagram of the Franklin v.f. exciter.

C_1—365-μμfd. broadcast variable
C_2—75-μμfd. midget variable
C_3—100-μμfd. midget variable
C_4—400-μμfd. zero-coefficient ceramic
C_5—200-μμfd. zero-coefficient ceramic
C_6, C_7—3-30-μμfd. mica trimmer
C_8, C_9, C_{10}, C_{11}, C_{12}, C_{13}—.01-μfd. 400-volt tubular
C_{14}, C_{15}—.003-μfd. mica
C_{16}, C_{17}, C_{18}, C_{19}, C_{20}—.0001-μfd. mica
C_{21}—.003-μfd. mica
R_1—100,000 ohms, ½ watt
R_2—500 ohms, 1 watt
R_3—5000 ohms, ½ watt
R_4—100,000 ohms, ½ watt
R_5, R_6—25,000 ohms, 2 watts
R_7—250,000 ohms, ½ watt
R_8, R_9—50,000 ohms, ½ watt
R_{10}—500 ohms, 10 watts
R_{11}—50,000 ohms, 1 watt
R_{12}—600 ohms, 10 watts
R_{13}—6000 ohms, 20 watts
R_{14}—20,000 ohms, 2 watts
L_1—18 turns no. 16 enam. 1⅝ inch in diameter and space-wound to a length of 1¾ inches. (See Buyer's Guide for manufacturers type no.)
L_2—30 turns no. 20 d.c.c. close wound on 1½ inch form. Link—6 turns no. 20 d.c.c.
RFC—2.5 mh. r.f. choke
J—Circuit closing jack
S_1—S.p.s.t. switch
S_2—Single-section 2-pole, 5-position selector switch
X_1, X_2—Band-edge crystals

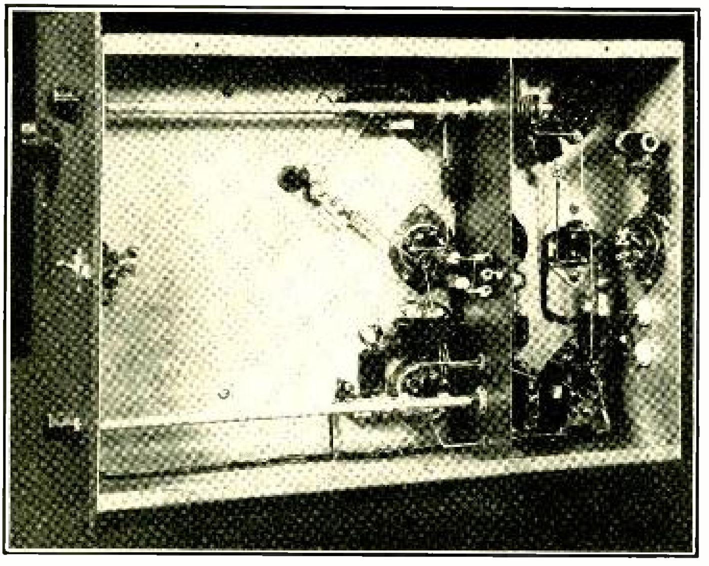
sembly is used to keep dust and stray r.f. from finding their way into this portion of the circuit. A small hole in the left end of this shield allows the 100-μμfd. bandsetting condenser to be adjusted after the shield has been placed in position.

A standard manufactured 40-meter coil is used for the oscillator. This coil is removed from its base and, when padded by 600 μμfd. of zero-coefficient ceramic condenser and the 100-μμfd. variable midget bandset condenser, will tune the 1750-2000 kc., range with the 365-μμfd. broadcast condenser. With two plates removed from this condenser the bandspread on the higher frequencies was improved and the full range was still covered. The link on the coil is left unused, of course.

Under the Chassis

Underneath the chassis a shield partition separates the oscillator and buffer stages from the output-doubler stage. The sockets for the oscillator tubes and the buffer are located directly in front of this shield. There is little that need be said about the wiring of these stages since the diagram is practically self-explanatory. The only precaution that need be observed is to make the leads from the grid of the 1852 through the 3-30 μμfd. coupling condenser to the tank circuit and the similar lead from the 6F6 screen as short and direct as possible. These leads are supported from the socket terminals at one end and by a tie point alongside the hole leading up to the tank circuit at the other. The coupling condensers are supported directly from the wiring.

An 1852 is used in the first stage of the oscillator since this type has higher transconductance than other pentodes and allows less feedback capacity to be used with the relatively low plate voltage available from the VR-150-30 voltage regulator. If higher plate voltage for the oscillator stages had been available there would be no objection to using a 6SJ7 or similar type in the first stage. Plate voltages up to 300 volts do not introduce any appreciable frequency drift from tube heating in this type of circuit, but voltages of this



Under-chassis view of the v.f. oscillator. The upper knob and shaft controls the amplifier tank condenser. The lower knob and shaft controls the v.f. crystal switch; the same switch also selects the desired crystal for edge-of-band operation.

order are somewhat more difficult to regulate. The r.f. choke in the plate of the 1852 permits the full 150 volts to be applied to the plate and acts as sort of a "damper" for any unwanted oscillations which might otherwise be generated in the oscillator when the coupling to the tuned circuit is loose. The r.f. choke has a rather low impedance to the random low frequencies at which the circuit tends to oscillate when the tank is not in control. By placing an element of such low impedance at these frequencies across the circuit, undesired oscillation is eliminated.

The second oscillator tube, which may be called a "phase inverter," "feedback tube," or what have you, is the aforementioned "electron-coupled" pentode. Either a 6F6, 6V6 or 6L6 may be used, the 6F6 seeming to have somewhat better shielding between the screen the plate than the 6V6, while the 6L6 has none. No cathode bias is necessary on this stage, a sufficient though small amount of bias being obtained from the grid- and contact-current flow through the grid resistor. From the plate of the stage the output is carried through the 100-$\mu\mu$fd. coupling condenser C_{17} to the two end positions on one section of the crystal-v.f.o. switch. Tying both ends of the switch together in this manner allows the unit to be switched from either one of the crystals to the v.f.o. position without first going through the other crystal position. With the switch in the v.f.o. position the output is carried through the 6F6 class A stage and then to the grid of the output-doubler stage.

Buffer Stage

The untuned class A stage is strictly conventional. An r.f. choke is used as the plate impedance to permit the full 150 volts of regulated voltage to be applied to the plate. This same regulated voltage is also used on the screen. When the selector switch is thrown to the crystal position this stage become a Pierce crystal oscillator. The method of circuit switching used requires that each crystal have its own grid leak and condenser. This is but a minor disadvantage since the grid leak and condenser are inexpensive items. The components in this stage have been chosen for use with 80-meter crystals since the exciter would be applicable to a wider field of usage with crystals of this frequency.

A 100-$\mu\mu$fd. condenser, C_{18}, couples the buffer stage to the output stage. This stage is also conventional except in one minor respect: In order to allow the tuning condenser to be mounted directly on the under-chassis shield partition and at the same time use series feed, it is necessary to isolate the tuning condenser from the coil with a blocking condenser, C_{15}. In all other ways the stage is an ordinary doubler with a combination of cathode and grid-leak bias.

The layout of the various parts should be fairly obvious from reference to the photographs. As mentioned before, the two oscillator tubes and the buffer stage are located along the chassis to the rear of the shielded

[*Continued on Page 177*]

Trends on Ten

By GEORGE M. GRENING,* W6HAU

The main difficulty experienced with ten-meter amateur mobile operation in the past has been the difficulty of securing a satisfactory car receiver for these frequencies.

At the present time there are several small commercially built communications receivers which can be obtained with six-volt power packs for portable use and which cover the ten-meter band.

If a regular broadcast receiver is already installed in the car, the converters previously described in this magazine will give surprising results.[1]

We recently acquired the original RADIO four-tube laboratory model converter and as a matter of interest, compared it with two ultra-high police sets using 10 and 11 tubes respectively and selling for \$150 and \$200. The converter, attached to a good broadcast receiver, pulled in every station the police sets would and except for the use of squelch circuits and noise suppression in the commercial sets (to be expected at the price) was just as satisfactory.

The one-tube converter, except on weak signals, performed equally well, its only minor disadvantage being a tendency to shift tuning slightly as the engine was "revved" up, increasing the B voltage due to the increased battery voltage.

In fixed operation, this of course does not occur. If it is annoying in car service it can be cured by incorporating a filamentless regu-

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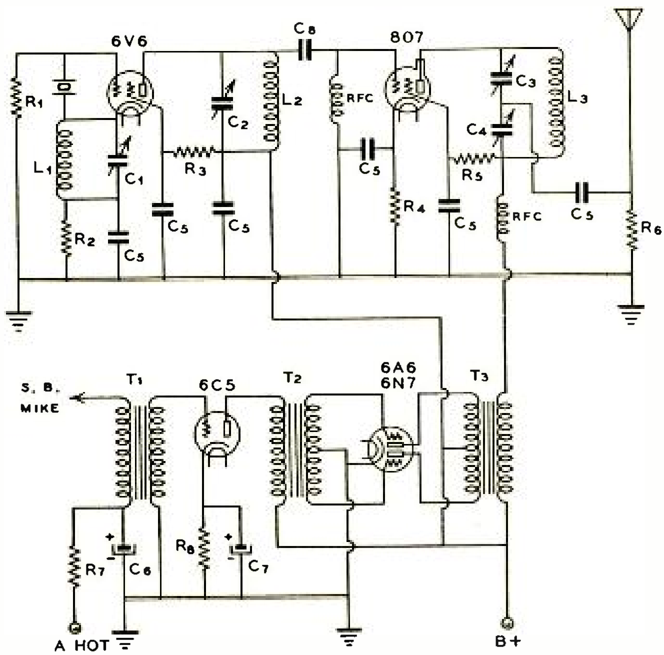
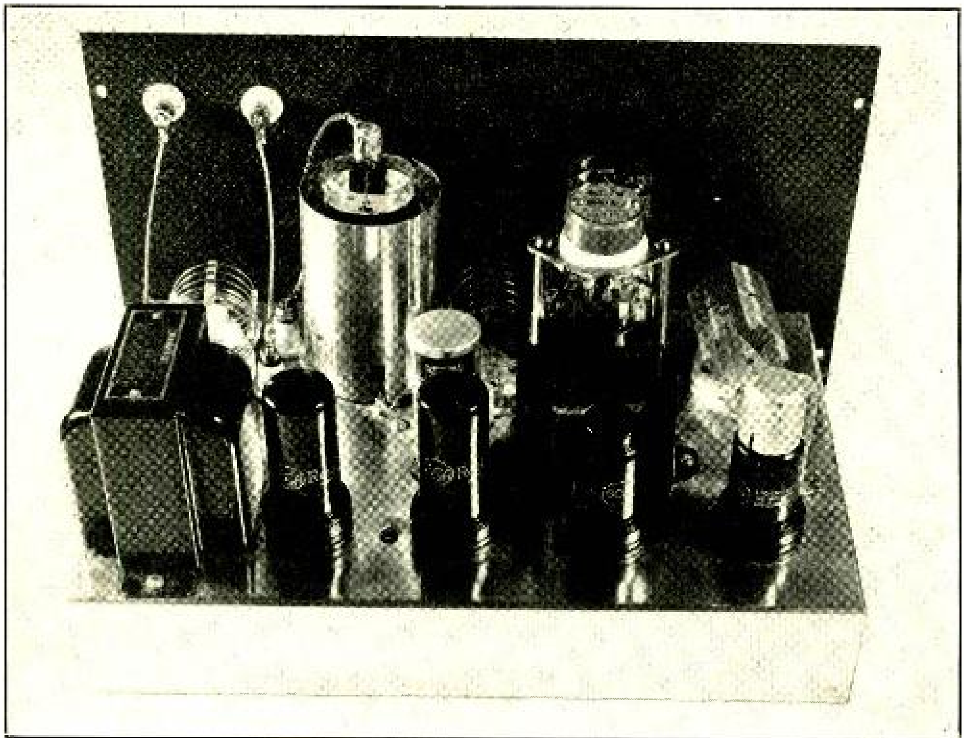
* Radio Supervisor, Police Dept., Santa Barbara, Calif.

[1] Gonsett, "Ten-Meter Auto Radio Converter," RADIO, Jan., 1939, p. 52. Dawley-Norton, "Improved Converter Design," RADIO, May, 1939, p. 9.

Figure 1. Diagram of simplest medium power mobile transmitter.

- C_1—140-μμfd. midget variable
- C_2—50-μμfd. midget variable
- C_3—35-μμfd. midget variable, double spaced
- C_4—140-μμfd. midget
- C_5—.005-μfd. mica
- C_6—1000-μfd. 15-volt electrolytic
- C_7—10-μfd. 25-volt electrolytic
- C_8—.00001-μfd. mica
- R_1—75,000 ohms, ½ watt
- R_2—500 ohms, 1 watt
- R_3—20,000 ohms, 1 watt
- R_4—150 ohms, 10 watts
- R_5—10,000 ohms, 3 watts
- R_6—20,000 ohms, ½ watt
- R_7—Depends upon microphone resistance. Try 500 ohms, and adjust for proper gain
- R_8—2000 ohms, 1 watt
- T_1—Single-button microphone to grid
- T_2—Midget class B input
- T_3—Class B 6A6 to r.f. load
- L_1—19 turns no. 24 enam. closewound on ⅜" dowel
- L_2—6 turns no. 10 enam. 1" dia. wound to a length of 1½"
- L_3—7 turns no. 10 enam. 1" dia. wound to a length of 1½"





6A6-807 transmitter, showing location of components. 6A6 tube partly hidden behind raised crystal socket. Extra filter choke and condenser in center of chassis optional (see text).

lator tube (VR-105 or similar) between the coil side of resistor R_4 in the original diagram and ground, and by changing R_4 to 10,000 ohms.

Interference Elimination

Except for sets having built-in noise suppression it appears almost impossible to eliminate ignition noise arising from other cars. By far the best method devised is that of placing a ¼-watt neon bulb, with base resistor removed, across the primary of the b.c. set output transformer. A switch should be incoporated to cut this suppressor out for broadcast reception and on loud or heavily modulated signals to keep it from clipping the peaks.

All the usual ignition suppression devices should be incorporated on your own car engine. Persistent generator interference which exists even though a regular generator condenser has been installed may be overcome by placing a .005-μfd. mica condenser in parallel with the regular condenser. Auto radio generator condensers are not very effective in eliminating ten-meter hash.

Muting Relays

To eliminate complicated send-receive switching, a "muting relay" may be installed to deaden the receiver while transmitting. If this relay is installed to short the voice coil of the b.c. loudspeaker in the transmit position there will be no click audible upon changeover.

Transmitter Designs

As far as transmitters are concerned, one has dozens of designs to choose from. The question of tube types, what stages to double, triple or quadruple in, the power and mechanical layout—all are governed by individual choice. Fortunately no two amateurs ever agree, which fact explains the pace at which radio is progressing.

Several examples of mobile transmitters will be described, not with the idea that they will be copied or that there are no other practical circuits, but to illustrate current trends in the field.

The 807 or RK-39 has proven particularly popular and with good reason. Such tubes require no neutralization if they are shielded and constructional practice adapted to them is followed.[2] Filament type 6L6's and 807's are now available (1619 and HY-69). They are designed to have a quick heating filament which will reach operating temperature as fast as the dynamotor will start.

Figure 1 shows a 6V6 tritet with cathode tuned to 40 meters and plate to 10 meters, feeding such a tube as a straight amplifier. At 350 volts, one to two ma. of grid current is available and the 807 may be loaded to 75 or 80 ma., or an input of 26 to 28 watts.

The modulator is conventional, using a 6N7G or 6A6 class B. Hash in the microphone voltage is eliminated by a 1000 *microfarad* low voltage condenser.

The simplified plate tank-to-antenna coupler is particularly efficient for transferring energy to a quarter-wave fishpole if the antenna lead is not too long. Such coupling networks are becoming quite popular for ten-meter mobile work, their characteristic of sometimes accentuating harmonics being immaterial on this frequency.

Power for this transmitter should be derived from a 300-volt, 150-ma. or a 350-volt, 150-ma. pack.

This is about the simplest crystal-controlled ten-meter transmitter possible. Many undoubtedly will condemn the use of a tritet as a fourth harmonic oscillator but may we point out the fact that one of the newest commercial police transmitters uses a similar oscillator circuit with excellent results.

[2]Smith, "On the Care and Feeding of 807's," RADIO, Jan., 1939, p. 75.

The W6QZA Transmitter

One of the most successful amateur mobile transmitters we have seen is that of Elliott Haberlitz, W6QZA, shown in the photos and diagrammed in figure 2. W6QZA has yet to receive less than a "5-7" on dx with this rig. He uses a one-tube converter[1] for reception.

To our mind, these frequencies offer their greatest mobile thrill in the manner in which dx is worked and not for purely local contacts. The outfit illustrated is used primarily for such distance work and has maintained daily schedules with the east and middle west.

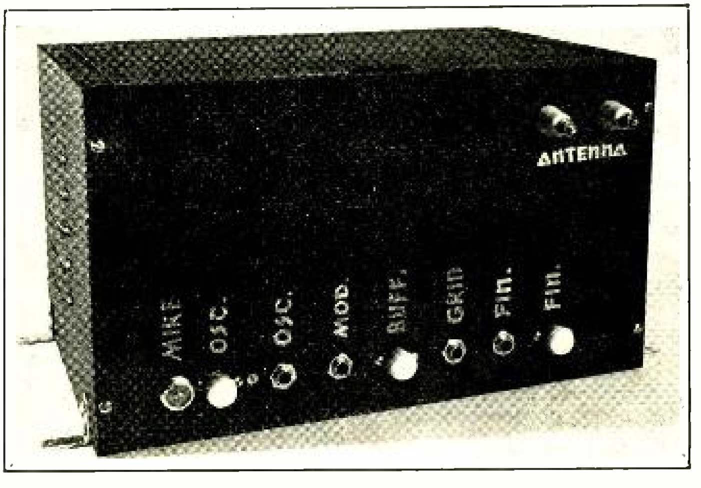
It is essentially a 6A6 oscillator-quadrupler capacitively coupled to an 807 as a straight amplifier. Speech is designed for a crystal mike and such a surplus of gain is available that the 6C5 might well be eliminated with most microphones.

The 20 μfd. of condenser is sufficient filter although in the original model an additional 20 henries and 8μfd. of filter was used. While this is shown in the diagram the additional filter is not essential.

The placement of parts is evident from the photographs, except for the 6A6, which is hidden behind the raised crystal mount. The metal box on the left of the under-chassis view holds the speech input choke, resistor and condenser. Coils used are stock 25-watt units (B. & W.).

This transmitter, including tubes but less crystal, cost exactly $31 to build (buying everything new). It is powered with a 350-volt 150-ma. dynamotor.

Constants have been worked out to give a total exciter plate current of but 37 ma. Minimum dip on the final is 35 ma., which is



Front view of 6A6-807 mobile transmitter.

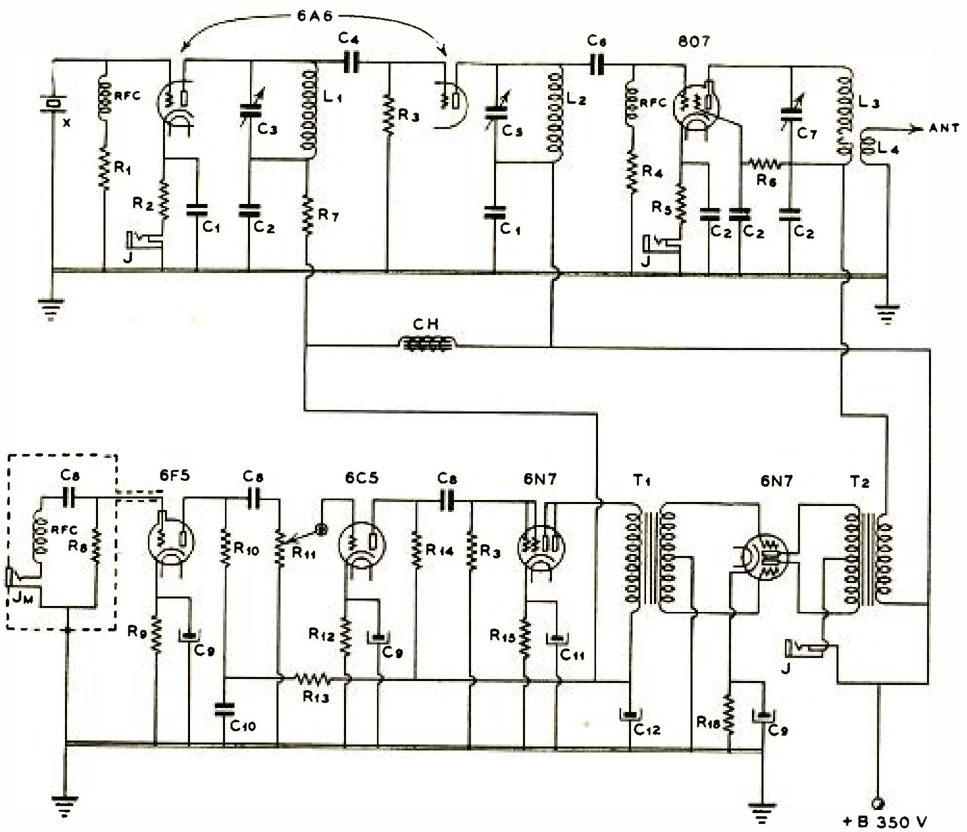


Figure 2. Schematic of the W6QZA transmitter.

C_1—.001-μfd. mica
C_2—.002-μfd. mica
C_3—75-μμfd. midget variable
C_4—.0001-μfd. mica
C_5—25-μμfd. midget variable
C_6—.00005-μfd. mica
C_7—25-μμfd. midget variable
C_8—.05-μfd. 400-volt tubular
C_9—10-μfd. 25-volt electrolytic
C_{10}—4-μfd. 450-volt electrolytic
C_{11}—25-μfd. 25-volt electrolytic
C_{12}—4-μfd. 450-volt electrolytic
R_1—20,000 ohms, 1 watt
R_2—1500 ohms, 2 watts
R_3—100,000 ohms, ½ watt
R_4—20,000 ohms, ½ watt
R_5—200 ohms, 3 watts
R_6—10,000 ohms, 10 watts
R_7—1250 ohms, 10 watts
R_8—2 megohms, ½ watt
R_9—2000 ohms, 1 watt
R_{10}—250,000 ohms, 1 watt
R_{11}—500,000-ohm potentiometer
R_{12}—5000 ohms, 1 watt
R_{13}—100,000 ohms, 1 watt
R_{14}—50,000 ohms, 1 watt
R_{15}—1000 ohms, 1 watt
R_{16}—100 ohms, 5 watts
RFC—2½-mh. r.f. choke
J—Closed-circuit jack
JM—Single-circuit jack
L_1—24 turns no. 22 enam. 1½" dia. wound to a length of 1½"
L_2, L_3—6 turns no. 22 enam. 1½" dia. wound to a length of 1½"
L_4—3 turns at ground end of L_3
T_1—Driver plate to class B grids
T_2—Class B 6N7 to r.f. load
CH—20 h., 50 ma.

loaded to 80 by the antenna. Grid current to the 807 under load is 1½ to 2 ma.

An unusual trouble experienced in the original model was self-oscillation in the final, evidently due to inductive feedback. The coils of the first two stages had their far end (away from the panel) connected to the respective plates. The final coil, however, was connected in the opposite direction. Reversing this, making B plus on all coils connect to the panel side of the coil, completely cured this trouble.

The Grening-Wasmandorff Mobile Transmitter

Some time ago the writer described a mobile transmitter using a 6A6 oscillator-quadrupler, feeding a 6A6 push-pull final.[3] Judging by the scores of letters received, it must have struck a responsive chord.

Carlton Wasmandorff, W6LFL, made several improvements on the basic circuit, which has become the most widely used composite police transmitter in this section of the country. In addition, amateurs by the dozens have built duplicates with excellent results. The circuit is given in figure 3, and two transmitters, different in mechanical construction but using the same circuit, are shown in the photos.

The construction of the first transmitter, while unorthodox, follows the original referred to, using a pair of stock Lynch mobile transmitter cans for separate r.f. and a.f. units.

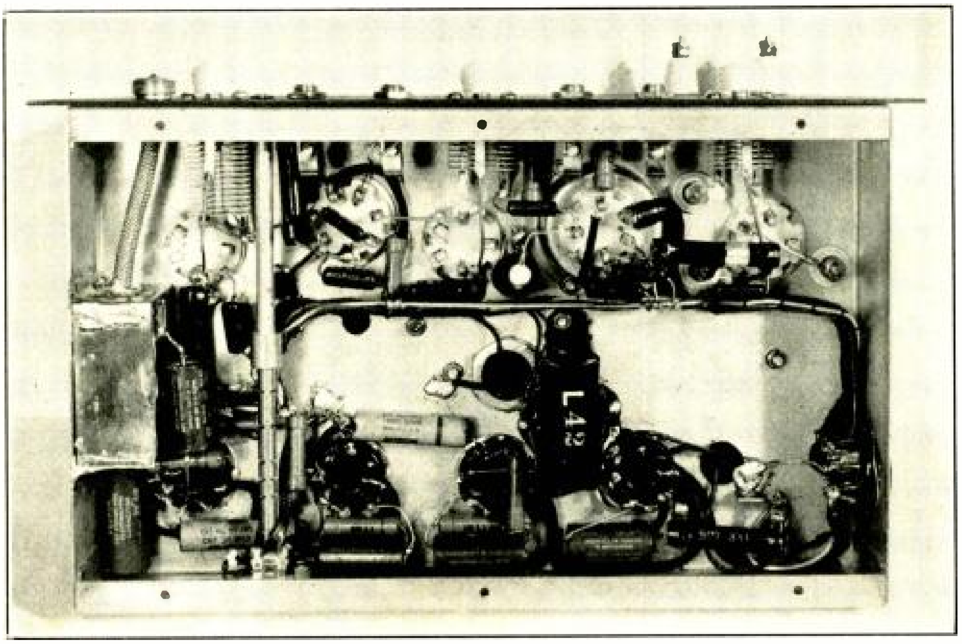
The second transmitter (using the power pack to be described) is built in a "coffin gray" cabinet with red tuning knobs, which unfortunately do not show up in the photo. This, together with the nickeled jacks, switch and chrome-catalin handles makes a nicer appearing outfit. It has been designed to have nothing above the chassis except the tubes, crystal and final tank coil. It could of course be constructed more compactly if this policy were not adhered to.

Past difficulties with road dirt dictated that it be made dust proof. This has been accomplished by capping the socket into which the handset plugs when testing the set from the trunk, by making the power cable plug's entrance a tight fit and by using removable telephone blank plugs in the meter jacks. The toggle switch is for a test tone, while the socket at the far right permits plugging in the concentric antenna cable. Two nickled snap switches hold the chassis in the can. The chassis pan, as can be seen, is well braced by the end plates.

Either a metal or glass 6V6 operates on the 40-meter crystal frequency. This tube, incidentally, proved to be the best low-power oscillator among the many tried.

The first section of the 6A6 operates at double the crystal frequency (20 meters) and the second section at four times the fundamental (10 meters). Regeneration is deliberately introduced into this section by condenser C_4, more than doubling the exciter output and making each end of the tank coil equally

[3] Grening, "Ten-Meter Mobile Crystal Control," RADIO, April, 1937, p. 22.



Under-chassis view of 6A6-807 transmitter. Volume control on end of shaft extensions. Input choke, condenser and resistor in shielded compartment at left of chassis.

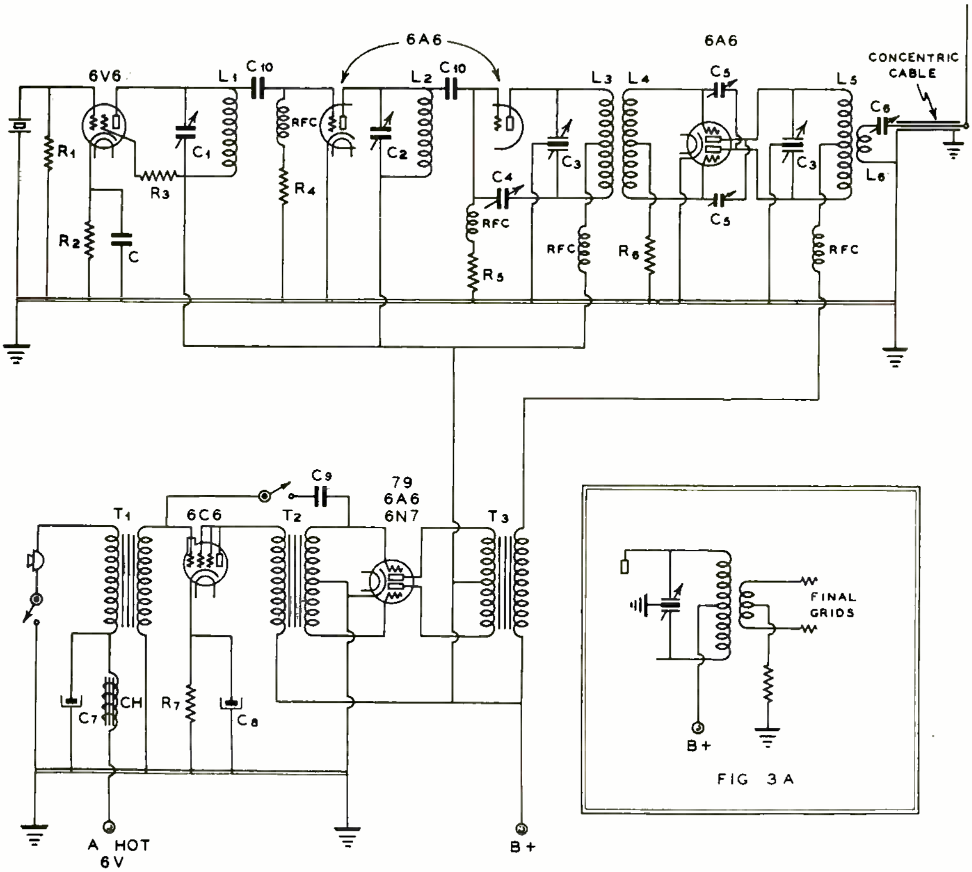


Figure 3. Wiring diagram of the de luxe mobile transmitter. Figure 3A shows alternative and simpler link method of coupling final grids to exciter plate coil.

C—.005-μfd. mica
C_1—35-μμfd. midget variable
C_2—15-μμfd. midget variable
C_3 — 35-μμfd. per section midget variable
C_4—15-μμfd. midget variable
C_5—10-μμfd. midget variable
C_6—75-μμfd. midget variable
C_7—25-μfd. 25-volt electrolytic
C_8—10-μfd. 25-volt electrolytic
C_9—.01-μfd. 400-volt tubular
C_{10}—.0001-μfd. mica
C_{11}—0.1-μfd. 400-volt tubular
R_1—100,000 ohms, ½ watt
R_2—5000 ohms, ½ watt
R_3—25,000 ohms, ½ watt.
R_4—50,000 ohms, ½ watt
R_5—15,000 ohms, ½ watt
R_6—1000 ohms, 1 watt
R_7—2500 ohms, ½ watt
T_1—Single - button microphone to grid
T_2—Driver to class B grids
T_3—Class B plates to r.f. load
CH—7 h., 40 ma.
L_1—25 turns no. 22 enam. closewound on ¾″ form
L_2—15 turns no. 18 enam. closewound on ¾″ form
L_3—17 turns no. 10 enam. ¾″ dia. 3″ long
L_4—23 turns no. 10 enam. ¾″ dia. 3″ long
L_5—Same as L_3
L_6—2 turns over center of L_5

• • •

"DE LUXE" TRANSMITTER COILS

L_1—30 turns no. 22 enam. closewound on ¾″ form
L_2—15 turns no. 18 enam. closewound on ¾″ form
L_3—13 turns no. 18 enam. on ¾″ form, spaced to a length of 1″
L_4—Three turns over center of L_3
L_5—6 turns no. 10 enam. 1¼″ dia. spaced to a length of 1½″
L_6—2 turns around center of L_5

hot. The correct adjustment of this condenser is the point at which the grid current to the final drops to zero when the crystal snaps out of oscillation on the "sharp" side. Too much capacity is indicated by a failure to do so, caused by self-oscillation.

Coupling to the conventional 6A6 push-pull final can be done inductively by either one of two different methods. A grid coil which is self-resonant at the operating frequency is placed alongside the exciter tank coil and at the approximate spacing from it shown in the photo of the one transmitter. The exact distance is not critical.

A more unusual and simpler method, used in the larger transmitter, is to wind (link fashion) three turns around the center of the 10-meter exciter tank coil, center tapping this link coil through the grid leak to ground and running the two ends of the coil direct to the final grids (figure 3A). This latter method is simpler from a mechanical standpoint, although not quite as efficient as the tuned inductively coupled coil.

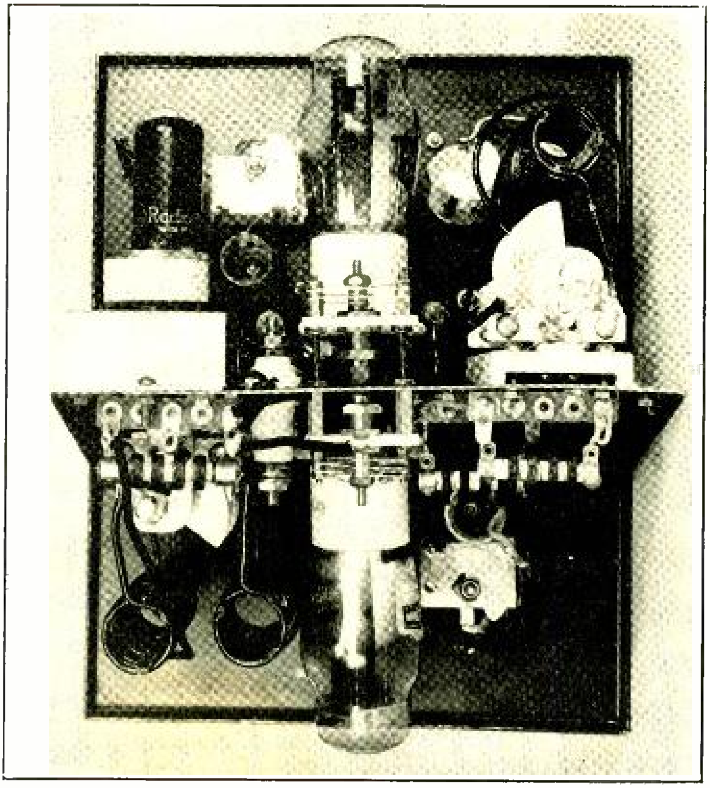
When a 100-ma. power pack is used, coupling to the final is adjusted to load it to 40 ma. and with a 150-ma. pack, to 75 ma.

The peculiar form factor used in the coils of the one transmitter was necessitated by the proximity to the shield can. A long narrow coil such as this has a small concentrated field.

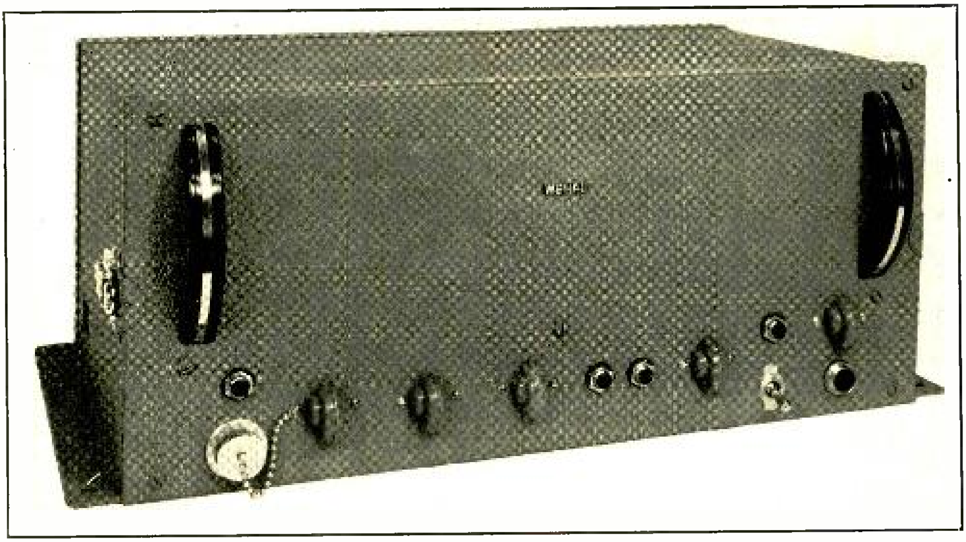
Plate current of the exciter is 40 to 50 ma., although it can be made lower by experimenting with grid leak values. For a 350-volt supply the grid leaks on the two 6A6 grids should be increased to 100,000 and 50,000 ohms respectively to give a conservative value of plate current.

The final dips to 15 or 20 ma. unloaded. While low plate current dips do not *necessarily* indicate a high order of efficiency, if you like lots of "dip" be sure to use heavy wire (no. 10) for the final tank. Tests with wire sizes from no. 24 to no. 8 indicate that the minimum dip is almost directly proportional to the size wire used up to the no. 8 limit.

Too much grid current on the final is more of a problem than too little! In the unit pictured at 280 volts it runs 30 ma. For maximum tube life it should be cut down to 15 or 20 by dropping the exciter plate volt-



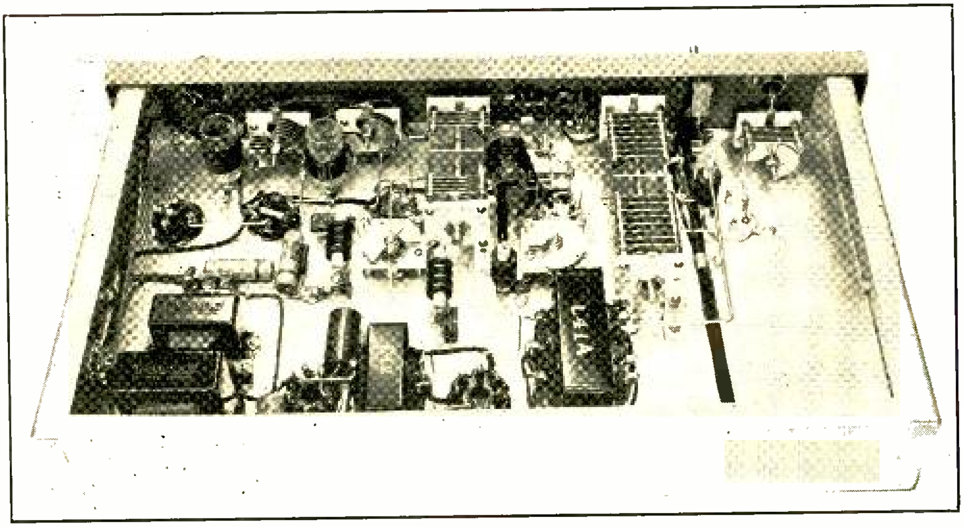
6V6-6A6-6A6 r.f. unit. 6V6 oscillator and 6A6 final on top shelf. Antenna coupling link visible around final tank coil. 6A6 doubler-quadrupler on bottom shelf. Note inductive coupling between this stage and final.



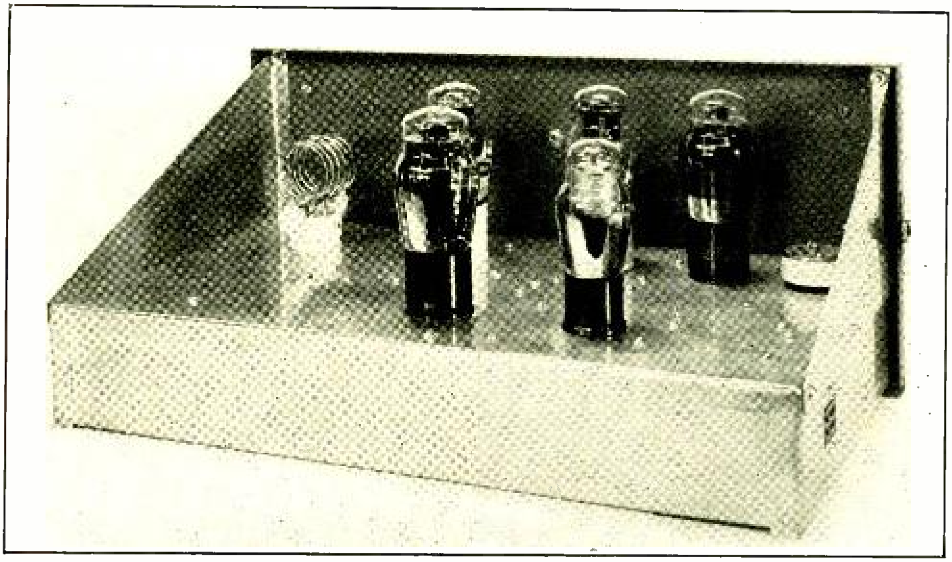
De luxe amateur mobile transmitter, 15 watts output. Designed to be dustproof. (Note removable plugs in meter jacks). Capped socket is for insertion of handset plug for trunk testing of the unit. Switch operates "test tone." Concentric cable plugs into socket far right.

age, not by reducing the regeneration. In almost all cases isolantite base 6A6's give the best results.

Coupling to the antenna may be done by any of the usual methods. Our personal preference is shown in the diagram. The final is loaded to the desired current by the condenser in series with the pickup coil. This has the advantage that antenna loading can be adjusted from the panel, and antenna height (except on extreme dx) is immaterial.



Under-chassis view of 6V6-6A6-6A6 de luxe transmitter. While plenty of space is available, no r.f. lead is over one inch long! Horizontal coil has three turn link as per figure 3A. At 350 plate volts, this gives 30 grid ma. to final. Regeneration condenser is between r.f. choke and split stator condenser.



De luxe amateur mobile transmitter, showing clean appearance above the chassis. The cadmium plating is polished with jeweler's rouge and a cloth buffer until it appears to be chromium plated.

Modulators

The modulator used with this r.f. section is the same as originally described: either a 6C5 or 6C6 (triode connected) feeding a 79, 6N7 or 6A6 class B. If the power supply only delivers 100 ma., then the 79 with its lower static plate current (14 ma. for entire speech section) is preferable; otherwise the 6N7 or 6A6 is indicated.

A number of these transmitters are in use with 400-volt 200-ma. dynamotors. At this voltage experimental models have produced up to 65 ma. of grid current to the final.

The 6A6's stand this voltage ok but the modulator requires extra bias, which is obtained from the car battery (figure 4). Both methods diagrammed give a six-volt negative bias on the class B grids.

Microphone voltage for the single-button mike is obtained from the car battery through a hash filter which completely eliminates all traces of this annoyance.

A convenient "test tone" is obtained by incorporating a 0.1-μfd. condenser between the grid of the speech tube and one of the grids of the class B stage. The proper grid must be determined experimentally. Closing the switch, which can be a relay controlled from the driver's compartment, produces a nice 1000-cycle note. The pitch is determined by the capacity of this condenser.

Crystals

Mobile transmitter crystals are of two types. A 40-meter fundamental thickness is usually used in tritets or similar harmonic oscillators. For double purpose tubes in which the first section operates at the crystal frequency, a harmonically operated crystal is preferable. Such units have a fundamental thickness three times normal but oscillate at the third harmonic. Since they are practically as thick as a 160-meter crystal, they are particularly rugged. Holders for this type are usually designed to clamp the corners of the crystal firmly, oscillation occurring in the center. Clamping crystals makes them impervious to

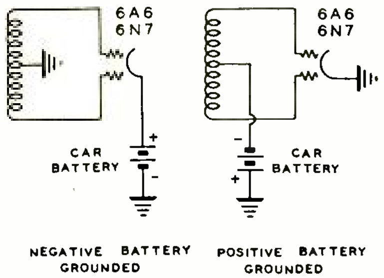
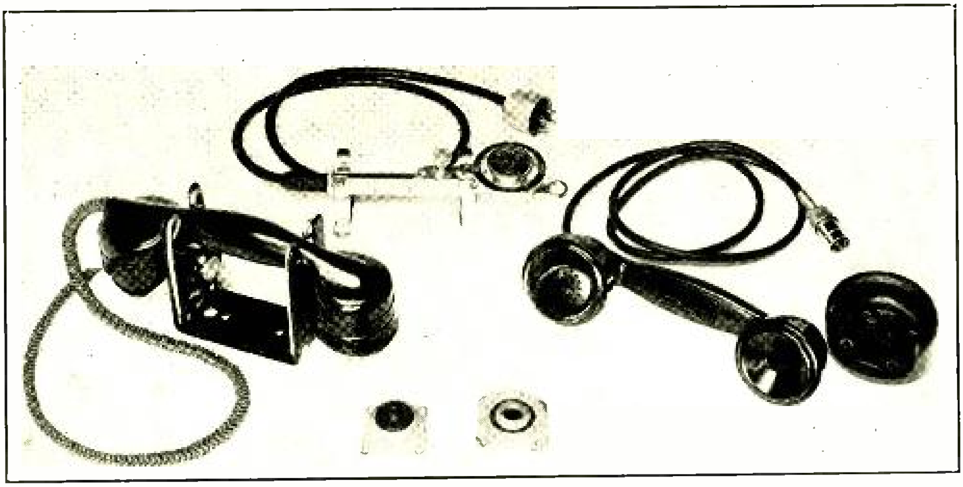


Figure 4. Method of obtaining bias for class B modulator using 6A6 or 6N7 when either terminal of the battery is grounded.



Types of mobile microphones and shock mounts. Lower left: handset with "Extensicord" in spring dashboard type holder incorporating filament switch on holder. Upper center: radio type mike with press-to-talk button in 5 and 10 broom holders. Lower right: handset with grip-type press-to-talk switch and rubber cup into which receiver end of handset fits for dash mounting. Lower center: two types of shock mounting cups.

mechanical damage. In a harmonic oscillator, however, unless the cathode is sharply tuned to 40 and plate voltage is low, such a crystal will oscillate at both its fundamental and third harmonic at the same time, resulting in a fracture.

Finding the Proper Harmonic

In adjusting the exciter ten-meter tank to the correct frequency, it is very easy to hit 8 or 13 meters. Particular care must be taken to get the right harmonic not only in this transmiter but in all ten-meter exciters. This can be determined by an absorption wavemeter or by tuning the station receiver to ten and modulating the transmitter with the test tone mentioned previously. Lack of modulation is an indication that you have the wrong harmonic. At a distance, of course, the carrier will be very weak or non-existent.

Antennas

To date, nobody has discovered a better transmitting antenna than a fishpole. A small fortune awaits the man who does. For occasional use, the "under $2.00" type is good enough, but for a permanent installation, one with locking joints is better. The most common feed methods are simplified coupler, off-center feed and concentric or twisted-pair fed. Western Electric engineers take 30 ohms as the average impedance of a quarter-wave fishpole (series fed).

With the fishpole mounted on the rear of the car, transmission is several R's better in the direction the car points. An aid in this respect, is a small dashboard compass with rubber suction cup attachment, obtainable at auto accessory stores.

Microphones

Our old friend the single-button carbon microphone still reigns supreme in mobile installations. They combine high output and ruggedness with good quality.

Years ago we spoke depreciatingly of "telephone mike quality" but no more. Both the Western Electric F1 and Automatic Electric 35A7 mikes as used in "French" phones have a speech characteristic substantially flat over the voice range.

Contrary to general amateur opinion, such telephone equipment may be purchased without trouble, either direct from the factory or through regional distributors. These telephone hand sets may also be obtained with a "push to talk" switch as a stock item. The receiver can be tapped into the b.c. set at a low level point.

Regardless of the type mike use, the practice of "kicking it around" inside the car is to be deplored. Rubber or spring handset holders are available for telephone units, as shown in the photos, while a little ingenuity will solve the problem of mounting other types.

A mike having a handle can be mounted in a "five and dime" broom holder. A holder for the round airplane type can be made by mounting a slotted piece of metal on the dash, into which a bolt, running from the back of the mike and having a small disk attached to its head, will fit (figure 5).

The annoyance of getting the mike cord tangled up in your feet can be avoided by installing an "Extensicord," which is a braided four conductor telephone cord, having a normal length of 21 inches. It looks like an optical illusion, but the cord stretches to 53 inches! Such a cord is installed on one of the handsets pictured.

Power

While dynamotors are very popular as a source of power, the newer high-output double vibrator packs are equally satisfactory. Their main advantage lies in their greater efficiency or lower battery drain for a given power output. Class B modulation has a tendency to vary their output to a certain extent, but in most cases this is not a serious factor.

For purely local work, 15 watts input to the final is more than sufficient. Local coverage is more a function of the frequency and topography than the power.

For dx, higher power is a distinct advantage, with a 30-watt input being a good economy/range compromise. Inspecting the catalog of one manufacturer, we find the difference in price between a 350-volt, 100-ma. pack and a 350-volt, 150-ma. pack (unfiltered) is but $2.50 net. Between this and a 400-volt, 200-ma. unit the difference is $3.50. Higher power means substituting a larger power unit only, up to the 400-volt limit.

Very little filter is required with dynamotors. Almost invariably a 16-μfd. condenser is sufficient. If ripple is present, it is probably either in the microphone supply or speech stage. A midget choke and 4-μfd. condenser in the B plus lead to this stage will effect a cure. Vibrator packs take more filter but even they get by on surprisingly little.

All such power units draw heavy current, ranging from 10 amperes on the smaller to 20 or more on the larger ones.

If the power pack is located in the trunk, *not less* than no. 4 or no. 6 cable should be used. Even with no. 6 cable, the terminal voltage on the power pack under load will probably be around 5.7 volts. Cognizant of this, the commercials often have their power packs built for 5.5-volt input. Almost every amteur installation we have seen has used cable which is far too light for the heavy drain.

It is always inadvisable to insert a switch in this line. There are few switches that will pass this amount of current without considerable voltage drop. Some that were tested showed a drop of a volt or more through their contacts.

Bulkhead Mounted Power Supplies

Our personal conviction, borne out by recent trends in the field, is that it is preferable to mount the power supply on the bulkhead of the car, either on the engine or on the driver's side. The battery cable in this position will be not over 40 inches in length, giving higher efficiency and saving on cable expense.

Such a power pack is shown in the photos. It was built to determine its efficiency as compared to a trunk installation and the improvement was well worthwhile.

It mounts on the bulkhead behind the right luggage compartment and is almost out of sight. The incorporated wing nuts and pull handles permit servicing the supply without unbolting the can. Lifting the handset from the spring holder releases a normally off switch, operating the filament relay which turns on the tubes in the trunk. Pressing the grip switch actuates the dynamotor relay. Each set of contacts on this relay is rated at 30 amperes. We paralleled them to secure minimum voltage drop. B plus is fused together with the relay-filament circuit. "A" hot is deliberately unfused. It is difficult to secure a fuse and holder which does not show a large drop under load. The only chance of the cable shorting is where it passes through the bulkhead, and an exceptionally heavy grommet, together with

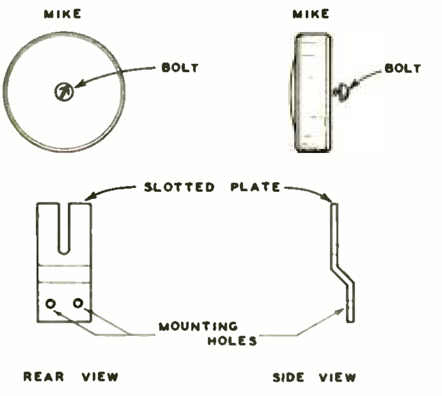
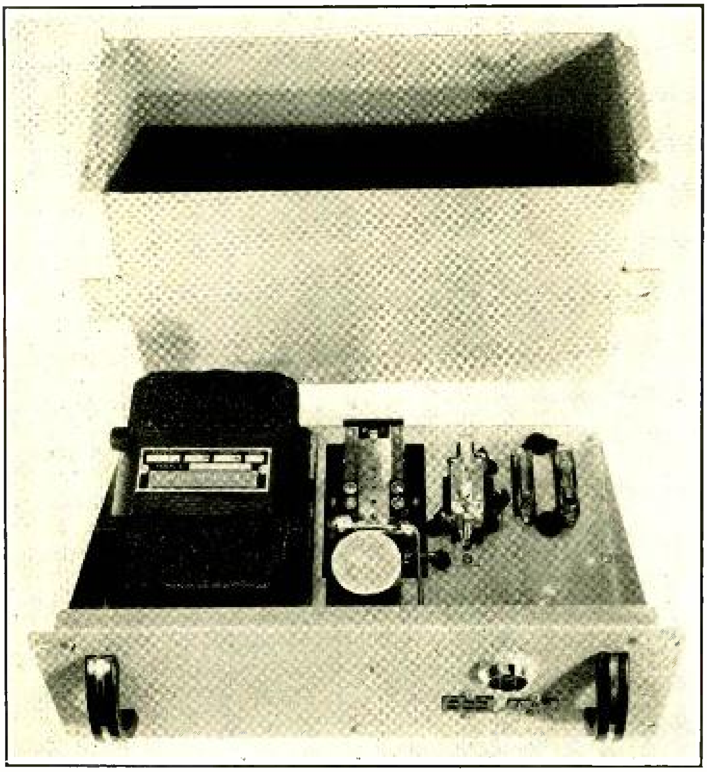


Figure 5. Making a mounting bracket for holding the microphone when not actually in use.



Bulkhead mounted power pack, controlled relay assembly. Mounts on bulkhead with handles downwards. Large relay to turn dynamotor on and small relay to turn filaments on. Power cables and microphone plug into panel.

thick loom, guards against this. Actually, there is less chance of this shorting than there is of the starter cable.

The handset plugs into the power pack. A six-wire speaker cable runs to the trunk, using one for B plus, one for speech, one to operate the dynamotor relay when the handset is plugged into the trunk transmitter for adjustments and three leads paralleled for filaments. To permit duplex, the receiver in the handset is connected to the output of the first audio stage in the receiver. Pressing the grip switch also operates a muting relay in the receiver, killing the speaker but leaving the handset receiver operative. It's like riding around with a telephone in your car!

Shock Mounting

Common practice has been to mount the transmitter on sponge rubber, kneeling pads, or airplane type shock proof cups. Incidentally, experience with the latter on motorcycle transmitters over a two-year period has indicated that they should be considerably stiffer than recommended by the manufacturer, since they are designed to eliminate higher frequency engine vibration rather than road shocks. The first units tried were designed for four pounds per cup and tore out. By using the eight pound type, putting four pounds on each, no further trouble has been experienced in this admittedly severe type of service.

The idea of shock mounting mobile transmitters is, we believe, a carry over from the aviation field. Did you ever see an auto radio shock mounted? Neither have we. Actually the components of a receiver are more subject to damage from vibration than those of a transmitter.

Assuming that the tuning condensers can be locked or tightened and that reasonable care is taken in construction, we believe it is beter to tie the whole unit down solidly. Many of the commercials are now designing their sets for rigid mounting and report no undue amount of trouble.

To prove this point to our own satisfaction, we removed the shock mounts on one of our local police jobs. We must have picked the right car, because before long it hit a dip at

[*Continued on Page 159*]

HOW ABOUT THE RECEIVER?

By JERRY CROWLEY,* W6HBT

I am a communication receiver. . . . My owner bought me two years ago for one hundred and fifty dollars, and for a few months I was the most prized part of his amateur radio station. Then one horrible day—I shall never forget it—my owner began to speak in a very disparaging manner about my services. Since then, life for me has been almost unbearable.

It started when the o.m. (that's what he calls himself) heard W6— down the street working a G6 station. The o.m. twisted my dials frantically, but all I let out was a loud hissing sound when he had me tuned to the station. I tried desperately to pull that weak station through my many stages and make it audible for him; but it was of no avail. The little spring-brass plates that formed a part of my trimmer condensers had become weak and shifted their positions. The result was that some of my circuits were tuned to the elusive signal, and the rest were tuned many kilocycles away and just bring in a lot of noise.

The o.m. finally gave it up in disgust, and that was the first night in weeks that I got to sleep before eleven o'clock. A few days later I was taken roughly from my honored position on the operating table, and shipped back to the factory where I had been built. There I was given a thorough going-over, and all my circuits were very carefully retuned. I could see for myself that I was having a good job done, because the man who worked on me was using an oscilloscope. I was glad then that my owner wasn't one of these hams that dive into a complicated receiver and try to align it without the proper equipment.

When I finally gave him the pattern he wanted on the oscilloscope, he checked me on the air and gave a big grin of satisfaction at the way I performed. The next day I was packed up and shipped back to California. But alas! The way was long, and I received some severe jouncing on the train.

The result was that my owner was frothing at the mouth by the time he had given me another trial. I guess the letter he wrote back to the factory was a scorcher. I heard him talking to W6— about it, and I almost blushed at some of the words the o.m. used. I remember that "lemon" was one of them!

Well, things went along that way for awhile, and I continued to do the best I could in my weakened condition. Then a few months later I was taken downtown and subjected to another re-alignment. This time I was handled with great care, and reached home in fine shape. But even though I now performed almost like new, my owner still had nothing but complaints to make about me.

It seems that the o.m. had been over to see W6—, and had listened in on his new receiver. When he came home, all he could talk about were things like: selectivity, sensitivity, stability, and noise level. That night he and the o.w. had an argument that lasted into the wee hours of the morning. At times they raised their voices so high I could catch a few words clear out in the ham shack. It seemed that the o.m. wanted to buy a new receiver, and the o.w. was holding out for a new fur coat.

I guess she won, because the next night, the o.m. dug under the table and brought out a lot of his back issues of RADIO. He spent all that evening going through them, and didn't even stop once to call a CQ. I wondered what it all meant, and the next day I found out. He was going to operate on me. . . . !

I felt pretty sick when I realized it was Saturday, and the o.m. would have two days to dig into my insides. I had seen him approaching the transmitter many times with the very same look in his eye that he had now. I had often been puzzled because he spent so much time in revamping the rig, and yet had always left me strictly alone.

I know the o.m. used to feel pretty good when he made a change in the rig that increased its efficiency by five or ten per cent. That made it all the stranger to me, because I knew that I was only operating at about half my potential efficiency. I guess he was a little afraid of me, but I can't for

[*Continued on Page 166*]

* 1647 Golden Gate Ave., Los Angeles, Calif.

