RADIO

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No. 227 ®

THE WORLDWIDE TECHNICAL AUTHORITY • OF AMATEUR • SHORT WAVE AND EXPERIMENTAL RADIO •

This Month:

Automatic-Modulation-Control Amplifiers

25-Watt 160-Meter Phone for the Newcomer

20-Meter Push-Button Beam Installation

Tank Condensers--Capacities and Voltages

RADIO

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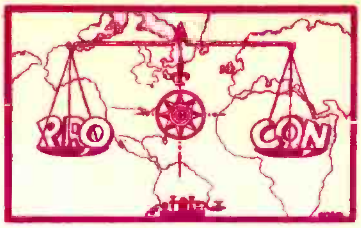
The . . . OPEN FORUM



New Westminster, B.C., Canada.

Sirs:

Here is an item I believe would be of interest for your readers:—

We would like to report that we believe we have the record for the longest continuous phone duplex QSO. VE5II of New Westminster, British Columbia, (3850 kc/s) contacted VE5UD of Queensboro, the suburb of New Westminster (1793 kc/s) at 1300 p.s.t. February 1. We worked duplex for two hours and then decided we would continue and have a real good chat. By the time the carrier switches were pulled at 1310 p.s.t. February 2, we had been on the air working duplex for 24 hours, 10 minutes.

In that time VE5II shaved, ate supper, drank five cups of coffee throughout the night, had breakfast and dinner. Six visitors called to see the rig.

Meanwhile at VE5UD's, his y.l., along with his brothers and sisters, provided the eye-keeper-opener and stomach satisfier.

RICHARD LOBB, VE5II.

•

Randolph, Mass.

Sir:

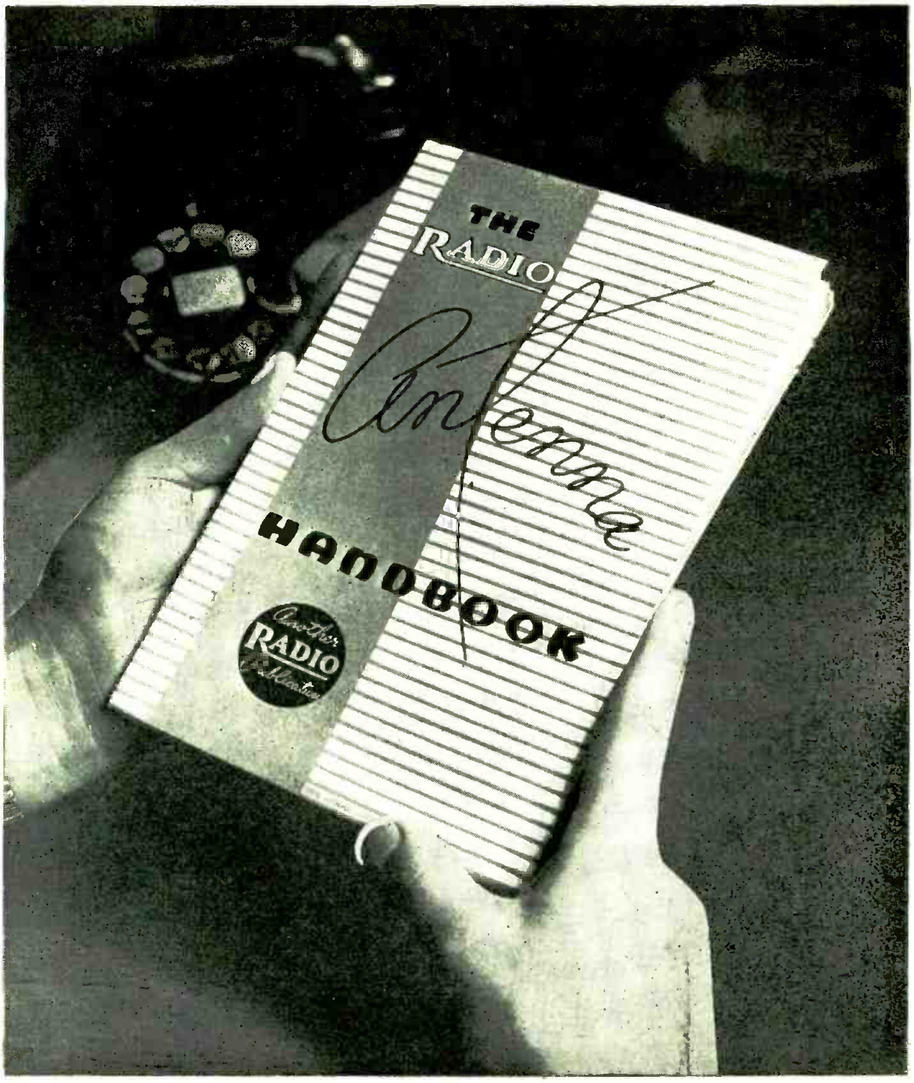
After reading with interest the letter by Harry O. Jones in the October RADIO and the letters by John B. Morgan, W3QP, and Carl O. Boltz, W6FTT, in the January issue, an old timer wants to explain his point of view.

As we all know, many of the s.w.l.'s make a practice of just collecting QSL's from hams. I do not know why a ham should refuse to send a QSL card in return if a report sent to him is correct and is also accompanied by return postage.

I know of a few cases where a certain ham, asked for a report and when he received one

[*Continued on Page 8*]

Off the press in March!



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RADIO

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

from an s.w.l whose report was correct and who also sent return postage, the ham made the remark, "The poor sucker," and put the postage in his pocket.

Back between 1925 and 1927 when ham radio was ham radio, we always extended this courtesy to an s.w.l. who sent correct reports. Many times a ham, when testing, requests reports. I know, because I have sent many and have received QSL's from every district and from many foreign hams.

Treat these s.w.l.'s fair, because you should remember that you were an s.w.l. yourself. Many of these s.w.l.'s of today will be hams tomorrow.

Do not discourage them; give them a break and q.s.l. correct reports.

CHARLES STEPHENS, Ex-U1CFJ.

•

That Poland Letter

Highland Park, N. J.

Sirs:

It seems to me a shame the way a lot of good space in your "Open Forum" column is going to waste by the publication of a lot of letters by "Non-Hams" as to how we should make the license exams easier so they can get

[*Continued on Page 10*]

The Open Forum

(Continued from Page 8)

their tickets and we can have the pleasure of working them. So far as I can recall, I do not remember having read any letter by any phone or c.w. ham stating that he would like to see the code examination done away with for fellows whose only interest in ham radio is in shouting into a "mike", nor in any of my personal QSO's with many hams run across any fellow who was of that idea.

Should this ever be done, it would simply mean that the phone and c.w. boys are going to drift all the farther apart. It seems to me that the two groups are separated enough as it is now, but gosh knows what it will turn into if we are going to have separate licenses. There are not very many phone men who cannot honestly say that they have not derived benefit from the code. The few who may be able to are no justification for the abolishment of the code test from the phone exams.

You may say I am a c.w. man. Well that's no lie, but my interest is far from being tied up in this one branch of the game. I operate on c.w. practically exclusively, but hold a class A ticket, and enjoy listening to the many f.b. phone sigs come rolling in, and give credit to the fellows operating them for getting such a nice sig on the air.

Should such an examination go through I can just imagine the nice battles we would have in our ranks. Phone men who know nothing of c.w. will be the first to start "squawking" for more frequencies at the expense of the c.w. gang, and we will have everything but the co-operation and harmony which is the most needed thing for the welfare of the game.

No, Mr. Poland, I don't think the majority of the boys agree with you about doing away with the code exam; you can hardly blame them if they don't. The phone men, as well as the c.w. boys, benefit by the code; pity the day it is done away with.

I don't believe many tears will be shed by the "gang" just because a few fellows won't learn the code to get their tickets.

JIM WALKER, W2FSN.

•

Beckenham, Kent, England

Sirs:

I have been reading with great interest the various letters by men who have been unable to learn the code or who are too lazy to learn it on principle, because they consider it redundant as a qualification to operate a transmitter.

In reply to Mr. H. O. Poland (see January RADIO), I would like to say that whereas I appreciate his present line of thought, it is my humble estimation that he is shouting before he is in a position to shout, rather like the small boy who won't eat his dinner because he doesn't like the looks of it and hasn't tasted it.

The only person fully competent to judge

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OFF THE PRESS

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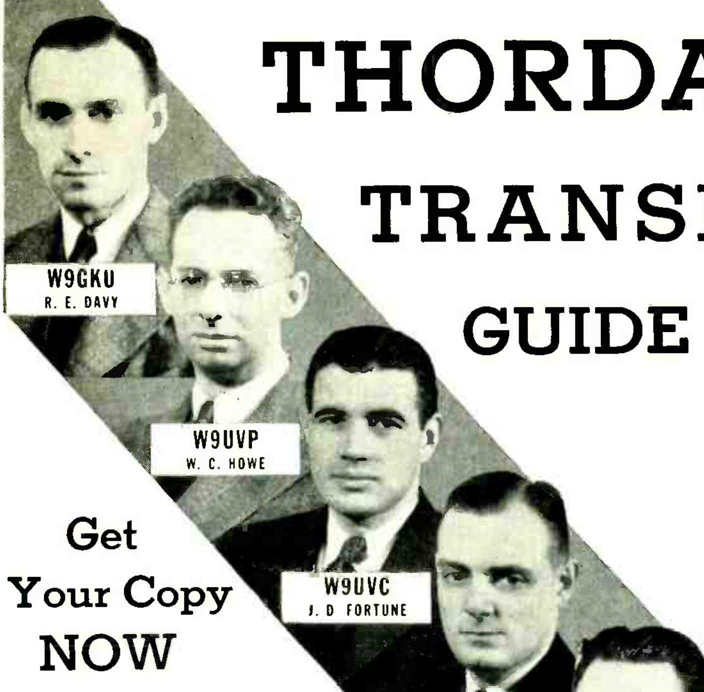

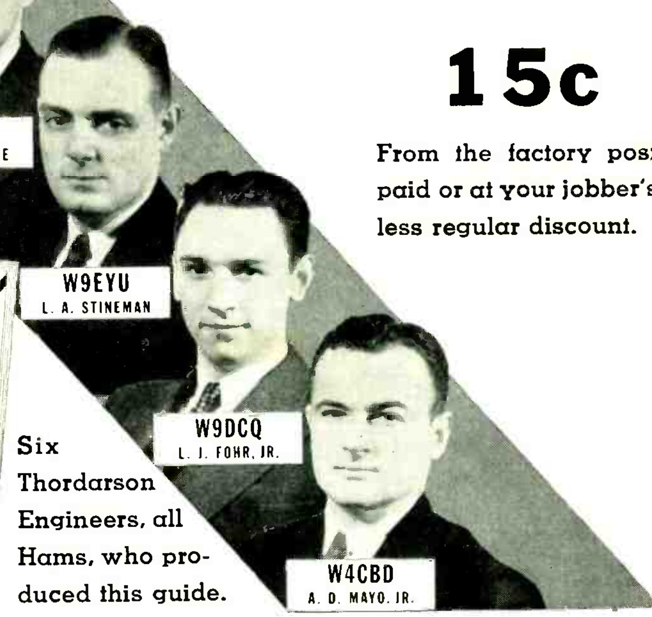

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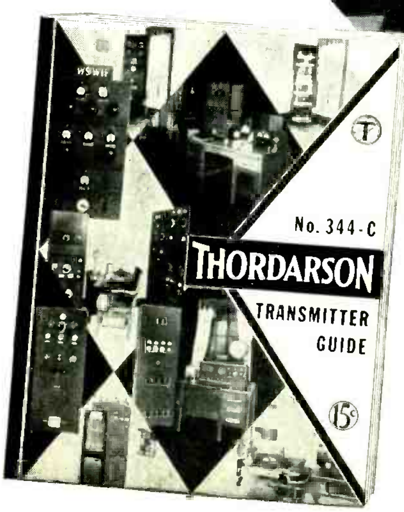

Six Thordarson Engineers, all Hams, who produced this guide.

4th Edition

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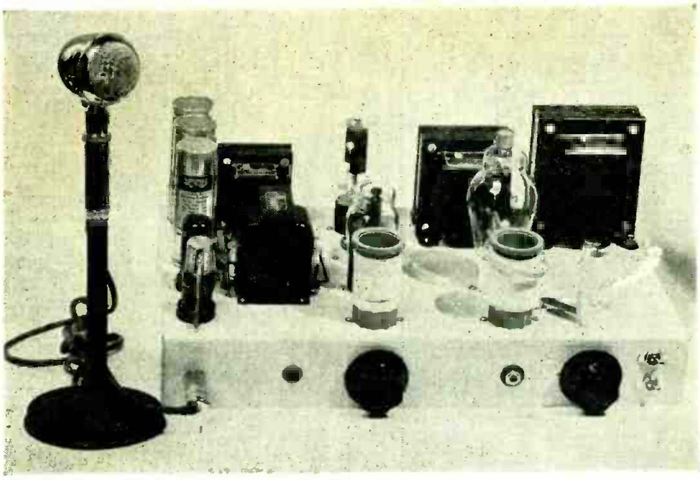
Frank C. Jones

TO RADIO amateurs, experimenters, and radio engineers the world over, the name of Frank C. Jones has become synonymous with the development of new and improved circuit arrangements. His name immediately suggests the Jones Exciter, the Gainers and Super-Gainers, the Jones Harmonic Oscillator, and a number of other equally important and widely-accepted developments in amateur communications technique.

■ In addition, a very large number of amateurs have personally met and come to know Mr. Jones through the medium of his well-known amateur station, W6AJF.

■ But his accomplishments have encompassed other fields than those strictly amateur. Particularly noteworthy among these was the design of the 56-Mc. communication equipment used in the construction of the San Francisco-Oakland Bay Bridge.



STRICTLY 160 METERS

• A 20-Watt Phone For the Newcomer

By W. W. SMITH,* W6BCX

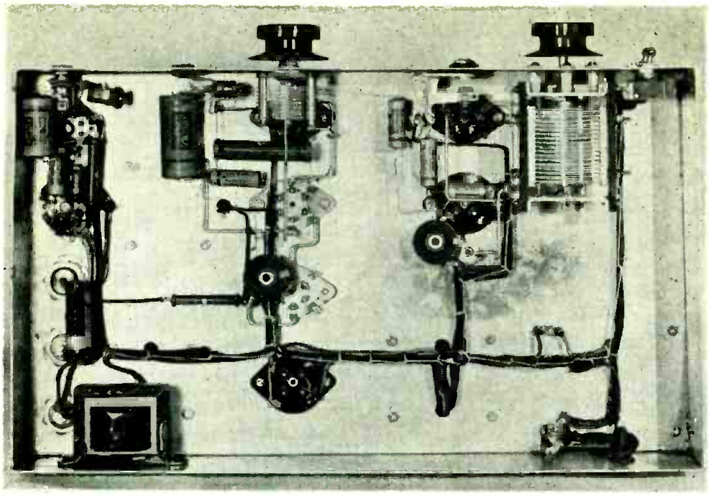
The amateur newcomer interested primarily in phone finds that he has his choice of three bands: 160 meters, or the u.h.f. bands, 5 and 10 meters. While a single transmitter can be made to cover both the 160 meter and the u.h.f. bands, a good part of the gear is either idle or superfluous when the transmitter is used on 160 meters.

The amateur interested in constructing a transmitter expressly for 160 meter operation, either because of preference for separate transmitters for the two bands or because of lack of interest in u.h.f. operation, is naturally concerned about keeping the number and cost of parts to a minimum. Then too, if he is a newcomer and has had little experience with transmitter construction, the transmitter should be easy to construct and get going.

Illustrated in the photographs is a 160 meter, 20-watt phone transmitter that meets these qualifications and is ideally suited for construction and use by the amateur newly initiated to amateur radio. Having a minimum of adjustments and controls, the transmitter is capable of between 20 and 25 watts of carrier and quite good quality up to 90% modulation. While the circuit is unconventional in several respects, the performance is excellent when the circuit is followed in every detail; no frequency modulation can be detected by a listening test and instability is conspicuous by its total absence.

The first thing unusual that will be observed upon inspection of the circuit diagram is the omission of a buffer stage and use of an unneutralized triode amplifier. This is made possible by tapping down the excitation lead on the driver tank to reduce the impedance between grid and ground on the 809 to a very low value. By tapping to the coil about a fifth of the way "up" from the ground end, oscillation in the 809 stage can no longer be sustained on 160 meters. The impedance of the 809 grid circuit is only 1/25th of what it would be were the grid tapped directly to the "hot" end of the coil, and under these conditions the 809 is more stable than most neutralized amplifiers,

*Editor, Radio.



The transmitter proper (exclusive of antenna tuning) has only two controls and no other adjustments.

the latter being subject to human shortcomings as regards adjustment.

As a check on the stability of this arrangement, the load on the 809 was removed entirely and the 42 oscillator thrown out of oscillation. The 809 stage showed no tendency to oscillate. The bias was then reduced in small steps until zero bias was reached. At no point did the 809 show the slightest inclination to oscillate. The two leads to the 809 tank coil were transposed, to preclude the presence of accidental inductive neutralization due to proximity of the two coils, and the procedure repeated. The 809 just wouldn't "take off" and oscillate on its own hook.

With the grid tapped down the coil so far, it is a little difficult to get much excitation to the 809. But in our case this is not serious, inasmuch as the 809 is being grid modulated and therefore requires but little excitation (roughly one watt) though as with all grid modulated stages the grid drive should possess good regulation. This is already taken care of by the large "step-down" in the driver tank and also by the "swamping resistor" R_1. And with the swamping resistor and high stepdown ratio there is so little reaction on the 42 oscillator that frequency modulation cannot be detected by any ordinary test.

Thus the transmitter proper (exclusive of antenna tuning) has only two controls and no other adjustments. C_1 is used to vary excitation (a necessary adjustment for grid modulation) and C_2 is used to resonate the amplifier tank. No interstage coupling or neutralizing adjustments need be made.

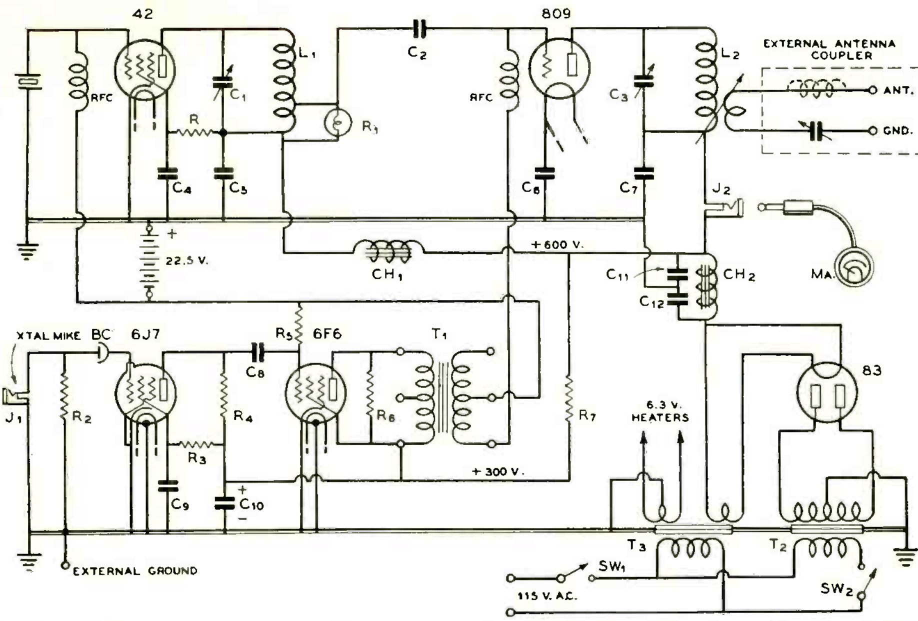
The R.F. Section

The 42 crystal oscillator is strictly conventional, except perhaps for the use of fixed battery bias. This prevents the tube from drawing excessive plate current when not oscillating and thus being damaged, and also keeps the crystal current down. The same 22.5-volt battery supplies bias to the 6F6 modulator and the 809 modulated amplifier, the bias being just right for these two purposes. The battery may be of the small, inexpensive "C" battery type, and will last almost indefinitely.

Rather than waste power in a plate dropping resistor, the 42 is run at the full plate voltage, the same voltage as that on the 809. Crystal current and plate current are kept down by the use of low screen voltage, the 100,000-ohm screen resistor being somewhat higher in value than is usually employed.

Because even the slightest amount of ripple in the excitation voltage will cause an appreciable ripple in the output of the 809, the plate voltage to the 42 must be absolutely pure d.c. The reason for this is that a class C *grid bias modulated* amplifier is "modulation gaining", in contrast to the "ironing out" effect of a *heavily excited* class C plate modulated amplifier. Pure d.c. to the oscillator is assured here by the use of an additional section of filter, comprised of the midget filter choke CH_1 and the ½ μfd. tubular paper condenser C_5, the latter serving also as an r.f. by-pass.

No meter or provision for measuring the plate current is incorporated in the oscillator, as the plate current cannot become excessive regardless of the tuning of the tank condenser.



C_1—140 μμfd. midget

C_2—.01 μfd. 600-volt tubular paper

C_3—365 μμfd. 0.03" air gap

C_4—.01 μfd. 600-volt tubular

C_5—0.5 μfd. 600-volt tubular

C_6—.01 μfd. 600-volt tubular

C_7—.01 μfd. 600-volt tubular

C_8—.004 μfd. 600-volt tubular

C_9—0.25 μfd. 400-volt tubular

C_{10}—8 μfd. 450 working volt electrolytic (can type)

C_{11}, C_{12}—4 μfd. 600 working volt oil-filled paper condensers, inverted can type

R—100,000 ohms, 2-3 watt carbon

R_1—G.E. Mazda 6-watt 120-volt miniature lamp

R_2—2 meg., ½-watt carbon

R_3—1 meg., ½-watt carbon

R_4—250,000 ohms, 1-watt carbon

R_5—250,000 ohms, ½-watt carbon

R_6—10,000 ohms, 2-3 watt carbon

R_7—7500 ohms, 20 watts

RFC—16 mh. b.c.l. type r.f. choke

BC—Mallory bias cell

MA—0-150-ma. d.c.

CH_1—15 to 30 hy. 40 or 50-ma. midget choke

CH_2—20 hy. 175-ma. smoothing choke

T_1—Driver transformer designed for p.p. 46's or 59's or 45's class A to grids of p.p. parallel 46's class B (pri. to ½ sec. stepdown ratio 5:1).

T_2—500 volts each side c.t. at 175 ma.

T_3—5 v. 3 amps. and 6.3 v. 6 amps.

J_1—Open circuit midget jack

J_2—Circuit closing midget jack

SW_1, SW_2—Midget toggle switches on chassis or 110-volt switches on operating desk

L_1—50 turns no. 22 d.c.c. close wound on 1½" dia. form, tapped exactly at 10th turn from ground end

L_2—35 turns no. 18 d.c.c. close wound on 1½" dia. form

The tuning condenser is used only as an excitation adjustment to the 809 amplifier.

An "A-T" cut crystal is preferable in the oscillator, not so much for the drift consideration (which is small regardless of the type crystal used) but because these crystals are usually much more active and stable than other cuts on 160 meters. However, any fairly active crystal may be used so long as it has only one peak. The latter is important because smooth excitation control would be impossible from a crystal that jumps from one peak to another as the tank is tuned.

The 809 tank circuit appears to be quite high "C" at first glance. However, when one remembers that the tank capacity should be 4 times the optimum amount for a split tank (as in a plate neutralized stage), the value used seems more in order. In other words, about 300 μμfd. is required in the circuit illustrated to provide the same "Q" as 75 μμfd. across a center tapped coil which has both ends "hot". If a lower ratio of C to L than that specified is used, the performance will suffer, harmonics and poor quality being the result.

The Coils

The two coils are wound on standard 1½-inch dia. forms. The oscillator coil consists of 50 close wound turns of no. 22 d.c.c., tapped exactly at the 10th turn up from the ground end. The amplifier coil consists of 35 close wound turns of no. 18 d.c.c. The coils should be polarized so that in each case the "hot" end is at the top of the coil form. The windings should be started at the extreme top end of the form in order to keep them removed from the metal chassis as far as possible.

The coils should not be placed closer than

[*Continued on Page 88*]

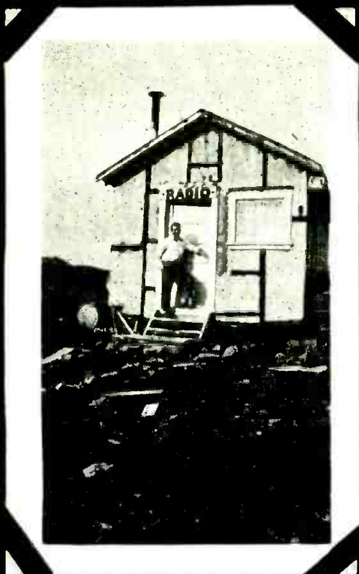
A Ham's Album...

A few snapshots from the album of John P. Gruble, K7RT-W7RT, who was located from May to December of last year at the largest platinum placer mine in North America—up on the barren, treeless coast of western Alaska, nine miles south of Goodnews Bay on the Bering Sea.

Nearest settlement is Platinum, huddled on the south spit of the entrance to Goodnews Bay. Its winter population comes to 20 white persons. A modern mining town, Platinum was boosted considerably by the 1937 stampede.

Although Platinum may be one of the last places in North America to be closely associated with civilization by plane, modern machinery and radio, the town's most popular mode of travel is via air. In fact, miners, prospectors and others prefer flying, which can be done any time of the year, of course. K7RT left Alaska by plane in mid-winter.

K7RT used a 50-T in the final with 200 watts input on 20, 40, 80 and 160-meter bands. The receivers were an SW-34 and an SW-3. All continents were contacted; his best dx included VU2FX, ZU5Q, PY2AC, and UP0L, the Soviet Drifting Expedition near the North Pole. Power for his station was supplied by a 1500 watt lighting plant



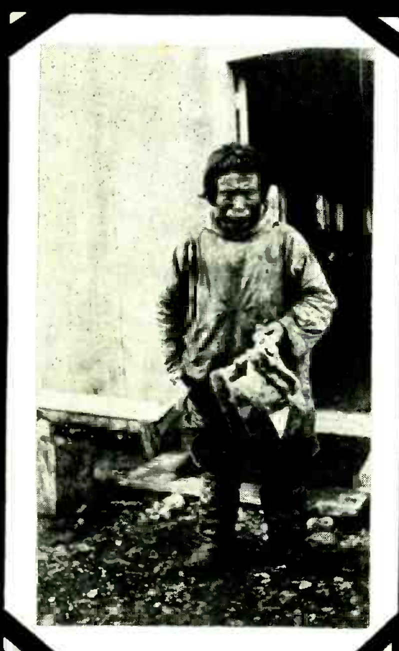
K7RT standing at the door of the cabin where he pounded brass for 8 months and observed weather effects on shortwave radio.

(Above) Goodnews Bay as viewed from 3000-feet up. Beluka Peak, which is named after a species of Arctic whale, can be seen. It is a favorite landmark for planes flying into Platinum.

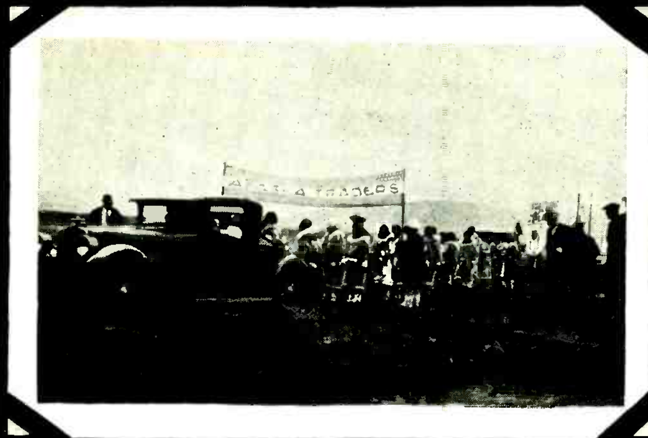
(Below) K7RT, on Bering Sea's frozen shores. As wind-protection he wore a parka, 3 shirts, wool jacket, 3 pairs of wool sox, shoe packs. He's carrying $35,000 in platinum 9 miles to the postoffice.

Mrs. E. P. Harwood, postmistress of Platinum and popularly known as the "Mayoress of Platinum". She holds a third-class telephone ticket and plans to get her ham ticket soon; at present she is practicing code with a small buzzer outfit. Fashion note: Her squirrel skin parka is standard apparel for northern winters. Mrs. Harwood and three other women constitute the feminine white population of Platinum during the winter.

Crooked Creek landing field. K7GOL lives here. Temperature was 20 below when the snapshot was taken.



The diminutive "Shorty" Kilbuck (he stands only 4½ feet tall), who accidentally discovered platinum ore in this district about 10 years ago. A friend had it assayed and that brought on an influx of prospectors. "Shorty" speaks no English, uses signs to get ideas across on his occasional visits to town. He is holding a pair of native mukluks which he made for K7RT. His price for them was an old wool sweater and some cigarettes.



The first Fourth of July parade ever held in Platinum, led by the only car in camp. Natives, dressed in their best, came from 50 miles around, to hold kayak races and display their hunting skill.

(Above) A half-million dollar dredge at Goodnews Bay. The machine is over 60 feet high, operates day and night, can dig 50 feet into the earth, requires a 25-man crew to run it.

(Below) K7RT beside the Pilgrim plane in which he left Platinum. At Crooked Creek the ship developed a broken oil line, which, had it gone undiscovered, may have meant finis for all aboard.

Snug as a Bug in a Rug

— and a whole lot safer!

Illustrated in the photo is probably the only communications receiver in the U.S.A. wearing a bullet-proof vest. The stone housing contains an ACR-136 receiver, tuned to 3445 kc. for picking up regular transmissions of the Michigan Department of Conservation's 22 radio stations used for control of forest fires.

The receiver is located a mile from district headquarters controlling fire fighting in the region of Mio, Michigan, and a three-wire control and transmission line feeds the 3445 kc. signals to the office free of QRM from the local power plant, which is too noisy to permit reception within the town proper.

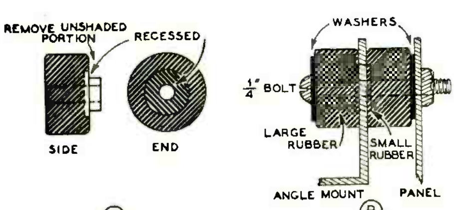
Located along side a forest fire lane in a locality open to public deer hunting, a cobblestone housing and a steel grader plate door protect the defenseless receiver from "pot shot" hunters who shoot at anything suspected of having horns and look for the horns afterwards. Near-sighted alleged sportsmen have already knocked off several of the cobblestones and dislodged many pieces of mortar.

The filaments in the receiver are never turned off and have been in operation 14 months without giving a bit of trouble. The three-wire line allows the B minus to be cut off during the night. The power company was kind enough to supply a 110-volt line entirely free from QRM.

Photo by Michigan Department of Conservation

The installation was made by W8JO, and the receiver is regularly serviced by W8CFQ.

Silencing Units for Noisy Rigs



By DeWAINE E. BAUER,* W8LGS

Upon completing a very "fine business" relay control unit for my transmitter and putting it into operation, I found that the a.c. relays were too noisy, producing a loud "clack" when starting, and sometimes an undesirable hum when closed. Ordinarily this would make no difference. However, I live upstairs, and complaints were soon evident from the "nether" regions.

Today the complaints aren't, and several b.c.l. repair jobs are minus their chassis mounting rubbers. Here's how it's done.

Each relay is mounted on a silencer, consisting of an iron angle and its respective sound-insulating rubbers. Also, the panel holding the relays is mounted on additional silencers. The silencers are constructed each of two 1¼" diameter by 11/16" thick sponge rubber chassis mounts; one ¾" diameter by 5/16" thick solid rubber mounts; two 1" diameter washers with ¼" holes; and one ¼" by 2" or 2½" machine screw with nut. A recess is cut into the shank side of each of the large rubbers (A). This recess is ¾" in diameter, and about 1/16" deep to accommodate the small rubber.

In adapting the relay to the rubber mount, a ¾" hole was cut into the center of one face

[*Continued on Page 85*]

Further Notes on

THE REDUCTION OF B. C. L. QRM

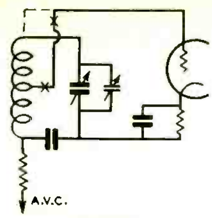


FIGURE 1

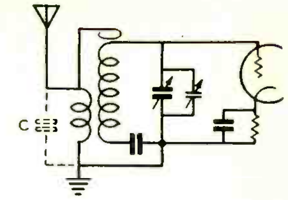


FIGURE 2

By **GEORGE W. EWING,* W6GM**

During the past year or so several articles have appeared in amateur radio publications explaining the reasons[1] for b.c.l. QRM and giving the remedial measures needed.[2] The appearance of repeat points on superhets, cross talk, "blanketing" and the application of line filters, low pass filters, wave traps and additional shielding have all been discussed. The writer, however, in clearing up his own QRM and helping others with theirs has encountered several peculiar cases and these with their cures will be the subject of this story.

Unshielded Diode Lead

A slight case of trouble developed on a seven-tube table-model superhet set. There was a pre-selector ahead of the first detector and the set showed all the "ear marks" of good design. However, the interference was in the background of any program and was particularly noticeable during the lulls when the b.c. station was changing programs. The setting of the tuning dial had absolutely no effect on the volume of the interference and 14-Mc. or 3.9-Mc. phone came in just the same.

Although a wave trap in the antenna lead would completely wipe out the trouble, an investigation showed that in wiring from the antenna terminal on the rear of the chassis to the band switch on the front, the lead was laid directly over the diode detector lead and the high frequency r.f. was being detected directly by the second detector.

The antenna lead was rewired around the other side of the chassis and the diode lead shielded. This simple change completely wiped out the trouble and no wave trap was necessary for any of the phone bands.

[1] "Pick Your Spot On The Neighbor's Supers"—Grammer. *QST*, September, 1937, p. 12.

[2] "Effective B. C. L. QRM Reduction"—Everett. RADIO, January, 1937, p. 124.

Tapped Input Coil

A very severe case of QRM showed up from 14-Mc. phone on an eleven-tube console which from all appearances was also a well-shielded and properly designed set. The interference was louder than the b.c. stations, was all over the dial, and wave traps, low pass filters or line filters had very little effect on it. Examination of the schematic of this receiver showed an r.f. stage ahead of the first detector but the lead to the grid or top cap of the r.f. tube was tapped half way down on the coil, as in figure 1. It was immediately apparent that this grid lead was "floating" as far as the high frequency r.f. was concerned, the two halves of the coil simply acting as two r.f. chokes in parallel. This grid lead had to be near the aerial lead since they both connected to the same coil form and it also was picking up the interference by itself, as evidenced by the fact that disconnecting the antenna completely only effected a slight reduction.

The cure for this case was to reconnect this grid lead to the usual place, the top of the coil, where the tuning condenser would act as a by-pass at the interfering frequency. It was necessary to readjust the compensator on this stage to take care of the added capacity of the grid. However, two or three turns out on the screw brought the stage back into resonance nicely. The interference was almost completely eliminated; the small part remaining will be discussed in the next paragraph. This type of trouble will tend to get worse as the frequency is raised and probably accounts for some of the 5-meter b.c.l. QRM that surprises us sometimes.

Floating Volume Control Shafts

Several sets have been encountered where there was only a slight interfering signal; but

*201 E. Tenth St., San Bernardino, Calif.

in placing one's hand up to the volume control it would greatly increase. These proved to have volume controls with shafts insulated from ground and connected to a critical part of a circuit, especially the grid of a high-gain audio stage. The cure is to install a volume control with all the terminals insulated from the shaft, and then to ground the shaft.

"Spray-Shield" Tubes

Although they are not being made any more, there are quite a few sets still in use employing "spray-shield" tubes. These are used in both r.f. and in audio circuits. In their audio application, sometimes the cathodes, to which the shield is connected, are not at ground potential, being by-passed with a large-capacity electrolytic condenser. This type of condenser is a very poor r.f. filter and in a strong r.f. field some detection will take place causing interference. The best cure is to install a standard glass tube with a glove shield which is actually grounded and also to shield the grid leads to these tubes.

Coupling Loops

In order to increase the gain on the high frequency end of the broadcast band, many sets use a loop of wire wound around the grid end of the input coil to provide some capacity coupling direct from the antenna to the grid as in figure 2. This, in conjunction with a high impedance antenna primary, which is used to help the low frequency end, allows the high frequency signal to be passed directly to the grid. The basic cure is to move the coupling loop a little farther away from the end of the grid coil or to introduce a small capacity from antenna to ground. The use of a short receiving antenna will help reduce the interference. Especially avoid one which is any multiple of a half-wave long at the interfering frequency.

External Cross Modulotion

The antenna and ground system of the troubled b.c.l. set should be thoroughly checked for oxidized joints. There are so many connections made by novices, where the wires are not thoroughly cleaned before connecting, or sometimes even just twisted together, that it's a wonder the sets work at all. These oxidized joints can cause rectification resulting in two or more strong signals mixing and riding in on each other or appearing at remote parts of the dial. Either copper oxide or iron rust has the properties of rectification and, as pointed out by Foster,[3] the rectifier element can be in another wire or metallic system in the vicinity of the receiving antenna. Iron pipes rubbing against each other or against stucco screen, poor contacts in the lighting circuits, or in fact, any two metallic objects in partial contact with each other may cause a cross modulation which is re-radiated and can be picked up on any set in the immediate vicinity.

Lastly but by no means least, don't forget to check and see that the aerial and ground connections are not reversed. This is easily taken for granted since the b.c. set will play, along with all the neighborhood vacuum cleaners, etc., but a set is very much more susceptible to interference from a short-wave station when connected up wrong. Several cases have been cleared up by simply correcting these leads.

It is hoped that these few remarks may help clear up some seemingly hopeless case of b.c.l. QRM and restore some amateur to good grace with his fellow neighbor.

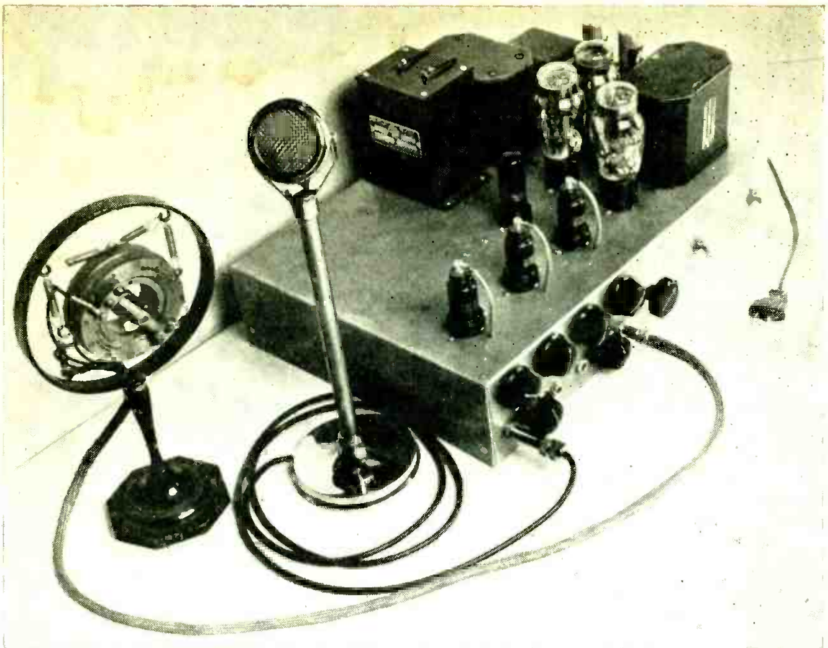
The 6J8G Mixer

The concensus of opinion of those who have done much experimenting with first detector-oscillator circuits in h.f. superhets seems to be that a triode high frequency oscillator working into the injection grid of a heptode mixer will give the best results. In the past, this arrangement has required two tubes with a connecting link between: one for the oscillator and one for the mixer, each requiring their filament and plate supplies and a certain amount of valuable space.

