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RADIO

ESTABLISHED 1917

SHORT-WAVE AND EXPERIMENTAL

OHM'S LAW

$E = I \times R$

$R = \frac{E}{I}$

$I = \frac{E}{R}$

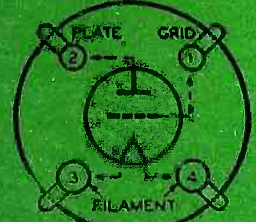
CONDENSERS IN SERIES

$C_{TOTAL} = \frac{C_1 \times C_2}{C_1 + C_2}$

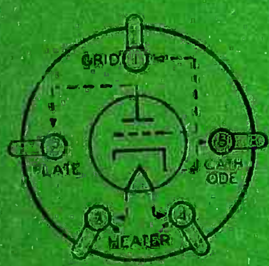
RESISTANCES IN PARALLEL

$R_{TOTAL} = \frac{R_1 \times R_2}{R_1 + R_2}$

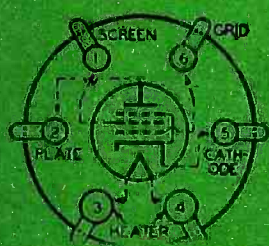
BOTTOM VIEWS OF SOCKETS



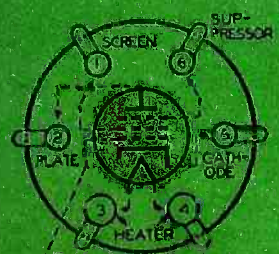
4-PRONG SOCKET
50-201-A, 45, 210, 30, 31, ETC.



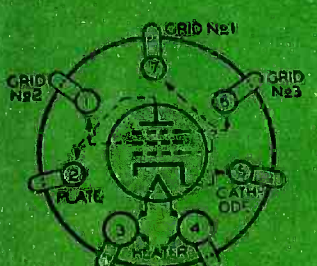
5-PRONG SOCKET
56-46-47-76-27-37



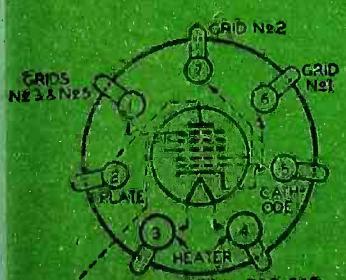
6-PRONG SOCKET
2A5-[illegible]-42-43



GRID-METAL TOP CAP
6-PRONG SOCKET
57-58-6C6-6D6-77-78



7-PRONG SOCKET 59



GRID No4-METAL TOP CAP
7-PRONG SOCKET
2A7-6A7

—IN THIS ISSUE—

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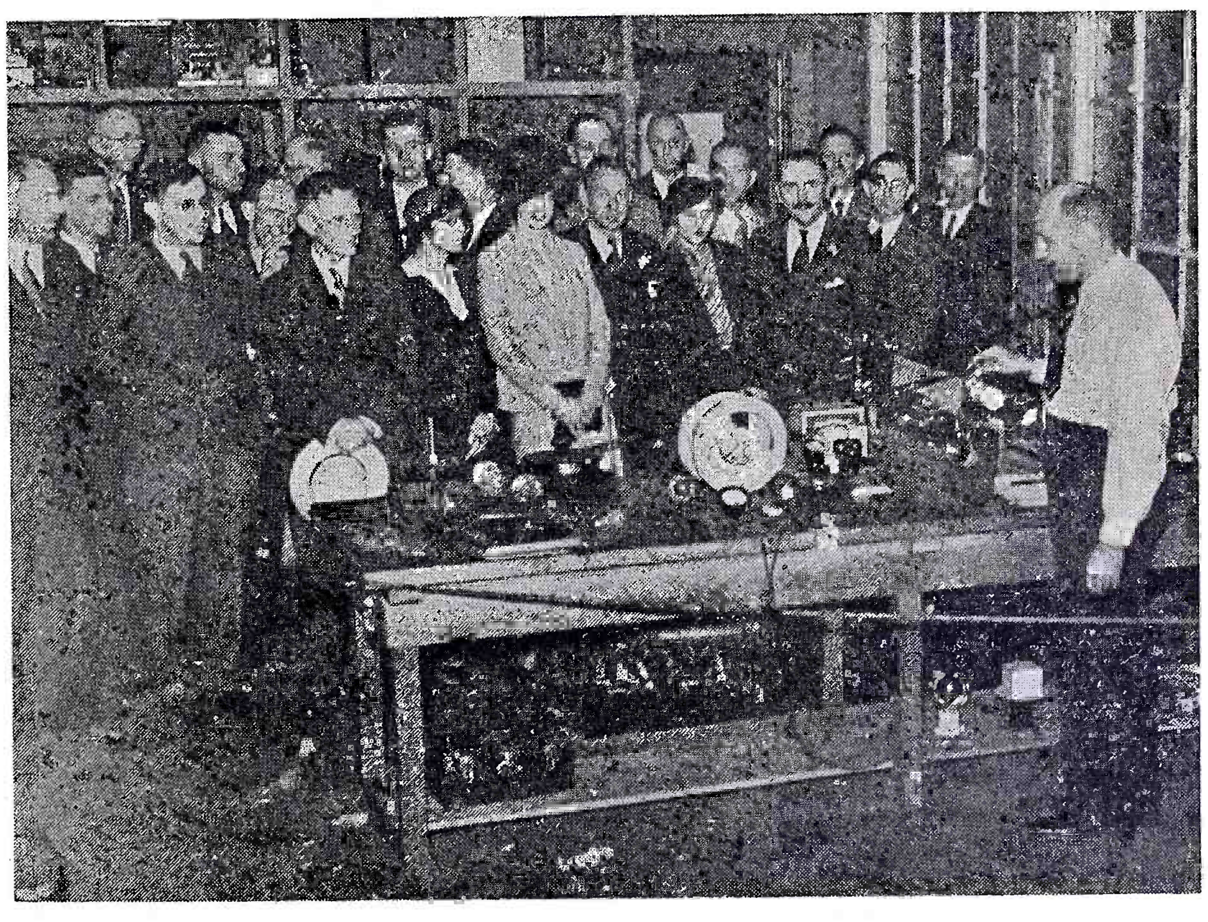
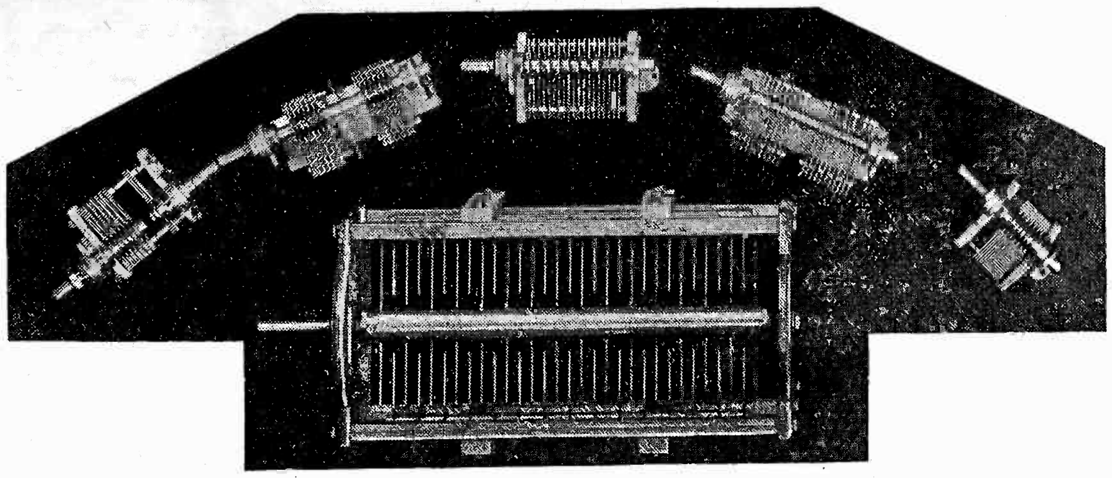


A new chapter in radio history is written. The Illustration shows Mr. Ralph M. Heintz adjusting a 150-watt R.F. Amplifier which is being driven by the sensationally new Farnsworth Electron Multiplier Tube. This new tube uses neither filament nor grid. "Among those present" in the photo are Dr. Leonard Fuller, Dr. F. E. Terman, Arthur H. Halloran, Herbert E. Metcalf, Donald Lippincott, George Everson, and other radio engineers and scientists.

FEATURE ARTICLES BY . . .

CLAYTON F. BANE - - - ARTHUR H. HALLORAN - - - J. N. A. HAWKINS

W. W. SMITH - G. F. LAMPKIN - FRANK C. JONES - BERNARD EPHRAIM



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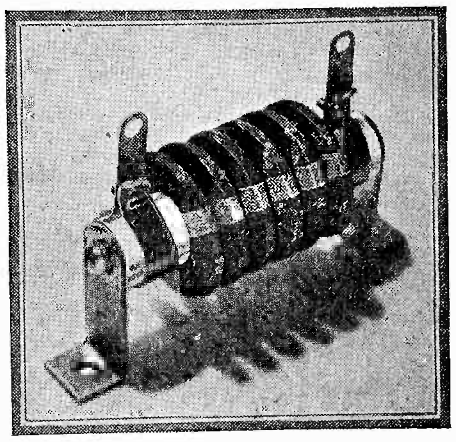
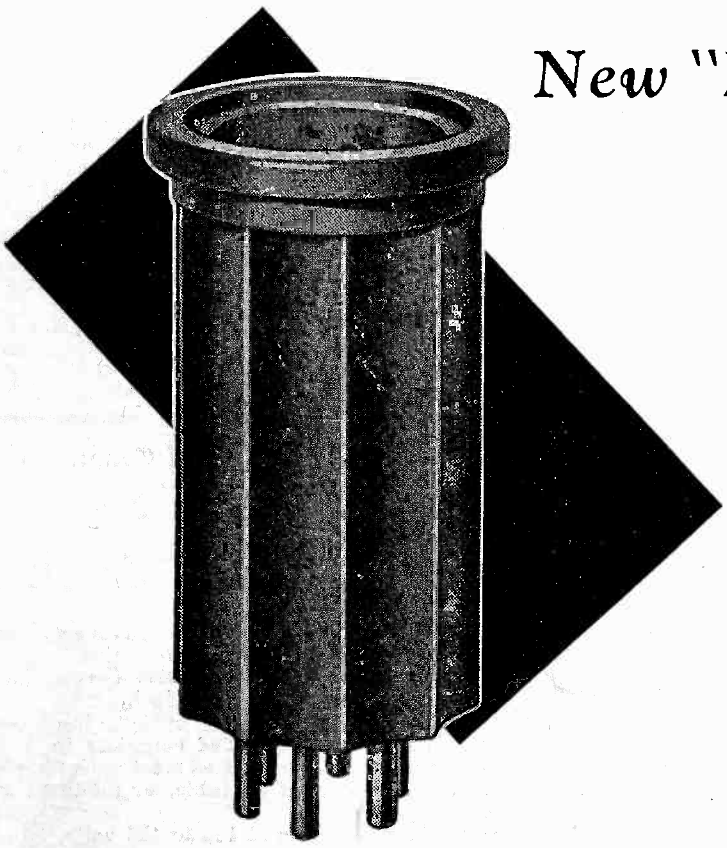


Heavy-Duty Transmitter Choke



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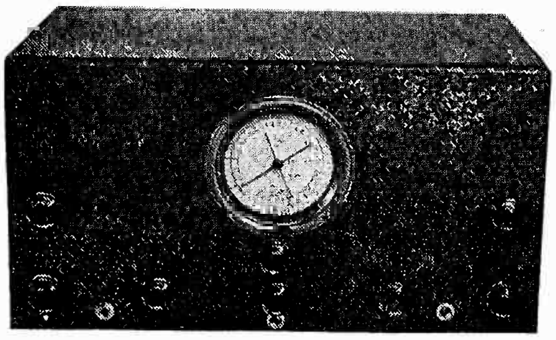
The NEW 5C PROFESSIONAL SINGLE SIGNAL SUPERHETERODYNE



The 5C is the 1934 improved model of the now famous 5B—choice of W9USA of the World's Fair and amateurs the world over in preference to all available competition.

The first outstanding feature of the new 5C is the accurately calibrated large airplane "watch" dial, having one pointer for the three-gang main tuning condenser, and a second pointer on a 0-100 division scale for the three-gang band spread condenser—available by simply pulling out the tuning knob!

The 5C has a new high-gain tuned r.f. stage on all bands for image selectivity, and manual or automatic volume control at the turn of a switch, plus all the features that have made the 5B famous, including air tuned i.f. amplifier.

That it is far in advance of all other competitive receivers is proven conclusively by the roster of its users—from W9USA to Col. Foster W6HM.

SEE WHAT W9USA SAYS ABOUT ITS PRECISION

"After four months' continuous daily operation at World's Fair Station W9USA and public demonstrations daily at Hall of Science Theatre, very glad report most uniformly satisfactory results four of your 5B receivers. ..Congratulations excellent design."
F. J. Hinds, Chairman, World's Fair Radio Amateur Council.