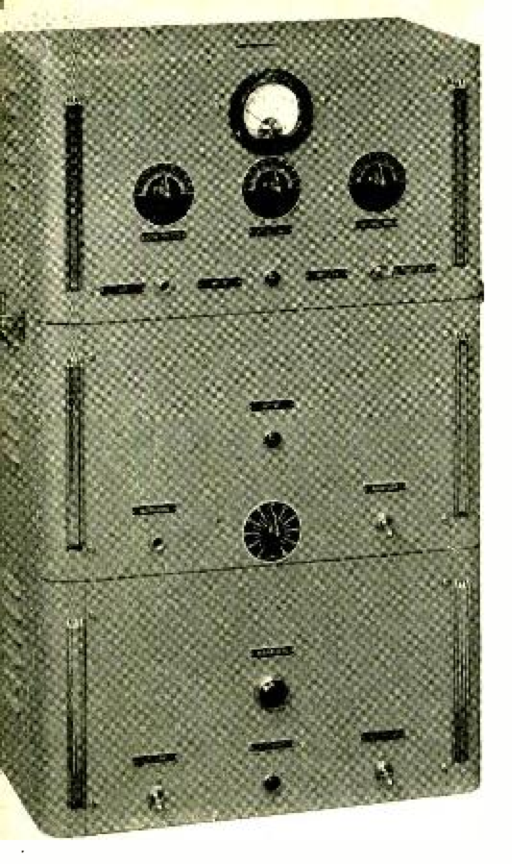


Figure 1. The neat and compact housing for the transmitter is made from three standard receiver cabinets stacked one above the other.

A 25-WATT TRANSMITTER

"in full dress"

By LEWIS VAN ARSDALE,* W8QZR

A description of a neatly built and well designed phone and c.w. transmitter operating on all the bands from 160 through 10 with a conservative 25 watts output on each.

Two schools of thought are prevalent in modern amateur radio design practice. First, there are those who are content to have equipment built in any convenient fashion just as long as it perks, and second, those who not only desire performance, but also desire a layout that is "easy on the eyes." Several unusual features in the circuit design herein described will undoubtedly be of interest to group one, while those in group two will, we feel, be interested in several ideas that were utilized to make what seems to us to be a very clean and practical layout.

The particular circuit used in the r.f. portion of this rig was decided upon after considerable experimentation because it gave good average output and efficiency on all bands from 10 to 160 meters without resorting to any intermediate doubler stages or complex tuning adjustments. The oscillator is an 802 or RK-25 pentode used as a tritet to drive a pair of ceramic based 6L6G tubes which are connected in push-push when doubling and in parallel when operating as a straight amplifier. Discussion always seems prevalent whenever the subject of "oscillator" is mentioned, so by way of putting in our bit, a word of explanation as to why the tritet.

Because of the push-push arrangement of the 6L6G tubes, together with the fact that fairly high values of grid resistors are used, it is desirable to have quite a bit more drive than would ordinarily be required to push the usual single beam tube. It was found that while several of the other popular oscillator circuits doubled quite well from 160- and 80-meter crystals, the tritet circuit shown was the only one that gave adequate output on twenty meters from a forty-meter crystal without a lot of critical adjustments. Twenty-meter output is, of course, quite essential in order to operate the pair of 6L6G tubes on ten meters.

* Bud Radio, Inc., Cleveland, Ohio.

POSSIBLE OPERATING COMBINATIONS

Crystal	L_1 Oscillator Cathode Coil	L_2 Oscillator Plate Coil	L_3 Amplifier Plate Coil
160 M.	40 M.	160 M.	160 M.
160 M.	40 M.	160 M.	80 M.
160 M.	40 M.	80 M.	80 M.
160 M.	40 M.	80 M.	40 M.
80 M.	20 M.	80 M.	80 M.
80 M.	20 M.	80 M.	40 M.
80 M.	20 M.	40 M.	40 M.
80 M.	20 M.	40 M.	20 M.
40 M.	10 M.	40 M.	40 M.
40 M.	10 M.	40 M.	20 M.
40 M.	10 M.	20 M.	20 M.
40 M.	10 M.	20 M.	10 M.

The change-over from push-push to parallel for the output stage is accomplished by the s.p.d.t. toggle switch clearly visible on the rear of the chassis in figure 2. While it is entirely possible that there may be some losses in this type of switching arrangement, this is not at all objectionable since there is plenty of drive from the oscillator tube at all frequencies.

Several other features of the r.f. circuit should be noted. Metering is accomplished through the use of a d.p.d.t. toggle switch which is used to connect the milliammeter across the 100-ohm resistors in either the oscillator or amplifier plate leads. While metering could have been done just as well in the cathode circuits, the 100-ohm resistors offer a smaller loss in the plate leads, and in addition, by metering in the plate circuit only, the plate input may be readily calculated—a point that always seems to come up for discussion sometime during every QSO.

The voltage for the screen grids of the two beam tubes must be secured through the dropping resistor as shown, rather than from a tap on the voltage divider, as it is necessary to modulate the screens and plates at the same time in order to secure linear modulation up to 100 per cent. The .00025-μfd. mica bypass condenser at the center tap of the amplifier plate coils may seem rather odd, but it was found that the output on the higher frequencies was considerably improved by the addition of this condenser due to its regenerative effect. At the same time, the condenser is not large enough to cause the amplifier to become unstable as it does when a larger condenser is inserted.

The modulator portion of the circuit has nothing particularly out of the ordinary. Unusually good speech quality may be obtained from this unit, and only one audio transformer — the modulation transformer — is required. In placing the modulator in operation, it may be necessary to vary slightly the values of R_{19} and R_{16} until the audio voltage at the grids of both 6L6G tubes is equal. This

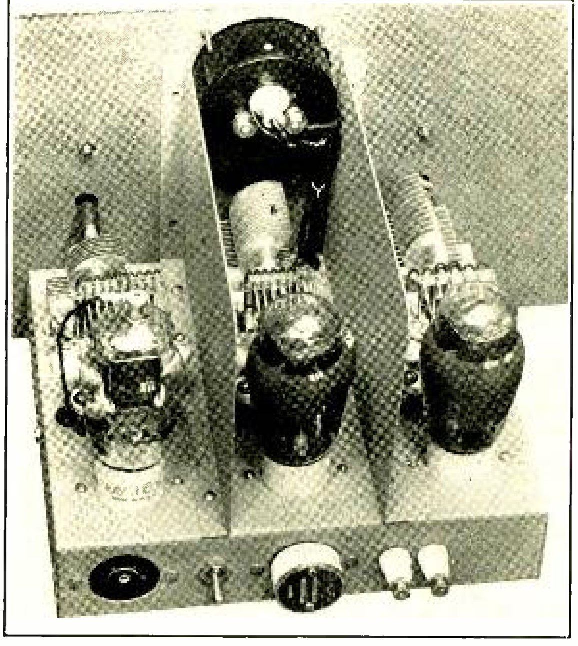
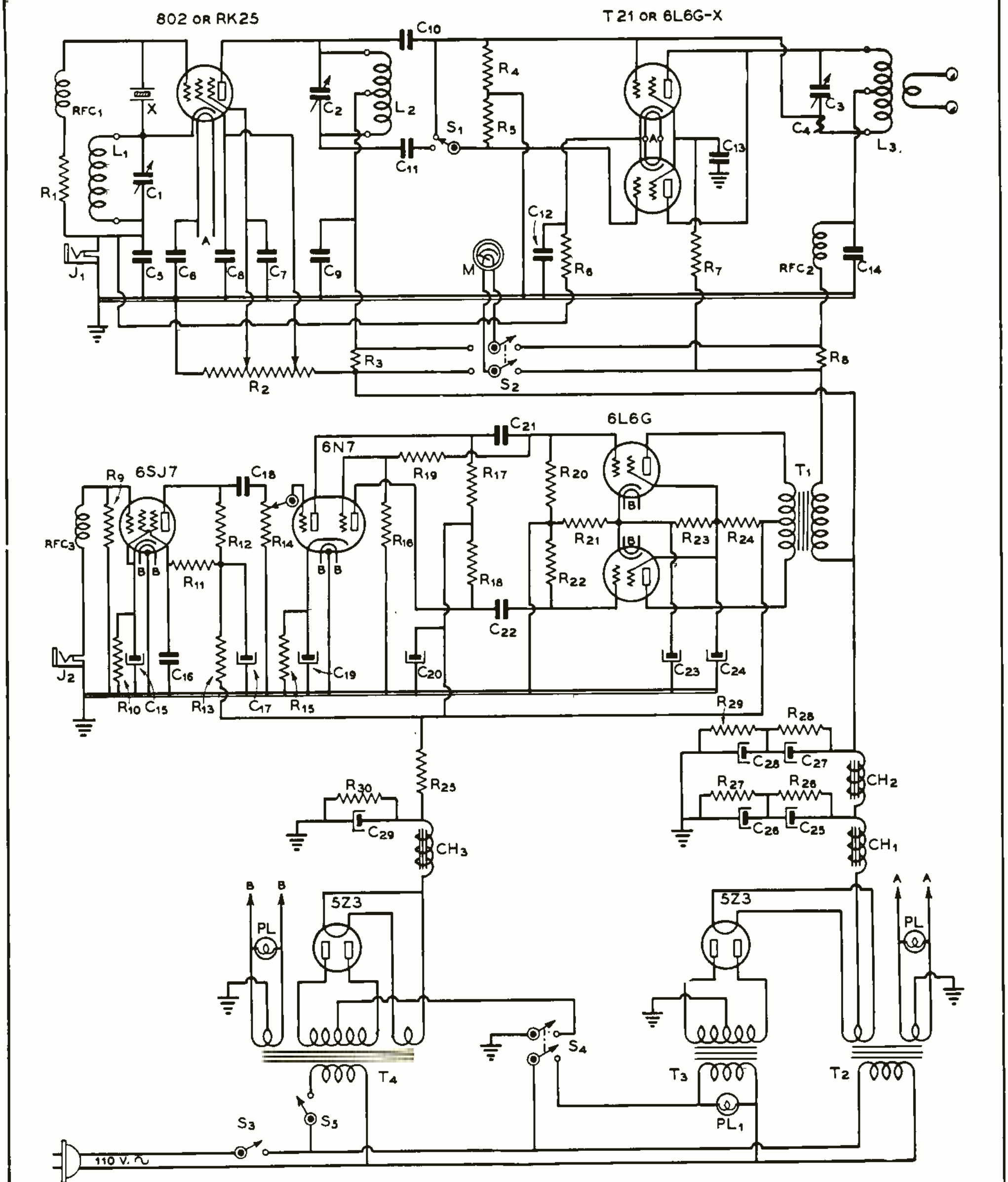


Figure 2. Rear view from above of the r.f. chassis of the transmitter.



General wiring diagram of the 25-watt all-band transmitter.

C_1—250-µµfd. midget

C_2—100-µµfd. midget

C_3—75-µµfd. midget

C_4—Neutralizing condenser, see text

C_5, C_6 — .01-µµfd. 600-volt tubular

C_7, C_8—.001-µfd. mica

C_9—.01-µfd. 1000-volt tubular

C_{10}, C_{11}—.00005-µfd. mica

C_{12}—.01 µfd. 600-volt tubular

C_{13}—.001-µfd. mica

C_{14}—.00025-µfd. mica

C_{15}—25-µfd. 25-volt electrolytic

C_{16}—0.5-µfd. 400-volt tubular

C_{17}—16-µfd. 450-volt electrolytic

C_{18}—0.1-µfd. 400-volt tubular

C_{19}—25-µfd. 25-volt electrolytic

C_{20}—8-µfd. 450-volt electrolytic

C_{21}, C_{22} — 0.1-µfd. 400-volt tubular

C_{23}—25-µfd. 25-volt electrolytic

C_{24}, C_{25}, C_{26}, C_{27}, C_{28}—8-µfd. 450-volt electrolytic

C_{29}—16-µfd. 450-volt electrolytic

R_1—50,000 ohms, 2 watts

voltage may be readily measured with an oscillograph or vacuum tube voltmeter. In the absence of these two measuring devices, the values shown may be taken to be approximately correct as they are the values which were found to be proper in the particular modulator used with this transmitter.

It should be noted that the B minus of the modulator power transformer is connected to the same switch that turns on line voltage to the power transformer for the r.f. portion. This type of connection permits the modulator to be turned on only when there is a load on the secondary of the modulation transformer thereby preventing possible damage to this component. The proper plate-to-plate load for the pair of 6L6G tubes in this modulator is 6000 ohms with 350 volts at the plates. The power supply for the r.f. section is entirely conventional.

Construction

As can be clearly seen in the photograph of figure 1, the entire transmitter is constructed in three separate sections. The top section contains the r.f. unit; the middle section contains the modulator and modulator power supply; and the bottom section contains the power supply for the r.f. portion. The rack in which these sections are mounted is novel inasmuch as it is made up by attaching three of the newly introduced "streamline" receiver cabinets together. These cabinets measure 8¼" deep, 14½" wide, and 8" high making the total transmitter height 24 inches.

This type rack construction has several points in its favor. In the first place, it is quite an economical method of securing a neat looking rack. Then too, the housing can be built to any desired size to accommodate a particular layout without having a lot of waste space, as is frequently the case when using standard size cabinet racks for small transmitters.

The parts layout of the three shelves can be clearly seen in figures 2, 4, and 5. The chassis for the r.f. section measures 8" x 9½" x 2", while the two bottom sections are built on chassis measuring 8" x 11" x 2". In connection with the r.f. section, the tuned circuits are so arranged that the cathode tank is in the middle of the chassis between the two shields as this places the oscillator and amplifier plate circuits a greater distance apart. The midget condensers, it will be noted, are mounted on insulators. The mounting feet closest to the panel are attached to regular small standoff insulators, while the rear mounting feet are mounted with the same size small feedthrough insulators, thus enabling the under-chassis rotor connections to be made directly to the feedthrough stud. A small fibre shaft extension is placed on the oscillator plate condenser to eliminate hand capacity effects. This, however, is not necessary on the amplifier plate condenser because no hand capacity effect is present when the stage is loaded.

Nothing particularly unusual is to be noted in connection with the parts placement on the modulator and power supply units as components were merely laid out for the greatest convenience in wiring concurrent with a pleasing appearance. While the microphone jack is quite a distance from the grid of the 6SJ7 speech input tube, no trouble from r.f. feedback has been encountered as the connecting lead is shielded, and the entire modulator unit

General wiring diagram constants. (Continued)

- R_2—25,000 ohms, 50 watts
- R_3—100 ohms, 2 watts
- R_4, R_5—100,000 ohms, 2 watts
- R_6—150 ohms, 10 watts
- R_7—10,000 ohms, 10 watts
- R_8—100 ohms, 2 watts
- R_9—5 megohms, ½ watt
- R_{10}—1500 ohms, 1 watt
- R_{11}—1 megohm, 1 watt
- R_{12}—250,000 ohms, 1 watt
- R_{13}—25,000 ohms, 1 watt
- R_{14}—500,000-ohm potentiometer
- R_{15}—1500 ohms, 1 watt
- R_{16}—25,000 ohms, 1 watt
- R_{17}, R_{18}—100,000 ohms, 1 watt
- R_{19}—500,000 ohms, 1 watt
- R_{20}—200,000 ohms, 1 watt
- R_{21}—250 ohms, 20 watts
- R_{22}—200,000 ohms, 1 watt
- R_{23}—15,000 ohms, 10 watts
- R_{24}—7000 ohms, 10 watts
- R_{25}—10,000 ohms, 10 watts
- R_{26}, R_{27}, R_{28}, R_{29}—250,000 ohms, 1 watt
- R_{30}—25,000 ohms, 20 watts
- S_1—S.p.s.t. toggle switch
- S_2—D.p.d.t. toggle switch
- S_3—S.p.s.t. toggle switch
- S_4—D.p.s.t. toggle switch
- S_5—S.p.s.t. toggle switch
- RFC_1—2½-mh. 125-ma. r.f. choke
- RFC_2—2½-mh. 250-ma. r.f. choke
- RFC_3—2½-mh. 125-ma. r.f. choke
- T_1—30-watt modulation transformer
- T_2—5 v., 3 a., and 6.3 v., 6 a.
- T_3—1500 v. c.t., 200 ma.
- T_4—800 v. c.t., 200 ma. 5 v., 4 a.; 6.3 v., 5.5 a.
- CH_1—8-30 h. swinging choke, 250 ma.
- CH_2—15 h., 250 ma.
- CH_3—8-3C h. swinging choke, 150 ma.
- L_1, L_2, L_3—Manufactured coils — see Buyer's Guide
- M—0-250 ma.

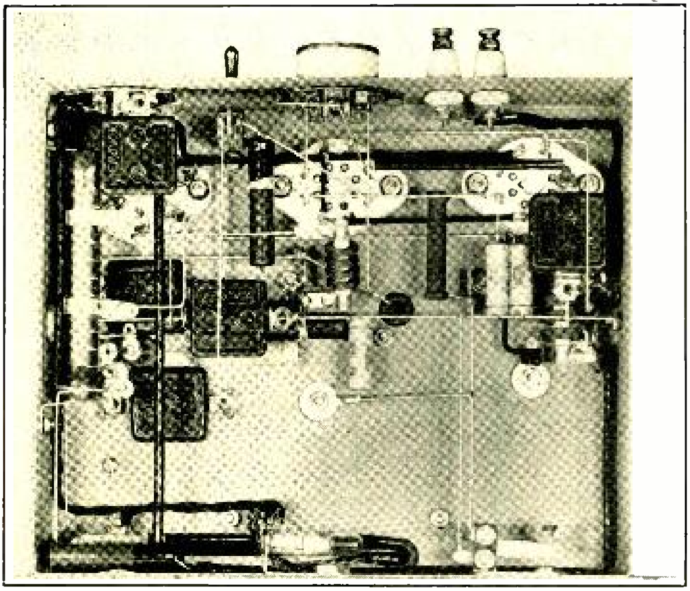


Figure 3. Under-chassis view of the r.f. section showing the neat bus-bar wiring.

is well isolated from the r.f. section. Jewel lights are provided to show when the a.c. line is on, when the modulator is on, and when the entire transmitter is on the air. This latter jewel light is the large one in the center of the bottom shelf and serves not only as an indicator but as a warning that high voltage is present on all shelves.

Wiring

In wiring the r.f. section, it will be noted in figure 3 that square corner wiring is used. While this always takes a little longer than point-to-point wiring, it is usually well worth the added effort as the unit is easily serviced, circuits are less difficult to trace, and, of course, it looks well. No. 16 half-hard tinned copper wire does the job very well as it stays in place, yet is easily worked. Filament and link leads should be connected with regular push-back wire. All ground connections are made to the ground wire running through the center of the chassis. In no case should the chassis be relied on for any ground connection, and the ground wire itself should preferably be attached to the chassis at only one point. Before wiring the voltage divider, the taps should be set at the points which, it is thought, will place 250 to 300 volts on the screen grid of the oscillator tube, and 50 volts on the suppressor. Final adjustment of these voltages should be made with the aid of a voltmeter when the unit is placed in operation.

As the 6L6G tubes require a small amount of neutralization, a small condenser is made by running a wire from the 6L6G grids to form a 3-turn snug fitting loop around a soldering lug on the rotor stud of the amplifier plate condenser. This loop is adjusted to neutralize the 6L6G tubes when amplifying straight through in the parallel connection. If this adjustment is made on the highest frequency where parallel operation is to be used (usually 20 meters), the stage will remain sufficiently neutralized on the lower frequencies for all practical purposes.

The feed through insulators on the rear of the r.f. chassis are the link output leads. The center 5-prong socket in the rear is for the crystal holder, while the 5-prong socket near the corner is for power connections.

In wiring the modulator, all by-pass condensers should mount as close to the corresponding tube socket pins as possible, and the grounding points for each stage should be the shield or no. 1 pin on the sockets. The volume control should preferably be mounted close to the sockets and controlled by an extension shaft to facilitate short wiring. High voltage wire or hookup wire with spaghetti covering should be used in making the modulator plate, modulator output, and B plus connections. No meter was put in the modulator as the current to the modulator tubes is essentially constant.

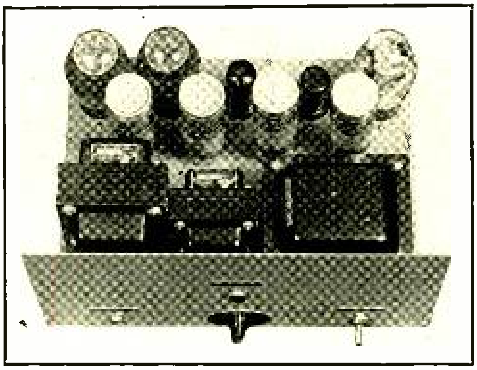


Figure 4. The speech amplifier-modulator section of the transmitter with its power supply.

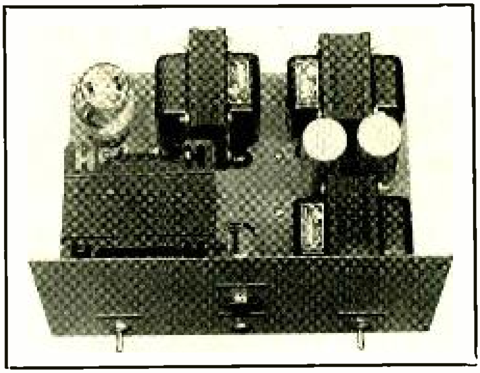


Figure 5. The bottom panel of the transmitter which contains the r.f. section power supply.

Operation

The accompanying operating table clearly shows all the combinations that are possible with this transmitter to secure output on the five bands. Very little difficulty should be encountered in adjusting and operating the entire transmitter. Small commercially available air-wound inductances were used throughout the r.f. portion, but coils wound on regular plug-in forms may be used with some sacrifice in efficiency on the higher frequencies. It will be noted that the coils recommended for the cathode circuit are ordinarily intended for circuits operating at four times the crystal frequency. This is due to the fact that the cathode circuit of a tritet oscillator is tuned to approximately twice the crystal frequency, but at the same time should be quite high C. It has been found, however, that with some sluggish 40-meter crystals, oscillation takes place more readily when a 20-meter coil is used in the cathode circuit instead of the 10-meter coil specified. The cathode tuning condenser should always be set at the least capacity consistent with good output as crystal current rises quite rapidly as this capacity is increased. The proper setting will be found to be much more critical when the scillator is doubling.

With a set of coils and crystals in place, and with the switch, S_1, in the proper position, the plate voltage may be applied to the oscillator alone after permitting the heaters to come up to operating temperature. Oscillator current will read about 50 ma. if the crystal is oscillating (about 70-75 ma. if not) and will show a pronounced dip when the plate circuit is tuned through resonance on the fundamental frequency and a small dip on the second harmonic.

With the oscillator functioning properly but without any plate voltage on the 6L6G stage, the amplifier should be neutralized as explained under *Wiring*. Once neutralized, the plate voltage may be applied and the stage tuned to resonance. Under normal operating conditions this amplifier stage should draw not over 30 to 40 ma. at resonance (without load) on all frequencies whether operating as a doubler or straight amplifier. This stage may be loaded up to 125 ma. for both phone and c.w. operation.

After it has been made certain that the modulation transformer is connected for the proper r.f. load, all that is required to place the transmitter in operation for phone work is to throw the switch, S_5, on the modulator and turn up the gain. As previously stated, the entire transmitter is put on and off the air by the one switch, S_4. One precaution in this connection is necessary. Care should always be taken to see that S_6 is off before placing the transmitter in operation on c.w. to prevent the modulation transformer from being unloaded with the modulator turned on. Also, when operating c.w., the crystal will usually follow the keying much better if the crystal oscillator plate condenser is tuned slightly higher in frequency than exact resonance.

While this is classified as a "25-watt" rig, outputs in excess of this amount are easily obtained on all bands and range upward to about 45 watts, secured on 40 meters. In addition to the 8-prong ceramic based 6L6G tubes shown in this r.f. amplifier, the 6-prong

[*Continued on Page 164*]

Receiver Circuits for

FREQUENCY MODULATION

By GEORGE W. BROOKS,* W1JNO

There is another article elsewhere in this issue which exhaustively treats the subject of frequency modulation. For those amateurs who would quickly be "exhausted" by such a treatment we present this non-technical discussion of the subject with especial emphasis on the design of receivers for the new type of modulation.

As this is a how-to-build-it paper and not a technical discussion, I suggest that the more technical minded skip this and allow us "simple folk" to get down to one lung words.

First let us take a look at the block diagram of the typical setup of a frequency modulated and of an amplitude modulated receiver. From this point on we shall call them the FM and AM receivers to save time and space. Gander the diagrams, and one thing is evident right off. That is that between the i.f. amplifier and the a.f. section we have some extra grief stuck in. These positions are filled by a limiter, discriminator, rectifier, and audio restoration circuit.

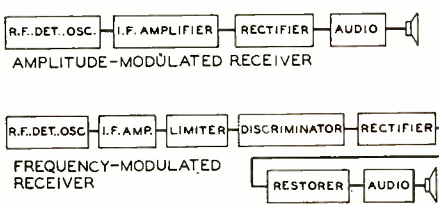
Don't let these names bother you. The limiter is nothing more nor less than a high sounding name applied to a tube working with low plate and screen voltage, and with its bias secured by a resistance in its grid circuit. The tube is operated nearly at the saturation point and any increase in input above a certain predetermined amount will give practically no increase in output. The discriminator is nothing but a glorified version of our old friend, automatic frequency control, and the discriminator employed in the FM receiver is very much like the one used in a.f.c. circuits. The same applies to the rectifier which is used in a very similar manner to the way the one is used in a.f.c. circuits. And the audio restoration circuit is nothing but a series condenser and resistor, to restore the audio waveform balance in the rectified program, a characteristic of the present practice of music and voice transmission. It is the purpose of the discriminator to change the variations in frequency to variations in amplitude.

Practical Considerations

We now are at the point of construction of a receiver and we shall begin with the input circuit and work toward the speaker or reproducer. The r.f. input and first detector circuits are similar to those used in any ultra-high frequency front end and any good one can be employed. The main requirement is, as in any good receiver, mechanical stability and freedom from hum modulation of the h.f. oscillator. The tuner can have either a stage of r.f. or not, although the r.f. stage is highly desirable. The tuner will be required to cover the frequencies from 40 to 44 Mc. The best thing I can say is that if you are lazy like I am, you had better purchase the high-frequency end.

Intermediate Amplifier

The i.f. amplifier is similar in construction to any good 1500 kc. or higher intermediate



Block diagram comparison of the various divisions of an amplitude modulation receiver as compared to those of a receiver for frequency modulated waves.

* 28 Friendship St., Newport, R. I.

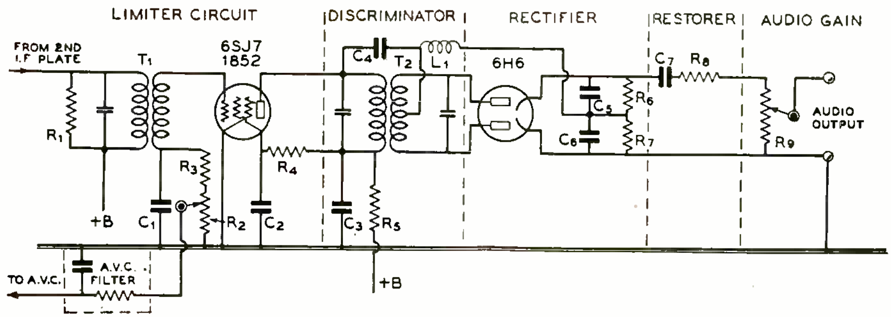


Diagram of the portion of the receiver in which the frequency modulated type differs from the conventional amplitude modulated type. These elements may be placed between a good front end that will cover the FM range and broad band i.f. amplifier and a high-quality audio amplifier-reproducer system.

R_1—10,000 to 15,000 ohms, 1 watt
R_2—50,000 ohm potentiometer
R_3—50,000 ohms, 1 watt
R_4—15,000 ohms, ½ watt
R_5—100,000 ohms, 1 watt
R_6, R_7, R_8 — 100,000 ohms, ½ watt
R_9—500,000-ohm potentiometer
C_1, C_2, C_3—.01-µfd. to 0.1-µfd. tubulars
C_4—.0005-µfd. mica
C_5, C_6 — .00005-µfd. mica
C_7—.05-µfd. tubular, 600 volt
L_1—10-mh. r.f. choke
T_1, T_2—1500-kc. (or higher) i.f. transformers with coils coupled more closely together. T_1, interstage; T_2, p.p. diode det. or c.t. secondary.

Experimentation with values of R_4 and R_5 may be helpful. Also R_5 may be cut out and R_4 and limiter plate cut over to i. f. screen supply.

frequency amplifier, with the exception that the amplifier is broadened so as to cover a much wider frequency band. This is accomplished by moving the coils on the i.f. transformers closer together and resistor loading the grid circuits. A 10,000 to 15,000 ohm resistor across the grid coil will accomplish the necessary loading. The only caution that must be observed is that the whole amplifier be accurately tuned up on one frequency and not tuned as a band-pass amplifier.

Limiter

We now come to the limiter circuit whose diagram is self-explanatory. As far as parts go, even the usual tolerances that amateur constructors employ should give no trouble. In fact the whole circuit is relatively non-critical as far as parts, construction, and design are concerned.

Discriminator

The diagram of the discriminator circuit needs some explanation, so here goes. Briefly its operation is such that at resonant frequencies the voltages produced in the secondary by both the inductive and capacitive coupling are in phase, while with a frequency shift either above or below the frequency to which the primary and secondary are tuned the induced voltage at the two ends of the secondary winding is the vector sum of the capacitive and inductive coupling. With the frequency shift above and below resonance with modulation an induced voltage in the secondary causes first one diode to become charged and then the other, setting up in the diode load resistance the audio component of the signal. As the output of the two diodes is in series across the output load resistor quite a large audio voltage swing is produced. This voltage after being restored to its proper audio balance in the series condenser-resistor combination is passed along to the audio amplifying system and reproducer. To realize the full advantages of FM reception the audio system and speaker should be of the very highest quality, with low distortion, and uniform frequency response from 30 to 13,000 cycles. As to the most satisfactory tubes for use in FM receivers, any of the newer high-gain tubes will be suitable. A good front end might use an 1852 or 1853 r.f. and a 6K8 or 6SA7 mixer either self-excited or with a separate oscillator tube. The i.f. amplifier can best consist of a two-stage affair with 1852's in both stages. These tubes are capable of giving considerably higher gain-per-stage than conventional pen-

[*Continued on Page 167*]

High-Gain MOBILE CONVERTER

The converter described in the following article uses 1852's in the r.f. and mixer stages, with a 6C5 high-frequency oscillator. It was built primarily for mobile use by Victor Reubhausen, W9QDA, Chicago.

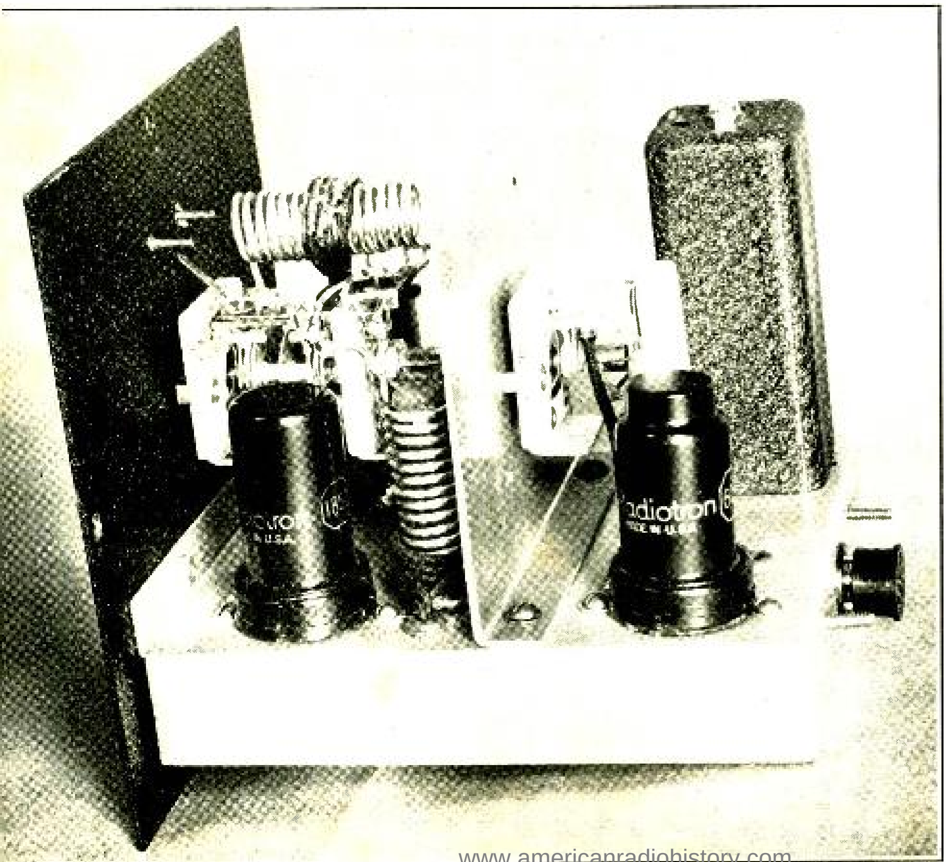
Ten-meter mobile converter designs have been plentiful, but a new mechanical or electrical arrangement should always be welcome in this rapidly progressing field. The converter shown in the accompanying photographs falls into the "new and different" classification and should therefore be of interest. Three tubes are used in the converter, which is designed to operate into an auto receiver tuned to 1500 kc. 1852's are used in both the r.f. and mixer stages, with their grids tapped down on the coils to reduce the effects of grid loading on the tuned circuits.

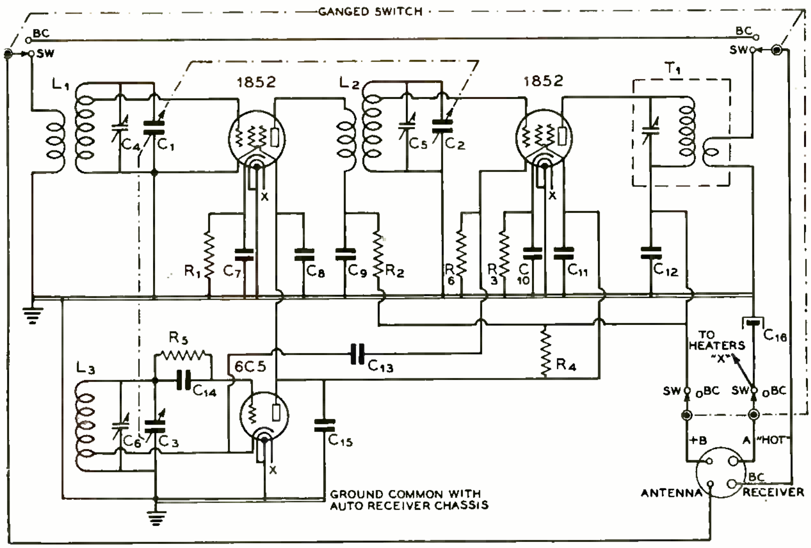
R. F. Stages

The r.f. and mixer stages are located on opposite sides of the tuning condenser and near the front edge of the chassis, which is divided into two nearly equal sections by a vertical aluminum shield. The r.f. stage is located on the left side of the tuning condenser, and the mixer on the right. Fifteen turns of number 12 enameled wire ½ inch in diameter and wound to a length of 1¾ inches are used as the r.f. stage grid coil. The coil is supported by being cemented with low-loss coil dope to an isolantite pillar insulator which is screwed to the chassis near the right rear corner of the front section. This coil is tapped at eight turns from the ground end for the grid connection. The antenna winding consists of four turns of hookup wire wound over the ground end of L_1.

A dual 15-$\mu\mu$fd. midget condenser is used

Figure 1. Side view of the high-gain mobile converter. The two 1852's, r.f. stage and mixer, are ahead of the separating shield, while the 6C5 h.f. oscillator and the 1500-kc. output transformer are to the rear of this partition. The bantam-type power plug can be seen on the rear drop of the chassis.





Schematic of the 10-meter converter.

C_1, C_2—Dual 15-μμfd. midget vaiable
C_3—13-μμfd. midget variable
C_4, C_5 — 3-30-μμfd. mica trimmer
C_6—10-70-μμfd. mica trimmer
C_7, C_8, C_9, C_{10}, C_{11}—.001-μfd. mica
C_{12}—.01-μfd. 400-volt tubular
C_{13}, C_{14} — .0001-μfd. mica
C_{15}—.01-μfd. 400-volt tubular
C_{16}—10-μfd. 25-volt electrolytic (polarity depends upon which side of car battery is grounded)
R_1—600 ohms, ½ watt
R_2—1000 ohms, ½ watt
R_3—600 ohms, ½ watt
R_4—15,000 ohms, 10 watts
R_5—60,000 ohms, ½ watt
L_1, L_2, L_3—See text
T_1—Rebuilt 1500-kc. i.f. transformer, see text

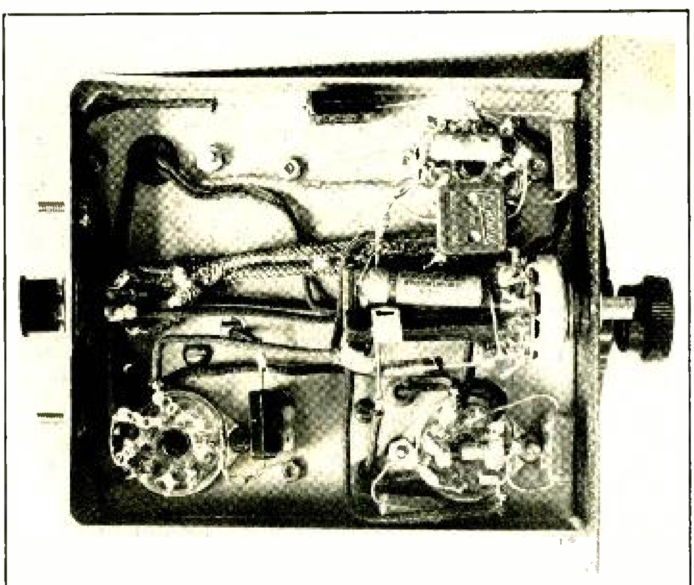


Figure 2. Under-chassis view of the unit. This photograph shows the use of polystyrene octal sockets for all tubes. the four-pole double-throw switch for s.w.-b.c. changeover is mounted upon the front panel below the tuning dial.

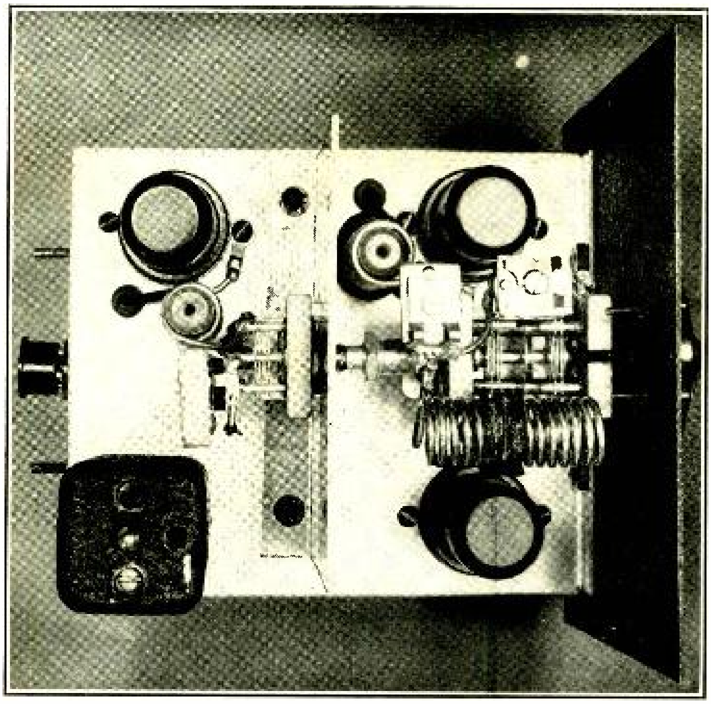


Figure 3. Looking directly down upon the converter. The r.f. stage and h.f. oscillator coils can be seen mounted vertically upon their respective pillar insulators. The mixer grid coil is mounted horizontally upon the two-gang tuning condenser.

to tune the mixer and r.f. stages. The particular condenser used has a circular shield between the two stator sections which aids materially in reducing undesired coupling between these stages.

The r.f. stage is both inductively and capacitively coupled to the mixer grid, although only the inductive coupling is apparent from the diagram. Actually, however, the primary is tightly wound over the center of the grid coil, thus giving the two types of coupling at the same time. The mixer grid coil is identical to the r.f. stage coil with the exception that it is supported by its leads from the tuning condenser rather than being cemented to a pillar insulator. As in the r.f. stage, the grid is tapped eight turns up from the ground end. The primary is four turns of hookup wire wound over the center of the grid coil. 3-30 $\mu\mu$fd. mica trimmers are used across both grid coils, a common ground connection for the trimmers being made to the tuning condenser rotor.

Mixer and Oscillator

Suppressor injection from the oscillator is used into the 1852 mixer. Although there is some question as to whether this particular arrangement with the 1852 results in suppressor injection or whether most of the injection is obtained by capacity coupling into the adjacent control grid pin on the tube base, the fact remains that it works quite well and results in a very satisfactory mixer. The suppressor is biased by a 50,000-ohm resistor to ground and coupled to the oscillator cathode by a .0001-μfd. fixed mica condenser.

For the sake of increased stability, somewhat higher C is used in the oscillator tank circuit than is used in the other two tuned circuits. The oscillator coil, L_3, consists of 7 turns of no. 12 enameled wire spaced the diameter of the wire with the cathode tap one turn up from the ground end. As in the r.f. stage this coil is cemented to an isolantite pillar insulator.

The oscillator tuning condenser is a single 13-$\mu\mu$fd. unit of a type similar to that used in the r.f. and mixer stages. It is padded by a 10-70-$\mu\mu$fd. isolantite base mica trimmer. The padding condenser is hung directly from the tuning condenser terminals, and the tuning condenser is in turn supported from the aluminum shield running across the chassis. The oscillator tube is a 6C5, operating as a grounded-plate Hartley.

The output transformer, a modified standard 1500-kc. i.f. unit, is located at the rear left edge of the chassis. One of the windings

[*Continued on Page 170*]

Radio

WORKSHOP PRACTICE

By K. CAIRD,* W9ADG

Valuable information is given in this article on best procedure in doing the type of sheet metal work most commonly encountered in the radio shop. Especial emphasis is given on favored practice in regard to drilling, as this is the most common operation performed in the radio shop.

Some of us remember the Hoover Cup awards which were made to outstanding amateur stations. One of the considerations in making the award was "the extent to which the station was built by the owner." Today the glory of the home-built station seems to be vanishing. Now our equipment is so complex that anyone attempting to build a modern station from the ground up would have no time to operate it. Admittedly, amateur radio is an operating activity. Construction work is a means to an end, but we could well do more of it. We should consider ourselves fortunate in having a hobby that provides a purpose and outlet for the products of the workshop in an age when home workshops hold so important a place in American leisure. Instead there seems to be a lessening of shop activity among radio amateurs. This may be due to two causes: the time involved in constructing equipment, and the difficulty of producing a satisfactory piece of modern equipment in some home-shops.

The answer to the first problem is simple. The time must come out of operating time. If radio men would transfer a few of their operating hours to the work bench they might discover new joy and satisfaction in their hobby. In addition their equipment and their signal on the air would probably be improved in proportion to the amount of time transferred. So far as producing satisfactory work is concerned, it can be done if the shop itself is satisfactory and modern. The home-shop isn't supposed to be a factory, but shop and worker will have to keep pace with the demands of the day.

The radio man's shop is a combination of many shops; his "building" is really assembling. The difference between two rigs is often merely the difference in the degree to which each has been preassembled. The outstanding stumbling block to real building, or even to satisfactory assembly work, seems to be the ability to work metals, as our rigs unquestionably have gone "all metal." The best way we know for a ham to improve on his abilities is to have a machinist or a die-maker sit in his shack and watch him work. A few caustic remarks will do wonders. The author is greatly indebted to W9HGR for his help in this respect; many, if not most, of the ideas and tricks to be presented are his.

As all assembling consists of making holes and plugging things into them, any attempt at uplifting the shop technique of radio hams ought to start there. The ability to put a clean-cut hole where it is wanted in any metal or insulating material will take most of us a long way. To begin with we are going to assume a drill press, though much of what is to follow will apply to hand work. A discussion of what is wanted in a drill press can keep for another time, but some kind of press —not a portable electric drill—is going to be the No. 1 requirement of the modernized ham shop. Then come the small tools pictured in figure 1. Add to the items pictured one of the gooseneck lamps that flood the market for about $1.00. Put a 60-watt bulb

* 324 E. Touhy Avenue, Park Ridge, Ill.

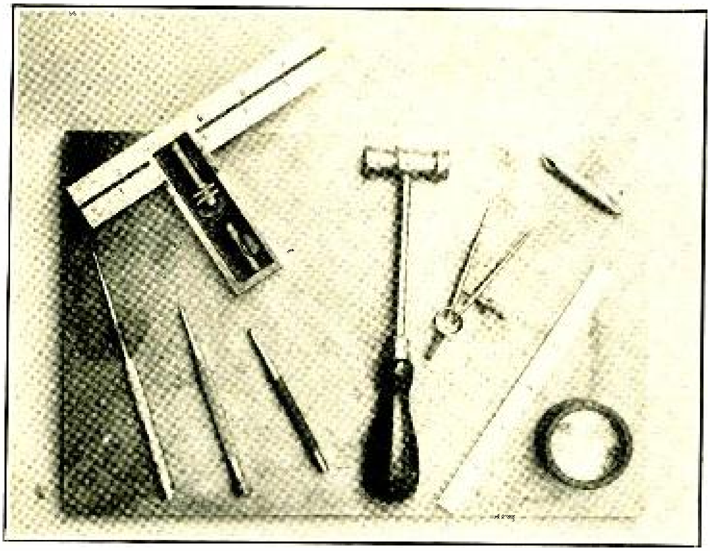


Figure 1. The small tools needed for radio metal work.

in it and pull the shade down to within an inch or so of the work. You may be surprised how things look with some light on them.

If the work is a panel, a small fitting or an angle bracket, it is placed on a surface plate to be marked and centerpunched. You can't do accurate work with a metal fitting flopping around on a battered bench top. The cost of real surface plates is prohibitive, but a slab of cold rolled steel will serve very nicely for our type of work. An 8" x 12" x ½" piece, as pictured, costs about $2.00.

Starting the Drill

Everyone knows that the long, thin scriber on the left is the tool for making the two crossed lines that locate the center of the hole, but everyone seems to have his own ideas as to just how this is done. Detail of layout procedure is a story in itself and had better be delayed for a moment while we get on with the pictured tools and the drilling. If you don't care to expend 30 cents for a scriber, you can grind down an old rat-tail file. Be sure to grind it slim enough and use care not to burn the point. No ground-down nail is going to do for layout work. Scribers must be long and thin with a nice feel to them, like a new pencil, and the point must be hard enough to stay sharp for a reasonable time.

Assuming two scribed lines at right angles the problem is to get the hole centered there. The first step is to make a prick mark with the prick punch shown next to the scriber, or with the scriber itself. Usually the point can be put on the intersection of the scribed lines by feel, and one down push will make a guide mark for the center punch. This is the time to resort to the magnifying glass, if it has not already been used in locating the prick punch. If the pin mark looks a bit "off," you can cheat by slanting the center punch. Usually the center punch is placed in the pin mark vertically and given one or two sharp raps. The little hammer pictured is known as a diemaker's hammer. It has a head of brass and a neat handle that compels you to hold it at the end; it is quite a handy tool for 80 cents.

The magnifier is a 10 cm. convex lens set in a fibre tube. Dime store magnifiers might do but some are apt to be more perplexing than helpful. A long tube is better than the reading glass type of handle, as the tube acts as a light shield and protects the lens against grease and breakage. If a second inspection with the glass shows all center punch marks apparently o.k. relative to the scribed lines, drilling might proceed using the center punch marks as a guide for the drill; in fact, that is the way most of us go about it. However, the point of a drill is a flat edge and it is not unusual for it to walk out of the punch mark, even when started by hand.

To insure success the center drill, shown in the upper right of figure 1, should precede

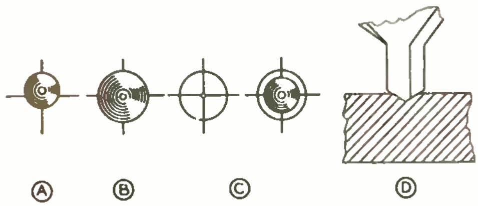


Figure 2. (A) The center-drill mark is off with respect to the crossed lines. (B) Nudging the center drill properly enlarges the mark but will locate it correctly with respect to the crossed lines. (C) Scribing circles about the center point helps to locate it properly. (D) The spot should be located correctly before going deeper than the lips of the center drill.

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the actual drill. This little gadget is more properly known as a combined drill and countersink. The countersink part is at 60° for preparing work for lathe centers. It is the point that is of value to us in making a starting spot for drills. The lip angle is the same as any drill, but the flutes are more like a router bit and allow the drill to be pushed sideways in the work. Anyone who has vainly tried to coax an ordinary drill to edge over a little can appreciate what this means.

Spotting all center punch marks very lightly with this drill would, of course, be no different than using any small drill for the purpose; but if examination with the glass reveals a spot to be off, like figure 2A, that spot is again put under the center drill and the work nudged sideways at the same time the drill is turned. If the nudging is done properly the spot will be larger, but moved as in figure 2B. Scribing circles about each center to help locate these spots (figure 2C) is regular procedure in some work but, for small holes at least, hardly necessary in ham work. Try to get the spot centered before going deeper than the lips of the drill point (figure 2D). This is reason for making the first spot very small.

During this spotting process the drill press had better be turned by hand—reach up and push the belt, or have a helper do it. You can manage alone by first lowering the center drill into the punch mark so as to hold the work. For the nudging part you will have to use power of course, the slowest speed available. With all the holes thus marked, put a drop of lubricant on each spot and drill away. Because the actual drilling can be done in a jiffy is no reason for the preliminaries to be slighted. If you follow the proper method for all your work, it will soon be just as quick as any less accurate way. The most elaborate preparation will never equal the time spent in correcting an error.

Holding the Work

While there are times when a panel or fitting is laid directly on the table of the drill press, more often the work requires some backing up or preparation. If the piece is small it should be held in a drill-press vise. The vise can be held down by hand but it is precaution to have a "fence" behind it. The work in figure 3 is a ¼" x ¼" corner piece for a box shield. Note the steel fence bolted at random in the slots of the table. It prevents the vise from twisting should the drill seize. Such a fence is even more necessary on small plates etc., that cannot be held in a vise. Work as big as a panel or chassis can be held by hand without fear of it flying around if the holes are small.

For holes that are ½" and larger it is wise to have things clamped, both in the interests of safety and in the neatness of the job. Aside from the common "C" clamps there are many special ones that can be worked out using bars held to the table slots by bolts with wing nuts. While it is a major crime to drill through the solid part of the table,

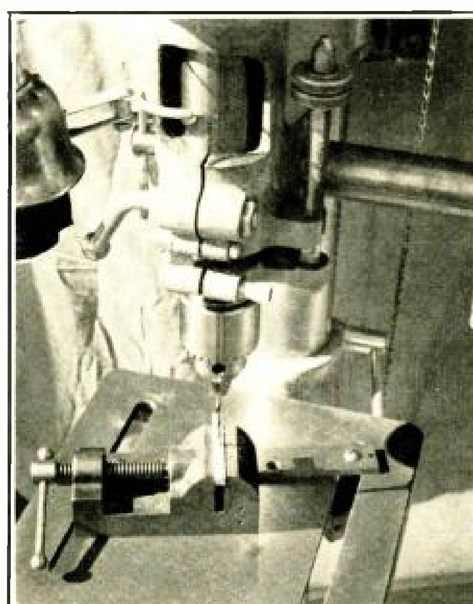


Figure 3. Showing how the work is held by a drill-press vise with a "fence" behind it.

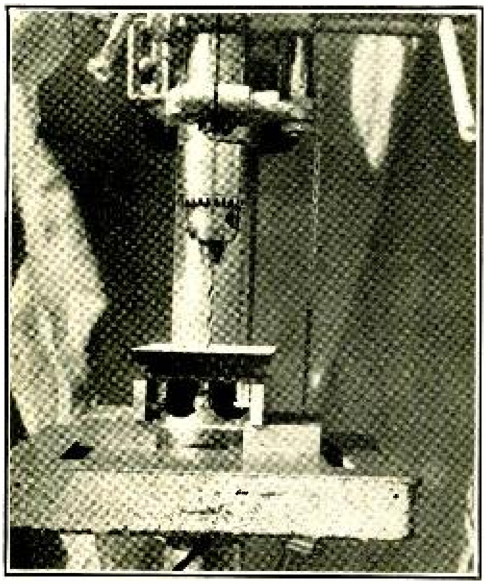


Figure 4. Drilling an irregular object with the help of a set of steel parallels.

there are times when some solid material backing up the work is helpful. A block of wood is a little better than nothing, at least on sheet aluminum. It must be hard wood with its faces flat and parallel, and, of course, it cannot be chewed up where the drill is to come through. Many of the blocks used on drill presses do more harm than good.

Steel parallels are indispensable when the piece to be drilled is irregular. Figure 4 shows a relay supported on two sets of parallels. They are also the proper thing under many pieces of flat work. Under a panel or chassis parallels have advantages over a block. First, they are more accurate. Then, as the work progresses, they can be moved about so as to miss the burrs that accumulate on the under side. Work that is laid flat on a block or table often gets tilted because of such burrs. Like surface plates real parallels are expensive, but there are cheaper substitutes. The small ones in figure 4 are 6" lengths of ¼" x 1" Brown and Sharpe stock; the others are just pieces of cold-rolled steel bar. Pieces of printers' "iron furniture" make excellent parallels.

The common chassis is always awkward to drill properly. The man with a hand drill can at least put the entire chassis on the work bench, but the drill press table is too small. A large flat board bolted on the drill table evens this score, but there is still need for support under the region being drilled. A set of large parallels would be the preferred method (figure 5). If the chassis must be clamped it may be easier to put a block under it. Two pieces of 2" x 6" board glued together, with a smaller hard piece for the drill to enter (figure 6), make a fair support for those who like blocks.

To drill the vertical edges of a chassis, swing the drill press table to one side and clamp an extension of heavy board to it, as in Figure 7.

Drilling Speeds

It is safe to say that most drill presses available for the home-shop are much too fast for radio metal work. Their frequent use in wood work is responsible for that. Such jobs as countersinking holes for flat head screws and spotting centers just cannot be done properly without turning the belt by hand. The desired speed for drilling depends on size of hole, kind of stock, rate of feed, etc. A typical job for a ham would be a lot of #27 or #19 holes in a steel chassis. The second speed on most drills, or about 1200 r.p.m., is about right. For electralloy or aluminum a step faster might be used. The 2400 r.p.m. pulley can be used for drills like #36 and smaller. First speed, usually about 600 r.p.m., will make those ⅜" and ½" holes. There are tables available about cutting speeds in feet per minute, etc., but experience can best tell you if the speed is right. The speed must match the feed—cut a continuous chip—and the drill should not run hot.

Lubrication

The right lubricant on a drill will make the job neater and easier, and will lengthen the life of the drill. Lard oil is accepted for the types of steel we find in our chassis and racks. Lard oil in a bearing would be a tragedy. Get your oil cans in different colors, and have them marked as well. For aluminum and its alloys kerosene is probably the most convenient, though milk works well and is a little easier to wash away with warm water. Electralloy, bakelite and brass are drilled dry. Some of the newer insulating materials will be considered later.

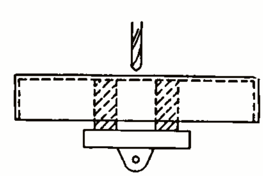
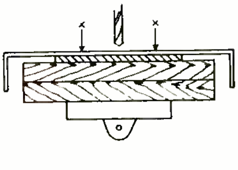


Figure 5. Using a set of large steel parallels to support a chassis near the point of drilling.



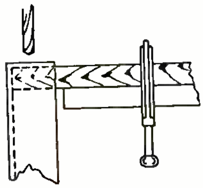


Figure 6 (left). Two pieces of 2 by 6 glued together with a smaller piece of hardwood for the drill to enter make an optional support for drilling a chassis.

Figure 7 (right). Drilling the vertical edges of a chassis by swinging the table to one side and clamping an extension of heavy board to it.

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Burrs

An excessive burr is an indication of a dull or improperly ground drill, but some burrs cannot be avoided. A large drill or countersink can be fitted with a handle, such as a file handle, and kept for the purpose of twisting off burrs. A good piece of hardwood under sheet aluminum will cut down some of the burr for which aluminum is notorious. Then what does occur can be sliced off with a knife (figure 8). On steel this slicing technique would require something heavier, like one edge of a three corner scraper or ground-down file. The wood block would be of no value under steel. Any burr that needs a cold chisel to remove it is entirely too much burr.

Some Common Difficulties

Brass is soft and easy to work but its very softness makes trouble. A twist drill in brass will usually grab or catch just as it breaks through the work. Work that is not well fenced or clamped will then go places. A new drill is worse than a dull one in this respect. The remedy is to stone the lip of the drill (figure 9) so that it presents a flat, scraping edge to the work rather than an undercut, biting one. You probably cannot afford two sets of drills but if you work a lot of brass have a few duplicates of the most common sizes stoned. If you must use regular steel drills in brass, exercise every precaution as to holding the work and ease up on the feed at the finish. Copper presents much the same difficulties, only more so.

Many radio parts mount in a single hole about 7/16" in diameter. Cutting this hole in thin steel panels or chassis is frequently troublesome. The drill breaks through and the work climbs up on it, with the hole anything but round. This is because the drill threads its way through before completing the cut, and the point wobbles throughout the job. Some help may be obtained by grinding the angle of clearance of the drill as figure 10. However, the drill won't be as good for heavier work. Another way is first to open up the hole with a smaller drill so the large drill will ride down on the heels of its point rather than wobble its way on the dead center or "flat." As figure 11 indicates, the lead hole must be about the size of the flat of the large drill. A starting spot countersunk around the lead hole is helpful. A center drill is ideal for this job if the point is big enough. The angle is steeper but the point of the large drill will ride the countersunk part very well.

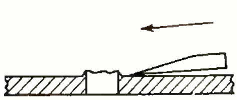

Figure 8. Slicing off with a knife the burr resulting from the drilling of aluminum.

Other than the lead hole just mentioned, there is no reason for drilling large holes in a series of steps. Large drills are more apt to run out, but you cannot do anything about it if a big part of the diameter is drilled away already. When starting a large drill the conical spot cannot be pushed around like the little center drill, though it can be moved. Chiseling a groove across the spot will make the drill move to the side with the groove (figure 12).