The 6J8G, recently announced by Raytheon, is a duplex tube containing both a triode and a heptode unit, internally connected in the proper fashion for an oscillator-first detector circuit. That is, the control grid of the oscillator triode is connected to the injector grid of the heptode. In other words, it is a tube specifically designed for the first detector-oscillator service in a high-frequency superheterodyne.

The tube has an octal base (with, incidentally, all the base connections and the top cap in use), a 6.3-volt 0.3-ampere heater, a reasonable conversion transconductance, and is designed to operate from the standard 250-volt receiver plate supply.

[3] "A New Form Of Interference—External Cross Modulation"—Foster. RCA *Review,* April, 1937, p. 18.



The complete a.m.c. amplifier shown with a crystal and a double-button microphone attached to two of the amplifier's four input circuits. Electronic mixing is used to mix any two of the four inputs. The peak rectifier unit is external (at the transmitter) and is not shown.

AUTOMATIC MODULATION CONTROL

By L. C. WALLER,* W2BRO

Although a number of articles describing automatic modulation control systems have recently been published, the writer believes that the subject has not received from amateurs as much attention as its importance warrants. In the opinion of the writer, who has operated a 'phone "off and on" since 1924, an amateur 'phone station without automatic modulation control (hereinafter referred to as a.m.c.) is like a broadcast receiver without a.v.c., or an automobile without brakes.

A preliminary discussion of an a.m.c. system developed by W2BRO was given in a previous article.[1] Since then, further experimental work has been done and a complete amplifier constructed. This amplifier, built for and with the assistance of W2ICA has been in operation at W2ICA for several months. Exhaustive tests have been made, both on the air and with a cathode-ray oscillograph. The results obtained have exceeded all expectations. Even though an oversized modulator is used in W2ICA's rig, over-modulation has been effectively squelched, with the result that the modulated carrier is clean, sharp, and without a trace of the side-splatter which causes such heavy interference in our narrow 'phone bands. In addition, the *average* modulation has actually been raised, so that the effective voice signal is several db higher with a.m.c. than without it.

Theory

Before the amplifier unit is described, a bit of theory on the operation of this a.m.c. system may be of interest. The original circuit developed by the author is shown in figure 1. Although this circuit is not the one finally used, it is about the simplest version and for that

*RCA Manufacturing Co., Inc., Harrison, N. J.
[1]*QST*, October, 1937.

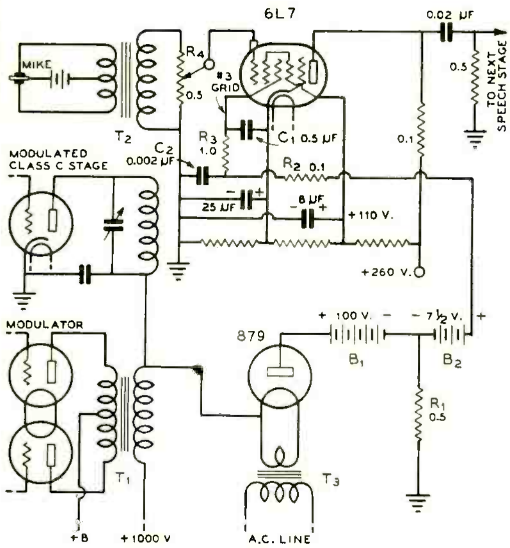


Figure 1

Simplified version of the automatic-modulation-control circuit for plate-modulated r.f. amplifiers.

reason will be used in the theoretical discussion.

The 6L7 is operated as a variable-gain a.f. amplifier. Its no. 1 grid (the signal grid) is biased about −10 volts with respect to the cathode, which is connected to +10 volts on the voltage divider. The no. 3 grid has a no-signal bias of about −2½ volts; the purpose of B_2 is to cancel 7½ volts of the cathode bias. Other operating conditions and circuit values for the 6L7 are conventional. Under these conditions, the voltage gain of the stage is quite high—in the order of 50. If, however, the no. 3 grid is made more negative than −2½ volts, the gain of the stage is reduced by an amount depending on the value of the bias voltage.

The next problem is to insert additional bias in the no. 3 grid circuit when the modulation peaks of the transmitter go higher than desired. This is readily accomplished by means of the 879 audio rectifier, shown in figure 1.

In the example chosen, the instantaneous plate voltage e_p of the modulated r.f. amplifier (disregarding the r.f. component) is 1000 volts—the d.c. plate-supply voltage—at point F, before the modulation cycle starts. If the audio modulating voltage across T_1 (figure 1) rises to D (figure 2) on the positive half cycle and falls to B on the negative half cycle, the class-C r.f. amplifier is modulated just 100 per cent. If e_p drops to point C on the negative half cycle of the modulating voltage, it is apparent that the plate of the r.f. amplifier is actually driven negative, with respect to ground, and that carrier cut-off occurs due to the excessive value of e_p. With the 879 diode connected as shown in figure 1 (its plate is at +100 volts because of B_1), rectification of all negative a.f. peaks greater in amplitude than AG will occur, and the resulting pulsating d.c. current will flow through the diode load resistor R_1 (figure 1). In the example given, the peak value of the pulsating d.c. voltage built up across R_1 equals GC, or 200 volts. The purpose of the "advance" bias supplied by B_1 is to make the diode start rectifying at point G,

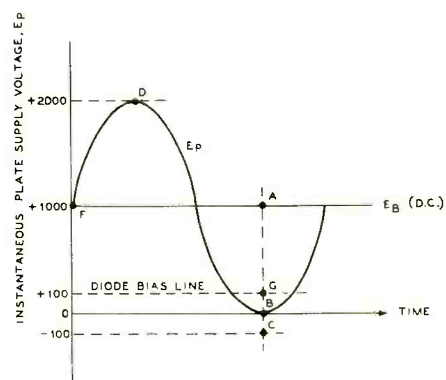


FIGURE 2

which corresponds to 90 per cent modulation. This allows the system to start functioning slightly before 100 per cent modulation is reached.

The pulsating d.c. voltage across R_1 must be smoothed before it is suitable for biasing the number 3 grid of the 6L7. This filtering is taken care of by a small mica by-pass condenser, which serves to by-pass any r.f. voltages that might be present. Its value is too small to affect appreciably the time constant of the audio filter. The 6L7 is an excellent tube for the variable-gain stage, because its no. 3 grid is capable of controlling the mutual conductance of the tube linearly over a wide range, with a relatively small change in bias voltage. (See figure 4).

Elimination of "Hush-Hush"

The large d.c. voltage across R_1 causes the charge on condenser C_1 to increase from its normal d.c. value of 2½ volts. Thus, the negative bias on the no. 3 grid is increased just enough to cut the gain of the 6L7 to a level where the excessive modulating peak CA (figure 2) is suitably reduced. The no. 3 grid bias cannot get too high, obviously, because the automatic reduction in speech amplification gain removes the generating source which tends to charge C_1. Thus, there can be no "hush-hush" effect due to sudden strong audio signals, a decidedly annoying fault which shows up when a very large condenser is placed across the diode load resistor (corresponding to R_1 in figure 1). Due to the relatively low resistance of the audio rectifier circuit, this condenser charges very rapidly to a voltage such that the variable-gain tube may actually be cut off for a short time. This causes the "hush-hush" effect mentioned above, due to the fact that the signal voltage and the amplifier gain "hunt" an operating point where stability is obtained. For this reason, no condenser should be placed across R_1, unless its capacitance value is quite small.

Automatic Modulation Control Contrasted with Automatic Peak Compression

Because the negative control voltage is obtained directly from the *modulator*, the system operates on the *relation between the actual d.c. plate voltage and the peak a.f. modulating voltage,* regardless of whether these values change due to power supply regulation, modulation transformer frequency characteristics, or other factors. In other words, the controlling action depends on the relative value of the two factors which, by definition, determine the modulation factor. In addition, the system is practically self-adjusting and is not critically dependent on the exact value of d.c. voltage applied to the modulated r.f. amplifier. This is not equally true of ordinary audio a.v.c. systems, where the control voltage is obtained from the driver stage. Such systems may work on the negative a.f. peaks from the driver, but they might just as well be made to operate on the *positive* peaks, as far as their effect on the true modulation factor is concerned. Such an arrangement is correctly termed volume compression, or audio a.v.c, rather than automatic modulation control. However, the use of audio a.v.c., as such, represents a tremendous improvement over the majority of audio systems now used in amateur 'phone stations. It also has the advantage of being readily applicable to almost any type of modulated amplifier, whereas the a.m.c. system described in this discussion is limited in application to plate-modulated transmitters. This limitation is not basic, however, because it is probable that suppressor-modulated and grid-modulated transmitters can be controlled by similar means, with suitable circuit changes in the diode and speech amplifier units. For those who are experimentally inclined, here indeed is room for development work.

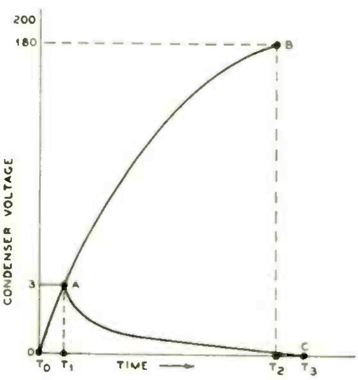


FIGURE 3

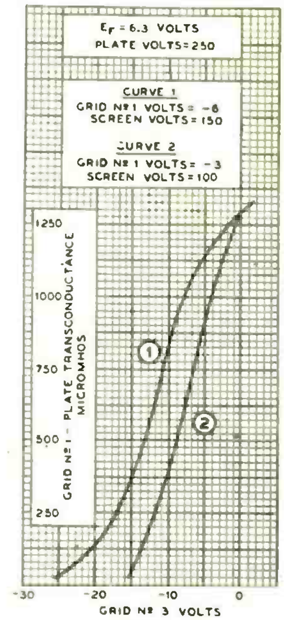


FIGURE 4

Questions that have arisen several times with respect to the operation of the circuit in figure 1 are as follows: With C_1 placed *after* the filter resistors R_2 and R_3, instead of across R_1, will not a large number of excessive a.f. peaks pass through the modulator before C_1 has time to charge sufficiently to cut the amplifier gain? Since the time constant of R_3 and C_1 is about 1.15 seconds, will not the circuit be too slow in "taking hold"?

Time Constant Considerations

At first thought, it does seem that such would be the case. The author was also dubious about

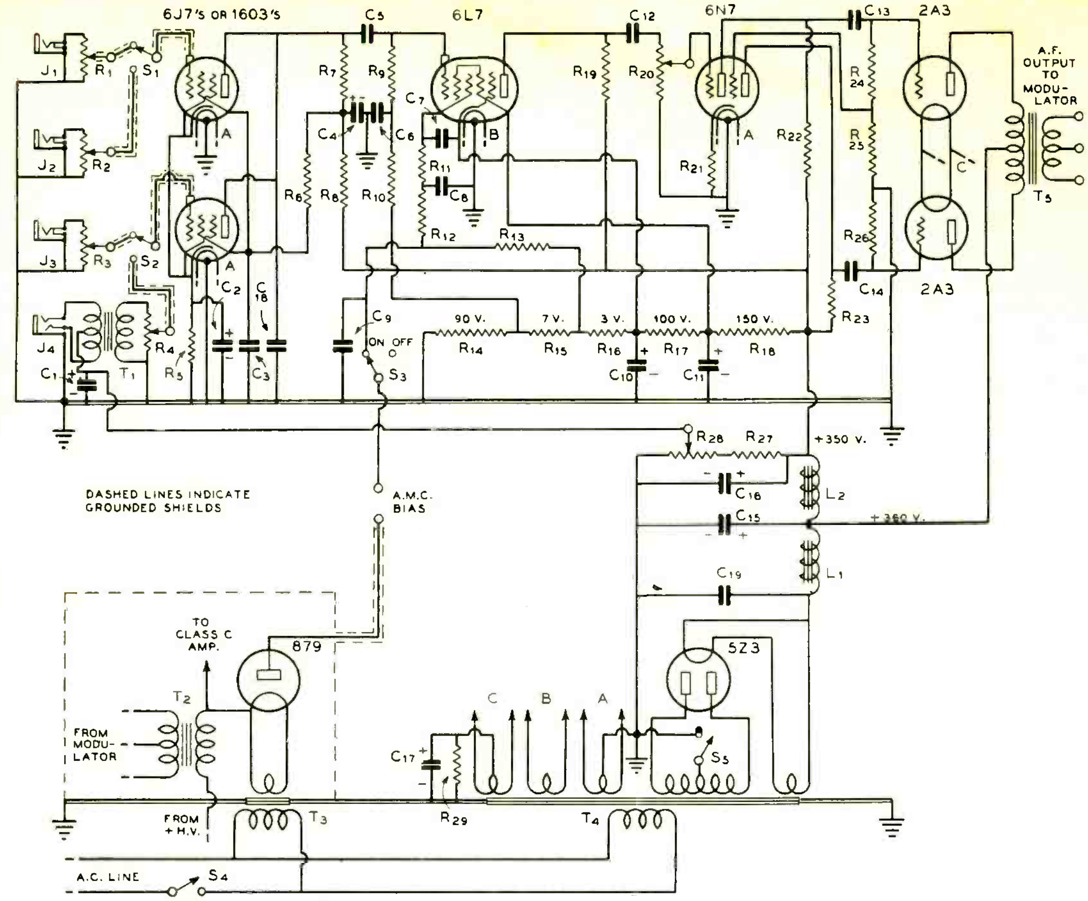


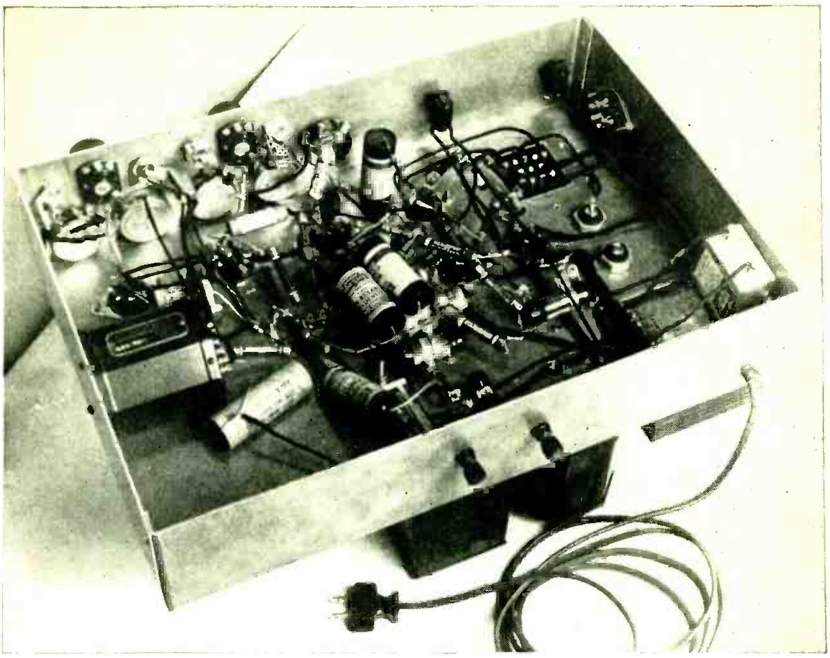
Figure 5

C_1—25 μfd. 50-volt elect.
C_2—25 μfd. 25-volt elect.
C_3—0.1 μfd. 400-volt tubular
C_4, C_{16}—8 μfd. 450-volt elect.
C_5—.02 μfd. 400-volt tubular
C_6, C_7—0.5 μfd. 200-volt tubular
C_8, C_9—.002 μfd. mica
C_{10}, C_{11}—8 μfd. 250-450-volt electrolytic
C_{12}—.02 μfd. 400-volt tubular
C_{13}, C_{14}—.015 μfd. 400-volt tubular
C_{15}—16 μfd. 500-volt electrolytic
C_{16}—8 μfd. 450-volt electrolytic
C_{17}—50 μfd. 100-volt electrolytic
C_{18}—.0002 μfd. mica
C_{19}—1.0 μfd. 750-volt tubular
R_1—1-megohm potentiometer
R_2—500-ohm potentiometer
R_3—1-megohm potentiometer
R_4—500-ohm potentiometer
R_5—500 ohms, ½ watt
R_6—250,000 ohms, ½ watt
R_7, R_8—50,000 ohms, ½ watt
R_9—100,000 ohms, ½ watt
R_{10}—500,000 ohms, ½ watt
R_{11}—1.0 megohm, 1 watt
R_{12}—100,000 ohms, ½ watt
R_{13}—500,000 ohms, 1 watt
R_{14}—4500 ohms, 5 watts
R_{15}—350 ohms, ½ watt
R_{16}—150 ohms, ½ watt
R_{17}—5000 ohms, 5 watts
R_{18}—7500 ohms, 5 watts
R_{19}—100,000 ohms, ½ watt
R_{20}—100,000-ohm potentiometer
R_{21}—1500 ohms, ½ watt
R_{22}, R_{23}—100,000 ohms, 1 watt
R_{24}—250,000 ohms, ½ watt
R_{25}—12,000 ohms, ½ watt
R_{26}—250,000 ohms, ½ watt
R_{27}—15,000 ohms, 20 watts
R_{28}—1500-ohm potentiometer
R_{29}—780 ohms, 25 watts
S_1, S_2—S.p.d.t. switches
S_3, S_4, S_5—S.p.s.t. switches
J_1, J_2, J_3—Shielded, closed-circuit jacks
J_4—Shielded, 3-circuit jack for double-button microphone
T_1—Microphone-to-500-ohm line transformer
T_2—Modulation transformer
T_3—2.5-volt filament transformer, insulated for 5000 volts
T_4—Power transformer
T_5—Output transformer; 5000-ohm plate-to-plate impedance
L_1—12-henry, 120-ma. filter choke; d.c. resistance, 80 ohms
L_2—40-henry, 50-ma. filter choke; d.c. resistance, 250 ohms

these points for a while, but, knowing that the performance as checked by an oscillograph belied such an undesirable behavior of the circuit, decided to see if a closer analysis might not explain what happens. The instantaneous voltage e to which a condenser C will charge through a resistance R in time t when a potential E is applied across RC is given by the relation

$$e = E\left(1 - \varepsilon^{\frac{-t}{RC}}\right) \qquad (1)$$

where ε is the base of natural logarithms. Assume that condenser C_1 (figure 1) must be charged to 5½ volts d.c. in order to take care of a 100-volt overmodulation peak. Since C_1 normally has a 2½-volt charge under steady-state conditions, the additional bias voltage



Bottom view of the amplifier chassis. The gain controls for the four input circuits are seen toward the top and to the left of the front chassis drop.

which must be furnished by R_1 is $5\frac{1}{2} - 2\frac{1}{2}$, or 3 volts (the voltage values assumed are not necessarily precise, but they are approximately in the right order of magnitude). The peak a.f. voltage rectified by the diode is 200 volts (GC in figure 2.) Therefore, going back to equation (1), we have

$$3 = 200\ (1 - \varepsilon^{\frac{-t}{(10)^6(0.5)(10)^{-6}}}) \qquad (2)$$

The denominator of the exponent of ε is RC, R being approximately 1,000,000 ohms and C being $(0.5)\ (10)^{-6}$ farads. Solving equation (2) for t, we get

$$t = \tfrac{1}{2}\log_\varepsilon \frac{200}{197} = 0.008 \text{ second, approximately.} \qquad (3)$$

Therefore, condenser C_1 charges from $2\frac{1}{2}$ to $5\frac{1}{2}$ volts in a very small fraction of a second. This action can more easily be understood by referring to figure 3, which shows the general form of the charging curve expressed by equation (1). If C_1 had to be charged to 90 per cent of E, or 180 volts, the time necessary would be

$$t = 2.3\ RC = 1.15 \text{ seconds,} \qquad (4)$$

where R is in ohms and C is in farads. This time corresponds to T_0T_2 in figure 3. Inasmuch as C_1 has to charge only 3 volts (additional), the time required for the circuit to take hold is only T_0T_1. The amplifier gain increases very gradually, after the excessive modulation peaks cease; the increase in gain follows inversely the curve AC in figure 3, so that the 3-volt increment of bias across C_1 takes from T_1 to T_3 to leak off. Actually, it takes longer than this, due to the fact that the voltage across C_1 has to leak off through R_1 as well as through R_3 (R_2 is neglected in the discussion given, because it is small compared to R_3).

In a "nut-shell", the system works rapidly because C_1 has a very large charging voltage available from R_1 and because the bias increment required by grid no. 3 is a very small fraction of this large charging voltage. In the theoretical considerations which have been discussed, the assumption is made that the voltage across R_1 is 200 volts supplied from a low-resistance source. Actually, of course, the 200 volts exists only at the extreme negative peak of the a.f. cycle. At most audio frequencies, the charging voltage is in the vicinity of its peak value for a sufficient time to affect C_1. If not,

C_1 gets "hit" by the following peak—but let's not go into that! It is realized that the analysis which has been made is not precise, but it should help to explain the general operation of the circuit.

Practically no waveform distortion is caused by the action of the a.m.c. bias, because the gain of the 6L7 is cut quickly when a few large a.f. peaks occur and the gain increases gradually thereafter. Thus, both large and small a.f. peaks are reduced in the same proportion, but only when the large ones go "out of bounds". The manual gain control is normally set considerably higher than it would be if a.m.c. were not employed. If the overall gain of the speech amplifier is made sufficiently high, the operator can talk in a low tone or at a distance from the microphone and still obtain complete modulation of the carrier. Conversely, he can talk louder or get very close to the microphone and still get complete modulation—without fear of overmodulating and without having to "back off" the manual gain control.

W2ICA and the author thoroughly enjoyed checking the amplifier (to be described) on a cathode-ray oscillograph, using the modulated-envelope type of pattern with the linear sweep oscillator synchronized with the a.f. system. Thus a whistle gave a stationary pattern having a good sinusoidal waveform. Whistle low or whistle loud, build the sound up slowly or very suddenly, the pattern was always the same—that of a nice, heavily modulated carrier which absolutely refused to look any way but proper. Quoting W2ICA, "I don't see how I operated a 'phone without it."

The Complete Amplifier

Figure 5 shows the circuit of the complete speech amplifier and driver, incorporating such features as a.m.c., a two-channel audio mixer having four separate inputs, a voltage sensitivity of better than 0.002 peak volts, a push-pull output stage delivering about 10 watts of high-quality audio power, and a self-contained power supply minus any hum difficulties. Figures 6 and 7 show two views of the amplifier. The circuit wiring is made with more attention to short leads than to appearance.

The two 6J7 mixer tubes have a common plate-load resistor, the resistance of which can readily be changed to increase or decrease the maximum gain of the amplifier. Values between 10,000 and 100,000 ohms were tried, the lower value providing just enough gain for close talking into a crystal microphone. The higher value increases the gain so that the operator can talk at a considerable distance from the microphone.

Four separate input jacks are provided—two for each mixer tube. J_1 and J_3 are high-impedance inputs for a crystal microphone or other high impedance signal source. J_2 is for a 500-ohm line and J_4 is primarily intended for a double-button carbon microphone. Voltage for the latter is supplied by potentiometer R_{28}, which should be set at its grounded end before the microphone is plugged in. J_4 can also be used for a low-impedance line, provided the movable arm of R_{28} is grounded. Either input of one 6J7 can be mixed with either input of the other 6J7, switches S_1 and S_2 being provided to select the inputs desired. Manual volume control of the mixed output of the 6L7 is made by means of potentiometer R_{20}, at the input of the 6N7 phase inverter. Some of the circuit constants shown are somewhat critical. The values given in the legend of figure 5 are recommended as being the result of a considerable amount of testing in actual station operation.

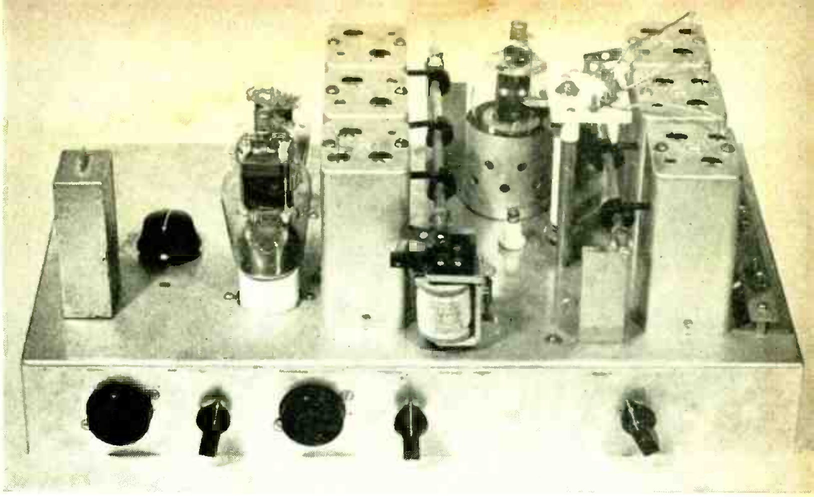
Little need be said as regards the construction of the amplifier. The aluminum chassis employed measures 17"x12"x3¾". It is probably somewhat larger than necessary, but it was desired to place the input transformer T_1 as far away as possible from the power transformer, to lessen the possibility of hum pick-up. The size of the input filter condenser C_{19} and the d.c. resistance of filter chokes L_1 and L_2 are important as regards obtaining the proper d.c. output voltages. Because the push-pull 2A3's are self biased, there is not much shift in the d.c. load current between no-signal and full-signal conditions. For this reason, a filter of the condenser-input type provides satisfactory voltage regulation.

There is little need for the a.m.c. off-on switch (S_3) in actual station operation. It is useful, however, when the amplifier is being tested initially for the operation of the a.m.c. circuit. For this testing, a cathode-ray oscillograph is indispensable. A pattern of either the trapezoidal or the modulated-envelope type is suitable for test purposes. If the latter type of pattern is used, the linear sweep-circuit oscillator should be synchronized with the speech amplifier.

The output transformer T_5 is designed with several secondary taps to match various voice-coil impedances as well as a 500-ohm line. The latter is used to connect the 2A3's to the class-

[*Continued on Page 72*]

Front view of the bandswitching, electrically-padded exciter. One of the padder-control relays can be seen in the center foreground. The two empty sockets to the left of the front drop of the chassis are for the two variable-frequency crystal units. The switch between them is the crystal selector switch. It also controls the padder relays. The center knob controls the bandswitch. The one on the right is not used at present.



OBTAINING FLEXIBILITY *at Low Cost*

By HAROLD CHRISTENSEN,* W6KLU

Spinning the dial around over an almost perfectly dead twenty-meter band the other evening, the following conversation was overheard between a couple of usually active hams:

Number One: "Boy is this band shot? Here lately the old band goes out about this time and I don't hear a thing on it again till morning."

Number Two: "Yeah, same here. Wish it wasn't so darned much trouble to move this rig to forty. I hear the boys are picking up some nice stuff there now."

"Yes, and ten goes on one of its streaks every now and then too, and would I like to snag some of those new countries the fellows talk about hearing on ten?"

"Well, I'd like to get this heap on forty but I would have to change about a dozen coils and then lining this rig up on a new band is nobody's picnic. Of course I would want to be back here again in the morning to keep my sked with ZS1AH. Oh well, it's just not worth it. Think I'll pull the switches and go read a book. 73 OM and cuagn sometime."

The above conversation pretty well expressed our feelings on this matter and caused to flame anew a desire to have a rig which would, at the mere flick of a switch, park itself right in any of the amateur bands in which operation was desired, and not only that but by the flick of another switch, scoot clear across that band to a new frequency at the other end where all the dx is anyway. And just to put the finishing touches on it (and to show just how lazy a person can be), why not dispense with any need for even as much as touching up any of the tuning in the rig so that the QSY would be not only immediate, but fully accomplished when that switch was thrown?

Sounds like rather a large order, doesn't it? Admittedly, those one-cent sales on aspirin helped, but really, when a little serious thinking was started on the subject, it was surprising how simply it could be done.

The Specifications

Summed up briefly, this was about what we wanted: Moderately high power, the very maximum of flexibility throughout, and these with the total cost held down to a point where our final investment in the rig wouldn't look like what Europe owes us but won't pay. So, with this idea in mind, the old eye was cast about long and persistently in an effort to clear up what still remained as a sort of hazy daydream.

Any way you look at it, the most signal for the fewest dollars is still obtainable with the medium sized triodes such as the 35-T, T-55, or 808. A pair of these tubes can be run up to

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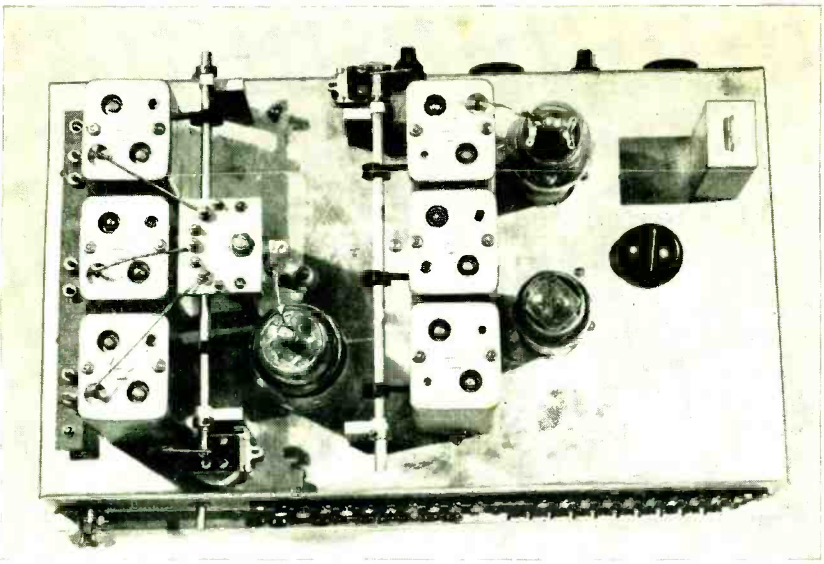


• Top view of the exciter. Keying relay and oscillator cathode tuning condenser to the right. Oscillator and doubler plate tanks and padder relay in the center. 807 bandswitch, plate tanks, and padders to the left. The mycalex strip just to the left of these tanks carries the binding posts for the three output links.

four-hundred-fifty watts input without having them emit so much as a murmur, and that amount of power will start a considerable amount of ether on the move. A full legal kilowatt will stir up only enough more to give a barely perceptible increase in signal strength, while an overgrown California (or Pennsylvania) kilowatt will in all probability not receive reports varying more than one "R" point from yours, provided your antennas are equally efficient.

So it was settled that the putter-outer would consist of a pair of tubes of this type in push-pull. The cost of the final amplifier will be a surprisingly low percentage of the total cost of the rig, so why not just have a separate final for each band? Ah—now there is an idea. (W6CUH originated it but it is just sinking in now.) And Dave Evans (RADIO, July, 1937) showed us how to handle the final amplifier padding to cover both ends of the band, so that part of the work is already done for us. Only one high voltage power supply will be necessary, and since it is of the 1500-volt variety capable of supplying around 350 ma., it can be seen that even this section of the rig can be supplied quite economically. Then, why don't we just leave the plate and grid voltages on the final amplifiers at all times and fire up the one we want to use by just lighting up its filaments? Now we have something.

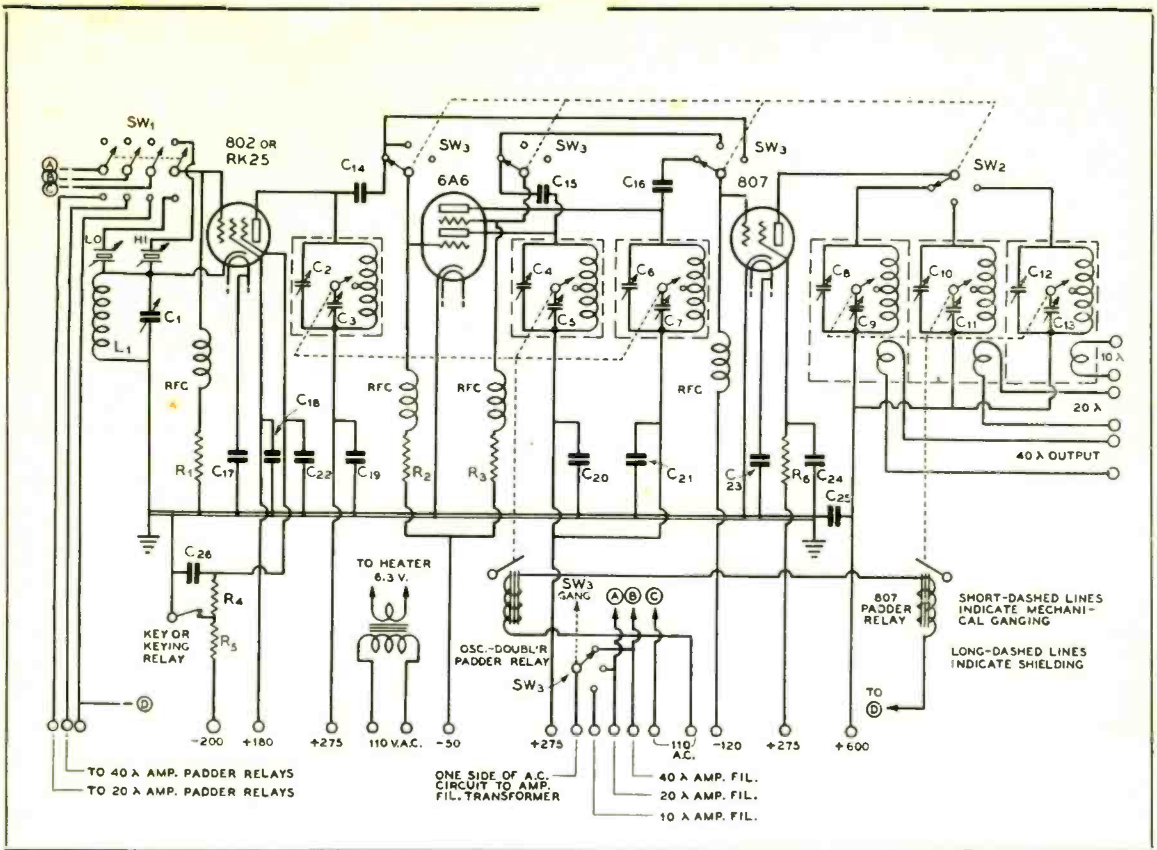
Metering of the finals is extremely simple this way also, since we can use a single grid meter and a single plate meter for registering the currents in whichever of the finals happens to be on at the time. We seem to be going at this thing backward by deciding on our final layout first, but that is usually the best method of designing a rig so we are not so far out of line after all. The next question of course resolves itself into, "But what are we going to use to drive these finals, and how are we to get the degree of flexibility which will be necessary to achieve the desired end?"

The Exciter Tube Lineup

With the announcement of the new ratings on the 807 beam power tube, it was realized that here was the answer to the daydream aforementioned. Under these new ratings the tube is easily capable of an output of over forty-watts. Since a good rule of thumb to follow in the design of driving stages is to divide the intended input to the driven stage by eight or ten to determine the output power necessary from the driving stage,"[1] it can be seen that our 807 will drive the following amplifier efficiently to an input of from four to five hundred watts. This is just where we had already decided we wanted to run the final input.

The 807 has a very high power sensitivity, which means that practically no power at all is needed to drive it. Therefore, we can use small tubes ahead of it and let the 807 worry about

[1]Applicable, of course, to triodes only.



SCHEMATIC DIAGRAM OF THE EXCITER

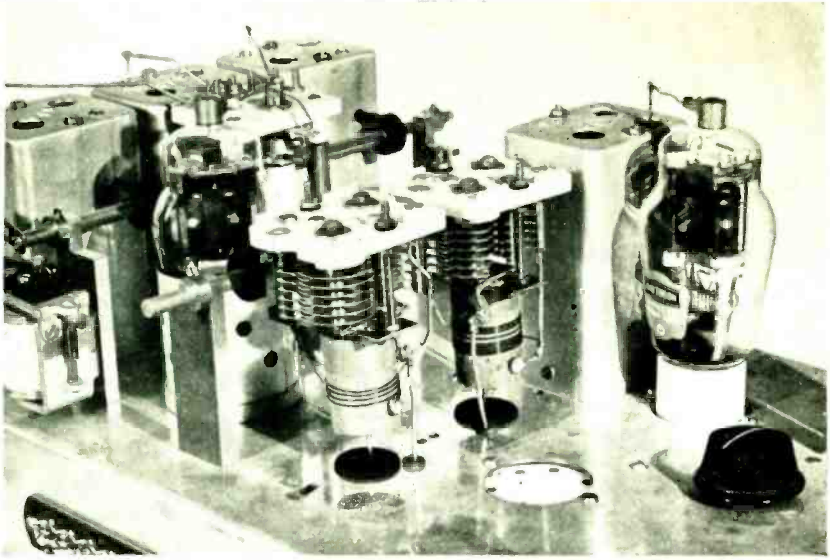
C_1—100 μμfd. midget
C_2 to C_{13} incl.—35 μμfd. midgets (in FXT tanks)
C_{14}, C_{15}, C_{16}—.0001 μfd. mica
C_{17}—.01 μfd. 400-volt tubular
$C_{18,19,20,21}$—.002 μfd. mica
C_{22}—.001 μfd. mica
C_{23}—.01 μfd. 400-volt tubular
C_{24}—0.1 μfd. 600-volt tubular
C_{25}—.01 μfd. 1000-volt mica
C_{26}—.35 μfd. 400-volt tubular
R_1—50,000 ohms, 1 watt
R_2—20,000 ohms, 2 watts
R_3—10,000 ohms, 2 watts
R_4—10,000 ohms, 5 watts
R_5—50,000 ohms, 2 watts
R_6—10,000 ohms, 10 watts
RFC—2½ mh., 125 ma. r.f. chokes
SW_1—Four-pole double-throw switch
SW_2—Isolantite insulated, one-pole seven-throw—only three positions used
SW_3—4-gang, 6-circuit switch
Relays—Guardian, or rewound Philco

amplifying this small amount of power up to a point where it will make the finals happy. In looking over the smaller-type receiving tubes, we found that the 6A6 lends itself admirably to doubling duty and we can even quadruple the frequency in this one tube.

An isolantite-based 6A6 was chosen in this layout because of its probable better efficiency on ten meters. This type of base, however, is not at all necessary since almost no difference will be noticed between this and the conventional-type base. In our particular case an RK-25 or 802 was chosen as the crystal oscillator for two reasons. First, break-in operation was desired, and second, the screen-grid pentode lends itself beautifully to clickless, chirpless, thumpless keying when use is made of its suppressor grid for this purpose. Nothing in the oscillator circuit is critical, except that it is not advisable to use a larger by-pass condenser on the suppressor grid than that specified; larger values may tend to make the keying somewhat sloppy.

Stage Switching

Now to obtain this flexibility we mentioned as being so necessary. This is accomplished by stage switching, so that the frequencies which appear in any of the preceding tanks can be impressed on the grid of the 807 for amplification. As fixed bias is provided for all stages to permit break-in operation, it is only necessary to open the grid of the 6A6 sections when their services are not desired and that section remains at cut-off. A single bias supply lead is used for both 6A6 sections. The 807 is also biased to the correct value from the bias regulator associated with it, and will be cut off unless



The two doubler plate tanks with the shields removed are shown in the center. These coils are wound on forms; those for the 807 plate circuits are air-wound.

receiving excitation. As was mentioned previously, very little power is needed for the 807 grid, so 275 volts was tried on the plates of the oscillator and doublers and was found to be more than enough.