TECHNICAL FEATURES

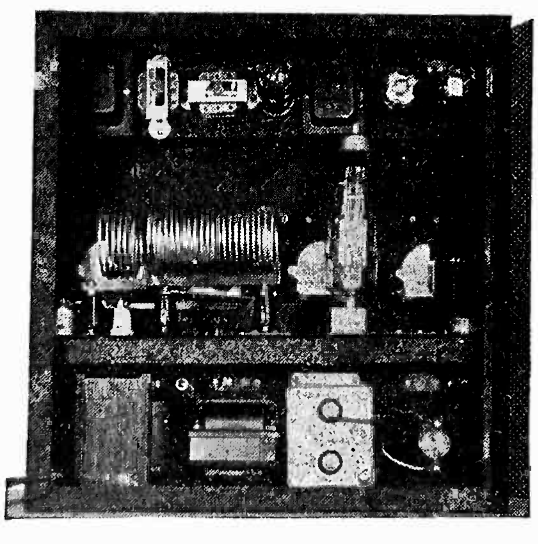
Sensitivity: Every 5C receiver shipped from the laboratory is guaranteed to have a sensitivity of 1 microvolt absolute or better.
Selectivity: Each 5C will have selectivity curve 26 kc. wide 10,000 times down without crystals, or 50 cycles wide with crystal.
Fidelity: The overall antenna to speaker fidelity of the 5C without crystal is uniform to 6 decibels from 30 to 4000 cycles—or absolutely uniform over the entire fundamental musical range at the loud speaker output. Yet by means of the crystal control knob, 50 cycles selectivity can be had at will.
Power Output: The undistorted power output of the 5C is three watts.
Volume Control: The 5C is equipped with audio volume control for use when the A.V.C. is switched in, and with manual i.f. sensitivity control for use when A.V.C. is switched out for high speed telegraph reception. By the turn of a knob the sensitivity can be raised to the maximum and very weak distant stations may be brought in easily—or lowered for locals.
Circuit: All wave superheterodyne employing a '58 r.f. amplifier, 2A7 high efficiency first detector and electron coupled oscillator, two '58 i.f. amplifier stages. '55 diode second detector, diode A.V.C. and triode first audio stage. '58 audio beat oscillator for C.W. code reception, 2A5 in Class A power output stage, and one '80 rectifier.
Wave Length Range: 13 to 200 meters, or 1500 to 23,000 kc. in three low C bands.
Dial: One illuminated dial accurately calibrated (error not over 1%) in megacycles (thousands of kilocycles) for the three short wave bands. Tuning ratio is nine to one.
Band Spread Tuning: All stations can be tuned on the main dial, or will be found well spread out and easy to tune on the band spread dial, which, located on the main large airplane "watch" dial, is brought into use by simply pulling out the tuning knob, which then operates the band spread pointer and three-gang band spread condenser. Band spread approximately 100 degrees for 80 and 160 meter, 50 degrees for 20 and 40 meter amateur bands approximately, and available anywhere in range of receiver by pulling out tuning knob.
Wave Length Change: One knob, with colored indicators matching dial scale colors. Knob actuates positive three position, six-gang selector switch having positive non-wearing, silver plated contacts.
I.F. Amplification: Two stages of dual air tuned 465 kc. amplification using a total of five "Litz" wound tuned circuits and two '58 super control tubes.
Shielding: All r.f. and i.f. circuits completely shielded from external pickup. Two antenna binding posts only "hot" points exposed. Heavy cabinet provided with hinged top for easy access.
Loud Speaker: Specially designed and matched Jensen dynamic unit in cabinet 7" square and 3½" deep.
Tropical Climate Provision: All transformers, coils and condensers specially sealed against moisture, particularly for tropical climates. All filter condensers, power transformers, chokes and resistors greatly oversize to avoid possibility of breakdown in places remote from replacement part sources.
Finish: Crystalline black on all parts except tube and r.f. shields, which are polished aluminum.
Dimensions: 17" long over all, 10¾" deep and 8¾" high.
Antenna: Separate r.f. primaries for each band and allow use of doublets or Marconi antennae at will.
Crystal: When ordered, the 5C can be supplied with special Bliley quartz crystal resonator in Bliley holder, and with i.f. amplifier properly aligned to exact crystal frequency.
Type 5C communication receiver ,as above, complete with eight tested Raytheon tubes, Jensen speaker and cabinets, ready to operate, list price $124.50. Net price to amateurs $74.20. Order it direct or from your dealer.
Add to above for Bliley 465 kc. crystal in Bliley holder and specific receiver alignment for individual crystal supplied, list price $15.00. Net price to licensed amateurs $9.00.

TYPE 10D
100 WATT PROFESSIONAL PHONE-C.W. TRANSMITTER

The type 10D transmitter is the amateur's dream come true. It provides 100 to 120 watts of crystal controlled r.f. power on the 10, 20, 40, 80 and 160 meter amateur bands modulated 100% with high fidelity broadcast station modulation, all at a cost below what you can build it for!

It employs one RK20 screen grid r.f. pentode as a crystal controlled Tritet (electron coupled) oscillator. Modulation is affected by suppressor grid voltage variation, which is obtained from a simple three stage audio modulator. But read its specifications, look at its price, and get on the air with 100 watts of broadcast station voice quality cheaper than you can build a 100 watt telegraph transmitter!

Order it from your dealer or direct and join the P.W.A.C. Club (Phone Worked All Countries).



SPECIFICATIONS

R.F. Output: 100 to 120 watts on fundamental crystal frequency. 60 watts on crystal second harmonic.
Frequency Range: 10, 20, 40, 80 or 160 meter amateur bands. One pair of two plug-in coils covers each band.
Tubes Needed: 1—RK20 Oscillator, 1—RK19 Rectifier, 1—2A5 Power Amplifier, 1—53 Voltage Amplifier (2 stages), 1—80 Rectifier.
Modulation: Linear suppressor grid modulation variable from zero to over 100% at will. Harmonic distortion less than 5% at 100% modulation.
Audio Frequency Range: Modulation curve flat to 4db. from 40 to 8000 cycles. Variable tone control provided for high audio frequency attenuation as desired.
A.C. Modulation Hum: Negligible.
Phone-Telegraph Section: Two position toggle switch and r.f. unit selects phone or C.W. telegraph operation at will.
Antenna Tuning: Two 365 mmf. condensers provided for series antenna tuning, or parallel antenna tuning by shift of two connecting links.
Meters: None provided except on special order (mounted on r.f. unit panel). One 0-150 ma. millameter and, if desired, one 0-2 antenna thermoameter are all required to check operation.
Controls: Oscillator plate, r.f. plate and two antenna tuning dials. Phone-Telegraph, send-receive, modulator on-off and power on-off switches. Screen and plate current measuring jacks. Key jack.
Size: Total height of all three 19" x 3/16" aluminum relay rack panels, 19¼". Supplied complete in dust cover shielding cabinet of perforated steel with hinged rear door. May be operated on table, or mounted in relay rack.
Power Required: 350 watts at 105 to 125 volts, 50 to 60 cycle A.C.
Accessories Needed: One Bliley crystal and holder (specify frequency), one crystal microphone, and tubes as listed above.
Price net to Amateurs, $119.70.
Five Raytheon tubes $25.23 net.
Coils, per set of two (one set included, specify if for 20, 40, 80 or 160 meter band) $3.60.

Send 3c stamp for new complete catalog describing above items, E.C. Frequency Meters, New Airplane Dials, Relay Racks, R.F. Chokes, Audio, Power and Filter Transformers, and a host of new and interesting amateur and commercial apparatus.

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Vol. 16 OCTOBER, 1934 No. 10

RADIOTORIAL COMMENT

THE thirty days which hath September were filled with good news about new tubes for the use of amateur transmitters, especially those who are working in the ultra-high frequency bands. There is a new RCA Radiotron of the "Acorn" type which oscillates at all frequencies up to 600 megacycles and which may also be used as an amplifier and detector. Another new ultra-high frequency tube is the Western Electric 304A. And finally comes word of the remarkable performance of the Farnsworth cold-cathode tube as an oscillator. Early mention of the latter was made in these columns in July with promise of more complete details. These appear elsewhere in this issue.

Such new tubes should be the means for popularizing the ultra-short wavelengths with a great host of amateur transmitters. They offer a practical means for relieving the congestion in the longer wavelengths. Already, many amateurs have equipped their cars with 5-meter transmitters and receivers for local communication. But it must not be forgotten that the ultra-short waves are not suitable for long distance work, and that other services will soon be clamoring for room therein.

★ ★

Politics

IN LAST month's RADIO was a request that the reader express his opinion of this magazine's political platform. The responses have been as many as they were varied. And still they come from all parts of the world. Those in foreign countries tell us that our politics don't interest them because they don't know what we are talking about . . . that our elephants are their mosquitoes. Others ask us to make it our business to see that the entire present clique of amateur radio's do-nothings be replaced by a more aggressive administration. Almost universally, the cry is for more frequencies.

So let's forget about politics and get down to some fundamental facts. First of all, there's hardly a man in Congress who knows what an amateur is or what he does. Consequently, it should be our business to make Congressmen amateur-minded. We want them to come to our stations . . . we want them to talk to their associates in other states . . . we want them to go to Congress with the indelible thought that the amateur is doing something, that he is the backbone of tomorrow's radio . . . and that his interests must be protected and respected.

How to do it? The International Radio Fraternity already seems to have the answer. Forty-one high-power phone stations will chain up for a transcontinental weekly chat, and Congressmen will be invited to come right into these stations and see, hear, talk and think amateur radio. Complete details are promised for the next issue.

★ ★

High-vs-Low Power

PROPOSALS for a 100-watt power limitation for amateur transmitters arise from the simple fact that the amateurs do not have sufficient room in which to operate. Rather than to self-restrict themselves to any further extent, doesn't it seem more wise to ask for a power increase . . . to 5 kilowatts . . . and go about getting more space in which to operate, so that any amateur, no matter if he uses a watt or a kilowatt, can operate to his heart's content? Why not crowd some of those unprofitable "frequency holding" signals into a narrower band, make more room for the amateur and give the high-power men a restricted band of their own, in which they can operate without molestation from the lower-power stations? Surely, something can be done about it. Let the high-power man first prove that he is worthy to enter a sacred spectrum, let him prove it by Federal examination, and let us put a chain of stations on the air that will be as dependable and as reliable to Uncle Sam in times of emergency as any commercially-owned system.

The low-power men don't like to be busted-up by those with high power. And who can say that this great majority of low-power users is not entitled to a voice? In the interests of public convenience and necessity, there is a place on the air where high-power men can operate to their heart's content, by special license, by possessing the required knowledge and experience to permit them to enjoy the special privilege—and it can be done if the amateurs will fight for what they need. When the highways became overcrowded the drivers of autos were not compelled to stay at home; they secured the necessary legislation to widen the highways. So it is with amateur radio. If there isn't enough room in the present bands to permit both high and low power stations to operate without falling all over each other's signals, then it is high time that something is done about it. There can be but one answer . . . not power restriction, but WIDER BANDS. If the amateurs voluntarily impose further restrictions upon themselves the time will soon come when they will have no bands at all left in which to work. A word to the wise should be sufficient here.

To this magazine has come a suggestion that the newcomer be restricted to the 80 and 160 meter bands for a period of one year before he is given the privilege to operate in the 40 and 20 meter bands, and that he be re-examined and re-licensed to prove his skill before he enters the higher-frequency spectrum. The CW portion of the 160 meter band is woefully void of signals, as every amateur knows. Statistical data and a comprehensive set of charts will be shown in November "RADIO" giving the facts as to what portions of the bands are used during the various periods of the day and night, and what the amateur must do if he intends to retain the almost unused CW portion 'way up there on 160. If the amateurs don't make use of that portion of the band, it will very soon be taken away from them. Others are clamoring for the space. The police want it, the air-minded interests want it, others want it. To the man who knows nothing about radio, and it seems to be he who tells the amateur what he can and can not do, a cruise across the CW portion of the 160-meter band will arouse in him the desire to hang a To Let sign on that wide-open space—or he may do as the squatter does. Then try to oust him!

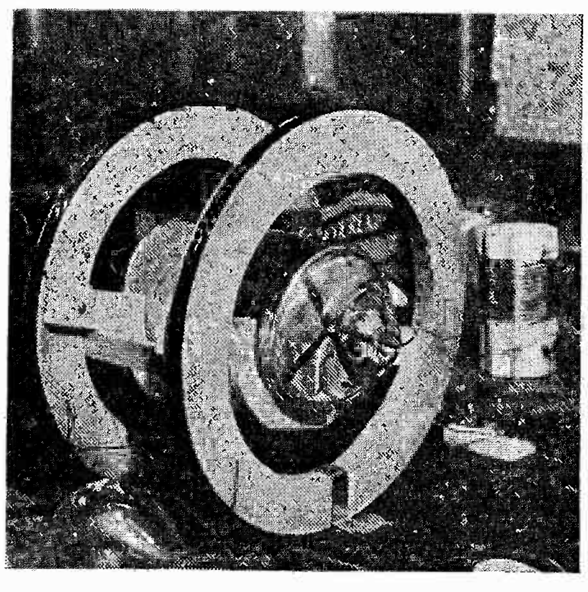
Farnsworth's Cold-Cathode Electron Multiplier Tube Uses Neither Grid Nor Filament

Ralph M. Heintz (center) explains the operation of the Farnsworth Cold Cathode Tube to Bernard H. Linden (left), U. S. Radio Inspector, and Donald Lippincott (right), director of Television Laboratories, Inc.

By ARTHUR H. HALLORAN

THINK of a vacuum tube without filament or grid, thus requiring neither an A nor a C battery, which generates high-frequency oscillations! This is what P. T. Farnsworth, the television genius, accomplishes with the cold-cathode tube which he originally developed as a current-amplifier for use with his cathode-ray pickup tube. It it also an exceedingly efficient detector and modulator.

Its first public use as an oscillator was in a radio circuit whereby communication was maintained between San Francisco and Honolulu and between San Francisco and New York on September 13, 1934, over the Globe Wireless 35-meter channel. In this test, with 30 milliamperes at 1100 volts on the anode, the tube drove a pair of 150-watt tubes in the final amplifier of a transmitter at the Heintz & Kaufmann factory in South San Francisco. The signals were received at both Honolulu and New York, and were reported as R9 by a ship 500 miles west of Honolulu. Wilkens of Dunedin, New Zealand, also heard the transmissions.



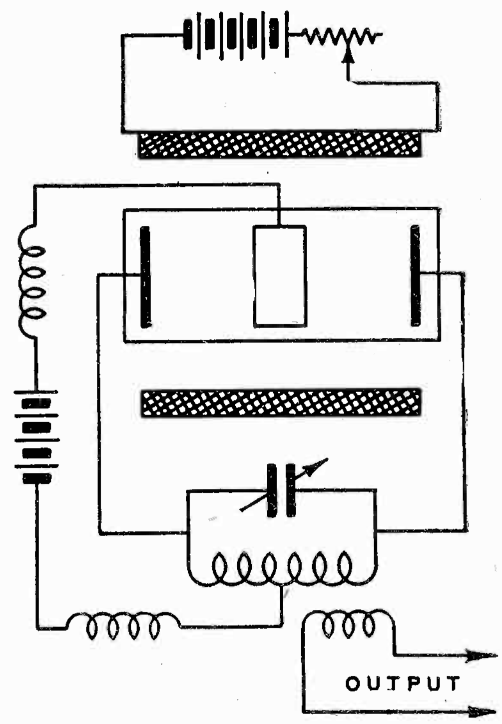
The Electron Multiplier as a high-frequency self-excited oscillator.

Previous laboratory tests proved that the tube is capable of generating oscillations of any desired frequency throughout the range from 200 kilocycles to 60 megacycles, these limits being set only by the dimensions of the available tuned circuits. An undistorted output of 25 watts was obtained from an input of 25 watts.

As an Amplifier

THE performance of this new type of tube depends upon the emission of secondary electrons from two cathodes which are bombarded with high-velocity primary electrons. The cathodes are coated with caesium silver oxide to enhance secondary emission. They, together with a central ring anode, are assembled in an evacuated glass tube. The tube is placed within a solenoid which is supplied with direct current so as to maintain an intense magnetic field throughout the length of the tube. When used as an amplifier, a high frequency voltage is applied to the cathode terminals and a D.C. voltage is applied to the anode terminal to hold it at a positive potential with respect to the cathodes, which are shunted by a coil and variable condenser in parallel. The shunt circuit is tuned so as to be in resonance for the applied high frequency voltage.