Any drill, even a new one, will cut a hole slightly larger than itself. In cases where a hole must be an exact size, a smaller hole is drilled first and then the drill of desired size is used as a reamer. With numbered drills the first hole should be one or two sizes smaller than the desired one. If the first hole is more than a few thousandths smaller the reaming may not be correct.

When the holes in two pieces must match perfectly the logical and correct solution is to clamp the pieces together and drill through both at once.

Very thin material, like copper ribbon, is sometimes impossible to drill without clamping it between two pieces of scrap stock. If you venture to drill a hole in a strip of phosphor bronze, hold it in a plier and rest it on a piece of scrap brass. Punching is the proper procedure with such stock, and little sets of hand punches are quite reasonable.

Punches for tube socket holes are now quite numerous. Though good ones are expensive, they are well worthwhile. As there is still a variety of sizes to cope with, you may prefer to cut your socket holes with a fly cutter. Here again is an example of the need for some slow speed on drill presses. A "slow

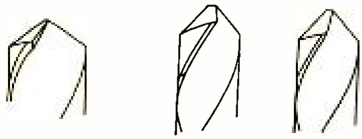

Figure 9 (left). Stoning the edge of a drill so that it presents a flat scraping surface for the drilling of brass. Figure 10 (right). Increasing the angle of clearance of the drill (right hand illustration of the two) so that the point will not wobble through a large hole in sheet material.

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speed" of about 600 r.p.m. is hardly slow but it might do for tube socket holes. However, it is too fast for anything like a meter hole. When fly cutting with a gadget similar to that in figure 13 see that the work is well clamped and use plenty of lubrication. Back up the work with hard wood.

There are also dies available for punching out square holes, such as are needed for small transformers. However, there is nothing wrong with the good old system of drilling a lot of holes in line and sawing out the piece. Clamp a fence to the table of the drill press at the proper distance and slide the work along it. Thus the holes can be drilled in a perfect line and the amount of filing reduced. Better take a coping saw to break between the holes. If the frame cannot encircle the job, a blade can be held with a plier in one hand and the fingers of the other. To file, clamp the work in a vise with a block of wood on each side just at the edge to be filed. Some workers knock out such a piece after the holes are drilled, but it usually takes more time to block it up preparing for the knocking out than it does to saw it. Knocking and chiseling such jobs just add to the work of filing and invite a bent chassis. Large, round holes are often cut by this same method.

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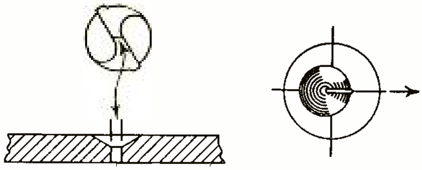


Figure 11 (left). The lead hole made for a large drill by a small one must be about the same size as the flat of the large drill. Figure 12 (right). Chiseling a groove across the spot to make the large drill move to the side with the groove.

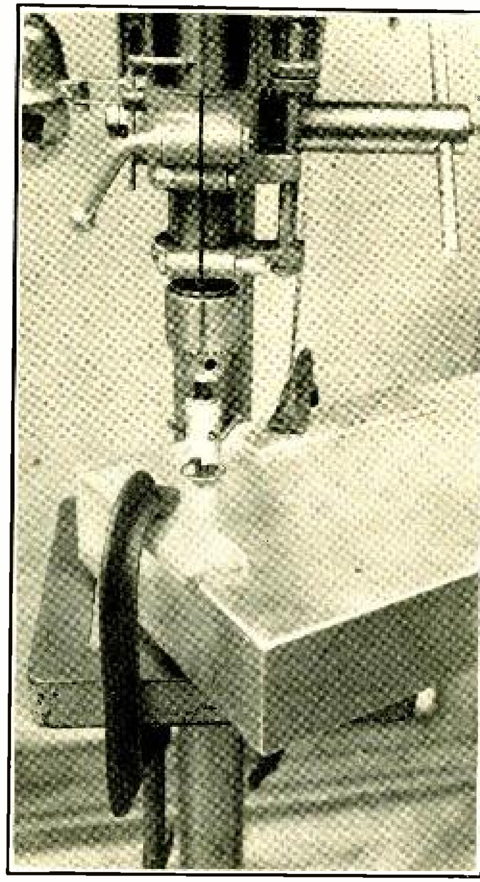


Figure 13. Showing how the work should be clamped for use of a fly cutter in making large holes.

Sharpening and Straightening Drills

Sharpening a twist drill is a job to be treated with respect. It is not always necessary to grind immediately a drill that has begun to dull. Small sizes can be touched up with a stone. Hold the drill under a good light and swipe each side a few times with a small oil stone. It will probably be easier to follow the original point with a small hand stone than with a wheel.

The ability to grind drills is well worth acquiring as it permits the worker to alter his drills for special purposes, as well as to keep the regular points in condition. Instructions on grinding drills can be found in several books. A booklet put out by the Delta

[*Continued on Page 156*]

An Experimental
FREQUENCY MODULATED TRANSMITTER

By E. SEILER,* W8PK

Frequency modulation offers an interesting opportunity for experimentation on the ultra-high frequencies. Since the new regulations have been in effect such experimentation is not permissible on 56 Mc. but is allowable on the 112-Mc. band. However, the experimental transmitter described herein was used on the 56-Mc. band some time ago.

There are two methods in use at the present time for the production of frequency-modulated signals. The first is extremely complex and is commonly called the Armstrong system. In this system a low-frequency crystal oscillator (in the vicinity of 200 kc.) is phase modulated and the resultant phase modulation is amplified and converted until the frequency band varies approximately 75 kc. either side of the u.h.f. carrier.

The other system is called reactance-tube modulation, is much more easily applied to amateur practice, and requires even less equipment than conventional amplitude modulation. The operation of the system is based on the same principle as used in the a.f.c. systems of automatic tuning broadcast receivers.

Figure 1 shows a simple 6F6 oscillator on 14 Mc. with its plate circuit tuned to 28 Mc. and a 6J7 reactance-tube modulator connected across a portion of the frequency determining tank of the oscillator. Audio voltage impressed on the grid of the 6J7 will vary the reactance between the grid and plate of the tube. Positive peaks of audio voltage will change the reactance in one direction while the negative half cycles of an audio envelope will change the reactance in the other direction. Hence, the impression of an audio voltage upon the grid of the modulator will vary the frequency of the oscillator in accordance with the waveform of the audio signal. If the audio waveform is symmetrical the frequency of the oscillator will vary an equal amount either side of the unmodulated carrier frequency.

In our tests it was found that excellent audio quality could be had with a swing 60 kc. either side of the carrier on the 56-Mc. band, or a total swing of 120 kc. Since the oscillator is on the 14-Mc. band, this means that the oscillator must only be swung 15 kc. either side of its unmodulated value on the 14-Mc. band.

Naturally the greater the capacity in the 14-Mc. tank the less the control tube can shift the frequency of the oscillator. Therefore a compromise must be struck where the stability[1] is reasonable but where the modulator tube can accomplish its job of varying

* Box 114, East Bloomfield, New York.

[1] A very satisfactory method of maintaining the stability of frequency of the oscillator over a period of time (sometimes called the average-frequency stability of the oscillator) is through the use of the circuit of figure 4 of the article by Harrison and Singer, "Frequency Modulation Fundamentals," beginning on page 13 of this issue. An alternative method of obtaining frequency modulation would be the reactance-tube modulation of a concentric-line-controlled oscillator operating on the output frequency of the transmitter. This system would give excellent average-frequency stability for the transmitter providing an arrangement such as that described just above were employed.—Tech. Ed.

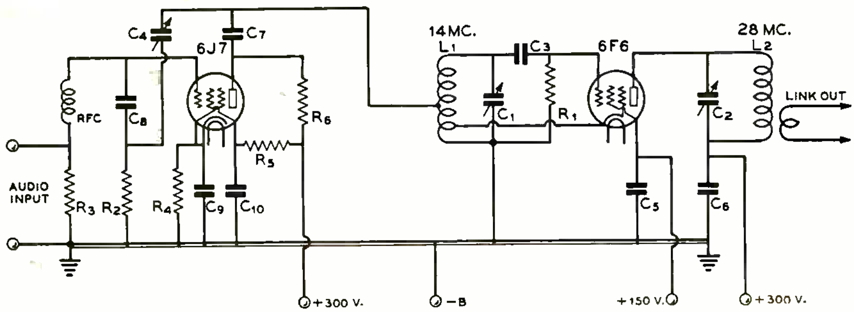


Figure 1. Schematic of the 14-Mc. electron-coupled oscillator and the reactance-tube frequency modulator.

C_1—Approx. 70-μμfd. but should tune L_1 to 14 Mc.
C_2—15-μμfd. midget variable.
C_3—.0001-μfd. midget mica
C_4—35-μμfd. midget variable (set at about 1/3 capacity)
C_5, C_6—.01-μfd. midget mica
C_7—.004-μfd. mica (not critical)
C_8—.0002-μfd. midget mica
C_9—.01-μfd. midget mica.
C_{10}—.005-μfd. midget mica
R_1—50,000 ohms, 1 watt
R_2—150 ohms, ½ watt
R_3—600 ohms, 1 watt
R_4—900 ohms, 1 watt
R_5, R_6—20,000 ohms, 1 watt
RFC—2½-mh. r.f. choke
L_1—6 turns on 1½-in. diam. low-loss coil form, cathode tap 1¼ turn from ground end, control tap 2¼ turns from ground end
L_2—11 turns, ⅞-in. diam., self-supporting no. 18 bare copper

frequency with modulation. The values given for figure 1 have been found to be satisfactory where the final amplifier is operating on the 56-Mc. band. For operation of the final stage on 112 Mc. the C/L ratio can be considerably increased, thus still allowing a 60-kc. shift with modulation at the higher output frequency but greatly increasing the stability of the oscillator over a period of time.[1]

The capacity in the 14-Mc. tank circuit is ample to insure a stable carrier without modulation other than the desired result of the action of the reactance tube. The balance of the transmitter consisted of an RK-39 doubler to 56 Mc. which drove a pair of WE-304B's as the final amplifier on 56 Mc. Keying of the final amplifier on 56 Mc. caused no more frequency change than when the transmitter was controlled by a crystal oscillator.

An important factor contributing to the average frequency stability of the oscillator was the use of a voltage-regulated power supply to furnish power to the screen of the 6F6. Incidentally, metal 6F6's were found to be more stable than the glass type.

Comparison Tests

In order to make a comparison between amplitude modulation and frequency modulation, two stations both equipped with superregenerative receivers were asked to listen for both types of signals. The tests were made using high-level amplitude modulation of 230 watts input, and with 150 watts input to the final amplifier with frequency modulation. The final amplifier ran class C, of course, for both tests so the power output was roughly proportional to the input of the final stage.

Both stations (about 35 miles distant) reported that the frequency modulation was fully as good as amplitude modulation and that the voice was somewhat more natural sounding with frequency modulation. A third station using a superhet receiver could not (naturally) make anything out of the frequency modulation tests but of course copied the amplitude modulation without trouble.

Of course, if either of the stations had been using a receiver designed for the reception of frequency modulated signals there would have been a considerable increase in the signal-to-noise ratio when using the frequency modulated system of transmission.

The receiver in use at W8PK is a revamped u.h.f. superheterodyne using a balanced detector along with a limiter tube. An excellent complete receiver description was given by J. R. Day in the June issue of *Electronics*.[2] The final design of the W8PK receiver was very similar to that given by Day.

[2] J. R. Day, "A Receiver for Frequency Modulation," *Electronics*, June, 1939, p. 32.

Determination of

ANTENNA RADIATION PATTERNS

By W. E. McNATT,* W8TLJ

With the spotlight of technical interest still at its brightest on the subject of antennas, the individual amateur may easily delve further into this fascinating subject by spending a weekend in the very interesting and informative occupation of determining his antenna's horizontal ground-wave radiation pattern. While there may be some divergence between the pattern so determined and the actual pattern at the optimum angle above earth, the results obtained will be quite valuable in assisting in the adjustment of a multi-element array.

Theoretical patterns are the only guidance that most of us have in choosing a particular antenna, aside from a personal fancy for one or another. As is well known, different local conditions surrounding any one antenna can make its performance distinctly variable, and greatly different from its theoretical performance. All of which means that an antenna operated under practical conditions may produce a pattern hardly recognizable when compared to the theoretical. On the other hand, a good installation can produce a quite acceptable radiation pattern. The only way to check up on the performance of your antenna is actually to measure its pattern.

Field Strength Meters

In order to determine the radiation pattern of your antenna, an adequate field strength meter is required. Now, the field strength meter is simply a device which detects the r.f. signal which it receives and shows the relative signal strength at a particular location. Usually the signal strength is shown by a d.c. milliammeter or microammeter. The detector may consist of a diode, or a triode with its grid and plate tied together to form a diode, or a simple form of power detector. Sometimes, for very close range work, a carborundum rectifier is used. However, for the work described here the vacuum tube circuit is to be preferred due to its much greater sensitivity. Excellent field strength meters have been described in past issues of RADIO and in the RADIO HANDBOOK. As it is not essential or necessary that the pattern be read in microvolts-per-meter, and since all readings are obtained at an equal distance from the antenna, the problems of linearity or μv/m calibration do not enter into the procedure.

For close-range measurements, the extremely simple circuit of figure 1 will prove entirely satisfactory. With proper filament voltage on the tube, the sensitivity of the device is, of course, dependent upon the power radiated by the transmitting antenna and the length of antenna used on the field strength meter. The milliammeter should have a range of 0-1 ma. (or 0-1000 microamperes). Be extremely careful not to get too close to the antenna or transmitter when first trying out the field strength meter; such instruments cost too much for the mere sinking feeling of seeing one burn out. The antenna for the meter may consist of a vertical copper rod, or the meter may be fastened to a short pole carrying the antenna wire. It is difficult to describe the maximum distance at which this meter may be used, due to varying conditions enter-

* Ex W6FEW, Production Manager, RADIO.

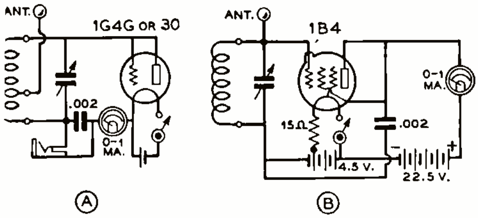


Figure 1. Two simple field-strength meters for making radiation pattern surveys. (A) shows a simple diode rectifier arrangement which is satisfactory with a fairly long pickup antenna when making measurements not too far from the transmitting antenna. (B) shows a more complicated but much more sensitive meter which requires a few more parts but may be used some distance from the transmitting antenna. In both meters the coil-condenser circuit should, of course, be tuned to the operating frequency of the transmitter.

ing into individual construction and use. However, no trouble should be encountered in getting readings at a distance of from three or four hundred feet from the antenna serving a transmitter having four or five hundred watts input.

If readings are to be taken at greater distances, a more sensitive meter is required. This may be accomplished by using a portable receiver with the milliammeter inserted in the plate circuit of the detector stage, which is battery-biased through a potentiometer so that the current through the meter may be kept within its limits. Since the majority of hams do not have the facilities for taking pattern measurements at distances of several miles, the more elaborate equipment required for such work will not be described.

For obtaining patterns of rotatable antennas the cooperation of a distant ham may be solicited in the event he is using a receiver with an R meter. The procedure for this type of measurement will be described later.

Patterns of Non-Rotatable Antennas

Since the readings for patterns of fixed antennas are to be taken at an equal distance from the antenna, it is first necessary to locate the points at which such readings may be taken.

In the greater majority of cities and towns there is an engineering department, or department of public works for the local government from which it is possible to obtain a map of the entire town, or of a desired portion of the town. If maps are not available at these offices, it is quite possible that the local power, gas, water or telephone companies will have a map which will serve the purpose. If all these fail you, try your local professional surveyors and engineers. As a last resort, write your county engineer and see what he has available. In some parts of the country, the major oil and gasoline companies publish small maps of the larger cities. However, these maps are not generally satisfactory, as they are originally drawn to a large scale which becomes very awkward to handle after the map has been reduced in size in the process of making a cut for printing purposes. So, avoid using these maps if you possibly can.

The next step is to determine the greatest distance from the antenna at which you can obtain a reading on your field strength meter. The minimum reading should not be less than one-half the scale of the instrument. You don't know how far the signal strength may drop when you change your location in order to get other readings. At any rate, you should try to make the combination of transmitter power, f.s.-meter antenna and distance such that a high scale reading is obtained at distances of from 600 to 800 feet. The farther away (in the local area) you can get readings, the more representative they will be of the ground-wave pattern of your antenna.

Unless you are located on a farm or in a sparsely settled section of town, you will likely be unable to measure directly the distance from the center of the antenna to the field strength meter. Knowledge of this distance is of no importance in obtaining the pattern; however, it is very useful if you intend to take for comparison a number of measurements at varying distances from the antenna.

The first use of your map is to locate the approximate position of your antenna on the lot you are occupying. Be sure to check it carefully, and also be sure you have located the lot correctly with respect to the North arrow; in other words, don't get mixed up with the lot across the street. The next step is to spot the position of the meter. This is probably done by estimation if you happened to have found the desired strength indication at a point about halfway down "the next block." If the meter position happened to come on a street intersection, spotting it on the map can be done quite accurately—but be sure to get the *right* corner of the intersection (NE, SE, etc.). Both the location of your antenna and that of the meter having been located, you may measure the distance between the two points by scaling it on the map. If the distance is found to be 4 inches

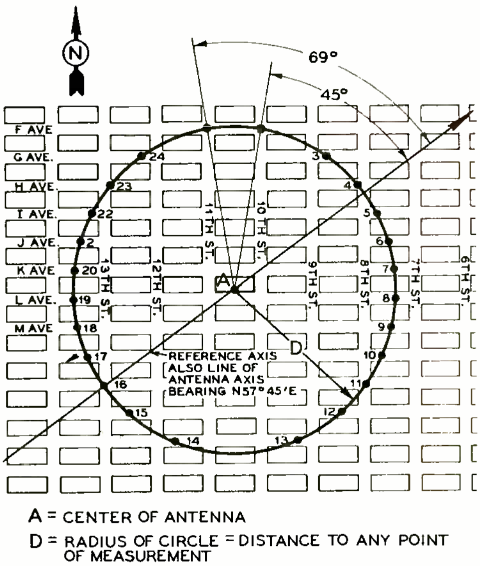


Figure 2. Example of the use of a map in making a pattern survey. Streets are assumed to run due north and south, avenues to run east and west.

on the map, and if the map is drawn to a scale of, say, 200 feet per inch, the distance on the ground is 800 feet.

Next required is the location of a number of points which lie the same distance from the antenna as that at which the meter was first set. These are found simply by drawing a circle on the map. Use the center of the antenna as the center of the drawn circle. It will be seen that the line of the circle cuts through other intersections and other streets, as shown in the example drawing of figure 2. As is seen, the points marked with "●" indicate positions at which readings may easily be taken. Advantage should be taken of every available point of reading in order to get a well-defined pattern. Not much will be accomplished, however, by taking readings at points closer than 50 feet, on the line of the circle. If the separation in degrees between any two points is desired, it may be measured by using a protractor (inexpensive ones are available at almost any stationery or book store).

One more item should be taken care of before going in the field with your meter and taking readings. This item is that of recording your readings and the position at which they were taken. The simplest way of doing this is by numbering on the map all points at which it is expected readings will be taken. Next, a sheet of paper should be set up as shown in figure 3. The columns "Location" and "Remarks" are helpful in noting the exact position at which you took the reading corresponding to the "Point" column.

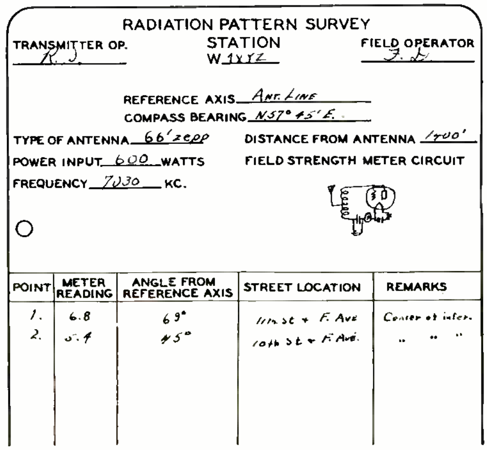
Having enlisted the services of a fellow ham to stay at the transmitter and make 15-minute station "signs" and to watch the performance of the transmitter, arm yourself with your map, notebook and f.s. meter and proceed to the location which you have chosen for the first reading. If traffic is light in your vicinity, a car may be used in order to take readings quickly, and to offer a less conspicuous appearance to passersby.

The procedure for taking readings at longer distances (1 to 5 miles or more) is principally the same as that for obtaining close-range patterns. Of course, a more sensitive field strength meter is required; and the map used should be that of the county. If you have trouble, don't hesitate to call upon an engineering acquaintance for help.

Patterns of Rotatable Antennas

It is somewhat easier to obtain the patterns of a rotatable antenna, since less field work is required. However, this is partially offset by the pains which *should be* taken in measuring and reading the angles of rotation of the antenna.

Simply, the procedure is to set up the field strength meter at some chosen location. The antenna is then rotated, in steps, through a number of degrees, preferably 10° increments,


RADIATION PATTERN SURVEY

TRANSMITTER OP. R. J. STATION W1XYZ FIELD OPERATOR J. L.

REFERENCE AXIS Ant. Line
COMPASS BEARING N57° 45' E.

TYPE OF ANTENNA 66' zepp DISTANCE FROM ANTENNA 1400'
POWER INPUT 600 WATTS FIELD STRENGTH METER CIRCUIT
FREQUENCY 7030 KC.

POINT	METER READING	ANGLE FROM REFERENCE AXIS	STREET LOCATION	REMARKS
1.	6.8	69°	11th St + F. Ave	Center of inter.
2.	5.4	45°	10th St + F. Ave.	" " "

Figure 3. Typical example of note sheet used in making the survey.

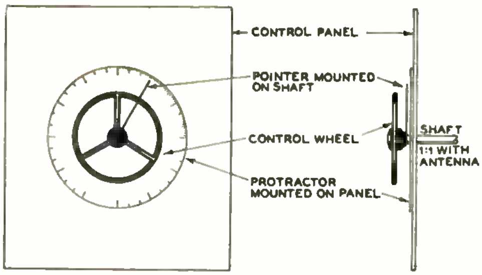


Figure 4. Methods of measuring degrees of rotation by means of a protractor referring to a control wheel which has a 1:1 ratio with the rotary array. An overly large protractor has been shown; a smaller one would work just as well.

at which point the field strength meter is read. This is repeated until the antenna has been rotated through 350°, for unidirectional arrays; 170° for bidirectional arrays, unless it is desired to compare the pattern of both "ends," or lobes. Antennas designed for one-direction service should be rotated through 350° in order to check the total effectiveness of the reflectors. Patterns thus obtained will indicate the necessity, or lack thereof, for adjustment of the reflectors and, if used, the directors of the array.

The patterns must be plotted on polar-coordinate paper since the readings were taken in polar-coordinate form. This requires means of measuring the degree of rotation of the antenna, which may be accomplished by one of several ways.

If the rotating control in the shack is in a 1:1 ratio with the rotation of the antenna, the degree of rotation may be read directly by mounting a large paper protractor on the panel behind the control wheel so that the center of the shaft corresponds with the center of the protractor. A pointer is then attached to the shaft of the control so that the degree of rotation may be read (see figure 4). The "0" of rotation calibration may be set to North if desired.

Accuracy in doing this is a matter of individual ability; the directional characteristic of the average rotary antenna is usually broad enough to allow two or three degrees error in estimating true North. Having set the antenna to North, the protractor on the control panel is rotated so that its "0" falls in line with the index line of the pointer mounted on the shaft. If the rotation of the antenna is effected by means of sash-cord or other light rope, too much faith cannot be held in a calibration of the control pointer for any length of time, due to the stretching qualities of the rope. Light steel cable, such as used for brake control on old-model automobiles, is more preferable although it requires greasing to permit continued flexibility.

Other methods of measuring the angles of rotation are easily devised. One is to assemble a separate panel for the pointer and its shaft, or hub. This is constructed so as to be in a 1:1 ratio with the rotation of the antenna.

The rest of the procedure is simple. In order for the field man to learn of the steps of rotation of the antenna a small portable receiver may be used; a simple one can easily be rigged up in a short time, or else a prearranged schedule of rotations and recording of readings can be worked out. All this, of course, if the field man is not within voice range of the transmitter.

A much better idea may be had of the antenna's operation if the above procedure is carried out with a neighboring station acting as the field strength observer. Of course, the receiver used at the other end must be equipped with an R meter to indicate relative signal strength.

It is interesting to compare patterns resulting from tests made at from 400 to 500 feet, (ground wave) up to several miles, and several hundreds of miles away (sky wave). Fading is very disruptive in making tests over a very great distance, however. If one selects an intelligent operator to act at the receiving position, fair results may be had by averaging the varying signals produced by fading when the antenna is at any one position during the tests. Or, the tests may be carried on at a time of day when there is little or no fading

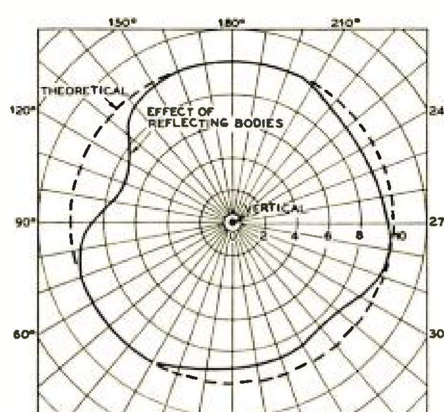


Figure 5. Actual measurement of the field pattern in the vicinity of the 14-Mc. vertical antenna in use at W7DTJ.

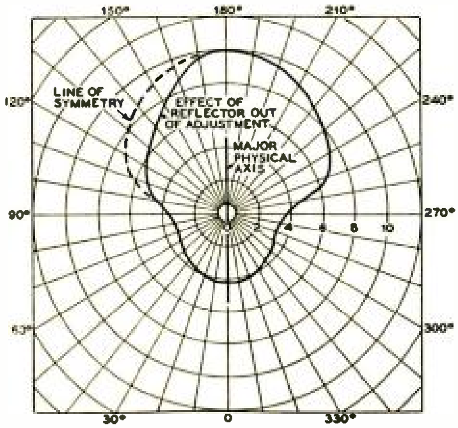


Figure 6. Close-range pattern (300 feet) of the 14-Mc. "circle-beam" rotary at W7ALZ.

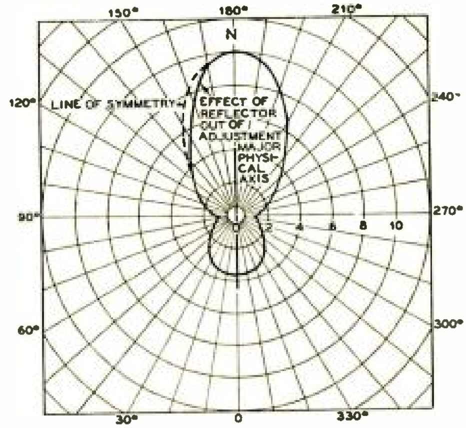


Fig. 7. "Long-range" pattern (approximately 2 miles) of the same "unidirectional" array shown in figure 6.

(or QRM, if you can ever find such a time!). A strong QRM'ing station will, speaking mildly, strain one's patience to the limit in making such tests! Just as good results may be had by testing with a station five or ten miles away, if no skip or fading conditions exist at the time. The operator making the test announces the degree of rotation at every change of position in order that the recording station may keep track of its observations. It is only too evident that the receiving station should be equipped with some sort of visual signal strength meter in order to produce intelligent and accurate results; most of us know how unreliable a "strength meter" the ear is.

Plotting and Using the Patterns

After the data have been collected for the particular type of antenna you are using, the story told by the various values is best shown by plotting the picture they make.

Most everyone in ham radio is familiar with plotting curves on rectangular coordinate or graph paper. However, plotting the pattern produced by the procedure outlined under "Patterns of Non-Rotatable Antennas" requires data from the map used in locating the points at which readings were taken. While the pattern reading procedure was laid out on coordinate paper (the map), the readings taken are actually *polar-coordinate* values and must be plotted on *polar-coordinate* paper if the familiar appearance of the radiation pattern is to appear (figure 5).

Polar-coordinate paper may be purchased from engineering supply houses, larger stationery houses, drafting supply houses or college book stores. The thin, tracing paper type is to be preferred because of its transparency. It also makes a very good 8-inch protractor. However, if you are unable to purchase such paper, you *can* make your own by using a protractor and compass. When drawing your own polar-coordinate paper, it will be sufficient to use only 5-degree intervals for the angular spacing.

With a protractor, measure the angles between the points shown on the map used in taking the field strength measurements. Take the angular reading of each strength reading with respect to a reference axis, such as a line drawn through the center of the circle and parallel to the street in front of your house. This identifies the directional characteristic of your antenna, since the approximate compass bearing of your street can be estimated from its relation to the North arrow of the map (figure 2).

On your polar-coordinate paper, draw a heavy line through the center of the circles. This line represents the axis chosen on your map. The rest of the problem is to simply mark the value of your field strength reading on the line of the angle at which it was read. Of course, it is assumed that in taking the angular values from the map that you *identified* them with their *proper corresponding values of field strength. Check* yourself on this, or else your pattern won't mean anything.

When you have finished locating all the values, sketch a smooth curve through all the points. If you have a French curve, and know how to use it, the job will be done

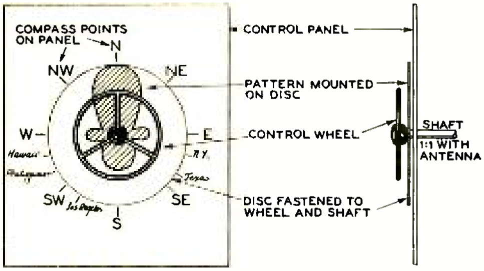


Figure 8. Drawing showing how the pattern of a rotatable array may be mounted behind the control wheel to assist in keeping track of the directivity of the signal.

much more quickly and neatly. Having previously identified the compass bearing by the heavy line, you can easily see where most of your signal goes. Instead of an arbitrary line, the line of your antenna may be used for reference *if* you can *estimate* its direction. This is an easy matter if you have erected your antenna so that it is parallel to a street having a bearing of due East or West.

The same plotting procedure holds for the pattern of the rotatable antenna, with the simplification being that the degrees rotation and relative signal strength were taken directly, and therefore no use of the protractor and map is necessary.

Since the compass direction of the antenna was determined at the start of the test, and is identified in the data by the "0" degree reading, the directional characteristic of the antenna is immediately evident upon completion of the pattern (figures 6 and 7).

In order to keep track of the beam while operating, it will be convenient to mount the pattern on a piece of heavy cardboard or masonite at the shaft of the rotating control so that the pattern rotates with the wheel (figure 8). Compass directions may then be indicated on the panel behind the control wheel by means of radial lines from the control shaft. Before locking the pattern into place on the control shaft, it may be orientated so that it will be approximately "true" with the direction of the antenna. Thereafter, the operator need but watch the relation between the *moving* pattern and the *stationary* compass marks on the panel as he rotates his antenna. As many operators will learn, the pattern obtained is not always symmetrical about the point representing the center of the antenna. This indicates a need of adjustment of reflectors, *if* the pattern is to be symmetrical about the antenna.

If you do not desire to go to the trouble of mounting the pattern, simply mount a pointer on the *shaft* so that it points on the line of maximum signal strength. Of course, compass marks on the control *panel* are necessary to determine beam *direction* accurately. The *entire foregoing suggestions* are based on the assumption that *your control wheel is in a 1:1 ratio* with the rotation of the antenna.

By comparing several patterns, obtained from readings taken at different locations, against theoretical patterns, and noting the *existence* and *location* of nearby reflecting bodies you may in many ways account for the deviation of your pattern from the theoretical, when the array is set for a particular direction.

Theoretical horizontal-plane radiation patterns may be found in a number of publications, while the patterns for beam antennas are usually included with the article describing their construction.

• • •

Application Made for NEW F.M. STATIONS

The Yankee Network has made application to the FCC for construction permits for two high power frequency modulated transmitters. One, of 50,000 watts power, would be built at Alpine, N. J., atop the Palisades and would use a part of the mast now used by Major Armstrong for his frequency modulation experiments. The other, of 5000 watts power, would be located at the summit of Mount Washington in New Hampshire. These two stations in combination with one already operating at Paxton, Mass., would provide improved reception to a potential 20,000,000 listeners in the densely populated areas from New York to Portland, Maine.

These applications are based on the contention that frequency modulation has long passed from the experimental to the practical stage. It was asked that stations using this type of modulation be licensed for operation as regular broadcast stations.

All frequency modulated transmission is carried out, of course, on the ultra-high frequencies where the comparatively wide band required for such transmission will be available. It is expected that the power levels applied for by the Yankee Network for its two new stations will be ample to give noise-free, high-fidelity reception to receivers within a 75- to 100-mile radius of the transmitters.

A Bandswitching

200 WATT AMPLIFIER

Utilizing the new Heintz and Kaufman 257 Gammatron beam pentode in a bandswitching amplifier for 175 to 250 watts output on the 80-, 40-, 20-, and 10-meter bands. Capacitive coupling to the control grid of the pentode is used to simplify the bandswitching problem.

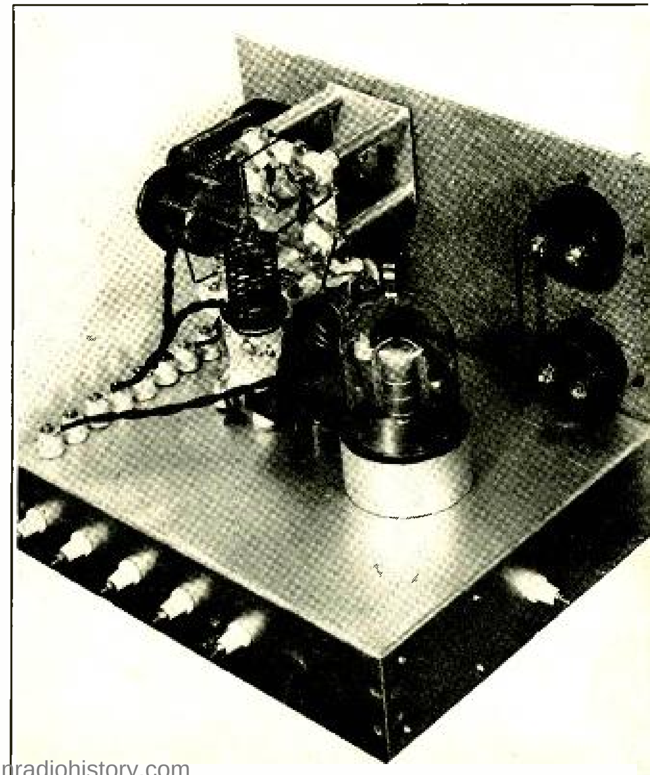
By RAY L. DAWLEY,* W6DHG

The new Gammatron 257 beam pentode lends itself admirably to the design of a medium power bandswitching amplifier with provision for cathode, control-grid, or suppressor-grid modulation. The tube is quite similar in external appearance to the 254 Gammatron triode and, in fact, uses a plate which is almost identical to that of the 254. Two other grids and an internal shield have been included in the envelope to make the tube a pentode. In addition, the control grid and the screen have been aligned to give the additional power gain to the tube which is afforded by the beam principle.

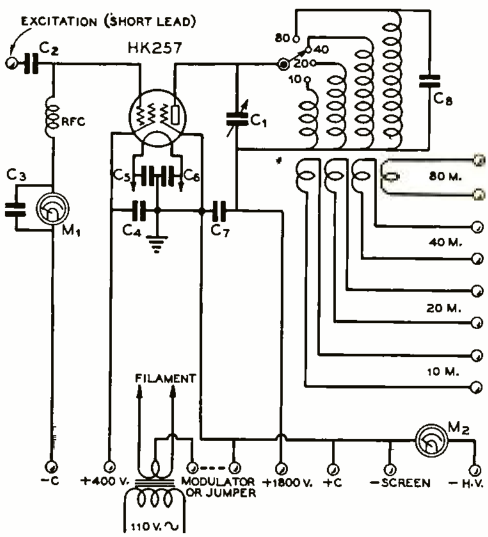
* Technical Editor, RADIO.

All the internal elements of the tube (except the filament, of course, are fabricated from tantalum and are supported directly by their leads without the use of internal insulators. The filament is of thoriated tungsten and draws 7.5 amperes at 5 volts as does the 254. Interelectrode capacitances are somewhat lower than is usual for multi-grid power tubes with the result that considerably improved operation is obtained at the higher frequencies. The more important tentative ratings are as follows:

Plate dissipation	75 watts
Maximum screen input	25 watts
Filament voltage	5.0 volts



Rear three-quarter view of the 257 band-switching amplifier. The bandswitch and four coils can be seen to the left of the tube. The final tank condenser is mounted below the bandswitch and the fixed condenser which is across the 80-meter coil is mounted to the left of the variable condenser. Note the aluminum shield around the base of the 257. The single feed through on the right drop of the chassis is the capacity-coupled input terminal for the grid circuit of the tube; the row of eight terminal insulators along the left edge of the chassis are to be connected to the individual antenna systems for the different bands.



Wiring diagram of the 257 bandswitching amplifier.

C_1—50-μμfd. 4500-volt variable
C_2—.0005-μfd. mica
C_3—.002-μfd. mica
C_4—.005-μfd. mica
C_5, C_6—.003-μfd. mica
C_7—.002-μfd. 5000-volt mica
C_8—50-μμfd. 4500-volt fixed
RFC—2½-mh. 125-ma. choke
Fil. Trans.—5.25 v., 12 a.
M_1—0-25 d.c. milliammeter
M_2—0-300 d.c. milliammeter
Coils—See coil table

Filament current	7.5 amperes
Plate-to-grid capacity	0.04 μμfd.
Input capacity	13.8 μμfd.
Output capacity	6.7 μμfd.

Radio-Frequency Power Amplifier—Class C Unmodulated

D.c. plate voltage	2000	2000	1500
D.c. plate current	150	150	150
D.c. screen voltage	400	500	500
D.c. screen current	15	25	11
D.c. suppressor voltage	60	0	60
D.c. suppressor current	5	0	4
D.c. grid voltage	-180	-190	-200
D.c. grid current	9	8	6
Driving power	2.1	1.9	1.4
Power output	230	225	170

If the screen voltage under the 2000-volt conditions with 60 volts suppressor voltage is increased from 400 to 500 volts, the driving power can be cut from 2.1 to 1.4 watts with all the other operating conditions remaining approximately the same. It will be noticed that operating conditions are given for operation both with the suppressor grounded and with a positive potential of 60 volts applied to it. Placing the positive voltage upon the suppressor reduces the screen current to a certain extent with only a very small amount of suppressor current. At the same time the positive suppressor voltage reduces the excitation requirements slightly. However, the improvement in operation obtained by placing the 60 volts positive upon the suppressor is small and for all normal operating conditions the suppressor can be grounded. Hence, the suppressor has been grounded in the amplifier described and shown herein.

Other 257 Operating Conditions

Operating conditions for plate modulation of the 257 are essentially the same as for unmodulated operation except that the maximum plate voltage for high-level modulation is 1800 volts. Also, the maximum plate dissipation for the carrier conditions must be held down to 65 watts and the maximum plate current must be held to 135 ma.

Since the suppressor grid on the HK-257 has been brought out to a separate base pin the tube may be suppressor modulated when only a small amount of carrier output is desired. 32 watts output may be obtained with 1000 volts on the plate of the 257 while only 35 watts output may be obtained with 2000 volts applied plate voltage. Consequently it is not worthwhile to operate with suppressor-grid modulation at more than 1000 to 1250 volts unless the stage is also to be used as class C c.w. amplifier without modulation. The suppressor bias for this type of modulation varies from -135 volts for the 100-volt conditions to -210 volts for the 2000-volt conditions. The excitation requirements are slightly lower than those for c.w. operation with the same plate voltage.

A comparatively small amount of suppressor modulating power (such as could be supplied by a 6C5 or similar tube with a 2:1 step-up transformer) is required for the 1500-volt and 2000-volt operating conditions. For operation with 1000 plate volts about 500 milliwatts of audio power will be required. This could easily be supplied by a single 6F6 operating into a 1:1 output transformer. The maximum plate current for suppressor modulation is 100 ma. and the maximum plate dissipation is 75 watts.

The HK-257 is capable of operating at efficiencies of 60 to 70 per cent as a frequency doubler. The maximum input for this service is limited to 200 watts. It is recommended that the positive 60 volts be applied to the suppressor to increase the transconductance for operation as a doubler; however, excellent operation as a doubler was obtained in the amplifier described with the suppressor grounded. Due to the low interelectrode capacitances of the tube it may be operated as a doubler to the 28- and 56-Mc. bands with comparatively good efficiency.

As a class A pentode amplifier the 257 is capable of putting out 34 watts of audio at 1000 plate volts and 75 ma. into a load of 12,000 ohms. The suppressor is grounded, the screen is operated at plus 300 volts and a grid bias of 27 volts is required.

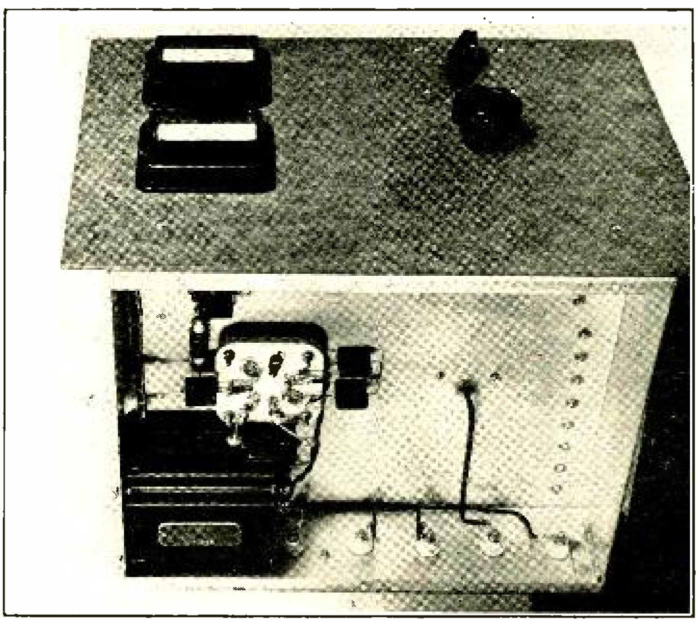
Shielding Precautions

A glance at the top-view photograph of the amplifier will show that a shield has been placed around the lower portion of the envelope of the 257 to assist in shielding the plate from the grid end of the tube. The 257 has a very high transconductance and extreme care must be taken to prevent self-oscillation. Only a very small amount of feedback capacity would be required to allow the stage to oscillate without benefit of excitation. The shield was made from the upper 1½ inches of a 3-inch coil shield. The socket of the 257 was lowered about ½ inch below the chassis on metal spacers thus allowing the internal shield of the 257 (the large metal disc in the lower portion of the tube envelope) to come approximately on a level with the external shield. Incidentally, the internal shield is brought out to the suppressor terminal of the tube and hence is connected to it. The screen lead should be by-passed directly at the socket; the same is true of the suppressor in case it is being operated with a positive potential upon it, or in case it is to be modulated.

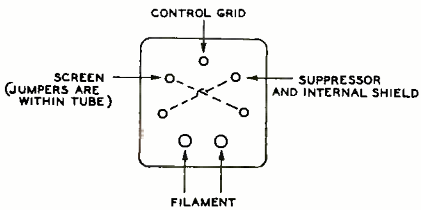
Operation

The excitation requirements of the HK-257 are very small. As was indicated at the beginning of the article, only about 2 watts of actual driving power are required at the grid. Allowing for losses in the coupling line and in other portions of the inter-connections, a five-watt exciter would furnish ample driving power for the 257 on all bands. There is one difficulty in assuming that any small exciter would have ample output, however, since the actual available output power from any conventional exciter falls off quite rapidly when it is used on the ten-meter band. Anyway, any exciter that will furnish 10 ma. of grid current to the 257 with 200 volts of grid bias will be large enough.

Of course it must be remembered that capacity coupling has been used between the exciter and the grid of the 257 amplifier. This has been done primarily to simplify the coupling system which would be required for coupling a bandswitching exciter to the grid circuit of the amplifier. With the arrangement shown it is only necessary to connect the plate of the output tube of the exciter (a



Front-panel and under-chassis view of the amplifier.



BOTTOM VIEW
SOCKET CONNECTIONS FOR HK257

6V6 in the output would give ample driving power) to the input terminal of the 257. As short and direct a lead as possible should be used. The excitation requirements of the tube are low but it doesn't require a very long lead to lose a considerable amount of r.f. on the 28-Mc band.

The Output Circuit

Only a single-circuit switch is needed on the plate coils of the amplifier. Since separate antennas are almost always used on the different bands, individual antenna coils have been placed on each of the four output coils of the amplifier. These links are individually brought out and each one goes to its own pair of terminals on the chassis of the unit. Thus each antenna may be connected to the output of the amplifier, and when the amplifier is switched to that band the antenna will automatically be connected.

A 50-$\mu\mu$fd. 4500-volt condenser is used to tune all four of the coils. However, an additional 50-$\mu\mu$fd. fixed capacity has been placed across the 80-meter coil to give a satisfactory amount of Q on this band. The fixed condenser, which is of the plug-in airdielectric type, is permanently connected across this particular coil.

COIL TABLE

28-Mc. Band 6 turns no. 12 enam., 1¼ inches in diameter, 1¼ inches long
14-Mc. Band 11 turns no. 12 enam., 1¼ inches in diameter, 2¼ inches long
7.0-Mc. Band 16 turns no. 14 enam., 1¾ inches in diameter, 1¾ inches long
3.5-Mc. Band 24 turns no. 14 enam., 2 inches in diameter, 3 inches long

Metering

Two milliammeters have been incorporated into the amplifier and are mounted upon the front panel. An 0-25 d.c. milliammeter is connected directly in series with the grid return of the tube to indicate grid current. It has been by-passed to reduce the possibility of damage to the instrument by r.f. leaking back through the r.f. choke.

The other instrument is a 0-300 milliammeter and is connected between the negative high-voltage lead from the power supply and the grounded chassis of the amplifier. By connecting the meter in this manner it will indicate only the plate current (and not the screen current also as is the case when the meter is connected in the cathode) and still be substantially at ground potential. Thus there is no danger of shock from the instrument and it still will read only the plate current of the tube. Of course this circuit has the disadvantage that the negative of the high-voltage power supply to the plate of the 257 cannot be grounded. But it is usually an easy task to remove the ground from the negative lead and still have the cases of all the pieces of equipment grounded. The increase in safety afforded by such procedure more than overbalance the trouble involved in running a separate negative lead to the h.v. power supply.

Cathode Modulation

Provision has been made for cathode modulation of the 257 amplifier. To cathode modulate the stage it is only necessary to insert a 500-ohm winding of the output transformer of an audio amplifier with about 25 watts output in series with the two terminals marked "Mod. or Jumper" on the circuit diagram. If it is desired to use series cathode modulation, two 6L6's in the modulator output stage will be ample; the plates of the series-cathode modulator tubes would be connected to the center tap of the filament transformer and the chassis of the modulator and the cathode modulated amplifier would be connected together.

Tuning up of the stage for cathode modulation is conventional and has been discussed in earlier RADIO articles.[1, 2, 3]. One thing that must be remembered is that the 257 has a very high transconductance and high μ, which means that the grid swing accompanying cathode modulation must be reduced with respect to the plate swing or else essentially grid modulation will be the result.

[*Continued on Page 168*]

[1] Frank C. Jones, "Cathode Modulation," RADIO, October 1939, p. 14.

[2] RADIO Staff, "Cathode Modulation Operating Data," RADIO, December 1939, p. 16.

[3] Ray L. Dawley, "Series Cathode Modulation," RADIO, December 1939, p. 24.

Continuously Rotatable

TWO BAND ARRAY

By H. L. JENKINS*

The worth of rotary multi-element antenna arrays has now been proven and widely accepted. Several improvements relating to continuous rotation and multi-band operation, not without considerable merit, have been proposed. Another approach to each of these will be discussed in this paper.

Series Capacity for Continuous Rotation

After consideration of concentric inductances as a coupling medium between a transmission line and a rotary array, R. C. Higgy, W8LFE, installed a simple rotary fixed condenser which has been very effective. In seven months, he raised 103 countries on c.w. and 84 on phone using a three-element array on 14 megacycles, fed with an open-wire line. The original rotary capacity placed in series with the transmission line has been redesigned into a more rigid and compact spun aluminum form having better protection against weather. This is shown in figure 1. A flat model of larger size will be more practical for construction in the average ham's workshop.

* General Rotary Antenna Company, Springfield, Ohio.

An advantage of a series capacity over the inductive method of coupling the line to the antenna is that the line is not terminated in a transformer but continues on to the antenna itself. A single job of matching and tuning may be accomplished there by any of several satisfactory methods. Through a capacity, an antenna may be fed at a voltage loop or a current loop. This means that two half waves may be fed in phase, with the transmission line connected between adjacent ends of the half waves. A matching stub connected through the capacity-coupled head can be used to avoid a tuned line if desired.

Two-Band Operation

The rotary capacity method of feed opens up several possibilities for two-band operation. We have tried one method and find it very satisfactory, but already we are flirting with improvements upon it or obtaining an untuned line on the second band; no doubt other arrangements will be put forth. The tried method as well as the suggested improvements will be discussed below.

Most fellows will find that the use of a short stub[1] or small tuning coil in the center

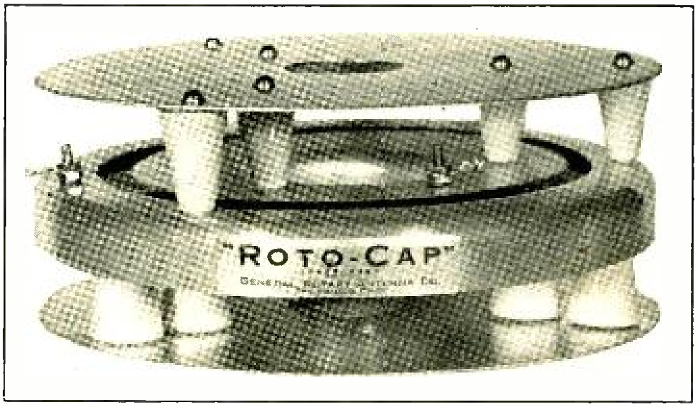
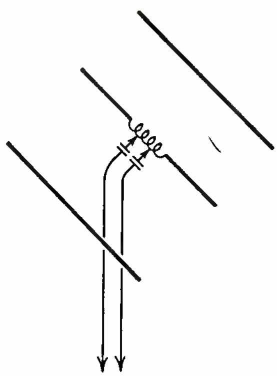
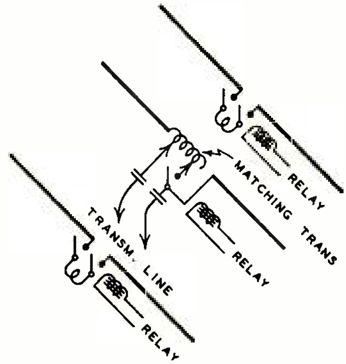


Figure 1.
Rotary fixed capacity designed to connect transmission line to beam antenna, permitting continuous rotation.



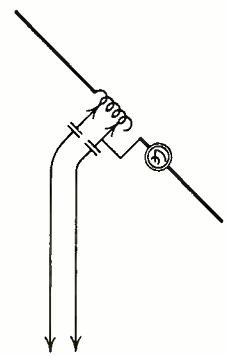
STRAIGHT-FORWARD METHOD OF FEEDING ROTARY ARRAY WITH ROTARY CAPACITY COUPLING.

FIGURE 2



TWO-BAND ARRANGEMENT USING ROTARY CAPACITY FEED, WITH LINE TUNED ON SECOND BAND.

FIGURE 3



AMMETER CONNECTION USED IN RESONANCE ADJUSTMENT, (BUT WITH LINE DISCONNECTED)

FIGURE 4

of the elements will make tuning and matching easier. In addition it will reduce the "wing-spread" of the array by a few feet, simplifying the matter of element support. The method still bothers some people, those who feel that shortened elements mean reduced radiation—but is that true?

One can assume a constant power input to a beam with either full length or slightly shortened, "loaded," elements. The shorter unit will have a little lower radiation resistance. The metallic resistance is very small. By slight modification of Ohm's law we find that the input power is equal to the element current squared, multiplied by the sum of radiation and metallic resistances. The decreased radiation resistance simply results in a compensating increase in current, bringing the radiation up to where it would be with a longer element. The very small increase in "copper losses" due to the heavier current flowing through the element is negligible with only a ten per cent shortening. So much for the objection to radiators shorter than 33 or 34 feet.

One method of feeding a 14-Mc. array is shown in figure 2. In order to operate on 28 Mc., it will be necessary to tune the reflector (and director) to the new frequency by opening them or by inserting a quarter wavelength stub. Either can be done, and relays can be arranged to permit remote control. Something must also be done with the radiator, the easiest perhaps being the use of a tuned line on this band. The complete arrangement is pictured in figure 3.

[1] Smith, "Design of Close-Spaced Arrays," RADIO, June, 1938.

The method of adjustment will be reviewed briefly:

1. With the reflector and director opened at their centers, make a rough adjustment of the radiator length and coil or stub tuning on twenty meters. This can be done with the transmission line disconnected and a meter inserted in series with one element to indicate current received from a separately excited antenna at least two wavelengths away. The element length allowing a 600-ohm coil will be about 14½ feet. The transmission line can then be hooked on as shown in figure 4. This arrangement will cause a negligible amount of unbalance if nearly the whole coil is necessary between the transmission line connections in order to obtain a match.

2. Next, shift to ten meters with one feeder connected to a radiator element and not to the coil, as shown in figure 3, and adjust the length of the two reflector elements for best front-to-back ratio, preferably with the director completely removed.

3. Adjust the director lengths for best forward gain or best front-to-rear ratio as desired. Inasmuch as the radiator is operating with tuned feeders as a double-zepp, it is not necessary at this point to make any adjustment on the radiator.

4. Shift to twenty meters and, with the director open, adjust the tuning loop or stub on the reflector for best front-to-rear ratio; in some cases this loop may be a coil but only a short connection between the relay terminals.

5. Close the center connection on the director and adjust its loop for best gain or front-to-rear ratio as desired.

6. Readjust the radiator tuning and trans-

mission line match (to compensate for the effects of the director and reflector tuning). This can be done by inserting an r.f. meter in the radiator, connecting the transmitter to a separate antenna to provide energy for adjusting the coil or stub with the feeder disconnected. Following this, the feeder can be hooked on and adjusted for maximum radiator current and minimum standing waves on the line, in one of the approved methods. It should not be difficult to reduce standing waves to a two-to-one ratio.

Indicating Device

The above adjustments may be made with a nearby receiver as an indicating device, or with a doublet antenna located several wavelengths away, with a thermo-ammeter, galvanometer, or field strength indicator connected at its center. The ordinary field strength instrument, which is *not* provided with a horizontal doublet antenna, acts like a Marconi antenna against ground. It indicates vertically polarized waves which may be the result of feeder unbalance or capacity coupling to the transmitter, and not at all the thing that is being adjusted.

The relay coils may be operated on a one-wire circuit against ground, permitting the use of a small commutator, or a long wire that will wrap several times around the pole, for the other connection.

The above method, involving the use of tuned feeders on ten meters, has not been found objectionable on efficient open-wire lines up to 100 feet long. Ten-meter tuned feeders using twisted pair or rubber dielectric concentric line should be avoided, and while solid concentric line is efficient, it will probably flash over at high voltage points unless it is of large diameter. Another method, which we have not tried, permits stub matching on ten meters or on both bands[2]. It is diagrammed in figure 5. It requires an additional relay, and permits the use of a radiator a full one-half wave long, or even longer if desired, on twenty meters.

It is hoped that the rotary capacity method of obtaining continuous rotation and the suggestion for two-band operation will be of interest to users of rotary arrays.

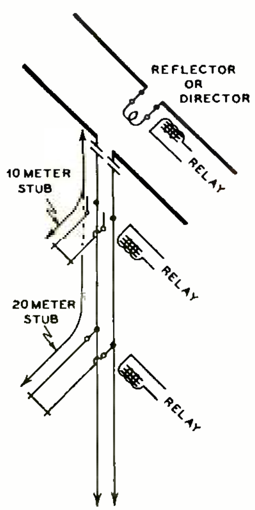


Figure 5. Two-band stub switching arrangement as applied to radiator element for matching on both bands, using rotary series capacity feed for continuous rotation.

[2] Willoughby, "Matching-Stub Switching," Radio, February, 1938.

Pickups . . .

Five Dollars Input

After working for hours and hours solving those mathematical formulas presented by the various authors of Radio, I have at last found the universal formula that shows all. Any person with a kindergarten education can arrive at a satisfactory answer and continue his normal place in society as a mentally sound individual.

Figure it out for yourself:

Take the power input to your final stage (Note)—Multiply by 2—Add 5—Multiply by 50—Subtract 365—Add the loose change in your pocket under a dollar—Add 115.

The last two figures in the answer are the change in your pocket. The figures to the left of the change in your pocket are your power input.

(Note)—The power input must be stated in whole figures and be greater than one watt.

—*W5ALK*

Any manufacturers interested in making humidity tests on their products should send them to K6QXY. The average rainfall is around *six hundred* inches.

W8ESP not only lives at 73 Lackawanna Avenue, East Stroudsburg, Pa., but the letters of his call are also the abbreviation of his home town and state.

STRICTLY 80 METERS

AN INEXPENSIVE, VARIABLE-FREQUENCY C. W. TRANSMITTER WITH OSCILLATOR KEYING AND A "CRYSTAL" NOTE.

By W. W. SMITH,* W6BCX

For traffic, navy or army net, or just plain ragchewing on 80-meter c.w., this 40-watt rig is hard to beat. You can work anywhere in the band with 100 per cent break-in. The note is very pure and stable, and the keying clean.

The c.w. man on 80 meters is not a dx man, at least for the moment, and is more concerned with operating ease and efficiency than with anything else. He usually goes up on 80 to work U. S. N. R. or A. R. R. S. drills, to keep skeds on traffic nets on spot frequencies, or to just plain chew the fat without being smothered with QRM or dropped like a hot potato after reports are exchanged.

Now anybody who has done much operating on 80-meter c.w. knows that 25 to 50 watts in an antenna worthy of the name will do just about as good a job as a kilowatt so long as there isn't somebody else with more power smack on your frequency. For this reason many c.w. amateurs do not attempt to put their regular transmitter on 80 meters, but instead use a keyed crystal oscillator which is left all tuned up "sitting in the corner" and ready to go on a moment's notice.