Now there is one more thing which will aid in getting us where we want to be when we want to be there—the variable air gap crystal. This choice more or less starts us on 3.5 Mc. whether we like it or not since most of the manufactured units of this type are for that frequency.

With the RK-25 operating as a tri-tet, 7-Mc. power is available in its plate circuit. The first section of the 6A6 will furnish 14-Mc. power, and the second section will get us down to 28 Mc. This means that the 807 can be operated as a straight amplifier on these three bands. And should one desire about 30 to 35 watts of crystal controlled power on five meters, this can easily be obtained by operating the 807 as a doubler. By merely extending these principles, this unit could readily be made to cover very effectively all the amateur bands from 1.7 Mc. through 60 Mc., crystal controlled all the way! In order to get from one end of the band to the other without running out of resonance, it was evident that padding would have to be used for the lower end of the bands.

At this point, attention was focused on the small FXT exciter tank units, which provide two 35-μμfd. variable air condensers and a coil form all within a shield only 2"x $2\frac{3}{8}$"x 4" in height. The use of these units permitted a very compact type of construction, besides providing the needed padder condenser which could be cut into the circuit at will through the use of a set of contacts operated by a relay. In order to provide the contacts with a very short lead to the tank circuit, it was decided that the contacts themselves should be mounted inside the shield can.

The Padder Condensers and Controls

After playing checkers with several arrangements, it was finally decided that a small bakelite or mycalex block could be mounted on one of the machine screws which carry the coil mounting, and have this block serve as the mount for the spring contact. In the isolantite block which carries the tuning condensers, there are two holes provided for bringing leads through the top of the unit. One of these holes was used for mounting the stationary contact, and the other for taking the plate lead out of the tank for the RK-25 and the 807. It was necessary to enlarge the hole in the shield can to prevent sparkover from the hot leads. For the 6A6 plates the hot lead goes down through the chassis beneath the tanks.

As it was desired to gang the contacts for each bank of tanks, all contacts were mounted in the same position, with the spring contact towards the side of the shield can so it could be operated by a small bakelite rod extending through a hole in the can. By drilling a small hole in the contact spring and putting a small peg in the end of the bakelite pushrod, there is no tendency for anything to slip out of place. The ends of the bakelite rod are rounded so as to provide a ball surface to prevent any possibility of sticking. The bakelite pushrods are operated by a small bakelite cam which is mounted on the ¼" rod running alongside the tanks. This cam also has a small hole in its face to accommodate the peg in the other end of the pushrod. These cams happen to be round in this version but could just as well be small square blocks.

The rod carrying the cams is carried by two standards, one at each end, which were cut so as to be the proper height to match the holes in the shield can through which the push-rods extend. On one of these standards is mounted the padder relay which is connected to the cam rod through a simple link. One relay could have been made to operate both cam rods by linking them together, but when first assembling a unit of this kind, it is best not to leave anything to chance and it was not known just how much contact pressure would be necessary. Thus, on the higher of the two frequencies used, the padder relays remain open and only the one condenser is across the tank. The tank is tuned to resonance and then the lower frequency crystal is picked off by SW_1 which also automatically closes the padder relays. The circuits are again resonated by this time by tuning the *padder* condenser which is across only a few turns of the coil. This method permits having the circuits tuned to resonance at all times with a negligible loss since the padders are across only that portion of the coil which is nearest ground potential.

Construction

The unit itself is constructed on a standard 10"x17" pan and there is plenty of room for everything although the photo of the bottom side of the unit would seem to belie this statement. This apparent complication arises from the rather large number of small parts instead of from actual crowding.

First, if we were going to have variable-frequency crystals, we wanted them out in front where they would be readily accessible, and not hidden back in the innards of the thing. So two sockets extend through the front of the chassis and the front panel and the crystal holders plug directly into them. For those who work spot frequencies on AARS or other nets, this provides a ready means of introducing the spot-frequency crystal into the circuit where it will do the most good with the least fuss in getting it there.

COIL TABLE

Oscillator Cathode 12 turns no. 24 1" long on 1½" dia. form	**807 Plate Coils**
Oscillator Plate 26 turns no. 24 1" dia., 1⅛" long tapped at 11th turn	**7 Mc.** 28 turns no. 18 wire 1⅜" dia., 1⅝" long tapped 7th turn from ground link 3 turns over coil at ground
First Doubler Coil 10 turns no. 24 1" dia., 1" long tapped at 4th turn	**14 Mc.** 13 turns no. 14 wire 1⅜" dia., 1¼" long tapped 5th turn from ground link 2 turns over coil at ground
Second Doubler Coil 4½ turns no. 24 1" dia., ¾" long tapped at 2nd turn	**28 Mc.** 7¼ turns no. 14 wire 1" dia., ¾" long tapped 2½ turns from ground link 2 turns over ground end

Oscillator cathode coil wound on part of plug-in coil form with prongs sawed off (see under-chassis photograph.) Oscillator plate coil and doubler coils wound on forms furnished with FXT units. Coils for 807 tanks are air-wound. They are made rigid by small celluloid strips cemented to them by Duco cement. Celluloid strip 5/16" wide cemented over ground end of plate coil and link turns wound over this and cemented in place.

Due to the loading of the circuits and the relatively low values of tuning capacity used, the tuning is very broad and any frequency in the higher half of the bands may be chosen without causing appreciable detuning of the circuits when the padder relays are open and likewise in the lower half when the padder relays are closed. As we wanted the padder relays to operate automatically when either end of the band was picked off, the two sockets are designated as high-end crystal and low-end crystal. SW_1 has the function of picking off the crystal desired, as well as operating not only the padder relays in the exciter unit itself but, as can be seen from the circuit diagram, the padder relays on the 20- and 40-meter amplifiers as well. By utilizing the filament-circuit switching of SW_3 as a source of 110 volts a.c., only the padder relays in the amplifier in use will be operative. It was not deemed desirable to attempt to pad the 10-meter amplifier since the efficiency would be too seriously affected by the introduction of the necessary additional parts into the circuit.

The pointer on SW_1 is placed on the shaft so as to indicate which of the two crystals are in service. This is easily done, since the switch is placed between the two crystal sockets.

Atop the pan are mounted the FXT tanks, tubes, relays and padding mechanism, keying relay, and the knob for control of the cathode tuning condenser. The latter need never be touched after it is once adjusted. As will be seen from the photos, the keying relay is mounted at the left end of the chassis and forward. Just to the rear and a bit to one side is the cathode condenser knob. The RK-25 is located directly beside its tank. The 6A6 mounts beside and midway between its two tanks. Thus the tanks can be lined up for easy ganging of the padder mechanism.

The 807 in its cut-down tube shield is located toward the rear of the pan and just in front of it is SW_2, which has the job of switching the 807 tanks. SW_2 is mounted on metal pillars to bring it up to the level of the tops of the 807 tanks, and close to the 807 plate cap. All parts were arranged to permit installation of an additional 807 to be operated in parallel with the first should this have been found necessary. (It was not.) Therefore, some improvement in placement of parts could probably be made.

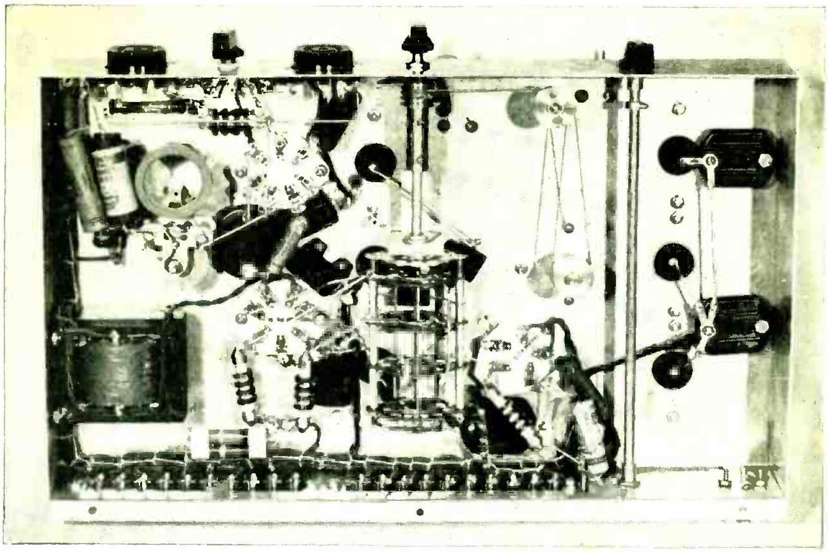
Since SW_2 does not have an insulated shaft, it had to be isolated from ground for d.c. and r.f. and this was accomplished through the use of an isolantite coupling having flexible couplings at each end. This simplified alignment and there is no danger of breaking or twisting anything if the shaft is not exactly on line. A 1/4" shaft extends through a bushing in the chassis for ganging SW_2 to SW_3 so that only one control is necessary to accomplish the switching operation in the entire unit. If it were desired to use the 807 as a doubler under some circuit set-ups, SW_2 could have its control knob brought out separately.

Under the chassis, at the left and toward the rear, is found the filament transformer. Just in front of it is the cathode circuit of the oscillator, beside which are the components of the click and thump filter. Next come the oscillator and doubler tube sockets with their associated chokes, by-passes, and wiring. Along the front can be seen the rear of the two crystal sockets with SW_1 between them.

Located centrally and somewhat to the rear is the heart of the whole exciter. This is SW_3, which is the stage-switching mechanism. This is a standard item, being a four-gang, six-circuit arrangement. For that portion of the switch handling r.f., alternate switch points have been removed to increase the spacing between them and to reduce capacity effects. Directly above the switch are the rubber grommets, of ample size to permit the wiring to be led through without touching the sides, through which the hot tank leads pass. The coupling condensers are placed closely around the switch to provide as short leads as possible. The switch was placed somewhat to the rear to provide the shortest possible leads for the ten-meter wiring and this care in placement has been amply repaid in a smoothly operating ten-meter circuit.

Attached to the shaft which drives SW_3 is a small drum over which runs a dial cable which goes around two idlers and then over another drum attached to the shaft which drives SW_2. This system of ganging is very smooth, has practically no backlash, and is very positive. The switches have been thrown throughout their range several hundred times without trouble and none is anticipated. Directly alongside the 807 grid section of SW_3 is located the tube socket for the 807, the grid prong being right alongside its terminal on the switch.

Around the 807 socket are its by-passes and the screen dropping resistor. At the extreme end can be seen the grommets through which



• Under-chassis view. The main bandswitch is in the center with the pulleys and dial cable leading from its control shaft to the vertically-mounted shaft of the 807 plate circuit switch. Filament transformer is on the left with the cathode coil of the oscillator directly above it.

the plate of the 807 is fed d.c., and the by-passes for the tanks. One by-pass condenser serves for the 40- and 20-meter tanks, but to keep lead length to a minimum, a separate by-pass condenser was provided for the ten-meter tank. Values for all components are given with the diagram.

Final Amplifier Switching

As we want to light the filaments of whichever of the final amplifiers are called for when the exciter unit is switched from band to band, the fourth section of SW_3 is used for this purpose. One side of the 110-volt a.c. goes directly to all filament transformers while the other is fed through the contacts of SW_3. From the output side of SW_3, the leads are carried to proper points on the terminal strip on the rear of the unit, to be carried from there to the other side of the respective filament-transformer primary with which each is associated. Also the padder relays for the final amplifiers are fed one side of the a.c. voltage which operates them from these terminals through SW_1.

Break In

Having the urge to use break-in, it was necessary to provide all stages following the crystal with cut-off bias. All finals receive their bias through a single regulator tube and the other stages have their separate regulators. This biasing is all accomplished through the use of a small 250-volt d.c. power pack, which was built by following instructions given in the January, 1937, issue of the RADIO yearbook. The bias pack also provides the suppressor grid of the oscillator with blocking bias for keying. Break-in cannot be used if the station being worked happens to be zero beat with the frequency being used, since the crystal is continuously operating in the screen circuit of the oscillator tube. With the shielding used however, any reasonably good signal can be worked through this interference right up to zero beat.

All links from the 807 tanks are brought out through the sides of the shield cans to terminals located on a mycalex strip running alongside the tanks and supported by small stand-offs at each end. Since each tank will be feeding only one final, no provision for switching the links was necessary although if only one final were to be used, this switching could be accomplished quite easily and simply.

Drive to the grid of the 807 was equalized for all frequencies by adjusting the value of the grid-leak resistors in the 6A6 grids and the screen voltage of the oscillator. The final adjustment provided a slightly rising value of grid current to the 807 with an increase in frequency. With about fifty volts of fixed bias on the 6A6 grids and the values of grid resistors shown, four ma. of grid current is furnished the 807 on 40 meters, four and one-half ma. at 20 meters, and five ma. at ten meters. The 807 is very lenient about variations in driving power but does seem to show a definite peak at about four and one-half ma. grid

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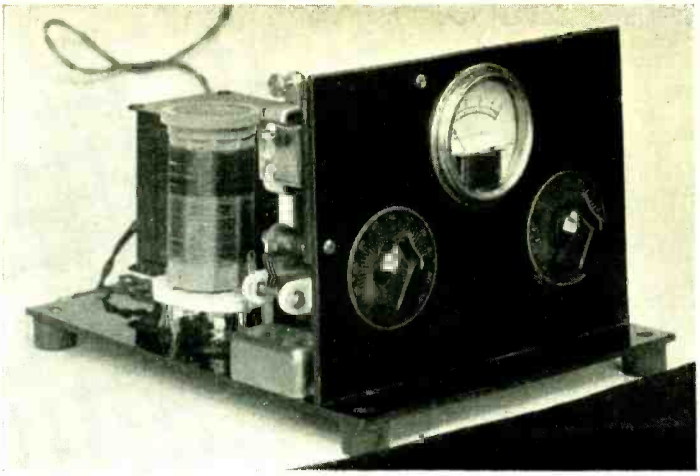


A Capacity-Operated ELECTRONIC RELAY

Although a gadget such as this will have little actual application around the ham shack, it could have such a multitude of outside uses that it warrents presentation. A few of the possible uses are: Safety protection on machines and from high voltage, remote control of equipment, indicator signal operation, fire alarm, speed regulator, door opening arrangements, device for advertising displays, automatic drinking fountain, counting device, etc. These suggested uses, of course, are only a bare beginning; a large number of additional applications will immediately suggest themselves.

The unit is easily constructed, quite inexpensive, and comparatively simple to get into operation. All parts are standard and easily obtainable. Their total cost, including that of the sensitive relay, should not exceed $8.00 to $10.00. And the majority of amateurs will already have a good proportion of the equipment in the "junk box."

Theory of Operation

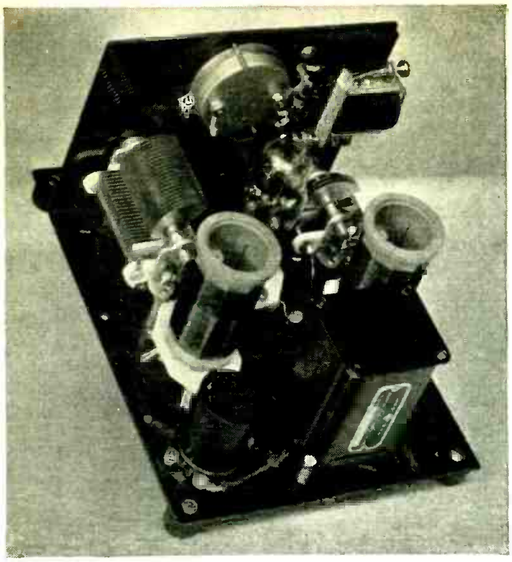
Similar electronically-operated devices, using vacuum tubes as control elements, operate on the change of plate current between the oscillating and non-oscillating condition. However, since the actual change in plate current depends upon the intensity of the oscillations, the operation is frequently unstable and often erratic.

In this circuit, however, a different method of obtaining the plate current change is employed. The operation can be explained as follows: The external plate (which triggers off the unit when someone approaches it) is connected to the oscillator as shown in the schematic diagram. Then the tuning condensers are rotated until the tube is on the verge of oscillating. Then, any person or any large conducting object approaching the plate will add additional capacity to the external circuit which will be coupled into the grid circuit of the oscillator tube. Since the tube is just on the verge of oscillation, this small additional capacity is enough to trip it off.

During one-half of each cycle of oscillation, due to the rectifying action of the grid of the oscillator, electrons are collected on this grid and on the side of the condenser, C_5, that is connected to it. Then, since there is no grid leak to furnish a path for these electrons to return to ground, each succeeding pulse drives the grid more negative with respect to the cathode.

In a very short time—about .001 second when using a .0001-μfd. grid condenser and an oscillator frequency of 1500 kc.—the grid becomes strongly enough negative to block the plate-current flow. When the plate current stops, the relay becomes non-operated and either closes or opens a contact as desired. In a short time, if the disturbance is removed from the vicinity of the external plate, the grid will lose its negative charge, plate-current will again flow and the relay will close.

If an extremely high value of resistance (50 megohms or more), is used as a grid leak, the time of "take up" can be adjusted to suit the



• The photographs show views of the gadget from two angles. Controls for the two tuning condensers and the optional milliammeter can be seen in the front view, while placement of parts is depicted in the back view.

conditions at hand. Also, by varying the value of the blocking grid condenser, C_5, the time required to block the tube may be adjusted.

Construction

The photographs show the unit constructed upon a bakelite subpanel with a bakelite panel. This method of construction is satisfactory, but slightly more stable operation with respect to external fields, etc., would be had if the unit were built into a thoroughly shielded metal box. The operation would be essentially the same but effects from local hand capacity would be greatly reduced.

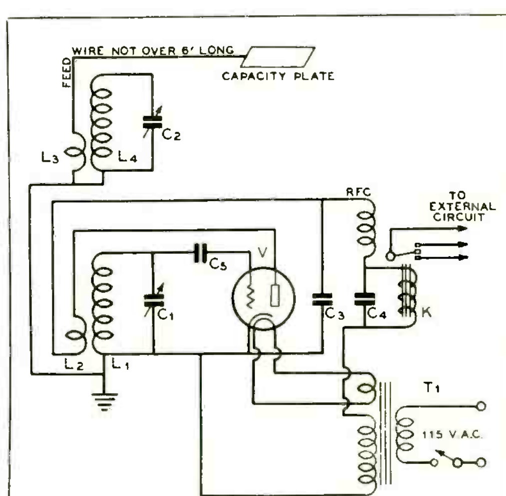
The meter shown upon the front of the panel is not required; it is there merely to assist in the tuning-up process and can be dispensed with, if desired, for the sake of economy.

The placement of the two, two-winding coils can be determined from the photograph. Nothing else in the layout is particularly critical; minor variations will have but little effect since they can be compensated for by an adjustment of the various tuning controls.

The transformer, T_1, is a power transformer of the midget b.c.l. variety. It should have 6.3-volt winding if a 76 is to be used or a 2.5-volt winding for a 56, in addition to the high-voltage winding. Ordinarily, only half of the high voltage winding will be required as plate voltage on the oscillator tube. In other words, the center tap of the h.v. winding is grounded and one of the outside leads is connected to the low side of the circuit-control relay. If more plate current is required to operate the relay, the whole winding may be used. No rectifier tube is required.

Results

The relay will ordinarily be sensitive enough to operate when a person comes within 3 to 6 feet of the metal plate. One caution: Do not make the lead from the unit to the external plate any longer than possible; the capacity-to-ground of this lead, if long, will greatly reduce the sensitivity. Four to six feet is just about the maximum that will still give good sensitivity.



SCHEMATIC OF THE RELAY

- C_1—350 μμfd. midget variable
- C_2—25 μμfd. midget variable
- C_3—.001 μfd. 400-volt tubular
- C_4—0.5 μfd. 400-volt tubular
- C_5—.0001 μfd. mica
- L_1, L_2—160-meter two-winding manufactured coil
- L_3, L_4—160-meter two-winding manufactured coil
- K—Sensitive relay, 10,000 ohms resistance
- RFC—8 mh. r.f. choke
- T—Midget b. c. l. transformer
- V—76 or 56 tube

The Effect of Average Ground on

While the perfect-ground assumption is justified for making certain antenna calculations, the effect of average ground is of great value in predicting the results that will be obtained from the antenna after its installation.

The majority of articles appearing in amateur journals discussing antenna radiation have been based upon an assumption—that the ground is a perfect conductor. In fact, a semi-technical review such as the writer's article in RADIO for January[1], almost has to make the perfect ground assumption in order to cover the subject. Yet little has been said about the real situation which exists, the ground generally being everything but a perfect conductor. Consideration of the effect of a ground that is not perfect may explain many things. While the effect can be summarized quickly, a discussion of what brings it about will make the explanation more useful.

The Phase Shift

If radiation from a horizontal antenna were to strike a perfectly conducting ground, the phase of the reflected wave would be shifted 180 degrees at the point of reflection. Speaking less technically, the wave arriving at a distant point via a reflection would be one-half wavelength (one-half cycle) ahead or behind what it would be if it had traveled exactly the same path but without any delay at the point of reflection. This is readily imagined when one considers very low angle radiation, from a horizontal antenna. If there were no delay or phase shift at the point of reflection, the direct and reflected waves arriving at a point in a nearly horizontal direction would have traveled practically the same distance, and the power in them would add. As it is, the reflection causes the phase shift, and the waves cancel.

Diagrams of radiation from one-half wave vertical antennas generally show maximum radiation horizontally. Why this differs from the horizontal case can be pictured as in figure 1. Because radiation from the lower half of the antenna is reflected before that from the upper half of the wire reaches the ground, it is "flopped over" in addition to undergoing the 180 degree phase shift, the result being as if neither had happened.

The Ground a Conducting Dielectric

When the earth is less than a perfect conductor, it becomes a conducting dielectric or, perhaps in an extreme case, a leaky insulator. Now three things happen:

(1) The reflected wave may not be as strong as the wave striking the ground, the power loss being due to lowered conductivity of the soil, to bad dielectric, and to complete loss of the *refracted* wave;

(2) The phase shift upon reflection may differ from 180 degrees, which like (1) may change when different vertical angles are being considered with consequent alteration of the "theoretical" pattern; and

(3) The reflection does not all take place exactly at the surface. An "image" antenna below the surface no longer provides a true picture of the operation, but the ground must be considered to have thickness. For one set of

[1]"Sugar Coated Antenna Theory," E. H. Conklin, RADIO, January, 1938.

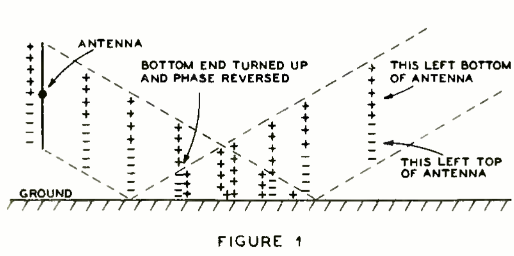


FIGURE 1

Above: Phase relations of reflected wave from vertical radiator.

Right: Ratio of reflected to incident intensity (A) and phase shift accompanying reflection θ for a vertical radiator.

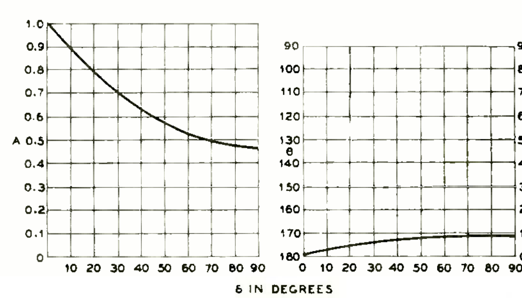


FIGURE 2

Antenna Radiation

By E. H. CONKLIN*

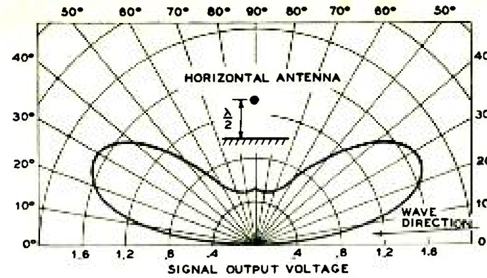


FIGURE 4

Calculated vertical-plane directional characteristic for horizontal doublet elevated one-half wavelength above "Netcong" ground.

ground constants and for wavelengths shorter than about 50 meters, the field at a depth of 12 feet is calculated to be about two-tenths of its value just beneath the surface.[2]

The Horizontal Antenna

Let us first study the horizontal antenna above "average" ground, because it is less seriously affected.

Figure 2 shows, for various angles measured upward from the surface, the factor A which represents the ratio of reflected intensity to the incident (direct) intensity, and Θ (theta) which represents the additional phase shift due to the deficiencies of the ground as a conductor.[2] It is seen that for low angles there is little loss or phase shift, and not a marked difference beyond some reduction in radiated power.

The resulting change in the pattern of an antenna one-quarter wavelength high is shown in figure 3, which includes a perfect ground comparison. The ground constants in this case are those for the A.T. & T. receiving site at Netcong, New Jersey. The country there is quite rolling, but the antennas are located on what amounts to a flat plateau. The ground, therefore, is well drained rather than generally damp. Figure 4 shows the pattern for an antenna a half wavelength high at the same location.[3]

Polar diagrams such as those mentioned above are of interest because they give a general picture of the shape of contour lines representing equal field strength or, in some cases, equal power. However, amateurs quite generally refer to the radiation in terms of the vertical angle at which the strength is a maximum. Actually, this may not be the angle at which signals are received or transmitted, so what is usually more important is the relative power at the useful angles. Furthermore, it is difficult to measure the intensity on a polar diagram when it is changing rapidly. For this purpose, rectangular coördinates have an advantage. This will be seen in later illustrations which give the same data in both types of charts.

Generally, radiation patterns are given in terms of field strength. This is what would be given by carrying a receiver or field strength meter about an antenna, plotting at each angle the distance at which the output is the same. This is not the same as a curve giving relative *power.* Field strength varies as the square root of the power. A curve in terms of power gives a much "sharper" looking pattern. In order to show visually the relative transmitted *power* that would be required to produce an equal signal strength at various angles, or with a different antenna, power curves can be used, or the readings taken from a field strength curve should be squared. Sometimes, however, multi-element beam patterns are drawn with the assumption that in each element there flows current equal to that which would have been delivered to one alone, and therefore the curve is a power curve if it is assumed that the total transmitter power is divided between the elements.

Power curves are often very useful, such as

*Associate Editor, RADIO.

[2]"The Optical Behavior of the Ground for Short Radio Waves," C. B. Feldman, *Proc.* I.R.E., June, 1933.

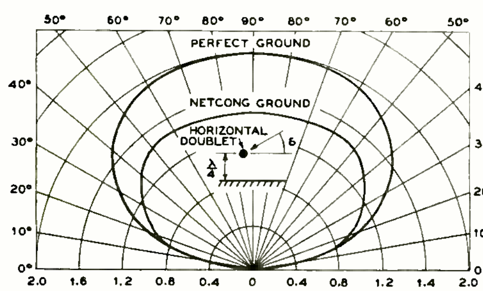


FIGURE 3

Vertical-plane radiation patterns for horizontal doublets above perfect ground and above ground at Netcong, N. J.

[3]"Some Effects of Topography and Ground on Short-Wave Reception," R. K. Potter and H. T. Friis, *Proc.* I.R.E., April, 1932.

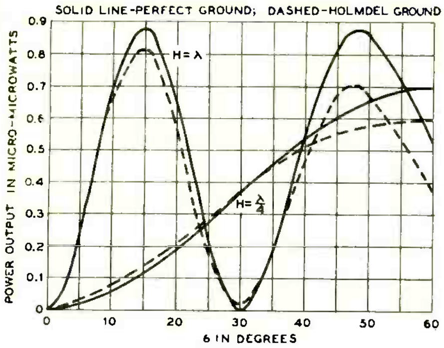


FIGURE 5

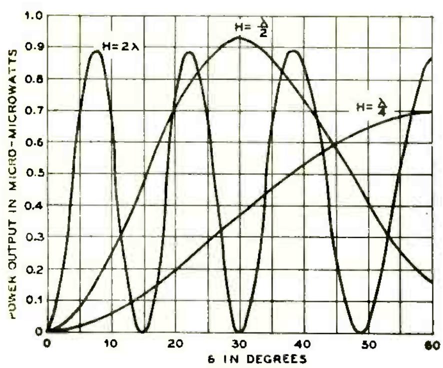


FIGURE 6

(Figure 5) Vertical directional patterns for horizontal doublets at height H above perfect and Holmdel ground.

(Figure 6) Vertical directional patterns of horizontal doublets calculated for perfectly-conducting ground.

measuring the vertical angle of signal arrival comparing the output from several antennas. h curves are given in figure 5, showing the tive power output of antennas one wavegth, and one-quarter wavelength high above fect ground and above flat farmland at lmdel, New Jersey.[4] This land has someit better constants than that at Netcong, and bably is similar to midwestern farm land. It be noted that here again, there is only a lerate loss in power due to the imperfect ınd. Figure 6 shows relative power for ennas at various heights over a perfect contor. In passing, we point out that these ves are illustrative of the need for height in er to favor the useful low angles, when using orizontal antenna.

The Vertical Antenna

milar coefficients in the case of the vertical antenna are given in figure 7. Here, it is seen that there is a distinct difference at the lower angles. In the horizontal case, the difference is one of degree; in the vertical case, it is one of kind. Even over the most perfect ground available, sea water or salt marsh, radiation at the lowest angles approaches that for a horizontal antenna, and complete cancellation takes place at the horizontal.

The effect on the radiation pattern is apparent from figure 8, calculated for the Netcong, N. J., ground constants as was figure 3. It shows how radiation from a half-wavelength vertical wire is severely reduced by deficiencies of the ground. Figure 9 gives in rectangular coördinates the shape of the pattern for a half wavelength antenna above sea water, Holmdel, and

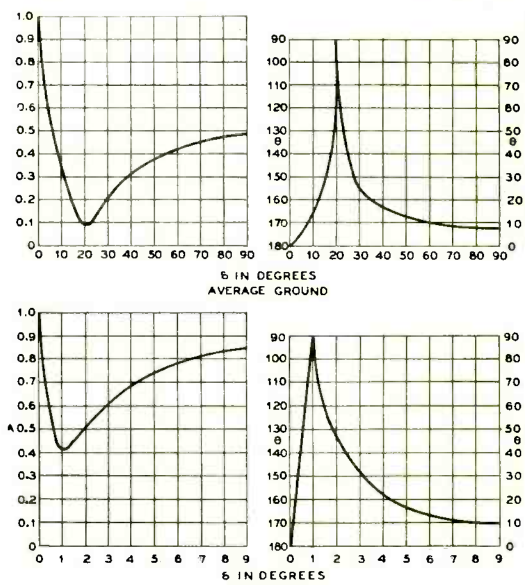


FIGURE 7

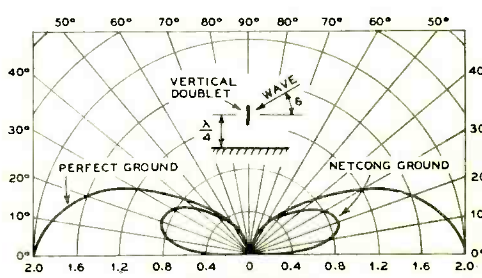


FIGURE 8

(Figure 7) Ratio of reflected to incident intensity (A) and phase shift accompanying reflection θ for a horizontal radiator above average ground and above sea water.

(Figure 8) Vertical-plane radiation patterns for vertical doublets above perfect ground and above ground at Netcong, N. J.

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e Determination of the Direction of Arrival of t Radio Waves," H. T. Friis, C. B. Feldman, and M. Sharpless, *Proc.* I.R.E., January, 1934.

Netcong ground. In this case, the curves are plotted in terms of per cent of maximum, the identity of the maxima for the three types of ground being meaningless. This set of curves was prepared to illustrate the correlation between actual airplane measurements at Holmdel and the curve for Holmdel ground.[2]

Figures 10 and 11 give a comparison between Holmdel ground and salt marsh for a half wavelength antenna the bottom of which is elevated 0.08 wavelength. These curves clearly show the progressive loss in power at low angles for poorer grounds, both cases being between the extremes of figure 8. Figure 12 gives in terms of power a polar diagram for half-wave and full-wave verticals over ocean water, while figure 13 shows the same in rectangular coördinates in comparison with what happens over Holmdel ground. It is seen that the full-wave antenna is not seriously affected, there being only a loss in power, inasmuch as horizontal radiation is cancelled even in free space. This chart readily illustrates the substantial loss in low angle power for a half-wave vertical over average ground.

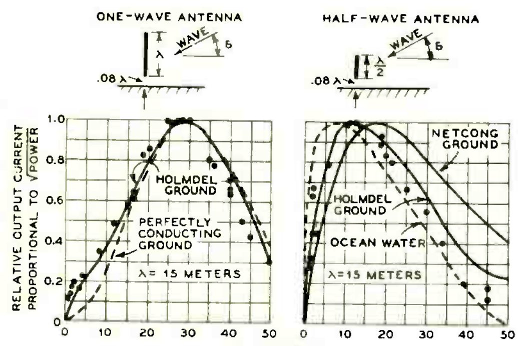


FIGURE 9

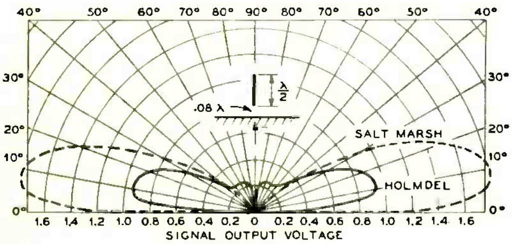


FIGURE 10

(Figure 9) Vertical directional characteristics of one-wave and half-wave vertical antennas above different ground conditions.

(Figure 10) Vertical-plane directional characteristic of a half-wave vertical antenna above two types of ground.

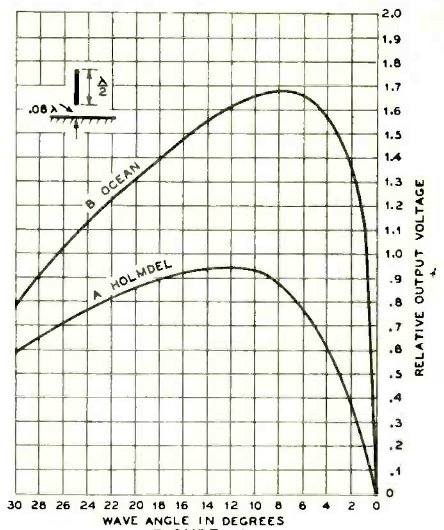


FIGURE 11

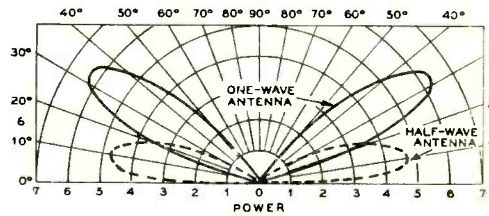


FIGURE 12

(Figure 11) Same as figure 10 but plotted upon rectar gular instead of polar coordinates.

(Figure 12) Polar representation of power gain of hal wave and full-wave antennas above ocean water.

Practical Verification

If an exploring receiver is carried up throug an arc in an effort to measure the radiatio characteristics, good agreement with optic theory is obtained with a horizontal antenn but in the vertical case the discrimination again grazing incidence (horizontal radiation) wholly or partially missing. At a greater di tance from the antenna, however, such as ca be obtained by airplane measurements, tl agreement in the vertical case becomes quit apparent even to the point of distinguishir between Netcong and Holmdel ground cond tions, as will be seen in figure 9.[2]

Horizontal vs. Vertical

A very important factor in the advantages c horizontal or vertical antennas, therefore, a pears to be the condition of the ground. Figu 14 shows a comparison between such double elevated 0.6 wavelength above Rumson, Nc Jersey, salt marsh, and Holmdel farmland. Tl suggests that the horizontal has some adva

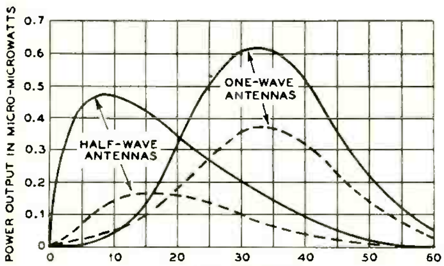


FIGURE 13

Same as figure 12 but shown upon rectangular coordinates and above sea water (solid line) as compared to average ground (broken line).

tages for high angle waves, but none for low angles over dry farmland. On the other hand, there is a substantial advantage favoring the vertical located over wet or marsh land, when low angles are involved.

Tests with automatic recorders[3] at several sites showed that the low angles South American signals came in with about equal volume on either antenna at Holmdel, but the vertical position for the salt marsh indicated an average improvement of over 8 decibels (2.5 times) when compared with the signals received at the Holmdel site. Similar tests on signals from England, which normally arrive from higher angles, showed a small average advantage in the salt marsh site for vertical antennas, but there were occasional periods of from 5 to 30 minutes during which large differences appeared. These differences during the test frequently ran around 8 to 10 db, and once reached 15 db.

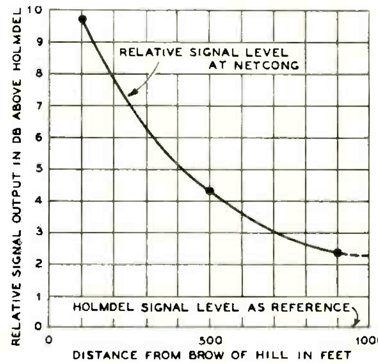


FIGURE 15

Variation of signal output from vertical half-wave antenna with distance from brow of hill in direction of received signal.

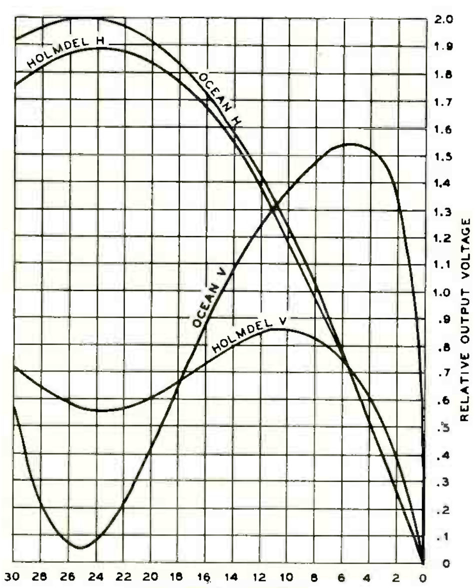


FIGURE 14

Vertical-plane directional characteristics of horizontal and vertical doublets elevated 0.6 wavelength and above two types of ground.

Sloping Ground

Some experiments have been made[3] on the advantages of a sloping ground toward the distant station. Low angle signals (possibly 3 degrees above the horizon) from South America, at various frequencies between 8 and 22 megacycles, at Netcong showed an average brow-of-hill advantage of something above 6 db (2.0 times) over the signal 1000 feet back, and higher at the beginning and end of the period for which a given frequency was useful, for vertical antennas. Exhaustive tests were not made below the brow but one measurement indicated a further increase on the slope itself. The average gain with horizontal antennas, on another occasion, was 8.8 db (2.75 times), somewhat more than with the verticals.