When the DC voltage is applied to the anode terminal, any free electrons in the inter-electrode space would immediately be drawn to the anode were it not that the longitudinal magnetic field neutralizes the transverse electrostatic field from the anode and were it not for the high-frequency electrostatic field which draws them to the alternately positively charged cathodes. The strength of these several fields can be adjusted to allow an electron to be shuttled back and forth in a zig-zag path between the cathodes any desired number of times before it is finally drawn out of circulation at the anode.



Oscillator circuit for cold cathode tube.

Each time that a high velocity electron strikes a cathode it causes the emission of from 2 to 8 secondary electrons, the number of secondaries depending upon the velocity of the impacting electron, and thus

(Continued on page 14)

Further Comments on the Banehawk

By CLAYTON F. BANE

A CONSIDERABLE number of those who have built the Banehawk front-end have attempted to do their testing by hooking it up as a T.R.F. unit. We mentioned previously that such operation was entirely feasible, but perhaps we did not sufficiently stress the importance of certain necessary changes. It should be remembered that the front-end, as described, was designed to operate as the RF, oscillator and mixer portions of a superheterodyne, and not as a separate oscillator, TRF set. The stipulations for proper operation of one or the other are entirely different.

Whether working as an autodyne or a superheterodyne receiver, the RF stage will remain substantially the same. The regenerative feature gives added gain and some measure of added selectivity, in either case. It is in the detector circuit that the trouble arises. It is certain that none will question the advantages of the power detector over the grid-leak type for the mixer stage in a superheterodyne. Remember, however, that even an excellent power detector with bias adjustment set to the optimum value will not give a gain higher than 10 or 15. Contrast this with the relatively enormous gain of several thousand, obtainable from a regenerative, grid-leak type detector, and there you have the reason why the original front-end does not have as much volume as a TRF set. The Banehawk was designed to work as the front-end of a super, and not as a TRF.

It might be very desirable, for a number of reasons, to operate the unit as a TRF. In this case some minor changes are necessary. Fig. 1 shows a TRF diagram. It will be seen that no radical changes are necessary.

For some unaccountable reason, many of those who tried this TRF idea on their Banehawks overlooked some simple but important points. Who would ever think of hooking-up an autodyne detector without an RF choke in the plate lead? On the other hand, no one would think of hooking a pair of 8000 ohm phones in the plate circuit of a screen-grid detector. But some have done it. If the circuit as shown is followed, the builder should be entirely satisfied.

One common trouble in Banehawks lies in failure to observe the correct polarities of the windings on the detector grid coil. Remember that both the detector grid winding and the RF plate winding are wound in the same direction, also that the lead of the RF winding nearest the grid end of the detector coil goes to the plate. If this polarity is not observed the results will be miserable, with no apparent cure. It is very easy to get these leads mixed when digging into the insides of the coil form and thus it is always well to check up, then come back later and make certain.

If the RF stage refuses to regenerate, look to the polarity and direction of winding on the cathode coil. This coil should be wound in the same direction as the grid coil, with the top of the winding (that nearest the ground end of the grid coil), going to cathode. If this is correct and still no regeneration is secured, measure the screen voltage or move the voltage divider tap on the potentiometer so as to have a greaer latitude of voltage range available across the poentiometer. At the optimum point of regeneration, the voltage (measured at the screen) should be approximately 80 volts. It is possible to obtain regeneration at much lower values of screen potential by increasing the number of cathode coil turns, or by moving this coil closer to the grid winding. In this case the tube will go into oscillation with the screen at a lower potential than is best for optimum gain. Should the stage still fail to regenerate after these precautions have been taken, the one remaining trouble is the possibility of too-close antenna coupling. If the coupling is too close, exactly the same condition exists as in any autodyne detector with the antenna coupling jammed up tight . . . no oscillation. If the reverse is true, and the stage breaks into violent oscillation with possible attendant howl, the condition can be remedied by either tightening-up the antenna coupling or lowering the voltage divider tap on the screen so that the stage, with the regeneration control full-up, will just reach the verge of oscillation.

In lining-up the front-end in conjunction with the IF, it is well to realize that the tracking of the RF and mixer stages is rather critical, more so that the usual front-end, due to the fact that the regeneration sharpens-up the RF stage considerably, and therefore the lining-up must be done carefully if the full potentialities are to be realized. One simple procedure for lining would be as follows: Tune in some signal with the oscillator and bring the signal strength up to the best possible value by tuning the RF-Detector gang condenser. If the trimmer is now rotated very slowly, meanwhile moving the RF-Detector dial rapidly back and forth over three or four degrees, a very definite point will be found on the trimmer where the signal strength increases tremendously. The stages are now in line, or very nearly so. An output meter would give an absolute check. Failure to find the optimum point means simply that turns must be added to, or removed until the stages come into line. Usually the position of the trimmer where the loudest signal is heard will show whether more or less turns are needed.

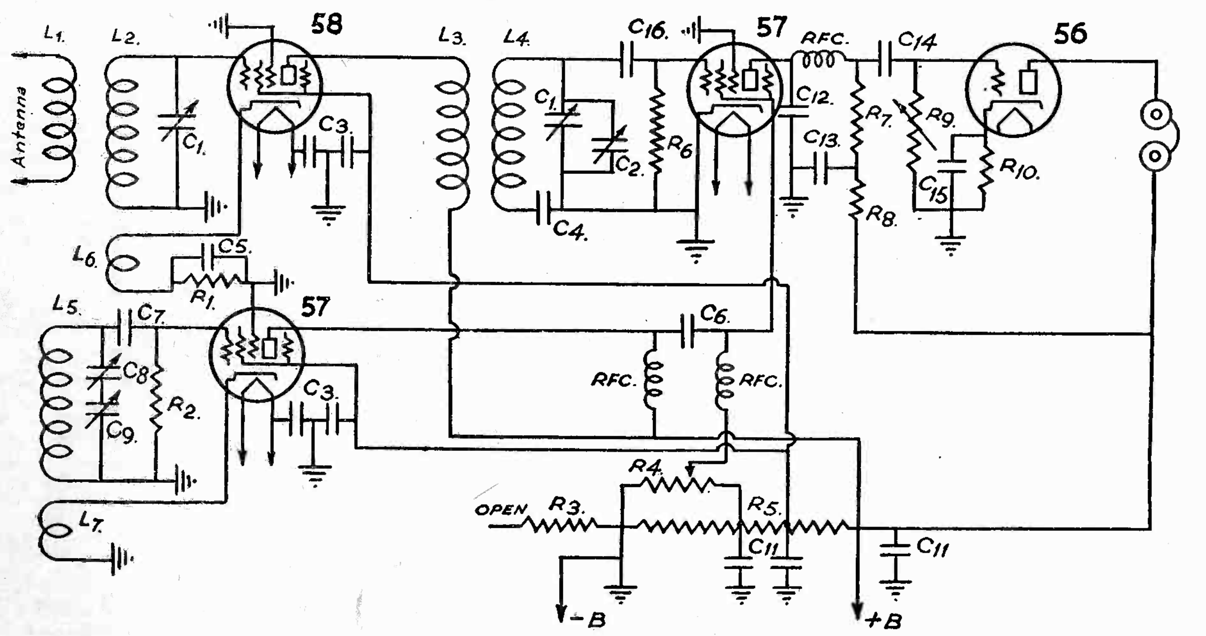
If it is found that the loudest signal is heard with the trimmer at minimum capacity, obviously a turn or two must be removed.

Crystal Filter

It will be recalled that we stated that an impedance step-down ratio of 30 to 1 was necessary for proper impedance matching of the usual 465 crystal. Please note that we said impedance ratio, not turns ratio! The impedance varies as the square of the number of turns; in this case a 30-to-1 impedance ratio would represent the square root of 30, or roughly 5.47 turns ratio. To show what happens when using the impedance ratio instead of the turns ratio, let us give an example: If an IF coil had, let us say, 225 turns, then according to the impedance ratio, the secondary should only have about 7 turns! The step-down ratio should be 5.47, or roughly 5-to-1, making a total of 45 turns on the secondary. Since the original step-down ratio was based on the assumption of certain values of impedance of the resonant circuit and the crystal, it is entirely possible that further experimentation with the turns ratio might prove advantageous.

The numerous requests for a good A.V.C. for the Banehawk must go unanswered until we work out a system that suffers from fewer evils than those commonly advocated. If you must have A.V.C., a diode second detector is an easy, but none too satisfactory answer. More on this subject at a later date.

To the hundreds of readers who have written for the promised pamphlet on the Banehawk we offer our apologies for the delay. We promised the pamphlet, and we will have it ready soon.



Circuit Diagram for T.R.F. Connection For Front-End of Banehawk Receiver

C1—Double Section, 100 mmf. per section, Hammarlund variable condenser.
C2—75 mmf. trimmer condenser, Hammarlund, variable.
C3—.01 mfd.
C4—.006 Sangamo mica.
C5—.1 mfd.
C6—.0001 Sangamo mica.
C7—.00025 mica.
C8-9—100 mmf. variable condensers, Hammarlund.
C10-11—.5 mfd.
C12—.00025 mica.
C13—.5 mfd.
C14—.02 mfd.
C15—.1 mfd.
C16—.0001 mica.
R1—500 ohms.
R2—25,000 ohms.
R3—500 ohms.
R4—50,000 ohm variable. Centralab.
R5—25,000 ohm, slider type voltage divider. Ohmite.
R6—1 megohm.
R7—200,000 ohm, carbon type.
R8—50,000 ohm, carbon type.
R9—500,000 ohm variable. Centralab.
R10—2000 ohm, 1 watt.
RFC—Hammarlund, short wave radio frequency chokes.
See "RADIO" for March, 1934, for coil data.

R. G. Martin, Manager of KUP

HOW PRESS IS SENT

R. G. MARTIN of "KUP" Takes You Behind the Scenes of a Newspaper "PX" Station

SPARKS is the familiar nickname of the radio operator who sails the seven seas. It originated from the crash and crackling of the once-famous spark gap, now sinking into oblivion. But the name "Sparks" will proabbly stay with the radio operator forever.

We scan the ocean with imaginary eyes, peer into the radio room of a slow tramp freighter, a sleek racing passenger liner, or an inter-island schooner and we find "Sparks" in his shirt sleeves, phones on his head or hung around his neck, twiddling the dials of his receiver at the zero hour for his few pages of press. Some vessels require from two to six sheets of press daily, others only one to two pages. The slow freighter needs only a page or so of press because the crew is small. But for passenger liners, carrying from two hundred to five hundred passengers, more press is necessary. A miniature newspaper is printed aboard ship daily. "Sparks" is always ready for his daily reception of press. If conditions are bad he loosens his collar, opens an extra pack of ciragettes and prepares for a strenuous job. But if conditions are good and when signals are booming through, ah!—it is a real pleasure to pound the mill and copy some fifteen to eighteen hundred words of press. No vessel is seldom out of reach of press.

We pause aboard the S.S. Mariposa, southbound from San Francisco to Sydney, Australia. The eight o'clock TR is about 4000 miles south of San Francisco. The second operator is lining up his receiver for the 0900GCT press. Right on the nose at 0900 (1:00 a.m. PST) he hears the 240-cycle or 360-cycle note pounding through announcing the day's press dispatches from KUP, the Mobile Press Station of the San Francisco "Examiner." The operator pounds the mill, . . . *Flash San Francisco, Cal.—The International Longshoremen's Association announces continuation of strike . . . Washington, D. C.—President Roosevelt's signature required on War Debt agreements . . . Chicago, Ill.—One of the worst droughts in history is being experienced throughout Middle West . . . San Francisco, Cal.—Jimmy Rolph Jr., Governor of California, dies . . . West Point, N. Y.—Two hundred fifty cadets graduate . . . Washington, D. C.—Silver Bill becomes part of Constitution . . . Rome, Italy—Mussolini urges greater air force . . . London, Eng.—England declares she will default next installment war debt . . . Shanghai, China—Three thousand bandits captured after fleeing with U. S. Missionary . . . Asbury Park, N. J.—Primo Carnera listed favorite to win over Max Baer, challenger, June fourteenth . . . Baseball scores, etc.*

And for an hour the operator pounds out his press for the day in order that his shipmates may know what is going on in the outside world. Perhaps you can call him a reporter as well as an editor of the ship's newspaper; nevertheless he's the man who supplies the news to the passengers and crew.

Let us wander to the source of these press transmissions. We stop before a tall skyscraper in the heart of San Francisco's business district. Here is the metropolitan newspaper of the Pacific coast, the San Francisco "Examiner." On the sixth floor of the Annex we find KUP, busy with transmission of news flashes. The operator is punching a tape perforator. The news is taken directly from dispatches received from the editorial rooms. Each bulletin is timed after each transmission.

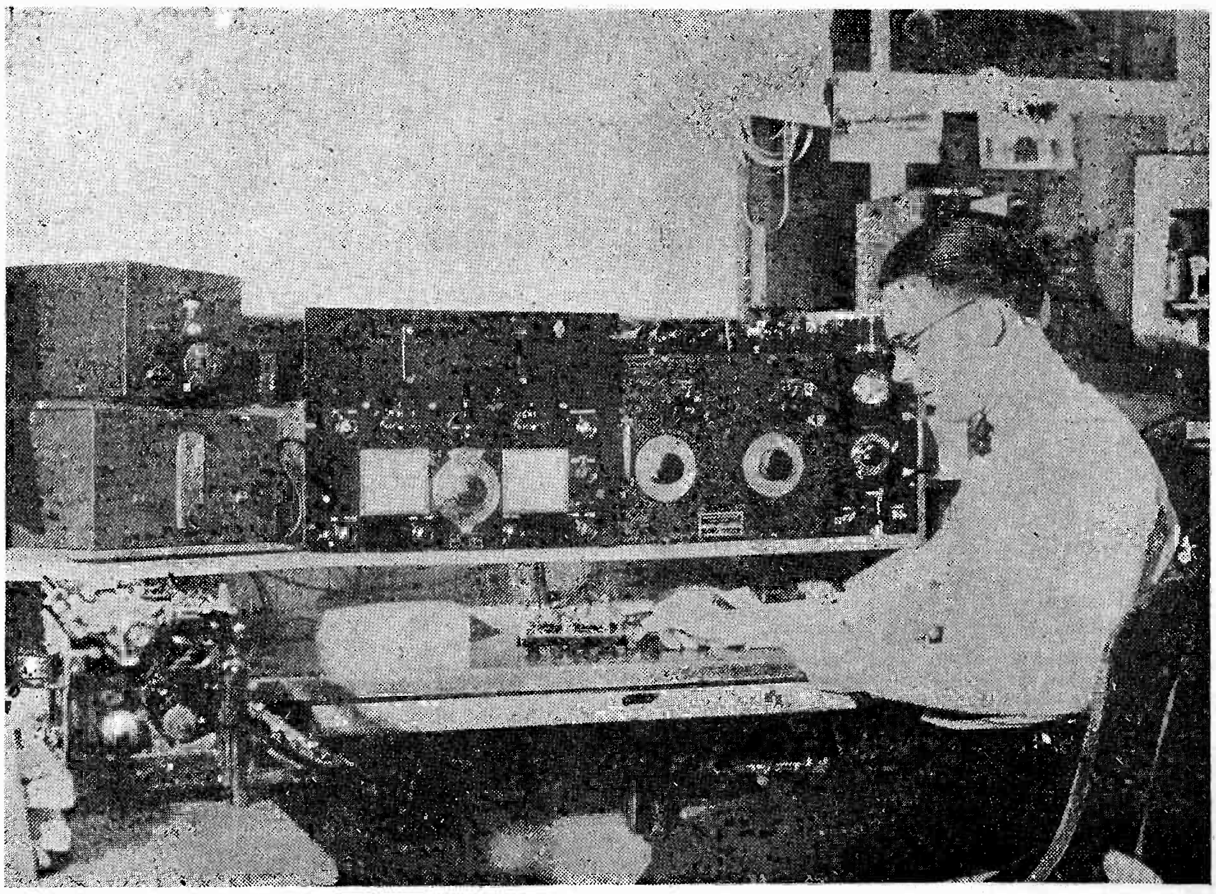
We leave the operating room and steal into the transmitter room. Here we see the 1.5 KW DeForest transmitter. It is a well-groomed piece of apparatus. The front panels hold the twenty-one meters, ten tuning controls, and three circuit control switches with the red and green pilot lights.