Now a keyed crystal oscillator is fine if you have enough crystals; but a continuously variable frequency oscillator is undoubtedly better yet. The unit shown in the accompanying illustrations is just what the doctor ordered in this respect, as it not only permits continuously variable frequency control, but sounds so much like a keyed crystal oscillator that the fellow at the other end will invariably assume that you are using one . . . until you show him how you can go blithely zipping around the band (*not* with the key down).

The heart of the system is a 160-meter high C push-pull oscillator that is very lightly

* Editor, RADIO.

Rear view of the unit. The oscillator components are to the right, the amplifier components to the left. Oscillator components must be firmly supported.

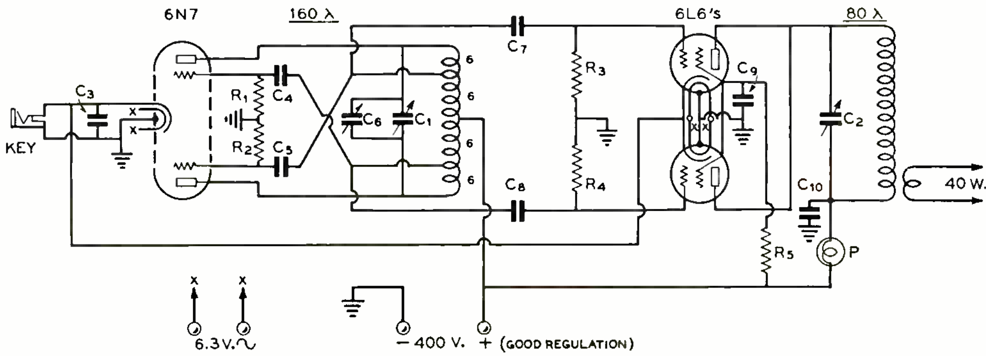


Figure 1.

Wiring diagram of the 80-meter v.f. transmitter.

C_1—365 or 375-μμfd. b.c. type variable condenser with adjusting screw on mica trimmer removed. Condenser is insulated from chassis.

C_2—100-μμfd. midget variable (insulated from chassis).
C_3—.01-μfd. 600 volt tubular.
C_4, C_5—100-μμfd. midget mica fixed condensers.
C_6—100-μμfd. midget variable (insulated from chassis)
C_7, C_8—50-μμfd. midget mica fixed condensers
C_9, C_{10}—.01-μfd. 600 volt tubular condensers
R_1, R_2—50,000 ohm 1½ watt resistor
R_3, R_4—150,000 ohm 1½ watt resistor
R_5—5000 ohms, 10 watts
P—6.3 volt 250 ma. dial light
Coils—See text

loaded and exhibits exceptional stability. A push-push doubler consisting of a pair of 6L6's provides excellent isolation due to the fact that the plate tank is on twice frequency and because the 6L6's require so little excitation and therefore are loosely coupled to the oscillator. There is very little reaction on the oscillator frequency when coupling or tuning adjustments are made in the antenna system.

The entire unit including tubes but less power supply can be built for about ten dollars. To keep the cost down a 6.3-volt 250-ma. flashlight bulb (type 44, 46, etc.) is used to indicate resonance and approximate plate current to the 6L6's. These bulbs can easily be identified by the color of bead, which is blue for this rating. If you have some 6.3-volt panel bulbs kicking around but can find no markings to indicate their type number, you can be sure they are 250-ma. bulbs if they have a blue head. They glow visibly at 75 ma. and light up brightly at 150 ma.

Construction

The unit is constructed on a 7 x 11 x 2 inch chassis to which is fastened a 7 x 12 inch front panel. The suggested layout of components is shown in the illustrations, though other arrangements should work equally well.

The variable condenser C_1 is insulated from the metal chassis by means of small standoff insulators. Be sure to remove the adjusting screw on the small mica trimmer on this condenser (assuming it has one). If this is not done the condenser may arc through the mica or possibly cause frequency drift.

The oscillator tuning condenser, C_6, is mounted by means of the small bracket furnished by the manufacturer as an accessory. This bracket fastens to the ceramic portion of the midget condenser and permits both sides of the condenser to be "hot." The 6L6 plate tuning condenser, C_2, is mounted likewise. Both are tuned from the front panel by means of insulated couplings and extension shafts.

Coils

Both coils are wound on 1½-inch outside diameter bakelite tubing. A 2-inch length of tubing is used for the oscillator coil and a 2¾ inch length for the amplifier coil. As the transmitter is designed for use only on one band, there is no point in using plug-in coils. In fact, it is possible to obtain higher Q in the oscillator coil (with a resulting increase in stability) by using the type of oscillator coil shown, instead of the usual plug-in coil. With plug-in coils it is customary to run the various leads and taps down inside the coil, and the coil is butted up against a metal chassis. As a result the Q is lowered considerably, and while ordinarily it might not be serious, we want just as high a Q as we can get in the tank coil of a self-excited oscillator.

The oscillator coil consists of 24 turns of no. 20 d.c.c. close-wound but not tightly pressed together on the shorter of the two 1½-inch bakelite forms. It should be mounted parallel to the chassis on ¾-inch insulators as shown in the illustration. This coil is tapped in the center and midway between the center and either end, as shown in figure 1. This means that in winding the coil a tap should be made every sixth turn. Be sure the taps do not short against the adjacent turns.

All oscillator components: padding condenser, tuning condenser, tank coil, etc. should be mounted rigidly and wired with heavy wire to prevent vibration.

The matter of Q is not quite so important in the amplifier plate coil; so it is treated differently. 33 turns of no. 20 d.c.c. are close-wound at one end of the 1½-inch diameter form and brackets are attached to the other end to permit mounting of the coil vertically as shown in the illustration. The lead to the top of the coil may be run down inside the form if desired, even though this practice was scrupulously avoided in the oscillator coil.

Two, pillar-type standoff insulators are mounted a short distance from the amplifier coil to act as supports and terminals for the antenna pickup coil. The pickup coil will consist of from 2 to 12 turns of pushback hookup wire, depending upon the type of antenna and feed system. The coupling is varied by adjusting the position of the coil with respect to the tank coil after the approximately correct number of turns has first been determined. The pickup coil fits loosely over the plate coil and can be slid up and down the form. Maximum coupling will occur with the pickup coil placed around the exact center of the plate coil. Coupling is reduced by sliding the pickup coil towards the ground (cold) end of the coil.

If it is impossible to obtain enough coupling by adjustment of the pickup coil, add more turns. If you cannot reduce it sufficiently without sliding the pickup coil clear down to one end of the form, reduce the number of pickup turns.

Particular care must be taken in wiring the keying circuit, as it may be a bit confusing. Note that the cathodes of all three tubes connect together and are by-passed to ground by C_3.

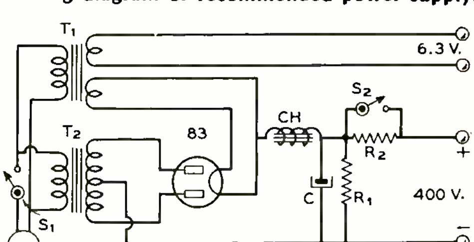
It is also important to ground the shells of the tubes. Make sure a ground connection is made to the shell connection on all three sockets.

The resonance or current indicator, P, is mounted by means of a rubber grommet just large enough to permit a "squeeze fit" of the panel bulb. Connections are soldered directly to the base of the bulb. An inexpensive yet neat job is the result. The bulb may be seen midway between the two tuning knobs.

As there appeared to be no particular reason for putting the key jack on the front panel, it was placed on the rear drop of the chassis along with the power socket. However, it could just as well be placed on the front panel.

Figure 2.

Wiring diagram of recommended power supply.

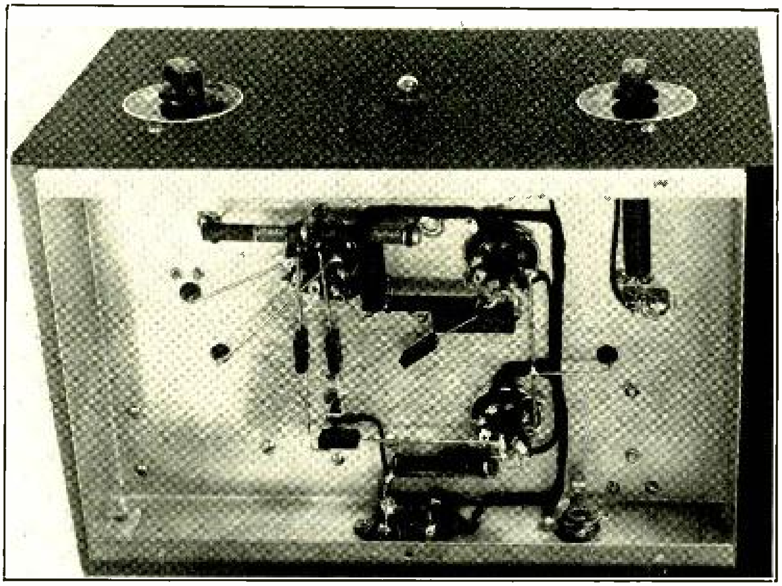


T1—5 v. 3 amp. and 6.3 v. 3 amp. or more
T2—500 to 525 v. each side c.t., 200 ma. or more
CH—5-25 hy. 200 ma. swinging choke, not over 125 ohms.
C—8-µfd. 450 volt working voltage electrolytic
R1—20,000 ohms, 20 watts
R2—20,000 ohms, 10 watts
S1, S2—Regular house type toggle switches

Power Supply

While the oscillator is sufficiently stable that there is very little change in the frequency with variations in plate voltage, some change is unavoidable. Therefore, to obtain the best possible note and keying, the power supply must have the best possible regulation. If the power supply does not have good regulation, the voltage will rise to a very high value when the key is up and then discharge each time the key is depressed. If the discharge were instantaneous this would not be serious except possibly from the standpoint of clicks. However, the discharge is not instantaneous, due to the storage ability of the filter condensers. This is the reason a keyed oscillator will "yoop" badly with a poorly regulated power supply unless it has an excellent plate voltage vs. frequency characteristic.

The power supply of figure 2 is strongly recommended. The supply delivers close to 400 volts under load and the voltage does



Showing front panel layout and arrangement of parts on under side of chassis. The keying jack may be placed on the front panel instead of on the rear of the chassis if desired.

not rise appreciably with no load. With poorly designed power supplies the variation in voltage from full load to no load may be as much as 100 per cent of the full load voltage.

The switch S_2 and resistor R_2 permit the application of very low plate voltage to the unit for the purpose of spotting your frequency on your receiver dial. With full voltage applied, the output is usually sufficient to block the receiver and make it difficult to locate yourself accurately on the receiver dial. It also permits you to place the rig on a predetermined frequency or spot on your receiver dial without causing QRM while you tune the oscillator condenser. If you should adjust C_6 with full voltage applied to the transmitter it would probably cause a certain amount of interference.

When you have spotted yourself to your satisfaction, close S_2, restore C_2 to resonance if necessary, and you are ready to go. If you move very far in the band it may be necessary to readjust the antenna coupling, but for moderate changes in frequency this will not be necessary.

For convenience switch S_2 should be mounted so that it is easily accessible from the operating position. Make sure both the switch and connecting wires will stand the voltage safely.

Tuning

When firing up the transmitter for the first time, the padding condenser C_1 must be adjusted. The rotor of this condenser is "hot" with r.f.; so if you want to adjust it without turning off the voltage or opening the key it will be necessary to put a small tuning knob on the shaft. This condenser should be adjusted so that the 80-meter c.w. band is "centered" on the tuning condenser, C_6. This should occur with the plates of C_1 nearly all the way in. If this does not occur, the turns of the oscillator coil should be spread or compressed until this condition is satisfied. It will be found that there will be a small overlap on either end of the band, and care must be taken to avoid out-of-band operation. If you should land in the phone band you will simply incur the indignation of the phone brethern; but if you should wander below 3500 kc., you might find the results disastrous.

With a superheterodyne, you must be especially careful in making the initial adjustment of C_1. If you are not careful you might be entertaining an image instead of the fundamental, because they both will be so loud that you can't easily distinguish between them. Opening switch S_2 on the power supply will reduce the strength of the signal sufficiently that you can tell just what you are doing. If the receiver has a good image ratio the fundamental or true signal will be much louder

[*Continued on Page 162*]

How to Operate

TRANSMITTING TUBES

By HARNER SELVIDGE, *W9BOE

Rumor has it that somewhere in these United States there is a ham who is operating a pair of T20's with 2500 volts on their plates. Since the T20 is rated with a maximum plate voltage of 750 volts, the manufacturer of these tubes is momentarily expecting confirmation of this rumor in the form of a letter from the aforesaid ham stating that he has a couple of T20's that he has used for a few months and they have gone bad on him in spite of the fact that he never let the plate get more than a dull red, and thus has never overloaded them. This is the sort of thing that makes tube engineers wear that peculiar look of baffled chagrin.

There once was a time when this sort of thing was excusable. Those were the days when the average ham got his transmitting tube second or third hand, and the only guide as to how to operate it was how much plate voltage the last owner used and got away with. But now we find that in spite of the very complete ratings available on most types of tubes, some misguided amateurs will put a tube in a transmitter and operate it under conditions not specified by the manufacturer, without the slightest idea of what they are doing, and what the consequences will be. The purpose of this article is to explain a little about how and why the manufacturer has rated the tube as he has, *and* to give some idea of how to operate the tube under conditions *not* specified in the ratings, and still get satisfactory results, both in performance and tube life.

A transmitting tube should have two types of ratings. They are usually listed in the tube data sheets as "Maximum Ratings" and "Typical Operating Conditions." Let us take a look at the former (see table I). We generally find that it consists of a list of maximum values for d.c. plate voltage, d.c. plate current, d.c. grid voltage, d.c. grid current, plate dissipation, and sometimes plate input. These are specified by the manufacturer as being values which should not be exceeded. When one of them is reached, it is the time to stop, even though some of the other values are below the maximum ratings.

Maximum Plate Voltage Rating

Let us first see what is behind this maximum d.c. plate voltage rating. Originally, maximum plate voltage ratings were limited largely by insulation problems in the base and the glass press on the tube, but modern high frequency tubes usually have their plate lead coming out the top of the bulb, with the result that voltage break-down within the tube is not so easy, providing leakage paths are kept at a minimum by the choice of proper internal insulation in the tube. However, high voltages usually mean high plate inputs and large peak plate currents, and this means that the life of the tube will be materially shortened. When high voltages are used at high frequencies, trouble is sometimes encountered from rapidly moving electrons which are attracted to the plate, but due to the mechanical construction of the elements, miss the plate, and go on to strike the glass walls of the tube. This may make a hot spot that will melt the glass and make a hole in the envelope at that spot. Some tubes are now made with the plate almost entirely enclosing the filament and grid structure to avoid this difficulty at high voltage and high frequency.

Plate Current Ratings

Providing the plate will dissipate the heat, the maximum plate current rating is determined by the size of the filament in the

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tube, and the life that is desired. This value is far below the maximum current that the filament is capable of giving. For example, a tube may have a maximum d.c. plate current rating of 150 milliamperes, and yet the filament may be capable of giving 2000 milliamperes of emission. That may seem to be a ridiculous safety factor, but it must be remembered that with a d.c. plate current of 150 milliamperes for class C telegraph, the peak value of the plate current at the crest of the r.f. cycle may be as high as 600 milliamperes. To this must be added some 100 milliamperes of peak grid current, making a total space current of 700 milliamperes on the peaks, with the filament capable of 2000 milliamperes total emission. There is still a good sized safety factor since we want to have some emission to spare for the time somewhere in the future when the filament will not give off electrons as generously as when it was new. It is also true that the filament will last longer if it is used in a restrained fashion, and not required to give its "all" every cycle of r.f.

For the plate modulated amplifier, the plate voltage is doubled on the peaks at 100% modulation, and this results in higher peak currents. It will therefore be noted that in the telephone ratings, either the d.c. plate voltage or the d.c. plate current are less than those specified for telegraph operation. In this case, not only do we wish to safeguard the life of the tube, but also to avoid flattening off the positive modulation peaks, a thing which would result if emission saturation were reached on the peaks in the audio frequency cycle.

Maximum D.C. Grid Voltage

The maximum d.c. grid voltage is a value that is specified mainly to prevent breakdown of the insulating material around the grid lead. The d.c. grid voltage of itself will cause no difficulty, but the higher the bias voltage, the higher must be the r.f. driving voltage, and tne losses in the glass around the grid lead may be enough to cause overheating and voltage breakdown, particularly at very high frequencies. The maximum peak r.f. driving voltage might be specified instead, since it is superimposed on the d.c. grid voltage, but that is not done because the average tube user does not have the vacuum tube voltmeter necessary to measure it.

D.C. Grid Current Rating

The maximum d.c. grid current is largely determined by the amount of power that the grid can dissipate. If the grid current is too high, the grid may get hot enough to emit electrons or perhaps even melt, either alternative being an undesirable one. In addition, the added heat radiated from the grid will throw an extra load on the thermal capacity of the plate. Sometimes the maximum value of the r.f. grid current is also specified. This may be several amperes, while the d.c. value is only a few milliamperes. If this maximum r.f. value is exceeded, the usual result is overheating of the glass seal where the grid enters the tube, or perhaps even melting of the grid leak itself. This effect is usually encountered at ultra high frequencies, and sometimes also happens to the plate lead in the event of a powerful ultra high frequency parasitic oscillation.

Plate Dissipation

It is sometimes found that when the values of the maximum permissible d.c. plate voltage and d.c. plate current are used in operating the tube, the plate input would be so large that the plate dissipation would be excessive. Therefore the value of maximum plate dissipation is sometimes specified under maximum ratings. Even if it is not mentioned, it is a good idea to confine operation to values of plate input that will not cause the rated plate dissipation to be exceeded. A transmitting tube is not a perfect converter of electrical energy, and we find that if we feed 100 watts of d.c. power into the tube, we may get only 75 watts of r.f. out. The missing 25 watts is lost in the tube, and appears at the plate in the form of heat. The plate must be able to radiate and get rid of this heat so that it will not damage the tube. If this excess heat were not disposed of properly it would raise the temperature of the elements and glass in the tube so that they might get hot enough to emit electrons, and emission from such unexpected places is a distinctly undesirable feature, to say nothing of the possibility of these parts getting hot enough to melt. Every element inside a tube no matter what its material, whether metal, glass, ceramic or otherwise is a potential source of gas if it is heated hot enough, and excessive heat for long periods of time may cause gas to appear in the hardest tube.

If you just can't help exceeding the manufacturer's maximum ratings on a tube, the safest one to pass is probably the plate dissipation. In the first place, a reliable manufacturer will have furnished you with a tube that will be quite free from gas and the rise in tube temperature which accompanies a small excess in plate dissipation will probably not cause gas to appear. This is particularly true for c.w. operation where you can sometimes get away with a considerable overload providing the key is not held down for dashes long enough to let the plate have time to get hot. More care must be taken for telephony, and if you are exceeding *any* ratings it is important to tune the transmitter with reduced power, so that momentary peak overloads encountered in out-of-resonance circuits will be reduced to reasonable values. Providing gas is not released, or emission encountered from elements other than the filament, tube life is not likely to be shortened from plate overload. However, exceeding maximum rated d.c. plate voltage or d.c. plate current is almost sure to cause reduced life.

Tube Life

In this connection it should be pointed out that in spite of all the care that goes into the manufacturing processes, two tubes of the same type may have widely different lives. Once in a while we find a tube with a very short life, and again we find them that apparently just never wear out. Remember that the fellow who says you can exceed the ratings on a particular tube and get swell life, may have had one of those super long-life bottles that the law of averages tosses out once in a while. The manufacturer has put out a rating on his tube that experience has shown will give the most satisfactory performance and reasonable life. Remember that when he found out that a particular current or voltage was too high, all he had to do was to take down a new tube from the shelf and toss the old one in the ash can, and it is suggested that unless you have an unlimited stock of spares or the wherewithal to get them, that you accept his maximum ratings.

Of course, some may reason that since tubes are relatively cheap these days, it is worth while to overload them and accept a shortened life, but a little pencil work will usually show the economical advantage of spending a little more for a larger tube in the first place, and operating it in a conservative fashion. Bear in mind that when you keep within the ratings, tube life can be fairly accurately predicted, but as soon as these ratings are exceeded, all the rules are off, and there is no way of telling just how much life will be lost by a 15% overload, for example. The reduction in tube life might be as low as 10% with certain tubes in certain applications and again it could easily be as high as 60 to 75% where the maximum ratings of the tubes were not too conservative.

Filament Voltage

There is one point that is too often overlooked in operating transmitting tubes. The owner will take great pains to get the plate voltage and the grid voltages just right, and have all current readings just so, and then pay no attention at all to the filament rating given for the tube. A tube that is designed to operate with a filament voltage of 7.5 volts, should be operated with a voltage of 7.5 *at the tube socket.* A cheap transformer labeled at 7.5 volts and connected to the tube socket with no. 18 or no. 20 wires about three feet long is no assurance that the tube is getting the proper voltage. Measure it at the socket with a reliable meter. Bear in mind that an ordinary copper oxide rectifier meter may be out by 10% or 15% and this will make a serious difference in the tube life. You would be surprised at the number of ailing rigs that are called to the attention of the tube manufacturer that are found to have low filament voltage in addition to other troubles. Good tube insurance is to get reliable transformers and mount them near the tubes and connect them to the sockets with heavy wire, and then check with a voltmeter if possible.

Typical Operating Conditions

Having given warning as to the limits to which a tube can be operated, the manufacturer then gives what are usually called typical operating conditions for that particular tube for various services. These are complete operating data for conditions that the manufacturer feels will be satisfactory for the average user. As an example, the complete class C ratings for the new TW-150[1] are given in table I. This illustration is given so as to have some numerical values to talk about and the discussion that follows will apply just as well to any other tube whether larger or smaller. Let us first look at the c.w. rating. Three different conditions for typical operating conditions are given, corresponding to plate voltages of 2000, 2500 and 3000 volts. For this particular tube the highest plate voltage and current given are the same as the maximum permissible values, although this is not always done in rating tubes. It will be seen that the higher the plate voltage the higher the negative bias that is used. The output goes up, as well as the driving power and efficiency. With the d.c. plate and grid voltage as specified, the excitation should be adjusted to give the rated

[1] The TW-150 is a thin-wall carbon plate triode with a mu of 35.

TABLE I

TW-150 CLASS C RATINGS

Telegraphy

Maximum Ratings

D.C. Plate Voltage	3000 Volts
D.C. Plate Current	200 Milliamperes
D.C. Grid Voltage	—600 Volts
D.C. Grid Current	60 Milliamperes
Plate Dissipation	150 Watts

Typical Operating Conditions

D.C. Plate Voltage	2000	2500	3000 Volts
D.C. Plate Current	200	200	200 Milliamperes
D.C. Grid Current	46	45	45 Milliamperes
D.C. Grid Voltage	—90	—120	—170 Volts
Plate Dissipation	110	130	130 Watts
Power Output	290	370	470 Watts
Plate Efficiency	73%	74%	78%
Driving Power	13	14	17 Watts

Telephony

Maximum Ratings (carrier)

D.C. Plate Voltage	3000 Volts
D.C. Plate Current	200 Milliamperes
D.C. Grid Voltage	—600 Volts
D.C. Grid Current	60 Milliamperes
Plate Dissipation	110 Watts

Typical Operating Conditions (carrier)

D.C. Plate Voltage	2000	2500	3000 Volts
D.C. Plate Current	200	185	165 Milliamperes
D.C. Grid Current	46	44	40 Milliamperes
D.C. Grid Voltage	—140	—200	—260 Volts
Plate Dissipation	105	100	95 Watts
Power Output	295	360	400 Watts
Driving Power	16	17	17 Watts

TABLE II

TW-150 CLASS C TELEGRAPH RATINGS

	A Regular Rating From Table I	B High Efficiency Ratings	C High Efficiency Ratings	D Low Driving Power Rating
D.C. Plate Voltage	2500	3000	2500	2500 Volts
D.C. Plate Current	200	167	200	200 Milliamperes
D.C. Grid Current	45	40	47	43 Milliamperes
D.C. Grid Voltage	—120	—260	—350	—71 Volts
Plate Dissipation	130	95	100	140 Watts
Power Output	370	405	400	360 Watts
Efficiency	74%	81%	80%	72%
Grid Driving Power	14	17	26	11 Watts

grid current and the output loading adjusted to give the rated plate current. If these conditions can be exactly duplicated in the transmitter and the circuits are of the customary efficiency, the power output and plate dissipation will be as specified.

Operation at Other Than Typical Conditions

In general there are likely to be two reasons why one would like to operate a tube at other ratings than those given. First, a very high efficiency might be demanded. This might be the case if two of these tubes were operated with the maximum legal input of 1000 watts. To get the most out, with this restricted input, demands the maximum possible efficiency. Referring to table I, we find that we have 500 watts input per tube with 2500 volts on the plate, each tube drawing 200 milliamperes. The efficiency is 74% giving an output of 740 watts for the two tubes. The question is, how shall we improve the efficiency without exceeding the ratings?

The matter of efficiency is tied in with plate voltage and grid bias. We get high efficiency with high plate voltage, and high negative grid bias. If, in this particular case, we have more plate voltage available we may increase both the plate voltage and bias, but reducing the plate current to stay within the legal 1000 watts input. Let us take first of all a plate voltage of 3000. The plate current per tube will have to be 167 milliamperes. A rating under these conditions may look something like the figures shown in column B of table II. It will be seen that with this voltage and current rating, the grid bias must be increased to about —260 volts, and the efficiency has increased from 75% to 81%, with an increase in driving power from 14 to 17 watts. If the grid bias were increased another 100 volts, the efficiency would increase about 2% and the driving power would go up to 20 watts. It it seen that extra watts come hard.

Let us now see what can be done with the plate voltage 2500 volts and the plate current 200 milliamperes per tube. If we increase the grid bias to —350 volts, we get the results shown in column C; an efficiency of 80% with a driving power of 26 watts. It will be seen that the driving power goes up more rapidly with increased bias, if the plate voltage is not also increased. Operation of a tube at high efficiency under conditions not given by the manufacturer is accomplished in actual practice by increasing the negative grid bias some 100% or more, while increasing the excitation enough to keep the d.c. grid current at approximately the same value as before. The plate voltage may or may not be raised also.

The second reason for wanting to deviate from the manufacturers' typical operating conditions might be lack of sufficient driving power. This can be helped by operating the tube at a lower value of negative grid bias, which will result in lowered efficiency but will cut the driving power down. Taking our case again of 2500 volts on the plate and 200 milliamperes plate current, with a driving power of 14 watts per tube (column A, table II) let us change the bias from —120 to —71 volts, which is about the cut-off value, thus making the tube operate more like a class B amplifier. We find that the efficiency has dropped to 72% while the driving power has fallen to 11 watts.

In case it is desired to operate the tube at plate voltages other than those specified, the values of grid voltage, power output and driving power can usually roughly be estimated by referring to the values given for normal ratings, and noting the trend of the various values.

Ratings for Telephony

For class C telephone service, it will be noted that the plate input is reduced from the maximum ratings and typical operating conditions for class C telegraph. This is to take care of the increased plate dissipation that is present when the tube is modulated, and to reduce the high peak current that flows during the peaks of the modulation cycle. When the tube is modulated with 100% modulation and sine wave audio, the power input to the tube is increased 50%. Since the plate efficiency will stay approximately constant during modulation, this means that the plate dissipation will be 50% greater than during carrier conditions. So strictly speaking the plate dissipation rating for carrier conditions should be 100 watts for a plate capable of dissipating 150 watts. However, due to the intermittent nature of speech, a reduction as large as this is seldom made in practice, it being more common to reduce the plate rating about 25% instead of 33%. This explains the carrier rating of 110 watts maximum plate dissipation rating of the TW-150. While the tube carries the same maximum rating of plate voltage and plate current as for telegraph operation, it is not recommended that the tube be operated at the limit of both of these ratings at the same time, as the rated maximum plate dissipation may be exceeded. One or the other of these values should be reduced as is done in typical operating conditions.

The negative grid bias is also increased for telephony. This increases the linearity of the tube when it is modulated. For best linearity, the bias should be supplied partly by grid leak and part by battery, the battery commonly being of a size that will keep the plate current down to a safe value in case of loss of excitation. However, quite satisfactory results are usually obtained from the use of grid leak alone for modulated class C amplifier bias. Operating under conditions different than those specified under typical operating conditions can be obtained in a manner similar to the c.w. case.

If you have any doubts about any particular way in which you wish to operate your tubes, write the manufacturer clearly stating your particular problem, and he will be glad to suggest a solution. His success depends upon your satisfaction, and a tube operated properly and within its maximum ratings usually gives the most satisfactory results.

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RADIO's production office is located on *Crystal* Street, E. Stroudsburg, Pa.

Results of

Chicago Emergency Field Day

By VICTOR RUEBHAUSEN, W9QDA

When Al Knodell, W9TLQ, chairman of the interclub activities committee of the Chicago Area Radio Club Council, suggested a Chicago Emergency Field Day, the Council although believing it difficult actually to simulate emergency conditions, decided in favor of holding the event. W9TLQ drew up the plans for the day and provided a scoring system which would be certain of creating and holding the interest of the participating clubs and at the same time would indicate to the Council exactly what type of equipment and which procedure proved the most effective under conditions similar to those of an emergency.

Several months before the field day was to be held eight Chicago Area Radio Clubs had filed entrance requests for competition in the event. These clubs were advised by the committee that this field day would be held on some unannounced Sunday in October. Twenty-four hours before the supposed emergency was to be called each club would be advised. Actual operations from a portable location were to be started at 9 a.m. on the particular Sunday, but under no circumstances was any club to authorize preparations at such a portable location before 8 a.m. on the field day.

During the summer months the eight com-

The control station crew at W9TLQ/9 during the CARCC Emergency Field Day. Reading from left to right the operators are: Al Knodell, W9TLQ; Ned Beatty, W9ZCH; Captain Michaels, N9QNS; Herb Hamilton, W9MRQ; Fred Garner, W9WDM; Howard Hinman, W9HLB; Bill Holst, W9MD; Art Olson, W9SDV; Bill Titus, W9JZY; Joe Munizza, W9SRZ; Glen Rogers, W9ASX.

CBS supplied the Illinois Ham Club with the de luxe operating headquarters shown in this photo. The club furnished the portable transmitters which were set up inside the trailer and which used the motor-generator supply of the trailer as a source of power.

peting clubs assembled, constructed and groomed their portable gear to assure efficiency when the day for its use arrived. In the meantime Chicago newspapers carried short articles advising the public concerning the activities of their local amateurs in the nature of making preparations in the event that there should be an actual emergency within that area.

As October neared considerable public interest was expressed in the field day to come. The Hallicrafters, Inc., volunteered all the receivers necessary at the key station to monitor all participants operating in the field. The Columbia Broadcasting System offered their mobile trailer with its power accessories to the Illinois Ham Club. Privately owned parks were made available for club operations should they prove advantageous for such work.

The field day was called for October 15 and W9TLQ must have had a rendezvous with the weather man for never could there have been a more ideal day to work outdoors.

The key station, W9TLQ portable, was set up at Belmont Harbor on the Chicago Lake Front and operated on phone on a frequency of 1887 kc. with 400 watts input. Eight receivers were used tuned to the transmitting frequencies of the eight competing clubs. One operator at the key station did nothing but operate the transmitter. Another operator devoted his entire time to keeping a log of all transmissions. The key station transmitter was on the air a total of 162 times during the period between 9 a.m. and 5 p.m.

In the field, members of the eight competing clubs scrambled with balky gasoline driven generators and tried nobly to maintain the same line voltages to the receivers when the transmitters were switched on and off. Reports of blown rectifier tubes and filter condensers were quite numerous after the field day had become history.

The 14 members of the Illinois Ham Club present in the field activities made certain that hunger would not be the emergency as they provided 14 husky steaks to keep the energy at its peak. Little did they realize that steaks and emergencies did not mix, for no sooner were those steaks sizzling on the fire when the order boomed from the speaker, "Attention all participating clubs, you are now to move to another location at least one mile from the present one." The speaker boomed forth more sad news, "Participants not reporting in from their new location within 20 minutes will be penalized in points." Needless to say the steaks were consumed by the members before moving to the new location and the penalty accepted.

The names and calls of the eight competing clubs were: Illinois Ham Club, W9SG; Austin Radio Club, W9LTC; Northwest Radio Club, W9GTM; Chicago Radio Traffic Association, W9TXU; York Radio Club, W9TGB; Hamfesters Radio Club, W9TFA; Tri-Town Radio Club, W9MWJ; Chicago Suburban Radio Association, W9PNV.

As would be expected there were many difficulties encountered both in the field and at

[*Continued on Page 164*]

A Compromise on QSY

By HARRY G. BURNETT,* W1LZ

A description of a method involving only a change in the interstage coupling and retuning procedure whereby wide frequency coverage without retuning may be had in the conventional high-frequency c.w. transmitter

There are two extremes to which we may resort in this matter of rapidity of frequency shifting. We may utilize a complicated system of switches, ganged tuning condensers, padder condensers, relays, pretuned tanks, tanks designed for very flat resonance curves, electron-coupled oscillators, variable-gap crystal holders, and so forth—or we may turn away in dismay from such an array of complexities and decide to remain more or less on one pet frequency and to retune the whole transmitter in the old-fashioned way when we wish to QSY.

If we choose the latter method, and if we happen to be interested in 14-Mc. dx, we shall soon discover that we have seriously handicapped ourselves, and that our more enterprising friends who chose the former solution are working the dx we are calling. This unfortunate stage of affairs may well lead us to change our minds and to attempt to make some improvements which will permit us to approximate at least the superior results attained by our more ambitious competitors.

May I suggest an examination of the following as a practicable, simple, cheap, and wholly satisfactory solution to our dilemma. It is, of course, a specific answer to the problem, applicable in exact detail only to transmitters similar to the one to be described. However, the simple ideas behind the method to be proposed can, I feel sure, let us be specific about this compromise solution and let us consider how a few easy concepts help to make my transmitter more flexible.

* 16 Windsor Road, Somerville, Mass.

My transmitter consists of the following tubes: 53 oscillator and doubler; 6L6G doubler; 242A driver; and HK354 final amplifier. Because I am interested primarily in 14-Mc. dx and because I find that I spend 80 to 90 per cent of my operating time on the frequencies between 14,250 kc. and 14,400 kc., it is my desire to develop as much speed as possible in shifting the frequency of the transmitter within this comparatively narrow band. Since the transmitter happens to be completely link coupled, with nine tuned circuits from oscillator to antenna, it would appear that QSY, even within this small frequency range, might offer a problem. It certainly does, if one is forced to tune all nine circuits every time one changes frequency. However, relatively flat resonance over this band is obtained in the cases of all tuned circuits up to and including the grid condenser of the 242A stage by making the L/C ratio of these tanks high, and by coupling the related tuned circuits tightly.

Beginning with the plate tank of the 242A stage there arises the necessity for a more exacting treatment of the tuning problem. Nevertheless, the procedure which I have found satisfactory for smoothing out this difficulty is simple. It is not done with the proverbial mirrors, but the solution is almost as mystifyingly facile. It is accomplished by applying some commonly known facts about the resonance of simple tuned circuits.

To hark back to the days of self-excited oscillators, you will remember that we were urged not to tune the antenna tank circuit to exact resonance with the plate tank circuit,

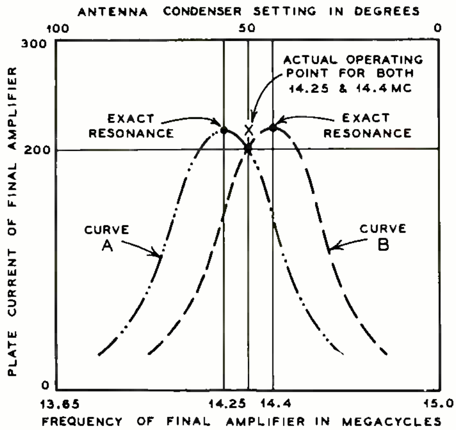


Diagram representing as closely as possible the effect of overcoupling the two tuned circuits to give a semi-flat top effect between the two peaks.

because doing so would encourage frequency instability. Instead, we were told to increase the antenna coupling beyond the normal point, and then to back the antenna condenser off from the setting for exact resonance until the plate current was again at the lower, proper operating value.

Later, when we changed to crystal-controlled transmitters there was no longer any reason for tuning the antenna slightly off resonance, and so we proceeded to tune the antenna condenser and to adjust the antenna coupling simultaneously until a condition was reached where tuning the antenna codenser away from the resonant point in either direction produced a fall in the plate current of the final amplifier. Still later, we applied the same methods of tuning to exact resonance when we began to adjust our driver plate and amplifier grid tanks, employing link coupling. Thus, we trained ourselves to think in terms of exact resonance between two coupled circuits.

You may have noticed, however, while adjusting the coupling between your driver plate tank and your amplifier grid tank that the grid current remains the same whether you tune the two circuits to exact resonance, or overcouple them and detune the grid circuit slightly. In other words, you have probably concluded that, although an overcoupled, slightly detuned grid tank may not be perfect theoretically speaking, it makes no difference in practice whether this circuit is tuned to absolute resonance with that of the driver plate, or not. Can we take advantage of this non-hypercritical condition?

We can, in a very simple way. To return to my transmitter and the problem of making the 242A plate tank and the HK354 grid tank remain in resonance at, say, the widely separated frequencies of 14,250 kc. and 14,400 kc., we find here an application. If we switch in the 14,250-kc. crystal, overcouple the link line between the driver and the final a bit, and proceed to tune the final grid condenser to obtain normal grid current, we note that we can obtain the correct grid current by tuning the grid condenser to either the high or the low capacity side of perfect resonance. Let us set the grid condenser so that the correct grid current is flowing with the condenser tuned to the low capacity side of exact resonance. Now let us remove the present crystal from its circuit and switch in the 14,400-kc. one. When we apply plate voltage to the 242A again we may find that its plate tank is not in perfect resonance for this frequency. A slight adjustment of both the link coupling and the grid condenser will bring the plate tank into resonance again.

Back we go to the first crystal; and we check the plate resonance again. By careful adjustment of the link coupling and the grid condenser it becomes evident that it is easy to discover a degree of coupling which will permit permanent settings of both the plate and the grid condensers to obtain resonance with either crystal. Of course, in the case of the 14,250-kc. crystal the grid condenser will be tuned to the low capacity side of the truly resonant setting; and in the case of the higher frequency crystal the grid condenser will be tuned to the high capacity side of the settings for perfect resonance. But, actually the two settings of the grid condenser will be one and the same; and thus we may switch in either crystal and we shall find that the plate circuit of the 242A and the HK354 grid tank are always in resonance.

Now that we have taken care of these two tuned circuits, let us apply the same tactical approach to attain permanent resonance on either frequency for the final plate tank and the zeppelin antenna tank. By this same cut-and-try method of tuning carefully the plate tank and the zeppelin tank condensers, and by simultaneously adjusting the degree of overcoupling between the plate circuit and the antenna link line we shall discover that there is a degree of overcoupling which permits the too low (for exact resonance) capacity setting of the antenna condenser for the 14,250-kc. frequency to match perfectly the too high (for exact resonance) capacity setting for the 14,400-kc. frequency.

[*Continued on Page 102*]

● A mother and daughter team in a really radio-minded family—Lucile Allingham (left), W7FXE, is the wife and Marjory Allingham (right), W7HER is the daughter of William Allingham, W7KY. Marjory obtained her license when she was 13 but could copy 10 per when she was five. Her transmitter is on 160 phone, W7FXE's is on 40 c.w., and the om's is on 20 phone.

Radio's 1940 YL Section

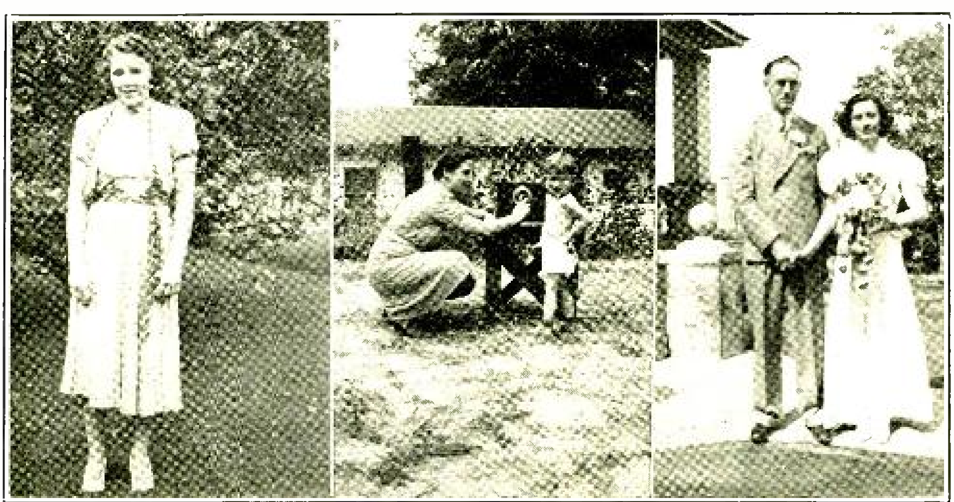
For the third consecutive year RADIO presents in its annual yearbook issue a section devoted to the activities and interests of yl amateurs.

● Mrs. E. C. Hamilton, W9OWQ, obtained her license when she was fifty years of age. She operates c.w. only on ten, twenty, and forty; made WAC and WAS several years ago; and is a member of the 210 DX Club. Radio is her only hobby; keeping skeds with Sedalia amateurs who are attending colleges in other states is her most gratifying activity.

● Kathryn Porter (below) W5GKH, holds a Telephone First commercial ticket in addition to her amateur class A. She operates both phone and c.w. with a 35T plate modulated in the final amplifier; 40 is her preference for c.w. and 10 for phone. She has had experience as a studio control engineer which is rather unusual for a yl.

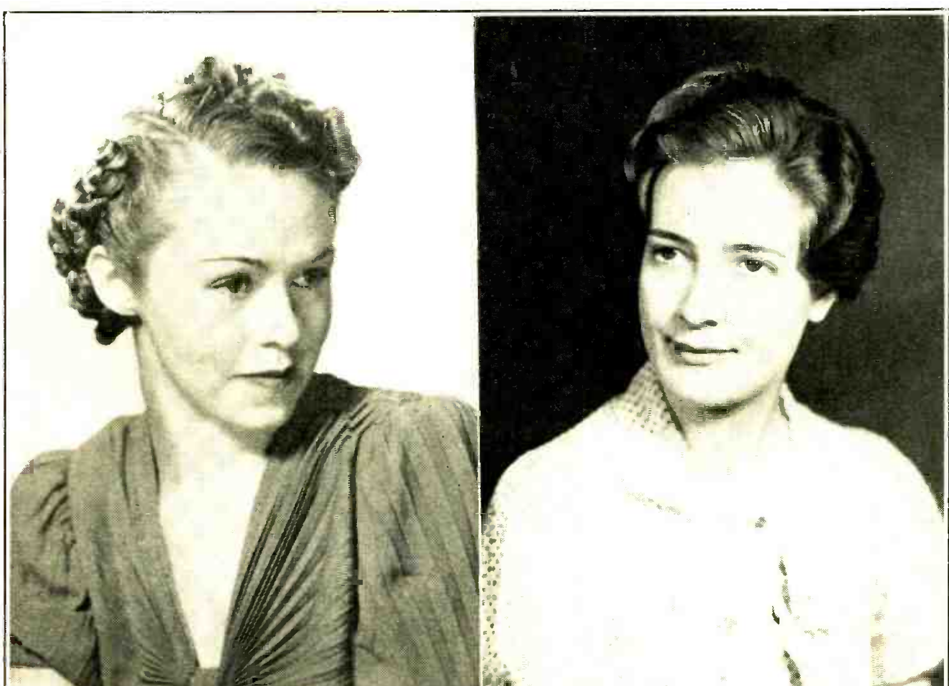
● Frances Morgan (above), W7GSR, obtained her license at the same time as her om, W7GNY; as a matter of fact they studied for their licenses together and went down together but Frances did not apply for her station license until sometime later than the om. The two of them are quite well known as a team on 160-meter phone where they spend most of their operating time.

● Mrs. Nell B. Coil W9MSW (left), holds a class-A ticket. She has been licensed since 1933 and now operates mostly on ten-meter phone. Priscilla C. Bellew, W5HBW, (center) usually signs her husband's call, W5FWD, on phone. She is shown here with her son, David. Mrs. Wallace V. Rockefeller, W9UBM, is shown on her wedding day in the picture at the right. The groom is W9TIP, whom she met via amateur radio.



● Ruth E. Raub, W8-ROP, who is a registered nurse by vocation, shown with Dr. Hard, XE1GE, at the 1938 National ARRL Convention in Chicago.

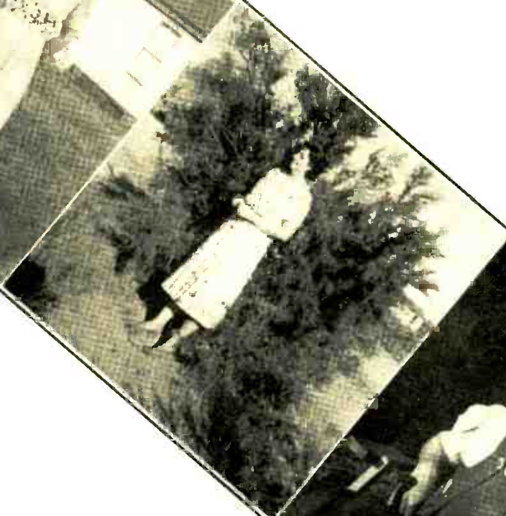
● Lillian M. Gunther, W2FQD, (left) operates on the 10-, 20- and 160-meter bands, phone and c.w. She often uses radio to contact her husband, W2ALS, when it is necessary for him to go out of town on business. In the summer her hobby becomes yachting aboard the *Morning After*. Mildred Chase, W9OEH, (right) also sails during the summer months. She has been licensed since 1933 and operates on both phone and c.w.



• Mrs. Henrietta W. Moore, W9PCV, (left) obtained her ticket while working at the Chicago World's Fair station, W9USA. Miss Oliva Rolli, W9ZQZ, (center) owns a cattle ranch in Nebraska. She may be found on the 40-, 80- and 160-meter bands. Helen Cloutier, W9CJX, (right) has been an active amateur for ten years. She operates 20, 40 and 80 meters.

• Mrs. Sarah E. Tracy (left), and her husband operate W1JEB on the 80-meter c.w. band. Her transmitter is a battery-operated 6L6 crystal oscillator. Mary E. Jewett, W8RSF, (right) holds a class-A license and expects to go on 20-meter phone in the near future. In the past her activity has been confined to the 80- and 160-meter bands.

• W5GAF is operated on phone and c.w. on the 10- and 160-meter bands by Mary Walker Reynolds, (left). Her other hobbies are tennis and flying. Mae E. Amarantes, W6DHV, (center) operates a 75-watt transmitter on 80-meter c.w. She has been active since 1931. Lillian M. Nollenberger, W8OZO, (right) is active on 160-meter phone. She built her own 50-watt transmitter.


● Reading from left to right: Mary Baker, W8JDJ, Shadyside, Ohio; Mrs. Nara Ochsner, W5FWS, Texon, Texas; Viola Grossman, W2JZX, East Rockaway, L. I.; Miss C. A. Cicerello, W8NAL, Massillon, Ohio; Mrs. Mabel V. Kelley, W9BJU, Woodlake, Nebraska.

W8JDJ is active on 160-meter phone and has an O.P.S. appointment. Mrs. Ochsner, W5FWS, is the xyl of W5FNQ; she runs 350 watts on c.w. and 200 watts on 28-Mc. phone. Mrs. Grossman, W2JZX, is a member of a radio minded family. Her husband holds the call W2JDG, and her son holds W2LJJ. W2JZX acts as net control station for the Southern New York AARS 'phone net and she also holds appointment as Nassau County Emergency Coordinator. Miss Cicerello, W8NAL, is also a member of the AARS and is District Net Control Station of net five of the Ohio Area. Mrs. Kelley, W9BJU, is the xyl of W9FXN and lives on a large cattle ranch in northeast Nebraska. She spends most of her operating time on 80 c.w. and 160 phone.


● Beatrice Holman, W1KTG, (left) obtained her license in August, 1937. Her interests lie in 10- and 20-meter phone and c.w. DXing and rag-chewing. Thelma Bromley, right, has had a long and colorful background in amateur radio. She has been an amateur for over 13 years, holding the call W6CXG until 1929, when she was assigned her present call, W6JW.

YL HAMS

● Mrs. C. S. Suzuki, J2IX, ex-J1DN, is very well known to all 40-meter dxers. She was on the air from 1933 to 1937 from Tokyo. In 1937 she was married and moved to Adawara, from where she has been on ever since. She operates both 40 and 20, phone and c.w., and now acts as foreign QSL manager of the J.A.R.L.

● Marianne Ullman, SM7MF, is a ham of about two years standing. Her husband, SM7-MU was licensed at about the same time. She operates on 20-meter phone and c.w. with a pair of T-40's in the final. A WAC on both 14-Mc. phone and c.w. are two of her accomplishments; New Mexico, Wyoming, and Idaho would give her another accomplishment in the form of a 14-Mc. WAS. A two-element rotary atop a 100-foot lattice mast gives her signals an initial boost on their way.

Across the Sea

● Alicia G. Rodriguez, K4EZR, was the first licensed yl operator in Puerto Rico. She spends nearly all her time of 28-Mc. phone and has obtained a WAS certificate on this band. All that she lacks for a 28-Mc. phone WAC is a contact with Asia. She is a member of the Puerto Rico Amateur Radio Club and serves in the official capacity of secretary of the club.

● Iris Hayes (Mrs. S. R. Hayes), ZS2AA, lives on a large sheep and cattle ranch called Poplar Grove near Whittlesea in South Africa. She was the first licensed operator in South Africa (obtaining her license in Nov., 1937) Her being an amateur has started quite a fad in this respect since there is an unusually large percentage of yl operators among the South African Amateurs. Since there is no source of a.c. power available, her transmitter, ending in a plate modulated 807, is powered by a vibrapack. To date her dx has been very limited although the W hams in particular "simply roar in" down there.

YL HAMS

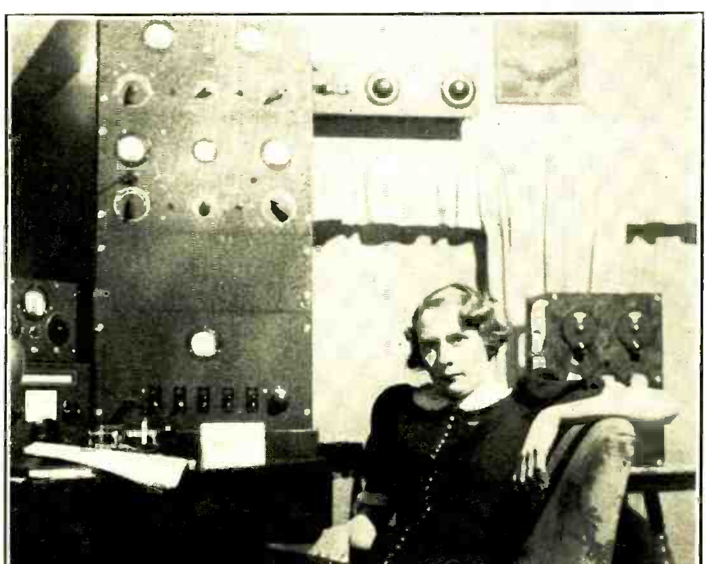
and their Transmitters

● Dr. Lois Lary at the controls of W6CEV. Her 80-meter vibropak-powered station is located at an altitude of 7000 feet in General Grant National Park.

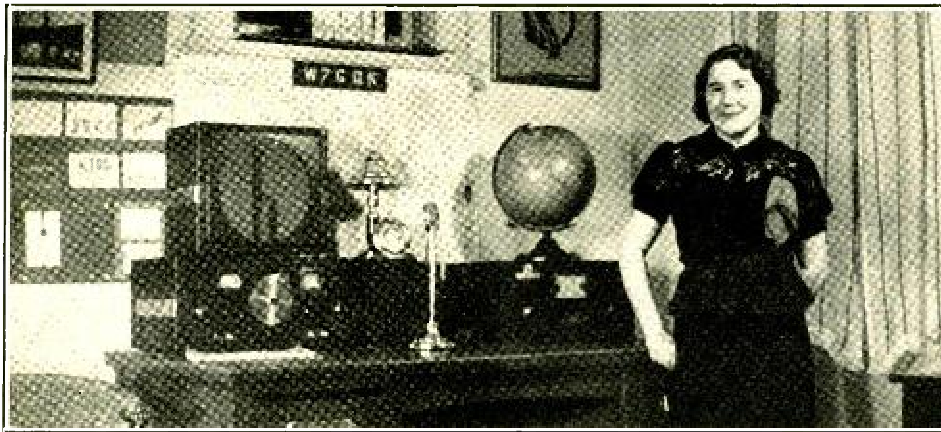
● Mrs. Esther Brunk, W6LFV, celebrated 10 years of hamming in November, 1939. Before moving to California in 1933 she held the call W7AHJ. Mrs. Brunk's other hobby is painting and her work may be found on display in exhibitions throughout California.

● Frances V. Rice, W3AKB/WLQP, is interested principally in Army Amateur and traffic work. She holds the position "Cryptographer 3rd Corps Area." She has held many AARS positions, including that of State Net Control Station for Pennsylvania.

● Mary E. Roden operates W7GPO on phone and c.w. In addition to amateur radio, she is interested in motion-picture photography and gardening as hobbies.

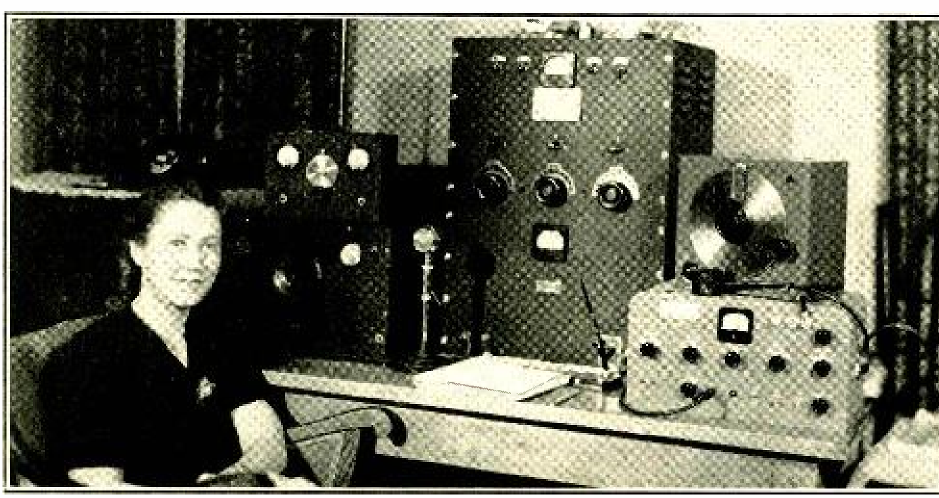


● Mrs. Ruth M. Beckwith, W8ODI. She and her husband, W8OCK, operate the 500-watt transmitter shown in this photo on the 40-meter band.



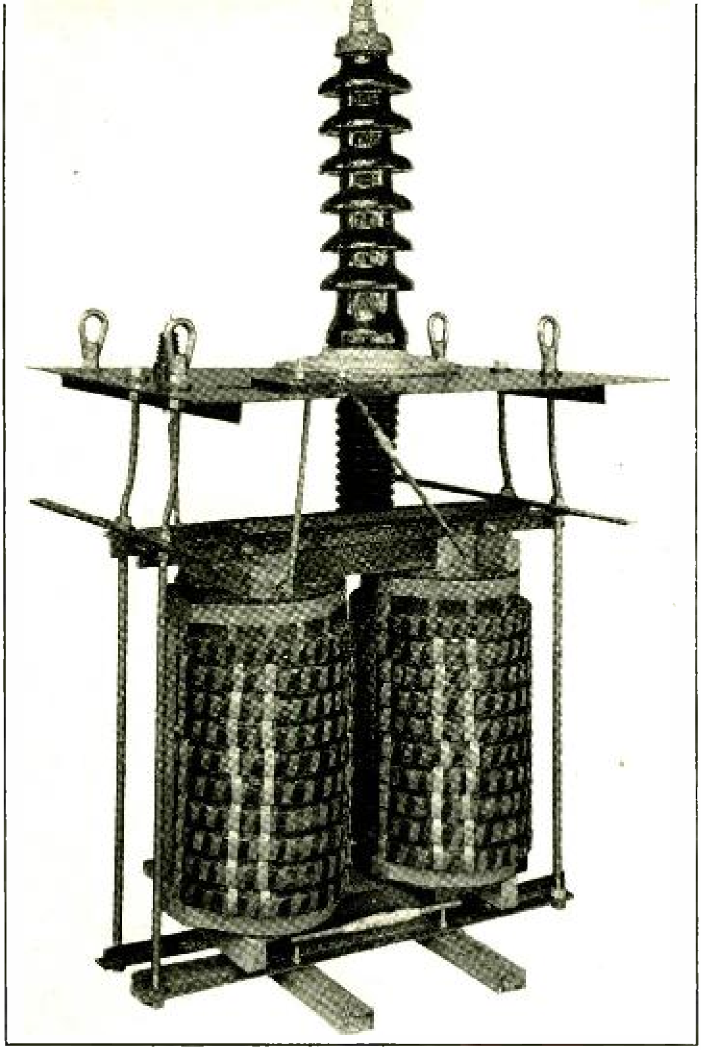
● This neat-appearing station belongs to Marguerite Willcutt, W7GQK . . . operation is mostly on 10-meter phone, occasionally 40 and 20 c.w. She has held her ticket since January, 1938. Her husband is also a ham, W7GKJ. She is a librarian by profession.

● Mrs. Dorothy Williams and her station, W6QLM. Her interests lie mainly in phone rag chewing and c.w. traffic handling. The station was licensed in October, 1939. The large transmitter on the table is an all-band affair, while the smaller is used for portable mobile work.



● A special oil-immersed 2500-v.a. transformer made for a geophysical lab. Five feet-four inches high and weighing 1000 pounds, it has a 70,000-volt secondary designed for half-wave rectification to produce 100,000 volts d.c. from the filter.