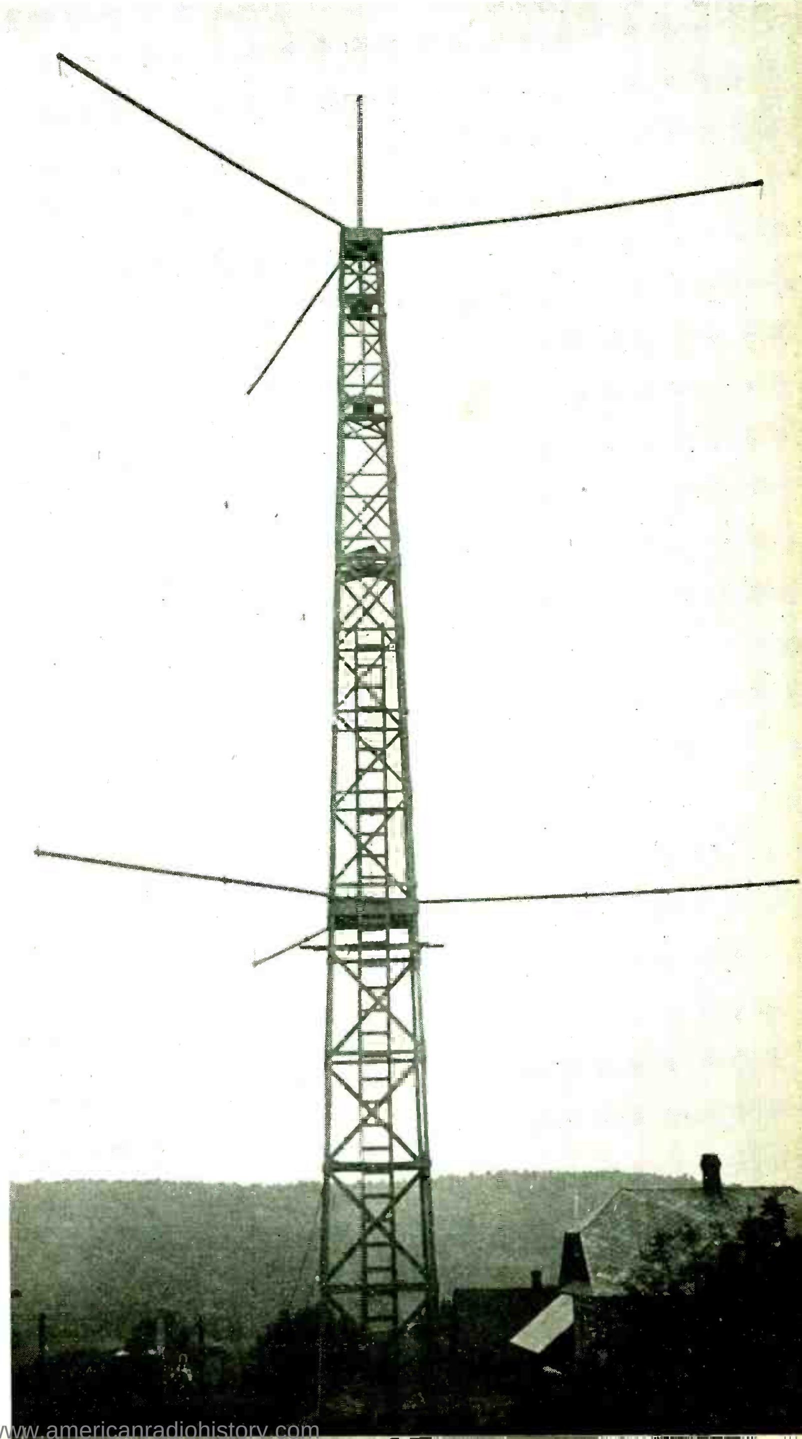
On the path to England, normally involving somewhat higher vertical angles (15 to 25 degrees), one test showed no noticeable improvement during several hours during the middle of the day, though more recent measurements on 14.44 Mc. on the same slope gave an average hill brow gain of 7 db during the early part of the normal useful period, decreasing to 3 or 4 db within a few hours, with an indication of an increase in gain toward the end of the period. The discrepancy in the tests has been attributed to a possible seasonal variation.

An idea of the distance at which the ground

[*Continued on Page 76*]

20-Meter PUSH-BUTTON BEAM Installation

By
R. N. JONES*
W8NUN



Twenty-meter antennas had added many gray hairs to those already present by reason of advancing years on the head of W8NUN, when Ray Dawley's article "Push-Button Antenna Directivity" appeared in the June, 1937, issue of RADIO. The location of the transmitter in a narrow valley well up in the Allegheny mountains in northwestern Pennsylvania seemed to offer radiation difficulties almost impossible of solution.

Trials of the usual half-wave arrangements, with and without reflectors, produced surprisingly uniform results. We could get out to the west and southwest, but in no other direction. In several months of operation, while Australia was contacted frequently and with ease, not a single contact was completed with Europe, South America, or even with the islands to the south.

Local conditions prevented entirely the construction of a rhombic or long-wire antenna of any sort, as no ground even approaching level was available near the transmitter. Experiments with half-wave and reflector antennas in fixed positions seemed to rule out the use of rotating beams, as those tried when installed at heights of ¼-wavelength would not produce results except in the directions already mentioned.

*701 Penn St., Johnsonburg, Pa.

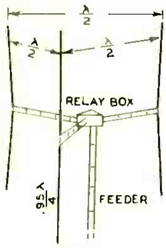


FIGURE 1
ELECTRICAL SYSTEM

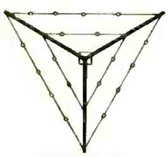


FIGURE 3
HORIZONTAL GUYING

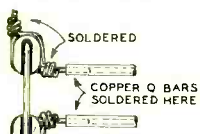


FIGURE 4
DETAIL OF CENTER INSULATOR

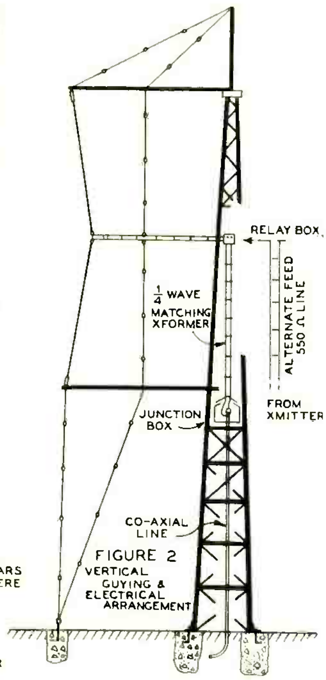


FIGURE 2
VERTICAL GUYING & ELECTRICAL ARRANGEMENT

For this reason the push-button antenna article immediately commanded attention and the decision to try it out was quickly reached.

For the benefit of those not having available a copy of RADIO for June, 1937, figure 1 shows the arrangement of the electrical components of the antenna under discussion. The phasing relays used are of the common r.f.-switching design, d.p.d.t., with a contact capacity of 4 amperes and operating coils wound for 110 volts a.c. These relays have handled the full output of a one-kilowatt transmitter for six months with no trouble of any sort. The three-conductor cable controlling the relay action is not shown in the drawing.

Single-Tower Design

The original layout proposed by Ray Dawley for the 20-meter antenna called for three separate antenna poles with a fourth and shorter one for the relay box. This idea was discarded, in our case, since the antenna was to be mounted on a slope exceeding 30°, and also because an effective height of approximately 66 feet was desired. Extreme weather conditions had to be met as high winds and ice storms are common to the long winters experienced in this location. For these reasons a substantial tower was designed and the guying system developed to provide the strongest assembly possible.

Co-Axial Feed to the Array

The tower had to be located approximately 400 feet from the transmitter which raised the problem of successfully feeding the array. Consideration of the losses in various types of lines for the frequency and distance resulted in the choice of a co-axial line. This type of feeder presented a new problem, that of matching the low impedance of the line to the 550-ohm impedance existing at the midpoint of the antenna system. The easy solution of this question was to provide a quarter-wave matching transformer between the co-axial line and the relay box.

The calculation:

$$Zq = \sqrt{Z_r \times Z_l}$$
$$= \sqrt{550 \times 70}$$
$$= 196 \text{ ohms.}$$

Substituting in the formula

$$Z = 276 \log_{10} \frac{S}{r},$$

$$196 = 276 \log_{10} \frac{S}{.25}.$$

$$\log_{10} \frac{S}{.25} = .710,$$

$$\frac{S}{.25} = 5.13,$$

$$S = 1.28.$$

We found that such a transformer could be conveniently constructed of ½" copper tubing spaced 1.28".

Having the general layout thus established, the tower was constructed to a total height of 76 feet, including the 10-foot mast at the top, which placed the top of the vertical radiators almost exactly one wavelength above ground. The tower was of considerably heavier construction than the usual lattice masts, as we had already had the unpleasant experience of losing two such masts 100-feet high in one of the storms already mentioned. The corner posts were made of 2¾ inch square long-leaf yellow pine and all cross bracing was standard ⅞-inch spruce varying in with from 3½ to 2 inches. The base of the tower was 6'x 6' tapering to 2'x 2' at the top. The mast extends 10 feet above the tower top and was made from a 4"x 4" yellow pine timber.

Detailed description of the construction of the tower and antenna array will not be attempted as the electrical system was thoroughly discussed in the original article, and the matter of support is one which must be determined by the constructor in almost every case.

Improvements in Structural Design

Some points, however, will be commented on as likely to save trouble for anyone attempting to build such an array. On account of the high wind and ice stresses which had to be met, heavy materials were used throughout. The radiators and all guys were made of no. 8 Stubbs gauge phosphor bronze. The method of assembling the radiators and guys is shown by figures 2 and 3.

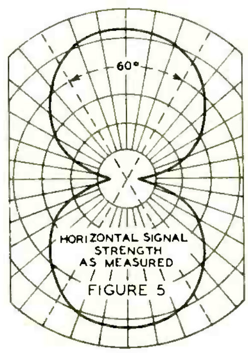
This method of guying has been very satisfactory and the assembly has easily withstood several severe storms with no distress. It was discovered early in assembly that for 20-meter dimensions the horizontal Q-bars were very flimsy and the additional inside guys were added to strengthen them. These guys are broken at the Q-bars by heavy hard rubber clamps which transmit the necessary tension and also serve as an additional spacing insulator.

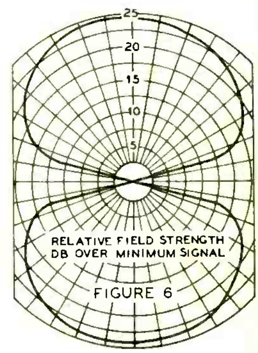
The first wind of any consequence resulted in breakage of the pyrex insulators used at the centers of the vertical radiators, with disastrous results to the Q-section. This condition was met by fabricating center insulators from two strain insulators wired together as shown in figure 4. All guys were well broken with strain insulators and no troubles with shock excitation and reradiation have been experienced.

The electrical setup was changed slightly to give minimum use of the relays. Since most of our working falls in the east-west direction, the connections were arranged to produce the proper phasing for a beam in this direction with both relays in the off position. Closing the operating switch for either of the relays produces a beam in one of the other two available directions. Closing both switches produces the non-directional condition which, incidentally, is never used at this station, due to the ease and facility of covering the entire circle. With this arrangement there is never more than one relay in use, and a great part of the time none at all.

Practical Results

The antenna was placed in service on August 2, 1937, and the results were amazing. Foreign contacts were made immediately in all directions, and in the intervening time numbers of contacts, well distributed over all continents except Asia, have been worked. Tests with numerous dx stations having signal strength meters have resulted almost uniformly in reports of from 2 to 2½ R's difference between "on the beam" and the least favorable position. Another characteristic of the array has been shown by the report frequently received, that at the time of contact, we are the only station being heard from this district. This would seem to indicate that the low angle radiation character-





istic expected from the design is actually being achieved.

The antenna is used with a changeover relay for reception and the results from this angle are equally pleasing. The meter of the RME 69 consistently shows a gain of from 8 to 12 db from the least to the most favorable position on received signals. The advantage of this discrimination has been very noticeable on dx contacts as many times it is possible to dig a phone signal out of c.w. or other QRM, making a QSO successful which would otherwise be impossible.

Field Strength Measurements

These excellent practical results were of sufficient interest to justify actual measurement of the radiation pattern and a sensitive field strength meter was constructed and the data obtained. The results are shown in figures 5 and 6 plotted as actual voltages and also as relative field strength in db's above minimum signal. These patterns show exactly what may be expected in performance and also the uniformity of coverage with three such patterns spaced 120° apart.

The construction of such an array is not easy, but the design permits installation of a rugged assembly in small space and in the face of severe topographical difficulties. And, once installed, it is not subject to the ills of mechanical rotation. At one station at least the array has produced the results in practice that most of us desire on the 20-meter band.

Just What Happens in a

By the following discussion, adapted from an article recently published in the "Proceedings" of the I. R. E.,[1] the author hopes to dispel some of the atmosphere of mystery which seems to surround the superregenerative circuit in the minds of many persons.

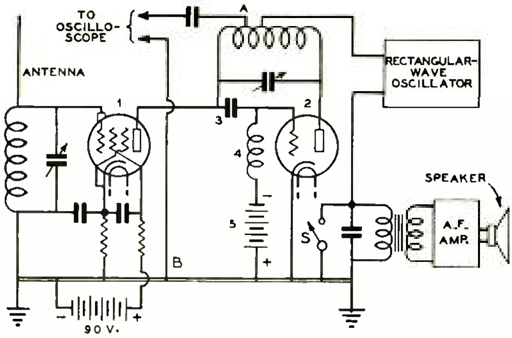


Figure 1. Receiver with fixed-bias detector and rectangular quench oscillator.

By FREDERICK W. FRINK*

Part I.

The superregenerative circuit is one of the most remarkable in the field of radio, not only because of the very high sensitivity obtainable with one, two, or three tubes, and the inherent noise-limiting and automatic volume control characteristics, but also because of the peculiar manner in which the amplification of the signal is obtained.

In a typical superregenerative receiver the regenerative coupling between the plate and grid circuits of the detector tube is great enough so that self-sustained oscillations are produced, and these oscillations are periodically quenched, by applying, between two elements of the tube, an alternating voltage having a frequency much lower than that of the oscillations. Subsequent to each quenching, the oscillations are started again by the received signal, if there is one, and build themselves up greatly by regeneration, at a rate which depends on the strength of the signal. If there is no signal, the ever-present circuit noises provide the impetus which starts the oscillations.

Operation of a Simple Superregenerative Receiver

In this discussion, the superregenerative receiver shown in figure 1 is used as the first example, because, although it is not a typical circuit, it has simpler operating characteristics than some of the more conventional circuits, and the experimental results are therefore easier to interpret. The receiver comprises a radio-frequency amplifier, 1, a fixed-bias superregenerative detector, 2, an audio-frequency amplifier connected to a loudspeaker, and a rectangular-wave oscillator which provides for the quenching action.

Plate voltage is applied to the detector and radio-frequency amplifier circuits intermittently by means of the rectangular-wave oscillator, at a frequency of 25 kilocycles. The wave form of the detector plate voltage produced by this oscillator is shown in the cathode-ray oscillogram, figure 2(a), which was taken with a linear sweep circuit operating at a frequency of 12.5 kilocycles. The detector plate voltage was 90 volts during each impulse, and zero between impulses.

To obtain figure 2(b), one of the vertical deflection plates of the oscilloscope was connected to the detector cathode and the other to a tap A on the detector tank circuit coil, so the oscillogram shows all of the 25-kilocycle voltage, together with a portion of the ultra-high-frequency voltage superimposed on the 25-kilocycle voltage. The receiver was tuned to a frequency of 60 megacycles per second, but no signal was being received when the oscillogram was taken, so the ultra-high-frequency oscillations were started by circuit noises alone. Switch S was kept closed to avoid distorting the wave shape of the 25-kilocycle voltage.

For figure 2(c) the conditions were the same as for 2(b), except that a strong unmodulated carrier wave having a frequency of 60 mega-

[1] "The Basic Principles of Superregenerative Reception," F. W. Frink, *Proc.* of I.R.E., January, 1938.

*17 Leighton Ave., Yonkers, New York.

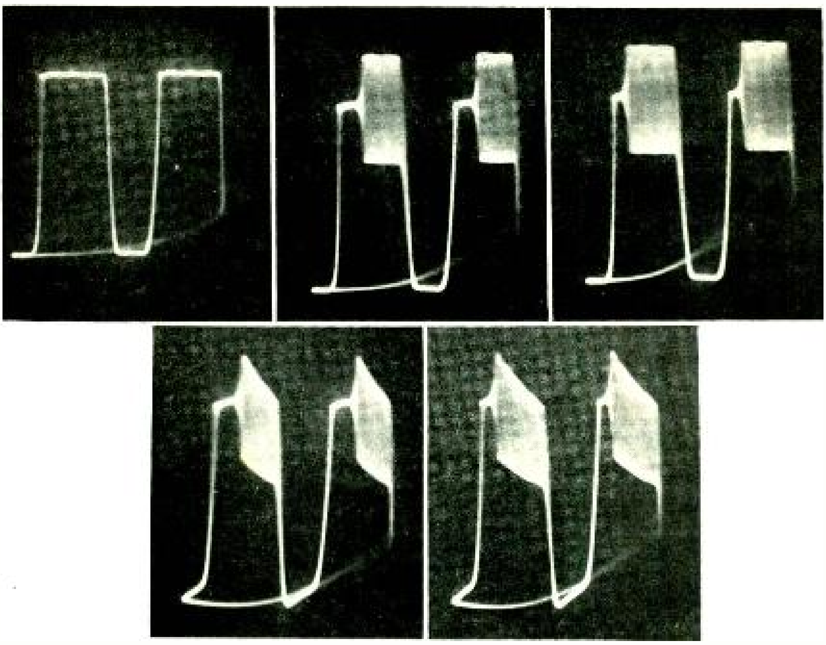


Figure 2. Top row, left to right: a—Rectangular-wave plate voltage. b—Voltage between points A and B of figure 1; switch S closed; no received signal. c—Same conditions as for the middle picture except that a signal (unmodulated carrier wave) is being received. Bottom row: d—Switch S is open; no received signal. e—Switch S open; signal is being received.

cycles was being received from a laboratory oscillator very loosely coupled to the receivers. A comparison of figures 2(b) and 2(c) shows that the ultra-high-frequency voltage built up to the same maximum amplitude in both cases and remained at this amplitude until quenching took place, but the maximum amplitude was reached earlier in the quench voltage cycle when the received carrier wave was present.

For figures 2(d) and 2(e) the conditions were the same as for 2(b) and 2(c), respectively, except that switch S was left open, thus introducing the audio-frequency transformer into the circuit. The only change in the operation was that the detector plate voltage dropped considerably after the ultra-high-frequency oscillations built up, because of the increase in detector plate current caused by the oscillations. Most of the voltage decrease took place gradually, because of the effect of the by-pass condenser across the audio-frequency transformer.

This receiver circuit and all other receiver circuits used in this investigation were tested by listening to speech signals from amateur stations before they were used for obtaining oscillograms, to make certain that the recorded performance represented the behavior of receivers in such conditions of adjustment that they could be used in actual speech communication.

The ability of the receiver in figure 1 to receive speech signals can be explained as follows: Because the detector is biased on the lower curved portion of the grid-plate characteristic, the ultra-high-frequency oscillations cause an increase in the average plate current. When a carrier wave is received, the average plate current increases further, because the ultra-high-frequency oscillations are at maximum amplitude during a greater portion of the quench-frequency cycle. If the amplitude of the carrier wave varies because of audio-frequency modulation, the duration of the maximum amplitude oscillations in the detector also varies, causing an audio-frequency variation in the detector plate current.

Ordinarily, superregenerative detectors em-

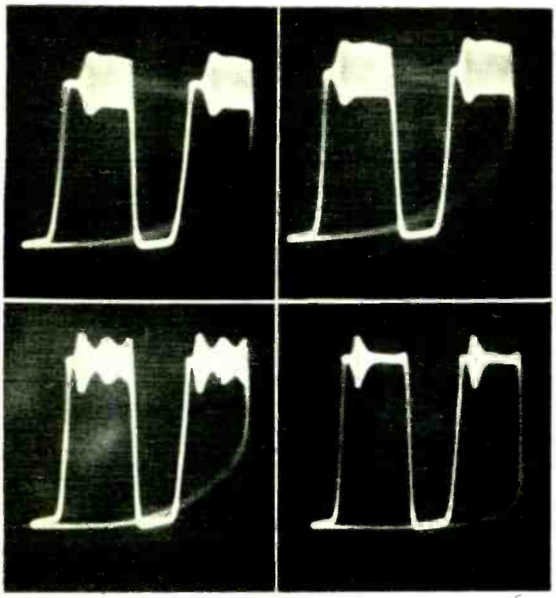


Figure 3. Top row: a—Operation with 25,000-ohm grid leak and no fixed bias; no signal. b—Same as preceding picture except that signal is being received. Bottom row: c—100,000-ohm grid leak; no signal. d—250,000-ohm grid leak, no signal.

ploy grid-leak bias, rather than fixed bias, and therefore function as grid-leak detectors; that is, the ultra-high-frequency voltage is rectified in the grid circuit of the tube, causing a voltage having an audio-frequency component, corresponding to the received speech, to be produced across the grid-leak resistance; and this audio-frequency voltage is amplified by the detector tube, producing an audio-frequency voltage across the detector plate circuit transformer. To obtain this type of operation, the circuits of figure 1 were modified by removing choke coil 4 and bias battery 5, and connecting a 25,000-ohm grid leak between the grid and the cathode of the detector tube, 2. The capacitance of the grid condenser, 3, was 50 micromicrofarads. Switch S was left open in taking the oscillograms.

Figures 3(a) and 3(b) represent, respectively, the operation with no received signal and the operation with a strong received carrier wave from the 60-megacycle laboratory oscillator. The ultra-high-frequency voltage built up to the same maximum amplitude in both cases, but reached that amplitude sooner when the received carrier wave was present. The maximum amplitude was considerably lower than in figures 2(b) and 2(c), because the negative bias voltage developed across the grid-leak resistor by the grid current flow reduced the output voltage of the tube. The quench frequency for figures 3(a) and 3(b) was 50 instead of the 25 kilocycles previously used, and the sweep frequency was 25 instead of 12.5 kilocycles. If the difference between the quench frequencies is kept in mind, a comparison of figure 3(a) with figure 2(b) shows that the ultra-high frequency voltage built up more rapidly in figure 3(a). This is due to the fact that the initial bias voltage was zero in the case of figure 3(a) and the tube was therefore biased on the steep portion of its static characteristic when the oscillations first started building up.

Another peculiarity of figures 3(a) and 3(b) is the fact that the ultra-high-frequency voltage first built up to a maximum and then dropped down slightly. This is because the charge in the grid condenser had to be increased, by the flow of grid current through the tube, before

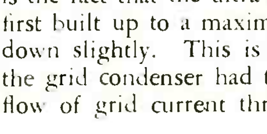


Figure 4. Logarithmic variation of detector plate current change with received signal.

any bias voltage could be developed. Since the grid resistance of the tube is appreciable, the grid condenser did not become fully charged until an appreciable time after the ultra-high-frequency voltage had built up to maximum. When the bias voltage finally caught up with

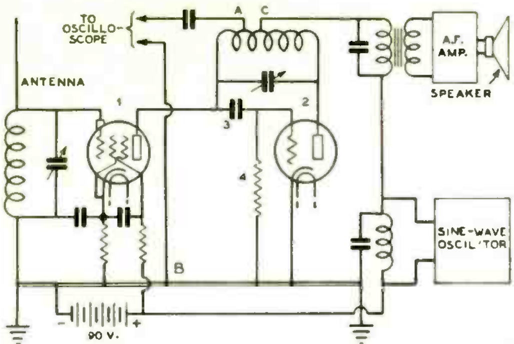


Figure 5. Receiver with sine-wave quench voltage inserted in plate circuit.

the ultra-high-frequency voltage, it caused the latter to drop down to a lower level.

"Partial Self-Quenching"

Figure 3(c) shows the "partial self-quenching" effect produced by increasing the grid-leak resistance to 100,000 ohms. The ultra-high-frequency voltage first outran the bias voltage and then started to drop, as in figure 3(a); but, because of the larger grid-leak resistance, the bias voltage was not able to decrease fast enough to stop the decay of the oscillations until the ultra-high-frequency voltage had fallen about 50 per cent. The oscillations then started building up again, and the cycle of operation was repeated. Figure 3(d), taken with a 250,000-ohm grid leak, shows a case in which the oscillations became completely quenched before the externally applied plate voltage started decreasing. Figures 3(c) and 3(d) are also of interest in connection with the study of self-quenching superregenerative detectors, which will be discussed more fully in the subsequent article. But the main reason for presenting them here is to show that the magnitude of the grid-leak resistance can have a large effect on the behavior of a superregenerative circuit, even when an externally applied quench voltage is used.

When grid-leak bias is used, the ultra-high-frequency voltage causes a decrease, rather than an increase, in the average detector plate current, and this decrease becomes greater when a carrier wave is received. In other respects the operation is similar to that of the fixed-bias detector previously discussed.

It has been shown that the change in detector plate current produced by the received signal is due to a more rapid building up of the ultra-high-frequency oscillations, rather than to an increase in the maximum amplitude reached by the oscillations. By means of a mathematical analysis,[1] which will not be given here, it can be shown that if the voltage of the received ultra-high-frequency wave increases from some amplitude A_1 to a greater amplitude A_2, the resulting increase in the detector plate current is not directly proportional to the ratio of A_2 to A_1, but is proportional to the logarithm

[1] loc. cit.

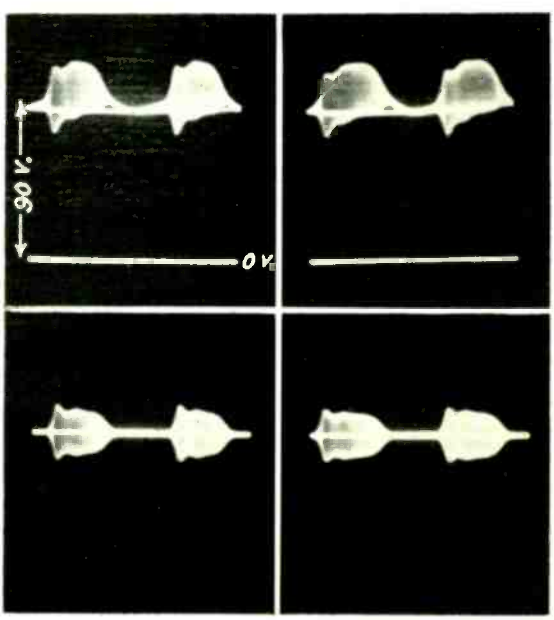


Figure 6. Top row: a—Voltage between points A and B of figure 5; no signal. b—Operation with signal. Bottom row: c—Voltage between A and C; no signal. d—Operation with signal.

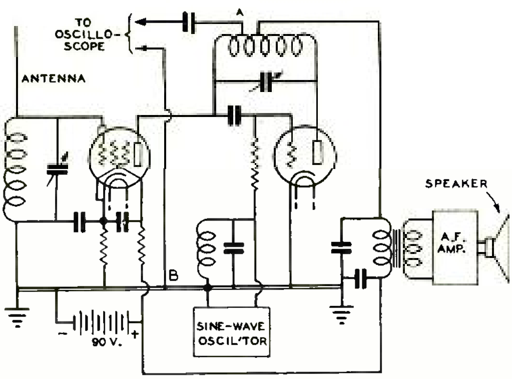


Figure 7. Receiver with quench voltage applied in grid circuit.

of that ratio; for that reason, the variation in detector current with respect to received signal voltage is as shown in figure 4. This type of variation is obtainable when a sine-wave quench voltage is used, also, and accounts for the inherent automatic volume control feature of the superregenerative receiver, for its disproportionately weak response to signals having a low percentage modulation, and for its ability to discriminate against noise impulses which are stronger than the signal.

Sine-Wave Quench

For studying the operation with a sine-wave quench voltage, the receiver shown in figure 5 was used. The quench voltage was inserted in series with the plate circuit, as this seemed to be the method most frequently used. Figures 6(a) and 6(b) show the operation with no received signal and with a received carrier wave, respectively. The oscilloscope was connected between points A and B, so that the oscillogram would show the sum of the direct voltage (90 volts), the 50-kilocycle sine-wave quench voltage, and part of the ultra-high-frequency voltage. A zero line was also recorded on the oscillogram, to represent the condition of zero plate voltage. The sweep frequency was 25 kilocycles. The horizontal line cutting across the ultra-high-frequency image was caused by the return of the cathode-ray beam. Figures 6(c) and 6(d) are for the same conditions, but the oscilloscope plates were connected between points A and C on the detector tank circuit coil, so that only the ultra-high-frequency voltage is shown.

A comparison of figure 6(c) (no signal) and 6(d) (with signal) shows that the only effect of the received carrier wave was an elongation of the ultra-high-frequency image, caused by the fact that the oscillations built up to maximum sooner when the carrier wave was being received. Figures 6(c) and 6(d) resemble the ultra-high-frequency portions of figures 3(a) and 3(b), except that the quenching action shown in figures 6(c) and 6(d) is less sudden, because a sine-wave voltage was used instead of a rectangular-wave voltage.

The distance from the image to the zero line in figures 6(a) and 6(b) indicates that the amplitude of the 50-kilocycle quench voltage was small compared with the direct voltage of the plate battery. The amplitude of the quench voltage had been adjusted so that when no signal was being received the "characteristic noise" of the receiver was clearly audible but not very loud. If the quench voltage was reduced much below that amplitude, the detector oscillated continuously and the characteristic noise disappeared entirely.

The reader may well question how it was possible to obtain quenching by means of a quench voltage having the small amplitude shown in figures 6(a) and 6(b). This is easily explained, however, if the constants of the circuit (figure 5) are considered. The grid condenser 3 had a capacitance of 50 micromicrofarads, which gives a reactance of 63,500 ohms at 50 kilocycles, and the resistance of the grid leak 4 was 100,000 ohms. From these figures it is clear that the 50-kilocycle voltage impressed across the grid leak must have been almost as great as the 50-kilocycle voltage between the plate and the cathode of the tube, and the quenching must have been due primarily to the 50-kilocycle voltage in the grid circuit.

Evidently, the introduction of the quench voltage in series with the plate circuit, although a frequently used procedure, was merely an indirect method of obtaining a sufficient voltage in the grid circuit for quenching purposes. The capacitance of the grid condenser and the resistance of the grid leak were no greater than the values ordinarily used in superregenerative detector circuits. It is probable that in most circuits of the type shown in figure 5 the quenching is due primarily to the quench voltage present between the grid and the cathode of the tube. The bias voltage developed across the grid leak by the rectification of the ultra-high-frequency current also assists in the quenching process, even though the resistance is not great enough to produce self-quenching.

Figure 7 shows a receiver in which the quench voltage was applied in series with the grid-leak resistor, which was reduced to 50,000

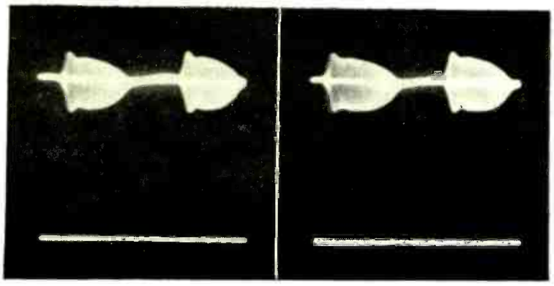


Figure 8. a—Voltage between A and B of figure 7. No signal: b—With signal.

ohms to facilitate the application of the quench voltage. The quench frequency was 50 kilocycles, and the amplitude of the quench voltage was adjusted so that the characteristic noise was distinctly audible but not very loud. The oscilloscope was connected as shown in the diagram. Figures 8(a) and 8(b) show the operation without, and with, a received carrier wave, respectively. The received carrier wave merely increased the effective duration of the ultra-high-frequency voltage without changing the maximum amplitude, and the ultra-high-frequency images are much the same as in figures 3(a) and 3(b), except that the quenching is not sudden.

This receiver gave good performance in receiving speech from distant stations, and the results did not disclose any reason why the quench voltage should not be introduced in this manner, instead of in series with the plate circuit as in figure 5. Introducing the quench voltage in the grid circuit has the advantage that it is not necessary to use an audio-frequency transformer having an electrostatic shield to keep the quench voltage out of the audio-frequency amplifier as is so frequently done when the quench voltage is applied in the plate circuit.

From the foregoing information it is evident that in a separately-quenched superregenerative detector the operation passes through three distinct periods during each cycle of the quench voltage, as follows:

1. *The build-up period,* during which the amplitude of the ultra-high-frequency oscillations rises to a saturation value due to the tube characteristics. During most of this period the operation of the tube is essentially class A.

2. *The class-C period,* during which the amplitude of the ultra-high-frequency oscillations is limited to a value depending on the plate voltage and the grid-bias voltage. During this period such variations as may occur in the amplitude of the ultra-high-frequency oscillations are due to variations in the plate and grid voltages, caused principally by the application of the quench voltage, and by the bias voltage built up by the grid condenser. These variations do not contribute to the sensitivity.

3. *The inactive period,* beginning as soon as the oscillations have dropped to a negligible amplitude, and lasting until the quench voltage reaches that phase of its cycle at which the oscillations are again able to start building up.

(To be continued in the April RADIO)

Oregon Amateur Radio Association Seventh Annual Convention

The Multnomah Radio Club has the honor to carry out the traditions of the Oregon Amateur Radio Association in presenting its seventh annual convention on April 23 and 24 in Portland, Oregon.

All west coast amateurs are invited to attend the affair which, it is promised, will be a really worthwhile meeting. Two full days of ham activities are planned: contests, interesting technical speakers, entertainment for the yl's, xyl's, ow's and om's, and a first class banquet.

Tickets and further information may be obtained by writing to Harold Sachs, W7BSJ, 3035 NW. Cornell Rd., Portland, Oregon.

Relay Coils

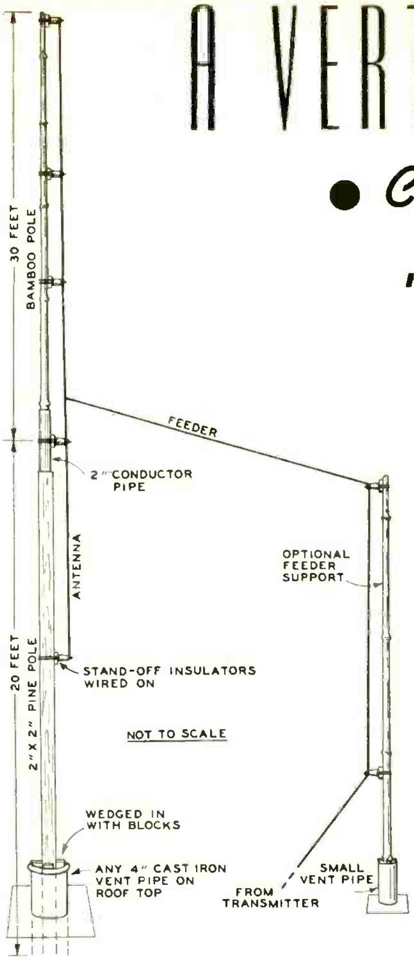
About this relay business—the potential coil from a watt-hour meter makes a very nice foundation for one when too heavy a pull isn't required. In addition, the Z/R ratio is such that the relay may be operated either by 110-volt 60-cycle a.c. or by a storage battery.

Thousands of old meters have been removed from service; these can quite often be purchased very reasonably and the potential coils removed from them. Or, if you can get an "in" with the meter repairman, often a coil assembly has the current coil burned out but the potential coil will be in perfect condition as far as relay manufacture is concerned.—W5EPW.

A VERTICAL ANTENNA

• Cost—$3.00 to $5.00

By **F. W. DONKIN,* W6MZD**



Many words, both enthusiastic and derogatory, have been spoken concerning the vertical antenna. Some say that they are worse than useless, and others maintain that they have always obtained their best results with a vertical radiator. It seems to be a matter of both opinion and location whether a vertical will operate satisfactorily or not.

But, be that as it may, a vertical will almost invariably give *different* results than a horizontally-polarized antenna. If a simple vertical could easily and inexpensively be installed, it would be a worthwhile adjunct to the regular beams or antennas in use at the station. When the results with the regular antenna are poor, try the vertical. More often than not the signal strength will be improved.

In other words, if the transmission conditions are not favorable to horizontal polarization, try a vertically-polarized radiator; the chances are at least even up that transmission will be improved. And, incidentally, when the band has "folded up" for dx work, a vertical radiator will give a very much stronger local signal for across-town QSO's than a horizontally-polarized array.

All these points indicate that it might be a worthwhile addition to the station equipment to install a simple vertical as an auxiliary antenna. And the one to be described is simple to install and is certainly inexpensive.

To enumerate materials required for a typical one:

1—30-foot bamboo pole.
1—2x2" pine pole, 20' long.
1—2½" piece of 2" gal. iron pipe.
5—small-size porcelain stand-off insulators.
75 ft. no. 14 enam. copper wire.

Total cost..$3.00 to $5.00

The pole itself is 50 feet long, and if mounted upon the top of a 15 or 20 foot house, the top will really be up in the air. It is so easy to install that one man can easily put it up within an hour after the materials are obtained. Also, it can easily be moved from one location to another.

The sky-wire itself may be either for 10, 20, or 40; the one in use at the author's station is a half-wave on 20 meters, single-wire fed. Any other method of feed could, of course, be used, but single-wire feed was used in this case because of its inexpensiveness and simplicity.

Installation

As the diagram shows, the bottom end of the 20-foot section of 2x2 is placed in one of the vent pipes that are found on almost every roof. The vent should not be completely closed; it will be possible, without too much effort, to hold the pole in place by means of wooden wedges and still not to close completely the opening in the top of the pipe.

The pole need not be guyed; the manner in which bamboo grows makes it naturally able

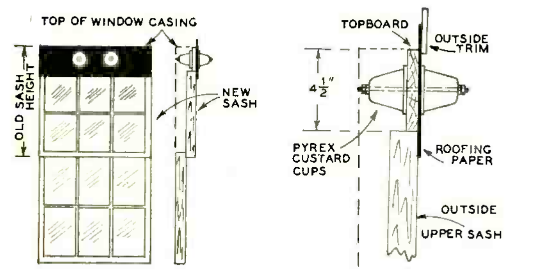
[*Continued on Page 76*]

*1409 Coldwell Avenue, Modesto, Calif

Solving

THE LEAD-IN PROBLEM

By LAURENCE F. TICEHURST,* W1CAV



As aptly expressed in the January RADIO by "Why Hams Leave Home," the method of bringing the lead-in into the house is quite a problem to the majority of amateurs. In the past seventeen years of operation at W1CAV, a large number of methods of bringing in the lead-in have been tried. The one in use at present has proven so satisfactory that the humanitarian instincts of the author have prompted him to pass it along. Who knows, some poor ham may be saved his happy home by this presentation.

For many years, a stock method of bringing in the feeders has been to lower the upper sash of one of the windows and then to place a board above the sash with the bowls in it. This, as we all know, is rather makeshift and highly unsatisfactory from a number of standpoints. Especially so is this true during the winter months. But, a simple variation upon this time-honored procedure makes a completely satisfactory and inexpensive installation.

The chief expense of this method is a new sash. This new, shorter sash is used to replace (as long as this lead-in position is used) the longer original sash. In my particular case I obtained one, made to order, for only $3.00.

The window board that is placed above the new sash and which carries the lead-in insulators can be any convenient thickness but should be about 4½" to 5" long. The insulators themselves can be custard bowls, drilled to carry ¼" brass rod, or of the manufactured variety. It is only necessary that the board be wide enough to provide ample clearance for them. The height dimension of the new sash will be the height of the old sash minus the height of the sash board that will be placed above it.

*8 Columbia Ave., Newton Upper Falls, Mass.

Installation

The installation itself is explained in the accompanying diagrams. However, a few tips may be of some help. The new board should be faced with heavy roofing paper on the outside surface. The paper should be allowed to project down about an inch below the bottom of the board so that it overlaps the top of the top sash frame. This will assist in making the installation weatherproof.

The whole lead-in board was assembled, pieces of flashing strip applied around its edge, and the unit fastened to the top of the window casing with a number of wood screws. That is all there is to the installation procedure.