The transmitter is six feet six inches high, six feet long and three and a half feet deep. It is divided into three panels, amplifier, exciter and power supply.

The oscillator is crystal controlled. An oven, which is kept at constant temperature by thermostatic control, accommodates ten crystals and is maintained at a temperature of 50 degrees Centigrade. A 210 triode is employed in the oscillator at the present time, but a 247 pentode will be substituted, because the grid current across the crystal will be considerably lowered, thus improving the stability. The output of the oscillator is fed into a buffer stage using an 865, 7.5-watt screen grid tube. The tuning of these two stages is accomplished by the conventional condenser and tank circuits. The output of the buffer excites the first amplifier, an 860, 75-watt screen grid tube. This stage acts as the first and only doubler on 6440 KC because the buffer stage is tuned to the crystal frequency at all times. The output of the doubler excites the second intermediate amplifier, an 860. The tuning of these two latter stages, as well as the other stages of the transmitter, is accomplished by a vrey novel arrangement of varying the inductance in the tank circuit. Fixed capacities are employed across the inductances. Each stage has a grid and plate milliammeter. The plate meter is placed in the center tap of the filament transformers to ground. Each meter is also by-passed with a .002 fixed capacity.

The voltages applied to the plate of the oscillator '10, 865, and two 860s are as follows: 180, 550, 1125 and 1550 volts, respectively. The screen voltages for the larger tubes are not critical, being semi-automatically adjusted by series resistors. Bias is obtained from a separate rectifier unit. Its output voltage is 750 volts and a divider is placed across the full voltage; it acts as a base voltage for each stage. Series resistors take care of the additional bias taps. A bias control relay is employed and if anything should happen to the bias rectifier the plate voltage is automatically shut off from every stage. This completes the exciter panel.

Next, the power amplifier or final amplifier panel. Near the bottom of the panel is the third intermediate amplifier employing the third 860, 75-watt screen grid tube. It is similar to the first and second 860 stages. Its output excites the fourth intermeditae amplifier, an 861, 750-watt screen grid tube. This stage can be called the "exciter" since its output pushes the grids of the final which uses two 861s in push-pull. The plate tank



Relief Operator George Conklin (CN) and the Receiving Line-up at KUP circuit of the 861 "exciter" stage employs split inductances, enabling balanced excitation to be supplied to each grid of the final tubes. There is nothing unusual in the transmitter's final amplifier. The antenna coupling is clipped on the cold ends of the tanks, coupled to the feeders through .004 condensers.

The power panel contains practically all of the voltage supplies, with the exception of filament transformers. The crystal power supply is a full-wave rectifier unit delivering approximately 750 volts. This is well filtered and has a voltage divider across the output in order also to obtain the plate voltage for the 865 buffer stage. The grid bias voltage supply (base) is obtained from the same type of a full-wave rectifier unit delivering 750 volts. A voltage divider is also connected across the output and additional bias is obtained through series resistors. The main power supply voltages are supplied from a 7.5-KVA 220-volt three-phase transformer, employing six 872As as rectifiers. This power supply can be varied in three steps, low power, 2000 volts; medium power, 3000 volts; high power, 5000 volts. Screen voltages for the larger tubes are obtained from this power supply. The 7.5-KVA transformer weighs approximately 500 pounds, the choke weighs 100 pounds, and the filter condensers weigh approximately 50 to 60 pounds each. The primary circuit (high voltage unit) contains overload (AC) relays and the secondary (DC) also has an overload relay to protect all circuits. In case of short circuits, or if excessive plate loads are drawn, the circuit breakers kick out. All overload relays can be reset from the front of the panel after the overload has been corercted. All doors and panels in the transmitter have safety switches.

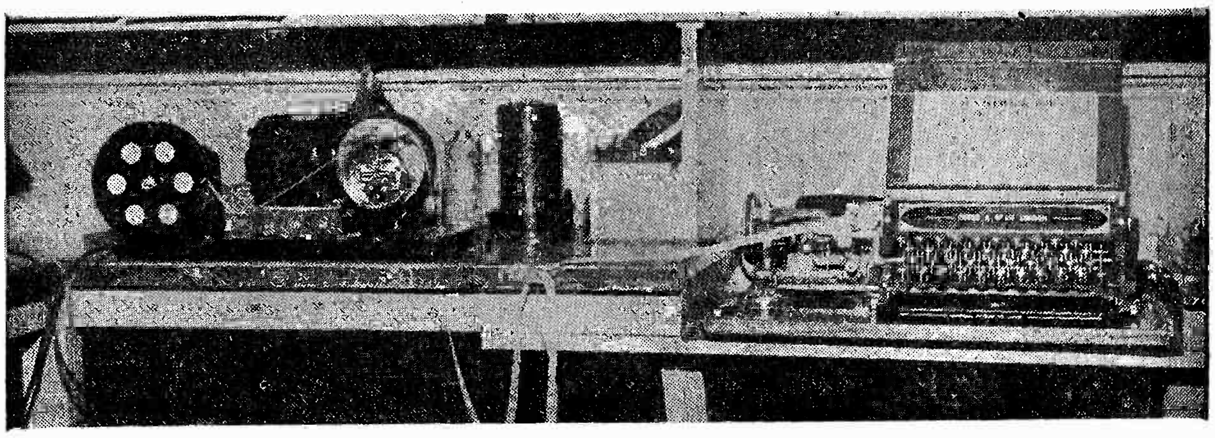
The transmitter was originally keyed in the first 860 grid circuit, "blocked grid keying," as it is commonly called. This system was discarded in favor of vacuum tube keying in the filament center-tap of the same stage. Since the plate current of that particular stage does not exceed fifty milliamperes a W.E. 211E is used as the keying tube. A type '45 was also found satisfactory. When this tube has sufficient grid bias it will not pass current, but when the key is closed, shorting out the grid bias, current passes in the stage which is being keyed. A low mu tube, one with exceedingly low internal resistance, should be used in a tube keying circuit. The 45s are good tubes for keying purposes, although a number of them should be connected in parallel if the keyed stage draws heavy current. Further tests with vacuum tube keying circuits are now being made. The results will be printed in RADIO in the near future.

Now let's climb the stairs and go on the roof to inspect the antenna systems. Nearly three hundred feet high hang KUP's main antennas. The high end is suspended from an 85-foot mast on top of the fifteenth story of the Hearst Building and the lower end is supported from a 65-foot mast on top of the seventh story of the Call-Bulletin Building. Two half-wave voltage fed matched impedance antenna systems are supported in this 500-foot span. The feeders run along the top of the building to a frame rack on the edge of the roof directly above the transmitter, and terminate in the transmitting room. A few receiving doublet antennas dot the roof.

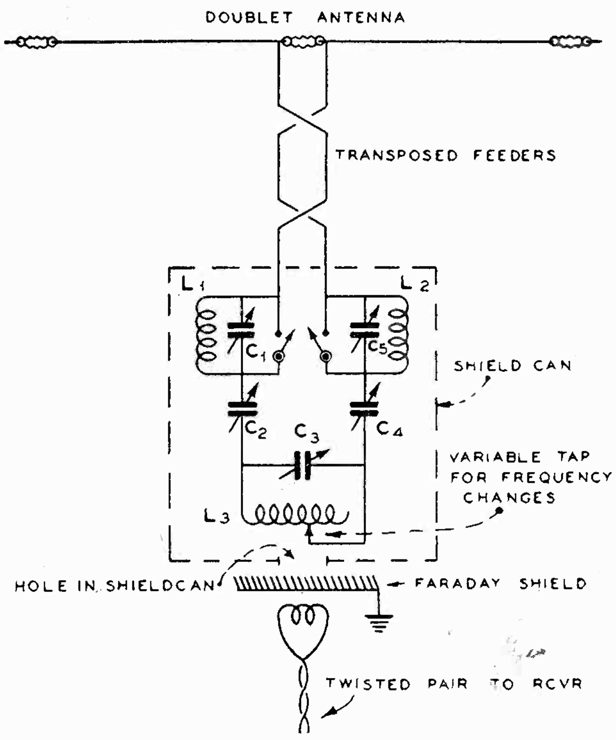
Back to the radio room. On the right as you enter the door is the tape perforator, tape transmitter head and polarized relay. On the west side of the room the receivers are situated, along with the controls, keys, etc. A 75-1000 KC receiver, LSR-101, is kept in readiness for any emergency. Two National jobs are used on high frequencies.

KUP took its bow seven years ago, licensed to operate as 6ARD and in the amateur bands. Fred G. Roebuck, an old-timer to the commercial brass pounders, with the aid of Mr. George Hearst, founded 6ARD. A 500-watt self-excited transmitter built by Heintz and Kaufman Ltd. was the first transmitter used. This transmitter served faithfully until regulations of the Federal Radio Commission made it necessary to install a crystal-controlled transmitter.

In 1928 the writer came to the station as assistant to Roebuck, later taking over manager's duties when Roebuck went with the Dollar company to pioneer their present radio circuits, Globe Wireless.

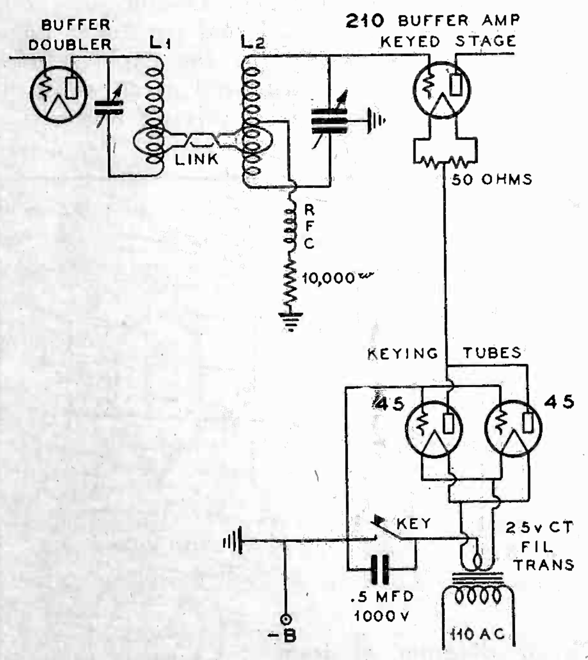


Tape Perforator, Tape Transmitter and Polarized Relay.

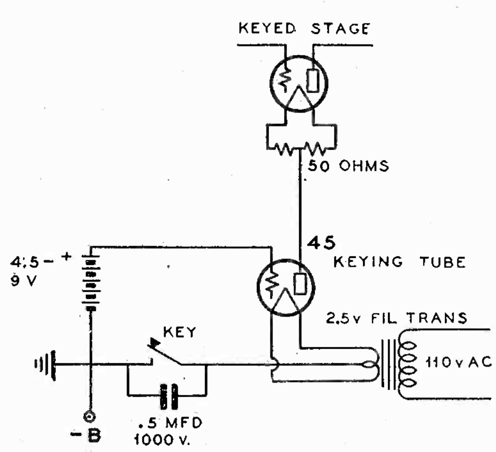


KUP Antenna Coupler.

XA	7:00 p.m.	(0300GCT)	Press Bulletin	6440 KC	1500-1800 words
XB	8:00 p.m.	(0400GCT)	Weather Bulletin	6440 KC	350- 500 words
XC	9:30 p.m.	(0530GCT)	Special Press Bulletin	6440 KC	500-1000 words
XD	1:00 a.m	(0900GCT)	Press-Stocks Bulletin	6440 KC	1500-1800 words



SIMPLIFIED VACUUM TUBE KEYING SYSTEM



VACUUM TUBE KEYING SYSTEM WITH BIAS BATTERY

An Ideal System for Keying an Amateur Transmitter. KUP uses this identical method with the exception than a 211E tube is used in place of a '45.

During the seven years of service, KUP has transmitted approximately 21,000,000 words of press, weather, and stock bulletins, not to mention the many special broadcasts, such as popular boxing bouts, world baseball series, and other events of interest.

At the present time the following schedules are transmitted daily, with the exception of Sundays and major holidays:

The following frequencies are assigned to KUP: 6440, 6230, 11340, 16700 and 22225 kilocycles.

Now that we know everything about a press station—let's wander back to the "Mariposa" and enjoy a trip to the South Seas and ask Sparks—"Didja get the press yet?"

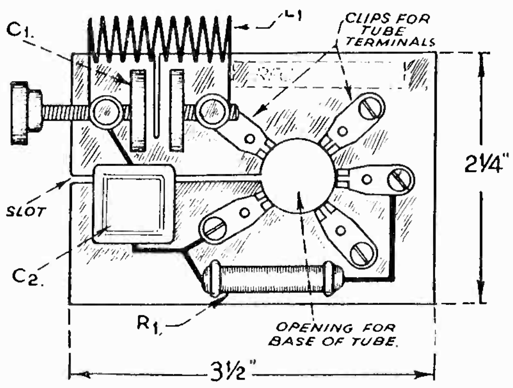
The New RCA 955 ½-Meter Tube

By CLAYTON F. BANE

EVER since the ultra-high frequencies became known, research in these bands has been handicapped because the high inter-electrode capacity of conventional tubes effectively prevents them from efficiently oscillating or amplifying in conventional circuits at frequencies higher than approximately 30 MC. The high capacity of conventional tubes from grid to cathode and from plate to cathode makes it impossible to use Low-C grid and plate circuits and therefore the resonant voltage which could be applied to the tube is limited. In other words, this high capacity acts as an effective by-pass condenser which, to all intents and purposes, short-circuits the input and the output of the tube.