—W2APT



DEPARTMENTS

RADIO

"WAZ" HONOR ROLL

CW and PHONE

	Z	C
ON4AU	40	158
G2ZQ	40	148
J5CC	40	130
W8CRA	39	156
W2BHW	39	156
W8BTI	39	154
G6WY	39	151
W2HHF	39	151
W6CXW	39	150
W6GRL	39	150
W9TJ	39	149
W2GTZ	39	149
W6CUH	39	143
W6KIP	39	143
W8OSL	39	143
W9KG	39	141
W6ADP	39	140
W6BAX	39	140
W4CBY	39	138
W6DOB	39	138
W9TB	39	134
W2ZA	39	134
VK2EO	39	133
G5BD	39	133
W2GVZ	39	132
W6QD	39	132
W3EVT	39	131
W5KC	39	130
W2GWE	39	129
W6KRI	39	129
VE4RO	39	126
W4CYU	39	126
W7BB	39	123
W6HX	39	123
G5BJ	39	120
W2IYO	39	119
W2CYS	39	117
G2LB	39	115
W4IO	39	115
W7DL	39	115
W6FZL	39	112
ON4FE	39	110
W6FZY	39	109
W9NRB	39	98
W6SN	39	95
W6GPB	39	94
XE1BT	39	90
K6AKP	39	67
W1BUX	38	152
W1CH	38	150
W2GT	38	143
W2GW	38	143
W5VV	38	143
W3HZH	38	139
W3EMM	38	139
W8BKP	38	138
W8LEC	38	136
W5BB	38	135
W9GDH	38	134
W3HXP	38	133
W8OQF	38	133
W4FVR	38	130
W9FS	38	130
W9TB	38	130
W3EAV	38	130
W8JMP	38	127
W2GRG	38	127
ON4EY	38	126
W3EVW	38	124
W3EPV	38	121
W8AU	38	120
W8LYQ	38	120
W8DFH	38	119
W9PST	38	119
W8QXT	38	119
W8JIN	38	119
W8DWV	38	118
W1GDY	38	118
W2BMX	38	118
W6AM	38	117
W1ADM	38	117
LU7AZ	38	116
W3DDM	38	116
W9UQT	38	116
W3GAU	38	115
W8MTY	38	114
W9KA	38	114
W6VB	38	113
W1BGC	38	113
G6CL	38	112
W8HWE	38	112
G2QT	38	112
W8EUY	38	112
W8JSU	38	112
W2BXA	38	111
W6GRX	38	111
W3FQP	38	111
LY1J	38	110
W1AB	38	110
W6HZT	38	110
W9ELX	38	110
W1AQT	38	109
W8KWI	38	108
W3BEN	38	108
W8BOX	38	106
W9ADN	38	106
W9CWW	38	106
W8OE	38	106
W8GBF	38	105
ON4UU	38	104
W9PK	38	104
G2IO	38	103
J2KG	38	95
G6XL	38	95
ON4FQ	38	92
W9VDQ	38	79
SU1WM	37	138
W2BJ	37	134
W6GAL	37	131
W8KKG	37	127
W7AMX	37	125
J2JJ	37	123
W2IOP	37	122
W1RY	37	117
W3GHD	37	116
G6NF	37	115
W8ZY	37	114
W9RCQ	37	114
W3TR	37	113
ON4FT	37	112
W9RBI	37	112
W6MEK	37	112
W6ADT	37	111
G2MI	37	110
ON4HS	37	110
W8LFE	37	109
VE2EE	37	108
W4DMB	37	108
W7AYO	37	108
W3KT	37	105
W4MR	37	104
W9PTC	37	103
W6ITH	37	103
W3FJU	37	103
W9GBJ	37	103
G6GH	37	102
W3AYS	37	102
VK2DA	37	101
W6FKZ	37	101
W6JBO	37	101
W8KPB	37	100
W4DMB	37	100
W9AJA	37	99
W4EQK	37	99
ON4VU	37	99
W3EXB	37	98
ZL2CI	37	97
W6MHH	37	95
G2UX	37	91
W2BSR	37	90
W6MCG	37	84
W9UBB	37	77
W8AQT	36	120
W6MVK	36	117
W3GGE	36	106
W6BAM	36	106
W8DOD	36	106
W9AFN	36	105
W8QDU	36	105
W6NLZ	36	104
W5ASG	36	104
W5PJ	36	105
W8PQQ	36	103
SP1AR	36	103
W6NNR	36	100
W6KWA	36	99
W8LZK	36	99
G6BJ	36	99
VE1DR	36	98
W8LDR	36	97
W8AAT	36	96
W6DLY	36	96
ZL1HY	36	95
G6YR	36	94
VE5AAD	36	92
W2IZO	36	92
W5ENE	36	91
W4ADA	36	90
W9LBB	36	90
W9GKS	36	90
W8JAH	36	89
W1APU	36	89
OK2HX	36	86
VK2NS	36	84
W6TI	36	80
W9GNU	36	80
W6GCX	36	76
W7DSZ	36	73
W2GXH	36	71
W8OXO	35	113
K4FCV	35	105
W6GHU	35	103
W4QN	35	103
W8OUK	35	99
W8CJJ	35	98
W6HJT	35	98
W2WC	35	98
OK1AW	35	96
W8AAJ	35	96
W3RT	35	95
W9EF	35	94
G6QX	35	94
K6NYD	35	94
W3DRD	35	93
W6AQJ	35	92
VE5ZM	35	92
LU3DH	35	89
W9GNU	35	88
W6KQK	35	85
W9ERU	35	83
W6ONQ	35	83
ON4NC	35	82
W9VDX	35	82
GI6TK	35	80
W4ELQ	35	80
W6MUS	35	76
W6GK	34	105
W6HEW	34	103
W9PGS	34	103
K7FST	34	102
W8BSF	34	100
W1APA	34	98
W2BZB	34	99
VK2AS	34	94
W8HGA	34	93
W3EYY	34	91
W8NV	34	91
W2FLG	34	89
W6TE	34	86
G6WB	34	88
W6CVW	34	88
VK2OQ	34	87
G5VU	34	85
W9BCV	34	83
ZS1CN	34	82
VK2TF	34	81
W6MJR	34	81
W6PNO	34	81
ON4SS	34	80
W6HIP	34	76
VK2TI	34	75
W7AVL	34	75
W8JK	34	75
W8QIZ	34	75
ZL2VM	34	72
W6LHN	34	71
VK2AGJ	34	70
VK2EG	34	70
VE5MZ	34	69
VK2VN	34	63
W9QOE	34	56
F8XT	33	112
W8ACY	33	106
W6KEV	33	96
W8BWC	33	93
W9VKF	33	93
W8CED	33	94
W6MEK	33	91
W6KUT	33	90
W8LFE	33	89
W6CEM	33	88
W9TJI	33	88
W6ANN	33	86
W8BWC	33	85

PHONE

W3LE	38	127
F8UE	38	103
W6OCH	36	107
W6ITH	36	97
W3FJU	36	87
VE1CR	36	81
W9NLP	35	95
W9TIZ	35	93
KA1ME	35	79
F8VC	35	78
W4CYU	34	93
W6EJC	34	84
W7BVO	34	80
W4DAA	34	71
ON4HS	33	91
W1ADM	33	88
W6NNR	33	88
GM2UU	33	84
F8XT	33	70
W3FAM	33	68
W6MLG	32	92
W2IKV	32	90
W8LFE	32	89
W9QI	32	86
W1HKK	32	85
W8QXT	32	85
G5BY	32	85
W9BEU	32	85
VK4JP	32	85
W4DSY	32	84
W6OI	32	83
W6IKQ	32	80
VE1DR	32	59
W3EMM	31	88
W1AKY	31	87
W8LAC	31	85
G6BW	31	83
G3DO	31	78
W1KJJ	31	78
W6FTU	31	77
G8MX	31	73
W8RL	31	71
W9UYB	31	71
W6AM	31	67
F8KI	31	58
W9ZTO	31	53
W2GW	30	86
W1JCX	30	81
W2AOG	30	77
W9BCV	30	68
W6MZD	30	52
W2IXY	29	93
W4BMR	29	80
CO2WM	29	78
K6NYD	29	73
W9RBI	29	71
W6NLS	29	64
W6NRW	29	60
KA1CS	29	59
W2GRG	28	74
W8AAJ	28	66
W6PDB	28	65
W7EKA	28	63
VE2EE	28	62
W4DRZ	28	62
W1BLO	28	62
VK2AGU	28	61
W6GCT	28	56
W3EWN	27	93
W2HCE	27	76
W2IUV	27	68
G6DT	27	59
W5CXH	27	52
G5ZJ	26	77
W5ASG	26	62
W8NV	26	62
W4EQK	26	61
W8QDU	26	61
W9NMH	26	61
W5DNV	26	60
W5VV	26	59
VK2OQ	26	56
W4TS	26	54
W6MPS	26	51
VE4SS	26	50
W6FKK	26	47
K6LKN	26	46
G6CL	26	46
W7AMQ	26	45
W3FQP	25	65

DX AND OVERSEAS NEWS

by Herb. Becker, W6QD

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

It's about time to make our New Year's resolutions for 1940. If we could exchange our resolutions for a wish, we would without a doubt wish for "more dx and better conditions for 1940." If the "wish" didn't produce any better results than most resolutions, we might just as well forget it . . . because resolutions seem to be made to be broken. Now we're back to where we started.

J5CC Third Confirmed WAZ

J5CC is the third station in the world to confirm 40 zones for his WAZ. He now is up at the top along with ON4AU and G2ZQ. All of his 40 QSL cards were for confirmation of c.w. contacts, and most of the stations are very well known to all dx men, being from quite recent QSO's. The oldest of the group were AU1AO, which dates back to 1931, and VK6DA, 1933. J5CC has been one of the most consistent dx stations over a period of years. His signal always packed a good punch and his all-around knowledge of dx operating is deflected in his achievement of WAZ. Only three stations, remember, have been able to produce confirmation of having worked all 40.

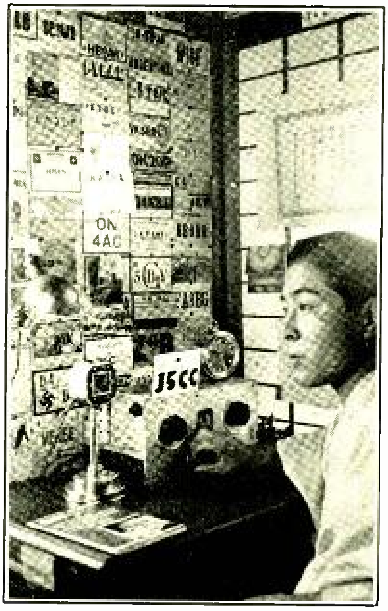
At present J5CC is a naval medical officer and probably will not be very active for some time, although he insists his interest will never lag. Here's hoping that we will hear that signal of his before too long. When he does get going I know he will receive the congratulations from dx men around the world. To Fumio Horiguchi RADIO extends its heartiest congratulations.

Fumio uses a pair of 861's in push-pull with "20 watts" input. Receiver is a 7 tuber and homemade. He informs us that J2KJ is testing daily on 56 Mc. and is keeping daily skeds with J2JK and J3FJ.

Marathon Deadline January 31, 1940

All reports on your results for the 1939 DX Marathon must be in our office by January 31, 1940, to be considered in the final judging. Contacts must have been made between January 1 and December 31, 1939. The final results will be published as soon as the committee has judged all lists. Whether RADIO continues with a 1940 DX Marathon, is entirely in your hands. We would appreciate an expression on this point from every one of you. Just add a note to your monthly contributions stating whether or not you favor a 1940 Marathon.

We have not had time to hear how the "World-Wide DX Contest" is shaping. At the



J5CC, Fumio Horiguchi, at his receiver.

CONTEST SCORES

As we go to press a few contest scores are beginning to arrive. None of these has been checked as yet, nor have they been segregated into divisions other than phone or c.w. Although the deadline for mailing logs has passed, we would appreciate receiving them from all who made contacts in the contest so that we may check the contestants' logs and also determine the extent of contest activity.

C.W.			
W6GRL	320,000	W2CJM	29,500
W6QD*	238,000	YS2LR	2,190
K6CGK	290,000	**PHONE**	
W8OQF	175,500	W6OCH	254,800
W6QAP	125,000	W6RCD	89,700
W9GKS	95,500	W9BEU	49,000
XU8MI	68,400	XE1AC	40,500
W1RY	63,232	W6AED	35,200
W7DVY	49,200	W8LFE	25,500
W9PK	44,100	W6NHK	20,900
W3EPV	41,800	W5EDX	18,100
W3ASW	37,800	W1FOV	15,100
W4QN	34,200	W6ITH	12,500
		W9ZYL	11,500

* Not eligible for award.

time this is being "milled" out, the contest is a week away and only a wild guess would give an idea of what to expect. It will not be as much of a "World-Wide" affair as we had at first hoped, but then again it is a starter, and next year we can look for bigger and better things.

Observing the activity in the "Sweepstakes" of the multitude of dx men has drawn a smile from many of us. Certainly bedlam broke loose this year in the SS. I heard such fellows as W6GRL, W2UK, W9CWW, W7AYO, W4FVR, and many, many others who never before had entered. Even W8CRA was heard passing out no. 9, almost causing W6QD to "pass out."

Brasspounders

Dick Cotton, W8LEC, is rebuilding and will have three rigs, one for each of the 7, 14 and 28 Mc. bands. The 14 Mc. job winds up with an RCA-833 in the final, the one for 7 Mc. will use the T-200 and the 28 Mc. rig ends with an Eimac 150T with 600 watts input. The other two will run at a kw. Dick now has 38 zones and 138 countries. The Marathon shows at 38 and 106.

AC4JS and Zone 23

We're still hoping that AC4JS is in zone 23. From several sources it appears that he may not be actually in Tibet but the chances are pretty good that he is in the elusive zone. W2GTZ has worked him three times and will be in there hoping with the rest of you that AC4JS is really there. I understand that AC4JS is on a trip at the present time but intends to be back and on the air around the middle of December. He would be a good Xmas present for me, too. W9RBI is up one in the Marathon with KB6RWZ which makes 102 countries. U0AD says to QSL via W9RBI, but there is still a certain amount of mystery about him. He has been "awful" loud in some places around the West Coast. Anyway, U0AD comes in around 14,400, and while I think of it UK9AN is out there about 14,400 kc.

W8JSU is feeling pretty good after receiving a card from U8ID, as well as one from U9AV. Some of Charlie's latest are U1AD, 14,400; EA7AV, 14,400; XU5WT, 14,400; U8IB, 14,375; UK3AH, 14,400; U9BC, 14,400; J8CH, 14,350; J8CL, 14,375; HA7U, 14,400; UK9AN, 14,400. W8JSU now has 38 and 112 and says for no. 19 and 23 to watch out. Alan Eurich, W7HFZ, ex-WCFT and W8IGQ, is at Williams College and is doing all he can to get their station, W1IJW, on the air. Alan says the yacht *Yankee* is off on another cruise and will operate on 8260, 14,420 and 16,560 kc. Give them a listen, gang; they will work hams.

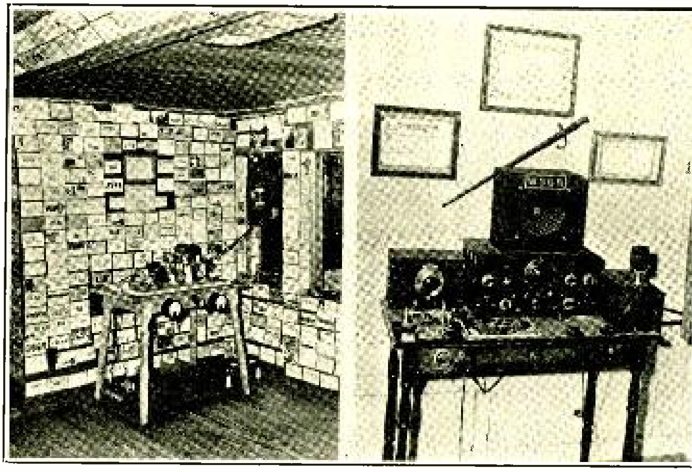
W5KC worked U0AD too, but he had better keep an eye on that other one. Other new ones for him are CR6AI, MX3H, KF6OWR, U8IB, OQ5AE, I7AA, HB1CE, UK6WA and EK1AA. Vincent has 39 and 130, and in the Marathon it's 35 and 104. W7AYO writes a letter that is about as disconnected as this colyum, sometimes. He was writing the letter while listening to the USC-Oregon State football game, and rebuilding the rig for the SS contest. Seemed a bit irked when the Trojans started making touchdowns—and the rest of the letter suffered. Even so Stan managed to squeeze in the fact he now has 37 zones and 108 countries.

From ON4HS, Harold Simmons, we learn that he had 37 zones and 110 countries when their stations were closed down. On phone he had 33 and 91, while the Marathon score ended at 33 and 92 for c.w. and for phone it was 29 and 73. ON4HS lacked only Idaho and Montana for WAS on phone, although he probably is the only European station to work all districts in USA on 80-

1939 DX MARATHON

C. W. and PHONE

Call	Z	C	Call	Z	C	Call	Z	C	Call	Z	C
W9TB	39	116	W5KC	35	104	W3FJU	32	81	F8UE	31	71
VE4RO	38	116	W9RBI	35	102	W2GVZ	32	71	F8VC	31	55
W8LEC	38	107	K6NYD	35	92	W6TE	32	67	W6OCH	30	82
W9TJ	38	104	W9GKS	35	79	VE5ZM	31	87	W9BEU	30	80
W4TO	38	99	W6SN	35	66	W8CED	31	80	W1KJJ	30	77
W9NRB	38	88	W4FIJ	34	97	W8BWC	31	80	W6NNR	29	73
G5BD	37	113	W8JIN	34	94	W9MQQ	31	79	W1JCX	29	72
W8BTI	37	113	W5PJ	34	90	W1RY	31	77	W1AKY	29	71
W2ZA	37	97	W3HZH	34	89	W9ERU	31	68	K6NYD	29	71
W8OQF	37	96	G2FT	34	76	VK2EO	31	67	CO2WM	29	70
W2BHW	36	105	K4FCV	33	95	W6OLU	31	58	VK4JP	29	67
W6MEK	36	103	ON4HS	33	92	W8AU	30	61	W1ADM	29	64
SU1WM	36	102	W5ASG	33	85	G2QT	30	46	W2AER	29	45
W8LFE	36	102	W2IZO	33	80	**PHONE**			W2IKV	28	68
W3EPV	36	100	W4QN	33	79	W3LE	34	83	W3FJU	28	60
W9GDH	36	100	W1BGC	33	79	W8LFE	31	89	W7BVO	28	57
W9ELX	36	91	G3AH	33	71	W1HKK	31	80	W6EJC	27	59
W4FVR	36	90	W9CWW	33	70	W8QXT	31	78	W6PDB	27	59
W3HXP	36	86	W6GK	33	69	W6ITH	31	71	W9NMH	26	61
W6NLZ	36	85	W9VKF	32	86				G3DO	26	57



W5BB, Tom Caswell's station in Austin, Texas.

meter phone. Harold says that he will be glad to listen to the boys in USA during the winter on 80 phone. His usual listening time is from 0100 to 0500 G.m.t. He's looking for the W's to keep the game going.

W9BNX, Bill Conklin, says that CE3DW built a radio trailer which came in very handy during the Chilean earthquake . . . that CT3AB reports a new jr. op. in the family, the fourth child, two and two . . . and that CT3AN is still trying to locate a recording of the number called "Honolulu Baby" from a picture called "Sons of the Desert." Bill also helps us keep tab on the boys in England. G6WY, G2ZQ, G2ZV, G6PA, G2YN, G5NM, G6HM, G2ZR, 5RP, are all in the R.A.F. while G3ZV, G2QM, G2ZP, G5SO are in the Royal Navy.

W5BB is at it again. Tom is getting set for some plain and fancy phone work, having a 300-watt modulator just itching to go to town. Only trouble is Tom can't find anything to work now. He could arrange a sked with his "nearby" relative W5VV, who lives next door. Tom spent most of the summer up in the Maine woods, and although he missed his radio, he had his y.l. there for about eight weeks. During this time there must have been some very nice moonlight because in the not too distant future they . . . Oh yes, Tom did say something about having 38 zones and 138 countries.

W1BGC nabs EK1AA making 38 zones and 113 countries. His Marathon score is 33 and 78. Here are some stations Rich has been working: EA5A, 14,400; KB6RWZ, 14,400; XU8WS, 14,400; UK9AN, 14,400; PJ7B, 14,400; K6QA, 14,395; EK1AA, 14,400; CT4AA, 14,400. W8QIZ has a few new ones that make him very happy. VO1R, VQ8AI, LZ1ID, J2KN, LX1SS, KB6RWZ and U6AN. Ed has 34 zones and 75 countries. LX1SS says he will QSL through W1FRU. Keep 'em crossed gang. W2GVX has been operating in Maine for some time and has worked some nice ones: J8CA, 14,395; J8CH, 14,360; KB4FCS, 14,390; MX3H, 14,320; EA7AV, 14,400; PK1XZ, 14,260; U9AW, 14,-400; J3FP, 14,380; LZ1ID, 14,400; and Y16ZC, 14,360 to 14,400.

W5PJ sneaks a couple in, CR4MM and SV1RX, giving him 36 and 105. 5PJ says he worked D4BRJ one evening in November. W6MEK worked both UK9AN and U9BC, zone 18. This zone makes Frank 37 and 112 while the Marathon is 36 and 103. W9VKF adds a few in HC3AL, EA7AV, KF6OWR and LZ1ID . . . total 33 and 93. W3TR had been trying for a long time to land some new ones when all of a sudden he got CR6AI and KB4FCS. This gives him 37 and 113. W6QL gets OQ5AE on c.w. at 14,386 kc. and then turns around to get CR9CA in Macau, who says to QSL via Box 651 Hongkong.

W3KT is another to get KB4FCS. W3DRD worked OQ5BD, 14,250; CR6AF, 14,210; U9AW, 14,400; HP1X, 14,360; CR4HT, 14,400; FT4AG, 14,400; bringing his up to 35 and 93. W9MQQ and his latest are U8IB, J3DG, YU7AY, OQ5AV. W2HHF is waiting for a card from AC4JS and K7FST . . . he has 151 countries. W4FVR has been quite active working such things as CR6AI, 14,300; KB6RSJ; KB6RWZ; U8IB; KA1FG; OQ5IM, 14,300; XU8WS; XU8BG, 14,400; KA1PO; U9BC; XU7A; XU6K, 14,380; U1AD, 14,400; UK9AN, 14,375. W9GKS is up one with OQ5BA making him 35 and 79 in the Marathon and 36 and 90 in the Honor Roll.

W8LDR finally snagged XU8MI, UK9AN who said U9AW was there visiting him. LDR thinks 8BTI was the first W for UK9AN. W8LDR uses a 398-foot Hertz, while the rig uses an HK-54 in the final with 250 watts. Look who's here . . . W9KG, ol' Keat Crockett. He has been very versatile during the past year working every band, I guess, from 10 to 160. Keat brings his Honor Roll up to date with 39 zones and 141 countries. K6DFE, who was a W6 until a short time ago, is in Hilo now, and runs 45 watts to an 807 on 20. He worked CR1OA who is supposed to be in Timor. This one sounds ok as I believe there are a few of his cards in the shacks of some W6's.

The VK4 gang that took part in the direction-finding test to try to locate an "enemy" mobile transmitter car which was supposedly reconnoitering in Brisbane and transmitting the information back to the "enemy" receiving position. The test proved to be quite successful. They are, from left to right: (not identified), VK4AW, 4GU, (Thorley), 4FJ, Gabriel, 4ZU, 4UR, 4JB, 4RT, 4ES. And in the front row: 4UU, 4CX, Pat Kelly, 4RY, 4JF, 4RC, 4AP, and 4PX.

W1APA still knows the code and with its help he worked LZ1ID, 14,350, and KB6RSJ, giving Gil his 98th country. Gil says he is a traveling salesman and covers Long Island, New York City, So. Western and Eastern Conn., Rhode Island and Eastern Mass. All I can say is that in covering this territory, it must keep him plenty occupied. W9VDX has a couple in J8CL, 14,396 and OQ5BA, 14,280, and OQ5BA gave his QRA as PO. Box 746, Elizabethville, Belgian Congo. OQ5IM is Box 747, same town. 5BA says that 5AV and 5AB are ok. W9VDX now has 35 and 82. W6GRL worked D4BRJ on 20 in the a.m. and again in the evening on 40. W2GUM is using a 250TH and has been on the air just one month after a year's layoff. He has worked a flock of Asiatic stuff which may prove of value: XU0A, 14,310; XU0RK, 14,320; XU6K, 14,265; XU5WT, 14,270; U5SW, 14,320; XU5LT, 14,370; XU6AL, 14,270; KA1WW, 14,330; LX1SS, 14,280; CR6AK, 14,400; OQ5AV, 14,310; J2KN, 14,400; J3DF, 14,400; PK3AC, 14,340; PJ7B, 14,400; XU8WS, 14,400; XU7A, 14,370; XU8MI, 14,350; XU8HM, 14,400; XU6DX, 14,275; XU5HR, 14,370; XU4A, 14,360; J2OV, 14,400; J3FP, 14,375; J3DG, 14,400; J8CH, 14,370; PK1TT, 14,360; KA1FG, 14,340; KA1PO, 14,345; KB6RWZ, 14,380; KB6RSJ, 14,380; CR6AI, 14,360.

OX7ZL . . . how many have received his card? He is ok so if you have worked him, don't give up hope, as there is only one mail out of there a year and that is in August. A friend of ours Hal Clein received a letter from him stating that he was running 10 watts grid modulated. OX7ZL said his complete name is Wm. (Billy) Stilling Berg, and the QTH is Angmagssalik, East Greenland. He states that the post office doesn't cash "money orders" (meaning International Reply Coupons) and send Denmark stamps amounting to 30 ore. His power was derived from a hand-cranked generator, and he used an inside antenna to prevent ice from forming.

BERS-195

Eric Trebilcock, BERS-195, the world famous listener, finally joined the ranks of hams . . . the call being VK5TK. It was short in life, however, as they are all off the air. Eric had heard 178 countries, getting confirmations from 146.

Phone Chatter

Phone dx has apparently taken more of a drop than c.w. has but nevertheless W8LFE tosses a few in our laps. HA1K, 14,205; SV2S, 14,110; EA7BA, 14,020, and the usual bunch of LU, PY, TI, etc. Bob received a card from EA7BB, the first since the Spanish conflict. He says QSL's for SV2S should go to Elias Fonaris, Syra Island, Greece. W8LFE really did a little more on c.w., so I imagine it would be a good idea to chronicle it here before it's too late, U0AD and U9BC being the best along with UK9AN, 14,400, XU2MC, 14,370, and J2KN. These were all on c.w. and makes his total 37 and 109 while the Marathon is 36 and 102.

W1KJJ grabbed off J2NG . . . and now has 31 and 78. W9RBI is up one with XU1B, 14,108, giving Ross 29 zones on phone. Other frequencies that may be interesting are EA7BA, 14,120; EA7BB, 14,140, EK1AF, 14,065; KB6ILT, 14,-250; XU0A, 14,225. W7AMQ comes out of hiding long enough to inform us that he has the "one and only," the event taking place last May. Says he, it is swell because she is interested in ham radio. Now fellows . . . hold off, don't remind him to recall that statement after a few years of "bliss." Well, anyway, Gale wanted us to know too, that he has 25 zones and 42 countries.

The above reminds me of the "equation" as suggested by J2GX a number of years ago. He said "Ham + YL = Minus DX," which isn't so very far from right . . . eh, what? W9UYB has these to offer: I1PB, OQ5AE, LY1J, HA3B, and HP1A, boosting his total to 31 and 71. W6PMB informs us that XU8MC passes along the info that there are a number of XU's who are going to get on 28 Mc. c.w. On 28 Mc. phone Charlie has worked XU8AM, XU8MC, XU8RJ, J2KN, J2NG, J2XA and J8CI.

XU0C is a new station that may open up in zone 23. KA1LZ sends this along through W6POZ on 10 phone. The frequencies available will be 13,500, 14,022 and 14,150. He will run about 200 watts, and if he has a fairly good antenna he should give many of the boys a treat on 28 Mc. W6ITH reports these as being worked recently: OA4N, 14,069; CX2CO, 14,065; CX3CG, 14,019; CE2AM, 14,100; OA4AI, 14,-013; YN3DG, 28,147; PY1AZ, 28,058; PY2AK, 28,256; TI2RC, 28,435. In 7½ hours operating time Reg worked 37 South and Central Americans on 10 and 20 phone.

That very active (formerly, I should say) dx man G3DO, Doug Edwards, sends his 73 to his friends in USA and says it will be perfectly ok to send QSL cards to England at the present time. In fact Doug says they will be most welcome. G3DO signs off with 31 zones and 78 countries while his Marathon total is 26 and 57. W8GXT says that K4FAY has shoved off with the navy so will be missing from the air for some time. W9NMH joins us with a Marathon list of 26 and 61, which is quite imposing. CO2WM was all hopped up over the DX Contest but now they are closed down. He is waiting impatiently for them to again authorize ham activities. Bill claims that the Cuban government is working on a new plan whereby the hams can get back on. Well, CO2WM has 29 zones and 78 countries, and in the Marathon it is 29 and 70, with some of his new ones listed as VP2LC, 14,125; OZ7KG, 14,128; LY1J, 14,080; YR5PB, 14,127; XU8RB, 14,090.

W6IKQ wants someone to get out and dig up some dx for him. If there are any volunteers, don't write to me but go direct to him. He sadly points out that the last two worked are OZ5BW, 14,080 and KB6ILT, 14,245. This gives Phil 32 and 80. K6NYD adds a few new ones to his list to give him 29 and 72. The stations are I1IR, LY1AH, ES5D, VQ8JM, FA3HC, EA7BA and VS1AE. NYD has 35 and 93 for c.w. and phone. W6NLS made a one-day 10-meter phone WAC by working I1OH, ZS6W, LU1DJ, XU8AM, K6OQM and W9DWU. John worked OQ5AB for his 29th zone on 10 phone while his countries total 63. W3LE is fixing up his new QRA, and his new rotary is going to be about 70 feet. The rig also is new and Lou expects to add more new stuff to his already imposing list of dx. Lou has worked 38 zones and 123 countries on two-way phone with confirmations from 38 and 111. I'd say that was a pretty good batting average. There are four others on the doubtful list and if any of these prove ok they will be added. Lou also leads the phone column of the Marathon with 34 and 83. VK4JP says that his family has suggested that he do some gardening around the yard, now that he isn't on the air any more. George reached the 85 mark for phone countries, while his main total is 32 and 90. His Marathon score winds up with 29 and 67. George was here in USA a little over a year ago and got some ideas on rotary beams. Now he has a two element for 20 and a three element for 10 meters, both mounted on top of a 50-foot telephone pole.

Last Minute News . . . Here and There

Just as we go to press I find a little information regarding XU0A, XU0C, and AC4JS. W6QGI has a daily 28-Mc. sked with XU8AM. From what XU8AM says it looks like there might

G3DO, Doug Edwards, was one of the outstanding British phone stations before they were taken off the air.

be three stations to shoot at in zone 23 before long . . . or four if AC4YN gets going again. XU0A is a portable operating in Chinkiang and moves into 23 once in a while. XU0C is a portable and is heading for Tibet. This one, if it goes as intended, will give you fellows a country as well as that old elusive zone. AC4JS at this time is on a trip, but is expected back . . . probably by the time you read this. AD4JS is not in Tibet . . . but seems definitely in 23 . . . Kansu Province to be more exact. XU8AM is going to try his best to get AC4JS on 28-Mc. phone when he returns.

W2AOG writes from the Hackensack Hospital to the effect that he can once again talk about ham radio. He was mixed up in an automobile accident and has numerous injuries including skull fracture. After the first five days in the hospital Fred suddenly remembered that he had a few skeds that had been neglected. He had the day nurse phone W2BMK and ask him to tell ZS6EG the reason he hadn't been on the air. Thirty minutes later W2BMK phoned back a message from ZS6EG wishing him a speedy recovery. W2AOG works 10 phone and has 32 zones and 79 countries, the last two being OQ5AB and CR7AK. We hope that Fred will be on his feet again real soon.

It looks very much like we are going to have a chance to work Little America again. Byrd and his gang, which includes a number of hams, are on the way. They are very well equipped with radio gear and after they once get going in April or May we should have many fine contacts. The West Base will use the call KC4USA, the East Base using KC4USB and even the Snow Cruiser has a call, KC4USC. Some guy around here who saw that call said, "Oh, the Trojan Warhorse!"

W3LE, Lou Bremer, caught in an off moment when he took time out from dxing.

The first weekend of the World Wide DX Contest has just finished. This is no time to give any predictions as to the outcome, but one thing is certain: it seems to be meeting with approval. Conditions are not too bad. I can remember many times when they have been much worse. We truly miss the VK's, ZL's, G's, D's, SP's, F's, and all the rest . . . and we're all hoping that they will be with us again before too long. During the past four years dx has come pretty easy for the boys breaking into the game. Before that, the oldsters will remember, you had to dig, strain, struggle and cuss sometimes to get a few thousand points. Today is more reminiscent of those days. Your suggestions will always be accepted and welcome regarding the contests.

What Do You Want?

During the past year many, many letters have come into this department's mail basket. Practically all of them offer a suggestion or two in regard to the Honor Roll, Marathon, Frequency Lists, Zone and Country verifications, etc. It has always been foremost in my mind to run the column according to the likes of the majority . . . provided of course the majority doesn't expect too much. This is as good a time as any to shout loud, lusty and long before what you want this next year. I am listing a number of questions which will give you a clue as to what might be involved. Your answers will be expected as soon as possible . . . within the month of January, shall we say. We shall assume those not answering are satisfied with the present method in use.

1. Do you want a 1940 DX Marathon?
2. Shall we require confirmations for zones?
3. Shall we require confirmations for countries?
4. Shall we list both confirmed and claimed?
5. Do you want the World Wide DX Contest the same time next year? If not, when?
6. Is the present method of "phone-to-phone" in the Honor Roll still satisfactory? Or would you prefer to revert to the original method of phone to either c.w. or phone?

If there are other ideas you may have which you would like to pass along, please do not hesitate to do so. No guarantees can be made that we can do everything requested. For example if a majority of you decide it would be better to have confirmations for both zones and countries, we would still have the problem of finding out how we could handle this extra detail.

Next month I'll try to give you some kind of an idea of some unofficial DX Contest scores. At least we'll have a rough idea of what went on, but the official results will have to wait for a while. A few calls heard in the contest, but having no definite information, are VE7AC who said he was in Baffin Land, and PZ6ZK and VU2XX. It just dawned on me that W6PDB is a proud "papa," and W4DRZ now has a jr. op.

Well, it's about that time again . . . to wind this up. Keep firing that stuff in to me, and especially any news regarding our friends overseas. We all like to know how they are getting along. Yes, I worked a W9 for my zone 4.

Countries of the World

WITH PREFIXES AND ZONES

This country list is a revision of the list published in the January, 1939, issue. After January 1, 1940, this will be the official list for determining accepted countries for the WAZ Honor Roll and other RADIO DX activities and contests.

Country	Zone	Prefix
Aden	21	
Aegean Islands	20	
Afghanistan	21	YA
Alaska	1	K7
Albania	15	ZA
Aldabra Islands	39	
Algeria	33	FA
Andaman Islands	26	
Andorra	36	PX
Anglo-Egyptian Sudan	34	ST
Angola	36	CR6
Argentina	13	LU
Ascension Island	36	ZD8
Australia	29-30	VK
Azores Islands	14	CT2
Bahama Islands	8	VP7
Bahrein Islands	21	VU7
Baker, Howland, Am. Phoenix, and Enderbury Islands	31	KF6
Balearic Islands	14	EA6
Baluchistan	21	
Barbados	8	VP6
Bechuanaland	38	
Belgian Congo	36	OQ
Belgium	14	ON
Bermuda Islands	5	VP9
Bhutan	22	
Bolivia	10	CP
Borneo, Netherlands	28	PK5
Brazil	11	PY
British Honduras	7	VP1
British North Borneo	28	VS4
Brunei	28	
Bulgaria	20	LZ
Burma	26	XZ
Cameroons, French	36	FE8
Canada	1 to 5	VE
Canal Zone	7	(K5)
Canary Islands	33	EA8
Cape Verde Islands	35	CR4
Caroline Islands	27	J9P-
Cayman Islands	8	VP5
Celebes and Molucca Islands	28	PK6
Ceylon	22	VS7
Chagos Islands	39	VQ8
Channel Islands	14	G
Chile	12	CE
China	23-24	XU
Chosen (Korea)	25	J8C-
Christmas Island	31	ZC3
Clipperton Island	7	
Cocos Island	7	TI
Cocos Islands	28	ZC2
Colombia	9	HK
Comoro Islands	39	
Cook Islands	32	ZK1
Corsica	15	
Costa Rica	7	TI
Crete	20	SV
Cuba	8	CM-CO
Cyprus	20	ZC4
Czechoslovakia	15	OK
Danzig	15	YM
Darien (Kanto-shu)	24	J8P-
Denmark	14	OZ
Dominican Republic	8	HI
Easter Island	12	
Ecuador	10	HC
Egypt	34	SU
Eire (Irish Free State)	14	EI
England	14	G
Eritrea	37	
Estonia	15	ES
Ethiopia	37	I
Faeros, The	14	OY
Falkland Islands	13	VP8
Fanning Island	31	VR3
Federated Malay States	28	VS2
Fiji Islands	32	VR2
Finland	15	OH
France	14	F
French Equatorial Africa	36	FQ8
French India	22	FN
French Indochina	26	FI8
French Oceania	32	FO8
French West Africa	35	FF8
Fridtjof Nansen Land (Franz Josef Land)	40	
Galapagos Islands	10	
Gambia	35	ZD3
Germany	14	D
Gibraltar	14	ZB2
Gilbert & Ellice Islands and Ocean Island	31	VR1
Goa (Portuguese India)	22	CR8
Gold Coast (and British Togoland)	35	ZD4
Gough Island	38	
Greece	20	SV
Greenland	40	OX
Gaudeloupe	8	FG8
Guam	27	KB6
Guatemala	7	TG
Guiana, British	9	VP3
Guiana, Netherlands (Surinam)	9	PZ
Guiana, French, and Inini	9	FY8
Guinea, Portuguese	35	CR5
Guinea, Spanish	36	
Haiti	8	HH
Hawaiian Islands	31	K6

Hejaz	21	HZ
Honduras	7	HR
Hong Kong	24	VS6
Hungary	15	HA
Iceland	40	TF
Ifni	33	
India	22	VU
Iran (Persia)	22	EP
Iraq (Mesopotamia)	21	YI
Ireland, Northern	14	GI
Isle of Man	14	G
Italy	15	I
Jamaica	8	VP5
Jan Mayen Island	40	OY
Japan	25	J
Jarvis Island, Palmyra group	30	KG6
Java	28	PK
Johnston Island	31	KE6
Kenya	37	VQ4
Kerguelen Islands	22	
Kuweit	21	
Laccadive Islands	22	
Latvia	15	YL
Leeward Islands	8	VP2
Liberia	35	EL
Libya	34	
Liechtenstein	14	
Lithuania	15	LY
Luxembourg	14	LX
Macau	24	CR9
Madagascar	39	FB8
Madeira Islands	33	CT3
Maldive Islands	22	VS9
Malta	15	ZB1
Manchukuo	24	(MX)
Marianas Islands	27	
Marshall Islands	31	J9P-
Martinique	8	FM8
Mauritius	39	VQ8
Mexico	6	XE
Midway Island	31	KD6
Miquelon and St. Pierre Islands	5	FP8
Monaco	14	
Mongolia	23	
Morocco, French	33	CN
Morocco, Spanish	33	EA9
Mozambique	37	CR7
Nepal	22	
Netherlands	14	PA
Netherlands West Indies (Curacao)	9	PJ
New Caledonia	32	FK8
Newfoundland and Labrador	5	VO
New Guinea, Netherlands	28	PK6
New Guinea, Territory of	28	VK9
New Hebrides	32	FU8, YJ
New Zealand	32	ZL
Nicaragua	7	YN
Nicobar Islands	26	
Nigeria (British Cameroons)	35	ZD2
Niue	32	ZK2
Non-Federated Malay States	28	VS3
Norway	14	LA
Nyasaland	37	ZD6
Oman	21	
Palau (Pelew) Islands	27	
Palestine	20	ZC6
Panama	7	HP
Papua Territory	28	VK4
Paraguay	11	ZP
Peru	10	OA
Philippine Islands	27	KA
Phoenix Islands (British)	31	(VR2)
Pitcairn Island	32	VR6
Poland	15	SP
Portugal	14	CT
Principe and Sao Thome Islands	36	
Puerto Rico	8	K4
Reunion Island	39	FR8
Rhodesia, Northern	36	VQ2
Rhodesia, Southern	38	ZE
Rio de Oro	33	
Roumania	20	YR
St. Helena	36	ZD7
Salvador	7	YS
Sardinia	15	
Samoa, American	32	KM
Samoa, Western	32	ZM
Sarawak	20	VS5
Saudi Arabia	21	
Scotland	14	GM
Seychelles	39	VQ5
Siam	26	HS
Sierra Leone	35	ZD1
Socotra	37	
Solomon Islands	31	VR4
Somaliland, British	37	VQ6
Somaliland, French	37	FL8
Somaliland, Italian	37	
South Georgia	13	VP8
South Orkney Islands	13	VP8
South Shetland Islands	13	VP8
Southwest Africa	38	ZS3
Soviet Union:		
European Russian Socialist Federated Socialist Republic	16	U1, 3, 4, 7
White Russian Soviet Socialist Republic	16	U2
Ukrainian Soviet Socialist Republic	16	U5
Transcaucasian Socialist Federal Soviet Republic	21	U6
Uzbek Soviet Socialist Republic (Uzbekistan)	17	U8
Turkoman Soviet Socialist Republic	17	U8
Asiatic Russian S.F.S.R.	18-19	U9, U0
Spain	14	EA
Straits Settlements	28	VS1
Sumatra	28	PK4
Svalbard (Spitzbergen)	40	
Sweden	14	SM
Switzerland	14	HB
Syria	20	
Taiwan (Formosa)	24	J9C-
Tanganyika Territory	37	VQ3
Tangier Zone	33	EK
Tannu Tuva	23	
Tasmania	30	VK7
Tibet	23	AC4
Timor, Portuguese	28	CR10
Togoland, French	35	FD8
Tokelau (Union) Islands	31	

Tonga (Friendly) Islands	32	VR5
Transjordan	20	ZC1
Trinidad and Tobago	9	VP4
Tristan da Cunha	38	ZD9
Tunisia	35	FT4
Turkey	20	TA
Turks and Caicos Islands	8	VP5
Uganda	37	VQ5
Union of South Africa	38	ZS
United States	3-4-5	W (N)
Uruguay	13	CX
Venezuela	9	YV
Virgin Islands	8	KB4
Wake group	31	KC6
Wales	14	GW
Windward Islands	8	VP2
Wrangel Islands	19	
Yemen	21	
Yugoslavia	15	YT-YU
Zanzibar	37	VQ1

AUTO LICENSE PLATES

Bearing Your Radio Call Letters

The squib on page 63 of the October, 1938, issue of RADIO and the photograph which ran on page 74 of the March, 1939, issue (repeated herewith) has created quite a flurry of requests as to how the Michigan hams "dunit," for as every ham on the air now knows a ham in Michigan may secure automobile license plates bearing his radio call letters instead of the type of letter-figure combinations usually assigned to such plates.

We know that the proper authorities have been approached in other states, but know of no state other than Michigan in which a definite plan has yet been arranged.

The U.C.A.R.A. is circulating petition forms for New Jersey. Any New Jersey ham who has not received such a form may secure one by writing the U.C.A.R.A. at 106 Orchard Street, Elizabeth.

In California a similar request was turned down about a year ago, due to the fact that the state officials had been sued for copyright infringement on certain license plates issues bearing non-standard combinations of letters and figures, and they weren't taking any more chances, even if these combinations were assigned by the federal government! The recent change in state administration may induce California hams to try again.

For the convenience of hams who wish to secure similar license plates in their states, we append a convenience "petition form." We suggest that you *don't use it!* The use of form petitions is so overdone in these days of high-pressure propaganda, that persons who receive them must discount them heavily. *Your own letter in your own words* will be worth more than a dozen forms.

A few hundred to a few thousand individual requests for special license plate combinations would throw a severe burden on the clerical staff of any motor vehicle commissioner or similar official at a time of year when it is swamped anyway. Therefore, it is suggested that any plan proposed to the state officials should provide for all requests to be handled annually through some leading radio club or association of clubs or other suitable organization, so that the entire lot including the necessary payments may be forwarded to the state offices in one group at one time.

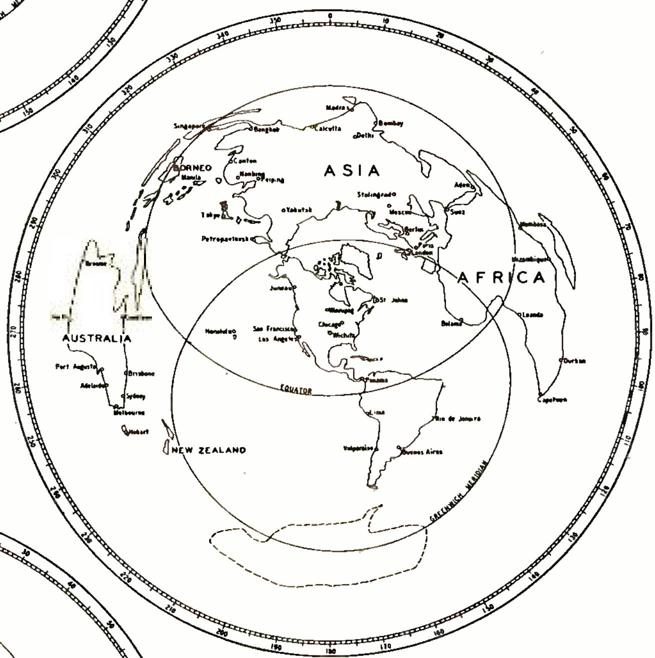
To the Motor Vehicle Commissioner
or similar official of the
State of ....

The undersigned radio amateur duly licensed for amateur radio transmission by the Federal Communications Commission respectfully requests that this state permit the issuance to resident radio amateurs of automobile license plates bearing their federally licensed radio call letters in lieu of the combinations usually issued by this state, in accordance with the practice already permitted in the State of Michigan and unofficially promised in other states, as a slight recognition of the services performed by such radio amateurs to the people of the state in times of emergency when regular means of communication are out of order, such services always being rendered by such amateurs entirely at their own expense.

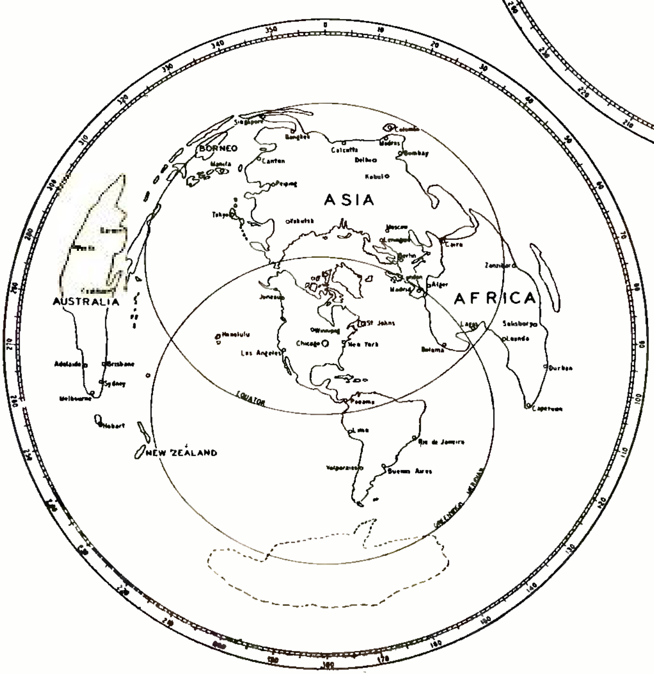
Licensed Call Signature ....

Letters .... Address ....

CENTERED ON LOS ANGELES

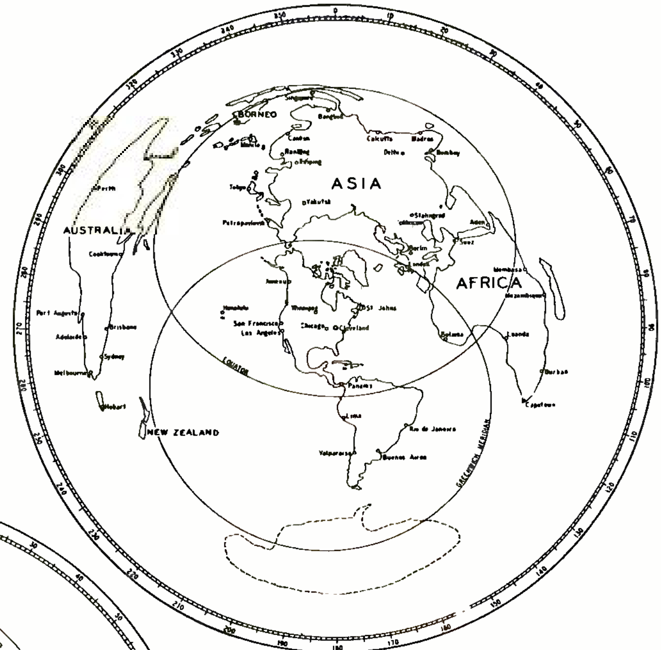


CENTERED ON WICHITA

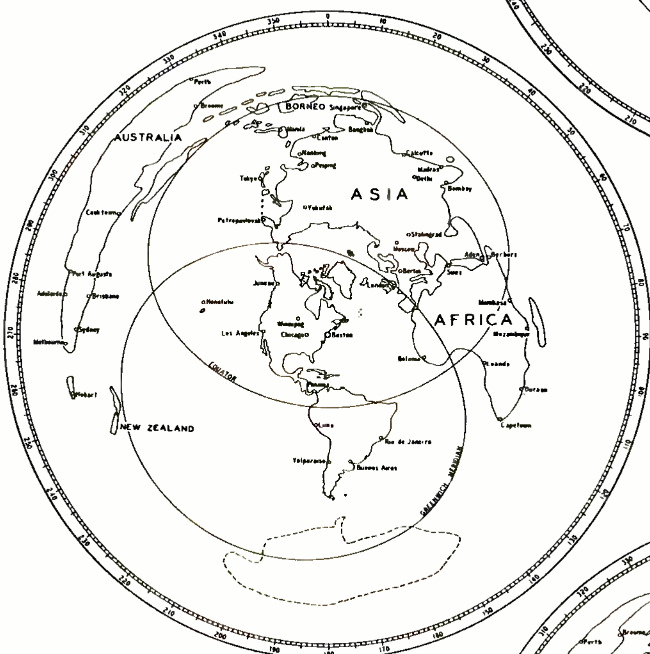


CENTERED ON CHICAGO

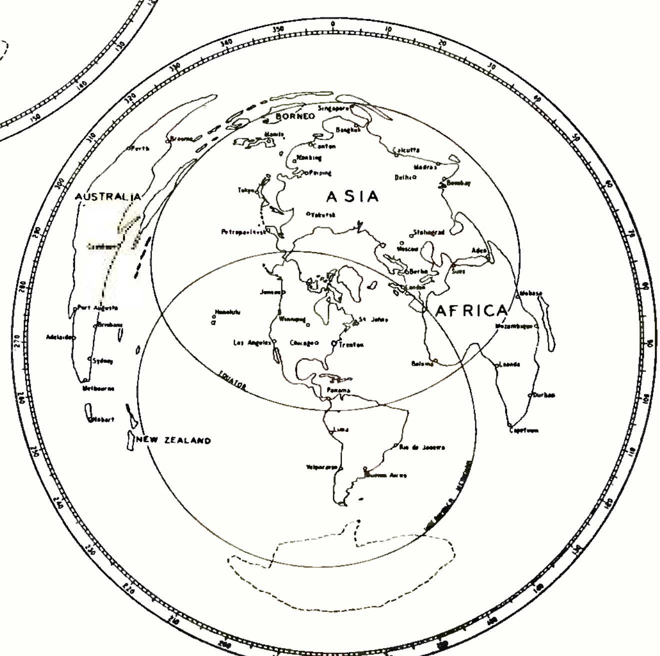
SCALE OF STATUTE MILES
0 5000 10000



CENTERED ON CLEVELAND



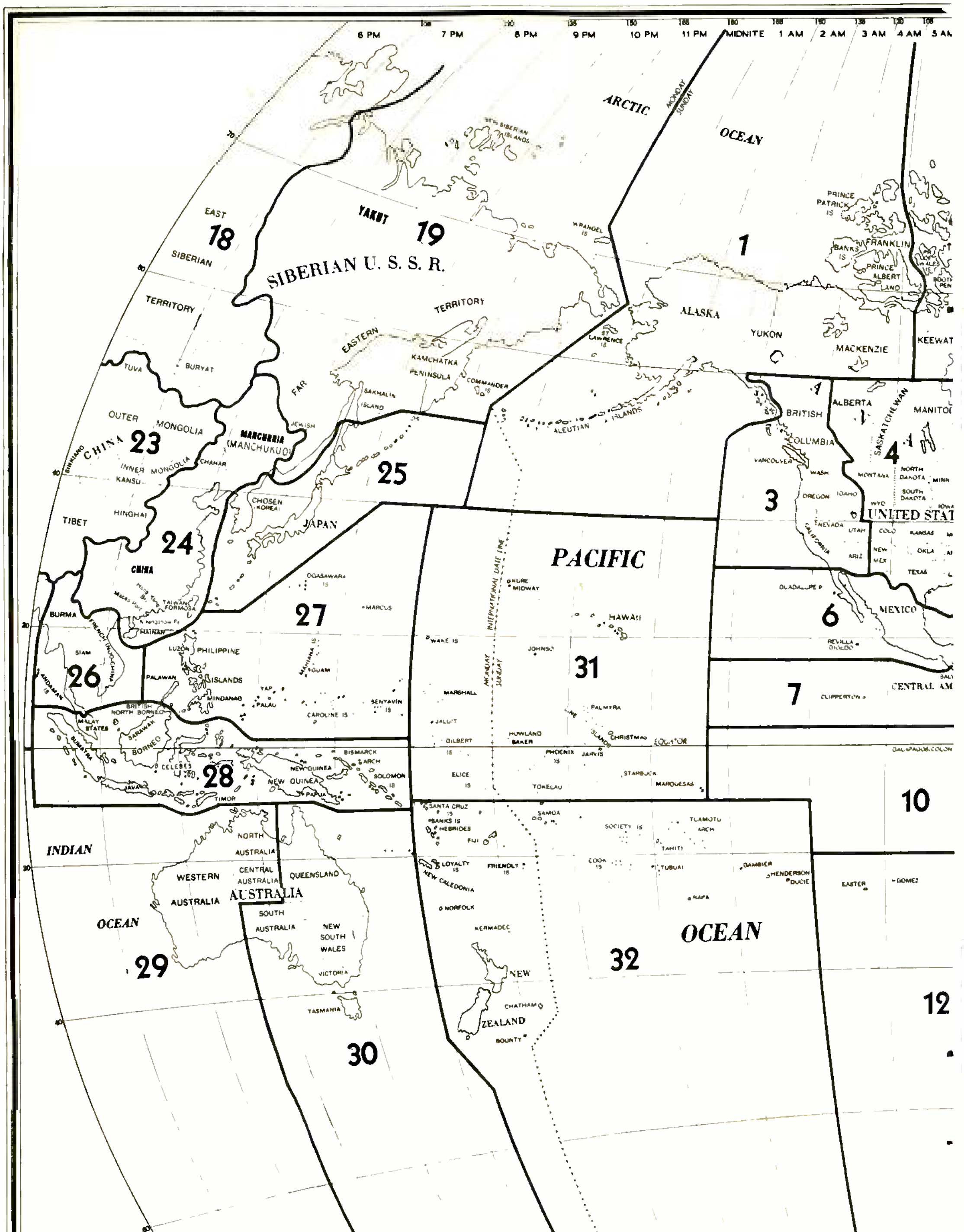
CENTERED ON BOSTON



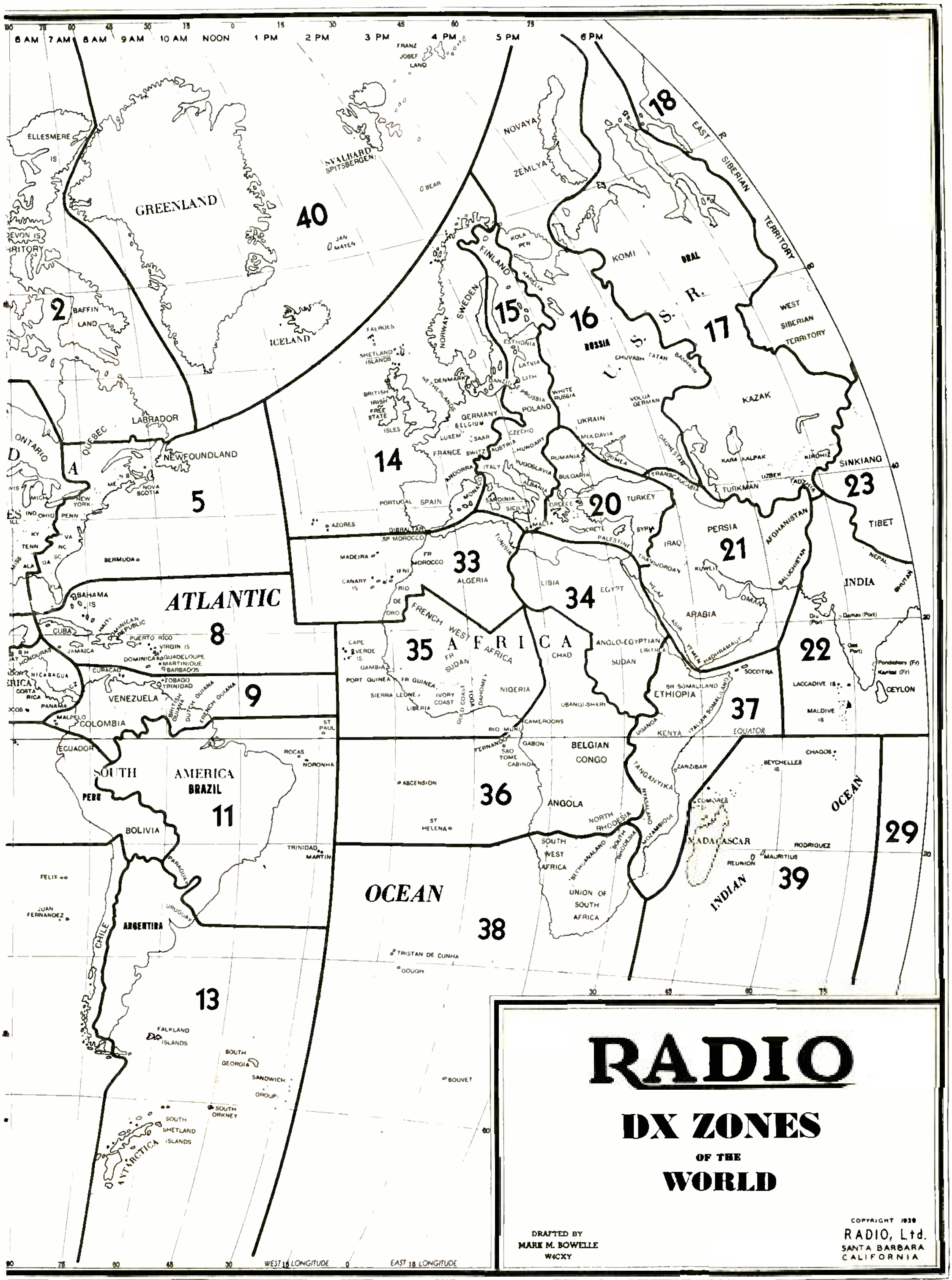
CENTERED ON TRENTON

SCALE OF STATUTE MILES

0 5000 10000



An enlarged duplicate of this map 28" x 50" on heavy white paper and including the six great-circle maps shown on pages 124 and 125 is available for 35c (or 7 international postal reply coupons) from our Circulation Department. The component maps are not sold separately. —*The Editors.*


6 AM
7 AM
8 AM
9 AM
10 AM
NOON
1 PM
2 PM
3 PM
4 PM
5 PM
6 PM
FRANZ JOSEF LAND
ELLESMERE IS
GREENLAND
40
SVALBARD (SPITSBERGEN)
BEAR
JAN MAYEN
NOVAYA ZEMLYA
18
EAST SIBERIAN TERRITORY
DEVON IS
2
BAFFIN LAND
ICELAND
FAEROES
SHETLAND ISLANDS
NORWAY
SWEDEN
FINLAND
KOLA PEN
KARELIA
15
16
RUSSIA
KOMI
URAL
U. S. S. R.
17
WEST SIBERIAN TERRITORY
CHUVASH
TATAR
BASHKIR
ESTHONIA
LATVIA
LITH
DENMARK
NETHERLANDS
BRITISH ISLES
IRISH FREE STATE
GERMANY
BELGIUM
LUXEM
SAAR
DANZIG
E PRUSSIA
POLAND
WHITE RUSSIA
VOLGA GERMAN
KAZAK
UKRAIN
MOLDAVIA
CZECHO
AUSTRIA
HUNGARY
CRIMEA
LABRADOR
ONTARIO
QUEBEC
NEWFOUNDLAND
NOVA SCOTIA
14
FRANCE
SWITZ
ITALY
RUMANIA
YUGOSLAVIA
BULGARIA
ALBANIA
ANDORRA
MONACO
SARDINIA
SICILY
GREECE
MALTA
CRETE
DAGHESTAN
TRANSCAUCASIA
KARA KALPAK
KIRGHIZ
SINKIANG
UZBEK
TURKMAN
TADZHIK
23
5
NEW YORK
PENN
OHIO
IND
KY
TENN
VA
NC
SC
GA
ALA
MISS
PORTUGAL
SPAIN
GIBRALTAR
AZORES
SP MOROCCO
20
TURKEY
SYRIA
PALESTINE
IRAQ
PERSIA
AFGHANISTAN
21
TIBET
BERMUDA
MADEIRA
FR MOROCCO
33
ALGERIA
TUNISIA
TRANSJORDAN
KUWEIT
BALUCHISTAN
NEPAL
BHUTAN
INDIA
BAHAMA IS
ATLANTIC
CANARY IS
IFNI
RIO DE ORO
LIBIA
EGYPT
34
HEJAZ
OMAN
ARABIA
CUBA
HAITI
DOMINICAN REPUBLIC
PUERTO RICO
VIRGIN IS
JAMAICA
8
FRENCH WEST AFRICA
35
AFRICA
CAPE VERDE IS
GAMBIA
FR SUDAN
CHAD
ANGLO-EGYPTIAN SUDAN
ERITREA
ASIR
YEMEN
HADHRAMAUT
SOCOTRA
22
DOMINICA
GUADELOUPE
MARTINIQUE
BARBADOS
NICARAGUA
COSTA RICA
PANAMA
CURACAO
TOBAGO
TRINIDAD
PORT GUINEA
FR GUINEA
SIERRA LEONE
LIBERIA
IVORY COAST
GOLD COAST
TOGO
DAHOMEY
NIGERIA
BR SOMALILAND
ETHIOPIA
LACCADIVE IS
CEYLON
MALDIVE IS
VENEZUELA
BRITISH GUIANA
DUTCH GUIANA
FRENCH GUIANA
9
COLOMBIA
MALPELO
ST PAUL
RIO MUNI
CAMEROONS
UBANGI-SHARI
UGANDA
KENYA
ITALIAN SOMALILAND
37
EQUATOR
ECUADOR
FERNANDO PO
SAO TOME
CABINDA
GABON
BELGIAN CONGO
ZANZIBAR
SEYCHELLES IS
CHAGOS
ROCAS
NORONHA
SOUTH AMERICA
PERU
BRAZIL
11
ASCENSION
36
TANGANYIKA
COMORES
OCEAN
ANGOLA
NYASALAND
ST HELENA
BOLIVIA
NORTH RHODESIA
MOZAMBIQUE
29
TRINIDAD
MARTIN
SOUTH WEST AFRICA
BECHUANALAND
SOUTH RHODESIA
MADAGASCAR
RODRIGUEZ
REUNION
MAURITIUS
39
FELIX
JUAN FERNANDEZ
PARAGUAY
URUGUAY
ARGENTINA
CHILE
OCEAN
UNION OF SOUTH AFRICA
INDIAN
38
TRISTAN DE CUNHA
GOUGH
13
FALKLAND ISLANDS
SOUTH GEORGIA
SANDWICH GROUP
BOUVET
SOUTH ORKNEY
SOUTH SHETLAND ISLANDS
ANTARCTICA
WEST 15 LONGITUDE
EAST 15 LONGITUDE
RADIO
DX ZONES
OF THE
WORLD
DRAFTED BY
MARK M. BOWELLE
W6CXY
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SANTA BARBARA
CALIFORNIA

U. H. F. . . .

By E. H. CONKLIN, W9BNX*

28 MEGACYCLES

How far can you work when the ten-meter band is closed? Which antenna polarization produces the best pre-skip dx? Does the station you work at a good distance—100 miles or so—have to use an antenna with a similar polarization?