There are a number of advantages to a window lead-in installation of this type. First, it is completely weatherproof; there are no gaps between windows, or above and below the window board. Second, both windows may be raised and lowered as usual; they can even be latched in the original manner. And third, in case the QTH should be changed, it is an easy job to remove the window board and the new sash and replace the original top window.

Of course, as to all intents and purposes, the new lead-in board is a separate unit from the window, there is no difficulty in the operation of the curtains and screens. The curtain rod is merely lowered to a point below the feeders and fastened, and the screen is shortened to fit the new total height of the window. Then, too, when the new installation is to be made, there is even a possibility that the window board and the sash will fit in one of the windows of the new location.

paper
C_5—25 µfd. 25-volt electrolytic
C_6—4 µfd. 450-volt electrolytic
C_7—8 µfd. 450-volt electrolytic
C_8—25 µfd. 25-volt electrolytic

ohms, ½-watt
R_5—2000-ohm, 10-watt adjustable resistor
R_6—10,000 ohms, 3 watts
R_7, R_8—Dual 500,000-ohm tone control
R_9—2000-ohm, 10-watt adjustable resistor
R_{10}—10,000 ohms, 3 watts

TR_3, TR_4—P.p. interstage transformer
TR_5—Output to line and voice coil transformer
TR_6—Power transformer: 5 volts, 3 amp.; 6.3 volts, 3.5 a.; 400 volts, 150 ma.

J_2, J_3, J_4—Plate-current monitoring jacks
P_1—Line-input plug
P_2—Bridging input plug
SW_1—Line or bridging input switch
SW_2—Output circuit switch

ing that one of the 6C5 stages might very well be eliminated. Constructional costs would be lowered, general design simplified, gain dropped down to about 85 db, and hum and noise effects and the problem of their elimination minimized. As the amplifier stands, it is distinctly a high-gain affair in spite of the use of the low-µ first and second stage 6C5's.

Though the layout is such as to place most of the transformer components in neutral positions (the input transformers alone are not ideally located and might stand either complete electromagnetic shielding or removal from the chassis altogether), and though the components TR_3 and TR_4 are balanced affairs, so designed that any hum or other audio frequency fields induce opposite and cancelling voltages in the windings, the high gain is sufficient to amplify any tube or other noises with a vengeance.

TR_5 provides for various line and voice coil outputs. A d.p.d.t. switch in the 6B5 plate circuits permits a possible changeover to a modulation output transformer if desired. TR_2 is simply a standard multi-line-to-grids transformer, and T_1 is the bridging input. S_1 is a second changeover switch allowing the selection of either input.

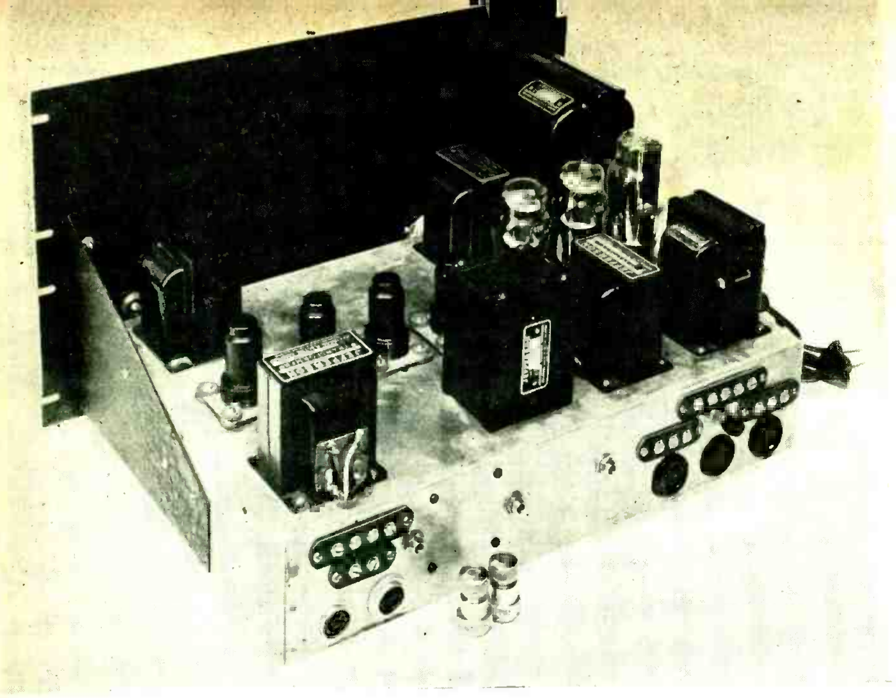
J_1 is a headphone jack so wired into the circuit that with a headset inserted the input transformer connections to the V_1-V_2 grids are broken. This jack affords a means of audibly monitoring the line. The jacks J_2, J_3, and J_4

and highs slightly to maintain or assure the flat curve which the amplifier, without input transformer, provides. But in amateur transmission work both feedback and filter control might be used to some advantage, in view of the facts that 90% of voice intelligibility lies in the voice frequency range between 250 and 4000 cycles. There is actually a power increase if cutoff conditions exist at these points or when the amplifier is so designed as to create a rising frequency response curvature between these limits. One can almost double a.f. power in amateur communications work by eliminating the low frequencies which do not contribute to

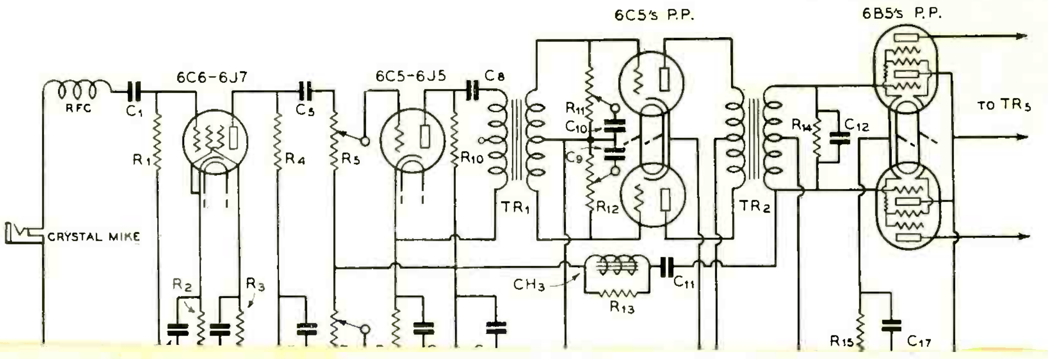
end impedance, neglecting radiation, is obtained when the inside diameter of the outer tube of the line is 9.18 times the outside diameter of the inner conductor. This ratio may be too large when radiation is present.[4] The existence of an optimum *length* for transmission

[*Continued on Page 86*]

[1]"High Frequency Receivers—Improving Their Performance," RADIO, January, 1938.
[2]Bernard Salzberg, "On The Optimum Length For Transmission Lines Used As Circuit Elements," *Proc. I.R.E.*, December, 1937.
[3]F. E. Terman, "Resonant Lines in Radio Circuits," *Elec. Eng.*, July, 1934.



A General Service



WHICH TUNING CONDENSER?

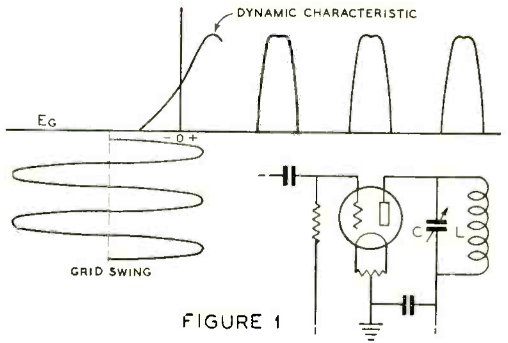


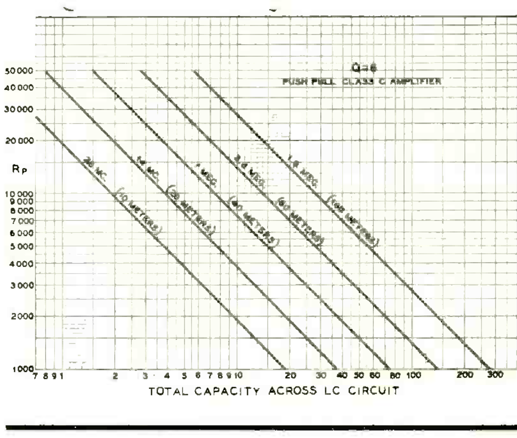
FIGURE 1

CLASS C AMPLIFIER PLATE CURRENT WAVEFORM

The subject of tuning capacity values for class-C amplifiers is important for anyone building a radio transmitter. The best value of capacity can be determined closely by charts or formulas for any frequency of operation. The ratio of C to L, capacitance to inductance, depends upon the operating plate voltage and current, and upon the type of circuit. Proper choice of capacity to inductance ratio for resonance at any given frequency is important in obtaining low harmonic output and also low distortion in the case of a modulated class-C amplifier.

A class-C amplifier produces a very distorted plate current wave form in the form of pulses as shown in figure 1. The LC circuit is tuned to resonance and its purpose is to smooth out these pulses into a sine wave of radio frequency output, since any wave form distortion of the carrier frequency is illegal, causing harmonic interference in higher frequency channels. A class-A radio frequency amplifier would produce a sine wave output. However, the a.c. plate current would be flowing during the full 360° of each r.f. cycle, resulting in excessive plate loss in the tube for any reasonable value of output. The class-C amplifier has a.c. plate current flowing during only a fraction of each cycle, allowing the plate to cool off during the remainder of each cycle. If the plate current is zero for 2/3 of each cycle, the *angle of plate current flow* is said to be 120°, since current is flowing during 1/3 of 360°. The tube in a class-C amplifier could have several times as much power input for a given plate loss as when used in a class-A amplifier.

The tuned circuit must have a good "fly-wheel" effect in order to furnish a sine-wave output to the antenna when it is receiving energy in the form of very distorted pulses such as shown in figure 1. The LC circuit fills in power over the complete r.f. cycle, providing the LC ratio is correct. The "fly-wheel" effect is generally defined as the ratio of radio frequency volt-amperes to actual power output ratio, or VA/W. This is equivalent to Q and should not be much less than 4π, or 12.5, for a class-C amplifier. At this value of VA/W or Q, one-

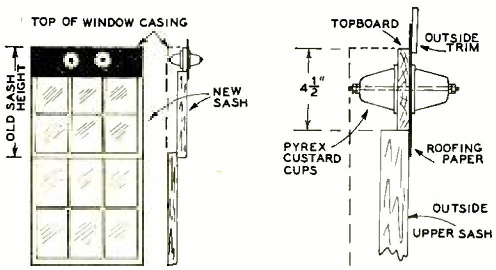


half of the stored energy in the LC circuit is absorbed by the antenna. If a lower value of Q is used, the storage power is insufficient to produce a sine (undistorted) wave output to the antenna and power will be wasted in radiation of harmonics.

Too high a value of VA/W or Q will result in excessive circulating r.f. current loss in the LC circuit and lowered output to the antenna. In high fidelity radiophone transmitters, too high a Q will cause attenuation of the higher side band frequencies and consequent loss of the higher audio frequencies. Too low a Q has its disadvantages also; so most transmitters are operated with LC circuit values of between 10 and 25. A value of 20 seems to be high enough for modulated class-C amplifiers; about 10 to 12 is enough for c.w. transmitters. With values of Q less than about 10, the maximum r.f. output will not occur at the point of mini-

Solving
THE LEAD-IN PROBLEM

By **LAURENCE F. TICEHURST,* W1CAV**



As aptly expressed in the January RADIO by "Why Hams Leave Home," the method of bringing the lead-in into the house is quite a problem to the majority of amateurs. In the past seventeen years of operation at W1CAV, a large number of methods of bringing in the lead-in have been tried. The one in use at present has proven so satisfactory that the humanitarian instincts of the author have prompted him to pass it along. Who knows, some poor ham may be saved his happy home by this presentation.

For many years, a stock method of bringing in the feeders has been to lower the upper sash of one of the windows and then to place a board above the sash with the bowls in it. This, as we all know, is rather makeshift and highly unsatisfactory from a number of standpoints. Especially so is this true during the winter months. But, a simple variation upon this time-honored procedure makes a completely satisfactory and inexpensive installation.

The chief expense of this method is a new sash. This new, shorter sash is used to replace (as long as this lead-in position is used) the longer original sash. In my particular case I obtained one, made to order, for only $3.00.

The window board that is placed above the new sash and which carries the lead-in insulators can be any convenient thickness but should be about 4½" to 5" long. The insulators themselves can be custard bowls, drilled to carry ¼" brass rod, or of the manufactured variety. It is only necessary that the board be wide enough to provide ample clearance for them. The height dimension of the new sash will be the height of the old sash minus the height of the sash board that will be placed above it.

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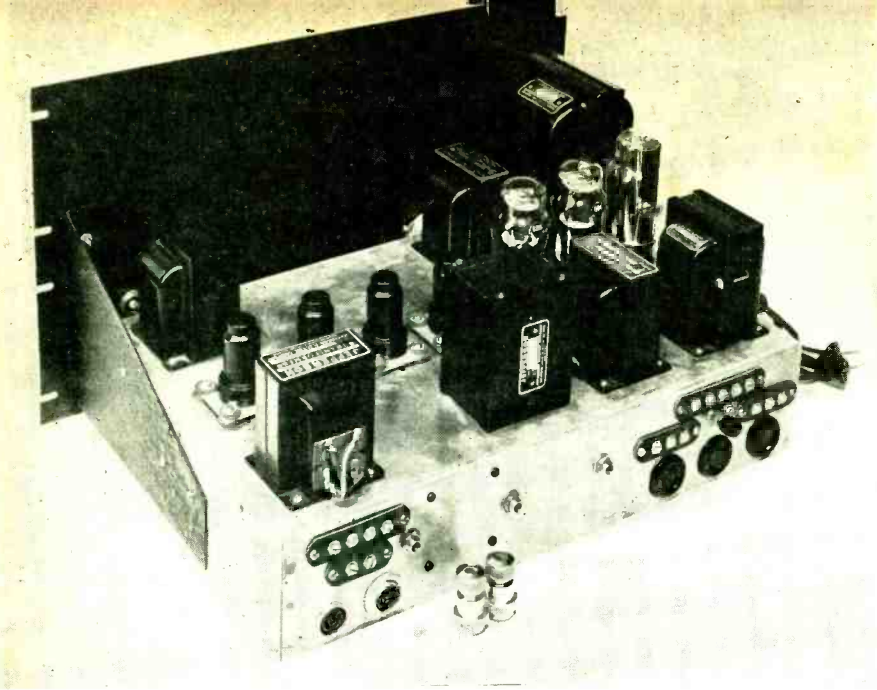
Installation

The installation itself is explained in the accompanying diagrams. However, a few tips may be of some help. The new board should be faced with heavy roofing paper on the outside surface. The paper should be allowed to project down about an inch below the bottom of the board so that it overlaps the top of the top sash frame. This will assist in making the installation weatherproof.

The whole lead-in board was assembled, pieces of flashing strip applied around its edge, and the unit fastened to the top of the window casing with a number of wood screws. That is all there is to the installation procedure.

There are a number of advantages to a window lead-in installation of this type. First, it is completely weatherproof; there are no gaps between windows, or above and below the window board. Second, both windows may be raised and lowered as usual; they can even be latched in the original manner. And third, in case the QTH should be changed, it is an easy job to remove the window board and the new sash and replace the original top window.

Of course, as to all intents and purposes, the new lead-in board is a separate unit from the window, there is no difficulty in the operation of the curtains and screens. The curtain rod is merely lowered to a point below the feeders and fastened, and the screen is shortened to fit the new total height of the window. Then, too, when the new installation is to be made, there is even a possibility that the window board and the sash will fit in one of the windows of the new location.



A General Service

BRIDGING AND SPEECH AMPLIFIER

By **RAYMOND P. ADAMS***

A bridging amplifier, by general definition, is simply an audio frequency channel equipped with a special input transformer. The transformer bridges a 500-ohm or lower-impedance low-level line and, when looking into the grid or grids of the first audio stage, draws a minimum of power from that line. The gain and output of the amplifier are of course determined by the level and the service and application desired.

There are a great many uses for this type of instrument: audible monitoring, simultaneous transmission and recording, program distribution from a common bus, local pickup, repeater service, simultaneous recording and P.A. work, transcription duplication, and, in strictly amateur application, the modulation of two transmitters from one microphone and low-level amplifier or the simultaneous reception and recording of special transmissions, fades, complete QSO's, or general receiver performance under varying and various operating conditions.

The input or bridging transformer required for any such assembly should and generally does look into low-μ triodes, high-μ triodes or pentodes equally well, should effect very little bridging attenuation, and should have a flat response curve and a characteristic such that with a volume control connected across its secondary, the bridging impedance will remain constant regardless of the level setting for the potentiometer.

Electrical Design

The author's new bridging job employs three push-pull, transformer-coupled stages: a 6B5 output stage which may be driven to 20 watts, a 6C5 triode intermediate stage, and a 6C5 triode first stage. Maximum output is 35.2 db and overall gain roughly 135 db. The use of the three stages is merely the result of personal preferences in application. It goes without say-

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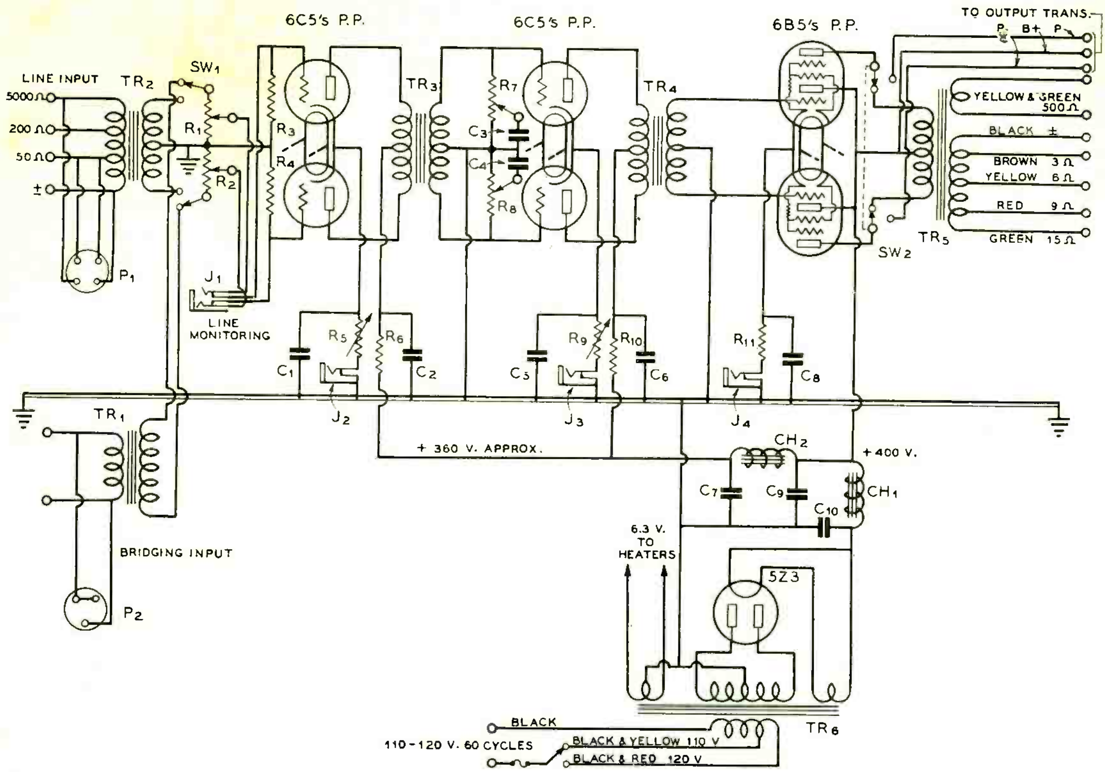


FIGURE 1.

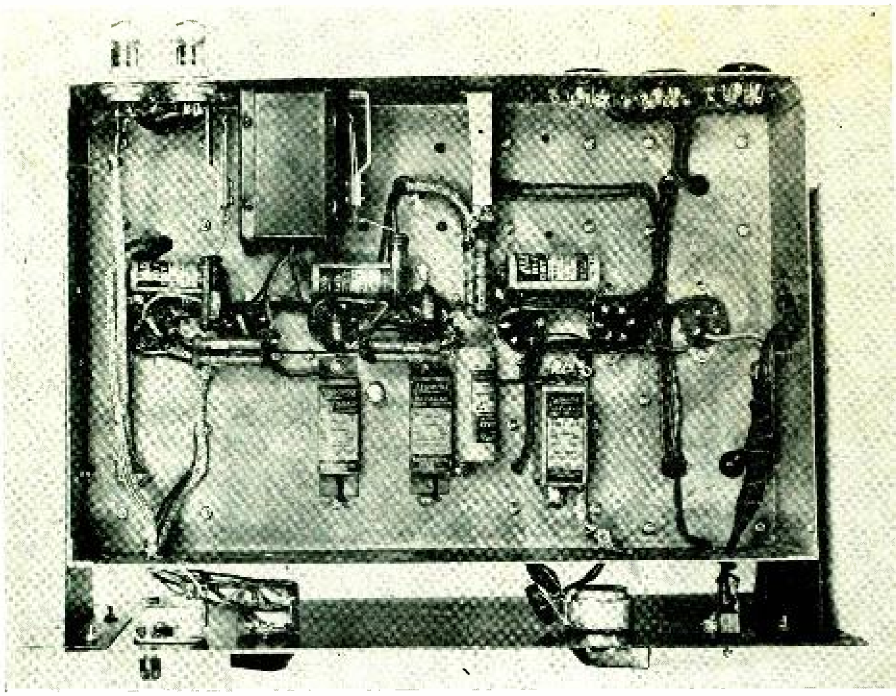
C_1—25 μfd. 25-volt electrolytic
C_2—4 μfd. 450-volt electrolytic
C_3, C_4—Optional. .002 μfd. paper
C_5—25 μfd. 25-volt electrolytic
C_6—4 μfd. 450-volt electrolytic
C_7—8 μfd. 450-volt electrolytic
C_8—25 μfd. 25-volt electrolytic
C_9, C_{10}—8 μfd. 450-volt electrolytic
R_1, R_2—Dual 100,000-ohm potentiometer
R_3, R_4—Optional. 2 megohms, ½-watt
R_5—2000-ohm, 10-watt adjustable resistor
R_6—10,000 ohms, 3 watts
R_7, R_8—Dual 500,000-ohm tone control
R_9—2000-ohm, 10-watt adjustable resistor
R_{10}—10,000 ohms, 3 watts
R_{11}—140 ohms, 3 watts
TR_1—Bridging input transformer
TR_2—Line-to-p.p.-grids transformer
TR_3, TR_4—P.p. interstage transformer
TR_5—Output to line and voice coil transformer
TR_6—Power transformer: 5 volts, 3 amp.; 6.3 volts, 3.5 a.; 400 volts, 150 ma.
CH_1—6 hy., 120-ma. filter choke
CH_2—60 hy., 1400-ohm filter choke
J_1—Line monitoring jack
J_2, J_3, J_4—Plate-current monitoring jacks
P_1—Line-input plug
P_2—Bridging input plug
SW_1—Line or bridging input switch
SW_2—Output circuit switch

ing that one of the 6C5 stages might very well be eliminated. Constructional costs would be lowered, general design simplified, gain dropped down to about 85 db, and hum and noise effects and the problem of their elimination minimized. As the amplifier stands, it is distinctly a high-gain affair in spite of the use of the low-μ first and second stage 6C5's.

Though the layout is such as to place most of the transformer components in neutral positions (the input transformers alone are not ideally located and might stand either complete electromagnetic shielding or removal from the chassis altogether), and though the components TR_3 and TR_4 are balanced affairs, so designed that any hum or other audio frequency fields induce opposite and cancelling voltages in the windings, the high gain is sufficient to amplify any tube or other noises with a vengeance.

TR_5 provides for various line and voice coil outputs. A d.p.d.t. switch in the 6B5 plate circuits permits a possible changeover to a modulation output transformer if desired. TR_2 is simply a standard multi-line-to-grids transformer, and T_1 is the bridging input. S_1 is a second changeover switch allowing the selection of either input.

J_1 is a headphone jack so wired into the circuit that with a headset inserted the input transformer connections to the V_1-V_2 grids are broken. This jack affords a means of audibly monitoring the line. The jacks J_2, J_3, and J_4



Below chassis there is a maximum of space and a minimum of wiring.

are simply closed-circuit jobs in the various cathode circuits to provide for milliammeter plug-in and the reading of plate currents.

R_7 and R_8 comprise a dual-section .5-meg. potentiometer which primarily acts as a tone control, by-passing high frequencies to ground to level out the overall characteristic. This control, by the way, might very well be moved to the V_5-V_6 grid circuits and of course should be where and if one of the 6C5 stages is eliminated.

With the specified power transformer, chokes, and R_5-R_9 resistors, proper operating voltages are obtained at all points. The 6B5's—note—are operated at a plate potential of 400 volts, with the grid bias for the output sections –13.5. Using a 1400-ohm choke at point CH_2, and with the four 6C5's drawing proper plate power, the measured voltage at C_7 is 360. If and when one of the 6C5 stages is eliminated, CH_2 might well be replaced by a 5,000-ohm filter component of high (approx. 250 hy.) inductance, as the carrying capacity of such a choke is generally well in excess of the total plate drain for two 6C5's in push-pull.

Volume Control

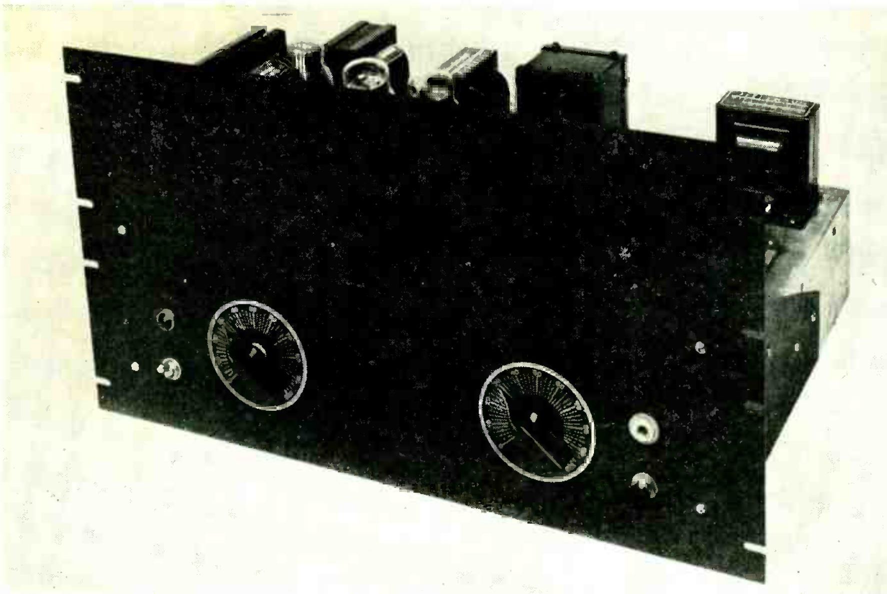
We have placed the volume level control in the grid circuit of the first stage. The control is another dual potentiometer of 100,000 ohms maximum resistance per section. With the control in this position, larger variations in input level can be compensated for without danger of overloading the first stage.

A word here about the bridging input transformer. This unit is a Jefferson Electric job, built more or less to our specifications, and one which we hope is now or will shortly be made available to the general trade.

Amplifier Layout

The tone and volume controls are mounted on the front panel, which is of standard relay-rack size and which supports the chassis by means of sturdy brackets. The bridge-line switch, a.c.-line switch, pilot light indicator, and input monitoring jack are likewise positioned on this panel, though these and the potentiometer components might be extended through from the front chassis drop.

On the rear wall of the chassis are positioned the two small receptacles for line and bridge input, with their associated terminal strips, the three jacks for plate drain measurements, the 4, 5, and 6 prong receptacles for line, voice



The tone and volume controls are mounted on the front panel, which is of standard relay-rack size.

coil, and external modulation transformer output, and the binding post assemblies associated with these last three items.

Below chassis there is a maximum of space and a minimum of wiring. Nine resistors (cathode and plate filtering resistors in our job may be considered as individual items, though they are actually paralleled groups of 1-watt carbons designed to provide proper value with 3 watt capacity), seven electrolytics, and the balanced transformer TR_3 are placed below deck. As the leads between front-panel components and the input receptacles run across the full chassis width, all are shielded as well as possible to prevent r.f. and hum pickup. This shielding does, to some extent, attenuate high frequencies. But the effect is not very noticeable and very possibly levels off the overall characteristic somewhat. However, this suggests that it would probably have been a more sensible move to have located the line-plug receptacles on the front panel, any associated terminal strips on the left hand support bracket, and both input transformers in such position on the chassis that very short unshielded leads might have been made between these coupling items and the changeover switch, receptacles, volume-level control, and first-stage sockets.

With the amplifier running wide open, it is possible to expect humless operation, using the three stages and the single-assembly power supply and amplifier set-up. Noise effects can be isolated to those caused by random voltages generated by the tubes. But with either input transformer switched into the circuit, a very bothersome hum appears once the gain control is opened to any appreciable extent. Though this hum is markedly attenuated once the transformer is bridged across or connected to the incoming line, it is present under any operating condition at some point of volume level. Frankly, any hum can be said to have its origin in the input transformer, and, as we have advised before, it might have been wise policy either to have removed the input components altogether from the chassis, or to have shielded them completely. Or the job might have been separated into two units, one of power supply components and one housing the amplifier.

The tubes line up along the center of the chassis, the four 6C5's mounted in the new Amphenol 11-A floating socket assemblies to reduce microphonic noises.

The input filter choke is near the power transformer, and the second choke (50 hy., 1400 ohms) between the output transformer and TR_4 at the rear of the chassis. These various components are very practically located, all things considered.

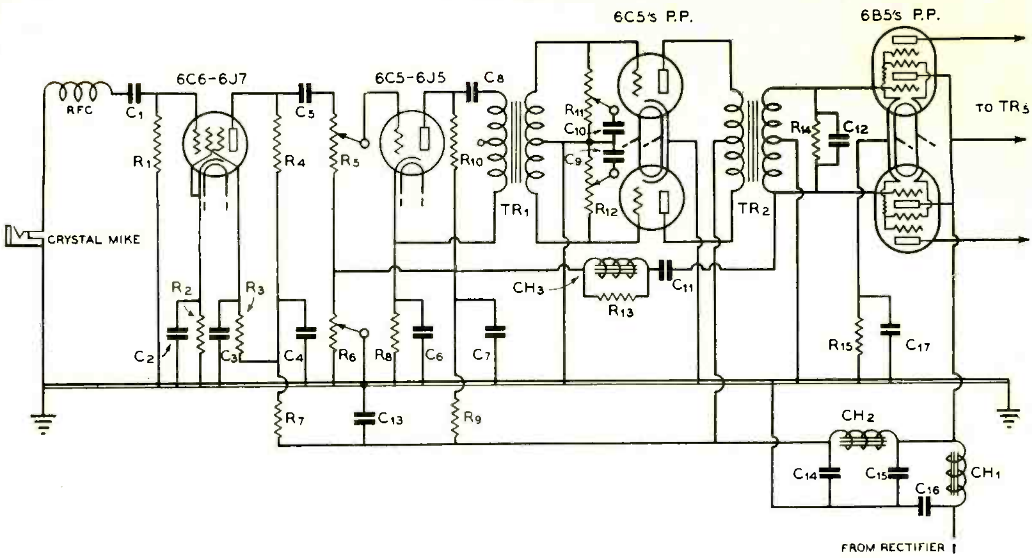


FIGURE 2. ALTERNATIVE HIGH-IMPEDANCE INPUT

C_1—0.1 µfd. 400-volt tubular
C_2—10 µfd. 25-volt electrolytic
C_3—0.5 µfd. 400-volt tubular
C_4—4 µfd. 450-volt electrolytic
C_5—.05 µfd. 400-volt tubular
C_6—10 µfd. 25-volt electrolytic
C_7—4 µfd. 450-volt electrolytic
C_8—.25 µfd. 400-volt tubular
C_9, C_{10}—Optional; .002 µfd. paper

C_{11}—0.1 µfd. 400-volt tubular
C_{12}—.01 µfd. 400-volt tubular
C_{13}—8 µfd. 450-volt electrolytic
C_{14}—.002 µfd. mica by-pass
C_{15}—8 µfd. 450-volt electrolytic
C_{16}—8 or 16 µfd. 450-volt elect.
C_{17}—25 µfd. 25-volt electrolytic
R_1—5 megohms, ½-watt
R_2—3000 ohms, 1 watt
R_3—1 megohm, ½-watt

R_4—250,000 ohms, 1 watt
R_5—250,000-ohm potentiometer
R_6—100,000-ohm potentiometer
R_7—50,000 ohms, 1 watt
R_8—2500 ohms, 1 watt
R_9—10,000 ohms, 1 watt
R_{10}—50,000 ohms, 1 watt
R_{11}, R_{12}—Optional tone control; dual 100,000-ohm potentiometer
R_{13}—250,000 ohms, ½-watt
R_{14}—25,000 ohms, ½-watt
R_{15}—140 ohms, 10 watts

RFC—2.5 mh., 125-ma. r.f. choke
TR_1—P.p. input or interstage trans.
TR_2—P.p. interstage transformer
CH_1—6 hy. 120-ma. filter choke
CH_2—60 hy. 1400-ohm filter choke
CH_3—250-hy. audio choke

Note—A switch should be placed between CH_3 and the resistor R_{13} to allow low-frequency cancellation or optional flat response.

Some Possible Changes

The use of triodes in the V_1-V_2 position may not appeal to some builders. The 6C5's or substituted 6J5's are self-shielded, of course, but a screen-grid tube is sometimes quite desirable in an input stage, not only for the increased gain which it affords, but for its better isolation. As it makes no difference whether the input transformers look into triode or pentode grids, there is no reason on earth why we could not employ 6J7's—or shielded 6C6's (which are less microphonic)—though any such change would of course require the elimination of TR_3 and the substitution of a suitable push-pull resistance coupling network. Screens, in such a case, should be by-passed with larger capacitors, and screen and plate circuits should be decoupled in the recommended manner for resistor-coupled high-gain pentode layouts.

A modulation transformer might be substituted for the standard TR_5 output component. 6B5's, under normal conditions of operation, (plate voltage, 300 and control grid voltage, 0) require a plate load of 7,000 ohms for the single tube. But under the operation of conditions used herein where the plate voltage is 400 and the bias −13.5, the output transformer must be designed for 10,000 ohms plate to plate. A modulation transformer, therefore, should be rated for service with such tubes as the 53, 6A6, 6N7, or RK34.

20 watts of a.f., of course, will 100% modulate 40 watts input with sine-wave audio, considerably greater input with voice. But at this output the amplifier is operating at maximum capacity. Better all-around results will be obtained with the amplifier operating at reduced output, say 80% of capacity.

The Amplifier as a Strictly Speech Unit

The one and only thing that makes this assembly a bridging amplifier is the input component TR_1. TR_2 simply increases the applications value of the instrument. The rest of the layout is perfectly conventional, a.f. channel design.

By eliminating TR_1, and TR_2 while we're at it, and by substituting pentodes for the triodes in the first stage and a coupling network for TR_3, we will have—without making any changes in either the rest of the circuit or the rest of the physical layout—a very practical speech amplifier or speech amplifier-modulator which, because of its extremely high gain, will do an excellent job with push-pull crystal mike input. But as push-pull mikes are few and far between, it would seem quite in order to re-design the input stage to some extent so as to make it more adaptable to general speech service, if, of course, we are not interested in the amplifier's use for bridging purposes.

TR_3, in this instance, might well be retained (figure 2). But this transformer might equally well work out of a single triode, with the d.c. balanced out, and with the triode resistor-coupled back to a high gain pentode. CH_2, in this case, might be replaced by a 5,000-ohm 200 or 250 henry choke. The rest of the layout could very well go as it stands, both as to physical position and values of components.

Whether or not some sort of feedback or filter control to provide for variable or fixed cutoff would be required, remains a matter of application and personal preference. We have nothing in the way of regulation to worry about, and with the components specified and with the figure 2 circuit wired exactly as shown, the overall frequency characteristic becomes by all means satisfactory, the curve being flat within 1 db from 40 to 10,000 cycles. For wide-range amplification anything like inverse feedback in this particular layout would hardly be worth while unless a transformer were used in the input circuit. In this case some feedback equalization in the first stage might raise the lows and highs slightly to maintain or assure the flat curve which the amplifier, without input transformer, provides. But in amateur transmission work both feedback and filter control might be used to some advantage, in view of the facts that 90% of voice intelligibility lies in the voice frequency range between 250 and 4000 cycles. There is actually a power increase if cutoff conditions exist at these points or when the amplifier is so designed as to create a rising frequency response curvature between these limits. One can almost double a.f. power in amateur communications work by eliminating the low frequencies which do not contribute to crisp intelligibility. Here some sort of control seems well worth while, and preferably a variable one so that both high and low frequencies may be attenuated to any desired degree.

In our laboratory job, wired up experimentally as the figure 2 circuit drawing indicates, we have applied frequency control with marked success. Various means of effecting cutoff are used without going to the expense and trouble of devising complicated filter systems. High-frequency cutoff, we found, was provided most simply and effectively—and at the same time to a variable degree—by the so-called tone control (R_{11}-R_{12}, C_9-C_{10}), which of course merely by-passes higher frequencies to ground. Low-frequency attenuation was obtained through the application of negative feedback, a choke being used in series with the feedback resistor to cause the feedback ratio to increase with decreasing frequency. Control is effected by manually decreasing or increasing the value of the resistor.

Construction and Wiring

As our photographs and discussion on parts placement are sufficiently illustrative of the general construction, and as the wiring is straightforward and the circuit strictly conventional, there should be no need for closing remarks designed to facilitate duplication of the laboratory model.

●

RESONANT LINES AS CIRCUIT ELEMENTS

In RADIO for January, Reber and Conklin[1] discussed the use of quarter-wave concentric lines as interstage couplers in efficient u.h.f. receivers. New information has been published[2] on the subject of the optimum *length* of such lines for maximum sending-end impedance.

It has been said[3] that the highest sending-end impedance, neglecting radiation, is obtained when the inside diameter of the outer tube of the line is 9.18 times the outside diameter of the inner conductor. This ratio may be too large when radiation is present.[4] The existence of an optimum *length* for transmission

[*Continued on Page 86*]

[1] "High Frequency Receivers—Improving Their Performance," RADIO, January, 1938.

[2] Bernard Salzberg, "On The Optimum Length For Transmission Lines Used As Circuit Elements," *Proc. I.R.E.*, December, 1937.

[3] F. E. Terman, "Resonant Lines in Radio Circuits," *Elec. Eng.*, July, 1934.

Which Tuning Condenser?