Under the direction of Mr. B. J. Thompson of the Research Laboratories of R.C.A. Radiotron Co., Inc., experiments were conducted with tubes specifically designed for use at the ultra-high frequencies. It was discovered that if all the physical dimensions of a conventional vacuum tube are proportionately reduced, the inter-electrode capacities can be tremendolsly reduced without causing an appreciable change in the electrical characteristics of the tube itself. The new RCA 955 is approximately the size of an acorn and, figuratively speaking, a microscope is needed to find the elements in the tube. In spite of its small size, the tube has a low plate resistance, 12,500 ohms, and a high amplification factor of 25 with the resulting high mutual conductance of 2,000 micromhos. Mutual conductance is a fairly-accurate yardstick of tube performance, and regardless of the compromises which have been made to enable this tube to operate as a regenerative oscillator at a wavelength of only 20 inches, the mutual conductance is higher than any of the conventional general purpose triodes, such as the 56 and 76.

In order to keep the capacities low, no base is used on this tube. The leads to the grid, plate and indirectly-heated 6.3 volt cathode come directly out of the glass envelope, and are widely separated. No attempt should be made to solder to these wires because soldering usually results in breaking the glass envelope.

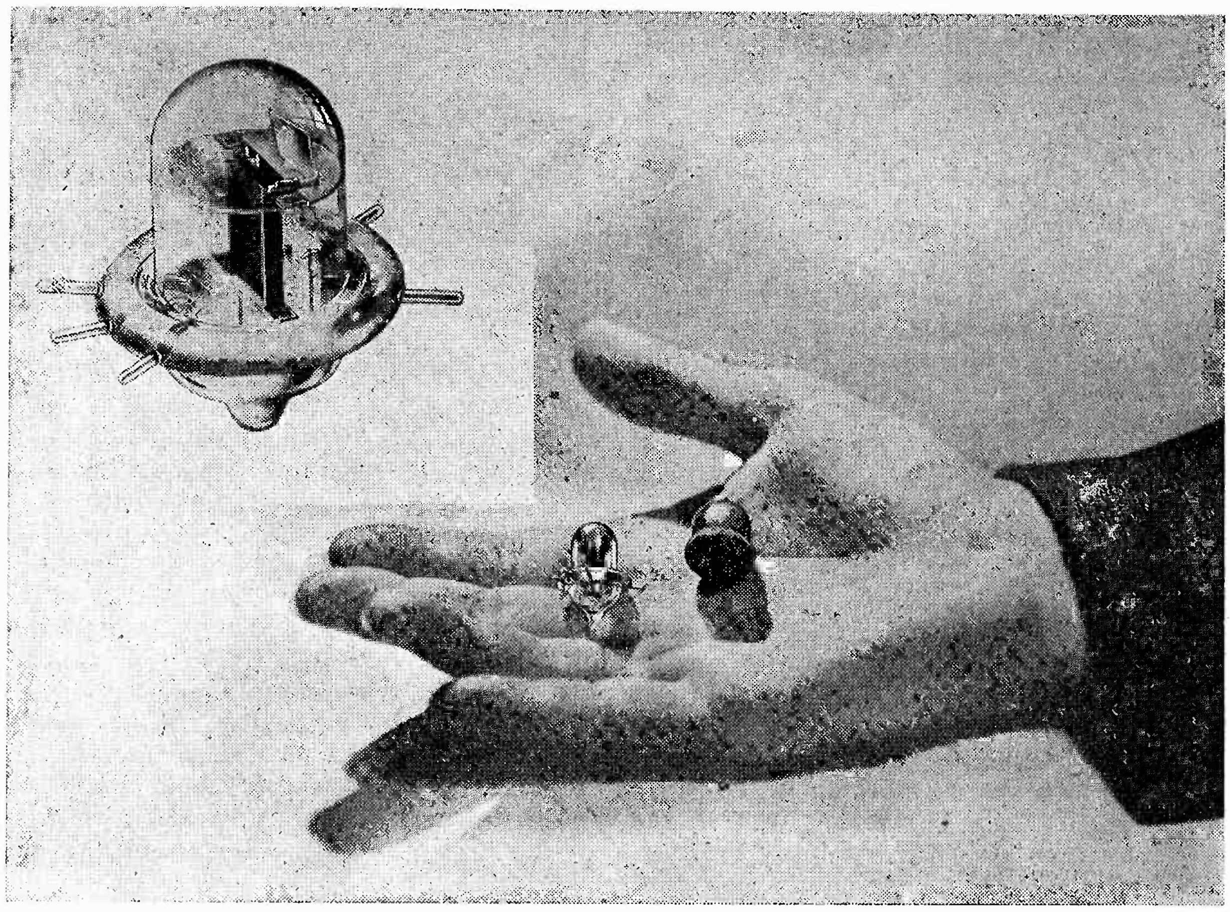


Plan view of transmitter.

With very low internal capacities and excellent characteristics, this tube will come into prominence for 5 meter work, although it is in the high frequency field that such a tube will really prove its merit. Although a number of the present tubes will oscillate at around 2 or 3 meters, the 955, to the best of our knowledge, is the only tube that will operate in the conventional manner as low as ½ meter.

With the B-K type of oscillator used by many experimenters for operation at frequencies below one meter, a number of difficulties limit the effectiveness of such oscillators. In the B-K circuit the grid must run positive, while the plate is negative. The power input to the tube is consequently greatly limited by the low heat dissipation of the average grid. With these limitations in mind it is easy to see why the conventional type of oscillator is much to be preferred.

* W6WB.


Showing minute size of the new RCA 955.

Using the little transmitter shown in the illustration, the 955 was given its first test. The extremely small size eclipsed anything in our previous experience, so we did not look forward to a great deal in the way of performance. However, the tube proved to be a very stable, vigorous oscillator. Calling on previous experience, we considered the number of turns in the tank and reached for the frequency meter which covered a range up to 60 megacycles. No deflection on the frequency meter galvanometer was visible, although the galvanometer coupled to the tank was showing a strong indication. The use of lecher wires was finally considered to determine the exact frequency of oscillation. We found that we were on 2 meters! Subsequent experiments showed that 1 meter was easily achieved, with a number of turns still left in the tank. It is safe to predict that the little tube will work nicely in the conventional Jones Self-Quencing circuit.

None of the troubles due to instability of oscillation were encountered. If this lack of crankiness is carried over to the super-regenerative receivers for ultra-high frequencies, it is reasonable to expect that records for two-way communication on low power will soon fall.

Here are some of the characteristics of the 955:

Heater voltage	6.3 volts
Heater current	0.16 amp.
Max. plate voltage	180 volts
Grid voltage	−5 volts
Max. plate current	4.5 MA
Mutual conductance	2000 micromhos
Amplification factor	25
Plate resistance	12,500 ohms

We understand that these tubes will soon be available through RCA-De Forest distributors for amateur and experimental use, but it should be emphasized that the tubes have been developed solely for the experimenter and are not to be considered as an addition to the standard line of receiving tubes.

RCA 955—CIRCUIT DIAGRAM AND SUGGESTED LAYOUT

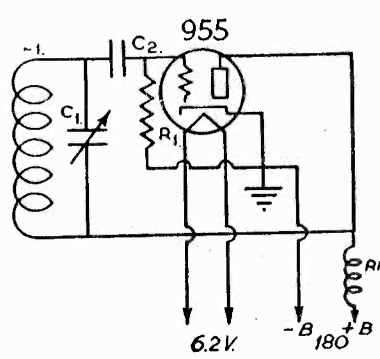
L1—8 turns, ½-in. outside diameter, No. 18 wire, spaced ¼-in. between turns.

C1—Tuning condenser; 2 circular brass plates, ¾-in. in diameter; 10/32 thread on adjusting screws.

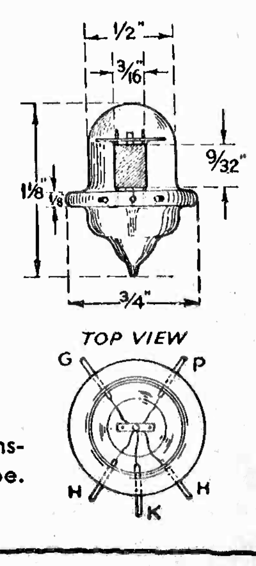
C2—.00025 mica condenser, postage stamp type.

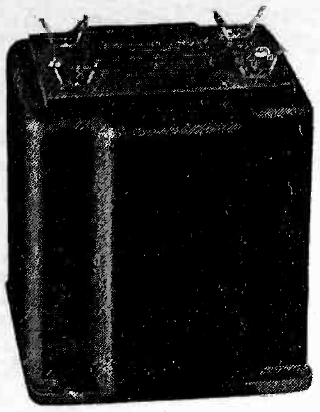
R1—15,000 ohms, 1 watt carbon resistor.

RFC—¼-in. bakelite rod wound 1½-in. with No. 32 DCC wire.



Circuit diagram of transmitter using RCA 955 tube.





The Resonant Filter Simplifies High-Power Problems

By CHAS. PERRINE, JR.*

NOT yet a year old, the resonant filter is already in use at a number of amateur stations but its advantages are not generally known.

Fig. 1 shows the complete circuit of a typical resonant filter as it would be connected to a two-tube, full-wave rectifier. C1 is the main filter condenser and should be rated, as is usual practice, at 1.4 times the RMS voltage delivered by the plate transformer, each side of the center-tap. L is the resonant choke, the "heart" of the whole affair, which forms a series resonant circuit with C1 across the rectifier output. C2 is a small condenser of about one-fourth the voltage rating of C1; it serves to iron out undesirable effects caused by harmonics developed across L.

This circuit increases the effectiveness of the condenser C1 several times. For example, one mfd. at C1 will filter a 2000 to 5000 volt, 500 watt load to near pure DC, while two mfds. easily handles a full kilowatt at the same voltages. Two mfds. will also take care of 500-watt loads down to 1000 volts. The filtering action of smaller loads will be even better. Compare the cost of such a set-up with the ordinary brute force filter using two filter condensers and a much larger (30 H.) filter choke which must pass the full plate current. The photograph strikingly shows the small size of a typical resonant choke, capable of handling I KW.

The resonant choke is truly the heart of the filter, and too much care cannot be taken in selecting a suitable choke. Chokes designed for this work are, of course, best, although quite often a suitable winding can be found in the form of the primary on an old 110-volt power transformer (100 to 200 watt), or some low-inductance choke. The value of the inductance should be such that the choke resonates with C to twice (1)* the ripple frequency (200 cycles in the case of 50 cycle power), and since the resonance peak is broad, the values to be given apply equally well to 60-cycle supplies. The inductance required for a 1 mfd. condenser is about .70 henry, and .33 henry for 2 mfd. Since it is almost impossible to know the true inductance (2)* of a choke without measurement, the best choke must be found by experiment. The DC resistance must be low, preferably less than 10 ohms. The current rating should be 500-100 M.A. No air gap is required because only AC flows in the choke.

It is well to repeat that C2 is very important for good results. If it is not used, the higher harmonics in the filter output will cause a serious AC modulation of the signal, which sounds like a low-pitched buzz superimposed on a pure DC carrier. The exact value of C2 depends on the remainder of the filter constants and varies somewhat with the load. On the average it will be about 1 mfd., varying from ½ to 2 mfd. in certain cases.

An input choke cannot be used with the resonant filter because it seems to destroy the resonant action. Hence the filter is essentially a capacity input filter, and if mercury vapor tubes are used the average load current should never exceed one-third the peak current rating of the rectifiers. But in these days of high voltage and low current operation, this limitation is not serious. In fact, it is advantageous in that it steps up the voltage just as much as the condenser alone does.

Now for the various applications of a resonant filter. If the filter is used alone, it will produce a two- or three-hundred cycle modulation of very low percentage (usually

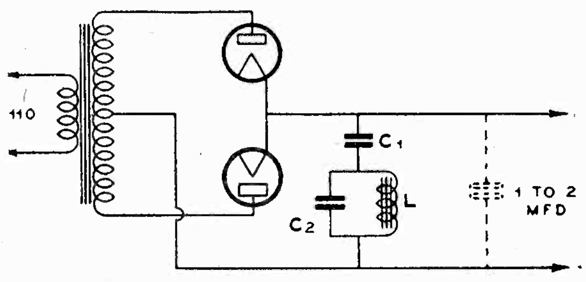


FIG. 1 — COMPLETE CIRCUIT

about 5 per cent). The signal in such cases will sound very much like filtered three-phase and is suitable (3)* for CW men who desire a little tone in the note. For fone and PDC CW men, the same resonant filter can be used with the addition of one or two mfds. across the output. Such a combination smooths the 200-cycle ripple left by the resonant part of the filter. In other words, the resonant part gets rid of practically all of the fundamental ripple, leaving only overtones which are easily taken care of by the output condenser. Even the resonant filter alone can give 98 per cent pure DC if properly designed—in many cases additional filter is not required.

Many have doubtless heard some of the various types of resonant filter notes on the air. What the performance of some of these might look like is shown by the curves in Fig. 2. These curves were taken on an oscillograph while in the process of developing a special resonant choke. The load was 300 ma. at 2000 volts. A 2 mfd. main filter condenser was used. Curve No. 1 in "A" is the output with the condenser alone, and shows a strong ripple. No. 2 was taken with the primary of a 100-watt transformer in series with the main condenser, C2 being left out. The smoothing is good, but the sharp Vs represent the AC buzz which is present when C2 is not used. Curve "B" shows the result when ¾ mfd. is placed across the winding; the buzz is gone, but so is the smoothing action. Curve "C" shows the output using a special choke, C2 remaining at ¾ mfd. The fundamental ripple is almost gone, and the remaining 200-cycle ripple is very pure in quality, as denoted by the well-rounded peaks. And last of all, "D" shows the result of connecting 2 mfd. across the output shown in "C"—99 per cent pure DC.

So much for the results obtained with the resonant filter. If you have any questions, the writer will be glad to hear from you. The filter has been thoroughly tested at a number of amateur stations. Its use has even been considered by local BC engineers for microphone pre-amplifier power supplies because of the saving in weight. A large 2 mfd. and a small 1 mfd. condenser, plus a 1/3 henry choke, are all that is required. If the all-important resonant choke is of the correct value, the results will surprise you. No matter what your present filter may be, a resonant filter section will vastly improve your note—and for the fellows who want that 4500 volts, here is a very cheap way to filter it.