These are some of the questions on which we should like to receive comments from our readers. With 1940 here, the sunspot cycle is well off the peak; in a very few years, winter F_2 layer skip may be confined to South American signals and occasional days for other dx, while summer sporadic-E layer skip may be less prevalent. Ten meters, like five, will still be excellent for the same type of work out to a couple of hundred miles, with a much greater probability of a few hours of interdistrict or dx signals; it is this "pre-skip" work that will probably have to be counted on to sustain interest in the band about 1943, or before.

An example of the spotty nature of sporadic-E patches is given to us by VE2JZ, now at Cambridge, Mass., who operated at Comeau Bay, Quebec, last summer. On several days, one of which was August 21, he and VE2KX worked lots of W's all of whom said that they could hear no other signal on the band.

Eugene Cole has on several occasions remarked upon the difficulty often encountered in Marquette, Michigan, of raising ten-meter stations. An example is June 12 when the band was hot at 400 miles with signals really pouring in. For three hours he called without a contact, although he had no trouble the previous day. He feels that the band in his town is sometimes a one-way proposition.

Some unexplained and peculiarly consistent 11-meter reception has been reported by Percy Ferrell in Pleasantville, New Jersey. He has been listening to W8NXU in Cincinnati, something like 400 miles airline. The signal comes in around 7:15 a.m. Eastern time shortly after they come on the air, and around the beginning of November, they were audible during every daylight hour, with a deep fade. The peak strength is at about 9 a.m. The shortest winter F_2 layer skip on 11 meters that Ferrell has observed is 690 miles, and is seldom less than 800 miles, so it hardly explains this consistent reception. No beams had been put up to see if the reception is direct or indirect. During the period when W8XNU is loudest, W3EOZ about 80 miles distant comes in with a rain-barrel fade, as though he were talking in an 8-foot room walled with tin plate! Best dx signals in early November were HA1K and OQ5AB.

But for a really "screwy" proposition, we return to some observations made by W9QDA in Chicago. We take this stuff seriously and hope that we aren't being "put on," but here is the dope. First, he agrees with W3BYF that the beam is best pointed north for Aurora skip, even on ten meters. As an example, one day W2's were coming through with a loud background noise, but turning the beam north cleared them up remarkably. The second condition, one that has been mentioned in these columns before, is regularly observed now whenever F_2 layer skip is bringing in European or African signals. A group of ten-meter phones in Chicago, Detroit, Syracuse, Coral Gables (Florida), Mobile, Baltimore and elsewhere get hooked up in an 8- 10- or 12-way QSO. Ordinary F_2 layer skip certainly won't account for such a variety of short distances. The amazing thing, though, is that W9QDA reports contacts possible only when all stations point their beams to the southeast! This reminds us of a statement made by an engineer of the Naval Research Laboratory in 1928 that ionosphere measurements were bringing in some unaccounted reflections that apparently were the result of the signal going out to a point in the Atlantic like Bermuda, and bouncing back again.

56 MEGACYCLES

The condition of getting dx signals better when the beam is pointed north during an Aurora display, was reported by W3BYF several months ago. Now comes W8NOR with a confirmation of this condition observed last May, proved both on horizontal and vertical beams. NOR talked about it with W8RV who had noted the same thing last spring when he worked an Ohio station during an Aurora display. Every time there are "northern lights" visible, NOR hears W2AMJ on c.w. working W1's, but not one of a

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* Ex-W9FM, Associate Editor, RADIO, Wheaton, Illinois.

great number of calls has been successful in making contact. With NOR north of Buffalo, and AMJ in New Jersey, it would make a nice contact.

New 56 Mc. Relay Record

What appears to be a record for the delivery of an addressed message was made on November 4 and 5 when W2NKF in Englewood, N. J., started a message to us in Illinois. W9VHG in Glenview, Illinois, took it across the lake from W8CVQ in Kalamazoo, Michigan, who got it via the relay chain from the east. Here is the message:

MSG NR 1 W2NKF CK 5 ENGLEWOOD N J 2 PM NOV 4 1939
TO W9BNX WHEATON ILL
HOPE THIS MAKES THE COLUMN
SIG W2NKF (Recd at W9VHG 11:05 p.m. Nov. 5)

Nice going, fellows! We do not have the details of the route taken by the message but assume that it is approximately the one through Pennsylvania that we tried to make work last winter, with the difficult central Pennsylvania gap filled by W8CIR/8 operating mobile in the mountains. The successful route in the first A.R.R.L. 56 Mc. relay contest was described in *QST*. Our hats are off to Ed Handy & Co., for making a contest out of it in order to get a number of five-meter stations on the air for the relay. We are glad to see the League take definite steps to encourage five-meter work by these relay contests and by the new column run by W1HDQ. Many years have passed since we proposed a u.h.f. column in *QST* to bring together observations, news and suggestions.

On the November 4-5 relay, W2MO found conditions relatively poor to W3DBC in Washington, almost 200 miles away, but made a contact. Messages, however, were routed through W3CUD, and W3BKB at York, Penna., a 150-mile jump. Conditions seemed to be the best of the year to the first district, permitting contacts with W1DEI in Natick, Mass.; W1HDQ at Mt. Wilberham (125 miles); and W1KTF who handled some of the traffic. W8CIR/8 who was located on Tuscarora Summit—with eight inches of snow on the ground and two inches of sleet on his feeders—copied one message direct from W2MO. W3FQS of Reading, W3BYF in Allentown, and many Philadelphia stations were contacted by MO, who uses 650 watts input, and has a new converter in front of his regular receiver.

Pre-Skip Work Improved

Other circuits of good length have been opened up in recent months by the increasing number of hams who find five-meter problems so interesting as to be worth real effort in developing better antennas, feeders, receivers and transmitters. W9ZJB in Kansas City has finally established contact with W9VWU in Topeka who is using 150 watts on a pair or 809's driving a three-element array. W9AHZ and W9SMM are also reported in Topeka but cannot hear VWU. The distance is 75 miles, covered consistently but with badly fading signals. ZJB is sending out a circular letter to hams within 200 miles of Kansas City urging them to get on five meters. He is lining up a group of stations in St. Joseph, Mo.; Falls City, Nebr.;

56 Mc. DX HONOR ROLL

Call	D	S	Call	D	S
W9ZJB	9	18	W2LAH	6	
W3AIR	8	24	W4DRZ	6*	
W3BZJ	8		W6QLZ	6	
W3RL	8	24	W8OJF	6	
W5AJG	8*	27	W9AHZ	6	
W8CIR	8*		W9NY	6	13
W8JLQ	8				
W8VO	8		W1JMT	5	9
W9ARN	8	15	W1JRY	5	
W1EYM	8		W1LFI	5	
W9CBJ	8		W2GHV	5	8
			V3GLV	5	
W9ZHB	7		W3HJT	5	
W2AMJ	7	22	W6DNS	5	
W2JCY	7		W6KTJ	5	
W2MO	7	25	W8EGQ	5	10
W3BYF	7		W8NOR	5*	16
W3EZM	7	24	W8OPO	5	8
W3HJO	7		W8PK	5	
W4EDD	7		W8RVT	5	7
W4FBH	7	19	W9UOG	5	8
W5CSU	7				
W5EHM	7		VE3ADO	4*	
W8CVQ	7		W1JNX	4	
W8QDU	7		W3FPL	4	8
W9CLH	7		W6IOJ	4*	
W9SQE	7		W8AGU	4	
W9USI	7	16	W8NOB	4	
W9VHG	7*		W8NYD	4*	
W9WAL	7				
W9QCY	7	10	W1KHL	3	
W9ZUL	7	11	W6AVR	3	4
			W6OIN	3	3
W1CLH	6	12	W7GBI	3	4
W1DEI	6	18	W8OEP	3	
W1VFF	6	11	W8OKC	3	6
W1LLL	6	17			
W2KLZ	6*				

* plus Canada. (reported In 1939)

Note: D—Districts; S—States

Omaha; and Des Moines in the hope of completing a circuit to W9ZHB in Illinois and on to the east. An alternative route is Butler, Mo., Jefferson City, or Columbia, and to W9GHW near St. Louis. At this point there is a break that will have to be filled in order to get through to W9ARN near Peoria, Illinois.

Each morning at 7:45 and evening at 7:00 Central time, W9RGH LLC BHT CBJ ARN ZHB in central Illinois get together and check on conditions. They are trying to find more stations especially to the south and west within 100 or 150 miles. W9CBJ in Washburn, Illinois, also mentions the local net; he puts 120 watts on HK24's now but will have a half kilowatt soon. His antenna is a "W9ZHB special" which, if we remember correctly, is horizontally polarized. W9ZHB never would tell us about it unless we drive down to see him; one of these cold wintry days we'll pack all of the children into the car and go down there.

In Glen View, Illinois, W9VHG has been active in the "trans-continental" relays. He has worked W8CVQ, about 120 miles away, fairly regularly on a vertically polarized antenna. CVQ uses two broadsided vertical W8JK's. But a vertical antenna would not bring in W9ZHB in Zearing about 100 miles away. VHG says, "So I put up an extended lazy-H (horizontal polarization) and it works fairly well but I want to put up a three-element horizontal that can be rotated which I think will work better. It begins to look to me as if a good horizontal antenna is the answer to extended ground wave work on five. The vertical antenna is f.b. for local contacts but doesn't seem to be much good for 100 to 200 mile contacts."

Perry Ferrell moved from Linwood to Pleasantville, N. J., and lost out on ground wave signals although seven-meter sky-wave signals are still good. On 55.75 Mc., he gets the sound channel from W2XAB, the CBS television transmitter in New York. This makes a good marker to indicate the nature of conditions to New York City. W2IKE in Tuckerton, N. J., is about the only signal he now hears.

Since September 25, W2MO and W3DBC have maintained a schedule over a distance somewhat short of 200 miles. Contacts were made about one night in three until DBC increased power to 700 watts, after which only four nights were missed in three weeks, and only one of these was due to conditions. MO schedules W3BKB in York, Penna., morning and evening on Sundays, over a 150 mile path. On November 3, MO worked W3GGR of Elkton, Md., who had moved his rig to a 400-foot elevation at Pleasant Hill, Maryland.

Whether it was low atmosphere bending or Aurora-type dx, we do not know; but on September 14 and 15 W2MO worked W8CIR who is west of Pittsburgh, intermittently over a three hour period like local; W8RUE in Pittsburgh was also contacted.

After being off the air, W8NOR returned on October 26 to work W8CIR west of Pittsburgh, for his first contact.

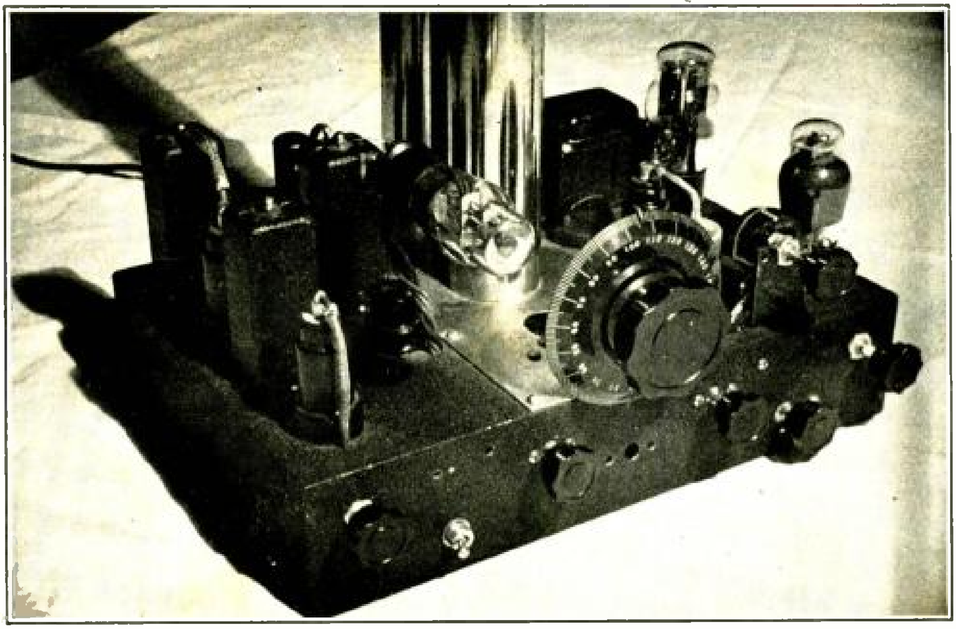
We have mentioned reception of W8QDU by W2KLZ on May 21 and June 13. This seems to be of the "Aurora type" rather than low atmosphere bending or sporadic-E skip. On May 21. W2KLZ and W8JHW took a ride up to Fort Edwards to see W8LWA. While listening on ten meters, mushy signals started to come through, suggesting that something would happen on five. Sure enough, at 9:45 W8QDU was heard on c.w. while the new concentric-line acorn-tube receiver was on its side on the work bench. On June 13, the band opened for flutter dx about nine p.m. Some signals got up to R8, making considerable racket. Although loud, phones could not be copied because of the rumble. Strengths were lower by ten o'clock but no one was identified except W8QDU in Detroit on c.w. at 11 p.m., and W8VO who came in several times. QDU was still coming through at midnight.

On October 14, W2KLZ saw a bright display of "northern lights" and heard a number of unidentified phones. At midnight he heard a keyed modulated signal sending V's and signing WQD. KLZ says that a lot of dx from New York City has been coming through to Albany all summer, including W1KTF KLJ HDQ W2AMJ MO and unkeyed carriers too weak to identify on phone. AMJ's carrier came through nearly every night. On rare occasions when there is Aurora, W1VC in Pittsfield, Mass., comes through. He is only 50 miles away but in the valley behind Mt. Greylock.

Occasional Skip DX Reported

September 2, October 7 and 13 were days of sporadic-E dx. During the relay contest on November 5, the band opened again. On November 5 around six p.m., W1CLH in Bridgeport worked W9CLH and W9VHG in Illinois. W2MO hooked W9GGH in Kenosha, Wisconsin, and W9ZHB in Zearing, Illinois.

W9ARN worked W1HDQ JLK JLI FBX KH and heard W1GDY DJ LLL BDI between 3:30 and 5:30 p.m. Central time. The Peoria stations were not able to hear W2's



The acorn-tube concentric-line-tuned receiver of W2KLZ. Gang tuning is used on the 956 r.f. stage and the 954 mixer; less trouble was experienced with gang tuning of pipes than is commonly had with gang tuning of coils at 56 Mc. The oscillator, a 954, uses a conventional 6-turn coil ½-inch in diameter and is tuned on the high-frequency side of the incoming signal. The pipes are 28½ inches long for the 56-Mc. band. Additional padding capacity could be used with the same pipes to cover the 28-Mc. band with a circuit Q still considerably higher than could be obtained with coils. More complete information on the receiver is given in the text.

but W9ZHB, somewhat north, worked both W1 and W2. Near Chicago, W9VHG worked W2HGU GHV W3CUD and heard W2AMJ MO W3HOH BZN. He says that it proves that the band is not quite so dead as some fellows seem to think it is.

W9QCY in Fort Wayne, Indiana, sends us a log for June and July dx, indicating that his antenna is 14 feet off the ground, co-axial fed. The Ohio and Michigan gang should help him stretch that line about 80 feet so he could provide some Indiana contacts via pre-skip dx.

W6QLZ has been hearing 43-Mc. signals from W1 and W2, during which time he transmits on 56 Mc., in the hope of an F_2 layer contact. He has had no luck so far.

Honor Roll

Additions to the Honor Roll are coming in, but we know that it is not complete. Let's have the dope—if the Roll gets long enough, it will serve the additional purpose of providing a list of stations with whom long pre-skip attempts can be made. So when you write us, give us all the local news as well as your own.

Antennas

Above, we mentioned W9VHG's experiences with a horizontal antenna. We shall also quote W8NOR on this subject:

"It burns me up every time someone says that the vertical beam has it over the horizontal beam for ground wave dx. I doubt this very strongly. The reason that they say this is because they listen to a vertically polarized transmitted signal. In case you don't think this means anything, try it some time with antennas low, twenty miles apart, over flat country. I built my horizontal beam just to prove horizontal antennas to be better, but I could get no coöperation from distant (50-200 mile) stations to change to horizontal polarization. As a result, I haven't proved my point yet. How about promoting the idea of using horizontal antennas for 2½ and 1¼ meters. They are certainly easier to build, rotate, tune, balance, and feed."

Ganged Receiver

When a receiver engineer saw the Avery-Conklin concentric-line-tuned receiver described in RADIO for June, he said, "And what's the periscope for?" Woody Smith, ye ed., said something about the plumbing. But the crowning blow was struck by Ray Dawley, technical editor of this here sheet, who called it a "sewer pipe receiver." We can take a lot, though, especially when it may encourage construction of acorn-tube, concentric-line-tuned receivers by fellows who really want gain and signal-to-noise ratio on ultra-high frequencies. So just to show that we are not the only ones to succeed in building one, we'll quote from W2KLZ's letter describing his ganged tuning job:

"The tube line-up is 956 r.f. amplifier, 954 first detector, 955 oscillator, two 6K7 i.f. tubes, 6H6 second detector and a.v.c., 6Q7 first audio, 6K6 power amplifier, 6J7 beat oscillator, 6E5 tuning eye, and if I had another socket hole I'd put a noise silencer in it.

"Yes, it is ganged. It was much easier to track with pipes than with coils. It is a very simple matter to make the circuits track perfectly if pipes, tubes and condensers are identical. On this receiver, to make sure of perfect resonance of the r.f. and first detector circuits, I have 30-μμfd. trimmers across the regular tuning condensers. These trimmers are adjustable from the panel of the receiver by the two center knobs. I like this arrangement because you can peak the receiver up to optimum sensitivity for a very weak signal. In ordinary tuning I don't touch these controls. To track the oscillator, I use a six turn coil ½ inch in diameter with a 30-μμfd. trimmer across this tuned circuit adjusted so that the oscillator is on the high frequency side of the signal frequency. All three tuning condensers are kept at the same capacity. The i.f. is tuned to about 1500 kc. The present transformers are not iron core but the latter would be worth while, I think. There is no image interference at all with the pipes but when I had coils in the tuned circuits the image was quite strong.

"Here's a funny thing, Bill. I tried coupling the antenna through your tuned and untuned coil arrangement but was very disappointed with the results. Even W8EID's signal just slightly winked the tuning eye. I tried all sizes and shapes of coils but no soap. Finally I tried tapping one feeder wire directly on the grid rod. What a difference it made. W8EID's signal now closes the tuning eye completely although it has to be R9 to do this. The antenna is a two section W8JK end fed with a 600 ohm line and matching stub. I bring both feeders to the receiver but only one is tapped on to the rod. Why it works is a mystery but it does. The feeders are not radiating because when the beam is swung broadside to a signal it will nearly disappear.

"The r.f. stage has fixed bias on it which accounts for a very good signal-to-noise ratio. The bias is adjustable by the knob to the left of the 80 rectifier. To protect the r.f. tube from an overdose of r.f. from the transmitter, there is a device on the first pipe which shorts the grid to ground when the receiver plate supply is switched off. Also, the bias on the r.f. tube is fed through a 4 megohm resistor which limits the grid current if it should get a dose of r.f.

"The band is from 100 to 150 on the dial using 20-μμfd. condensers and 28½ inch pipes. No beat oscillator harmonics are heard.

"Altogether, it makes a very fine receiver and it lives up to all the claims you made for it. Not only the sensitivity is better than an ordinary super but it is more stable and more selective."

Thanks for all of those kind words, Bob.

W9SQE has nearly convinced W9VHG that one of these jobs would be the thing. VHG is starting gradually with a preselector, with room to expand it into a converter when he is convinced.

Miscellany

These comments on five-meter activity made by W2MO are of interest:

"Activity on 56 Mc. has been quite unsatisfactory because of the lack of newcomers to the band since the advent of the new regulations. Prior to the beginning of this year, I was able to work an average of 300 new stations per year—almost one new station per day—and reference to my complete card file shows most of these new stations to have been those who recently received calls. So far this year (to November 7) I have been able to add only slightly over 100 new stations although I now have 650 watts instead of 200, and a good converter before a superhet instead of a one-ten superregen. I have been on the air at least as much as any previous year. It is true that the newcomers did not stay on the band, but there was always a crop of new ones who maintained enough activity so that the few stations regularly on the band never failed to find activity. Now, however, those regularly on the band find contacts much less frequent than before. Therefore, I should like to sug-

[*Continued on Page 179*]

The Amateur Newcomer

A MULTIPLE OUTLET PANEL

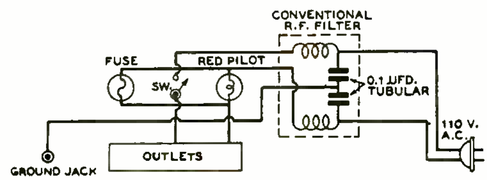
for the Station

By W. E. McNATT,* W8TLJ

Time and again when trying out something it's been necessary to pull out one or more cords from our limited number of wall outlets in order to accommodate a 110-volt connection to a power supply, soldering iron or other needed item. This limitation has always been a source of irritation and lost time. Recently, it was decided that something must be done about it.

The result is shown in the drawing of a little unit which was built to eliminate—we hope—the past prevailing shortage of outlets in our particular location. While rack-mounting construction was used in this particular case, there is no reason why the unit could not just as easily be a small cabinet affair if it is to be used on a work bench most of the time. Since our setup occupies a portion of a large bedroom, it was imperative (by demand) that all permitted items be put away when not in use.

With the exception of the 19" x 5¼" x 3/16" presdwood panel, which was cut out by a local lumber dealer at a cost of 25c, the entire unit consists of items from our



Suggested wiring diagram of the multiple-outlet unit.

favorite "5 & 10." The total cost of the parts was $1.55; of the assembled unit, $1.90.

While there is nothing at all complicated in either the construction or wiring, it might be well to explain a few points about the "gadget" which may not at first be quite clear. One thing in regard to the wiring, the pilot light is connected in parallel with the fuse. This is done so that the red pilot will light up if the fuse should accidentally be blown while one's attention is concentrated on some sort of test procedure. A glance at the pilot light will verify the presence or absence of the 110-volt supply, if something should occur to cause inoperation of a power supply under test, for instance. Another use

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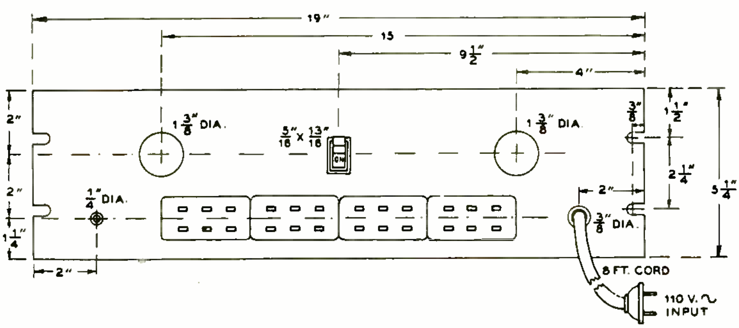
* Technical Dept., RADIO.

Plan drawing of the rack mounting multiple outlet panel. A similarly useful device could be constructed in the form of an outlet box which could be plugged into the nearest wall outlet.



of the parallel-connected fuse and pilot is the insertion of a light-bulb resistor in series with the power leads to the device being worked on. Simply unscrew the fuse and pilot lamp and insert the required light-bulb resistor into one of the sockets; or, if just any sort of resistor is desired, merely back off the fuse a couple of turns, thus leaving the pilot light in the circuit as the desired resistance. In order to facilitate the isolation of r.f. feed-back a conventional line filter was added to the circuit.

Constructional problems are at a most pleasing minimum. The bakelite lamp sockets are submounted with long machine screws on the panel so that their tops are flush with the front of the panel. In the same manner, the switch is also submounted, the necessary opening being cut into the panel for the lever. The type of outlet units used are those which accommodate 3 "flat" plugs, or 2 of the older style round plugs. The outlets are mounted on the panel by machine screws. Unless longer 4-40 or 4-36 screws are available than come with the outlets, it will be necessary to retap the bakelite case for ½" x 6-32 screws. Incidentally, the bakelite taps very easily.

The r.f. line filter is encased by a box, mounted on the rear of the panel, and the ground lead runs from the by-pass condensers to a small "banana-plug" type jack seen at the lower left in the drawing.

The maximum load which may be drawn through this unit is dependent primarily, of course, upon the carrying capacity of the outlet into which it is plugged. It is secondarily determined by the current capacity of the wire, outlets, switch and fuse used in its construction. Wire of the same size as that used in the house wiring system should be used throughout the outlet.

• • •

The 28 Mc. Band in War Times

By NELLY CORRY, G2YL

Conditions during October were similar to those of a year ago, but the general impression among the regular listeners seems to be that the band was quieter, not only because of the great reduction in the number of signals, but also because average QRK's were not up to the standard of recent years. Toward the end of the month the high frequency limit gradually increased, and G6DH heard U.S.A. signals up to 46 Mc. on October 25, and up to 42 Mc. on several other days. The band was exceptionally quiet on October 4, 6, 14, 15 and 17, and BRS3003 heard the hissing phenomenon at 16.17 G.m.t. on October 2, and at 15.25 G.m.t. on October 19.

The only amateur signals reported from Oceania and Asia were K6PLZ and U9ML, heard by BRS3179 and BRS3003, but G6DH logged JUM on about 27.5 Mc. fairly regularly around 08.00 G.m.t. BRS3179 also heard stations in J, XU, PK, KA and ZL being called, so there are still quite a few hams active on 28 Mc. in these continents.

From Africa a total of 28 ZS stations and OQ5AB were reported, and a few were logged every evening up to October 29, except for the 6th, 14th and 15th. BRS3003 heard 10 different ZS stations on October 9, 16.30-18.00 G.m.t., all using phone. But on October 29 BRS3179 overheard the sad news, from ZS5T, that he and all other ZS stations were being closed down from midnight on that date.

South Americans were only heard spasmodically, and those reported were CE3AG, PY2AC, PY2MI, PY4FE, YV1AQ and YV5AE. Central American and West Indian stations were more consistent and included HI7G, TG9BA, TI2AK, TI2FG, TI2RC, TI3AV, XE1CQ, XE2FC and five K4's. G5BM heard a new country in YN3DQ of Nicaragua on October 8.

W's were heard on most days, but were erratic during the periods October 3-7 and 13-20. BRS3179 found W6's and W7's more numerous than for many months, particularly on October 1 when he logged no fewer than 52 different W6's! The same evening at 19.00 G.m.t. G6DH heard 27 W6's and one W4 in half an hour, and on October 2 BRS3003 logged 20 W6's. Two American ship stations

[*Continued on Page 158*]

Sainted Barbers, Caulif.

Dear Hon. Ed.,

Scratchi are very sorrowfully that he are not able to write you last month to report on activities, but are get hisself all tangle-footed up in collosus loving affair while in E. Shroudsburg, Pu., and are in too much of dither to write own name even.

As you know, hon. ed., while Scratchi are not even having enough monies to make the down pavement on a carbarn resistor, he are a very illegible batchelor fellow just the same on account of he are so handsome. Maybe Scratchi are not quite having to beat off feemail admirers with club, but as I are often say those fellow Gaybull are got nothing on Scratchi when it come to sex apeel.

Well Scratchi are meat a very hot stuffs grass widdow name Crystal Watanabe what are fall for Scratchi like a ton of plate transformers. Also she are very buxom, hon. ed., very buxom indeed. You see her ex-husband are having lots of monies, not like peoples in radio business, and he are forking over lots of bux to her every month in alimoney. Now if there are anything what apeel to Scratchi more than bux, it are more bux. So Scratchi are turn on the old razzle dazzle and swoop her right off feets. Scratchi are not leaving grass grow under feets, even if she are a grass widdow, no sir. In one week Scratchi are got hisself engaged, with promise to buy her ring with rock the size of cockroach soon as get married up and she will give Scratchi monies to purchasing same.

Then are come the grate disallusionment. Oh, oh, woe are me. What you think, hon. ed., when Scratchi try to get Justice of Piece to perform ceremoney on charge act. baysis, with promise to give him fee soon as wife are get her next alimoney check, he are break tragic news to Scratchi that if Crystal get married she are no longer get alimoney from Mr. Watanabe. Are that not a shameful outrage, hon. ed.?

Well, Scratchi are suddenly realize that he are not longer got love for Crystal, and of course, hon. ed., it are only fare to her to let her know that Scratchi's love are no longer like an HK54 with 800 watt on plate, and he are no longer sigh like dying sea cow.

So Scratchi are manage to get hisself disengaged into celebait and are free sole once more, but are wishing could find buxom widdow who are got compleatly defunct husband and got all bux in one piece and not every month in alimoneys.

If you are having QTH of any of same Scratchi would be gratefull on account of if are not getting hisself monies some place soon will having to go to work, which as you know are violencely disagree with Scratchi.

Disgruntfully yours,
HASHAFISTI SCRATCHI

• • •

Government Printing Office
RADIO DOCUMENTS

The U. S. Government Printing Office publishes a large number of pamphlets and booklets that are of interest to radiomen. The following are available at the time of this writing:

Subject	Price
Act for regulation of radio communication, and for other purposes. Approved Feb. 23, 1927. (69th Cong., Public Law 632)	5c
Airplane radio set, type SCR-134, and receiving equipment used in conjunction therewith. (War Dept., Technical Regulations 1210-5.)	10c
Analysis of continuous records of field intensity at broadcast frequencies. (Standards Research Paper 752.)	5c
Application of vertical-incidence ionosphere measurements to oblique-incidence radio transmission. (Standards Research Paper 1100.)	10c
Applying visual double-modulation type radio range to the airways. (Standards Research Paper 148)	10c
Art of teaching by radio. (Educational Bulletin 4, 1933)	10c
Basic field manual, vol. 4, Signal communication. (Adjutant General's Dept.)	30c
Characteristics of ionosphere and their application to radio transmission. (Standards Research Paper 1001)	10c
Commercial aviation communication system showing radio station locations [in United States, with insets]; map. Scale 1:5,000,000. 1937. 23.7 x 38.3 in. (Federal Communications Commission.)	35c
Communications Act of 1934. Act to provide for regulation of interstate and foreign communication by wire or radio,	

[*Continued on Page 171*]

What's New . . . .

IN RADIO

DIRECTIONAL CRYSTAL MIKE

The new Model 44X Crystal Microphone of The Turner Co., Cedar Rapids, Iowa, gives selective directional pick-up. It has a 13-15 db differential between front and rear pick-up, so that the microphone may be considered dead at the back. This eliminates audience noises and background disturbances, and helps eliminate reflections, and reduces feedback problems. It allows microphone operation under bad acoustical conditions.

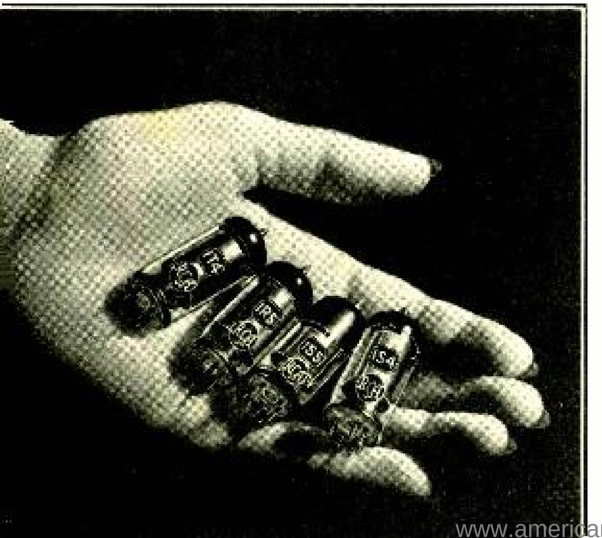
The 44X has a 90-degree tilting head, for semi- and non-directional operation. The level is —58 db with 25-foot cable. Fifty-foot lines are possible without frequency discrimination, and with minimum loss of level. Response is smooth from 30-10,000 cycles. It is finished in full satin-chrome, and fits any 5/8-27 stand. Model 44X has a moisture-proofed crystal automatic barometric compensator, and is free from blast. It is mechanically shock-proof.

NEW RCA MINIATURE TUBES 1R5, 1S4, 1S5, and 1T4

RCA has recently announced to equipment manufacturers a series of 1.4-volt miniature receiving tubes of radically new design. The four new tubes are illustrated in the accompanying photograph. Together they provide a complete complement for the design of compact, light-weight, portable equipment. They are unusually small in size (only about 2" in length and ¾" in diameter) and highly efficient in operation from a 45-volt B supply. The high operating efficiency of the new types has been attained by a new design which provides compactness without decreasing the size of the essential electrode parts. Compactness has been achieved by replacing the conventional base with a new glass "button 7-pin" base sealed to the glass envelope and by mounting the electrodes directly on the glass button.

The functions of the tubes are as follows: 1R5, pentagrid converter; 1S4, power amplifier pentode; 1S5, diode-pentode; 1T4, super-control r.f. amplifier pentode. All tubes have 1.4-volt filaments and are designed to operate directly from a 1.5-volt dry cell. The power-amplifier pentode has a filament drain of 100 ma. while all the other three drain only 50 ma. from the filament supply. The electrical characteristics of the tubes are more or less what would be expected from miniature tubes which are designed to operate from a 45-volt supply. However, they do have one feature which should be quite valuable in u.h.f. work, both portable and fixed: their interelectrode capacities are approximately half those of the conventional 6.3-volt receiving tubes. This fact places them in a class intermediate in suitability to u.h.f. work between the acorn tubes and the tubes of the 6J7 class.

This feature coupled with their extremely low power requirements and very small size should make them ideally suited to pack-type u.h.f. equipment where it is felt that the usage of the equipment would not warrant the expenditure for acorns.



WUNDERLICH RADIATOR CONNECTORS

Wunderlich Radio, Inc., San Francisco Airport, So. San Francisco, Calif., is now manufacturing a complete line of radiating connectors for the plate and grid caps or lead wires of high-frequency vacuum tubes which employ such leads as connections to the elements. The connectors are of dural and have integral radiating fins turned along their length; a set screw in the lower portion allows them to be secured tightly to the element lead and another screw in the top allows the connection to the element to be made. Finned radiator connectors cause the elements and appropriate seals of the tubes to which they are connected to operate considerably cooler with the same amount of element dissipation; conversely, the safe element dissipation may be increased when radiator element connectors are used.

3,527°C v.s. 1,452°C

Taylor WONDER Tubes

T-40 and TZ-40

Built to Take It—*AND THEY DO!*

Here's Why . . .

The *plus* features built into every Taylor Tube result in greatly increased *safety factors*, longer dependable life and better all 'round performance. COSTLIER TO BUILD, Taylor T-40's and TZ-40's, with their heat resisting, complete molybdenum grids and rugged carbon anodes, represent the utmost in true value.

STANDS 800% to 1,000% OVERLOAD

Taylor's Wonder Tubes, T-40 and TZ-40, with the famous "Processed" Carbon Anodes, are able to withstand tremendous *temporary* overloads without injury. The extremely high melting point of the Taylor Carbon Anodes is 3,527°C as against 1,452°C for a nickel anode. An overload of only 300% will puncture the average nickel anode while the Taylor Carbon Anode will stand an 800% to 1,000% overload without damage. A T-40 or TZ-40 can be operated at 225 watts input in class C telegraphy service and 156 watts input in class C telephony. *See pages 5 and 6 of November QST for increased ratings.* The new ratings can be applied to all T-40's and TZ-40's now in use and in dealers stocks.

OVER 20,000 ALREADY IN SERVICE

Your best proof is heard *on the air.* Satisfied Amateur users take pride in boasting of their T-40's and TZ-40's in all classes of Radio service including operation on 112 MC. The *Wise* Amateur will insist on Taylor's Wonder Tubes thru comparison. Every T-40 and TZ-40 is actually tested at 300 watts plate dissipation before it leaves the factory. Again we say—"They Cost More to Make and They Do More for You"!

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TAYLOR'S BIG 1940 TUBE MANUAL & CATALOG NOW READY

Send us five cents in stamps or coin and it will be mailed direct from the factory, or at your parts distributor FREE. Contains new circuits, technical data, tube uses, building information, etc.—a real up-to-the-minute storehouse of valuable information.

"More Watts Per Dollar"

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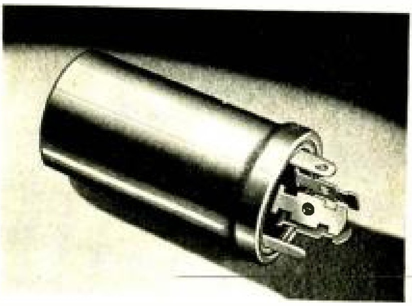
Radiator connectors are made for small tubes from the HK-24, 54, Eimac 35T, WE-304B size up to the very large radiation-cooled Eimacs. When ordering specify the tube with which the connectors are to be used.

PRONG-BASE MIDGET ELECTROLYTICS



Prong-Base midget can electrolytics are announced by Aerovox Corporation, New Bedford, Mass. Compact, economical, simply mounted, these dry electrolytics are rapidly growing in popularity for compact assemblies and replacements.

Mounting prongs slip into an elliptic fibre supporting washer (insulated can) or metal washer (grounded can) rivetted or eyeletted on chassis, and bent over. Terminal lugs slip through hole in washer, for soldered connections.

Despite small size, these units incorporate standard Aerovox dry electrolytic sections. No attempt has been made at ultra-etching or other means of reducing bulk and cost at possible expense of performance and life. Hermetically sealed. Safety vent. Negative can. Single and multiple-section units.

NEW BROWNING VARIABLE-FREQUENCY EXCITER-TRANSMITTER

and Voltage Regulated Power Supply

A new variable-frequency-oscillator all-band switching Exciter-Transmitter and voltage regulated power supply has been developed by the Browning Laboratories, Winchester, Mass. This apparatus is cooperatively sponsored by Amphenol, Cardwell, Cornell-Dubilier, Kenyon, Ohmite, Par-Metal, and Raytheon.

Painstaking electrical and mechanical designs coordinate in making the v.f.o.'s stability comparable to the better grade X-cut crystals. The u.f. oscillator allows operation in any portion of any amateur band from 10 to 160 meters inclusive. The circuit is so arranged that crystals may be used if desired.

A brochure and circuit diagram may be obtained from your jobber or from any of the cooperating manufacturers.

CODE PRACTICE OSCILLATOR

Bud Radio, Inc., of Cleveland, Ohio, has recently announced a very neat Code Practice Oscillator operating on 115 volts a.c. or d.c. and suitable for either individual or group code instruction. This oscillator is housed in a grey-crackled case and is sold completely wired with built in dynamic speaker and tube. The pitch of the note emitted by this unit may be changed by means of a switch on the panel. Provision is also included on the rear of the oscillator chassis for an additional speaker (available in matched case) and extra key for two-way communication.

In addition to its usefulness in teaching and learning the code, this oscillator is handy for furnishing a constant tone source for checking modulation percentage or p.a. coverage, and may also be used as a keying monitor for a transmitter.

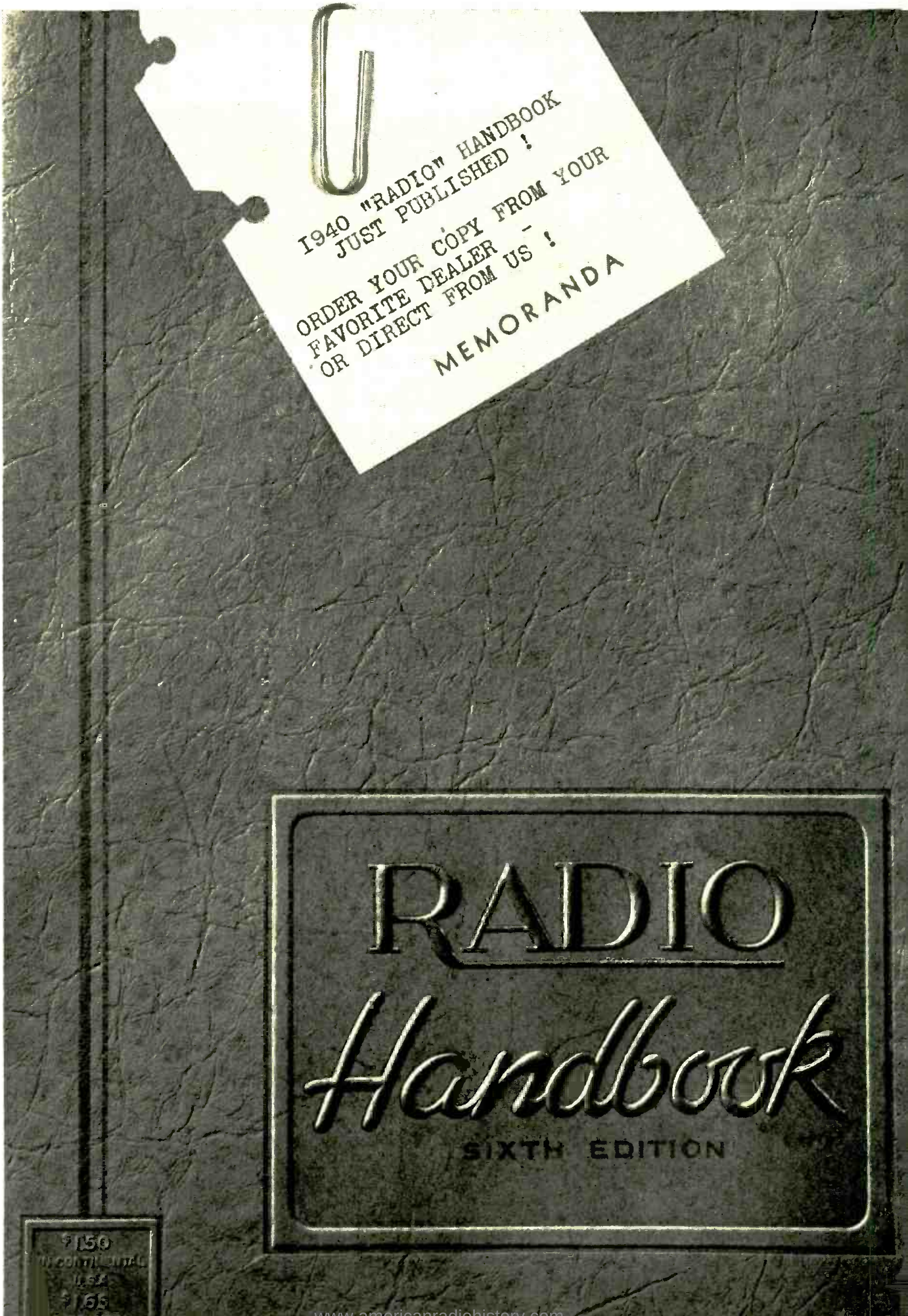
LOW-COST COORDINATED SOUND SYSTEM

To meet the demand for an amplifier system of reasonable price yet capable of a high grade of performance, Radio Wire Television Inc., 100 Sixth Avenue, New York City, offers the Lafayette Model 757-T Coordinated Sound System.

The foundation of this system is the 7-tube Model 452 "beam-power" amplifier with normal output of 30 watts (peak output of 40 watts) and with complete mixing facilities for simultaneous operation of two low-level microphones and two record pick-ups or other high-level inputs. The gain is 130 db from the low-level, and 80 db from the high level inputs. The modernistic metal housing is finished in crackle gray with plastic handles of red and chrome. Fittings include duo-tone dial scales, ivory knobs and pilot light.

The coordinated accessories include two 12-inch dynamic speakers with wall baffles and 100 feet of rubber covered cable; choice of one velocity, dynamic or crystal microphone; 25-foot microphone cable, friction-clutch microphone floor stand, and all tubes, plugs, etc., ready for operation.

An unusual built-in feature of the amplifier is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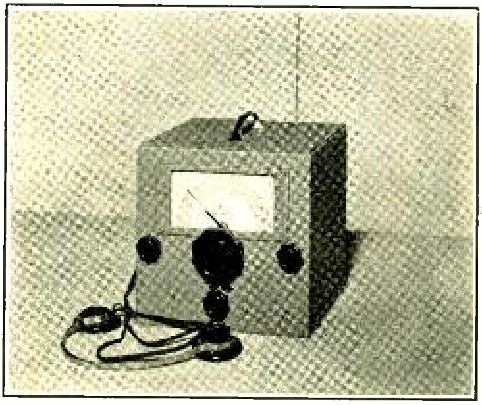
the "Dialogue Control" by means of which low tones may be built-up or suppressed as required for best voice reproduction even under unfavorable acoustic surroundings. Also included is provision for remote-control mixing.

ME-14 PORTABLE RECEIVER



The ME-14, a completely self-contained, self-powered, 6-tube superheterodyne has many features which recommend it for use in a multiplicity of radio services where portability is of prime importance. Among the characteristics making this unit outstanding as a receiver of wide usefulness are its unusually small size and its light weight. Its overall measurements are 8¼" high, 8" wide, 8⅝" deep and its weight, with batteries, is only 11 lbs.

The ME-14 uses 6-low-drain battery type tubes including: 1N5G r.f. amplifier, 1A7G detector and oscillator, 2-1N5G's i.f., 1H5G second detector, and 1A5G a.f. amplifier. The total battery drain is 0.3 amperes A current and 10 milliamperes B current. When used with a 15-foot antenna a full 100 milliwatts audio output is provided, while excellent reception may be had with antenna only 3 feet long. A carrying handle is provided for easy transportation of this unit.

The frequency range covered is 180 to 4100 kilocycles, making it invaluable for use in amateur stations, for private pilots in "riding the beam," for tuning in weather reports, for small boat service, and many others.

HF-10, 5-AND 10-METER RECEIVER

The HF-10 is a complete 5- and 10-meter superheterodyne receiver incorporating the latest circuits and engineering principles used in the design of ultra-high frequency equipment.

The 1852 type tube is used in the tuned r.f. stage for the purpose of providing real gain at these high-frequencies; a Dickert type automatic noise silencer is incorporated as standard; a beat oscillator is also provided, enabling reception of c.w. signals and the location of extremely weak carriers.

Its cast aluminum chassis, its unit type r.f. coil assembly, and its compact, neat wiring make the unit outstanding in mechanical construction. Dual antenna input is provided in order that antennas of most efficient design may be used on both 5 and 10 meters. Ceramic insulation is used in the construction of the HF-10 in many component parts, such as switch sections and input terminals.

Included in one cabinet is the speaker, DB-R meter, and all controls necessary for precision operation. Tuning is accomplished by means of a planetary driven dial providing a bandspread of approximately 6 inches on each band.

MEISSNER "SIGNAL CALIBRATOR"

Meissner Manufacturing Company of Mt. Carmel, Illinois, announce a new addition to their line in the form of a secondary frequency standard. This precision instrument is known as the "Signal Calibrator"; a product designed especially for the radio amateur, the serviceman and the laboratory where the necessity for extremely accurate frequency measurement is encountered daily.

The "Signal Calibrator" is a radical departure from the usual "1000/100 Kc. Frequency Generator." The "Signal Calibrator" employs the uniform action and high stability of a special silver-

[*Continued on Page 184*]

"Radio" for Christmas

AN IDEAL GIFT

RADIO's annual Christmas gift rates will be in effect from November 15th to January 15th. To radio amateurs with a "fellow ham" to remember, to radio employees with a radio-minded employer who must not be forgotten, and to radio manufacturers and distributors who want to remind a favored customer repeatedly through the year of their appreciation of his business, a RADIO subscription is an ideal (and effortless) solution of that puzzling Christmas shopping problem.

ONE SUBSCRIPTION (one year)	$2.50
TWO SUBSCRIPTIONS, each	2.35
THREE or more SUBSCRIPTIONS, each	2.25
SIX or more SUBSCRIPTIONS, each	2.00
TWELVE or more SUBSCRIPTIONS, each	1.75

Subscriptions at $2.00 or less must be **cash with order.**

Above rates apply for U.S.A., Canada, Newfoundland, Cuba, and Mexico. To Pan-American countries and Spain, add 50c per subscription. Elsewhere, add $1.00 per subscription.

YOU MAY ENTER OR RENEW YOUR OWN SUBSCRIPTION AT THESE RATES

Rates for more than one subscription, as listed above, apply only on gift orders entered and paid for at one time by one individual or company. Unless otherwise requested, the subscriptions will be commenced with the January issue, which will be delivered as near Christmas as possible, together with an attractive card announcing the gift and the sender's greetings; those who are at present subscribers will automatically have subscriptions extended unless otherwise requested.

RADIO

POSTSCRIPTS... and Announcements

RATING SYSTEM CHANGED ON RCA RECEIVING TUBES

RCA Application Note No. 105 gives a discussion and listing of a number of changes in the system of rating and the ratings of certain RCA receiving tubes. The changes in ratings are based upon the premise that the supply voltages to a modern receiver, whether an auto set or one of the a.c. operated variety, vary over quite a wide range. The assumption has been made that the supply voltage to an a.c. operated receiver may vary over a range of plus or minus 10 per cent of the nominal value of 117 volts. Research has also shown that the supply voltage to an auto receiver may vary over a range of 40 per cent or more. However, since the maximum voltage under variation in an auto receiver would seldom approach the nominal value used in an a.c. operated set, only the plus-or-minus 10 per cent variations encountered in a.c. operated receivers have been taken into consideration in the revised ratings.

The system of ratings which has been used up to the present was originated in the early days of radio when B supply voltages were obtained from batteries. In those days the output voltage of a 90-volt supply fell below 90 volts during receiver operation but it never rose above this value. Maximum plate voltage ratings, therefore, were set up as absolute maximums which were never to be exceeded. However, under the new rating system where consideration has been made of the fact that the supply voltage may vary just as far above the nominal value as it may fall below it, the name of the maximum rating has been changed from "absolute maximum" to "design maximum," and the design maximum has, in certain cases, been lowered proportionately.

The new design maximum ratings for many rectifier and power amplifier tubes have been made less than the former absolute maximum values to take into consideration the normal line voltage fluctuations. As an example, the maximum plate voltage and plate dissipation ratings of the 6L6 and 6V6 have been reduced 10 per cent. In certain other types, the new values of design maximum ratings are the same as the former absolute values. For these types the change in interpretation of ratings is, in effect, an increase in ratings. In some of the voltage amplifier types a further increase has been made in that the design maximum plate voltage rating has been made 300 volts instead of the former 250-volt absolute maximum. This, of course, can be considered as a sizeable increase in rating when the 10 per cent-above-design maximum tolerance is taken into consideration. RCA publications are being changed as rapidly as possible to show ratings in accordance with the new RMA-recommended system.

THIS MONTH'S COVER

Some of RADIO's staff have been experimenting with an automobile transmitter feeding a pair of three-element beams in phase strung between a couple of trees on the hill which is to be the new location of the office and laboratory of the magazine. The 10-acre tract runs along the flat crown of a 400-foot hill, with the main portion of Santa Barbara on the northeast and with the Pacific Ocean a short distance away on the other three sides. The hills* in the background are about six miles distant and are the foothills of the Coast Range. The peak in the distance (with the fire road below it) is called La Cumbre Peak and has an autitude of 3985 feet. Other peaks ranging to 8000 feet lie behind these foothills. On the other side of the range lies the lower end of the Sacramento Valley, and then the High Sierra with peaks averaging about 14,000 feet, topped by Mount Whitney at 14,500 feet.

The problem was to determine if the low-angle radiation necessary to 28-Mc. dx transmission would be impeded to any extent by the mountains. There is a direct over-sea-water path for more than 200° in the directions away from the foothills. To date the tests have indicated that the signals are not impeded to the slightest extent.

(3¼ x 4¼ Graflex, 1/195 at f.32, Agfa Superpan Press.)

* Easterners call them mountains.

BIAS CELL POLARITY

While most amateurs find bias cells most convenient and quite handy gadgets for use where a simple method of obtaining fixed bias is required, some amateurs shy away from them because they always have trouble

in figuring out which way the cells should be hooked up. These are usually the same fellows who break out in a cold sweat whenever they have to figure out which way to hook up an electrolytic cathode by-pass condenser.

In the case of bias cells, however, there is additional reason for possible confusion: unless the bias cell is correctly labelled in the diagram as to polarity with plus and minus signs it is difficult to determine from a schematic diagram just which way the cell should be connected, unless you take time to analyze the circuit and determine the desired polarity in this manner.