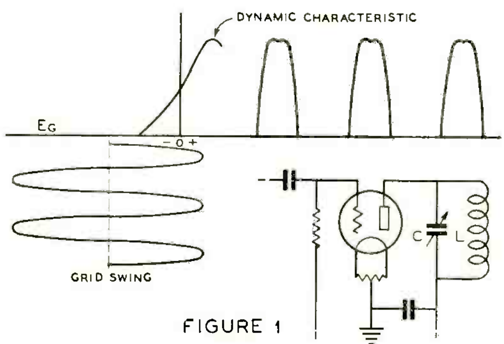


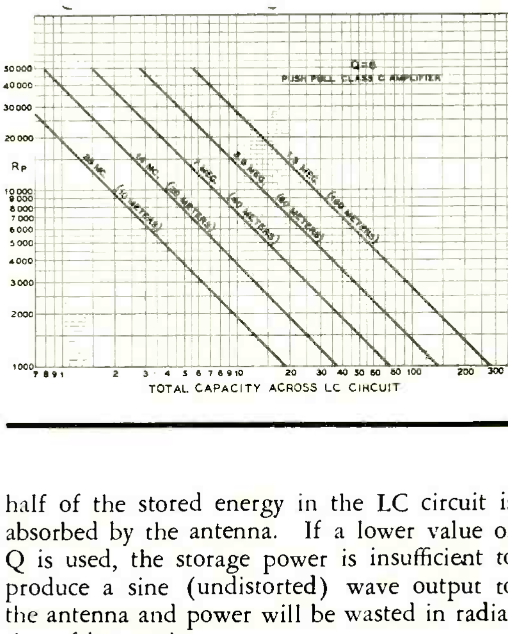
FIGURE 1

CLASS C AMPLIFIER PLATE CURRENT WAVEFORM

The subject of tuning capacity values for class-C amplifiers is important for anyone building a radio transmitter. The best value of capacity can be determined closely by charts or formulas for any frequency of operation. The ratio of C to L, capacitance to inductance, depends upon the operating plate voltage and current, and upon the type of circuit. Proper choice of capacity to inductance ratio for resonance at any given frequency is important in obtaining low harmonic output and also low distortion in the case of a modulated class-C amplifier.

A class-C amplifier produces a very distorted plate current wave form in the form of pulses as shown in figure 1. The LC circuit is tuned to resonance and its purpose is to smooth out these pulses into a sine wave of radio frequency output, since any wave form distortion of the carrier frequency is illegal, causing harmonic interference in higher frequency channels. A class-A radio frequency amplifier would produce a sine wave output. However, the a.c. plate current would be flowing during the full 360° of each r.f. cycle, resulting in excessive plate loss in the tube for any reasonable value of output. The class-C amplifier has a.c. plate current flowing during only a fraction of each cycle, allowing the plate to cool off during the remainder of each cycle. If the plate current is zero for 2/3 of each cycle, the *angle of plate current flow* is said to be 120°, since current is flowing during 1/3 of 360°. The tube in a class-C amplifier could have several times as much power input for a given plate loss as when used in a class-A amplifier.

The tuned circuit must have a good "fly-wheel" effect in order to furnish a sine-wave output to the antenna when it is receiving energy in the form of very distorted pulses such as shown in figure 1. The LC circuit fills in power over the complete r.f. cycle, providing the LC ratio is correct. The "fly-wheel" effect is generally defined as the ratio of radio frequency volt-amperes to actual power output ratio, or VA/W. This is equivalent to Q and should not be much less than 4π, or 12.5, for a class-C amplifier. At this value of VA/W or Q, one-



half of the stored energy in the LC circuit is absorbed by the antenna. If a lower value of Q is used, the storage power is insufficient to produce a sine (undistorted) wave output to the antenna and power will be wasted in radiation of harmonics.

Too high a value of VA/W or Q will result in excessive circulating r.f. current loss in the LC circuit and lowered output to the antenna. In high fidelity radiophone transmitters, too high a Q will cause attenuation of the higher side band frequencies and consequent loss of the higher audio frequencies. Too low a Q has its disadvantages also; so most transmitters are operated with LC circuit values of between 10 and 25. A value of 20 seems to be high enough for modulated class-C amplifiers; about 10 to 12 is enough for c.w. transmitters. With values of Q less than about 10, the maximum r.f. output will not occur at the point of mini-

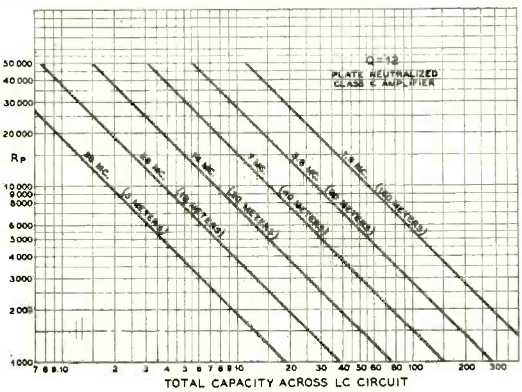
A treatise on air-gap and C-L ratio considerations for various applications, in which one common fallacy is debunked.

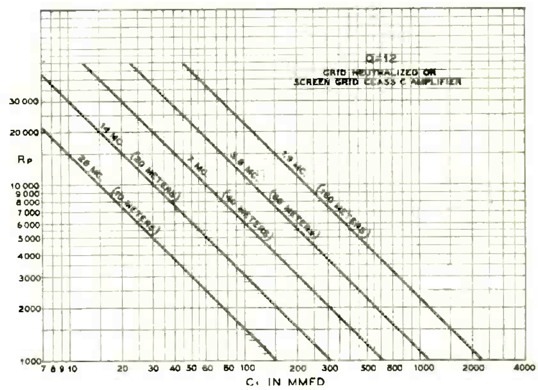
By **FRANK C. JONES,* W6AJF**

mum plate current in the amplifier tuning adjustment.

There is a wide difference in opinion as to the correct value of Q, but a careful analysis of the whole problem seems to indicate that a value of 12 is suitable for most amateur phone or c.w. transmitters. A value of 15 to 20 will result in less harmonic radiation at the expense of a little additional heat power loss in the tank or LC circuit. The charts shown have been calculated for an operating value of Q=12.

The curves shown in figure 2 indicate the sharp increase in harmonic output into the antenna circuit for low values of Q. The curve for the second harmonic rises nearly vertically for Q values of less than 10. The third harmonic does not become seriously large for values of Q greater than 4 or 5. These curves show that push-pull amplifiers may be operated at lower values of Q if necessary, since the second harmonic is cancelled to a large extent *if there is no capacitive* or *unbalanced coupling* between the tank circuit and the antenna feeder system.





Effect of Loading on Q

The Q of a circuit depends upon the resistance in series with the capacitance and inductance. This series resistance is very low for a "low-loss" coil not loaded by an antenna circuit. The value of Q may be from 100 to 200 under these conditions. Coupling an antenna circuit has the effect of increasing the series resistance, though in this case the power is consumed as useful radiation by the antenna. Mathematically, the antenna increases the value of R in the expression $Q = \omega L/R$ where L is the coil inductance and ω is the term $2 \pi f$, f being in cycles per second.

The antenna coupling can be varied to obtain any value of Q from 3 to values as high as 100 or 200. However, the value of Q = 12 (or Q = 20 if desired) will not be obtained at normal values of d.c. plate current in the class-C amplifier tube unless the C to L ratio in the tank circuit is correct for that frequency of operation.

The vacuum tube is a generator of r.f. power and it supplies maximum power to the tuned circuit when its a.c. plate impedance is equal to the impedance Z of the tuned circuit load. If the plate and filament of the tube is connected across the whole tuned circuit, the impedance of the tuned circuit should match a certain a.c. impedance of the tube. If the tube is connected across half of the tuned circuit as in a single-ended plate-neutralized or push-pull amplifier, the circuit impedance should be four times as great as the tube impedance. The tube impedance for a class-C amplifier is not equal to the d.c. plate voltage divided by the d.c. plate current but is equal to the corresponding a.c. values E_{AC}/I_{AC}.

The ratio of I_{AC} to I_{DC} depends upon the

*Engineering Editor, RADIO.

amount of grid excitation and operation of the tube and its ratio is from 1.57 up to 2 for angles of plate current flow of from 180° down to zero. Most amateur class-C amplifiers are operated at from 90° to 150° with an average at 120°. Plate circuit efficiencies in the vicinity of 75% are easily obtained for plate current (pulses) flow during 120° of each 360° r.f. cycle. The ratio of I_{AC}/I_{DC} for this value is 1.79.

The value of E_{AC} is equal to $E_{DC} - E_{min}$ and is usually in the vicinity of 0.8 E_{DC}. For example, if an amplifier is operated at 1000 volts d.c. plate supply, the a.c. value of voltage would be 800 volts. If the d.c. plate current was 100 ma., the a.c. plate current I_{AC} would be 179 ma. This gives us a method of calculating the a.c. plate impedance easily if the d.c. plate voltage and current are known.

$$Z = \frac{E_{AC}}{I_{AC}} = \frac{.8E_{DC}}{1.79I_{DC}} = .45\frac{E_{DC}}{I_{DC}} = .45R_p$$

since $R_p = \frac{E_{DC}}{I_{DC}}$.

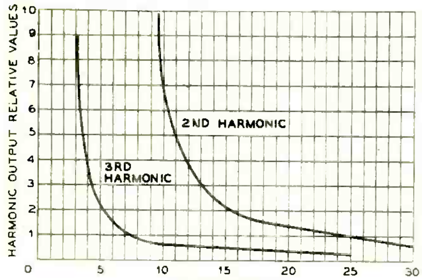


FIGURE 2. HARMONIC OUTPUT VERSUS TANK CIRCUIT Q FOR CLASS C OPERATION

In the above case $R_P = 1000/.100 = 10{,}000$ ohms, while $Z = .45\ E_{DC}/I_{DC} = .45 \times 10{,}000 = 4500$ ohms. The a.c. impedance is approximately half of the d.c. plate resistance (the latter is used in calculating the load for a modulator system).

The value of Z should be matched by the LC circuit for antenna loading which produces normal d.c. plate current in the tube. This should occur at the desired value of Q if harmonic radiation is to be minimized. The circuit impedance is $Z = L/CR$ for values of R small in comparison to the reactive components ωL or $1/\omega C$.

Since $Q = \frac{\omega L}{R}$, $L = \frac{QR}{\omega}$.

$$\text{Then } Z = \frac{L}{CR} = \frac{QR}{\omega/CR} = \frac{Q}{\omega C}$$

by substitution and cancellation.

This gives us an expression for the correct value of C for any value of Q within the range of Q between 5 and the upper limit of 100 or over,

$$C = Q/\omega Z.$$

Then R_p can be substituted for Z since R_p is easily calculated for any amplifier i.e., $R_P = E_{DC}/I_{DC}$, the DC values.

$$C = \frac{Q}{.45\ \omega\ R_P} = \frac{Q}{.45\ R_P\ 2\pi f}$$

If $Q = 12$

$$C = \frac{12}{.9\ \pi\ f\ R_P}$$

When C is in μμfd., and f is in megacycles this formula becomes

$C_1 = \frac{4{,}250{,}000}{f\ R_P}$ which is correct for a single-ended grid-neutralized or screen-grid amplifier in which the plate and filament of the tube are connected across the whole tuned circuit as shown in figure 3.

When the tube is connected across half of the tuned circuit as shown in figure 4A or 4B, the tank circuit impedance must be four times as high across the complete circuit in order to match exactly the tube impedance. Since Z is four times as great as for the circuits shown in figure 3, the correct value of C will be one-quarter as great and the formula becomes

$$C_2 = \frac{1{,}060{,}000}{f\ R_P}.$$

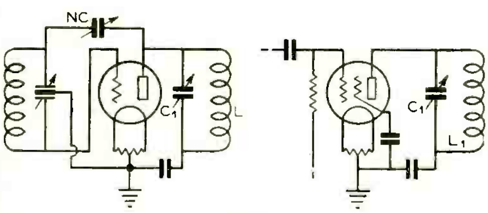
The coil inductance should be four times as large in order to maintain resonance with a capacity one-quarter in value. This will again provide a Q of 12 for normal values of plate current and antenna load.

In the push-pull circuit of figure 5, each tube works on a portion of each half cycle so less storage of fly-wheel effect is needed and a value of $Q = 6$ may be used instead of $Q = 12$. Since only one tube is working into the tank circuit load impedance at any given instant, the circuit is similar to that of figure 4A. The formula becomes

$$C_3 = \frac{530{,}000}{f\, R_P}$$

for a push-pull class-C c.w. amplifier.

The values of C_1, C_2, and C_3 for the three types of class-C amplifiers are for the total capacity across the inductance. This includes the tube inter-electrode capacities, distributed coil capacity, wiring capacities and tuning condenser capacity. If a split-stator condenser is used, the effective capacity is equal to half of the value of each section since the two sections are in series across the tuned circuit. The total stray capacities range from approximately 2 up to 30 μμfd. and largely depend upon the type of tube or tubes used in the class-C amplifier. These values may be represented over this range by 35T's in one extreme and 203A's in the other extreme.



Ⓐ FIGURE 3 Ⓑ

GRID-NEUTRALIZED OR SCREEN-GRID AMPLIFIER

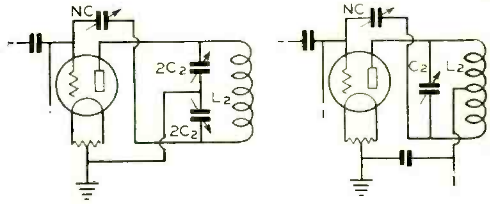
The values of R_P are easily calculated by dividing the d.c. plate supply voltage by the total d.c. plate current (expressed in amperes). Correct values of total tuning capacity are shown in the charts for the different amateur bands. The shunt stray capacity can be estimated closely enough for all practical purposes. The coil inductance should then be chosen which will produce resonance at the desired frequency with the total calculated tuning capacity.

The capacities shown are the minimum recommended values and they should be increased 50% to 100% for modulated class-C amplifiers where economically feasible. The values shown in the charts are sufficient for c.w. operation of class-C amplifiers.

Twice or Four Times?

There seems to be a great deal of difference in opinion about the values of tuning capacities for grid vs. plate neutralized circuits for any given value of Q. Some handbook and parts manufacturer's charts indicate that the tuning capacity should be one-half as great for plate neutralization since the tube plate circuit is connected across one-half of the tuned circuit. This is in error, as can be easily proven in several ways by very simple mathematics.

The value of C is a function of the impedance of the tuned circuit for a given Q and frequency. $C = Q/\omega Z$ is the general formula. When the tube is grid neutralized or is a screen grid tube, the plate circuit is generally connected across the whole tuned circuit as shown in figure 3. In this case the value of Z should be the same as the a.c. impedance of the tube. In the case of a split-coil or split-stator tuned circuit with plate neutralization, the tube impedance is across one-half of the tuned circuit,



Ⓐ FIGURE 4 Ⓑ

PLATE-NEUTRALIZED AMPLIFIERS

or across one-quarter of the total tuned circuit impedance, Z. Assuming the same tube impedance, Q and frequency for either case (figure 3 or figure 4) the tuned circuit impedance Z will be four times as great in figure 4 as in figure 3. The effective capacity across the coil in figure 4 should be one-fourth as large as in figure 3 since $C = Q/\omega Z$.

In figure 6, the impedance across points a and c, is

$$Z_{ac} = \frac{(\omega L_1 + \omega L_2)^2}{R}.$$

The impedance across the tapped coil from b to c is

$$Z_{bc} = \frac{(\omega L_2)^2}{R}.$$

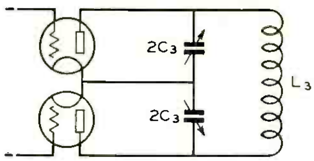


FIGURE 5. PUSH PULL AMPLIFIER

If the coil is center-tapped, $\omega L_1 = \omega L_2$ which gives

$$Z_{ac} = \frac{(2\omega L_2)^2}{R} = \frac{4(\omega L_2)^2}{R} = 4Z_{bc}.$$

This gives us proof number one.

In figure 7, $C_1 = C_2$, the usual split-stator plate-neutralized circuit in which the a.c. impedance of the tube plate circuit is across one of the condenser sections C_1. The impedance of the total circuit is Z, that across the tube or C_1 is Z_1.

$$Z = \frac{E_{LC}}{I_T} = \frac{X_L^2}{R} = \frac{L}{RC} = \frac{X_C^2}{R},$$

all general impedance formulas for parallel resonant circuits.

$$Z = \frac{X_C^2}{R} = \frac{1}{(\omega C)^2 R} = \frac{1}{(\omega C_{1\text{-}2})^2 R} = \frac{4}{(\omega C_1)^2 R}$$

$$Z_1 = \frac{1}{(\omega C_1)^2 R}$$

Therefore, $Z = 4Z_1$. Proof number two.

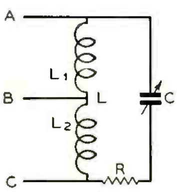


FIGURE 6

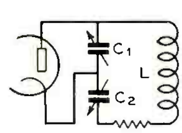


FIGURE 7

Using voltage relations as a third proof that the center-tap on a tuned circuit gives an impedance of one-quarter of the total circuit impedance when referred to either end, the following is given:

P_0 = power output through plate circuit in either figure 3 or 4,
E_1 = maximum value of r.f. voltage across tuned circuit figure 3,
E_2 = maximum value of r.f. voltage across tuned circuit figure 4,
I_1 = maximum value of r.f. current in figure 3,
I_2 = maximum value of r.f. current in figure 4,

$$\text{Then } P_o = \frac{E_1 I_1}{2} = \frac{E_2 I_2}{2}$$

The voltage E_1 is a direct function of the tube plate voltage for any one form of class-C amplifier operation. In figure 4, the tube is connected across one-half of the tuned circuit and that portion of the circuit has the same r.f. voltage across it as the whole circuit in figure 3. In figure 4, the total r.f. voltage will be twice as high as across one-half of the coil or condenser. This gives $E_2 = 2E_1$. Then $I_2 = \frac{1}{2} I_1$, since $E_2 I_2 = E_1 I_1$ from the formula

$$P_o = \frac{E_2 I_2}{2} = \frac{E_1 I_1}{2}$$

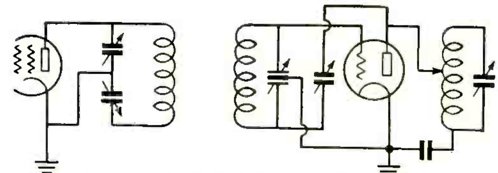
$$Z_1 = \frac{E_1}{I_1} \text{ and } Z_2 = \frac{E_2}{I_2}$$

where Z_1 = the impedance across the tuned circuit in figure 3,
and Z_2 = the impedance across the tuned circuit in figure 4.

Substituting values in Z_2

$$Z_2 = \frac{E_2}{I_2} = \frac{2\,E_1}{\frac{1}{2} I_1} = 4\frac{E_1}{I_1} = 4Z_1$$

All of these proofs are given in order to remove all doubt that the impedance is one-quarter across the center-tapped coil or condenser in a parallel-tuned resonant circuit. This means that the capacity C_2 in figure 4 should be one-fourth as much as C_1 in figure 3 for equal values of Q and the same values of plate voltage and current and frequency in each case.



(A) FIGURE 8 (B)

The circuits of figure 8A or 8B may be employed to reduce the required tuning condenser

[Continued on Page 81]

—GENE MAGEE, W6NJT

DEPARTMENTS

- **Calls Heard**
- **Yarn of the Month**
- **56 Megacycles**
- **Dx**
- **Postscripts and Announcements**
- **Question Box**
- **New Books**

POSTSCRIPTS...

and Announcements

National Convention

The League has given the Chicago Area Radio Club Council authority to proceed with plans for a National A.R.R.L. Convention to be held over the Labor Day week-end. This is the group that sponsored the 1936 Central Division Convention in Chicago, stated to be the largest ever held.

•

End-Fire

There may be some ambiguity in the use of the term "end-fire" as applied to flat-top beam antennas. As usually employed, "end-fire" refers to the directivity in the plane of two parallel, vertical out-of-phase antennas. The directivity of a flat-top beam turned vertically is "end-fire" strictly in this sense.

The antenna, of course, also has this same type of directivity when it is used horizontally, but it is often more convenient in this case to speak of the directivity as "broadside".

In the article by Sprole and Kraus in the January issue, the term "end-fire" was used with an entirely different meaning. Here "end-fire" referred to the directivity in the general direction of the ends of an end-fed "flat-top beam" when it was worked similar to a long wire antenna. In this case, the expression "end-fire" is not synonymous with "broadside".

•

Pierce Oscillator

A number of the fellows have mentioned the fact that when using the Pierce oscillator, if the crystal tube is removed from its socket, the second tube will take off and oscillate on its own accord. In response to a letter concerning this, G. E. Smith, W4AEO, whose airline transmitter was described in the November RADIO, writes:

"With reference to the exciter unit, it is true that when working straight through, the oscillator tube may be removed and the second

[Continued on Page 78]

NEW BOOKS

AND REVIEWS of CATALOGS

[Books submitted to the Review Editor will be carefully considered for review in these columns, but without obligation. Those considered suitable to its field will also be reviewed in RADIO DIGEST.*]*

HANDBOOK OF CHEMISTRY AND PHYSICS, 22nd Edition. Edited by Charles D. Hodgman, M.S., published by the Chemical Rubber Publishing Co., Cleveland, Ohio. 2069 pages, $6.00 in U.S.A. and Canada.

This handbook needs no introduction to those who have worked in a chemical or physical research laboratory; it is the standard reference work. Although a large number of the tables will be completely useless to the radio amateur or designer, still, in 2069 pages there are an extremely large number of tables to choose from.

The handbook is divided into eleven sections, the titles of which are: Mathematical tables, 301 pages; properties and physical constants, 557 pages; general chemical tables, 200 pages; specific gravity and properties of matter, 190 pages; heat, 155 pages; hygrometric and barometric tables, 19 pages; sound, 4 pages; electricity and magnetism, 135 pages; light, 149 pages; quantities and units, 161 pages; and a section devoted to miscellaneous tables, a large proportion of which will be highly useful in radio work, 144 pages.

The mathematical tables and the ones in the miscellaneous section alone make the book well worth the purchase price; then the others are always at hand in case they should be needed at a future time.

•

Raytheon Production Corp. announces a complete databook containing the chief technical data on all tube types—from the oldest tube to the newest. Prepared in the form of a compact 200-page pocket size book, it includes a wealth of information on tube applications and uses—maximum rating, values of essential characteristics and the more important characteristics in operating curves for each active tube.

The information on these curves is even more valuable and useful than the ratings and nominal characteristics, as it has not been heretofore generally available in convenient and readily accessible form.

Much of this information has previously been obtainable only by a limited number of receiver design engineers. Data are given on all tubes that have been at all widely used in the past in receivers and amplifiers that are still handled in the trade as replacements; also on all types announced up to the end of 1937. For completeness there is included the necessary data on resistor, radio receiving, special receiving tubes and panel lamps.

The Raytheon Databook gives definitions of the various tube characteristics and terms and explanations of how these quantities may be determined from the characteristic curves; simple circuit diagrams showing the essentials of the various sections of a modern radio receiver, including the newest features, and convenient charts for determining the proper values of certain tube circuit constants and operating voltages.

The Databook is available at all Raytheon jobbers.

YARN *of the* MONTH

SCANNING 1948

"Hello, Eddie; just thought I'd drop by to see if you were going to catch the club tonight. Hattie has the car and it is too far to walk."

"Hadn't intended to, Reg, but seems like a good idea. We don't have to start for half an hour yet; come on in and we'll kill a few minutes. Say, incidentally, my higher power seems to be doing some good. Got my mug into two new zones last night: zones 23 and 26."

"Say, I never could hear zone 23. I've received several short wave looker cards from that zone but never hear anybody on. You will have to give me the dope on where and when to look for the bird you worked."

"Okay, Reg, you can get it out of my log the next time you work me; I'll hold my log up in front of the scanner and you can also note some other new stuff I've worked. Guess I had better send it in to W6QD's "DX PX" department in RADIO; there are lots of fellows after zone 23. Say, I worked Herb the other night. Golly, he is as bald as a ping pong ball.

"Herb gave me some interesting news on Charlie Perrine. Claims Charlie is finally going video. Guess there got to be so few left on c.w. that it was hard to work anybody."

"What! Charlie on video? Seems incredible, Eddie. Boy, will Herb put him on the pan in his column."

"Herb handed me a laugh when he said he thought Charlie would have gone video long before this if he could have worked it in conjunction with c.w. instead of having to go phone."

"Well, it might be easier to synchronize, at that Eddie. Wonder if Charlie considered using pantomime. He might get around using a mike that way. Or maybe by talking with his fingers.

"How come you haven't a date tonight with the girl friend, Eddie? I'd work pretty hard on that if I were you. Helen is a nifty number, and there are lots of advantages in having an x.y.l. who is a ham too. Wish mine were."

"Oh, I've really been rushing her in a big way, but right now I'm sort of in the dog house. She got mad last night because I didn't bother to remove the whiskers before working our 6 p. m. sked. Said I could stay away from her house till I learned to show her more consideration and respect over the air. I tried to tell her that my rig was slightly on the blink, and suggested that as the reason my face looked as though it needed mowing. But she has been reading the ham mags too much lately to fall for that. Sometimes I think she knows more about the stuff than I do.

"Not to change the subject, but did you know that the boys formed a vigilantee committee last night and cut down Clark Taylor's antenna —rotary and all?"

"Naw, but I'm glad to hear it, Eddie. All that conceited rat would do by the hour was test, leaving his carrier run with his picture propped up in front of the iconoscope while he watched it in a monitor and made minor changes in his rig. They should have chopped him down along with the antennas. Last time I heard him working Slim he answered Slim's suggestion that he use a dummy antenna for testing with the declaration that he had nothing to use for a dummy antenna. Slim came back and told Clark that *he* would make a suitable dummy, and that lots of the boys would be willing to come over and show him how to hook himself up to the rig so as to do the most good.

"By the way, Eddie, what's happened to Slim lately? I haven't seen him on the breakfast club the last few mornings."

"Didn't you hear? He got his license suspended for indecent exposure. The gang 'turned it over' to Slim one morning when he had just finished slipping on his shorts, and Slim came back to them without waiting to slip some more clothes on. Guess one of the boys at the monitoring station happened to get up early that morning and took a gander over the band just then. Unfortunately for Slim, he already had a pink ticket chalked up against himself for thumbing his nose at some guy whose image was splattering all over the band and QRM'ing everybody."

"I've never actually met poor old Slim in

[*Continued on Page 76*]

56 Mc. . . .

Ultra Dx Again

By E. H. CONKLIN

Cecil Mellanby and Don Knock have done it again! At 14:20 G.m.t. on October 31, Mellanby in Pwllheli, North Wales, British Isles, logged VK2NO's c.w. five-meter transmission while calling ON4AU on schedule. Signal strength this time was QSA3 R5/6, better than a year ago when he reported VK2NO's phone. Here is what Don has to say:

"This is again all OK with my log. I have been calling ON4AU starting at 12:15 a.m. Saturday nights here, but so far have had no success with our Belgian friend. However, here Mellanby goes and hears me with, as he remarks, greatly improved signal strength. What is the explanation? Apparently, there is something favorable between our two locations for a signal that travels around the globe at this frequency. Unless I am mistaken, he is high up in the mountains. As a young Englishman, I remember Pwllheli fairly well, having passed through it by auto on a few occasions. It is very mountainous. Anyway, it is all very encouraging.

"I sent you the information previously that I had been logged in Wellington, New Zealand, recently. So I am reaching out, but not reaching *in,* and I have a pretty hot t.r.f. receiver with 956, 954, and 41. At the present time, W phones are roaring into Sydney in the mornings on 28 Mc., so why I can't hear a skerrick on 56 Mc. beats me. Anyway, I will keep on trying. I get a lot of fun out of *working* dx on 14 Mc., but a whole lot more out of *trying* for it on 56 Mc.

"The antenna I was using this time when Mellanby heard me was the W8JK vertical, cut for 57 Mc. Slogan now is, 'Two-way 56 Mc. dx contacts or bust.' "

Transatlantic Reception Again

We note that W1KH was heard in England on December 12 at 1609 G.m.t. on 56.2 Mc. c.w. The report was QSA4 R7-5, slightly chirpy. The transmitter input was 250 watts, crystal controlled, feeding a vertical antenna. W1KH is none other than George Bailey, vice-president of the League.

Norman Gfeller, W9SDJ, writes us rom Slater, Iowa. He is located on a farm fifteen miles north of Des Moines. He heard some peculiar five-meter signals for a few minutes on several days in the first week in January. They had a slow fade, and were too low in pitch and slow in variation to be television. Generally, three to five such signals were heard. He is curious to find some explanation for this reception.

Ionosphere in January

Conditions in January for very long distance reception were not nearly as favorable as those in November and part of December as previously reported, during both of which transatlantic dx occurred. The Wednesday noon data on maximum usable frequencies for F_2 layer transmission, supplied by the National Bureau of Standards, is shown below.

It is nothing like the 51-Mc. maximum in December. Conditions in February and March, we hope, may be better.

High daytime absorption on the medium high frequencies was reported on January 1, 2, 3, 5, 16, and the 18th to 26th inclusive. Ionosphere storms were observed on January 17, 22, and 25, the last of these obscuring the ionosphere layers at midnight. Radio fadeouts were reported on January 11, 13, 14, 15, 17, 18, 20 and 24.

Pittsburgh Activity

O. H. Mills, W8NED, gives us a report on the doings on five meters around Pittsburgh. One most interesting thing is that he was on the air last July 4 and 6 when W5EHM re-

[*Continued on Page 78*]

MAXIMUM USABLE FREQUENCIES FOR F_2 LAYER TRANSMISSION

DISTANCE (km.)	(miles)	JAN. 5	JAN. 12	JAN. 19	JAN. 26
400	250	12,800	11,800	14,000	13,600
700	435	15,100	13,800	16,500	16,100
1000	625	18,300	16,600	20,200	19,600
1300	800	21,800	19,600	23,800	23,000
1600	1000	25,000	22,500	27,400	26,400
2000	1250	29,100	26,000	31,600	30,500
2500	1550	33,000	30,000	36,000	34,600
3500	2200	38,700	34,600	41,100	40,100

DX

HERB. BECKER, W6QD

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

When most of you are reading this the contest fever will be at its highest point. At this moment there is plenty of activity throughout the world in preparation for this DX "Battle Royal". When the gun is fired on March 4th the various power companies throughout the world will know something has happened. Their huge generators will groan at the increased load, but you know that they will be pulling for you. I hate to think of how many house service meters are going to vibrate themselves right off the wall. Yessir, that first weekend, especially, will be a humdinger.

John Hunter, G2ZQ

For a long time we have wanted to show you what the station of G2ZQ looked like. This is an ideal time for several reasons, one of which you cannot help but notice with Johnny in the picture. Another reason is that he is one of the two who have made WAZ. Yessir, all forty of them, and we thought it would be a swell time to show you these cards along with his station photo. Look 'em over and if you see any you want, well, just get out there and pound brass. The yl plays a very important part because shortly after the contest they will be married and then . . . . After a while we will be able to sit back during one of our "bull sessions" and say, "Gee, remember when G2ZQ was in there grabbing that dx. That guy sure used to be a great dx man." Fellows, April 2nd is the date, and after that . . . . oh gosh, ain't love grand. Solong, Johnny.

The Zone List

No changes have been made in the zone or country totals this month, although the changes sent in have been duly noted throughout these columns. Next month the list will be brought up to date.

W7AMX admits he has a perfectly good double-button carbon mike of 1920 vintage. Huh, going modern. Art has 115 countries by the new list. KA1QL, who is ex-W6QL, is going to town in KA and says that that sure is a good dx location. He called six stations and raised 'em without a miss . . . . WAC. Jim is coming back to the states for a while, about the middle of April. W7GK, Johnny Henry, is back on and with a kw. into a pair of 100TH's. He really puts out a swell sig.

Look Who Gets The "Handle"

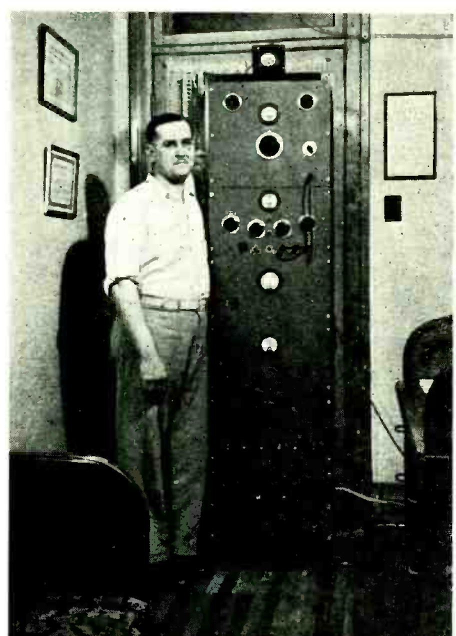
This month the "handle" goes to W8ZY, Karl Duerk. Last summer when on the coast, he vowed he was a c.w. man and never would get on fone. The end of the story—he is on fone. Therefore, the "handle" to you Karl . . . . . and "that's the dope on that".

"Upholstered Key" to G2ZQ

The good ol' upholstered key must go to Johnny, as he sent in four dx reports. And then too, he'll need it after April 2nd.

Frequency List

Most of the dx shown throughout this section will be found compiled under the frequency list additions. By clipping all of these out from a few months back, they may help during the dx contest in locating some of those elusive ones. By the way, fellows, when writing in about the new stuff you have hooked, please show the frequencies, as these may be valuable to someone else. When you send in the call letters, it doesn't do the next guy very much good.



Above—VE2EE; WAC, phone and c.w.; WBE, phone and c.w.; WAS; F.B.T.O.C.
Left—G2ZQ and the y.l.

"WAZ" HONOR ROLL

	Zones	Countries
G2ZQ	40	136
ON4AU	40	
W8CRA	39	135
W6CXW	39	132
W6CUH	39	128
W6ADP	39	127
W6GRL	39	119
W8OSL	39	113
W6HX	39	111
ON4FE	39	110
W6FZY	39	101
G6VP	39	
W8BTI	39	
W7BB	39	
W3SI	39	
W3ANH	39	
G6WY	39	
W4DHZ	39	
W8BKP	38	132
W1BUX	38	120
G5BJ	38	120
W8DFH	38	119
W2GTZ	38	115
W1CC	38	108
W2GW	38	104
W2AAL	38	104
W9ALV	38	102
W6AM	38	101
W8LEC	38	100
W9UQT	38	97
W2GT	38	95
W5BB	38	91
VE4RO	38	85
W9VDQ	38	79
XE1BT	38	69
G6RB	38	
W9TJ	38	
G5YH	38	
W8HWE	38	
W1ZB	37	124
W6KIP	37	118
W7AMX	37	115
W8ZY	37	114
G2LB	37	111
W6QD	37	111
W8DWV	37	109
W6GAL	37	106
W9PTC	37	103
W8KPB	37	100
W6LYM	37	100
W6FZL	37	99
W9AJA	37	99
ZL2CI	37	97
W8OQF	37	97
W2HHF	37	95
W7BYW	37	93
W8AU	37	92
W9KG	37	91
W3EXB	37	90
G6GH	37	89
W6GCB	37	81
W2BSR	37	
W2GWE	37	
G6NJ	37	
W2DTB	37	
W3EMM	37	
LY1J	37	
W4AH	37	
W6VB	37	
W9AFN	36	105
W2GVZ	36	103
VK3EO	36	101
ON4EY	36	97
W5VV	36	96
W6BAM	36	97
ZL1HY	36	95
W9KA	36	92
W6KWA	36	90
G2UX	36	83
W9CWW	36	71
W4AJX	36	
W8KKG	36	
W9ARL	36	
W3EDP	36	
W2OA	36	
W6KBD	36	
U1AD	36	
W2BJ	35	105
W8CJJ	35	98
W2BXA	35	98
W3EVW	35	97
W1AQT	35	96
W6DOB	35	95
W9EF	35	94
ON4FQ	35	92
ON4FT	35	92
W1GDY	35	89
W3AYS	35	85
W6FKZ	35	83
W6ITH	35	78
G6QX	35	75
W9UBB	35	71
K6AKP	35	63
W6NHC	35	
W6GRX	35	
W2AIW	35	
W3BBB	35	
W2IOP	35	
W8BSF	34	94
W3EVT	34	90
LU7AZ	34	89
VE2EE	34	87
W3GAU	34	86
W6HEW	34	86
W8EUY	34	84
W6GHU	34	83
ON4SS	34	80
W6LHN	34	71
W8JK	34	
W3EGO	34	
W2FAR	34	
W9PK	34	
W8AAT	34	
W6TI	34	
W8CNZ	34	
W1RY	33	92
W9LQ	33	84
W3TR	33	80
G2IO	33	76
W7AYO	33	73
W6LCF	33	71
VE4LX	33	69
OK2HX	33	66
W8LDR	33	
K6JPD	33	
W6LDJ	33	
W9LBB	33	
W5AFX	33	
ON4TA	33	
G6CL	33	
VK2VQ	32	99
ON4VU	32	86
W6JBO	32	81
W9FLH	32	80
ON4NC	32	79
W3CIC	32	75
W6AX	32	74
W3GAP	32	70
W6JMR	32	70
W6KZL	32	67
W9DEI	32	66
W6KRM	32	62
W6MHH	32	62
W6DIO	32	
W8HYC	32	
W8BTK	32	
W5EHM	32	
W4MR	31	92
OK1AW	31	86
W8HGA	31	83
W9LW	31	82
W6LEE	31	57
W6IES	31	57
K6CGK	31	54
W3DCG	31	
W5CUJ	31	
W6HXU	31	
I1TKM	31	
W5KC	30	81
W4DCZ	30	80
W6DRE	30	78
W3UVA	30	76
W6GNZ	30	73
W2WC	30	72
W6CEM	30	69
W4DTR	30	68
W8MPD	30	66
W9PGS	30	63
W6KEV	30	58
W8PHD	30	57
W6LCA	30	46
W6JJA	30	
W8MAH	30	
W7AVL	30	
W8DED	30	
W9IWE	30	
W1APU	30	
W3RT	30	

PHONE

W6ITH	33	57
W6LLQ	31	68
W6AM	31	
W4AH	31	
W6OCH	30	63
W4DSY	30	
W6NNR	29	58
W6MLG	29	55
W3EMM	28	
W3FAM	27	55
W9ARA	27	53
W9BBU	27	45
W2HUQ	27	
W5DBD	27	
VE2EE	26	53
W9NLP	26	48
W6BGH	26	
W9TIZ	25	36
VK2ABG	25	
W3SI	25	
W1BLO	24	50
W2IUV	24	41
W6FTU	24	35
W8JK	24	
W9NLP	24	
VE5OT	24	
W9QI	24	
W6AAR	23	
W2IXY	23	63
W7AO	22	
XE1BT	22	
W2HCE	21	51
W6GCT	21	30
W7ALZ	21	25
W6MVK	21	22
YV5AK	20	45
W5ASG	20	38
W8QDU	20	33
W1COJ	20	
W6GRX	20	

If you have worked 30 or more zones and are ready to produce confirmation on demand, send in your score of zones and official countries on a postcard.

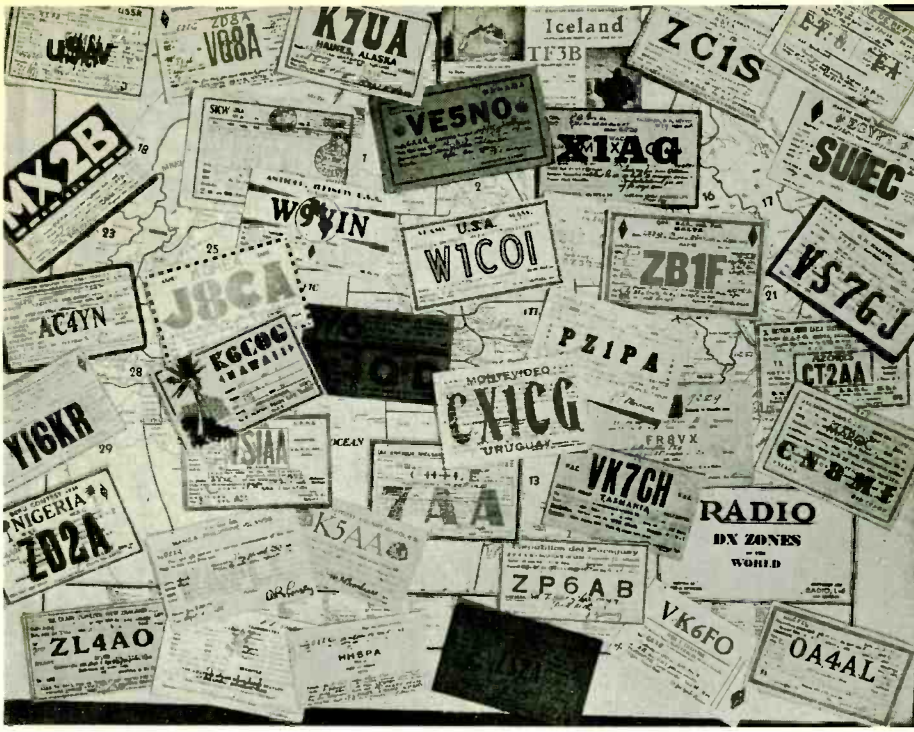
Phone stations need work but 20 zones, but stations must be raised on phone. Stations worked may be either c.w. or phone.