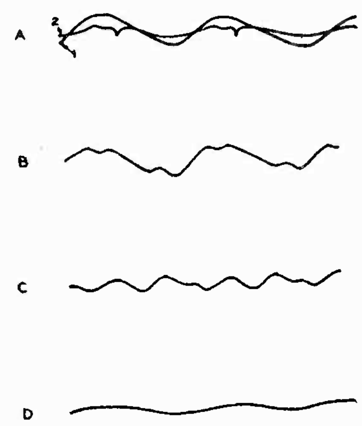


FIG. 2
SEE TEXT FOR EXPLANATION OF CURVES

(1) *Contrary to previous opinions, the filter has little effect when tuned to the fundamental 100-cycle ripple. But when tuned to the second harmonic, it smooths the note by filling in the valleys with an extra bump, so to speak, and producing a 200 cycle ripple of greatly reduced amplitude.*

(2) *Ordinary chokes have been known to vary as much as 400 per cent from rated inductance.*

(3) *Unofficially, this filter has been judged "adequate" by representatives of the FCC.*

* Amateur Equipment Engineer, Audio Products Co.

EDITOR'S NOTE: In some cases, the modulation caused by a resonant filter may be objectionable. It is advisable to use at least a one microfarad condenser across the output of all such filters. As the author states, this small capacity is enough to change the note to a shrill, piercing DC.

W6CTT Code Tests

W6CTT is now in its third year of volunteer code transmission. The rig has been rebuilt with 511 in final, grid-bias mdoulated. Link coupling is now being installed. A microphone in front of speaker from audio oscillator picks up the code signals. Texts from printed manuals are used. Lawrence Rauch, W6JVT, is code instructor. L. C. Barnes, W6CWX, installed the grid modulation, as supervising engineer. Bud Perry is station manager. G. H. Seward, licensee.

Transmissions are on Friday evenings, 7:00 to 8:00 p.m., 1900 KC radiophone. At 7:30 a secret message is sent, which is printed in the newspapers the following day. At 7:45 an educational feature is given, usually some theory or interview with an invited guest or visitor. Contact is always made with some other station for monitoring purposes, QRN, etc. Checks are made each 15 minutes and reports secured.

Listeners are registered and assigned numbers with district prefix, e.g., W6-516. Over 500 are on the register in which is noted the age and telephone number. A certificate of membership and a copy of a new "Short-Wave Magazine" is given. The organization is known as the Amateur Short-Wave League—"The Air Audience."

The New 2B6 Tube

THE new 2B6 is a super triode that combines the merits of other output tubes without their disadvantages; yet possesses greater flexibility in circuit applications. The tube provides Class A triode quality of reproduction most economically because of its higher power output, greater sensitivity, and lower power consumption. The 2B6 may be used singly or in push-pull at low or medium current operation. The tube requires no costly fixed-bias voltages or good power pack regulation. It has a high input impedance even under overload conditions, making resistance couple push-pull or phase inverter input stage practical. The tube has a unity match between its impedance and the output transformer. Explanation and application of these advantages follow:

Fundamental Explanation

THE new 2B6 embodies two sets of triode elements mounted in tandem, using a common heater but electrically separated cathodes. An examination of Fig. 1 will show the simplicity of the tube and circuit. In this diagram, the left hand set of triode elements represents the small input; and the right hand set the large output. The voltage across R_0 determines the bias for the input grid. Since the second grid is internally tied to the input cathode, the drop in R_0 would put this grid at a high positive bias with respect to its cathode. This is nearly offset by the drop in R_1. Thus, the output grid bias is the difference between these two voltages. This bias is normally 2.5 volts positive with respect to its cathode. Therefore, the grid conductance is appreciable, causing the input plate current to divide, part flowing through the output grid resistance and part through R_0. Consequently, the current for determining the input grid bias should be measured between the input cathode and R_0, not between input plate and B −. The average DC current through this resistor is 3.0 MA. This resistor also forms part of the input section's load resistance, so it must not be shunted by capacitance. The complete load is the parallel combination of R_0 and the grid impedance of the output section. Degeneration in resistor R_1 is prevented by capacitor C_1.

The high efficiency of the 2B6 is obtained by a new principle. The large triode section delivers the output power. It operates at nearly the mid-point of its eg-ip characteristic. The entire characteristic is utilized—that is, not only the usual negative half where the plate current swings between zero grid bias and plate current cut-off, but also, the positive half, making the swing just twice as great. Since the grid draws current when the signal excursion travels in the positive region, the grid must be driven during that part of the cycle. The input section performs this duty and also provides a high input impedance as its grid does not draw current. Hence, no input power is required. The compensating theory of the input section for developing a signal voltage across the grid-cathode of the output section, independent of the variations in the grid impedance of this output section, has been published[1], and therefore, will not be treated here. Summarizing, however, the characteristics of the first section are arranged so that the internal impedance varies with the amplitude of the signal, during the positive half of the cycle, to maintain a constant ratio between this impedance and the output load of the first section. Hence, the voltage developed across this load is not influenced by changes in the load's value. In other words, the voltage impressed across the input of the second section is not affected by variations in the grid impedance of this section.

Now it should be evident that the tube cannot be driven extraneously as in Class B or so-called Prime A since the input section actually accomplishes this action by driving the power grid.

The 2B6 is absolutely stable as the circuit functions are free of regeneration and since no reaction exists in the coupling of the two sections, there is no phase displacement. The steady-state power consumed by the tube is in excess of that taken under maximum excitation. Thus, there are no complications in the power pack, and its design principles may be the same as used with any Class A system. A high DC resistance may be used in the grid circuit as the transconductance of this section is relatively low, and its physical size helps to minimize residual grid emission or gas current. The use of a high grid resistance is often advantageous as its shunting effect on the plate load resistor of the preceding stage is lessened.

TRIAD TYPE 2B6—Technical Data

Bottom View of Base

PIN		ELECTRODE
1	—	Heater
2	—	Output Plate P_2
3	—	Input Plate P_1
4	—	Input Grid G_1
5	—	Input Cathode K_1
		Output Grid G_2
6	—	Output Cathode K_2
7	—	Heater

POWER AMPLIFIER—UNI-POTENTIAL CATHODE

Average Electrical Characteristics

Heater:	
Voltage	2.5 volts
Current	2.25 ampere
OPERATING AS CLASS "A" AMPLIFIER	
Input Section:	
Plate (Max) P_1	250 volts
Grid G_1	–24 volts
Plate Current*	4.0 ma.
Amplification Factor	7.2
Mutual Conductance	600 umhos
Plate resistance	12,000 ohms
Load resistance	8,000 ohms
Grid resistor should not exceed	1.0 meg.
Output Section:	
Plate (Max) P_2	250 volts
Grid G_2	+2.5 volts
Plate Current	40 ma.
Amplification Factor	18
Mutual Conductance	3,500 umhos
Plate resistance	5,150 ohms
Load resistance	5,000 ohms
Signal volts**	27 volts
Power Output***	4.0 watts

* Measured between plate and B+. Current in cathode lead approx. 3.0 ma.
** Volts r.m.s. for rated power.
*** 5% total harmonic distortion.

Output Speaker Load

THE unity match between the internal plate impedance and the speaker load largely explains the improved rendition of the 2B6 over Class B and Pentode. The optimum load for maximum power and the optimum for minimum distortion are the same. This value almost perfectly matches the plate impedance of the tube, rather than the plate impedance being some multiple of the load. Also, the only harmonic that climbs at any appreciable rate with increasing load, is the second. These conditions aid in minimizing the transient response of the speaker, especially when the signal frequency approaches speaker resonance. Then, too, the fall in power with increasing load beyond the optimum value is not as steep as ordinary negative bias triodes. For example, with three times the rated load, the power is down only 1.6 DB. Thus the average speaker, whose impedance varies considerably with frequency will receive more nearly a constant power, regardless of the signal frequency. It has often been noted that the aural frequency response, when compared under similar conditions, is improved over ordinary triodes. The high register is more prominent. This improvement is explained by the load characteristic mentioned above. Also, this condition permits greater flexibility in designing the speaker.

It should be noted that the input grid does not draw current even though a 27-volt r.m.s. signal (low gain input connection) is required for full output while the grid is only biased to –24 volts. This is possible due to unrestricted degeneration in the input section, making its voltage transfer less than unity. Under these conditions, the AC component of the voltage developed across R_0 is approximately 16 volts. Since the input voltage and this developed voltage are in phase with respect to ground, the voltage difference, 11 volts, is the actual alternating potential difference between the grid and cathode[2]. However, the DC potential difference between these two points is 24 volts which is more than adequate to prevent grid current.

The optimum output load for a single 2B6 is 5000 ohms, for push-pull, 10,000 center-tapped. These values should be used for best results. However, since the tube's load characteristic is quite flat, some existing speakers may be used with more or less success, providing the speaker can withstand the increased power output and providing the output transformer does not saturate. Such speakers designed for 45 or 50 tube operation, having 4000 ohms for single tube or 8000 for push-pull, may do. Speakers for 47 tubes, having 7000 ohms or 14,000 ohms, have also been used with success. A common fault in attempting to economize in the size of an output transformer is to use one whose primary inductance is far too small. This condition often accounts for distorted reproduction at certain frequencies. The transformer may reflect the proper load to the tube at, say, 400 cycles but as the frequency decreases, the impedance falls off rapidly with the consequent steep rise in distortion introduced by the output tube. In nearly all output tubes, distortion rises rapidly if the load decreases much below the recommended value. The effect is more noticeable in single tube operation. The rising impedance of the speaker at its resonant period may aid in offsetting the low reflected load, but to use this advantageously, care must be used in both the design of speaker and transformer. In general, if it is necessary to economize on the size of the transformer, it is better to use one that will reflect a greater load at 400 cycles than that recommended so at lower frequencies, the load is still not too low. Exact values cannot be cited here since particular design characteristics are necessary to ascertain the proper values.

Most modern speakers are designed to op-

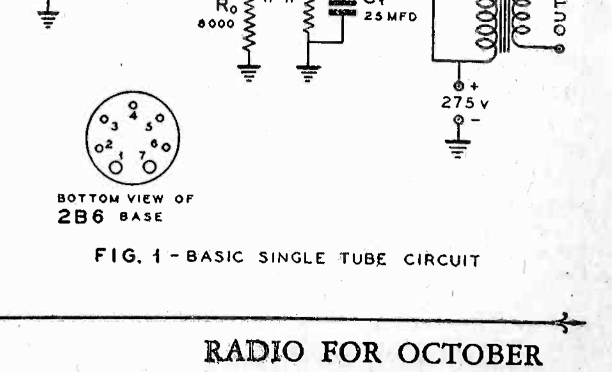


FIG. 1 - BASIC SINGLE TUBE CIRCUIT

erate, in addition to matching load conditions, with certain other characteristics of the particular output system and, therefore, in order to obtain ultimate results, the speaker manufacturer should be consulted for individual requirements.

Single and Push-Pull Circuits

FIG. 1 is the basic circuit for a single tube. The components required are few in number, but the usual by-pass condenser represents an appreciable expense. The circuit in Fig. 2 shows a very satisfactory method of eliminating this condenser. Here, the voltage drop supplied by R_1 in Fig. 1 is obtained from a resistance in the negative leg of the power pack. This arrangement supplies the necessary by-passed voltage without an extra condenser. The frequency characteristic is slightly better than that obtained from the circuit in Fig. 1. The inherent hum of the 2B6 is so low that the slightly higher lever introduced by the circuit in Fig. 2 is still a negligible factor.

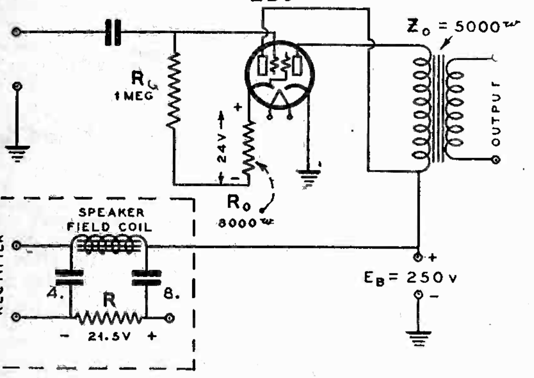


FIG. 2

The 2B6 is readily adaptable to push-pull operation, the same as any regular Class A triode. A typical circuit is shown in Fig. 3. A common bias resistor, R_1, of 270 ohms, capable of continuously dissipating 2 watts, is used for the output sections. Shunting of this resistor by capacitance is not necessary, since the push-pull action prevents the developing of any appreciable alternating voltage across R_1. Again the voltage drop produced by R_1 may be supplied in some other manner. Note that each input cathode has its separate 8000 ohm load resistor.

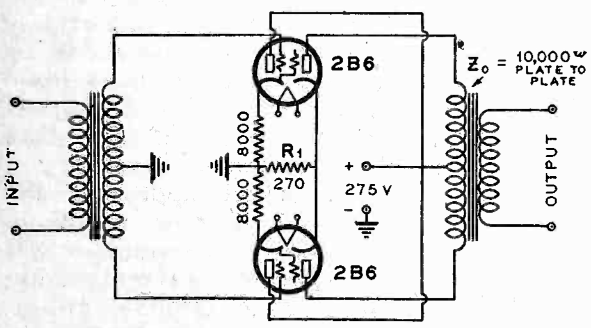


FIG. 3 PUSHPULL 2B6

Higher Voltage

THE characteristics of the 2B6 are given for standard 250 plate volt operation—that is the voltage between cathode and plate or a supply voltage of 275. The tube may also be safely operated at higher plate voltages than 250, providing the plate currents are restricted by correct bias values. When more power output is desired, this flexibility is definitely advantageous. For example, a full clean six watts may be obtained from a single tube or sixteen from a pair in push-pull, when operating with 320 volts between plate to cathode or at a supply voltage of 355. The current requirement is remarkably low—approximately 50 MA for a single tube and 100 MA for push-pull. Higher plate voltages than 320 are not recommended except in special over-bias applications where the plate current is held well down.

Recommended values for both 250 and 320 volts operation follow:

Eb = 275
Ep = 250 (plate to cathode)
Eb = 355
Ep = 320 (plate to cathode)

	Single	Push-Pull	Single	Push-Pull
Power Output	4	10	6	16 watts
Load impedance (Plate to Plate)	5,000	10,000	5,000	10,000 ohms
Resistor—R_0	8,000	8,000	10,000	10,000 ohms
Voltage across R_0	24	24	34	34 volts
Current through R_0	3	3	3.4	3.4 MA
Resistor—R_1	540	270	730	365 ohms
Voltage across R_1	21.6	21.6	33.5	33.5 volts
Current through R_1	40	80	46	92 MA

See circuits for location of Resistors.