The reason for the confusion is easily explained. It is standard drafting and engineering practice to indicate polarity of a battery (in schematic) by always drawing the short, thick bar as negative and the thin long bar as positive. While not universal, this practice is generally considered as standard.

The difficulty is that in the case of a dry battery it would be more logical to indicate the positive, or carbon, by the thick, short bar, and the negative, or outside shell, by the long thin line. In fact, many amateurs automatically have put this interpretation on our schematic of a bias cell (which is really a dry battery) when the polarity has not been indicated by plus and minus signs.

To dispel this confusion once and for all, which has been made worse because of our method of designating a bias cell as distinguished from a battery by drawing the long thin line in the shape of a curve, we have decided to carry the distinction still further. In the future we shall use a symbol that looks like a bias cell and discontinue to treat it as a modified battery symbol. We shall show the outside shell as negative, and the symbol won't look enough like a battery symbol that purists will be able to accuse us of defying convention. And to make doubly sure somebody doesn't put positive instead of negative bias on something, we shall embellish the symbol with plus and minus signs.

C.W. MONITOR-FREQUENCY METER

Mr. Broderson has called to our attention two minor errors in his article "C.W. Monitor-Frequency Meter" which appeared in the Newcomer Department on page 58 of the November Radio. The diagram showing the winding and connections to the coil states that the 14-Mc. tap is taken at the 20th turn. The tap should be taken at the 6th turn; however, the text is correct and clarifies the discrepancy. Also, under "Construction" 6th paragraph, mention is made of a .0002-μfd. condenser. This should be .002 μfd. but in this case the caption beneath the wiring diagram is correct so again the discrepancy is clarified.

NEW NUMBERING SYSTEM FOR FCC REGULATIONS

The FCC recently adopted a new numbering system for its regulations and, in order that your present copy of the regulations may be brought up to date, the following list is given. It may be clipped from this page and pasted in your new 1940 Radio Handbook, which went to press before the new numbers were received.

Federal Communications Commission
Washington, D. C.

Old Chapter XII now becomes "PART 12" Rules Governing Amateur Radio Stations and Operators

New Sect., No.	Old Sect., No.	New Sect., No.	Old Sect., No.
12.1	150.01	12.82	152.09
12.2	150.02	12.83	152.10
12.3	150.03	12.91	152.11
12.4	150.04	12.92	152.12
12.5	150.05	12.93	152.13
12.6	150.06	12.101	152.14
12.21	151.01	12.102	152.15
12.22	151.02	12.103	152.16
12.23	151.03	12.104	152.17
12.24	151.04	12.111	152.25
12.25	151.05	12,112	152.26
12.26	151.06	12.113	152.27
12.27	151.07	12.114	152.28
12.41	151.15	12.115	152.29
12.42	151.16	12.116	152.30
12.43	151.17	12.117	152.31
12.44	151.18	12.118	152.32
12.45	151.19	12.131	152.40
12.46	151.20	12.132	152.41
12.47	151.21	12.133	152.42
12.48	151.22	12.134	152.43
12.49	151.23	12.135	152.44
12.61	152.01	12.136	152.45
12.62	152.02	12.151	152.50
12.63	152.03	12.152	152.51
12.64	152.04	12.153	152.52
12.65	152.05	12.154	152.53
12.66	152.06	12.155	152.54
12.67	152.07		
12.81	152.08		

SUNSPOT DATA

"The Sunspot Period" is an interesting 18-page booklet obtainable from the Smithsonian Institute, Washington, D. C. (Smithsonian Miscellaneous Collections, Volume 98, No. 2) for ten cents in coin. It forecasts dates of sunspot maxima and minima.—*W3AIU.*

YARN of the MONTH

Oil is Well, II

SEQUENT TO THE YARN IN THE JANUARY, 1939 ISSUE

August 13, 1939

Dear Bill:

Hooray for the Northern Republic! Hooray for radio! Hooray for everything, including yours truly! In fact, yippee!

Well, I know you want a reason for the exuberance, but you'll just have to tuck in your shirt, loosen your tie, extend the pedal extremities over the edge of that dilapidated card table you call a desk, and hold tight. I'm rushed all day and I'll be darned if I'll let you rush me tonight. Ye ancient brasspounder is about to settle down into what may be a good yarn. And I do know I haven't written to you for more than a year now.

After I last wrote, I spent some time improving the country. I took the white man's burden to be my own and went to town. Don Jose, his daughter, Margarita, and I first made a tour of the country. It was most evident that I was living in a backward community. Sanitation was nil, mosquitoes were kings, and even clothing was conspicuous by its complete absence in some villages. In reference to the latter, you should have seen . . . ! ! Oh, oh! I don't think I'll write that. But you really should have, and I'll tell you when I next see you.

Well, I was appointed Minister of Civil Improvements. That "Civil" part is a joke. The clothing problem was first on the list. Margarita and I got together on the subject (no remarks, please) and spent many anxious hours. It obviously wouldn't do to put them in low-backed dresses. Housedresses didn't seem suitable, for a house is something one dreams about in this country. We then had the happy thought of aprons, but Margarita balked on the grounds that it was poor military strategy not to cover one's retreat. Finally, and we should have thought of it sooner, we settled on a hula-hula costume. After a little research we found that most of the women and girls in the country could be outfitted for a total cost of $3,000. The Prexy said, "Ok," so we let out the contract and got the clothes via the next mail boat from the U. S.

Boy, were those gals happy! The last effort to put clothes on them left them looking like 1900 Miss Prudence America. They all remarked, in native tongue, that they enjoyed the bright colors and freedom. Really, a three inch wide band above and six below leaves one amazingly free.

The men were no problem as all of them were in the Army. We bought up a bunch of purple pants from a college football team and some orange ushers' coats from a Chicago theatre, and settled that easily. The officers wear green sashes around their waists, making quite some picture. Even if they can't shoot straight, an enemy would be so blinded by the colors that he wouldn't even be able to see.

Getting back to the women, they are something! Oh, oh! Here comes Margarita, and I'd better duck this out of sight. I'll write more tomorrow.

73,
Cy

P.S. That's once he didn't fool me. How am I going to get his mind off of the native hula costumes and back on me?

Margarita

August 14, 1939

Bill Ol' Soak:

Doggonit! I wrote a letter to you yesterday and I can't find it now. Maybe it will show up in a day or so. If not, I just told you about some improvements I made in the natives' clothing.

By CY STAFFORD, W9KWP

When Margarita and I had solved the clothing problem, we went into sanitation. Margarita went through the problem like an expert. In fact she went right through it by way of Havana, Miami, Philadelphia, and Vermont, where she is spending the rest of the summer.

After sanitation came communications. My two months' tour of the country convinced me that telephones in this jungle would be impossible. We (the President and I) decided that we needed radio communication rather than wires. Unfortunately there is only one operator in the country. Admittedly I am pretty good, but I haven't yet solved the problem of handling both ends of a two way QSO between two points separated by a vicious assortment of snakes and jungle.

The President, Don Jose, has a great deal of confidence in me. He has more confidence in me than my Mother has, and that is too much. What I'm trying to tell you is this. I have just completed the most difficult task of teaching five sergeants the manly art of brasspounding. A sergeant, as you know, is generally an intelligent person. But a sergeant with purple pants, and orange coat, and a black and white striped neckerchief (indicating a non-commissioned officer) may be and was almost anything.

It took two months to pound the proper dit-dahs into their heads. I then started teaching them Q signals. Unfortunately, all of my pupils had a slight knowledge of spelling and the general confusion between native words and Q signals was horrible.

Tomorrow will be a busy day, so I shall stop. We are making an inspection of transportation facilities.

With a glass arm,
Cy

August 20, 1939

My Dear Margarita:

After I received your postscript on Cy's letter, I received a letter from him indicating that you were spending the rest of the summer in Vermont. Yesterday I talked to my cousin, who is staying at the same resort as you, and he described you and your arrival in glowing terms.

May I suggest that I can answer your questions much better in person, and that I am about to make some field-strength measurements on one of the Vermont stations?

Sincerely yours,
Bill

August 21, 1939

Dear Bill:

Cy has talked of you so much that I almost feel that I know you. *Of course* I would like to talk to you! Why don't you make the resort your headquarters for the survey, and we would have much more time to be together?

Love,
Margarita

August 23, 1939

Hi Cy:

This a diff. Nutz! This is a most difficult letter to write. I just got back to my room from the bar and I am tired and the lights are doing funny things and someone is pulling the chair out from under me but nobody is in the room so it can't be.

What I mean to say is that I came out here to see a radio station and make field-strength measurements on your gal. No, that isn't right. I came out here to answer a letter she wrote to me on the field-strength of a postscript.

Aw, nuts, I can't see. I'm stinko, so I'm going to bed and I had a swell girl with your evening.

So long, pal,
Bill

August 23, 1939

Cy Dear:

I think Bill is just too divine.

Margarita

August 30, 1939

Dear Bill and Margarita:

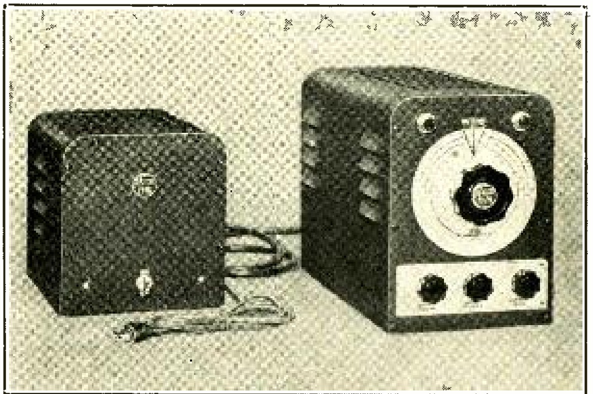
You drunken bums! I should have known better than to let either one of you know about the other.

Well, just like old times. I find them and Bill takes 'em away. There was Jean, for instance. I spent more money on hamburgers for her than you do on radio equipment. Then I gave up in the face of your competition (root beer sodas, as I recall it) and went after Mary. The same thing went on for years, so I'm used to it.

The transportation survey ended with two flat tires, and one logical conclusion. The jungles of the Northern Republic are not suited to roads. After we had cut our way through four miles of the stuff, one of the natives mistook the rear tires for a snake and called for help. Two of the boys, afraid that the snake was going to squeeze the car to death, let go with their machetes. Boy, what a mess! When the tires blew, the entire crew

"THAT'S WHAT THEY ALL SAY"

THE "X-EC" HAS EVERYTHING



W1IJW—WILLIAMS COLLEGE, WILLIAMSTOWN, MASS. THOMPSON PHYSICS LABORATORY. ALAN R. EURICH, W7HFZ, EX-WCFT, W8ICQ, OPERATOR. ". . . is proving very satisfactory in every way, stability, performance. I have never handled an exciter I have liked as well, and that covers a lot of territory."

W8LYQ—ED HARRY, PLYMOUTH, OHIO. ". . . the best item I have ever bought for my station. The calibrated dial is really something to rave about. My house lights blink but there is no change in the "X-EC."

W6LS—LEO SHEPARD, CBS ENGINEER, LOS ANGELES, CALIF. "When operating 14mc. phone, the "X-EC" allows every contact to be 100%. With such flexibility at your finger tips, it eliminates long calls, thus saving time."

The "X-EC" comes to you COMPLETE with Isolated, well regulated, power supply, shielded connecting cable and a full set of RCA tubes. It is Wired and Tested and licensed by RCA.

"X-EC" HM-103

Licensed by RCA

NOW **$47.50** NET

With Tubes and Power Supply—F.O.B. Los Angeles

W7GGG—DR. SAM. S. ZUCKERMAN, CHEYENNE, WYOMING. "On CW, reports have been T9. It is indispensable as a means of getting out from under QRM."

W6QAP—BUD KELLER, TUCSON, ARIZONA. "The "X-EC" is an A-1 job. It is the finest method of frequency control I have ever used. It sets next to my HRO and gives me instantaneous QSY. The "X-EC" is worth my money any day in the week."

W7HTY—H. R. DAY, IDAHO FALLS, IDAHO. "I am using the "X-EC" as a control unit for my Bi-Push. I operate on 10 meter phone and have not lost one QSO due to QRM since I installed the control unit."

W9UM—M. W. MACY, LAKE WAWASEE, SYRACUSE, IND. "Heretofore, I used 22 crystals, both variable and fixed. Now with the "X-EC" I can cover the bands faster than a receiver can be changed, making it possible for 419 contacts in 37 hours in the "Sweepstakes."

W2ARB—JOHN J. KULIK, NBC ENGINEER, CLIFTON, N. J. "It is a pleasure to verify all the claims made by you on the "X-EC" . . . none can compare with it. For any amateur wanting a precision instrument for varying his frequency, the "X-EC" is the answer."

W8AU—LOUIS E. DE LA FLEUR, CHIEF, OPERATOR WBGI UTICA, N Y. "I have my band-edge crystals in the "X-EC" unit, but I must admit they haven't seen service, even though I still work the edges. The accuracy of the dial allows me to work within two or three kc. of the edge without worry. Indeed, it is almost a pleasure to be QRM'd by another "X-EC."

W7AYO—STAN BELLIVEAU, YAKIMA, WASHINGTON. "The "X-EC" is sure swell. I used it every minute of the "Sweepstakes" and without it I would have been lost."

K6LCV—GEORGE HAMMOND, HONOLULU, T. H. "I have schedules with the States every day on 14 mc. phone. The flexibility of the "X-EC" with its accurately calibrated dial make these contacts 100%."

W9YKH—ERNST BAGEL, MILWAUKEE, WISCONSIN. " . . . it's the answer to the QRM problem. We could not work 20 fone worth a whoop even though we were running 350 watts. Now with the "X-EC" we are getting results, because we can move around the band in lightning fashion. You folks do not praise the stability enough."

W8JMP—CARLTON L. WILLIAMS, GLENWILLARD, PA. "The tone quality and stability cannot be beaten. It meets with the approval of other boys around here, W8OSL, W8CRA, W8CXX, and W8BSF."

W6CHE—JACK McCULLOUGH, EITEL-McCULLOUGH, INC., SAN BRUNO, CALIF. "Exceptionally efficient in every respect, tone quality, flexibility, accuracy, and stability. The calibrated dial adds to making this device the best variable frequency control I have ever used."

W8FAF—PAUL BEALL, ROYAL OAK, MICHIGAN. "I was truly surprised when the boys told me they couldn't tell the difference beween the EC and Crystal.

A "HUGHES-MITCHELL" PRODUCT

The "X-EC" now has its frequency range extended to cover the entire 80 meter band, 3.5 to 4.0 mc. Break-in keying is, also, an added feature.

The "X-EC" is a combined EC and Xtal oscillator. It has RF output on 40 and 80 meters. No plug-in coils. The smooth vernier dial is calibrated in megacycles for the 7, 14, and 28 mc. bands.

The Isolated power supply is actually the "pulse" of the "X-EC". A special resistor network is employed for the screen voltage supply. Zero voltage co-efficient is obtained by the accurate adjustment of the cathode tap. BREAK-IN keying is perfect . . . no bloops or yoops. DX men, traffic men, and ragchewers are making every QSO 100%, by avoiding QRM with an "X-EC".

ASK YOUR DISTRIBUTOR OR WRITE US FOR BULLETIN No. 22

RADIO-TELEVISION SUPPLY CO.

"Where Ham Spirit Prevails"

1701 So. Grand Ave. Los Angeles, Calif.

got scared and really went to town. The back end of the car was in pretty sad shape when I finally convinced them that they were in no real danger.

While we were in conference on the solution to the transportation problem, a runner came in to tell me that my master control station had been attacked. I got on the motorcycle and tore out there to see what was up.

When I erected the station, which has directional antennas pointing towards all of the inland towns, I couldn't find enough poles to support the Beverage antennas I wanted to use. The simplest way was to plant banana trees at the proper intervals and directions, wait a couple of months until they grew to a reasonable size, and then string up the wires. This was eleven months ago and everything went along fine until this morning. The Minister of Agriculture, a dope of the first varnish, decided that the seashore would be a good place to start the monthly harvest. Not only were my masts chopped down for the harvest, but I received a bill for damages. My operator switched the full plate voltage to the antennas!

Tomorrow will be another busy day. When the conference was resumed, we decided to abandon all thought of roads and install a weekly air service. There are six towns, and the plane will make a round-robin flight every week. Now I can laugh at you scoffers who said I was wasting time and money on flying lessons.

73,
Cy

P.S. I hope Margarita is taking Bill for a nice ride!

September 10, 1939

Bill:

What am I going to do with that conceited guy? He isn't even worried.

Perplexed,
Margarita

September 13, 1939

Margarita:

I don't like to do this to a pal, but why are you worrying about him? He'll always be a rolling stone, and won't gather any moss.

Could you spend a couple of weeks at the family cottage in the Michigan Dunes? My two sisters will be there for chaperons and we could have a swell time.

Love,
Bill

September 15, 1939

My Dear Pal:

You wolf! Who ever said anything about rolling stones? I knew he is one, and I like it.

Nevertheless, you old moss-back, your proposition sounds interesting. When and where do I arrive?

No love,
Margarita

September 15, 1939

Cy:

Bill is awfully nice. He just invited me to spend two weeks with him and his sisters at their Dune's cottage. Of course, I accepted. I know I'll have a grand time with him as he always thinks of everything while I'm with him. It's a shame you're always all business.

Sincerely,
Margarita

September 19, 1939

Dear Billy the Wolf:

I suppose you've been turned down by now. She wouldn't fall for an old line like yours. That family cottage in the Dunes is the biggest laugh. I can just imagine the reaction you'd get to that line if you pulled it on Margarita, especially if you added that old gag about the sisters for chaperons.

The Prexy bought a couple orange crates with egg-beaters on the front of them and expected me to fly them. I took one look and doubled my life insurance. But there wasn't any way out, so I have been flying them. I must have more nerve than sense. I then went to work clearing fields for airports and trying to sell the natives on flying.

Just as I had everything in order for the opening of the airline I ran out of fuel and oil. You don't consider that up North because no matter where you are, you can always find a filling station of some sort.

Do you remember how I squawked when I was forced to take that course in sheet metal work in college? I'm certainly ashamed of myself now. If I had not had that course, the Northern Republic would be without transportation.

The Sunny Skies Oil Company, for whom I worked before I became Minister of Civil Improvements, recently started piping oil out of the interior. These new wells are honeys. The oil comes out of the ground a brilliant clear green, and has an 80% yield of volatile fuels when distilled. The residue is a bright stock that makes a wonderful crankcase oil. The pipe line runs through three of the towns and the Company lets me use all of the oil I need in exchange for a few favors I have been able to extend them.

BUY Hallicrafters from Bob Henry, W9ARA

I guarantee you a fair and square deal and to personally cooperate with you to see that you are 100% satisfied.

YOU get prompt shipment in factory sealed carton from the world's most complete stock of amateur equipment. Or shipment from factory if you prefer.

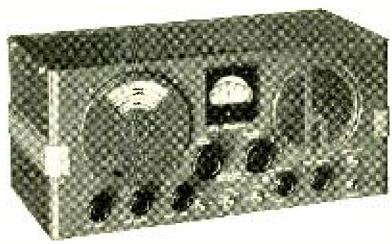
YOU get ten days' free trial—you don't buy unless you are satisfied.

YOU get 6% terms financed by myself so you buy with less cost—more convenience—quicker delivery.

YOU get big trade-in for your equipment—describe it and I will tell you its value—pay the balance on terms if you wish.

So write me fully about your wishes and I will send you full information and will see that you are 100% satisfied. Or send me your order and I will guarantee you can't buy for less or on better terms elsewhere.

Model	*Cash Price*	*Down Payment*	*12 Monthly Payments*
Sky Buddy	$29.50	$5.90	$2.08
The new S20R	49.50	9.90	3.49
SX-24 Defiant	69.50	13.90	4.90
SX-23	115.20	23.10	8.16
SX-17	137.50	27.50	9.71
Skyrider 5-10	69.50	13.90	4.90
S-22 Marine	64.50	12.90	4.55
HT-6	99.00	19.80	6.99
HT-1	195.00	39.00	13.78
HT-4	695.00	139.00	49.11



See it! Operate it! Compare it!

Prompt shipment of the new 1940 S20R and other receivers on ten day trial.

Similar Terms on All Other Hallicrafters Receivers and Transmitters

I have a complete stock of all amateur receivers, transmitters, kits, antennas, tubes, parts, etc. Send to me for anything at the lowest net wholesale price in any catalog or ad. Your inquiries and orders invited.

Bob Henry
W9ARA

HENRY RADIO SHOP
BUTLER, MISSOURI

You probably can't even guess the connection between crude oil, sheet metal work, and the solution to my fuel problem, but it is quite simple. First I connected the liquid cooling system of the plane to the oil intake on the crankcase. Then I connected the drain on the radiator to the carbureter. A large tank connected to the liquid cooling system and another one to the crankcase drain completed the system. Boy, it's a thermodynamic engineer's nightmare, but it works.

First, I fill the intake tank with crude oil. This feeds into the cooling jackets on the cylinders. The lighter fuels boil out and the vapor passes up into the radiator where it condenses. The fuel thus collected flows down into the carbureter and is then used in the regular manner. The heavy oil which is left in the cooling system flows into the crankcase where it is used for lubrication. The excess is fed into the second auxiliary tank.

Just in case you have any doubts as to the efficiency of my one man power plant and refining industry, I shall remark in passing that the excess cranckcase oil is used as a binder on the new runways.

Flying six days a week is getting tiresome, but it won't continue for long. I am working on radio control for the ship so that I can fly it from Magdellan. Won't that make those airlines up North sit up and take notice?

The weather in the tropics is always the same, so I don't anticipate any trouble from that source.

73,
Cy.

September 21, 1939
RADIOGRAM

MISS MARGARITA JOSE
HOLDEN HANDS RESORT
ROCKY FARMS VERMONT USA
RECEIVED YOURS OF FIFTEENTH STOP BILL HAS NO SISTERS STOP
CY

September 22, 1939

Margarita:

Sorry to hear that you can't make the Dunes trip.

Did you see this item in the morning paper? I hope it isn't a serious situation.

> Magdellan, Sept. 22. Local authorities reported to the U. S. Consulate that Cy Jones, American engineer at large, is lost in the jungle. Jones was riding as a passenger in a radio-controlled airplane of his own design in a flight from Magdellan to Mesa Baja. The ship left Magdellan under good control, but has not been seen since. Jones is four hours overdue at Mesa Baja.
>
> Jones, during his term as Minister of Civil Improvements, has made many striking changes in the Northern Republic. Perhaps his most elaborate move was outfitting the native women in costumes that would delight a chorus girl. The consulate reports that his activities are a constant source of embarrassment.

That lug can get himself into more trouble than a rat-terrier at a cat show. Why don't you take my advice and forget him.

Lots of love,
Bill.

October 16, 1939

Dear Bill:

In again, out again. That's me. Don't believe anything you've read in the papers lately. I'll give you the straight dope on what's been going on.

Just after I last wrote to you, I went to work on the radio control for my airline. The Oil Company gave me some old motors and things and it looked like easy sailing. I kept the system as simple as possible. There were only four controls. These were normal glide, normal climb, straight flight, and shallow right turn. Four separate receivers with associated relays handled this set-up. The landing gear was equipped with a switch which turned off the ignition when the wheels touched the ground. I ran a number of highly successful check flights. Level flight was maintained by first climbing and then gliding, giving a roller-coaster effect.

In order to establish confidence, I decided to make the first flight. Everything went well until I was over Uca Verde, one of the native villages. They were having some sort of a ceremony and I was hanging over the edge of the cockpit getting an eyeful through the binoculars. One of my dumb sergeants started playing with the transmitters back at Magdellan, and before I could get to the controls the ship was in a spin. To make a long story short, I recovered just over the trees, and as I heaved a sigh of relief, the undercarriage brushed the top of one. Of course the motor was automatically shut off and I lit in the jungle

It was only five miles back to the native village, but one glance was enough to show me that I couldn't get through, even had I known what direction to travel. There was only one thing to do, so I just sat and waited.

When Margarita received your last letter and the clipping she hopped an airliner for

[*Continued on Page 179*]

The Editors of RADIO

AND THEIR BUSINESS ASSOCIATES

Wish all their many friends

A Merry Christmas

and a

Happy and Prosperous New Year

THE EDITORS AND ASSISTANTS

W. W. Smith	W6BCX	Ray L. Dawley	W6DHG
Frank C. Jones	W6AJF	Leigh Norton	W6CEM
Elmer H. Conklin	W9BNX	Herb Becker	W6QD
Jack Rothman	W6KFQ	[illegible]	W6QX
W. E. McNatt	W8TLJ	B. A. Ontiveros	W6FFF

AND

A. McMullen

[illegible]

Clyde W. Nelson

Roy Iloberg

M. F. Geis

OF THE BUSINESS STAFF

Gaseous Voltage Regulator Tubes

There exists a considerable amount of doubt in the average amateur's mind as to the proper method of utilizing the regulating characteristics of the VR-105-30 and VR-150-30 gaseous discharge tubes. These tubes are quite similar in their operation to the older type 874 regulator tube and to the conventional neon tube with the base resistor removed. However, they have improved regulating characteristics, are less expensive than the 874, allow the use of a higher voltage across their elements, and are more uniform in their characteristics.

The two tubes are essentially the same except that the voltage drop across the VR-105 is 105 volts and across the VR-150 is 150 volts. They both are quite useful for stabilizing the voltage on variable-frequency exciters, frequency meters, receivers, and other devices requiring a very constant supply of voltage between 100 and 300 volts.

The 6K8, 6J8G, 6SA7, and similar combined mixer-oscillator tubes require, for good stability, a very constant supply of about 100 volts for the oscillator section of the tube. The VR-105 is admirably suited to use in this position. The incorporation of one of these voltage regulator tubes across the plate return of the oscillator section of a high-frequency mixer, such as a car ten-meter converter, will greatly improve the stability of the converter with respect to supply voltage variations as the engine speed varies.

Both the VR-105 and VR-150 are well suited to use in the cathode of the feedback tube of 2A3-type voltage-regulated power supplies. The VR-150 will be best when the supply is for a comparatively high voltage.

Combinations of voltage regulator tubes may be connected in series to regulate a supply voltage higher than one tube will control. Two VR-105's may be connected in series to regulate 210 volts, a 105 and a 150 can be used for 255 volts, and two 150's will operate on 300 volts.

VR tubes can be used as regulators in stabilizing two kinds of variations. First, they may be used to stabilize the voltage across a variable load, or they may be used to maintain the voltage constant across a fixed load from a supply of variable voltage.

If it is desired to stabilize a device requiring only 50 plate volts against supply voltage variation, it is only necessary to place a VR-105 across the supply voltage and then to place a suitable resistor in series with the regulated voltage to the load to drop the voltage from 105 to 50 volts. However, it should be borne in mind that under these conditions the device will not be regulated for varying load; in other words if the load resistance varies the voltage across the load will vary even though the regulated voltage remains at 105 volts.

To maintain constant voltage across a varying load resistance there must be no resistance between the regulator tube and the load. This means that the device must be operated exactly at one of the voltages previously mentioned if not more than two voltage regulator tubes are to be used.

Most of the difficulty in the application of this type of voltage-regulator tube comes in making a choice of the proper size series resistor between the voltage supply and the VR tube. The object of the series resistor is to destroy the inherent regulation of the supply and thus allow the voltage-regulator tube to maintain a constant voltage across its terminals by varying its internal resistance.

A few simple calculations will eliminate the guesswork in choosing this resistor. However, there are two things which must be known before the resistor value may be determined; the supply voltage (this is the voltage available at the point to which the series dropping resistor is to be connected, not necessarily the power-supply voltage) and the amount of current to be drawn by the load connected across the regulator tube. With these two factors known a simple bit of arithmetic with one or the other of the following equations will give the value of the series resistor:

For the VR-150-30 $R_S = \dfrac{E_S - 150}{I_R + I_L}$

For the VR-105-30 $R_S = \dfrac{E_S - 105}{I_R + I_L}$

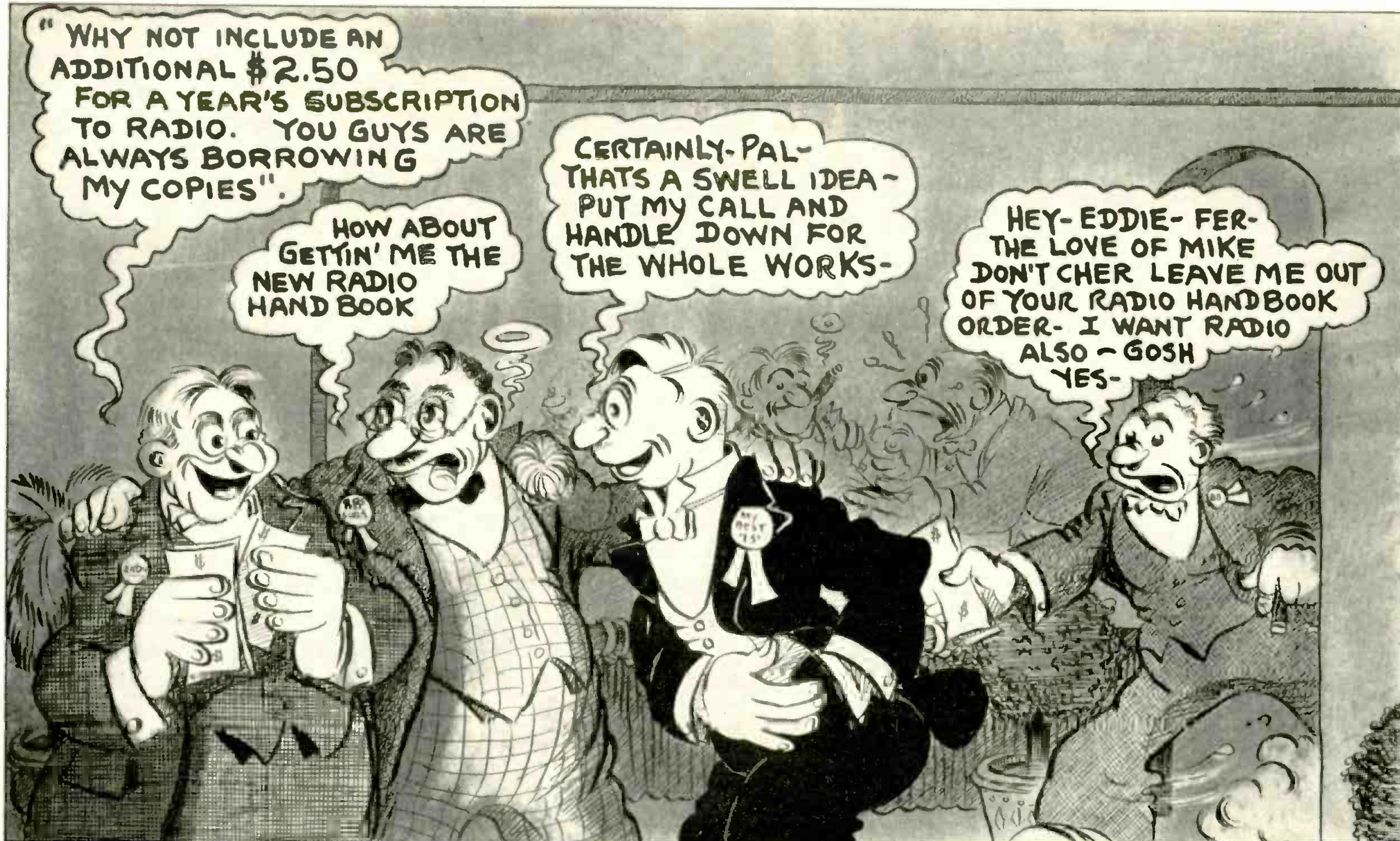
where

E_S = the supply voltage,

I_R = the current through the regulator, and

I_L = the current drawn by the load

[*Continued on page 169*]



WHEN REAL HAMS GET TOGETHER ~ BY W-8EA.

Radio Workshop Practice

[*Continued from Page 74*]

Manufacturing Company is very helpful.[1] Some real instruction by one who knows how should supplement book knowledge on this job. Until he has devoted considerable time and practice to drill grinding, it might be smarter for the home-worker to set the bad ones aside and let someone else grind them. A machinist can do a fair job "free hand," and in cities there is usually some industrial tool service house that grinds drills in special jigs. For small size carbon drills it is almost as cheap to throw them away; or, after you have doctored them, they can be used in the hand drill or in wood working.

Drills that get bent can be trued by chucking them just above the bend and rapping them lightly as they spin in the press. If the first rap makes things worse, the next one may do the trick.

[1] "Getting the Most Out of Your Drill Press," James Tate, Delta Manufacturing Company, Milwaukee, Wisconsin.

Drilling Mycalex, Victron and Other Plastics

There are often places in amateur equipment where a specially prepared plate or strip will eliminate a forest of standoffs. Today we can get excellent r.f. insulation in various forms and prepare it with only a little more trouble than our old standby, bakelite. There are two kinds of Mycalex. The kind on the Cardwell condensers is known as G.E. 1364; then there is a softer kind called leadless, which drills easier but is more apt to chip and crack. The G.E.1364 kind can be bought in strips of various sizes, and the strips cut up with a hack saw. Sawing a wide piece would be laborious.

Drilling a piece of Mycalex is like drilling a piece of stone, and drills are bound to dull rapidly. There are special drills known as Fosdick drills that can be used to advantage if any great amount is to be drilled. Ordinary twist drills will do if they are sharpened after every hole or two. The powder which results from drilling must be removed by blowing, as fast as it forms. Another way to remove the powder is to drill the piece submerged in water. The powder will float to the top and not clog the drill. Just to lubricate the drill with water or oil in the usual way will make things worse however. Then the powder will form a paste around the drill. Better to drill dry, with slow speed and frequent stops for cleaning the drill and hole. When the drill point starts to break through, the work should be turned over and finished on the reverse side to prevent chipping.

Lucite and polystyrene products like "Victron", "912-B" etc. drill and tap as easily as bakelite except for their notorious susceptibility to heat. Drilling speeds can be about the same as for brass or bakelite; slower if heating results. When drilling through a thick piece of the transparent kind you can see the side wall of the hole turn white and flaky if the point warms up. A little of this roughness isn't objectionable, but keep the point cool. Drills must be sharp, and the flutes kept clear of chips. Frequent sharpening is not necessary as these plastics are very easy on tools. If any quantity is to be worked special "bakelite drills" with coarse flutes can be used. Some of these materials are more flexible than others; but it isn't wise to hit the center punch too hard. Use soap and water to wash the work after handling.

The author is indebted to the Allen D. Cardwell Mfg. Corp. and Communications Products Co. for suggestions on working these materials.

• • •

Title on an unrevised *Radio Technical Digest* page proof fresh from the printer: "New Bush-Bull Bean Tetrode."

Calls Heard

Numeral suffix indicates "R" strength. Send Calls Heard to Calls Heard Editor, c/o RADIO, 1300 Kenwood Road, Santa Barbara, Calif.

D. W. Heightman, G6DH
234 Burrs Road
Great Clacton, Essex, England
(October, 1939)
(28-Mc.)

W1—AKC; DLJ; DLY; ELU; GKJ; GRV; HJB; HON; HQO; JUJ; KJT; KTF; KUA; KUD; LEU; LFI; LJB; LJU; LMB; LXR; SS; **W2**—AMS; AXZ; BQK; COK; EFM· EBT; ETN; FGB; FJQ; FZF; JCY; JMC; JOQ; JYE; KLM; KQP; LVV; LWT; MFS; MKZ; QF; VH; **W3**—BYL; BZJ; CBT; CMO; COP; EOZ; GRO; GTL; HHZ; HXO; IJB; **W4**—AZB; BMR; BYA; EIA; EKI; EZK; FBI; FMN; FRP; FT; GMR; **W5**—EKF; HUB; **W6**—AAR; AGG; AWB; BOF; BZF; ERT; GRL; GZZ; KYL; LSN; LUG; MEP; MUU; MZD; NIO; NWV; ONY; OYY; PFT; PMB; POZ; QDC; QDT; QNT; QNW; QOZ; **W8**—AHC; BTR; CKY; CLS; DST; FGP; HEC; JAK; KYY; LKP; PK; RFN; RKR; RLT; QCK; SIY; TBZ; VEQ; **W9**—AQQ; CGO; GPB; HRC; HVN; IIU; JRY; QIQ; VUR; ZHL.

Bob Rasche
2170 East Lake Rd., N.E.
Atlanta, Georgia
(May 4-June 4, 1939)
(14-Mc. C.W.)

CE—3AG; 3AJ; 3BF; CN8AY; CN8MS; CP1XA; **CR**—4HT; 4MM; 7AF; 7AG; **CT**—1JS; 1OI; 1ZZ; 2BJ; 2BQ; 3AB. **CX**—1CB; 2AF; 2AJ; **D**—3ANK; 3AUK; 3CDK; 3FZI; 4IYI; 4XJF; 4ZCW; EI6G; **F**—3AM; 3DN; 3KH; 3LG; 3LQ; 3MW; 3NB; 3WN; 8AI; 8ZE; 8IZ; 8GS; 8KR; 8KJ; 8NB; 8KF; 8JL; 8AT; 8FW; 8IO; **FA**—3RY; 8BG; 8DA; 8RY; FM8AA; **G2**—AT; DH; LC; SY; VF; ZQ; **G3**—AH; AS; DG; FM; JR; OT; PP; QV; RR; SD; ST; G4AP; G4DN; **G5**—BQ; CL; DQ; LP; MS; PJ; XB; ZD; ZT; **G6**—AG; BP; GH; GN; MK; SC; TI; VQ; WR; WY; **G8**—AQ; CP; II; JR; KP; OA; RE; RG; RQ; GI6WG; **GM**—8FB; 8MQ; 5SC; GW3VL; HA2L; HA4K; **HB9**—AW; BD; CE; CS; HG1HM; **HH**—2ES; 2MC; 3L; HI6Q; HK2BL; HK5EK; HR2ON; I1FC; J3DF; **K4**—DBE; DTH; ESH; FCV; FYD; KD; RJ; **K5**—AA; AC; AE; AF; AG; AM; AN; AY; **K6**—GQF; IAE; ILT/KB; JEG/KF; JLV; LBH; LKN; MTE; MVF; NPO; MXM; NYD; OKN; OQV; PAH; PGQ; PHD; PHK; PHO; PPR; PRI; PSB; PUS; QA; QBI; QIU; QLG; QYI; KA1F; KD6QHX; K7LZ; LA2X; **LU**—1CA; 2CA; 3CW; 3EV; 3FB; 4AG; 6DJ; 8AD; LY1AP; LY1J; LZ1AK; **OA**—4D; 4Q; 4R; OH3OI; **ON4**—AB; AU; BO; CD; FE; HC; JC; JW; KF; LV; MH; NO; PW; PZ; XS; WH; **OZ**—7CC; 7HS; 7KG; 7SS; **PAΦ**—AE; AZ; CE; KW; LO; OB; OK; QL; UV; XM; PJ3CO; PJ5EE; **PK**—1MF; 1RI; 1TM; 4KS; **PY**—1AH; 1AZ; 1DC; 1GJ; 1MH; 1QJ; 2DN; 2KT; 2KX; 5QJ; WM7YE; **SP1**—DC; IA; IO; KG; KM; LP; LS; MX; QY; WJ; YX; SV1KE; TF3F; **U**—3BK; 3BX; 3CY; 5HD; 5YH; 8IB; **VK7**—CM; CW; GJ; KR; **VK9**—DK; RM; VG; **VP**—1AA; 1DM; 1JR; 2AC; 4TR; 5AD; 5PZ; 5SB; 6RB; 7NT; 9X; VQ2BI; VQ3HJP; **XE**—1AM; 1AT; 1BC; 1CM; 1DA; 1DX; 1LM; 1LX; 1NU; 1PE; 2FG; XU8MA; XU8MI; YR5ML; **YU**—7BJ; 7LX; 7TE; 7XU; **YV**—1AD; 5AE; 5AK; ZB1E; ZB1Z; ZE1JS; **ZS**—1AJ; 1AW; 1CG; 1DA; 1M; 2AG; 5CU; 6DM; 6FD.

Elliott Wolheim
3477 Knox Place, Bronx, New York
(August 5-August 10, 1939)
(20-Meter Phone)

CO2GY-8; CO2WM-9; CT1EA-5; CT2BP-8; F3PS-8; F3PS-8; F3XD-6; F8DP-8; F8NT-6; F8JE-9; F8KI-5; G2MQ-8; G2VG-9; G2XN-9; G3GQ-9; G6KL-9; G8SW-7; GI6CC-8; GW5FQ-5; GW5PC-7; GW5PH-8; K4EJF-7; TI4AC-8; XE2FC-6.

(20-Meter C.W.)

CM2SW-5; CM7AI-6; CM2AZ-6; CR4MM-4; CT1JU-5; D3BPY-5; D4IFI-6; D4GKR-4; D4YET-6; EI9N-7; F3NB-6; F3QW-6; F8NW-8; F8PK-6; F8PQ-7; F8LP-6; G2FP-6; G2LZ-7; G2MI-6; G2XJ-6; G3BI-7; G3FP-7; G3KP-6; G3LL-5; G3RZ-5; G3SR-5; G3TK-8; G3UH-6; G3YB-4; G4AR-7; G4DN-8; G4GQ-8; G4HW-5; G4IG-7; G4JZ-7;

G5BM-5; G5IV-8; G5MY-7; G6NC-5; G5PR-7; G5YU-8; G5YV-7; G5XB-8; **G6**—FB-4; GH-7; KS-6; PD-5; VQ-5; WT-6; WX-5; **G8**—DL-7; DI-8; CE-5; FC-7; KP-5; PO-5; RQ-5; ON-4; LU-8; GI6TK-7; GI5WD-7; GW3JI-8; HA1B-6; HA1R-8; HA2N-6; HA5C-7; HB9CZ-5; K4OTH-8; K5AG-7; K5AP-6; LA1RA-5; OK3DK-7; **ON4**—CC-7; DC-8; IF-7; OC-7; OU-5; PS-7; PZ-6; WX-6; XS-5; OZ7HS-8; OZ7UM-6; **PAφ**—BE-7; GP-7; KV-5; JQ-7; UW-6; VB-6; WF-8; XF-8; PY2LN-4; SM6WE-8; SM6WL-7; SM7YE-6; **SP1**—AA-6; KQ-6; MX-5; LS-6; YX-4; SP3CM-6; XE1CF-6; XE2CJ-9; YL2AA-7; YM4AD-8.

Bob Everhard
"BelleVue," Nelson Park,
St. Margarets-at-Cliffe,
Near Dover, Kent, England
(July 27-August 27, 1939)
(14-Mc. Phone)

CE3EW; **CO2**—GY; JZ; KY; RH; VK; WM; CO5EV; CO8JK; DA3B; DA4AW; GI2CC; HC2CC; HK1AG; HK5EE; HR5C; K4KFC; K4ENT; K5AM; K6BNR; K6CMC; K6NYD; **KA**—1CS; 1ME; 1HS; 7EF; LU1HI; LU2DG; OG5AE; PK1OG; PK3WI; PK4DG; PK4VR; PY2AC; PY4CT; TG5JG; TG9BA; TI2FG; TI2RC; TI4AC; **VE4**—ADV; BD; BT; IF; JV; OF; YR; **VE5**—ACN; AHU; EF; OT; PC; PD; **VK2**—ADE; AGS; AGU; AHA; AIO; AKJ; AKQ; DG; LZ; MH; NQ; OQ; QI; RJ; TC; YO; ZC; **VK3**—CZ; DG; HG; IG; KX; TE; VA; XP; XS; ZX; **VK4**—AG; JP; KA; KS; VB; VK5RN; VK6MW; VK7GJ; VP1WH; VP5PZ; VQ8JM; VS2AK; VS2AL; VS7RA; VU2CQ; VU2FA; VU2JG; **W6**—AM; AH; BUW; CLS; CNA; EJC; EWE; FUD; GA; GOM; GRL; HV; IBS; IDY; IKQ; ITH; JP; KNI; LEN; LXA; LYP; MEK; MGQ; MHL; MLG; MQF; MWK; NHK; OBE; OKQ; PAB; PER; SE; SQ; VB; **W7**—AMQ; BDD; BVO; DC; DX; EGV; EKA; LOI; EYD; GAL; GXU; HJS; MF; XE1CQ; XE1GE; XE2FC; XG2BH; YR1UX; YV1AQ; YV4AG; ZE1JA; ZE1JS; **ZS**—1T; 2AV; 2OQ; 2BJ; 4H; 5BQ; 5Q; 6AJ; 6CJ; 6DY; 6EQ; 6W.

(August 7-August 27, 1939)
(3.5-Mc. Phone)

VE1—CR; GR; IN; IJS; IN; IW; LR; **W1**—AHR; AIZ; AW; BTG; DVP; DZL; EZL; FOF; IFD; IXI; **W2**—EYH; HNP; INA; JMC; JZR; **W3**—AVP/AWU; BSY; CNY; EFS; EVK; HEO; W4DCY; W4EYH; **W8**—AOC; BOZ; CHU; CNA; KDX; NPI; RYA.

(August 1-August 27, 1939)
(28-Mc. Phone)

CE3OG; F3QC; F3WT; **LU**—1QA; 5BT; 7BK; 8AB; PY3EN; PY2MI; ZS1AX; ZS5T.

(September 27-October 27, 1939)
(3.5-Mc. Phone)

W1—ABY; AW; FBJ; FOF; FIV; GAN; IM; JIE; LEJ; PZ; WL; **W2**—CGY; HXQ; JZR; LO; **W3**—AHS; AWU; BXR; CNY; DMZ; DQ; EOZ; FJU; HEO; HFD; **W4**—BAH; BPD; CL; CQG; DCQ; EQZ; W5DEW; **W8**—BOX; CHU; DUS; GPS; RYA.

(28-Mc. Phone)

W1—AGR; AKC; APU; CJL; CND; COG; CCQ; CQR; DLY; DQK; DZO; EBO; EYD; FGU; FXM; GEJ; GOU; GRV; GQL; HOM; HSX; IAH; IAO; IF; IFD; ILO; IMA; KPA; IWN; IYE; JUJ; KBT; KEG; KNB; KQN; KSB; KUA; KZU; LC; LEU; LGQ; LJB; LLL; LMB; LNE; LOB; LWE; MGQ; OQ; SI; SS; ZR; **W2**—AMF; AMM; AOG; BMT; CCP; CMU; DUG; DVU; EYE; EZC; FGB; FIT; FUL; FXB; GFH; HBA; HTL; IFL; IKV; JCY; JDQ; JEV; JLV; JMC; JQX; KIC; KKZ; LBK; LXY; LWZ; MAF; MDQ; MIC; MID; MFS; QH; VH; **W3**—AFH; CBT; DDG; DUK; EA; EET; EJT; EMM; EOZ; EZQ; FIL; GLL; GQL; GRD; GTL; GZJ; HHZ; HKY; HOH; IJB; **W4**—AZB; BNN; BYA; CYV; DUF; DV; EBM; ECI; EDD; EKI; EMV; ERH; ERY; EZK; FFM; FUM; FWA; FYN; GC; TW; **W5**—AYH; DUK; DYT; EHM; EKF; FST; FTA; GAB; GBS; GQP; GZK; HDK; HDU; HGC; HUB; WR; ZA; **W6**—AK; AXI; DGY; FDM; ITH; KFY; LDQ; LIP; MOU; MZD; NG; NES; NOG; OZB; PBD; POZ; QDT; RGW; RKV; W7GLX; CE3AC; CE3AG; HR5C; K4EZR; LU2DG; OQ5AE; OQ5AB; PY4FT; PY1AZ; TI2RC; TI3AV; YV1AQ; **ZS1**—AF; AX; IN; IT; **ZS2**—AF; AH; AL; BT; J; ZS4AA; **ZS5**—AW; BE; BZ; CD; D; T; **ZS6**—AA; BB; DU; EG; FD; W.

(14-Mc. Phone)

CE3EW; **K6**—BNR; LKN; MVA; OQE; RRM; K7HCX; KA1CS; KA1CW; KA1LZ; KA7EF; YV1AM; YV1AQ; YV5ACE.

28-Mc. Band in War Time

[*Continued from Page 134*]

were also heard active in the Gulf of Mexico, viz., W2CQB, S. S. "Pan-Kraft" heard by BRS3179, and W5FTA, a tanker, heard by BRS3003. Another ship, heard by G5BM, was W5HQP in the Pacific Ocean.

A few signals were logged from Eastern Europe (ES, OH, HA, U2, 3 and 5) and stations were heard calling HB, I, ON, TI and YU. In addition, BRS3179 logged "D4BUF," and W's were heard working this station and other D's. It seems unlikely that there are any genuine D's active at present, and a possible explanation is that the erstwhile "Rare Country" pirates have temporarily changed over to "Belligerent" call signs!

We'll Take Pigskin, Please!

"Anything to please" seems to be the slogan of one BC manufacturer who recently announced that leather covered cabinets are now available in natural shades, or in any of the popular colors.

Trends on Ten

[*Continued from page 56*]

70 on a chase, flew 36 feet through the air and landed so hard the rear wheels collapsed. The transmitter was used to call the wrecker!

Soon after going back into service it was hit from the rear, while parked, by a runaway car, telescoping the trunk. So hard was the impact that the ¼-inch mounting bolts were *sheared* off. This time the cables were sliced in half but when respliced, the transmitter worked perfectly. We are now convinced.

Generator Alterations

On the newer cars having a shunt wound charging generator and voltage control relays, little battery trouble will be experienced. On the older three-brush generators, which are usually set to deliver 10 amperes, the old trick of putting a charge control resistor on the dash comes into its own (figure 6).

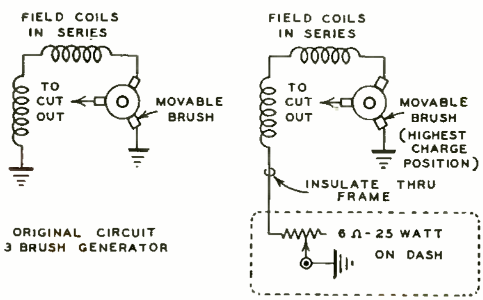


Figure 6. Method of converting an ordinary automobile generator for controlling its output by means of a rheostat on the dash.

This procedure was quite popular some years ago, the only trouble being that the carbon pile rheostats used had a vicious habit of packing. With the wide choice of heavy-duty wirewound units now available no trouble will be experienced if the generator output is not run over 18 to 20 amperes; above this point the smaller generators will throw solder.

If you think ten-meter mobile is only good for local work, give it a try. You have a big surprise in store.

See Buyer's Guide, page 192, for parts list.

U. H. F. and the Weather

[*Continued from page 34*]

determine which route they will follow, although they usually move along the longer axis of the high pressure area. Cyclones appearing over southern British Columbia follow our northern border. Those starting in the basin of Great Salt Lake or in eastern Texas usually travel northeasterly toward the Great Lakes although some go easterly to Florida. Those appearing over Florida pursue a northerly course up the coast sometimes as far as Maine before veering off to sea. The position these masses will probably assume within twenty-four hours is usually indicated by isothermal bars.

Predictions Based on Weather Data

The prediction of u.h.f. bending over any path depends upon the ability to predict a temperature inversion extending along that path. Although in theory only a very small area of inversion is necessary for refraction, in practice this area should be rather large in order for any particular signal to remain "in" for any useful length of time since this area is constantly moving. Inversions due to two different air masses can be predicted at least for the east coast during summer months as many as four days in advance. The second type of inversion can seldom be predicted more than a day in advance and since it thus would not be of any great interest at this time, the rest of this discussion will pertain only to the first type.

Very accurate predictions can only be made from three dimensional weather data. Few people, however, are fortunate enough to have such available, and must be limited to two dimensions. These data are presented by the U. S. Weather Bureau in the form of a weather map and can be most useful for predicting. These maps appear in many daily newspapers; if permanent record is desired they may be purchased from the nearest weather bureau office for less than a cent a day. It might be mentioned, however, that when receiving them by mail, they will arrive a day later unless one is located near the office. These maps show general conditions as observed on the surface of the earth, and the reader must attempt to construct an idea of conditions in the lower troposphere to a height of less than two miles by carefully noticing precipitation, temperature distribution and other such indications. With a little practice this is not impossible.

Local regional irregularities probably have a marked effect upon modifying general conditions and any such should be known. It would thus be best to check carefully general weather conditions against actual bending before any predictions are attempted for any area. For the east coast, at least, it has been found that bending is more pronounced along the direction of a *front*, or contact plane of two different air masses. The distance the signals will be refracted are a function of the extent of this front. As stated by Hull, the maximum signal bending takes place when the front is between one and eight thousand feet above the ground. Since all fronts which are useful for u.h.f. bending are neither vertical nor horizontal but at an angle with the surface of the earth, the height of the front along any path is constantly changing. In the summertime the *highs* and *lows* are usually spread out, and their centers travel slower. The average humidity is higher and conditions are better for u.h.f. bending to take place over a larger area. The length of time bending present is thus longer. Usually a warm front is much better for refraction than a cold front (when a *high* is present and a *low* is approaching). On the other hand during the winter period the opposite is true. The air mass movement across the continent is faster, the masses of air are more confined and definite in their characteristics. This causes the length of time that bending is present to be much shorter, and the distance of the path less. In this season (November) refraction is better along the contact plane of a *low* with an oncoming *high*.

Knowing the general weather stratification necessary, prediction of refraction of u.h.f. waves becomes only a question of telling when these conditions will materialize. When suitable air masses in the proper sequence show their presence on the west coast, the speed and direction can be determined. Usually four days are required for these masses to move to the east coast during the summertime. When a *high* is centered just off the New England coast, and a *low* is centered near Cleveland at 8 a.m., and a front is present running north and south over western New York state, bending will be very noticeable that evening between the first and second districts. If the front is large enough in extent, it is very possible for signals to be exchanged between New Hampshire and the third district. Other orientations of these air masses will favor other directions. In the wintertime the masses are reversed for best bending, and the oncoming mass should be centered even as far west as the eastern Lake Michigan area. Predictions of longer than twelve hours in advance will of course be in proportion.

Simple But Incomplete Methods

In conclusion it might be well to mention some of the "rule of thumb" means employed by many u.h.f. workers in attempting to predict bending, for many have a very logical basis, and become very apparent when the phenomena are understood. On the east coast where air mass bending has been noticed for the past five years, the most prevalent rule is that an east wind after a hot summer day always brings bending. This inversion, of course, is by substance, coupled with the advantage of really cool air from the Atlantic flowing in under the warmer rising air above the land. Another favorite is that just before a rain signals from the New York area attain high levels in Boston. This bending is of the air mass type. Inversions always are unstable and usually end by precipitation.

Another pet rule is that if there is a circle around the moon, conditions will be very good the next night. In this case the circle is caused by high-flying cirrus clouds, which often appear on the "leading edge" of a front. Although refraction of signals is very possible at the time this is noticed, the height of the front is usually too great for large signal levels unless coupled with a lower inversion.

The waves should strike the front at a smaller angle, as they will within the next twenty-four hours. Many other means of prediction such as observance of barometric pressure, humidity, and such local conditions can be traced to movements of air masses. It is well to remember, however, that local conditions may be very misleading, and a general knowledge of weather conditions is absolutely necessary.

Strictly 80 Meters

[*Continued from Page 93*]

than the image when the signal is not so strong that it blocks the receiver.

Once C_1 has been set correctly, it should not be necessary to touch it again unless the transmitter receives a severe jar. All tuning is then done with C_6 and C_2.

With no load on the amplifier, the flashlight bulb indicator will go completely out at resonance. As the load is increased, a point is reached where the bulb gets dimmer at resonance but is still visible. For maximum output the coupling should be increased until there is just a perceptible dimming of the bulb as the condenser C_2 is tuned through resonance. Under these conditions the output will be between 35 and 45 watts if a 400-volt supply is used.

If the transmitter is placed on the operating desk, it is advisable to cushion it on pieces of sponge rubber to prevent mechanical vibration during keying, as otherwise the note will suffer.

Antenna

While it is true to an extent on any band, it is even more noticeable on 80 meters that the type of antenna employed has more effect upon the strength of your transmitted signal than has the actual power used. If possible, a half-wave horizontal antenna should be utilized for general coverage work, even if it cannot be elevated much above the ground. The type of feed system is relatively unimportant; twisted pair feed, single wire feed, zepp feed, etc., may be used with equally good results. In fact, one end of the antenna may be brought in to the transmitter and the antenna end fed with virtually as good results. The important thing is that the antenna be an electrical half wave, and be horizontal or substantially so.

While it is possible to use 40- and 20-meter antennas on 80 meters by tying the feeders together and shock exciting the entire system or working it against a waterpipe ground, the results ordinarily will not begin to compare with the reports you will get on a half-wave horizontal antenna, even though the latter may be only 20 feet or so off the ground. This applies to medium distance work, and not to local ground wave or extreme dx. You will be loud enough locally anyhow, and for extreme dx it is simpler to switch to 40 or 20 meters than to put up an 80-meter low-angle radiator.

See Buyer's Guide, page 193 for parts list.

Frequency Modulation Fundamentals

[*Continued from page 21*]

The carrier varies up and down from the carrier frequency, converting frequency variation limits linearily into amplitude. The carrier should operate in the center of one of these straight sides. Therefore, when this frequency rises 100 kc., the gain will go down, and when the frequency decreases, the gain will go up a corresponding amount. If the transmitter had been modulated so that the level of the audio was causing a ± 100 kc. variation at 1 cycle per second, the receiver gain in the slope-filter stage would be going up and down between two given levels at the rate of 1 cycle per second. If ± 100 kc. variation was observed at the transmitter for an audio frequency of 15,000 cycles per second, the receiver would have the same audio level as it had with the 1 cycle audio applied and would be varying at the rate of 15,000 cycles per second. This high-pitched tone would be observed to be at the same level as the 1 cycle audio signal, even though the 1 cycle audio cannot be detected by the ear.

This low frequency was used as an illustration, as was the 100 kc. variation of the carrier. The usual practice is to make the carrier frequency vary approximately 85 kc. Figure 10 is a schematic circuit of a frequency modulated receiver whose values are not to be taken as a final design, as they represent an average value. This receiver does not require special parts nor elaborate shielding, and it operates over a frequency range of 25 Mc. to 44 Mc. The receiver's sensitivity is approximately 5 microvolts.

This paper was written as a non-mathematical concept of frequency modulation, which automatically limits its scope and leaves many statements in dire need of verification. The authors hope, however, that their explanation will assist in clarifying the subject of frequency modulation, and that it will help to create a better understanding of future developments.