Revision and additions to the honor roll will be made every other month.

issue (not too far back) Call Books to their local post office. There are hundreds of QSL cards sent addressed by call and town, and this will enable the postmaster to deliver your card properly.

W4ELQ down Birmingham way is all smiles these days on account of getting his 30th zone. It was VU2FH. He heard W1BUX working him, so immediately grabbed RADIO with the frequency list to find out where the VU's spot was in the band . . . . . and yessir, sure 'nuf there he was pretty close to the published frequency. W4ELQ has 64 countries and uses low power . . . . . says you don't need big high power rigs to work dx. He gave a try on 40 but gave it up as a bad job and now wants to give it back to the Indians. Anyway from W4ELQ we learn a little bit about other BirmingHAMS (pea yoo): It seems that W4ECI is now WAC, and that W4BSQ is on 7 Mc. working W9's (the chisler) . . . . . W4BOE is finishing a new rig with a kw. output . . . . . we mean input. . . . . And this same rig will have band switching . . . . . ready for the contest, he hopes. W4APU is active on 7 Mc. and 3.5 Mc. . . . . W4EVI is just getting started on 40, and W4EHH is knocking off dx on 20.

W9RCQ pops up with some gossip from the Egyptian Radio Club. He says that there are really only a couple of dx men in the club: W9KEH and himself. Of course, there is that old timer W9DZG, who has been a ham since 1916.



HOW TO WORK WAZ

Merely collect an assortment of cards such as these of G2ZQ, and, there you have it.

A line from W8PHD tells of Bob Haas, W8HWE fooling around with beam antennas, and has especially good luck with the 8JK affair, gathering in a bunch of new countries. W8PHD went down to see ol' "Ming Toy" Lucas, W8CRA, and found he had three big telephone poles arranged in a triangle on top of his mountain. W8OSL is still chasing new zones and wants to know where AC4YN is now. W8PHD hasn't done so bad in adding 4 new zones and 11 new countries to his totals.

W8GXC calls his rig the "Bean Shooter" because all of his sigs terminate near Boston. Must have a bean complex. He has erected 26 antennas in the last 6 months . . . . . and "Hello CQ" . . . . . R8 . . . . . always near Boston. Probably a penalty for liking codfish. W9WCE has been spending some time on 40 and thinks the band has some possibilities, as he worked a few good dx stations. Still the same old trouble . . . . . not enough of the dx'ers on the band. Wait 'till the contest; the boys will find 40 is not so dead after all. That is, providing conditions are half way good generally. If 10 meters proves a washout during the dx brawl, 40 will be twice as popular. From another nine, W9VCF, we hear that ZU6U will become ZS6DY after March 1st. W9VCF running 50 watts to a T20 had a 30 minute QSO with ZU6U the other night.

W9KG reveals, first, that he has just received a QSL card from OQ5AQ (ex-ON4CJJ) who says for all those who have had a QSO with ON4CJJ or OQ5AQ to send a self-addressed envelope, international coupon, and some used stamps (as he is a stamp collector) to: ON4FQ, A. Legrand, Glons (Liege) Belgium. He will QSL direct and at once . . . . . and incidentally OQ5AE will again be on the air in the Congo some time in March. Now for the second item from Keat . . . . . quote: "My card to VR2AB was returned by M. Salmon at Kamakusa who says some bootlegger is using his call and his name." Gee, sometimes it looks as though a guy can't win.

W2IYO has accumulated 34 zones and 88 countries, and some of his latest include ST2LR, FR8VX, U8IB, U9AV, U9ML, FQ8AB, VU7FY, SU1DB, SU2TW, VQ4KSL, ZP1AX, ZB1H, OX2ZA, ZB1J, FP8PX, U6SE, EA7AV, PZ1AA, UX5AE, ZE1JI, ZE1JG. Here's W3AYS, who says he hooked FI8AC and was his first W3. That's nothing; I hooked FI8AC and he was my first FI. W6NLZ is doing all right with his 30 watts to a TZ20; the first part of January he hooked OK1BC, a PY and K4AAN on 40 meters. Says the band is worth watching late in the afternoon or early evening.

If any of you boiled owls work VU2AN, please don't think it just another India station. He's in Baluchistan, zone no. 21. This almost got by W8OSL but he caught it and now has "39 and 113" . . . . . still using a 210. W8LZK now has 34 zones and 87 countries, some of the 20 meter dx being VS6AG, VU2FH, VU2AN (up pops this one again), VU2GJ, KA1AF, KA1AX, FB8AA, ZS3X, CR7AW, ST6KR, I7EY, U9ML, U3DS, U1BC, U5OL and many others.

W6JJA comes up with the suggestion for the boys scattered throughout the country to take their back

[*Continued on Page 86*]

Automatic Modulation Control

[*Continued from Page 26*]

B modulator tubes, through a line-to-push-pull-grid input transformer. Thus, the amplifier can readily be adapted to p.a. work provided a separate source of field excitation is available for the speaker field coils. The 2A3's can be coupled directly to the grids of the class-B modulator provided a suitable transformer is used at T_5.

The audio rectifier tube (type 879) and its filament transformer should be mounted *in the modulator unit* and not on the speech-amplifier chassis, in order to keep all high-voltage leads away from the speech equipment. The lead from the 879 plate to the a.m.c. bias terminal on the speech amplifier is not at a dangerous potential. *This will be dangerous, however, if the 879 is connected incorrectly!* The secondary of the 879 filament transformer (T_3) should be insulated for twice the d.c. plate-supply voltage of the modulated r.f. amplifier, plus 1000 volts. For a final r.f. stage operating at 1250 volts, T_3 should be insulated for at least 3500 volts. The 879 can be used where the d.c. plate voltage of the modulated r.f. amplifier does not exceed about 3000 volts. Higher d.c. voltages will exceed the peak inverse voltage rating of this tube.

Performance

Considering the remarkable improvement in the performance of a plate-modulated transmitter which an a.m.c. system will provide, there is little reason to doubt that its use will eventually become as widespread as that of quartz crystals for the control of frequency. The advantages of the particular system described herein may be summarized as follows:

1. Eliminates substantially all overmodulation.
2. Increases the *average* sideband power several db, thus providing an actual gain in the effective audio signal at the receiver.
3. Makes the modulated carrier "clean" and sharp, due to the elimination of "side-splatter" caused from carrier cut-off on excessive negative modulation peaks.
4. Operates entirely on the *negative* audio peaks, which are the ones that ordinarily cause the most trouble.
5. Can be adjusted to limit the percentage of modulation to any predetermined value, by means of the "advance" bias on the audio rectifier.
6. Reduces the chance of overloading the modulator, in a properly designed transmitter.

807 makes it possible. And this thing of being able to flit about from band to band, and from end to end or to the middle of those bands without doing more than just flipping a switch or so, will probably eventually make us so lazy that we won't care whether we even answer a call when it does come in—but darned if we are going to be without it!

Effect of Average Ground on Antenna Radiation

[Continued from Page 40]

constants have an effect can be gained from figure 15 by extending the curve to the point where increasing distance from the brow of the hill gives no appreciable change in gain. This appears to be on the order of 1000 to 1500 feet.

Measuring Ground Constants

It is possible with an oscillator and a receiver, carefully shielded, to measure the vertical and horizontal components of the ground wave, at wavelengths in the vicinity of 4 to 18 meters.[2] With the help of equations and a set of curves, the ground constants can be determined. Sample measurements can also be made, with a cup-full of earth, which will yield the conductivity and dielectric constant, but stratification of the subsoil and varying moisture content may produce a number of results for different samples.

For amateur purposes, it will probably be sufficient to know the nature of the effect of earth constants upon the radiation, and to make an assumption as to which of the types in the illustrations probably comes close to the actual conditions.

A Vertical Antenna for $3.00 to $5.00

[Continued from Page 50]

to take care of itself. In the strongest winds it has been noticed that the pole bends only slightly at the top, and wind resistance is, of course, practically all the force that the pole is required to buck.

Yarn of the Month

[Continued from Page 65]

person. Is he really that homely or does he have the wrong bias on one of the tubes in his rig?"

"Well, he would never cop any prizes for pulchritude, Reg. For one thing, it takes a wide-angle scanning tube to get all of his schnoz on the screen in a profile, or all of both ears on the screen in a head-on. I don't see why he doesn't get one of these fancy new portrait filter attachments that are guaranteed to flatter your phiz and make you look like a movie actor. If he got one that changed his looks enough, he might be able to bootleg until he gets his license reinstated. Say, Reg, how was W4DLH coming in last night over at your place? He seemed to be skipping a bit."

"I wasn't getting him very good either. About visibility 2-7 and readability 4-7. Guess he was skipping all right, because he usually boils in. Heard him say that he saw all continents last week in two minutes and 27 seconds. He's trying to line up the stations for a try at a record WAC video QSO. Bill told me that VK4GU's beam is putting both his ears into the east coast in good shape now. Frank was having a little trouble putting in a good pic with his old antenna. Like the time he was only visibility 1 to 2 and, without first telling Bill what he was going to do, put the pup's face up to be scanned as a test image. Bill came back and told Frank, 'Your face has sharper definition now, but is somewhat distorted.' Frank wouldn't speak to Bill for two weeks."

"Guess we had better get going, Reg, as I'd like to stop off at Helen's for a moment to see if she has cooled off any since last night. I want to slip a rhombic on the significant digit just as soon as possible, before some movie talent scout short-wave-looker happens to tune across her sig some night. She puts a wicked signal into Hollywood since she put up that new rotary array last week. I won't be but a moment."

* * * * *

(One hour later.)

"Hello, Reg. Glad to see you turn out to the meeting. Say, that's Eddie's car you drove up in, isn't it? Did he come with you?"

"No, he won't be here. He *was* coming but something unexpected detained him; so he let me use his car. I gotta pick him up after the meeting. Say, how did that new W8JK Square Side beam that you put up work out?"

56 Megacycles

[*Continued from Page 66*]

ported signals of "W8MED."

The band has opened up for 100-mile contacts from Pittsburgh to Akron and Youngstown, Ohio, and W8GBK in Sherman, N. Y., has been heard. A "Tri-State Five-Meter Network" is being organized for communication in this area, including W8NQM, W8GRX and the following crystal controlled stations:

W8QVC	58.896 Mc.	20 watts
W8OUT	56.140 Mc.	125 watts
W8NQG	56.824 Mc.	125 watts
W8GWU	57.404 Mc.	100 watts
W8OJJ	56.080 and 57.312 Mc.	80 watts
W8NED	56.064 Mc.	42 watts
W8PEJ	59.430 Mc.	40 watts
W8CLS	57.660 Mc.	120 watts
W8CIR	56.128 Mc.	250 watts
W8VO	58.640 Mc.	35 watts
W8LHU	56.200 Mc.	35 watts
W8PWW	56.440 Mc.	40 watts

Prospects for Spring

The F_2 layer type of transmission (up to 2200 miles and multiples thereof) may become less probable during the spring, following the usual seasonal fluctuation, though some cases of transatlantic 56 Mc. dx were reported as late as May last year. Commencing in April or May, and extending to the fall, sporadic E layer transmission should again be possible over distances of from 400 to 1100 miles, repeating the excellent records of last summer. The band may pop open for an hour or two, sometimes twice in one day. It may happen at any hour, though the late forenoon and the evening are slightly favored periods.

Let's get those c.w. and phone rigs ready, even if they boast of a stable output of only a few watts. Particularly, let's get some sensitive receivers capable of finding weak carriers that might be overlooked when tuning rapidly over the band. Also, urge stations in the southeast and southwest to put in some time—remember what a grand piece of work W5EHM did last summer, often being the only southern station on the air but occasionally working twenty or more northern stations in an hour or two.

Postscripts and Announcements

[*Continued from Page 64*]

tube will take hold. But this only happens with tubes such as the 42 and 6L6; the more perfect screen tubes will not oscillate. Of course, this is perfectly natural as the second tube then becomes an ordinary pentode or tetrode crystal oscillator when the Pierce tube is removed. However, you will find that with the first tube in, it is actually the oscillator. This can be clearly seen by noting the resonance dip of the second tube; its dip is the dip of an amplifier and not the one of an oscillator. We have not found this condition to be of any disadvantage in our equipments."

To add further, if the second tube is so well shielded that it will not operate as an oscillator without external feedback anyway, the above is especially true. Thus with an 802, 807 or similar well-shielded tube, there would be no possibility of its acting as anything but an amplifier.

Another thing in connection with this article, the circuit diagram as it appeared on page

33 showed the 1250-volt plate supply connected directly to ground. Of course this is incorrect; this lead should jump over the ground bus and connect to the bottom of RFC_4.

Calls Heard

[Continued from Page 70]

8EBS; 8FIP; 8FMI; 8FOC; 8FYC; 8GWZ; 8HCR; 8HHH;8HHZ; 8IHJ; 8ISE; 8IWC; 8JHI; 8JFC; 8JKS; 8JLQ; 8JLW; 8JRL; 8KAY; 8KQ; 8KYY; 8LAC; 8LJ; 8LMP; 8MDL; 8MID; 8MRK; 8NAT; 8NDH; 8NDL; 8NHP; 8NHQ; 8NK; 8NWD; 8NZU; 8ODE; 8OG; 8OTK; 8OZJ; 8PEN; 8PHB; 8PNJ; 8PU; 8PWA; 8QQZ; 8QLK; 8QUI; 8QVR; 8QWB; 8QYI; 8RCO; 8REU; 8SX; 9AGM; 9AGO; 9ARK; 9BBR; 9BBU; 9BHT; 9BOF; 9BQY; 9CCI; 9CET; 9CHI; 9CRD; 9DHK; 9DKU; 9DSA; 9DWU; 9DXP; 9EBI; 9EKD; 9EMB; 9EW; 97YM; 9FAA; 9FEY; 9GIC; 9GWM; 9GWM; 9HDU; 9HDZ; 9IJN; 9IJX; 91TQ; 9JIL;9JJK; 9JVW; 9KCL; 9LBB; 9LNO; 9LO; 9LQ; 9LQT; 9LUO; 9LZP; 9MHM; 9MMM; 9NKX; 9OL; 9OS; 9PBY; 9PQH; 9PUY; 9PZI; 9QI; 9RGT; 9RMC; 98NX; 9ROQ; 9RUK; 9SQE; 9TBQ; 9TMP; 9TYJ; 9UAK; 9UDO; 9UEC; 9UIZ; 9UOR; 9NQJ; 9UUH; 9UVV; 9VCF; 9VQJ; 9WAH; 9WDA; 9WIP; 9WSB; 9WDA; 9WIP; 9WSH; 9WXT; 9YHQ; 9YIM; 9YLV; 9YPO; 9YQI; 9YRR; 9ZHB; 9ZNX; 9ZOR; 9ZUZ; 9ZYR; CN8AJ; CN8DV; CN8MI; FA3JY; HI7G; K4DDH; K4EIL; K4EJG; K4EMG; K4EPO; K4EZR; OH2NB; PY5AQ; SP1HB; SV1CA; SV1RX; TI2FG; TI2RC; VE—1AU; 1BR; 1DR; 1DT; 1EA; 1JU; 2DV; 2KX; 3AAF; 3AIB; 3AIW; 3AQ; 3NH; 4AU; 4BD; 4SN; 4ZK; VO1I; VO1J; VO2Z; YL2BB; YV5AA; YV5AK; ZE1JJ; ZE1JN; ZE1JR; ZS2N; ZS6AJ; ZT6J; ZT6T.

●

Ben Tylka, VE4SH, 1016 Burrows Ave., Winnipeg.
(December, 1937)

(14 Mc.)

CM2BC; CM2DO; CN8AR; CO2GE; CX2AJ; D3GPF; D4CSA; D4GDF; EI4J; F3KH; F8DC; F8EO; F8DC; G2DK; G2ZY; G5DF; G5RI; G5UF; G6HB; G6YG; HB9BD; HB9J; K4DUZ; K4ESH; K4FAY; K5AA; K5AN; K5AV; K6HOO; LU1CA; LU2AX; LU3DH; LU4BH; LU7BH; OE3AH; OE3JV; PH1NV; OH5FF; OH6NG; OH6NF; OK1BE; OK1XX; OK2HX; ON4AU; ON4HE; ON4NC; ON4SS; ON4UU; ON4VA; OX2QY; OZ2M; OZ3J; OZ7UU; PA0AZ; PY2DO; SM5UU; SM5VJ; SM5YU; SM5ZL; U1AV; U1BC; U4OG; U9ML; VK2AHA; VK2EO; VO3X; VO6J; VP3THE; XE1AA; XE1AG; XE1AM; ZL1IY; ZL1MQ; ZL1MR; ZL2FA; ZL2MN; ZL2SX; ZL3BJ; ZL3BR; ZZ2A.

(28 Mc.)

K5AN; VK2GU; ZE1JR; ZS2AH.

●

Robert E. Kayatt, W2KKC, 6135 Spencer Ave., New York City, N. Y.
(January, 1938)

(14 Mc.)

CM2AG; CM2BY; CM2NA; CM2RZ; CX1BG; D4GAD; EI6G; FT8AG; G2SN; G5JM; HA6H; HH1L; HH4AS; HI6O; HK3AL; HK4EA; K4DRN; K4EJF; K4SA; K4UG; K5AA; K5AL; K5AY; K6EO; K6LNW; LU4BH; OK6HA; ON4HK; OX2GR; OX2GY; PA0EH; VE3LL; VK2QI; VK3WA; VP5PZ; VP5TG; XE1AA; XU5AA; ZL1CH.

●

Donald W. Morgan, 2CBG, 15 Grange Road, Kenton, Middx., England.
(October 1 to November 1)

(14 Mc.)

W—1ANV; 1AQT; 1CBJ; 1CH; 1DIV; 1GSA; 1HME; 1JOJ; 1KKA; 1LQ; 1ME; 2AGA; 2CTO; 2GSA; 2GW; 2GWE; 2HKP; 2JVU; 2KIV; 3AXR; 3CXI; 3DHV; 3DQU; 3FAO; 3PF; 4AQ; 4CFPP; 4IR; 7VG; 8BTE; 8ELP; 8LGZ; 8OR; 8QUE; CE7AA; CN8AR; CN8AZ; CN8MI; CR7AR; CR7AU; CT1OR; CX1AJ. D—3BEN; 3CLD; 3CUR; 4ABA; 4CDM; 4GAF; 4GKF; 4GRB; 4OAP; 4QNM; 4RVE; 4SNP; EA7AV; EI6G; EI8B; ES1E; ES5D; ES7D; F3AV; F3CH; F3EG; F3PK; FA8LE; HA1P; HA2B; HA3B; HA5H; HB9BD; HB9BX; HM9K; HB9XU; I1GA; LA3B; LA4A; LA4K; LA4P; LA7A; LA7J; LA7K; LA7U; LA7W; LY1SL; OE5JD; OH1NP; OH2NG; OH3O1; OH5LS; OH5NR; OH5OH; OK1AM; OK1CK; OK1JM; OK1MA; OK1OD;

OK1OM; OK1TV; OK2MM; OK3NS; ON4CRE; ON4CW; ON4FF; ON4NW; ON4XF; OZ—1F; IL; 3D; 3G; 4R; 5D; 5J; 5R; 5X; 8D; 9G; 9H; PAON; PAOYZ; PY—1AH; 1DK; 2AL; 2HN; 2HQ; 2KT; 2KX; 2ZN; 8AH; SM5PG; SM5ZL; SM6PA; SM6WL; SP1BA; SP1ER; SP1HA; SP1MX; SP1XZ; SU1SG; SV1CX; SV1RX; U1AD; U1CJ; U2AG; U3FE; U9AX; UK1AK; UK1CC; UK3CC; YL2BG; YL2CG; YR5AA; YR5TR; YT7KP; YT7TJ; YU2CU; YU5AK; YU7AY; YU7TS.

Warren Mayes [illegible]WL, 1438 South Eleventh Avenue, Maywood, Illinois.
(October 1 to January 12)

(14 Mc. phone)

CN8AJ; CN8AM; CT1GG; CT1ZZ; CT3AB; EA8AE; EA9AH; EI2L; EI3J; F3HL; F3HY; F3NF; F8KW; F8MG; F8NX; F8PC; F8AB; G—2PU; 2PX; 5KH; 5ML; 5NI; 5QN; 5RV; 5SP; 6DT; 6LK; 6PC; 6XR; 8CS; 8GT; 8GX; GI5QX; GM5NW; GM5ST; HA4A; HA8N; J5CC; K6BAZ; K6BHL; K6BNR; K6CMC; K6MZK; K6NZC; K6OQE; KALME; LA1F; LA1G; ON4SS; OQ5AA;PA0AD; PA0EO; PK—1GL; 1MX; 1RI; 1VM; 1WL; 3GD; 4VV; 4WS; 6HI; SU1CH; SU1SG; SU8MA; SV1KE; VK—2ABT; 2ADE; 2AX; 2AZ; 2HF; 2HS; 2NO; 2OQ; 2OJ; 2UC; 3GK; 3GQ; 3IL; 3KR; 3MR; 3MX; 3PL; 3QR; 3ZZ; 4BB; 4GG; 4JU; 4JX; 4VD; 5DC; 6MU; 6MW; 7CL; VQ4KTB; VS1AI; VS2AK; VS2AO; VS6AG; VS7GJ; VU2BG; ZU8MC; ZU8RL; YI2BA; ZE1JB; ZE1JR; ZS2N; ZS5AB; ZS5J; ZS5M; ZS6AJ; ZT—1M; 1R; 2G; 5S; 6AK; 6AL; 6AM; 6N; 6Y; ZU5L; ZU$Z; ZU6AF; ZU6N; ZU6P; ZU6V.

Dixon C. Greenwood, Lee Street, East Longmeadow, Mass.
(December 12 to January 1)

(14 Mc.)

1W7AHS; W7CJR; W7ECK; CE1AO; CE2AA; CE3AK; CO—2EC; 2EG; 2HY; 2LY; 2RA; 2RH; 2RO; 2WM; 2WR; 2WW; 7CX; 7HF; 7HI; 7OP; 8BC; 8RS; CT1AY; CT1QG; EA9AH; EI2L; EI3J; EI6G; EI8M; F3KH; F3OV; F8MG; F8PQ; G—2MF; 2PU; 2VG; 5JD; 5LU; 5ML; 5QN; 5TP; 5TZ; 5VM; 5WH; 5WO; 5ZJ; 6IA; 6JF; 6KL; 6ML; 6UN; 6WT; 6WX; 6XR; 8KW; 8NY; 8OG; 8TA; GM2UU; GM5NW; GM5ST; GM6RV; HH2G; HI1C; HI2W; HI3N; HI5N; HI5X; HI7G; HI7I; HI9I; HK1OG; HK3JB; HK3JV; HK5AR; K4DDH; K4ENY; K4ESH; K4FAY; K4RJ; K6BAZ; K6BNR; LU9BV; OA4R; ON4PA; ON4SS; TI2AV; TI2FG; TI2RC; VE4IF; VE4NI; VE4UK; VE4VD; VE5ACN; VE9BW; VK3AL; VP2AT; VP2DA; VP3THE; VP6MR; VP6TR; VP7NA; VP9G; VP9R; VO1I; VO1Y; VO3Z; VO6D; VO6J; XE1KB; XE1R; YV—4AA; 4ABE; 4AV; 4AX; 5AA; 5ABE; 5ABY; 5AEL; 5AN; 5AR; ZE1JR.

Walter H. Smith, W6JMR, Route 1, Box 190. Novato, Calif.
(December, 1937)

(14 Mc.)

D—3BFN; 3DSR; 3GPF; 3HKV; 4CSA; 4DLC; 4GDF; 4GWJ; 4HCF; 4HNG; 4HSG; 4JVB; 4SZK; 4VGH; 4XQF; EI2L; F—3KH; 8AM; 8BS; 8EO; 8FK; 8KR; 8PZ; 8UK; 8WK; FA8ZZ; FB8AA; FB8AD; FR8VX; G—2AV; 2BY; 2DK; 2FT; 2FZ; 2HD; 2JG; 2LB; 2LU; 2MA; 2NN; 2OA; 2PU; 2QB; 2UX; 2YB; 2YL; 2ZQ; 2ZT; 2ZY; 3BQ; 3BK; 3BS; 5BJ; 5HH; 5IV; 5JX; 5KM; 5MP; 5MY; 5NL; 5OJ; 5PP; 5PR; 5RI; 5SX; 5WI; 5WP; 5YU; 6CJ; 6GH; 6GL; 6NF; 6OS; 6QS; 6RH; 6SN; 6VP; 6WY; 6XP; 6UG; 8AP; 8HH; 8IP; 8IX; 8JO; 8MF; 8ON; 8QC; 8QL; 8RH; 8UQ; 8WC; GM2JF; GM5DK; GM5YG; GM5YN; GM8AT; GW5KJ; GW8HI; HA8D; HB9BD; HB9CC; I1IY; I1KN; LA2B; LA4K; LY1J; OE1EK; OE3AH; OE7JH; OK—1AUX; 1BC; 1RW; 2FB; 2HX; 2KJ; 2PN; 2SO; ON—4BA; 4BZ; 4DI; 4DKW; 4EJ; 4FL; 4FT; 4GO; 4GW; 4HC; 4HF; 4HM; 4HW; 4MZ; 4NC; 4NO; 4NW; 4OU; 4PA; 4PZ; 4RZ; 4SS; 4TF; 4UF; 4UU; 4WX; 4XX; OX2QY; OZ2M; OZ4L; OZ7CC; OZ7FK; OZ7UU; OZ9R; PA—AZ; CV; CX; DO; DS; FA; FV; FX; GF; GN; KN; KV; KZ; LB; MQ; MZ; VB; ZB; SM2VP; SM5ZL; SM6VX; SP1AU; SP1FD; SP1HH; SP1JB; SP1KM; U5AT; ZE1JG; ZE1JI; ZE1JV; ZE-JZ; ZS—1AH; 1AN; 1Z; 2F; 2G; 2X; 5AG; 5B; 6BA; 6EO; 6EQ; 6H; 6J; 6M; ZT5P; ZT5Y; ZU2G; ZU5AQ.

Jack Spall, 34 Olive Avenue, Northmount P. O., Ontario, Canada.
(December 10 to January 8)

(14 Mc. phone)

CE1AO; CE3CO; CT1QG; CZ2AK; EI2L; F8QD; G5LU; G5ML; G5QN; G6BJ; G6VX; G6WT; HI1G; HI1W; HI3N; HI5X; HP1A; K4DDH; K4XET; K6BNR; K6CJQ; K6KSB; LU3AQ; LU4BH; LU4BL; LU7AC; LU7AP; LU7AZ; LU7BK; OA4AL; OX2QY; PY2AK; VP2CD; VP3BG; VP3THE; VP6TR; VP9R; ZE1JR; ZP6AK; ZS6AA; ZT5X; ZT6AM; ZU6AJ; ZU6AN; ZU6P.

(28 Mc. phone)

GM6RG; HI7G; K4EZO; K4EZR; YP9R; ZV5AA.

K2EO; V

(28 ...)

REN; D4VZV; EI5F; EI8B; EI9J; F3CP; F8OL; F8RR; H; G—2JD; 2KI; 2QT; 2WV; 5LU; 5YD; 6MK; 6QX; 6XM; K5AN; LA1Y; OA4J; OK2HX; OK2RN; ON4DA; Z; PA0FZ; SM5OI; SP1HH; XE1CM.

●

A. C. Pearce, VK2AHB, 14 Pearce St., Double Bay, Sydney, Australia.
(December, 1937)

(28 Mc. phone)

W—3HAX; 4FT; 5ZS; 6AEC; 6AOQ; 6APL; 6BBD; 6CRY; 6ERD; 6MTV; 6MWD; 6NAP; 6NEM; 6NLS; 6NSN; 6OTE; 7AWP; 7DJO; 9DCQ; K6BNR; K6CMC; K6KPH; K6LCV; K6OQE; K*OTH.

(7 Mc.)

W—1AAT; 5EDR; 6CNK; 6GLD; 6JXR; 6KDR; 6LGD; 6MJP; 6NWS; 6OLU; 6PCK; 6PDN; 7AYO; 7GGE; 8EEA; 8GMZ; 8KGJ; 8REO; 9JXR; 9TSV; HS2BK; J2PC; J8CG; **K**—6BIF; 6PCM; U2AG; XU7CK; XU8AG; XU8NA; ZL2VA; ZL2VG; ZL4FD; ZL4FW.

(14 Mc.)

W—1JZI; 6BIF; 8CRA; FI8AC; HS1BJ; J2KA; KA7EF; PK1MF; U3BE; VS7RP; XU8HM; XU9MK; ZL1CA.

(28 Mc.)

W—6BCX; 6CXW; 6GCX; 6IFZ; 6NKY; 9FGA; 9LLX; D4VRR; G2PL; ON4HC; PA0AZ; PA0QZ; PA0XR; PK3BM; PK3GD; SM6WL; VE4TJ; VR2FF; VU2CQ; YR5CF; ZS5U; ZU6E.

Which Tuning Condenser?

[*Continued from Page 62*]

capacities. Tapping the plate circuit across a portion of the tuned circuit reduces the required amount of capacity at the expense of greater plate spacing to withstand the higher values of r.f. voltage. This is a practical means of obtaining normal output in an all-band transmitter with a fairly low capacity tank condenser. It is especially recommended for screen-grid tube operation. If the plate is tapped down across one-half of the turns, the capacities shown in the chart for plate neutralized amplifiers are correct. The required capacity varies inversely as the square of the turns ratio or capacity ratio in the split stator condenser sections.

Referring to figure 7 again, most engineers have figured that C_1 should be equal to C_2 of figure 3 without realizing that the coil reflects C_2 across C_1 in figure 7. This is true because the coil can be considered as two coils in series

[illegible] shou[illegible] [illegible] The total cap[illegible] circuit of figure 7 would [illegible] be one-fourth, since C_1 and C_2 are in series. Al[illegible] of these lines of reasoning point to the fact that about 80% of the published tuning-capacity-versus-Q charts are incorrect, with an error as large as 100%.

Part 2: Tuning Condenser Flash-Over

A Discussion of Plate-Spacing Requirements for Various Circuits and Plate Voltages.

Many radio amateurs and engineers have a very hazy idea about condenser air-gap requirements for transmitting-amplifier tuned circuits. Even different condenser manufacturers disagree, as can be seen by comparing catalogue ratings. Some manufacturers play safe by listing only the air-gap. Small wonder that the majority of designers have had difficulty in choosing the best condenser plate spacing for a new transmitter design.

The peak r.f. voltage impressed across the condenser is the important item, since the experimental and practical curves of air-gap versus peak volts as published by the Allen D. Cardwell Mfg. Corp. may be applied to any condenser with polished plates with rounded edges. Typical peak breakdown voltages for corresponding air-gaps are listed in the table. These values can be used in any circuit. The problem is to find the peak r.f. voltage in each case and this can be done quite easily.

Breakdown Ratings of Common Plate Spacings

Air-gap in inches	Peak voltage breakdown
.030	750
.050	1500
.070	3000
.078	3500
.084	3800
.100	4150
.144	5000
.175	5700
.200	6200
.250	7200
.300	8200
.350	9250
.375	10,000
.500	12,000

Determining the Peak Voltage

The r.f. voltage in the plate circuit of a class-C amplifier tube varies from nearly zero to twice the d.c. plate voltage. If the d.c. voltage is being modulated by an audio voltage, the r.f. peaks will reach four times the d.c. voltage. These are the highest values reached in any type of loaded amplifier; a class-B linear, class-C grid or plate modulated or class-C c.w. amplifier. The circuits shown in figures 10 and 12 require a tuning condenser with plate spacing which will have an r.f. peak breakdown rating at least equal to 2 times or 4 times the d.c. plate voltage for c.w. and plate modulated amplifiers respectively.

We can reduce the air-gap to one-half by connecting the amplifier so that the d.c. plate voltage does not appear across the tuning condenser. This is done in figures 9 and 11. These circuits should always be used in preference to those

(14 Mc.)

D4SZK; G2JG; G2YY; G5G th 'A: G8OH; HH4AS; K4CVV; LU2AX; LU2CW; LU3HK; P2AT; YV5AN; ZF1 ZL2SX; ZL3FZ; ZI onse ently,
abnate ex e.

The peak r.f. vo age of a plate-modulated class-C amplifier still varies from nearly zero to four times E_b, the d.c. plate voltage, but only one-half of this voltage is applied across the tuning condensers of figures 9 and 11. For a

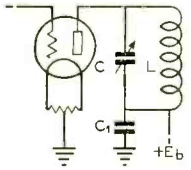


FIGURE 9

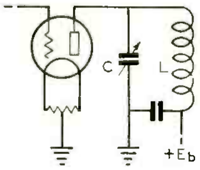


FIGURE 10

class-B linear, class-C grid-modulated or c.w. amplifier, the peak r.f. voltage across the tube varies from nearly zero up to twice E_b. The r.f. voltage is an a.c. voltage varying from zero to a positive and then to a negative maximum over each cycle. In figures 1 and 3, the zero reference line is at $+ E_b$ for the tank tuning condenser. The fixed (mica) condenser C_1 in figure 9, and C_2 in figure 11 insulates the rotor from d.c. and allows us to subtract the d.c. voltage value from the tube peak r.f. voltage value in calculating the breakdown voltage to be expected.

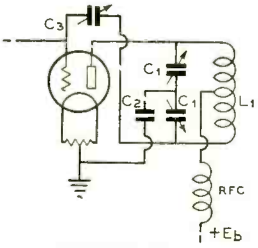


FIGURE 11

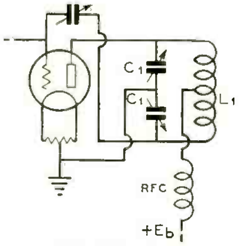


FIGURE 12

Plate-Modulated Amplifier

This gives us a simple rule to follow for a normally-loaded plate-modulated r.f. amplifier. The peak voltage across the tuning condenser C or C_1 of figures 9 and 11 respectively will be *twice the d.c. plate voltage.* If a single-section condenser is used in figure 11, with the bypass condenser C_2 connected to the coil center-tap, the plate spacing or air-gap must be twice as great as that of a split-stator condenser so there is no appreciable saving in costs for a given capacity.

C. W. Amplifier

For c.w. amplifiers, the air gap must be great enough to withstand a peak r.f. voltage *equal* *to the d.c. plate voltage,* for each section C_1 of figure 11, or, C of figure 9. A linear or a grid-modulated amplifier has less grid drive and the minimum r.f. plate voltage is greater than in a class-C amplifier driven fully. This means that the r.f. peak voltage is less and the tuning condenser could have about 25% to 50% less air-gap than for a c.w. amplifier.

These rules apply to a loaded amplifier or buffer stage. If the latter is ever operated without an r.f. load, the peak voltages may be very much greater, by as much as two or three times in ordinary LC circuits. For this reason no amplifier should be operated without load when anywhere near normal d.c. plate voltage is applied.

A factor of safety in the air-gap rating should be applied to insure freedom from r.f. flash-over. This is especially true when using the circuits of figures 2 and 4; in these circuits the plate supply is shorted when a flash-over occurs. Knowing the peak r.f. voltage, an air-gap should be chosen which will be about 100% greater than the breakdown rating. The air gaps listed will break down at the approximate peak voltages in the table. If the circuits are of the form shown in figures 10 and 12, the peak voltages across the condensers will be nearly twice as high and twice as large an air-gap is needed. The fixed condensers, usually of the mica type, shown in figures 9 and 11 must be rated to withstand the d.c. plate voltage plus any audio voltage. This condenser should be rated at a d.c. working voltage of at least *twice the d.c. plate supply in a plate modulated amplifier* and at least *equal to the d.c. supply* in any other type of r.f. amplifier.

Recommended Air-gap (approx. 100% factor of safety) for the circuits of figures 1 and 3. Spacings should be increased by 1.5 to 2 for same factor of safety with circuits of figures 2 and 4.

D.C. Plate Voltage	C. W.	Plate Mod.
400	.030	.050
600	.050	.070
750	.050	.100
1000	.070	.084
1250	.070	.144
1500	.078	.200
2000	.100	.250
2500	.175	.375
3000	.200	.500
3500	.250	.600

Push-Pull Amplifiers

The circuit of figures 11 and 12 apply without any change in calculations to push-pull amplifiers. Only one tube is supplying power to the tuned circuit at any given instant, each one driving a part of each half cycle. The different value of Q and increased power output change the expected peak voltages somewhat but for all practical purposes, the same calculation rules may be employed.

These rules are based on average amateur design for any form of r.f. amplifier with a recommended factor of safety of 100% to prevent flash-over in the condenser. This is sufficient for operation into normal loads at all times, providing there are no freak parasitic oscillations present. The latter sometimes cause flashover across air-gaps which should ordinarily stand several times the normal peak r.f. voltages. This is especially true of low-frequency parasitics.

The actual peak voltage values of a stable, loaded r.f. amplifier are somewhat less than the empirical calculations indicate, which gives an additional factor of safety in the design.

The Open Forum

[Continued from Page 10]

whether he prefers phone or code, is the man who uses both or has used both, and has achieved something with both, i. e., the thrill of two-way phone with another continent or the achievement of a long rag chew on c.w. through QRM and being able to say "R Solid" each time. If Mr. Poland had studied his code, obtained his license and achieved w.a.c. (phone) and w.a.c. (c.w.), then I should imagine he could be listened to as an authority.

Personally, I think that a true ham will endeavor to have experience with not only both methods of communication, but on all available bands at his disposal, thereby getting away from a narrow minded view point which is far too prevalent throughout the world of ham radio today. Each band, every method of communication allowed, has a great deal to be said for it; therefore, let us try something before we stand up and shout against it; let us try and be experienced men at the game, and not a lot of unruly bad tempered schoolboys. If it is necessary to learn the code, then accept the majority opinion and learn it.

H. A. M. Whyte, G6WY.

Silencing Units for Noisy Rigs

[Continued from Page 18]

of the angle to allow the small rubber to pass through. In mounting the unit, a washer was first placed on the screw. Then came one of the large rubbers with its flat face toward the washer; then a small rubber (which was pushed into the recess in the large rubber); next, the angle, which is pushed over the small rubber, and finally, a large rubber, which is pushed against the small rubber so that its hole fits over the small rubber (B). This whole assembly is mounted to the panel with the rest of the screw and nut.

For mounting the panel to the relay rack, the panel occupies the place of the angle on the rubbers, and the washer flat face goes against the rack. Several rubber units are used to distribute the weight of the equipment on the silencing units. Each unit will support about 3 pounds. The unit can be adjusted to the weight by drawing down on the screw.

The silencer described can be adapted to other equipment in the shack, for instance, a fan is so mounted here. It is possible that other dimensions for the parts will work equally well.

Dx

[Continued from Page 69]

issue (not too far back) Call Books to their local Post Office. There are hundreds of QSL cards sent addressed by call and town, and this will enable the Postmaster to deliver your card properly.