Low Current Operation

IN SOME push-pull applications, especially for the sake of economy, it may be advantageous to lower the current consumption. In fact, the total plate current may even be reduced to one-half its original DC value with only about 15% loss in power output, and of course, some decrease in sensitivity. This is accomplished by using the push-pull over-bias method. Resistance R_1 is simply increased until the desired plate current is reached. The value of R_0 should remain the same as recommended for normal push-pull operation. For the best results, degeneration caused by the alternating voltage developed across R_1 which is produced by the somewhat unbalanced currents of an over-bias system, should be suppressed. R_1 may be simply shunted by suitable capacitance or the bias voltage provided by R_1 may be obtained from some other place in the power pack where effective by-pass shunting can be obtained. For a small degree of over-biasing, capacity shunting is unnecessary. The output load impedance is not critical but best performance is obtained when operating into a higher load. It should be increased from 10,000 ohms to 18,000 (plate to plate), depending upon the degree of over-biasing; at one-half the total current, 18,000 is approximately correct. Good regulation of the power pack is not entirely necessary, since for example, the current increase's only about 10% from no signal to full signal as measured by a DC meter in series with the center lead of the output transformer.

Phase Inverters

EXCELLENT results may be obtained by using a phase inverter circuit in place of the usual push-pull input transformer. Since a gradual overload of the 2B6's output section occurs long before input-grid current flows, the quick break in quality at high levels commonly experienced with resistance input coupling circuits is eliminated. Such a coupling system is more economical, has better high frequency response, and weighs less, besides eliminating the bother of orienting the transformer. The type 53 tube has sufficient gain and performs admirably well as a phase inverter. A circuit for this operation is shown in Fig. 4. A pair of 56 tubes coupled in an inverter circuit or in resistance push-pull is also recommended.

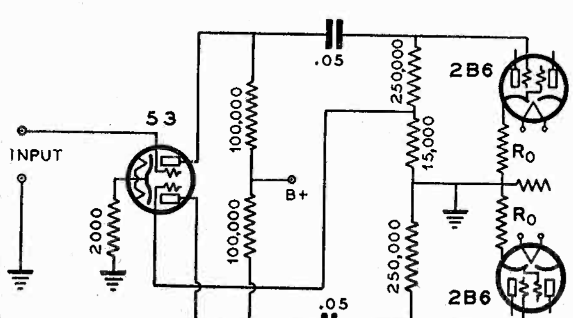


FIG. 4 RESISTANCE COUPLED PUSHPULL

Sensitivity

THE sensitivity of the 2B6, connected as shown in Fig. 1 is between the pentode and the triode. A signal of 27 volts is required for rated output. This represents an actual voltage gain of 5.25 or a power sensitivity of .074. Since the advent of high gain detectors, the problem of directly feeding into an output tube having the sensitivity of a 2B6 is no longer difficult. Detectors of the 57, 2B7, and 55 type, when operated under optimum conditions with a supply voltage of 250, will deliver ample output to fully load the 2B6.

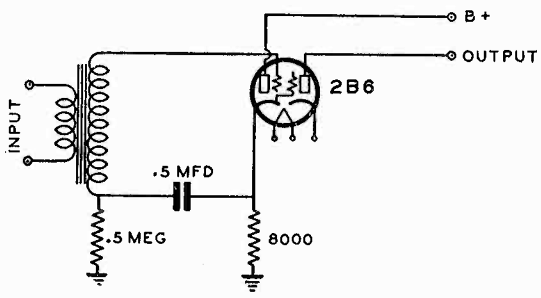


FIG. 5 TRANSFORMER COUPLING FOR "HIGH GAIN" CONNECTION

In a previous paragraph, it was shown that the voltage transfer of the input section was less than unity. If degeneration in this section is suppressed, the overall sensitivity increases more than twice. The input signal is simply isolated from ground and coupled through a suitable cathode input condenser so that the signal is impressed between grid and cathode rather than grid and ground. This connection is identified as "high-gain". Now, only 11 volts are required for full output. Although this is a considerable improvement in sensitivity, the harmonic content is somewhat higher. Consequently, for ultimate quality it is not recommended, but such operation may be advantageous in small receivers where the speaker or cabinet design is responsible for certain quality limitations rather than the tube. Fig. 5 shows a method of isolating the signal when using an input transformer. The 0.5 meg. resistor simply provides a DC path for the grid return. Figs. 6 and 7 show several methods for resistance coupling. The circuit in Fig. 6 provides the better gain. The output of the detector or pre-stage is developed across resistor R_2 and arrives at the 2B6's cathode via condenser C_2. The resistor R_3 isolates the signal off ground and also functions as a hum filter. Since the detector plate current returns through R_0, the current must be sufficiently low as not to be seriously upset the voltage drop across R_0. R_0 should not be greatly lowered in the attempt to compensate for an appreciable increase in current, otherwise this resistance will become too small to properly provide the cathode load for the input section. Specific values are not given here as particular detector operating conditions would be necessary in each case. The detector cathode is above ground exactly the same as the 2B6's cathode. Consequently, the input to the detector is also above ground. This offers no problem when coupling with the usual intermediate frequency transformer. Circuit in Fig. 7 is limited to coupling with very high plate impedance detectors—that is, the tetrode or pentode type. R_2 must be

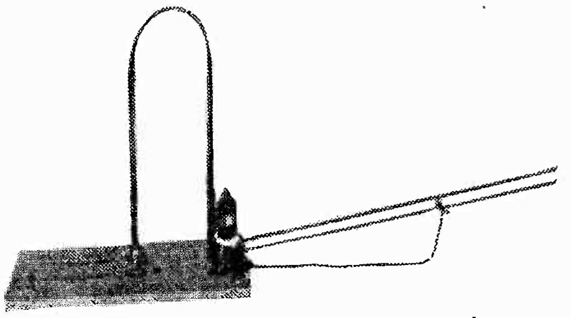
(Continued on Page 32)

A Resonant-Line Transmitter

By G. F. LAMPKIN*

THE conventional 5-meter transmitter or receiver is limited in several respects by the tube interelectrode capacity. The high-C oscillators, the high-efficiency output tanks, the link-couplers, and other elements so well used on the lower frequencies, are of small help at 56 MC.

It is fortunate, then, that at the frequencies where ordinary lumped tank circuits begin to lose their utility, resonant lines begin to have dimensions within reason. For resonant lines can be used to simulate an inductance, capacity, tank circuit, or what-not. Those interested in the background of the subject would do well to look up the references given below.



A '53 tube and some No. 12 wire makes an excellent 60 MC Transmitter

In the photo, and in the circuit of Fig. 1 is shown a 5-meter rig using a '53 tube and some No. 12 copper wire and not much else. The simplicity approaches the ultimate, yet the transmitter puts out a more stable signal, and a stronger signal at less plate input than the more usual types. The No. 12 wire is the output tank, the grid coupling condensers, the transmission feed line, and the wavemeter.

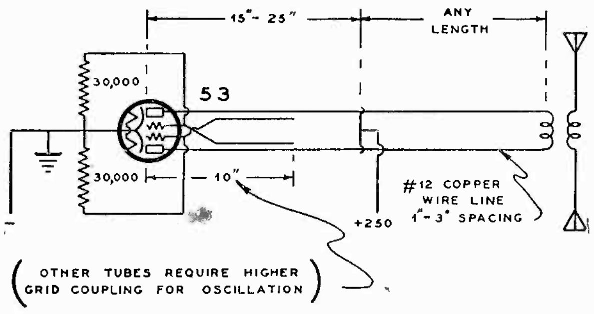


FIG. 1 – THE SIMPLEST 5 METER TRANSMITTER

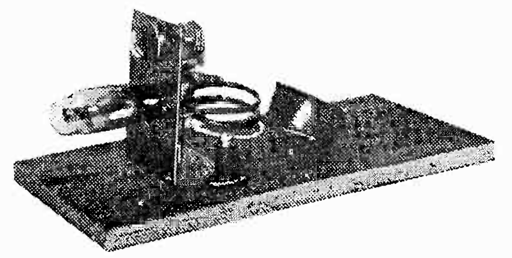
In the layout of Fig. 1, the portion of the line to the left of the shorting bridge is the oscillator tank. The grid coupling wires are spaced from and tied to the plate wires by knotted string, fixed in place with a drop of paraffin or rosin. Tuning of the oscillator is done by sliding the shorting bridge. The portion of the line to the right of the bridge is a non-resonant transmission line, properly terminated on the antenna by the usual Y-spread, Pickard or Johnson scheme. The transmission line is coupled to the oscillator by the impedance in the shorting bridge.

To check the wavelength, the feeders can be opened up at the antenna and a flashlight-lamp bridge slid out along the transmission line, till it lights at maximum. The distance in meters from the oscillator bridge to the lamp bridge is one-half the oscillator wavelength. This, of course, is nothing more than the usual Lecher wire set-up.

If 5-meter work palls for awhile, and 10-meters wants a try, all that is necessary is to slide the oscillator bridge on out the line, and couple up a 10-meter radiator.

A short-circuited transmission line less than a quarter-wave long presents an inductive reactance at the open end. When connected to a vacuum tube, the electrode capacity in combination with the line inductance forms a tank circuit. The losses of the tank inductance can be made comparable to or smaller than those of the low frequency tanks.

An open-circuited line less than a quarter-wave long has a capacitive reactance. The transmitter arrangement in Fig. 2 uses a line very nearly one-quarter wave long for the grid tank. The open-circuit portion to the left of the grid connections is a capacity, and the shorted portion to the right is an inductance. The effective capacity can be made of the order of 100 to 200 mmfd.—impossible to use in the ordinary lumped condenser—and the oscillator performance compares to that of the high-C on lower frequencies. The output is somewhat lower, and the note is more stable. The oscillations persist over only a small range of the plate line tuning.



The unity-coupled '53 tube on 60 MC used for comparison

In using the quarter-wave line as a high-C grid tank, sometimes inductive coupling exists to the plate tank, and the performance can be improved by reversing the grid connections. The grids should be tied in about 5 or 10% of the conductor length from the shorted end.

A point which perhaps should be brought out is that a high-Q circuit does not necessarily make a stable oscillator. By Q is meant the usual definition, $\omega L/R$. Assume a tank circuit is at hand with a Q of infinity—i.e., its resistance is zero. Even though this be in the grid circuit of an oscillator tube, the frequency would still hop around as long as the effective tube input capacity varied. What is more important, as regards frequency stability, is the arrangement of the frequency determining circuit, in order that tube capacity shall have small effect. In a parallel tuned circuit, the tank capacity must be large—such as in the high-C method; or, in a series tuned circuit, the tank capacity must be small—as in the equivalent circuit of a quartz crystal.

A long resonant line is an excellent means of stabilizing ultra-high frequqency oscillators. Any shorted line less than an odd and more than an even quarter-wavelength long presents inductive reactance at the open end, and will form an oscillator tank against the grid capacity. Imagine a very long line used in the grid tank. If the tube capacity tries to create a frequency change of, say, .01%, each quarter-wavelength along the line would have to change .01%, and would shift the last quarter-wave the total accumulated difference. As a result, only a very slight frequency shift will make large changes in the line input reactance, which will offset the tube variation. RCA used a 10-wavelength line on a 40-KW oscillator with average measured frequency stability as good as with crystal.

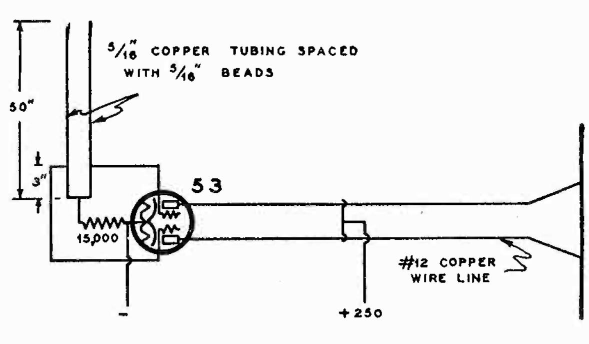
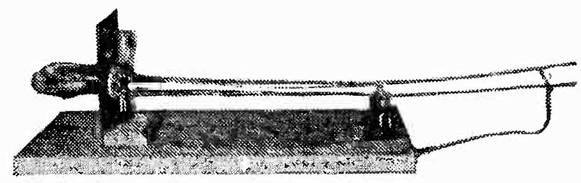


FIG. 2 – A HIGH C 5 METER OSCILLATOR

Actual full-size long line control for the amateur is hardly practical. However, even a 1-1/8 wavelength (225 inches of No. 12 spaced 5/16-inch with Isolantite beads and string) grid tank on a 5-meter modulated oscillator gave noticeable improvement. Where other carriers, as received weakly on an autodyne detector, would completely disappear under modulation, the line-controlled carrier did not wobble more than 10 KC, roughtly.



Fixed tune high-C oscillator with tuned-line plate tank

These paragraphs are given mainly as something to break the ice. It should not take much amateur experimenting to develop some very practical methods with resonant lines.

REFERENCES:
1. *New Methods of Frequency Control Employing Long Lines, Conklin, Finch, and Hansell. Proc. I. R. E., v. 10, Nov. 1931, p. 1918.*
2. *A New Type of Ultra Short Wave Oscillator, J. E. Mouromtseff and H. V. Noble. Proc. I. R. E., v. 20, Aug. 1932, p. 1328.*
3. *Resonant Lines in Radio Circuits, Frederick Emmons Terman, Electrical Engineering, v. 53, No. 7, July 1934.*

* Lampkin Laboratories, Cincinnati, Ohio.

Farnsworth Cold Cathode Tube

(Continued from page 6)

upon the amplitude of the voltage applied to the cathodes. Each emitted secondary likewise causes the emission of more secondaries, so that the process is rapidly cumulative and gives rise to a tremendous amplification of current.

In the foregoing simplified account of the tube's operation as an amplifier, one important factor has been omitted. The anode attraction, which causes an electron to leave the vicinity of a cathode and which accelerates its velocity as it approaches the plane of the anode, also decelerates its velocity as it leaves the anode plane and approaches the second cathode, which is now positively charged so as to attract it. Its resultant velocity may therefore not be sufficient to cause emission from the second cathode. To insure emission, additional energy must be imparted to it, this energy being obtained from that stored in the resonant circuit, as indicated in the accompanving circuit diagram.

The high-frequency supply is of the order of 50 megacycles and is loosely coupled to the tuned circuit so as to apply from 25 to 90 volts across the cathode terminals. The positive potential on the anode may be 100 volts or more, depending upon the desired current output.

The tube has a discontinuous voltage-current output characteristic with a series of successively higher current peaks as the voltage is increased. Maximum current output is obtained when the anode voltage is just sufficient to allow an electron to travel from one cathode to the other during ½ cycle of the high frequency excitation. Other successively lower peaks occur at anode voltages corresponding to transit times of 3/2, 5/2, 7/2, 9/2 cycles, the last being the least which has yet been measured.