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25-Watt Transmitter in Full Dress

[*Continued from page 63*]

type of 6L6G tubes (also known as T21) may be used with equal results. It is also possible to use regular 6L6G tubes in this stage, but there will be a noticeable loss in efficiency on the higher frequencies.

This complete transmitter has been on the air for about two months, and results have been very gratifying. The voice quality is always acclaimed as "excellent," and the signal strength has been very good considering the relatively small power output. Aside from its performance, the fact that we don't have to hide the outfit under the bench to keep from getting "Haywire Hallucinations" makes operating this rig a genuine pleasure.

See Buyer's Guide, page 193, for parts list.

Chicago Field Day Results

[*Continued from page 100*]

the key station. The principal difficulty at the key station was due to the fact that some of the competing stations were operating on 160 meters the same as the key station transmitter. The monitoring receivers on these 160-meter field stations were located directly under the transmitting antenna at the key station. This made it necessary for the operators monitoring the 160-meter band to be warned when the transmitter was to be thrown on in order that the receivers could be switched to the stand-by position. In the same way they had to be advised when the key station transmitter left the air. Considerable loss of time was experienced due to repeats needed from field stations who had been cut off by the control transmitter.

Many things that gave trouble could easily have been corrected had they been foreseen, but since they have been discovered they will be taken into consideration should another such day be planned. As a result of the emergency field day Chicago has at least eight clubs with complete emergency equipment all in operating condition and 90 per cent of which could be put into operation within a few hours.

The consensus of opinion among the participating clubs indicates that these field days are good sport, excellent practice, beneficial to the community as well as to amateur radio and no doubt most important, they produce an ever increasing degree of preparedness. When an actual emergency does strike even the most careful preparation proves insufficient.

Compromise on QSY

[*Continued from page 102*]

Graphical Representation

Those who prefer pictures to words as an aid to understanding a theoretical concept will probably find the graph in figure 1 helpful. This graph is an attempt upon my part to give as inclusive a snapshot of what takes place under the conditions described above as the rather rigid graphical medium permits. Ip, the ordinate, may be considered as representing the plate current of the final amplifier. C, the upper abscissa, represents the setting of the antenna tank condenser in degrees. F, the lower abscissa, indicates the frequency in kilocycles of the final amplifier. Curve A represents the conditions existent when the amplifier is operating on 14,250 kc. Curve B shows the conditions incident to operation of the amplifier on 14,400 kc.

Examination of both curves makes clear that when the amplifier is tuned as previously described the setting of the antenna condenser in degrees is the same for both frequencies (the setting of the amplifier tank condenser remains constant too, but graphical limitations prevent indicating this on the graph). Likewise, the plate current is the same on both curves at the common point at X. Yet, strange as it may seem at first, point X indicates simultaneously the two actual operating frequencies of 14,250 kc. and 14,400 kc. The difference in frequency results, as is plainly shown on the graph, because of the overcoupled state existent between the final amplifier plate tank and the antenna tank at both frequencies. In the one case, 14,250 kc., it is easily seen that the antenna circuit is tuned to the high frequency side of exact resonance; and in the other case, 14,400 kc., this same tank circuit is tuned to the low frequency side of true resonance.

Thus far we have accomplished the following: All tuned circuits from the crystal stage through to the antenna will always be in tune on either 14,250 kc. or 14,400 kc. To change from one frequency to the other all that need be done is to switch from one crystal to the other. But, need we stop here? Let us exchange our 14,400-kc. crystal for one at 14,375 kc., and our 14,250-kc. crystal for one at 14,260 kc.; and what is more, let us put each of the new crystals in a variable gap holder. If we then tune the transmitter by the method already described, so that it is in permanent resonance at either 14,387.5 kc. or 14,272.5 kc. (the midpoints of the variable gap ranges), we shall make instantly available all the frequencies between 14,260 kc. and 14,285 kc., and between 14,375 kc. and 14,400 kc. Lost motion in QSY'ing will now be confined to turning the crystal-shifting switch and the variable gap knobs. In addition, it seems safe to make the statement that the frequency range permitted covers by far the most effective frequencies for raising dx and should allow us to compete more confidently with our ambitious friends of the "Rube Goldberg" turn of mind. We may give these Frankensteins of our friends still further competition by resorting to the variable-frequency oscillator. V.f.o., in addition to high L/C tank ratios and tight coupling of related tank circuits, should make it possible, with slightly reduced efficiency in the middle of the band considered, to cover nearly all of the desired 150 kc.

With the realization in mind that all of us are not able to afford the time, energy, or money needed to build the perfectly flexible transmitter, may I suggest that an application of the ideas already presented to your particular transmitting problems may afford you a satisfactory compromise on this rapidly growing necessity for frequency flexibility.

How About the Receiver?

[*Continued from page 57*]

the life of me understand why. Whenever RADIO comes out with some new circuit for the transmitter, the o.m. tries it out right away; but he just seems to skip over the swell dope the magazine prints about receivers.

He sure got a surprise when he found out how simple it was to add a voltage regulator tube to my oscillator circuit. When he had done that, and replaced a few of my mica condensors with some of the new silvered type, the results really astonished him. Instead of my oscillator drifting across the band for hours after I was turned on, it was now so stable I could almost have been calibrated for use as a frequency meter. That took care of my lack of stability that had bothered the o.m., especially when I was operating in the ten meter band.

The next thing he tackled was a little more difficult, but by following closely the article in RADIO, he carried it off fine. I now had a pre-selector stage ahead of me that amplified those weak signals tremendously. The o.m. had used the circuit that has a Faraday Screen in between the primary and secondary windings of the antenna coil. This cut down the noise pickup considerable; so he gained not only sensitivity and selectivity, but also achieved a better signal-to-noise ratio. I now could have brought in that G6 station with at least an R7 signal.

The pre-selector was finished about five o'clock, and of course the o.m. had to sit right down and try it out. When he heard some of the dx I brought rolling in, he jumped up and turned on the rig. In half an hour we were able to work three PK's and a South African! It tickled him so much that the o.w. had to drag him from the ham shack to eat his dinner.

Later that evening I got a real workout. We worked several dx stations; and was the o.m. happy when he worked those last two countries he needed for his W.A.C. certificate!

After the band went dead about eleven-thirty, we hooked up with W6—for a local rag-chew. I sure felt swell about the way the o.m. bragged about me. It seems that I'm not a "lemon" anymore. I distinctly heard him refer to me as a *"peach"*.

Receiver Circuits for Frequency Modulation

[*Continued from Page 65*]

todes with the resistor-loaded i.f. transformers required in FM receivers. The limiter can be an 1852 or 6SJ7 (the 6SJ7 might as well be used since it is somewhat less expensive). The rectifier, a 6H6. The audio system should really be high fidelity with small distortion. Any combination that suits the individual desires will be satisfactory. And, last, the speaker must really be good to take full advantage of the capabilities of the other elements of the system. Some of the manufacturers are now bringing out special speakers designed to handle the wide range permitted by frequency modulation.

Results

Now about results. Here in Newport it is possible to hear all three of the stations regularly broadcasting this form of transmission: W1XOJ at Paxton, Massachusetts, owned and operated by the Yankee Network, who were the first broadcasters to employ this system; W1XPW, at Meriden, Connecticut; and Major Armstrong's own station W2XMN at Alpine, New Jersey.

My location is across the street from the Newport Hospital and their QRM machines at times all but wash out everything on the broadcast band except the three stations in Providence, R. I., who are about 30 miles airline. Even these have the noise on their background. But any of the three FM stations come in without more than a trace of the noise, and the signals have program material many times better than their b.c. brothers. Persons who have heard the signals have remarked on them and have given most favorable comments.

Another favorite trick is to couple an electric razor to the antenna lead in and then try to get stations on the b.c. and FM bands. B.c. nil. FM still o.k. without any noise from the extremely severe electrical disturbance.

Now I would like to comment on commercially available receivers that I have heard. The RCA and Stromberg-Carlson models HM-80 (GE) and 425-H (SC) are in about the sixty dollar class and when employed in conjunction with a *really good* audio amplifier and reproducer will give a signal of quality that is far better than any regularly scheduled program on the regular broadcast band. These receivers with their own speakers are not tops, but are considerably better than most of midget sets or inexpensive larger ones on the market. Both these receivers tune only the 40-44 Mc. FM band. GE and Stromberg also have higher priced models and these are excellent jobs covering both AM and FM bands. Also, the Yankee Network's REL receiver (employed with a Waite high-fidelity speaker) leaves nothing to the imagination. The program is in the room with you.

With stations in all parts of the country applying for construction permits for this system it will only be a matter of time until either a homemade or a commercial FM receiver will be a requirement in every metropolitan or suburban home.

• • •

A new manufacturing concern in Boonton, N. J., is called *Microvolts, Inc.*

Bandswitching 200-Watt Amplifier

[*Continued from Page 86*]

The grid modulation percentage may be reduced by using an unby-passed grid lead of about 5000 ohms in series with the grid return to the grid bias supply. If only grid-leak bias is to be used, a total value of about 15,000 ohms would be proper with about 10,000 ohms by-passed and the remaining 5000 ohms not by-passed.

The grid swing may be reduced also by tapping down on the secondary of the modulation transformer so that only about half the a.f. swing in the cathode circuit is applied to the grid.[2]

The amplifier may also be suppressor modulated by making a few very slight and obvious changes in the connections to the suppressor circuit.

Grid-bias modulation of the 257 will also give excellent results, and only a very small amount of audio power will be required. The comparative output power to be expected with various types of modulation are: suppressor-grid modulation, 35 watts; grid-bias modulation (class C high-efficiency type), 60 watts; cathode modulation, 75 to 90 watts depending upon the linearity of modulation desired.

See Buyer's Guide, page 193 for parts list.

• • •

Scotchmen: Please Note!

Old chassis lying around the shack can often be put to good use again by sawing out the top so that about a half inch lip remains around the sides. This lip may be drilled so as to take a new chassis top formed from heavy sheet metal or an undrilled, unpainted panel. It's a money saver for the confirmed "builder-upper" and "tearer-downer."

Gaseous Voltage Regulator Tubes

[*Continued from page 154*]

I_R, the current through the regulator may be arbitrarily set at 20 milliamperes where normal variations in supply voltage are expected. If a large increase but a small decrease from the normal voltage is expected a value of 15 milliamperes may be used. On the other hand, if the voltage is not expected to go greatly above normal but is expected to drop considerably from time to time, I_R may be taken as 25 milliamperes.

For example take the case of a VR-150-30 which is to regulate the voltage to a load drawing 10 milliamperes from a supply of 250 volts in which normal variation is expected:

$$R_S = \frac{250-150}{.020 + .010} = 3333 \text{ ohms}$$ (a 3500-ohm resistor will be suitable)

If the required value of R_S turns out to be less than 3000 ohms the effectiveness of the VR tube in maintaining a constant voltage will be reduced. To alleviate this condition a higher supply voltage must be used.

To find the wattage rating of the series resistor, the power formula, $W = I^2R$, may be used. The current is the sum of the regulator-tube and load currents; in the above example:

$$W = (.020 + .010)^2\ 3333 = 3 \text{ watts}$$ (a 5-watt resistor should be used)

Past, Present and Prophetic

[*Continued from page 8*]

he speaks in "Trends on Ten," beginning on page 45. Recently the editors of this journal were privileged to make a tour of inspection of Grening's police radio system, including a ride in a police car with a siren 'neverything. We were amazed at the smooth-working installation George has assembled. The transmitter and receiver are atop a hill some distance away and completely remote controlled. By means of an ordinary telephone dial the operator can do just about everything except sweep out the transmitter house.

Coming Up

When the little three-tube super shown in the 1940 "RADIO" HANDBOOK proved to be a mighty satisfactory piece of equipment after several months of use in regular amateur communication, it was decided to build a slightly larger and improved version of the same set. The new set finally wound up with 5 tubes, including an r.f. and i.f. stage. This set has given an excellent account of itself in the World-Wide DX Contest. A quick glance at the list of parts brings forth an estimate of about 25 dollars for the complete set. It's scheduled for the February issue.

1623 Transmitter-Exciter

[*Continued from Page 38*]

A pair of 6L6's operating class AB_1 at 400 plate volts and with a fixed bias of 25 volts probably make the most economical modulator for this amount of audio power. The output transformer should be designed to match the modulator 6600-ohm plate-to-plate load to a 6500-ohm r.f. load, which means that a 1:1 ratio will be satisfactory for all practical purposes. An a.m.c. circuit operating on the negative modulation peaks must be included in the modulator if full advantage of the capabilities of the extended positive peak voice modulation is to be obtained.

[1] Smith and Dawley, "Comes the Revolution," RADIO, Dec., 1939, p. 11.

Under Operation

The following current readings will give an indication of the type of operation to be expected at the two extremes of the transmitter-exciter frequency range.

Power supply voltage .... 650 volts

160 Meters

Oscillator plate	50 ma.
Frequency-mult. plate	0 ma.
1623 grid	30 ma.
1623 plate	100 ma.

10 Meters

Oscillator plate	30 ma.
Frequency-mult. plate	65 ma.
1623 grid	25 ma.
1623 plate	100 ma.

See Buyer's Guide, page 192 for parts list.

High-Gain Mobile Converter

[*Continued from Page 68*]

is removed from the transformer as purchased and approximately 15 turns of small silk or cotton covered wire wound around the dowel as close to the remaining winding as possible. The correct number of turns to be used on this "link" winding will vary from one auto set to another. 15 turns is a good average for most sets, however. If it is desired to do any experimenting, windings of from 10 to 25 turns may be tried, these figures representing the minimum and maximum number of turns which have been found proper with a wide variety of auto receivers.

RADIO

A four-prong "bantam" tube socket at the rear of the chassis is used for antenna, output, and power connections. The change from broadcast to 10-meter operation is made by a four-pole double-throw rotary switch located on the panel just below the dial. This switch connects or removes the A and B power to the converter, switches the antenna leads from the converter input to the auto receiver input and connects the output of the converter to the b.c. receiver antenna when in the "shortwave" position.

See Buyer's Guide, page 193 for parts list.

Radio Documents

[*Continued from Page 135*]

—*Amendment to above.*—Act [S. 595] to amend Communications Act of 1934, approved June 19, 1934, for purpose of promoting safety of life and property at sea through use of wire and radio communications, to make more effective International Convention for Safety of Life at Sea, 1929, and for other purposes. Approved May 20, 1937. (Federal Communications Commission.)	15c
Comparison of data on ionosphere, sunspots, and terrestrial magnetism. (Standards Research Paper 913.)	5c
Continuous measurements of virtual heights of the ionosphere. (Standards Research Paper 582.)	5c
Determination of output characteristics of electron-tube generators. (Standards Scientific Paper 355.)	5c
Electric hygrometer and its application to radio meteorography. (Standards Research Paper 1102.)	15c
Electrolytic resistors for direct-current applications in measuring temperatures. (Standards Research Paper 1126.)	10c
Exchange of information concerning issuance of radio licenses, agreement between United States and Canada, effected by exchanges of notes, signed Mar. 2 and 10, Aug. 17, Sept. 8 and 20, and Oct. 9, 1937. (Executive Agreement Series 109.)	5c
Experiments with underground ultra-high-frequency antenna for airplane landing beam. (Standards Research Paper 1006.)	10c
Extension of normal-incidence ionosphere measurements to oblique-incidence radio transmission. (Standards Research Paper 1013.)	5c
Federal Communications Commission. Annual reports, 1935	15c
1937	30c
1938	25c

Federal Communications Commission reports, decisions, reports and orders: (Cloth bound)	
Vol. 1, July, 1934-July, 1935	$1.00
Vol. 2, July 1, 1935-June 30, 1936	$2.00
Vol. 3, July 1, 1936-Feb. 28, 1937	$2.00
Vol. 4, Mar. 1, 1937-Nov. 15, 1937	$1.50
General information pertaining to holding companies. 1937. (Federal Communications Commission.) (Form.)...	5c
This form is intended for use of holding companies controlling one or more carriers engaged in wire or radio communication, which controlled companies have aggregate average annual operating revenues not exceeding $50,000. Harmonic method of intercomparing oscillators of national standard of radio frequency. (Standards Research Paper 925.)	5c
Improved audio-frequency generator. (Standards Research Paper 367.)......	10c
Information for amateur designer of transformers for 25- to 60-cycle circuits. (Standards Circular 408.)	5c
International code for radio weather reports from ships. (Weather Bureau.)	5c
International Radio Consulting Committee (C.C.I.R.), 3d meeting, Lisbon, Sept. 22-Oct. 10, 1934, report of delegation of United States, and appended documents. (State Dept., Conference Series 21.)	50c
International Radiotelegraph Conference of Washington, 1927, delegation of United States, committee on tariff, word count, and acounting, report on history of use of codes and code language, international telegraph regulations pertaining thereto, and bearing of this history on Cortina report. (State Dept.)	20c
Maximum usable frequencies for radio skywave transmission, 1933 to 1937. (Standards Research Paper 1096.).....	5c
Method for investigation of upper-air phenomena and its application to radio meteorgraphy. (Standards Research Paper 1082.)	10c
Methods, formulas, and tables for the calculation of antenna capacity. (Standards Scientific Papers 568.)	20c
Monitoring standard radio-frequency emissions. (Standards Research Paper 766.)	5c
Multifrequency ionosphere recording and its significance. (Standards Research Paper 769.)	5c

National Radio Conference, 3d, called by Herbert Hoover, Secretary of Commerce, proceedings of conference and recommendations for regulation of radio, held at Washington, D. C., Oct. 6-10, 1924 .... 5c

Note on resistance of radiotelegraphic antennas. (Standard Scientific Papers 257.) 5c

Opinions expressed by International Technical Consulting Committee on Radio Communication, meeting at The Hague, 1929, and Copenhagen, 1931. (State Dept., Conference Series 9.) ... 20c

Performance tests of radio system of landing aids. (Standards Research Paper 602.) 10c

Primary batteries. (Signal Office Training Pamphlet 7.) 10c

Primary radio-frequency standardization by use of cathode-ray oscillograph. (Standards Scientific Papers 489.) 10c

Principles of radio transmission and reception with antenna and coil aerials. (Standards Scientific Papers 354.) 10c

Principles underlying radio communication. 2d edition, revised to May 24, 1921. (Radio Communications Pamphlet 40.) Cloth $1.00

Production of accurate one-second time intervals. 1938. p. 367-373, il. (Standards Research Paper 1136.) 10c

Quantitative experiments in radiotelegraphic transmission. (Standards Scientific Papers 226.) 5c

Radio broadcast stations in the United States. Edition of January 1, 1934. (Federal Radio Commission.) 10c

Supplement No. 1 to above 5c

Radio broadcasting, arrangement between United States and Dominion of Canada; effected by exchange of notes signed May 5, 1932. (State Dept., Executive Agreement Series 34.) 5c

Radio broadcasting, hearings, 73d Cong., 2d sess., on H. R. 7986, Mar. 15-20, 1934. (Merchant Marine, Radio, and Fisheries Committee, House.) 15c

Radio broadcasting station, hearings before subcommittee, 75th Cong., 3d sess., on S. 3342, bill to authorize construction and operation of a radio broadcasting station designed to promote friendly relations among the nations of the Western Hemisphere, May 12, 18, 19, and 23, 1938. (Interstate Commerce Committee, Senate.) 15c

Radio communications between amateur stations on behalf of third parties, arrangement between United States and Chile; effected by exchange of notes signed Aug. 2 and 17, 1934, effective Aug. 17, 1934. (State Dept., Executive Agreement Series 72.) 5c

Radio communications between private experimental stations and between amateur stations, arrangement between United States and Dominion of Canada continuing arrangement effected by exchange of notes signed Oct. 2, 1928, Dec. 29, 1928, and Jan. 12, 1929; effected by exchange of notes signed Apr. 23 and May 2 and 4, 1934, effective May 4, 1934. (State Dept., Executive Agreement Series 62.) 5c

Radio direction finder and its application to navigation. (Standard Scientific Papers 428.) 15c

Radio facts and principles, limiting the number of broadcasting stations which may operate simultaneously in United States; testimony of John V. L. Hogan before Federal Radio Commission, Washington, D. C., July 23, 1938. (Federal Radio Commission.) 5c

Radio field-intensity and distance characteristics of a high, vertical broadcast antenna. (Standards Research Paper 874.) 5c

Radio field-intensity measurements at frequencies from 285 to 5,400 kilocycles per second. (Standards Research Paper 429.) 5c

Radio fog signals and their use in aviation in connection with radio compass, 2d edition, 1924. (Lighthouse Service.) 10c

Radio instruments and measurements. 1924, reprinted 1937, with certain type corrections and omissions. (Standards Circular 72.) 60c

Radio laws of United States (June 24, 1930-May 31, 1938). (House of Representatives.) 15c

Radio markets of the world, 1932. (Trade Promotion Series 136.) 10c

Radio method for synchronizing recording apparatus. (Standards Research Paper 269.) 10c

Radio observations of Bureau of Standards during solar eclipse of Aug. 31, 1932. (Standards Research Paper 629.) 5c

Radio servicing, outlines of instruction for educational advisers and instructors in Civilian Conservation Corps camps. (Education Office, Civilian Conservation Corps, Vocational Series 13.) 10c

Cause and elimination of night effects in radio range-beacon receptions. (Standards Research Paper 513.) 10c

Characteristics of airplane antennas for radio range-beacon reception. (Standards Research Paper 313.) 5c

Course-shift indicator for double-modulation type radiobeacon. (Standards Research Paper 77.) 5c

Design of tuned reed course indicators for aircraft radiobeacon. (Standards Research Paper 28.) 5c

Directive type of radiobeacon and its application to navigation. (Standards Scientific Papers 480.) 5c

Method of providing course and quadrant identification with radio range-beacon system. (Standards Research Paper 593.) 5c

Phase synchronization in directive antenna arrays with particular application to radio-range beacon. (Standards Research Paper 581.) 5c

Simultaneous radiotelephone and visual range beacon for the airways. (Standards Research Paper 341.) 20c

Theory of design and calibration of vibrating-reed indicators for radio range beacons. (Standards Research Paper 338.) 10c

Radiotelegraph convention and general regulations between United States and other powers. Signed at Washington, Nov. 25, 1927; proclaimed, Jan. 1, 1929. (State Dept., Treaty Series 767.) 30c

Supplement to above publication 5c

Recent studies of the ionosphere. (Standards Research Paper 780.) 5c

Relation of radio wave propagation to disturbances in terrestrial magnetism. (St.ndards Research Paper 76.) 5c

Report of Federal Trade Commission on radio industry in response to H. Res. 548, 67th Cong., 4th sess. 1924.. 40c

Report on social and economic data pursuant to informal hearing on broadcasting, Docket 4063, beginning Oct. 5, 1936, by Engineering Dept. of Federal Communications Commission, July 1, 1937. (Federal Communications Commission.) Cloth 60c

Rules governing construction, filing, and posting of tariffs, relating to interstate and foreign wire or radio communications, by carriers subject to Communications Act of 1934, excepting connecting carriers as defined in sec. 3 (u) of act and excepting carriers operating in Alaska; effective Sept. 1, 1935. Issue of July 31, 1935. (Federal Communications Commission, Tariff Circular 1.) 10c

Safety rules for radio installations comprising pt. 5 of 4th edition of National Electrical Safety Code. (Standards Handbook Series 9.) 10c

Set, radio, type SCR-132. (War Dept., Technical Regulations 1210-30.) 15c

Set, radio, type SCR-136. (War Dept., Technical Regulations 1210-20.) 10c

Some experiments at radio frequencies on super-conductors. 1938. p. 109-123, il. (Standards Research Paper 1070.).. 5c

Some studies of radio transmission over long paths made on the Byrd Antarctic expedition. (Standards Research Paper 412.) 10c

Spectroradiometric analysis of radio signals. (Standards Scientific Papers 477.) 10c

Speech in House, Feb. 1, 1937, by Representative Wigglesworth, requesting thorough investigation of radio broadcasting monopolies, also to determine whether or not the Federal Communications Commission has performed its duties in accordance with the Federal Communications Act. (In Cong. Record of Feb. 1, 1937, vol. 81, no. 21, pp. 799-800.) 11c

Sudden disturbances of the ionosphere. (Standards Research Paper 1016.)... 15c

12-course radio range for guiding aircraft with tuned reed visual indication. (Standards Research Paper 154.) 10c

200-kc. piezo oscillator. (Standards Research Paper 576.) 5c

Unicontrol radio receiver for ultra high frequencies using concentric lines as in-stage couplers. (Standards Research Paper 856.) 5c

The following information on how to send for public documents is given for the benefit of those who may wish to obtain copies of any of the foregoing publications:

How to Remit for Public Documents

"The rules of this Office require that remittances be made in advance of shipment of publications, either by *coupons*, sold in sets of 20 for $1 and good until used, or by *check* or *money order* payable to the Superintendent of Documents. Currency may be sent at sender's risk. Postage stamps, foreign money, and defaced or smooth coins are not acceptable.

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"Deposits of funds are also invited from our regular customers, against which publications may be charged as ordered, thus obviating the necessity of first obtaining quotations of price.

"Price lists on different subjects are supplied without charge on request. Be sure to mention subject in which you are interested.

"Promptness in handling correspondence is insured by sending *separate requests* for information instead of embodying them in cash order. *Full name and address* should be given on request for additional information.

"Publications are sold to dealers and quantity purchasers of 100 or more at a discount of 25 percent, on condition that purchasers will adhere to public sales price set by Superintendent of Documents, and that publications shall not be overprinted with any advertising matter."

Superintendent of Documents.
United States Government Printing Office
Division of Public Documents
Washington

Plus or Minus

The F.C.C. estimates that there are not over 15,000 amateurs active during any single month in the year.

The Franklin Oscillator Circuit

[*Continued from Page 44*]

oscillator tank circuit. Along the rear edge of the chassis are located the VR-150-30, the output coil and the 6L6 output tube. Between these two rows of components and on the right side of the chassis are located sockets for the two crystals. Underneath the chassis the parts are located as convenience dictates. The crystal-v.f.o. switch and the output tank condenser are mounted on the shield partition and located an equal distance in from each edge.

Originally it was intended to attempt to use the output stage as a quadrupler as well as a doubler and a socket to take plug-in coils was installed for this purpose. However, the attempt failed as the output when quadrupling was too low to be useful. Consequently, the plug-in coil and socket might well be replaced by a single permanently mounted 80-meter coil.

Keying

Requests for a v.f.o. unit which could be keyed led to the installation of a keying jack in the Franklin. The keying jack is between the cathodes of the two 6F6's and ground. A switch, S_1, in the keying lead to the first 6F6 allows this stage to be disconnected when it is desired to key the buffer stage as a keyed crystal oscillator. This switch must be opened whenever the buffer stage is used as a crystal oscillator. If the switch is not opened when using crystal, enough of the Franklin-oscillator output will leak through to cause two-frequency output.

Tests show little difference between crystal and v.f.o. operation as far as keying is concerned. The keying sounds like the ordinary keyed crystal oscillator in either position; it is not perfect but is satisfactory for most purposes.

Tuning

Tuning up an oscillator of this type is not in the least difficult. The power supply should deliver 500 volts, well filtered, at about 150 milliamperes and 6.3 volts at 2.5 amperes. With the plate and heater voltages applied, the keying plug removed from the circuit-closing jack, switch S_1 closed and switch S_2 thrown to one of the end, or v.f.o., positions, the feedback condensers C_6 and C_7 should be adjusted for stable operation. This adjustment is not critical; if a great deal too much capacity is used the oscillator will break into a high pitched audio oscillation which may be heard coming from the tubes and other parts of the circuit. If too small a capacity is used the circuit will not oscillate at all—that's about all there is to it. The range over which satisfactory oscillation may be obtained is quite wide—about 2 to 20 $\mu\mu$fd. with each condenser. The final setting of the condensers should be at the least capacity which allows stable oscillation and sure-fire keying. About 15 watts of power output is available on the 80-meter band at the link terminals whether crystal or v.f. control is being used.

See Buyer's Guide, page 193 for parts list.

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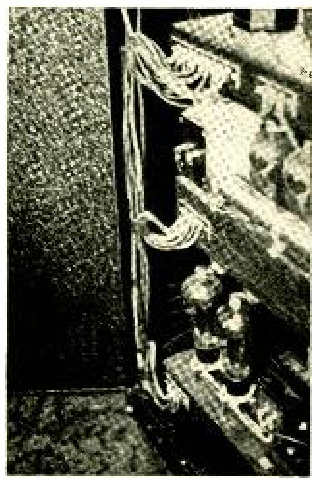
SIMPLIFIED TRANSMITTER CABLING



Laced connection cables such as those used in commercial transmitters of the enclosed cabinet type are pretty but difficult for the amateur to copy. In addition, it is difficult to remove individual wires from a laced cable as is so often necessary in ham work.

W2TY solved the problem in his home-rolled rig by obtaining a length of thick-walled composition tubing, thence cutting it up in one-inch lengths. These "rings" are fastened opposite each deck into the corners of the transmitter cabinet back near the rear door. A single hole is drilled through the cabinet from the side, and a metal screw is passed through this hole into one tapped into the composition ring just far enough to hold the ring in place. The metal screw must not be allowed to protrude through to the inside of the ring.

Individual wires may thus be connected to the binding posts of one chassis, passed through the rings spaced a foot or so apart to the other. The wires may readily be removed or inserted, the "cable" looks well and the wires stay nicely out of the way. In addition, as the rings are of composition rather than metal, they cannot short through to ground even should the wire insulation fail.

Yarn of the Month

[*Continued from Page 152*]

Miami. There she borrowed an autogyro and flew to Magdellan. Is my face red! I've been telling her all about flying ever since I met her a year ago, and she has held a commercial ticket all the time.

The third day I spent in the jungle, I saw her overhead. I dropped the 152nd banana (I counted them to help pass away the time) and started to yell like an idiot. She couldn't hear me, but must have guessed what I was doing. She dropped a shoe with a note tied to it telling me to shut up and informing me that there was a clearing thirty feet to the north in which she intended to land. It took me two hours to cut my way through the underbrush, but I finally made it. The trip home was uneventful.

Prexy has promised to import a pilot so that I can get along with my improvements and forget my radio controlled airline. Until then, Margarita and I will do the flying.

73,
Cy,

P.S. I'm not having any more trouble with Cy as I've gone native! Don't you wish you were here?

Margarita

U. H. F.

[*Continued from Page 132*]

gest that to revive 56 Mc., some way must be found to get the newcomer on five meters; let's look into it, anyway, and see if the way can be found.

Juan Lobo y Lobo, XE1A-XE2N, writes to tell us that his five-meter transmitter with a pair of HF100's in the final will be going, in Mexico City, about January. This will be auto-keyed. Under present plans, it will be hooked to a beam rotating between New York and San Francisco every five minutes. We wish you luck on contacts, o.m., and we know that plenty of W's will be hoping for F_2 or off-season sporadic-E dx which may give them a chance to work you.

W8OKC in Pennsylvania has made some interesting observations on working in and out of valleys. The front-to-side ratio of his twin two-section W8JK's, is 43 db when working over a mountain, but several checks with stations within the valley indicate not much difference—in some cases, out-of-phase reflections weaken the signal. A station in the next valley reported signals best with the beam pointed out directly but at a mountain to the side. The same thing occurs on reception. OKC concludes that ground wave work at his location is best done by bouncing the signal off hills like three-cushion billiards!

Last spring, VK3PH along with other VK's noticed that sometimes an airplane passing by will cause a cyclic variation in twenty meter signal strength. This was very nicely recorded by Bell Labs. engineers on ultra-high frequencies about two years ago. It was reported to be the results of beating between signals coming by the usual path, and by a new path caused by reflection from the plane. Of course, it is the same general phenomenon observed in sky-wave fading.

1939 European Summary

Several of our readers have asked about five-meter conditions in Europe during 1939. We shall be glad to mention some of the work and experiences, as reported in the *T & R Bulletin*, the *Short-Wave Magazine*, and in correspondence that we have received.

Last spring we mentioned English work beyond 100 miles, most of it done with long horizontal antennas, on code, using straight regenerative receivers. A test in February brought little dx, although it came out that G6DH had heard signals out to 120 miles on nights that had an Aurora similar to that observed on February 24.

In April, G6CW in Nottingham (neither the Sheriff nor Robin Hood, we understand) worked G5OX at 120 miles. G8JV worked G5MQ, 114 miles away, and other good distances were covered. G5BY heard G6FO (126 miles) again. G5TX on the Isle of Wight, with a beautiful location at the top of the island, has an antenna 550 feet above the sea and 100 feet above the ground. His quarter kilowatt started to reach out about a hundred miles. G6CW used a transmitter line-up of 89-6L6-6L6-35T feeding a horizontal six half waves in phase, and an acorn t.r.f. receiver. G6FO stayed with an antenna ten-half-waves long on which he got out a hundred miles in directions end-on and elsewhere.

May was only a little better. During a 126-mile contact with G6FO, G5BY swung his W8JK antenna slowly from horizontal to vertical, in which position the signal disappeared, to return again gradually when the beam approached the horizontal. We listened at several points in London and southern England, to hear only c.w., no phone at all. The gang become disgusted with hearing unidentified carriers and successfully carried out a campaign for signing transmissions with a key. At G5BY we did not have enough luck to pick up G6FO over near Wales although the contact was made nearly every night. G5TX and a station beyond London were heard by us at G2ZV in Sussex near the south coast. On the 30th, conditions picked up enough for G2ZV and G6CW to establish a new English 56-Mc. dx record of 155 miles.

June brought real sporadic-E layer dix with I1IRA, EAK, IBE, IRX, and a German-speaking phone heard by various G's on the 1st. Italian commercials were also heard on the 6th and 12th, but on the lucky 13th G6CW and G8JV worked I1FA and I1SS; ten meters had opened up to Europe just before the Italians came through. More Italian commercials were reported on June 16, 17, 19 and 22. The 24th brought numerous contacts between English and Italian amateurs, reception of an Addis Ababa commercial harmonic and a phone report of F8VC in Paris at G6YL. F8VC picked up a GM phone on the 18th. More I-G dx on the 25th. SU1RD was heard by OZ2AU on June 22. While all this was going on, many 100-150 mile contacts were made, and G5TX on the Isle of

Wight logged PAΦPN and ON4DJ on low atmosphere bending.

Early in July, GW6AA went up Snowden mountain. Although the wind brought down four of the six masts he managed to erect, he worked EI8L and many G's over 100 miles and heard GI8TSP, EI2J, G8JV and other good dx. Had he been able to set up his beams, even better results may have been possible. On the 13th, G8ML logged an unidentified French station, and on the 9th, R. J. Lee heard F8AA, F8NW and ON4DJ on low atmosphere bending. G2ZV repeated his English record contact with G6CW, getting only about four or five watts from a 6L6 doubler, working into a four-element widely spaced horizontal Yagi array. On the 31st, G5CD heard and called ON4NA who came back with the wrong call. Skip dx continued in this month, being reported on July 3, 7, 8, 10, 11, 14 or 15, 17, 19, 20, 21, 22, 24. DX stations heard included CS3VA (a government 56-Mc. station in Lisbon, Portugal, that held schedules with G6YL and others), SM5SN, and SM7, I1ZU, SPW (Poland commercial harmonic), UOY1 calling UXN, SNB (also Poland, it is reported), CTH (Portuguese commercial). On the 14th or 15th, G6IH heard SU1R? which may have been SU1RD who is active on the band. SU1RD heard G speech at times on the 10th.

August brought no skip dx except that I1ZU reported hearing G6DH 6CW 5BY on the 2nd. G2OD (who, we understand, was the first English station to work the U.S.) set up a new pre-skip dx record in a 187-mile contact with G8KD in Sheffield. September brought war, and that's that.

British Equipment

Equipment in England is somewhat different from ours. Many stations use c.w. entirely or sign phone transmissions with the key, so super-regen receivers are useless. Many fellows use acorn tubes, although they cost the equivalent of something like $15.00! Some 60 per cent of the reporting stations in one contest during the summer used acorns in the r.f. stage; an increasing number were going over to superhets by September because of the freedom from instability that occurs in t.r.f. jobs. 2DDD was working on a concentric line tuned acorn tube job. Quite a few use an acorn r.f. stage ahead of a ten-meter communications receiver, with a five-meter circuit in the mixer grid.

Very few G's use vertical antennas. Possibly it is due to widespread use of long-wire horizontals which are directional nearly end-on. G6QK and G6DH have rotary horizontal W8JK's. GM6RG has a beam directed at the U.S. G6CW points out that those who do not use the same antenna for both transmission and reception may miss out on contacts because of the different directional patterns of two antennas. G2ZV ran comparative tests between an 84-foot wire and a three-element array. The latter showed up as being definitely better.

Transmitters appear to run to single-ended finals. Although some European tubes are used, transmitters generally end with a T20, 35T, 6L6, 6V6, or 6N7, with 10 to 35 watts input, according to tables describing contest entries.

Many receivers may be in operation in Great Britain during the winter in the hope that an F_2 layer dx signal will slip through, but transmitting equipment has been stored away by the government.

112 Megacycles

A suggestion for promoting the use of horizontally polarized antennas appears in the 56 Mc. antenna comments above. We should like to receive observations on antenna polarization experiments on the 2½-meter band too.

W2JND in Syosset, Long Island, gives us a list of 2½-meter stations that are active nightly and all putting through nice signals:

W2MCG Brooklyn, N. Y.
W2GZ Hempstead, L. I.
W2LFL Valley Stream, L. I.
W2MLO Rockville Centre, L. I.
W2LJJ East Rockaway, L. I.
W2KTW Bronx, N. Y.
W2BZB Palisade, N. J.

JND says that the boys should concentrate on the antenna for this band because it means everything in putting the signal in the right place. He asks for more dope to be published on directive antennas. He uses a three- and a seven-element array. With about fifty watts input at each station, he works W2BZB in Palisade, New Jersey, who has a five-element array. JND suggests using insulated wire on the antenna feeders, pulling them through the plate rods from the plate end, without any tuning. But, o.m., won't that work well only when the feeders present a high impedance at the plate end of the output rods?

224 MEGACYCLES

Bernard Bates, W1BBM, has had fine results on 2½ meters from Cape Cod, Mass. He now is down on 1¼ meters using a Yagi antenna with plenty of gain and is all set for tests, schedules and the like. Drop him a line if you are interested in tests, and are within a hundred miles or so of him.

Speaking of Yagi antennas, we telephoned W9SQE one day. His wife answered the phone but said that SQE could not come because he was on the roof playing with his *Yogi*. Quick, Jeeves, the Webster (with apologies to W1JPE and P. G. Wodehouse).

So here we shall sign off until next month.

What's New in Radio

[*Continued from Page 140*]

plated quartz crystal having a fundamental frequency of 100 kc. The low temperature coefficient of this crystal insures stability and accuracy of frequency measurements, making the instrument highly desirable for both amateur radio and laboratory use.

Individual multi-vibrators furnish 50 kc. and 10 kc. signals. The "drag" action of the multivibrator stages on the crystal is entirely eliminated by the use of buffer tubes. A four position, pushbutton switch enables the operator to instantly select the "Standby," "100 KC," "50 KC," and "10 KC" output frequencies. Continuous coverage is available over a range of from 100 kilocycles to 60,000 kilocycles with strong signals up to 60 Mc.

The output frequencies of the "Signal Calibrator" enable the Radio Amateur to accurately identify all band edges, including the phone band edges starting and ending on 50 kc. Modulated or unmodulated output is instantly available and intensity of modulation is regulated by a control on the front panel. Provision is also made on the front panel for "zero beating" the crystal with WWV or other transmission standards of known accuracy. A third control regulates the output, making it possible to couple the "Signal Calibrator" either directly or indirectly to the receiver.

The Meissner "Signal Calibrator" is furnished completely assembled, wired and tested: ready for immediate operation. The entire unit, including the power supply, is mounted in a well-ventilated black crackle finished steel cabinet measuring 8"x8"x12" deep.

NEW LONG-LIFE ELECTROLYTIC

The Solar Manufacturing Corp., Bayonne, N. J., has just announced a dry electrolytic capacitor, type DY, incorporating new features of construction designed to contribute greatly to long life and freedom from service troubles. The base is a novel soft rubber molding through which all terminals are brought and sealed under compression in a manner similar to that successfully used for years in wet electrolytic practice. Low contact resistance, improved r.f. characteristics, thorough sealing, freedom from the cause of intermittents, and the advantages of the wet electrolytic type of vent are claimed as prominent features. A special engineering data sheet is available.

CORRECTION

The caption to the photograph atop the Departments Page in the December issue of RADIO was in error. It stated that the de Luxe trailer installation went under the call of W2KJY. Instead the owner and designer is Myron Zobel, W1LSV, and W2KJY is merely accompanying him.

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Yarn of the Month

(see *Fiction*)

The Marketplace

Classified Advertising

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

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

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

(d) No display permitted except capitals.

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

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

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

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

The Marketplace

[Continued]

FREE "Radio" Handbook! Send us three 5-issue trial "Radio" subscriptions at $1 each (new subscribers only) and we'll send you the latest handbook free. "Radio", Santa Barbara, Calif.

FREE "Radio" Subscriptions for Clubs! Send us three 5-issue trial "Radio" subscriptions at $1 each (new subscribers only) and we'll send your club a 1-year subscription free. "Radio", Santa Barbara, California.

WESTERN ELECTRIC 633A "salt shaker" dynamic microphone complete with swivel, baffle, and 25 feet shielded rubber-covered cable, $35.00. This excellent broadcast mike is nearly new and is absolutely in new condition. Other extra equipment for disposal consists of: General Trans. Co. #2811 plate transformer, 4660 c.t. at 500 ma., 110-220-volt 1200-v.a. primary, $16.00 FOB Santa Barbara. Weston high-speed v.i. meter 500-ohm line. $7.50. General Radio 653-MB 200-ohm ladder attenuator, $6.00. Weston 301 d.c. milliammeters, 25, 50, 250 ma., 0-1 amp. d.c., $3.00 each. Ray L. Dawley, Radio Ltd., 1300 Kenwood Road, Santa Barbara, Calif.

Statistics on Radio Stations

The Federal Communications Commission now has approximately 65,000 active radio call letter assignments outstanding, exclusive of Government stations.

In round figures, this includes some 800 standard broadcast call letters; 600 broadcast other than standard; 400 experimental; 3800 ship radio; 1800 aviation radio; 1100 police radio; 250 forestry radio; 54,000 amateur radio; 300 coastal radio; 800 fixed radio, and the rest miscellaneous.

Advertising Index

Buyer's Guide

● Where to Buy It

PARTS REQUIRED FOR BUILDING EQUIPMENT SHOWN IN THIS ISSUE

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

TURNEY AND KENYON MODULATED TRANSMITTER

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C_1—Cardwell ZU-100-AS
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CN—Cardwell BDN
C_4, C_{16}, C_{17}—Cardwell NP-50-DD
C_5, C_6, C_7, C_8, C_9, C_{10}, C_{18}—Cornell-Dubilier 1R-5D2
C_{11}—Cornell-Dubilier 4-52010
C_{12}, C_{14}, C_{15}, C_{27}—Cornell-Dubilier 4-12010
C_{13}—Cornell-Dubilier 4-14050
C_{19}, C_{20}—Cornell-Dubilier 1R-5D1
C_{21}—Cornell-Dubilier TJU-25020
C_{22}, C_{23}—Cornell-Dubilier PE-CH-6008
C_{24}, C_{25}, C_{30}, C_{31}—Cornell-Dubilier EH-9800
C_{26}—Cornell-Dubilier DT-4S1
C_{27}, C_{28}, C_{34}—Cornell-Dubilier DT-4P25
C_{29}—Cornell-Dubilier BR-252-A
C_{32}, C_{33}—Cornell-Dubilier BR-102-A
C_{35}, C_{30}—Cornell-Dubilier EH-9400
R_1, R_7, R_{10}, R_{11}, R_{12}, R_{13}, R_{15}—LRC BT-1
R_2—IRC DHA
R_3—Ward Leonard 507-557
R_4—Ward Leonard 507-748
R_5—Ward Leonard 507-743
R_6—IRC 13-139
R_8, R_9—IRC BT-½
R_{14}—IRC 11-128
R_{16}—IRC AB
R_{17}, R_{18}—IRC BT-2
T_1—Kenyon T652
T_2—Kenyon T-360
T_3—Kenyon T-655
T_4, T_5—Kenyon T-386
T_6—Kenyon T-357
T_7—Kenyon T-205
T_8—Kenyon T-471 "Cath-O-Drive"
CH_1—Kenyon T-178
CH_2, CH_3—Kenyon T-151
CH_4—Kenyon T-153
RFC—Johnson 750
RFC_1—Hammarlund CH-8
RFC_2—Hammarlund CH-500
Coils—One each Barker and Williamson Baby-40, Baby-20, BL-20, BVL-20, TVL-20
Tubes—2 RCA-80, 1 RCA-807, 3 RCA 6L6, 1 RCA-6J7, 1 RCA-6C8G, 2 RCA-866, 1 Eimac-35T, 2 Eimac-75T

ROTHMAN EXCITER-TRANSMITTER

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C_1—Cardwell ZR-50-AS
C_2—Cardwell ZU-100-AS
C_3—Cardwell MR-260-BD
C_4—Cardwell ZT-15-AS
C_4 mounting brackets—Cardwell M
C_5,C_6,C_{10}—Solar S-0219
C_7,C_{11},C_{13},C_{14}—Solar MW-1239
C_{15}—Solar XM-12-24
R_1,R_2,R_3,R_4,R_8,R_9,R_{10}—Centralab 516
R_5—Centralab 514
R_6,R_{11},R_{12}—Ohmite Brown Devil
MS—Centralab 2505
L_3—Bud OCL series, see coil table for alterations on 160-meter coil
Tubes—RCA
Standoff insulators—Johnson 44 and 600
RFC_1—Bud 921
RFC_2—Ohmite 21
RFC_3—Bud 922

FRANKLIN VARIABLE FREQUENCY OSCILLATOR

Page 41

C_1—Meissner 21-5224
C_2—Hammarlund MC-75-S
C_3—Hammarlund HF-100
C_4, C_5—Centralab
C_6, C_7—Hammarlund MEX
C_8, C_9, C_{10}, C_{11}, C_{12}, C_{13}—Cornell-Dubilier DT-4S1
C_{14}, C_{15}—Cornell-Dubilier 3L-5D3
C_{16}, C_{17}, C_{18}, C_{19}, C_{20}—Cornell-Dubilier 5W-5T1
C_{21}—Cornell-Dubilier 3L-5D3
R_1, R_3, R_4, R_7, R_8, R_9—Centralab 710
R_2, R_{11}—Centralab 714
R_5, R_6, R_{14}—Centralab 516
R_{10}, R_{12}, R_{13}—Ohmite Brown Devil
RFC—Hammarlund CHX
S_2—Centralab 1405
X_1, X_2—Bliley BC3
Tubes—RCA
Dial—Crowe 530 Precision Dial

GRENING TRENDS ON TEN

Page 45

Telephone handsets with press-to-talk switch — Automatic Electric Co., type AF-10 Monophone handset with optional thumb or grip switch.

(Also RCA part number MI-7718A). Western Electric E3B grip switch handset. (Comes with four-conductor rubber cable.)

Mountings for above—Spring handset holder with incorporated switch. Fits Automatic Electric AF-10 and WE E3B (sideways). RCA part number MI-7728.

Rubber cup holder—WE part number KS-10053. Fits both Automatic Electric and WE handsets.

"Extensicord"—For Automatic Electric handsets, AH-20. For WE handsets, AH-22. Supplied with three wires with solder lugs. Fourth wire requires lug attachment by user. Automatic Electric Company, Chicago, Illinois.

Rubber shock cups—Type on left in photo: Lord Mfg. Co., Erie, Pa. (Make many models) Type on right in photo: Made for motorcycle receivers by Harley-Davidson, Milwaukee, Wisconsin.

Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.

Western Electric Co., distributed by Graybar Electric. Distributors in all large cities.

RCA Mfg. Co., Regional distributors. Main plant, Camden, N. J.

VAN ARSDALE 25-WATT TRANSMITTER

Page 58

C_1—Bud MC-909
C_2—MC-905
C_3—Bud MC-899
C_5, C_6, C_{12}—Solar S-0221
C_7, C_8, C_{10}, C_{11}, C_{13}, C_{14}—Aerovox 1450
C_9—Solar S-0279
C_{15}, C_{19}, C_{23}—Solar DT-882
C_{16}—Solar S-0263
C_{17}, C_{20}—Aerovox GL-450
C_{18}, C_{21}, C_{22}—Solar S-0238
C_{20}, C_{24}, C_{25}, C_{26}, C_{27}, C_{28}—Aerovox GL-450
R_1, R_3, R_4, R_5, R_8—IRC BT-2
R_2—IRC type EP
R_6, R_7, R_{23}, R_{24}, R_{25}—IRC type AB
R_9—IRC BT-½
R_{10}, R_{11}, R_{12}, R_{13}, R_{15} to R_{20}, inclusive, R_{22}, R_{26}, R_{27}, R_{28}, R_{29}—IRC BT-1
R_{14}—Mallory-Yaxley N
R_{21}, R_{30}—IRC type DG
S_1—Bud SW-1118
S_2—Bud SW-1120
S_3, S_5—Bud SW-1115
S_4—Bud SW-1119
RFC_1, RFC_3—Bud CH-920
RFC_2—Bud CH-876
T_1—Stancor A-3892
T_2—Stancor P-5009
T_3—Stancor P-3699
T_4—Stancor P-6165
CH_1—Stancor C-1402
CH_2—Stancor C-1412
CH_3—Stancor C-1718
L_1, L_2, L_3—Bud OCL series

HIGH-GAIN MOBILE CONVERTER

Page 66

C_1, C_2—Bud LC-1660
C_3—Bud LC-1641
C_4, C_5—Meissner 25-5255
C_6—Hammarlund MICS
C_7, C_8, C_9, C_{10}, C_{11}, C_{13}, C_{14}—Aerovox 1467
C_{12}, C_{15}—Aerovox 484
C_{16}—Aerovox PRS25
R_1, R_2, R_3, R_5—IRC BT-½
R_4—Ohmite Brown Devil
T_1—Meissner 16-8092

DAWLEY BANDSWITCHING AMPLIFIER

Page 83

C_1—Cardwell NP-50-DS
C_2, C_3—Aerovox 1467
C_4—Aerovox 1450
C_5, C_6—Aerovox 1467
C_7—Aerovox 1457
C_8—Cardwell JD-50-OS
HK—257 socket—Johnson
Feedthrough and standoff insulators—Johnson
Fil. Trans.—Kenyon T-357
Bandswitch—Heintz and Kaufman 892
Tube—Heintz and Kaufman 257 Gammatron

SMITH 80-METER C. W. TRANSMITTER

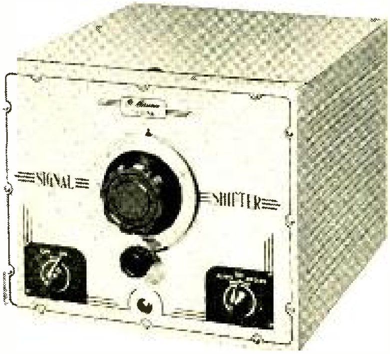
Page 90

C_1—Meissner 21-5224
C_2, C_6—Cardwell ZU-100-AS
C_3, C_9, C_{10}—Cornell-Dubilier type DT-6S1
C_4, C_5, C_7, C_8—Cornell-Dubilier type 5-W
R_1, R_2, R_3, R_4—Centralab type 516
R_5—Ohmite Brown Devil
Cone Insulators—Johnson 600
Knobs and scales—Crowe
Octal sockets—Meissner 25-8209

Power Supply

T_1—Thordarson T-79F84
T_2—Thordarson T-84P60
CH—Thordarson T-19C35
R_1, R_2—Ohmite Brown Devil
Panel and chassis—Bud Radio

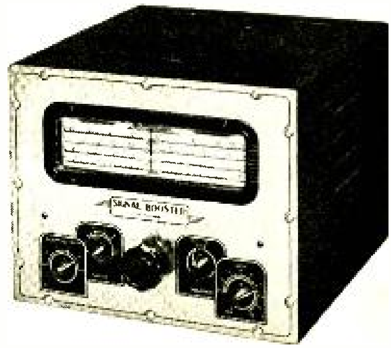
FOUR NEW MEISSNER INSTRUMENTS



Deluxe Signal Shifter

Variable Frequency Exciter Unit

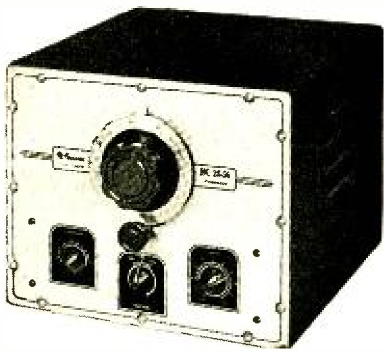
The new DeLuxe model Signal Shifter is particularly designed for both CW and Phone operation. Two voltage regulator tubes and high-C temperature compensated oscillator circuit provide stability comparable only to crystal control. New precision dial with full coverage on any selected band. Built-in keying filter assures clean-cut keying action. Completely assembled, wired and laboratory adjusted, ready for use (except for tubes) when you buy it. $44.95 Net.



Signal Booster

High Gain Preselector

The Signal Booster provides high-gain preselection with complete coverage from 1,600 to 31,000 KC. The average gain of 40 Db. gives weak signals a tremendous boost . . . signals which quite often are inaudible on the receiver alone. A front panel control permits adjustment for maximum signal-to-noise ratio with either standard or doublet type antenna. Designed to match standard receiver impedances. A flip of the antenna change-over switch proves the high gain action of this outstanding communications product. Uses two 1852's and a 5Y4G rectifier. Completely assembled, wired and adjusted for peak performance. Your jobber will supply it, less tubes, for $38.25 Net.



MC 28-56

5 and 10 Meter Converter Unit

A voltage regulated, stabilized frequency Converter unit designed to extend the frequency range of existing receivers to include the popular high frequency bands of 5 and 10 meters and to improve performance of receivers which may have 5 and 10 meter coverage. Three tuned circuits, with tubes having very favorable noise suppression characteristics, are employed to provide high gain output. Tuning is controlled by a precision type dial with auxiliary vernier compensator. Stability and drift-free operation assured by voltage regulated power supply and special high-C oscillator circuit. Unique antenna selector switch permits selection of antenna best suited to conditions and frequency. Completely assembled, wired and laboratory adjusted. $41.25 Net less tubes.

Signal Calibrator

Precision Type Frequency Standard

This precision built instrument belongs in every Amateur station. Enables the operator to comply with government regulations and keep a constant accurate check on transmitter frequency. Makes use of a special silver-plated quartz crystal having very low temperature coefficient and adjustable to exact fundamental frequency of 100 KC. Multivibrators operate at 50 KC. and 10 KC. enabling the operator to identify all Amateur band edges including phone bands. Strong signal output up to 60 MC. Furnishes either unmodulated or modulated signal output, adjustable over wide range. Retains calibration over long periods of time. Complete with tubes and ready to use . . . $39.90 Net.

PASTE ON 1c POSTCARD

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DOLLAR FOR DOLLAR ...WATT FOR WATT

RCA's Top Them All!

Note in particular the last two columns of this chart comparing popular RCA Transmitting Tubes with leading competitive makes. Here you have proof positive that RCA's give you more for your money in terms of power input per dollar than any other air-cooled transmitting tubes on the market . . . And, back of this, stands the world-wide reputation for reliability that is your guarantee of longer life, and finer performance in *every* respect.

The reason is simple: RCA has never rated tubes "up to the hilt." Previously, RCA ratings were based on continuous service in the world's most exacting commercial applications. These ratings are still in use, but are known as the RCA CCS Ratings (Continuous Commercial Service). Meanwhile, the new ICAS Ratings (Intermittent Commercial and Amateur Service) have been developed to pave the way for intelligent use of the big extra measure of RCA quality for amateur applications where the call is for dependable power—and plenty of it—for the least possible money.

It pays to buy RCA's for real economy.

Ask your RCA distributor for November Ham Tips containing complete construction article on RCA-812 Transmitter shown in December QST.

Manufacturer's Tube Type	Tube Classification	Plate Dissipation# Watts ●	D-C Plate Input # Watts ●	Amateur Net Price ●	Watts Input Per $ ☐	
RCA-802	Pentode	13	33	$3.50	9.44	
Tube A	Pentode	10	27.5	4.50	6.11	
Tube B	Pentode	10	27.5	3.95	6.95	
RCA-804	Pentode	50	150	15.00	10.0	
Tube A	Pentode	40	120	15.00	8.0	
RCA-806	Triode	225	1000	22.00	45.5	
Tube A	Triode	200	750	22.00	34.1	
Tube B	Triode	200	875	21.50	40.7	
Tube C	Triode	200	750	18.50	40.5	
Tube D	Triode	150	600	15.00	40.0	
Tube E	Triode	250	1050	24.50	42.9	
Tube F	Triode	150	1000	24.50	40.8	
RCA-807	Beam Tetrode	30	75	3.50	21.4	[illegible]
Tube A	Beam Tetrode	25	60	3.50	17.2	[illegible]
Tube B	Beam Tetrode	25	60	3.00	20.0	[illegible]
RCA-809	Triode	30	100	2.50	40.0	10
Tube A	Triode	25	79	2.50	31.6	7
Tube B	Triode	20	56	2.25	24.9	6
Tube C	Triode	25	112	3.50	32.0	[illegible]
RCA-810	Triode	150	620	13.50	46.0	[illegible]
Tube A	Triode	125	400	13.50	29.6	64
Tube B	Triode	150	600	15.00	40.0	87
Tube C	Triode	100	400	13.50	29.6	64
Tube D	Triode	125	315	13.50	23.4	51
Tube E	Triode	100	500	12.50	40.0	87
RCA-811/812	Triode	55	225	3.50	64.3	100
Tube A	Triode	40	115	3.50	32.8	51
Tube B	Triode	55	225	6.00	37.5	58
Tube C	Triode	60	225	6.95	32.4	50
Tube D	Triode	50	260	6.75	38.5	60
Tube E	Triode	70	300	6.00	50.0	78
Tube F	Triode	50	225	6.95	32.4	50
Tube G	Triode	65	175	3.95	44.3	69
Tube H	Triode	65	175	3.95	44.3	69
RCA-814	Beam Tetrode	65	225	17.50	12.85	100
Tube A	Beam Tetrode	50	170	17.50	9.72	75

Class C telegraph ratings—ICAS values used for RCA types.
● Data based on published values as of Oct. 15, 1939.
☐ Factor W/in has value shown in fourth column.
▲ Approximate.

Radio Tubes

FIRST IN METAL—FOREMOST IN GLASS—FINEST IN PERFORMANCE

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