"California Here I Come," by W4DHZ

Through the grapevine route and the efforts of Operative No. 1492 we learn that Dave Evans, W4DHZ, is heading for California . . . . . Ventura to be exact. By an odd quirk W6GRL, Doc Stuart, holds forth in Ventura, and this same Operative says that Doc is sure getting worked into a lather over the dx contest. Dave's transmitter works really swell on 40 and 80 meters. If you were to piece together these two parts . . . . . say, you don't suppose they . . . . . ???????? Oh gosh.

W3AKX is doing very well on 10 meter fone these days and has to his credit 20 zones and 32 countries. His antenna is a diamond, 16 half waves long. W2GVZ snags I7AA at 5.16 p.m. e.s.t. for country no. 104 . . . . . frequency 14,415 kc. W8EUY worked him also for his 88th.

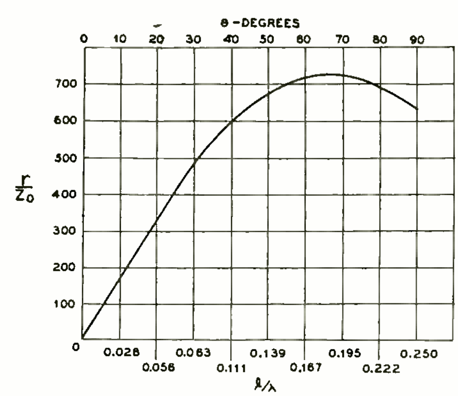
W7EYI worked a station on January 13th at 1100 G.m.t. who signed MX5A and wants to know if he is OK. Couldn't swear to it here . . . . . MX is the right prefix but all calls reported so far are in the MX2 series. However, in this day and age anything can happen, and sometimes does. This fellow's frequency was 7065 kc.

XE1BT dropped in for a nice chat. He is hoping to be back home in time for the contest. At present

[Continued on Page 92]

Resonant Lines As Circuit Elements

[Continued from Page 57]



lines which gives maximum sending-end impedance does not appear to have been treated until recently in the literature. Assuming that a concentric transmission line is tuned as a resonant circuit element with a variable condenser at its end, the problem is to determine the optimum ratio of line length to operating wavelength which results in the maximum impedance across the capacitor. It is something like determining the best L/C ratio, in which the

[4] See article in August, 1937, issue of *Electrical Engineering*, by Reukema.

inductance is entirely in the form of a concentric line.

The results of Mr. Salzbe[illegible]'s analysis[2] i[illegible]cate th[illegible] the optimum line [illegible]ength is only 18.[illegible] per cent of a wavelength for the short-circuited line and 47.2 per cent for the open-circuited line, the condenser being adjusted to give resonance in each case. This result ignores radiation, and hence is strictly true only for the completely-enclosed coaxial line. These figures are somewhat below one-quarter and one-half wavelength respectively. The study also indicates that the short-circuited line gives higher impedances than the longer open-circuited line.

The accompanying figure gives the variation of the resonant impedance, for a typical short-circuited line, as the line length is varied and resonance re-established by tuning the condenser. This shows that a tuned one-eighth wavelength line is as good as a quarter wavelength line, so that if tube and circuit capacities are small, the line is reasonably good even if used on two adjacent amateur bands simply by tuning with a variable condenser.

It is also obvious that when the line is designed for optimum results, the tube and stray capacities will do no harm and will become a part of the necessary capacity across the shortened line to obtain resonance. Also, it will be seen that a trimmer condenser for band-spread tuning can be placed across the tube end of the line to give control over the resonant frequency in receivers which use a number of such lines as efficient interstage couplers, thus obtaining an over-all resonance curve too sharp to be useful over a whole amateur band.

Question Box

[*Continued from Page 70*]

In other words, the surge impedance is equal to 276 times the log to the base 10 of the ratio of twice the spacing to the diameter of the conductors. Now, this same equation can be expressed in this manner:

$Z_L = 276 \log_{10} S/r$.

Of course this means exactly the same thing, except that we have changed the last part of the expression to read,—276 times the log to the base 10 of the ratio of the spacing of the conductors to their *radii.* We have just divided this last ratio by two; twice the spacing divided by the diameter will give exactly the same result as the spacing divided by the radii.

One point that might be stressed, the above formulas are only approximations, although they are quite accurate for ratios of 2S/d of ten or more. When the ratio of 2S/d is less than ten, and very accurate results are desired, the following general formula for transmission-line impedance should be used.

$Z_L = \sqrt{L/C}$, where L is the inductance per unit length, and C is the capacitance for the same unit of length. These quantities can be determined from the equations:

$L = 9.21 \log_{10} S/r \times 10^{-9}$ henries per centimeter; and

$$C = \frac{12.1 \times 10^{-14}}{\log_{10} S\text{-}r/r}$$ farads per centimeter.

The substitution of these values in the general equation for transmission line impedance $Z_L = \sqrt{L/C}$ will give much more accurate results in the calculation of the surge impedances of lines composed of large-diameter conductors spaced closely together than the more commonly used formulas as given at the outset.

Strictly 160 Meters

[*Continued from Page 15*]

about 6 inches center to center, and should preferably be separated a little more. If the coils are spaced at least 6 inches, no shielding will be required.

The Modulator

The speech system is designed to work from a diaphragm type crystal microphone, or other high-impedance, high-output type. As the quality of a phone transmitter is influenced to a greater extent by the microphone than any other single item in the transmitter, it was deemed somewhat unwise to skimp on the cost of the microphone. An excellent one can be obtained for $15 or less, and this represents only a small portion of the money tied up in a phone station when everything is considered—receiver, antenna, etc. However, for those who wish to keep the investment down by using a single button microphone, a method of hooking one into the circuit with the fewest number of components will be described in detail next month.

The pentode-connected 6J7 into the 6F6 provides sufficient gain for a diaphragm type crystal microphone (output level of -55 to -60 db) but none to spare. For this reason no gain control is used. The cathodes of both tubes are grounded; bias for the 6J7 is obtained from a bias cell and bias for the 6F6 is obtained from the 22.5-volt battery bias supply. The values of C_8 and R_5 are chosen so as to cut off just below 200 cycles. This has no noticeable effect on speech, but minimizes any 120-cycle supply hum which may be generated in the first stage. The resistor R_6 reduces the gain of the 6F6 somewhat, but is necessary in order to stabilize the load on the 6F6, the latter being critical to changes in load impedance when pentode connected.

The modulation transformer T_1 can be most anything so long as the taps or windings are such that the primary turns used will handle 40 ma. d.c. and fall somewhere between 5000 and 15,000 ohms. The stepdown turns ratio should be approximately 5:1. The transformer illustrated can be made to meet these requirements perfectly by using all of the primary and half the secondary as indicated in the diagram.

It is important that an individual ground lead be run from the metal chassis to the nearest water pipe. Using a common ground lead for both speech and antenna system is courting trouble. The antenna system ground lead should *not* be connected to the chassis, even though both are designated as "ground".

[redacted]wer Supply

A single pl[redacted]y is used to supply power to the entire [redacted]itter. A single filament transformer su[redacted] all tubes. This makes for good economy, besides simplifying the construction. With the constants and values specified the plate voltage should run very close to 600 volts under load. If it is more than 25 volts too high or too low, it may be corrected by using the alternative primary tap on the plate transformer, which has both a 105 and 115-volt tap. If the voltage is allowed to run much over 600 volts, the 6F6 will run too hot and the 42 may arc in the base. If the voltage is less than 600, the output will fall off. A plate transformer that delivers a good 500 volts r.m.s. each side of center tap under full load will provide very close to 600 volts d.c. out of the filter when used with an 83 and a 4 μfd. input condenser. The filter choke CH_2 should preferably be of low d.c. resistance to minimize voltage drop.

Construction

The entire transmitter exclusive of antenna tuning unit and bias battery is constructed on a standard metal chassis 10x17x2¾ inches. The two variable condenser frames, which are at zero r.f. potential but 600 volts d.c. "hot" to chassis, are insulated from the chassis by means of suitable fiber washers. The 809 tank condenser C_3 may well be one of the older type b.c.l. condensers, one made before the manufacturers began skimping on the air gaps. These can often be picked up for a song from a radio serviceman, or from a dealer who takes trade-ins. Just make sure that it has good plate spacing and that the maximum capacity is at least 350 μμfd., and that it will fit under the chassis.

With the rotors of the two tuning condensers at a d.c. potential of 600 volts above ground, care should be taken in choosing knobs to make certain that it is impossible to get "bit" from the set screw. The type illustrated avoids this possibility.

The meter jack J_2 is insulated from the chassis by means of a rubber grommet of suitable size. The latter makes a good insulating washer, holding the jack quite firmly when the nut is tightened. If desired, the jack can be eliminated and the meter mounted on the chassis and wired permanently in the circuit. This does, of course, prevent one from making use of the meter for other purposes.

Though not particularly necessary, the swamping lamp, R_1, can be so mounted behind a hole in the front of the chassis that the glow is visible. The bulb lights to about half normal brilliancy. Into the hole may be inserted either a grommet or a red jewel to give it a finished appearance. The bulb will indicate when the plate voltage is on and the oscillator osci [illegible] g. The lamp m [illegible] expensive sw [illegible] g resistor that do [illegible] e in value [illegible] ct the excitation [illegible] transmitter [illegible] on for a few r [illegible] These lamps (G. [illegible] Mazda 6 watt 12 [illegible] e commonly available at the five and dime [illegible] lware stores, and electric supply houses. They have a miniature screw type base and are used as pilot indicator lamps in many applications. This particular lamp has just the right resistance for the use to which it is put here.

Because operation is confined to 160 meters, it is not necessary to use high frequency dielectrics. This means that expense can be kept down by using ordinary garden variety wafer sockets and by using low-cost tubular paper condensers for r.f. by-passing. .01 µfd. mica condensers are quite expensive, and are no more effective than the tubular paper ones at 160 meters.

The resistor R_7 becomes quite warm during operation, and should be mounted in the clear. The r.f. chokes should be mounted at least two inches apart. The input lead connection to the bias cell should be made as short and direct as possible, and should be kept close to the horizontal portion of the chassis to minimize electrostatic hum pickup. The lead should be shielded where it leaves the chassis to the grid cap of the 6J7, and a shield "hat" placed over the top of the 6J7. The crystal mike plug should have a *metal* shell. If these precautions are observed and a good ground is made to the chassis, no trouble from hum pickup should be encountered.

Antenna Coupling

The antenna coupling or tuning apparatus was not made part of the transmitter because it will vary in nature with the type of antenna chosen, and the tuning unit can just as well be external to the transmitter as integral with it. Regardless of what type of antenna and feed system is used, inductive coupling is to be preferred. For this reason a pick-up coil was supported on stand-off insulators with semi-flexible leads in such a manner as to allow coupling or loading adjustment. The pick-up coil should be made about 2¼ inches in diameter in order to fit easily over the 809 plate coil. The actual number of turns will depend upon the antenna system used, ranging anywhere from 5 to 35 turns, the former being about right for a twisted pair doublet and the latter for an end-fed half-wave Hertz with parallel tuning.

Possibly the most widely used and undoubtedly the simplest 160-meter antenna system is the "Marconi". In its most popular form it consists of a single wire from 75 to 160 feet long, as high and straight and in the clear as possible, worked against a water pipe ground. Quite good results can be obtained with this system, The Po ɔ be recommend here there is i ate suppl pace available to half-wave transm he antenna tunin illustrated pplies mpanying diagram of the transmitter able for use with such an antenna. It consists merely of the pick-up coil already described (5 to 10 turns in this case, depending on individual antenna) and a variable condenser similar to the one used for tuning the 809 plate tank circuit. Provision is made for inserting a series loading coil (dotted), necessary where the antenna is shorter than a quarter-wavelength. If the overall total length of antenna and the ground lead is over 130 feet, no loading coil will be required.

If the ground connection is within a few feet of the transmitter, the antenna can be made nearly 160 feet long to advantage. However, if the ground lead must be more than a few feet long (it never should be over 30 feet in any case), the length of the ground lead should be subtracted from 160 feet to determine the maximum allowable length of the antenna proper. Increasing the length of the antenna will improve its performance (raise the radiation resistance, lower the circulating current, and get a better "bite" on the ether) but if it is made much over 160 feet long (including ground lead) difficulty will be encountered in series tuning it.

If it is impossible to get up a full quarter-wave of wire and a loading coil is required in order to resonate the system, one may be made by close winding sufficient no. 18 "bell wire" on a two- or three- inch form. The number of turns required will be determined by how much too short the antenna is. The shorter the antenna, the more turns required, and vice versa. Tapping the loading coil every few turns will facilitate the initial adjustment. The number of turns should be such that the antenna condenser resonates in the middle of the band somewhere near half scale.

Tuning: Operation

A small flashlamp or dial light connected to a three-turn loop of hook-up wire is an aid in tuning up the transmitter. After the filaments and heaters have been allowed to warm up for at least 30 seconds, the plate voltage may be applied. Plate voltage should not be applied before the 6F6 has had time to reach operating temperature; otherwise it will draw no plate current, there will be no drop across resistor R_7, and the full 600 volts will be applied to the electrolytic condenser C_{10}. The latter will survive such treatment few times at most. Also, if plate voltage is applied before the envelope and mercury of the 83 has had time to warm up a bit, the tube may flash over. The moral is obvious: don't be in too big a hurry to throw on the plate voltage after the filaments are first turned on.

With a good crystal in the oscillator, rotation of C_1 should produce lumination of the small Mazda swamping bulb over a portion of the dial. This indicates oscillation.

With C_1 tuned for greatest brilliancy of R_1, the amplifier tank condenser should be tuned for minimum plate current, which will be in the neighborhood of 20 ma. The antenna should then be coupled and the loading increased until the 809 draws about 80 or 85 ma. at resonance (assuming a plate voltage of 600). A whistle in the microphone will probably result in the plate milliammeter kicking downward slightly. The excitation should be reduced a little by backing off on the oscillator condenser and the antenna loading increased until the 809 again draws approximately 80 to 85 ma. This procedure should be repeated until the plate milliammeter kicks *upwards* about 5 ma. on a loud, sustained whistle, instead of kicking downward or standing still.

When the amplifier is adjusted properly, the plate current will run between 80 and 85 ma.. going up only about 10 ma. when the 809 plate tank condenser is detuned from resonance. The plate current will kick up about 5 ma. on a sustained whistle, and just show an occasional upward flicker on speech. The 809 should show no color when viewed in normal "inside daylight". The dial light pick-up loop indicator should show just a slight upward flicker under modulation when coupled sufficiently to a one or two turn "hitch" in the ground lead to produce an indication of about half normal brilliancy. Rotating the 809 plate tank condenser in either direction should result in reduced brilliancy, as should rotation in either direction of the antenna tuning condenser. This indicates exact resonance. The tuning will not be found critical, but an attempt should be made to get both these circuits "on the nose" even though they tune broadly.

Loading adjustments should always be made by varying the coupling between L_2 and the pickup loop, *not* by detuning the antenna condenser. The latter should always be adjusted to exact resonance as indicated by maximum brilliancy of the dial lamp coupled to the ground lead. If it is impossible to get sufficiently heavy loading, more turns are needed in the pickup coil. A grid modulated amplifier requires very heavy antenna loading, and more coupling turns will be required than would be needed for a plate modulated amplifier.

Before operating the transmitter on the air, the quality should be checked on a phone monitor, and the signal checked for splatter. The signal should continuously be checked for carrier shift and over-modulation by any of the numerous suitable devices described in past issues of RADIO and in the "RADIO *Handbook*."

Precautions

Be sure to wait 30 seconds after first turning on the filaments before applying plate voltage. If you do not trust yourself to observe this precaution, substitute an 83-v for the 83. The former costs more, but will take sufficient time to reach operating temperature that the 6F6 will also have reached operating temperature. This prevents application of plate voltage to the 6F6 before it is sufficiently warm to pass plate current, and thus protects the filter condenser C_{10}.

Until you are familiar with the settings of the condensers for your different crystals and can do it rapidly, do not attempt to tune up your transmitter during the busy evening hours.

Don't try to use the circuit shown (unneutralized) on the higher frequency phone bands.

Use a separate ground lead for the speech system, *not* the ground lead used for the antenna system.

Do not run the bias lead (to the 22.5-volt battery) any further than necessary. The battery should preferably be mounted within a couple of feet of the transmitter.

Do not attempt to raise the readability of your signals when working dx by hitting the mike harder. All it will do is distort and make your signals less intelligible, besides producing bad interference locally.

Dx

[*Continued from Page 86*]

he is on a tour of the Western and Central states.

G2ZQ has been doing some extra hard brass-pounding on 40 lately and has added VQ3TOM, PY2DN and U0NB, 7150 kc. in Irkutsk. Another nice one is TA1FF, 14,260 and 7130 . . . . . and still a couple more are VQ2HC, 14,100 and EA9DI; 7100. QRA's TA1FF, Bandyir no. 8, Smyrna. EA9AI, Dr. Mora, Canatejas N. 1, Metilla.

More for John: G2ZQ gets CR6AF, 7220 kc., and then G6WY works him right afterward. Boy, that's dx for ya.

Dx conditions for the phone men have been picking up lately over what they have been for the past two months. W6ITH has recently been working VK's, ZS, KA1ME and XU6LT in Canton, where it has been pretty tough to get them during the past "low" period. Reg also says that the government of Chile apparently has put the ta'oo on any of their amateur licensed stations speaking any other language but Spanish. Both CE1AO and CE1BC are Americans and lately they have blossomed out with their Spanish.

Oddly, there are more Japanese stations on now. As a matter of fact, here on the West Coast they have been thundering in between 8 and 10 p.m. p.s.t. . . . . . with their "20 watts." I understand there is a new law, or something, in effect in Japan limiting their hams to three-minute QSO's . . . . . and that includes the time they take calling, etc. Gee, at the rate some of them call a fellow they never will really get hooked up on account of lack of time.

The pet gripe for the boys this month is that all during the BERU contest they just have to sit there and listen to all of that good stuff and can't work it. A lot of 'em call this juicy dx. . . . . but about the only one that benefits by it is the power company. To those fellows all we can say is, "Next month you can let go all of that pent up energy."

W6MVQ is now eligible for the WAZ list. He has 30 zones, 20 on phone . . . . . W6KWA is now located in Fresno. W3ETE wants to know what's wrong with 20 . . . . . and the answer is that it is getting better and should be about right for the contest. If it isn't, sue me. Anyway, we shouldn't kick at the past two years we are getting spoiled . . . . . especially are the newcomers to the dx racket. Yessir, just wait 'til conditions get the same as they were in 1933-34 when we on the Pacific Coast would sit around for hours without even as much as hearing a European. The great topic of conversation in some of the dx hangouts around town was . . . . . "Gee, gosh . . . . . ol' Oscar heard a European about R4 last night . . . . . do ya spose he'll be on tonight."

Wilmer Allison, W5VV, has been doing his share of heavy brasspounding lately and now has 36 and 105. Here are some that made him that way: . . . . . FY8AB, FY8AC, TF2C, ZE1JZ, I7EY, I7AA, ZS3F, U5AH, VU2EO. I7EY is the same station as I7AA; in fact from now on he will sign I7AA only . . . . . QSL via the Italian Bureau. Don't forget ZS3F and U5AH might be worth working, as they count as countries in the new list. Wilmer wants to know QRA of TG1S. He has a heck of a time trying to get a card out of the TG and swears that if he doesn't get one pretty soon he is going to head south after him. For those of you who may not know, ... Wilmer is a former member of the Davis Cup Tennis team from USA, but has been catching up on his hamming during the past year. I understand he is going to start training soon in an effort to make the team this year. I don't think the dx contest is much of a place to train, but seriously we all wish W5VV luck in his campaign.

Johnny Kraus, W8JK, now has 25 zones and 47 countries on phone, and his c.w. and phone score is "34 and 74." Johnny uses some kind of a beam for his dx work, a "Flat Top" beam I think. W9AIC shoots in a bit of 7 Mc. dx and he's another one that claims his QRA is the darkest dx hole on earth. Anyway, this was worked on 40 between 0500 and 0830 G.m.t.; HA2L, HK5JD, D4NXR, D4AII, G5FA, F3KH, ZL1LZ, ZL1BR, VK4CW and the frequencies are in the list. Now here comes W6KEV with a little 40 info; his are HA2L, G2LC, G2PL, SM6SO, F3CX, ON4DAM . . . . . the latter three were heard but not worked . . . . . yet. Also KEV hooked HJ1K and LU5BL. He wants to know if G, GI and GM are counted as separate countries. For his benefit and others who may not know it . . . . . all countries listed in January 1938 RADIO are considered as separate; every name listed is to be counted as a country.

W2BJ is still puttering around and not on the air much any more; wonder what's troubling him. W6DRE in Phoenix, Arizona, has been waiting for the bands to open up. He has a perfectly good 25 watts waiting to go into his rhombic or two vee antennas. W9KG last month was crabbing because 40 wasn't so hot and now he sends in a list that would choke an ox. In fact, he made WAC on 40 between December 16 and January 15th. Keat is still running 90 watts to a pair of T20's and has 38 zones and 101 countries. W8AU has been doing himself a little good in hooking FI8AC, and I7EY who says his QRA is Addis Abababababababa, etc., Ethiopia. This makes him "38 and 98." W8AU has been stringing the boys over the air, and now a lot of 'em think he is a yl and they want pictures, dates, and what have you. I don't know what the score is but there are apparently a few suckers. Those who got roped were W9RFA, W6LRH and W6EAR. . . . . and oh yes, W3DUK thought he was a beautiful blonde and used to tell him "sweet things" over the air and write nice slushy letters. Instead of the usual 88 to W8AU . . . . . W3DUK would always send 98, explaining that was 10 degrees hotter. Oh my!!!! The guy finally wised up to the fact he was being "took" and some way or another he got his letters back, and in the struggle he ate them to get rid of 'em. Now the gang call him "Billy Goat Bunch". I could think of a worse one.

ON4AU sends in a few calls heard on those bands which are not supposed to be so hot as dx bands. For a few day during December he heard the following on 7 Mc. K6PEJ, K6OXJ, and W6WA, NZE, PCE, OZF, LXY, BVC, OSQ, FSD, W AQE, GGE, GQI, BQA, AXS, AVH, XE2JK YS1FM, HK5JD, CR5CH, CM7AB, CM6PZ, XE1BA, CM6DV, VE5ACN, PY2DN, VP1DM, VP5IE. Since January 1st the following have been heard on 3.5 Mc. 6W's, 1FYS, 1HKY, 3FLM, 3DNU, 3CHH, 3FHA, 3AGK, 4BQM, 4EYC, 8QMK, 8KWA, 8EIS, 8RFM, 2BCX, 2DYO, 2JKH, 2KPI, 9RIE, 9YOS, VE2GE, TF5X. ON4AU is using a rig with pushpull 804's running around 240 watts.

Walt Stiles, W8DPY, says that CN1CR works on 20 and 40 and is close to 7150 kc. Usually hears him from 4 p.m. to midnight e.s.t. He will QSL direct if you do. FK8AB works 20 on about 14255. He tunes from 14250 to 14400, but seldom gets past the 14260 mark without hooking up. He likes to chew the rag and likes a good snappy fast call, call five times and sign twice. W8DPY has worked them both with 8 watts and an attic antenna. WOW!! DPY also has worked 20 zones and 23 countries since January 1st.

From another W4, L. E. Benjamin, W4AJX, puts it this way ,"Please increase my zones to 37; FI8AC was that wonderful person." From that I take it AJX really was glad to hook him. W8DOD has just grabbed his 30th zone and 85th country. W8AAT now has 35 and 87.

W6NNR, Guy Dennis, dropped in the other day to inform us that the band is opening up again for the fone boys. So, of course, I sat up and threw out my ears. Not that what he said would affect me much—but thought I would make a mental note of it, and here it is. Says NNR, "On the morning of February 13th I awoke early enough to get on the air and there was a signal just a rippin' through. I thought it was a VE fone tuning up, and you can imagine my surprise when he signed ZS3F". Anyway, Guy got him and found out that ZS3F had just put up an 8JK 60 footer (meaning antenna), and was just trying it out. Later on that day he hooked a station in Guatemala signing TG5. Kind of a screwy call but that's what the guy thought too. Anyway that makes 60 countries for him and he still has 29 zones.

W2HCE has hooked ZS3F, GW5KJ and G8MF (Channel Isles) and CX2AJ on 14 Mc. fone and now has 21 zones and 55 countries. Others for him are CN8AV, CN8AM, ZU6P, FA3QV, and a flock of ZS's. W6ITH also has worked ZS3F, and reports that the band is loosening up.

W6LPC with his 175 watts has been doing some nice dx with SU1WM, ZB1H, I1IY, F3KH, CR7AW, PY2AC and CX2AJ. He uses an 8JK beam. W6DOB is now going to town in a big way since he put up his 60 foot 8JK beam. Says there's nothing like it for a compact beam. Must be OK as he has increased his countries to 103. Lloyd is using a pair of Gammatrons with a cool kw. W2HCZ gives up a couple of good ones, FU2X, Dahomey, Africa, 7060 kc., and ZB1P, Malta, 7025 kc.

Ham Whyte, G6WY, has been on 40 quite a bit and he made WAC on that band in December. A few of them are ZL4FB, ZL4BQ, ZL2IW, PY2DN, U0NB(Zone 18), W1, 2, 3, 4, 5, 8, 9. ZP1P is active and SV1SP is a new one in Athens. LX1TW is on phone. Ham advises to look out for ZB2-OXVC, a Danish salvage steamer tied up at Gibraltar. He has a nice card with Gibraltar written written all over it. Any Americans can QSL via

[Continued on Page 96]

The Marketplace

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

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

(i) We reserve the right to reject part or all of any ad without assigning reasons therefor. Rates and conditions are subject to change without notice.

"We'd Guyed Her Full Well—"

O come all ye hams from far and from near;
To this tale of woe lend each can-cramped ear.
It happened last week, alas and alack,
In our nice front yard and right by the shack.

I first read a piece in good ole "R/9"
About sixty-footers with not a guy line.
("The Mayor" did mention—now I recall—
That concrete he used so his wouldn't fall.)

Then came all the dope in May RADIO
On Smith's Signal Squisher. I wasn't slow
To figure on how to make a small pole;
For holding the Squisher was my only goal.

Material on hand made thirty-four feet
Seemed the ideal height above the street.
So out came the hammer, the saw and the nails,
And soon she's complete to the smallest details.

The rotating "works" was not very good,
Simply a pulley made out of wood
She slips on the shaft but we don't care,
As long as we raise her up in the air.

So three of us hams tried giving a push;
And up came the thing, but not with a rush!
She's up in the air and looks a bit tall
When counting the Squisher, tower and all.

Wind blows on the Squisher up on the top;
She wiggles and bobs; she looks like a flop.
We pull on the rope; the thing works OK
Except that we can't revolve it that way.

At last we guy it with three little wires.
The wife comes to see it—nearly expires—
Cries: "Oh! it will fall without more support!"
I tell her: "Heck no! It's strong as a fort!"

Well, Boys, you can't win—the OW was right—
The blame' thing fell that very night!
We'd guyed her full well 'gainst wind from the south—
Who'd thought a wet norther would break the drouth?

—W5FGL.

Dx

[*Continued from Page 94*]

G6WY. G6GH was the first G contact for VR4AD in Br. Solomon Island. FQ8AB is returning to France this coming spring or early summer, so better hurry if you want a genuine FQ8. FB8AA is old FB8AG. Ham now has 39 zones and 138 countries. G6YL writes that in January RADIO it was stated that G2XC was the first G QSO for ST2CM. This is an error because she had the first contact on October 28th, while the QSO with G2XC was on the 29th. Of course I am sorry this happened but that particular section was reprinted from the RSGB *Bulletin* and we naturally assumed it to be correct. If everyone is happy now, then so are we.

G8MX has contacted 23 zones and 52 countries on phone, which is mighty fine work He uses a single T20. W4ELQ now has 30 zones and is glad to make the list. W2GT thinks the dx column is the *nuts,* what ever that is. Hi. Well, anihoo, he has 38 zones and 108 countries, which is a nice sum. ON4VU tells us that he can now show a total of 36 zones and 96 countries. He has 405 QSL's from USA, but still wants Nebraska, Nevada, Arkansas and New Mexico. He is hoping there are still some amateurs in those states.

W8HWE, Bob Haas, is headed for Los Angeles for a stay of several weeks. I guess after taking a slant at Hollywood, he might even extend those weeks . . . . . I've known it to happen. Bob has 38 and 112. His total will probably stick there for sometime, as, even though he does return to Pittsburgh . . . . it'll take him a while to "thaw out" after he gets back, if you get what I mean.

HERE ARE SOME MORE ADDITIONS TO THE FREQUENCY LIST WHICH BEGAN IN DECEMBER RADIO.

7 Mc.

CN1CR	7150	I1EC	7100
CR6AF	7180	K4KD	7030
D4AII	7030	LU5BL	7100
D4NXR	7030	MX5A	7065
EA6AF	7060	ON4DAM	7030
EA9AI	7100	OK1BC	7299
F3CX	7150	SM6SO	7100
F31B	7040	SP1LG	7100
F3KH	7035	SX3A	700
FU2X	7060	TA1FF	7130
G2LC	7170	U0NB	7150
G2PL	7050	YR5CF	7000
G5FA	7070	YV5AK	7025
HA2L	7100	ZB1P	7026
HJ1K	7015	ZD1Z	7030
HK5JD	7095		

14 Mc.

CN1CR	14405	OQ5AA	14060 fone
CN8AM	14080	OQ5AE	14320
CN8AZ	14315	OX2ZA	14440
CN8AV	14070	TA1FF	14260
CR7AW	14305	TF2C	14300
CR7AY	14035	TF5C	14300-040
CR9AC	14386	U5AH	14410
CT2BC	14320	U6WB	14390
CT2BE	14410	UK8IB	14300
ES5D	14040-325	VP1DM	14412
FA3QV	14328	VP2CD	14425
FY8AB	14450	VPCF	14295
FQ8AB	14282	VP6LN	14310
FY8AC	14375	VU2AN	14080
G8MF	14340	VU2CQ	14080 fone
HI8X	14050	VU2EO	14390
HI2T	14145	VU2GJ	14150
HR1JR	14410	VU2JP	14350
I7AA	14430-400	VS1AA	14015
I1ZZ	14380	VQ1AJ	14330
J2KJ	14250	VQ2HC	4100
J2MH	14270	VQ4CHS	14035
J2NG	14120 fone	VQ4CRI	14140
J2OV	14290	XU8AM	14080
KA1AX	14100	XU8AK	14240
KA1QL	14350	YL2CG	14400
K7EVM	14310	ZE1JV	14300
K7FNE	14025-380	ZE1JZ	14390
		ZS3F	14030

Just as we go to press we learn through W6AM, the retired c.w. man (ooooh) that the recent ruling in Chile requiring all amateurs to speak English, has been abolished. Through CE4AO Don was told that the law was misinterpreted, as that really applied to announcements made from any b.c. station. They are required to speak English, while the amateurs may again "use their own".

Well, gang, this is running far into the night and if I don't shut this thing off pretty soon, you'll be so worn out you won't be worth a d-d-d-doggone in the contest. Listen you, and you too, ... how about giving me a lift on contest scores, immediately after the turmoil is over. Round up a batch and shoot 'em in to me. The more everyone sends in the more scores we will be able to give to you. As for me . . . . I'll round up my score . . . . without much trouble. Last year I made almost 793 points single handed in the dx contest and this didn't include a solitary W9 contact . . . . . believe it or nix. This year I hope to make a few more points than the 793 . . . . even if I have to throw in a bunch of nines. Remember . . . . don't let yourself get out of the band, for two reasons, disqualification and "pink tickets" . . . . it's a bad combination. Now, wouldn't my face be six shades of red if I went sliding 'way out there? I'll tell you what I am going to do . . . . . you've heard of this guy, By Goodman, W1JPE . . . . . well, I have a feeling he is going to be in there plenty next month, and I'm going to park my variable crystal right on top of him. Just good clean fun, you know.

Good luck fellows, in the "free-for-all" and don't wear any brass knuckles.

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.

BEGINNER'S 809 PHONE

C_1—Hammarlund "Star"
C_2, C_4, C_5, C_6, C_7, C_8, C_9—Cornell Dubilier "Dwarf Tiger"
C_3—Cardwell "Midway" MR-365-BS
C_{10}—Cornell Dubilier type EB-9080
C_{11}, C_{12}—Cornell Dubilier TL-6040
R_7—Ohmite "Brown Devil"
RFC—Meissner 1995
Coil Forms—Hammarlund XP-53
CH_1—Stancor C-1277
CH_2—Stancor C-1410
T_1—Stancor A-4416
T_2—Stancor P-3010
T_3—Stancor P-5009
Crystal—Monitor type AT
Mike—Astatic type T-3 "Acorn" crystal
Knobs—Crowe
"C" Battery—Burgess type 5156

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TELEPHONE, ARMITAGE 1730-1

To the Amateur:

I honestly believe that the T-40 and the TZ-40 represent the best values ever offered to an amateur.

When you use these tubes you will get a new conception of quality, stamina, dependability and performance.

We are proud to be able to offer you these wonder tubes.

Yours for MORE WATTS PER DOLLAR.

Frank J. Hajek

FRANK J. HAJEK - W9ECA
SECRETARY & TREASURER

TWO NEW

WONDER TUBES

TZ-40

A high Mu zero bias Triode offering wide possibilities in Class B Audio operation and as a high power doubler and buffer. 175 watts of Class B Audio output with 3 watts drive! As an exciter it will drive efficiently an amplifier stage to 700-800 watts input. Complete technical bulletin for the asking — at your Distributor or write us.

TZ-40

GENERAL CHARACTERISTICS

Filament	7.5 volts
Filament current	2.5 amps.
Amp. factor	62
Plate to Grid cap	4.5 MMF

CLASS B AUDIO OPERATION (Values for 2 tubes)

Plate Volts	1000
Bias	0
Peak A.F. Grid to Grid voltage	220
Zero signal DC plate current	44 MA
Max. Sig. plate current	280 MA
Plate to plate load	6800 ohms
Av. Driving Power	3 watts
Power output	175 watts

CLASS C OPERATION

Plate volts	1000
Plate current	115 MA
Grid volts	−45
Grid current, Max.	35 MA
Driving power, Max.	10 watts

OVERALL DIMENSIONS

Max. length	6½
Max. diam.	2

Comparison Sells Taylor Tubes

Taylor HEAVY **CUSTOM BUILT** DUTY **Tubes**

TAYLOR CHAMPS

T-40 TZ-40

A pair of WONDER TUBES—setting an entirely new standard of value. Experienced Radio Distributors, Tube Builders and Engineers, marvel at Taylor's aggressiveness and ability to continually produce better transmitting tubes at "More Watts Per Dollar" values. You, the amateurs of the world will wonder at the more efficient results of these truly amazing WONDER TUBES. Read the characteristics and remember that the rugged carbon anodes used in these and other Taylor tubes operate at red heat without injury to filament emission. The T-40 and TZ-40 operate efficiently in all transmission services on all amateur frequencies. These new WONDER TUBES are destined to be the outstanding sales champs of 1938. See them before you buy —comparison sells Taylor Tubes.

T-40

A general purpose Triode with characteristics that make possible super-efficient performance in all Class C services on all Amateur Frequencies. Extremely easy to drive—the ratings given here are maximum requirements for high level modulated amplifiers. For CW or buffer operation the drive required is 50% less. Ask your distributor or write us for complete technical bulletins.

T-40

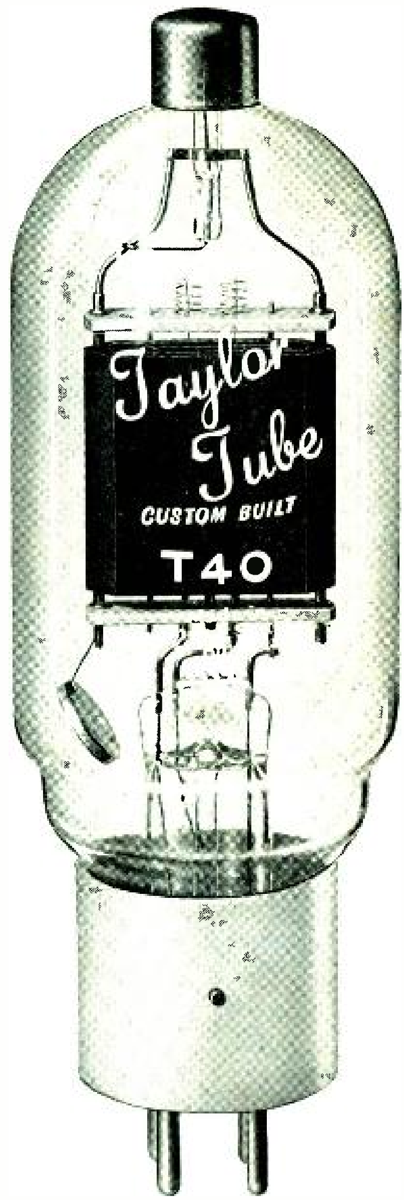
GENERAL CHARACTERISTICS

Filament	7.5 volts
Filament current	2.5 amps.
Amp. factor	25
Plate to Grid cap	4.5 MMF

CLASS C OPERATION
(1.7 MC. to 60 MC.)

Plate volts	1000
Plate current	115 MA
Grid volts	–80
Grid current, Max.	35 MA
Driving power, Max.	10 watts

$3.50



Actual Size

Recommended by Leading Parts Distributors

"More Watts Per Dollar"

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

Every Amateur Station Can Use These RCA Types to Great Advantage

RCA-808
$7.75

The RCA-808 offers you many outstanding features—check them off below. The RCA-808 is excellent as a medium-power final stage or high-power buffer doubler.

1. TANTALUM PLATE... Gives high plate dissipation and assures freedom from gas.

2. LEADS... Plate at top, grid at side, provide maximum insulation, maximum convenience of circuit arrangement, and low inter-electrode capacitances.

3. BULB STYLE... Gives maximum heat dissipating area and cooler bulb for equivalent size tube. Large spacing between plate and bulb reduces possibility of gas evolution from bulb.

4. ELECTRODE SUPPORTS... Constructed with minimum of insulating materials.

5. LARGE PLATE CAP... Provides low contact resistance and greater strength.

6. HIGH PERVEANCE... Perveance is a fundamental tube constant inversely proportional to tube impedance. A high-perveance tube is, therefore, a low-impedance tube. A high-perveance tube can be operated at reasonable plate voltages with high plate efficiencies, thus avoiding the necessity for costly high-voltage power supplies.

7. HIGH-MU GRID... Requires less bias—is economical and convenient. Low cut-off voltage means low plate current at zero bias; thus, the tube is protected should excitation fail with grid-leak bias.

8. HEAVY DUTY FILAMENT...7.5 volt, 4 amp. filament provides large reserve emission for heavy-duty operation.

RCA-913

NOW $4

The demand for the RCA-913 has resulted in increased production, which permits a saving in costs. Hence, a price reduction. At its new low price of $4.00, the RCA-913 is now a greater value.

The RCA-913 is *the* cathode-ray tube for use where a larger tube would be unsuitable. Its convenient size plus the fact that it requires only a simple power supply (operates at a maximum of 500 volts and gives good images at voltages as low as 250) makes it particularly suitable for portable equipment, and a highly desirable unit to be built permanently into the transmitter for checking operation and for modulation monitoring.

9. CONSERVATIVE RATINGS... Class C telegraph service; 50 watts plate dissipation, 1500 plate volts, 200 watts input power—RCA's conservative ratings assure long, economical, and satisfactory tube operation.

RCA *for Amateur Radio*

AMATEUR RADIO SECTION

RCA Manufacturing Co., Inc., Camden, N. J. • *A Service of the Radio Corporation of America*