(Continued on page 18)

Impedance Matching

By A. E. THIESSEN*

ONE of the first and best learned lessons in communication-system design is that, to obtain the greatest possible transfer of energy from one circuit to another, the impedances of the two circuits must be matched. So straightforward is the concept that the lesson may have been overlearned. In very many cases the reason for the use of transformers as impedance-matching devices is not so much to gain in power transfer as to reduce distortion, frequency discrimination, and other common defects in voice-transmission circuits.

It is very easy to fall into the error of exaggerating the amount of reflection loss that occurs due to mismatched circuits. From the single consideration of power loss a surprising amount of mismatch can be tolerated. To arrive at a figure for reflection loss, the simplest example is the case of a resistive power source connected to a resistive load. In actual practice it is not often that pure resistances will be found in radio- or audio-frequency circuits, but in most cases the phase angle is so light that for purposes of practical demonstration it may be considered to be zero. In Fig. 1 a generator producing a

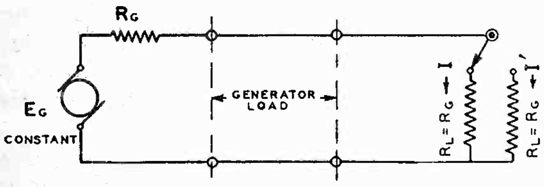


FIG. 1

Circuit on which to base calculations of the reflection loss at a single junction.

voltage E_G and with an internal resistance R_G is shown connected to a load R_L. The current that will flow in the circuit is

$$I = \frac{E_G}{R_L + R_G}.$$

When $R_L = R_G$, that is, in the case where the generator and load impedances are matched, the current, $I = \frac{E}{2R_G}$, and the power in the load is

$$I^2R_L = I^2R_G = \left(\frac{E_G}{2R_G}\right)^2 R_G = \frac{E_G}{4R_G}.$$

When the impedances are not matched the current in the load $I' = \frac{E_G}{R_G + R_L}$ and the power is

$$I'^2R_L = \left(\frac{E_G}{R_G + R_L}\right)^2 R_L.$$

The ratio of the power in the load for the matched condition to the power for the mismatched condition expressed in decibels is the mismatch or the reflection loss. That is

$$N_{db} = \frac{I^2R_L}{I'^2R_L} = 10 \log_{10} \frac{(R_G + R_L)^2}{4R_GR_L}$$

or

$$N_{db} = 20 \log_{10} \frac{R_G + R_L}{\sqrt{4R_GR_L}}.$$

From this formula can be calculated the reflection loss that occurs due to connecting together any two impedances having small phase angles. For instance, if a 5000-ohm vacuum tube were connected directly to a 500-ohm line, the impedance mismatch of 10 to 1 would calculate to cause a loss of 4.8 decibels. The losses calculated for a number of different impedance mismatches are shown in the chart in Fig. 2. For phase angles of less than 45° the loss curve is practically the same, but the mismatch loss is always less when either circuit has a reactive component.

It is obvious, therefore, that in many cases the actual power loss due to operating between mismatched impedances is not serious. If "ideal" or no-loss transformers could be realized, it would certainly be worth while to use them where every milliwatt of the available power must be utilized. However, well-designed and carefully made audio-frequency transformers of the usual types may have an inherent copper and iron loss of about 20%, or 2 decibels. When it is considered that small power transformers have efficiencies in the neighborhood of 85%, an efficiency of 80% for audio-frequency transformers is quite good in view of the many other problems involved in their design, such as frequency characteristic, freedom from distortion, etc.

The real value, however, of audio-frequency transformers and the reason why their use is so essential is to keep the circuit impedances at the correct operating values. For example, the design of a transformer to operate from a low-impedance line to the grid of an amplifier is not a simple job, and the successful operation of this sort of transformer depends upon its operation from the impedance for which it is designed. A line-to-grid transformer designed to operate from 500 ohms is apt to show frequency discrimination if operated from a line of 200-ohms impedance. Thus, a designer of a voice-input circuit finding that the output impedance of his mixer panel is 200 ohms, which has probably been determined by the microphone impedances, would certainly insert a 200- to 500-ohm transformer between the mixer and the input of his amplifier, if its input transformer were designed to operate from 500 ohms. The use of the transformer is dictated not by the consideration of the reflection loss between the 200- and the 500-ohm circuit, which is less than one decibel, but by the fact that the impedances must be kept to their correct value to maintain proper frequency characteristics.

Another example of the necessity for correct impedance matching is in the familiar case of output transformers from vacuum tubes. The distortion introduced by a three-element tube is a function, among other things, of the impedance into which it works. Ordinarily, the distortion is a minimum when the tube is worked into an impedance equal to approximately twice the plate resistance of the tube. In the case of the 2A3 tube the plate resistance is about 800 ohms and for two tubes in push-pull is 1600 ohms. The General Radio Type 541-D Transformer is designed to couple this system into dynamic speakers. When operating at a fixed bias potential, it is recommended that these tubes in push-pull work into 3000 ohms, which is approximately twice the plate resistance. From a consideration of the power loss due to mismatch the tubes could be worked into impedances varying widely from 3000 ohms, but the distortion would become a serious factor. This is one of the reasons why the selection of the correct output transformer is so important.

The impedance of ribbon and velocity microphones averages between 25 and 40 ohms. The customary volume control used with these microphones has an impedance of 50 ohms. An inspection of the chart in Fig. 2 will show that the reflection loss due to coupling a 25- to 40-ohm generator and a 50-ohm load is negligible. The frequency characteristic of these microphones is not affected by such a small impedance mismatch. Therefore, it is sound practice to operate them into the regular 50-ohm mixer. If a transformer were used to couple these two circuits together, it would introduce a loss approximating 2 decibels which would be entirely unnecessary. Similarly, 500-ohm and 600-ohm lines can be connected together without trouble, unless special balancing or isolating problems are present. Impedance-matching transformers play a very important part in the

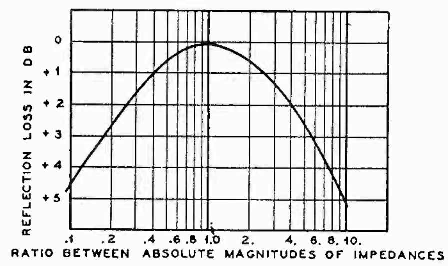


FIG. 2

Reflection loss at a single junction in decibels as a function of the ratio between the absolute magnitudes of the two impedances. This curve is for a phase dieffrent of 0°.

circuits where these questions are serious. Generally, telephone lines are well balanced, particularly high-quality lines of the sort used to connect remote pickup points with the broadcasting studio. If these lines are connected directly to an unbalanced amplifier, which is one without a balanced and shielded input transformer, the resulting unbalance would affect the line and might introduce cross-talk. The customary cure for such a condition is to insert a 1-to-1 transformer between the line and the amplifier input transformer. The General Radio Type 585-R Transformer is an example of this. It has balanced windings and an electrostatic shield between the primary and secondary circuits so that a balanced line connected to its primary will remain balanced even though the secondary be connected to an unbalanced circuit. On short lines running around a studio or a laboratory, the question of unbalance is not usually so serious, but it is surprising the amount of pickup difficulties that have been encountered due to the fact that some part of a short link between a mixer panel and a speech amplifier or some other short local circuit is unbalanced. In the case of larger studios where several voice channels are running parallel through patch boards, relays, or other switching mechanisms, it is always considered good practice to run the wires in the form of twisted pair, shielded by flexible copper braid. This type of connector maintains a capacity balance to ground, and if well-balanced transformers are used most of the cross-talk difficulties are eliminated.

*Reprinted from General Radio "Experimenter."

A 5-Meter Transceiver

By FRANK LESTER, W2AMJ*

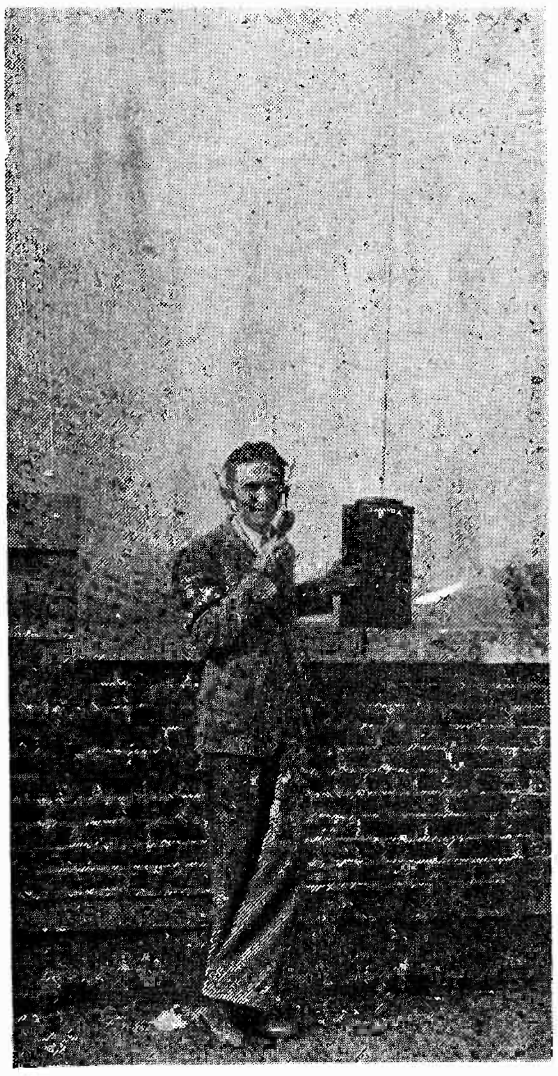
ONE of the most interesting pieces of apparatus in amateur radio is the five-meter "transceiver," which gets its name from the fact that it is a combination transmitter and receiver using the same tubes and accessories for both purposes. A recent ruling of the Federal Communications Commission permitting mobile as well as portable operation on five meters has greatly accelerated amateur activity along these lines, and amateurs everywhere are deserting the hopelessly crowded 20, 40 and 80 meter bands to find considerable pleasure on the shorter wave.

Five meters offers many opportunities because one can pack a complete outfit into a box about the size of a typewriter case and set it up for operation in a few seconds. A 5-meter set can be operated in a car in motion, and dozens of different "hams" can be contacted as you drive from one town to another. Five-meter "field days" held on Saturdays or Sundays, are getting to be regular affairs in amateur circles.

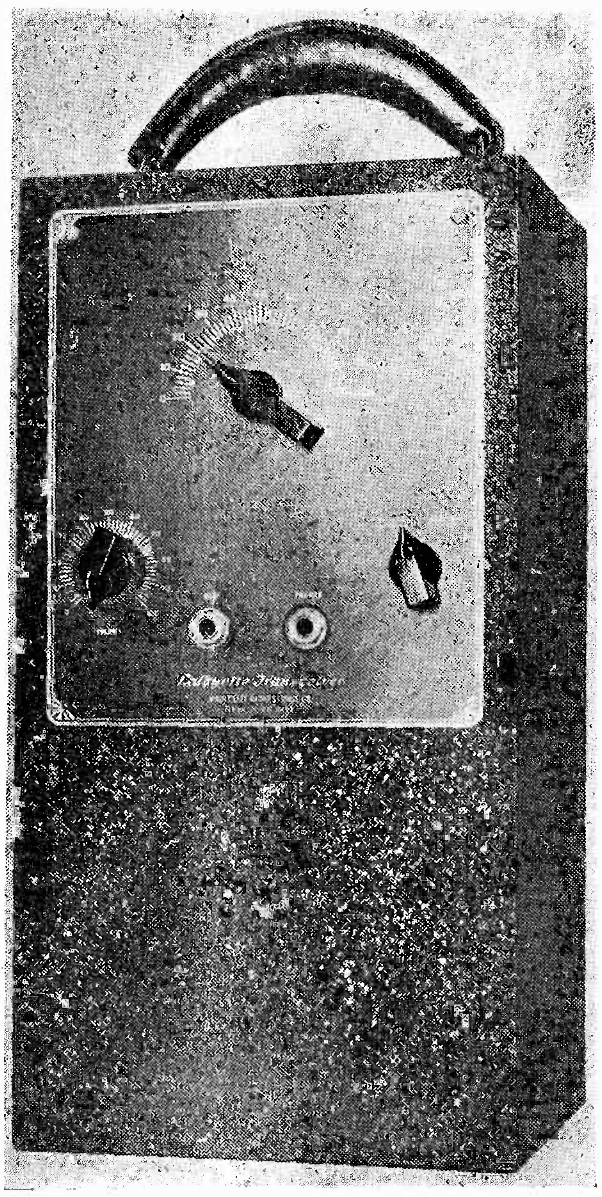
In recognition of this growing acclaim of five meters, the writer has designed a three-tube transceiver which has proved exceptionally successful, and can be purchased complete for a price that would have been considered low a few years ago for just an ordinary power pack.

A single case, made of steel finished in durable black crackle, and measuring 15¼ inches high, 8 inches wide and 7 inches deep, houses the complete outfit, which is known as the Lafayette Transceiver. Why steel and not aluminum for a portable job? you may ask. The writer has found that steel stands the punishment of portable service better than aluminum, and its extra weight pays for itself in durability.

* Engineer, Wholesale Radio Service Co., Inc.



The Author and his Transeiver atop the 100 Sixth Ave. Building.



A he-man's carrying case.

As shown in the illustrations, the case is formed on four sides and has removable front and back panels. A man-sized carrying handle is fastened to the top. The upper half of the box is occupied by the transceiver proper, the lower by all the required filament, plate and microphone batteries. A decorative plate for the front panel carries three controls and two jacks; the former are the main tuning knob, in the upper center, volume control, lower left, and receive-transmit throwover switch, lower right. The jacks are for earphones and a small hand microphone.

The knobs are of the new pointer type and look very distinctive. A plain knob and not a vernier dial is used for the tuning condenser (C1 in the diagram) because the tuning is not critical and a knob permits quick scanning of the entire five-meter band.

The three tubes in the Lafayette Transceiver actually do the work of five, and this accounts to some degree for the effectiveness of this little outfit. The diagram shows all of the connections in detail.

Transceiver hookups always look confusing at first sight, but this particular one is really easy to understand if you follow it through carefully. Tubes V1 and V3 are both type 19 double triodes, V2 a type 30. The four switches marked S are all part of a single four-pole, two-position unit; the points marked T represent the transmit position; the points R the receive position. The variable resistor R1, which acts as volume control, is combined with the filament switch SW. C1, R1 and S are the only variable instruments in the whole transceiver.

The coil marked L2 looks a bit peculiar. It consists of two turns of ¼-inch copper tubing about 2 inches in diameter, with a split length of insulated flexible wire inside. The tubing acts as the plate coil, the wire as the grid coil, of a simple push-pull oscillator. The close coupling between the two coils makes this a powerful oscillator indeed. Tuning condenser C1 (a 15 mmfd. midget) is connected across the ends of the plate or "tank" coil and to the plates of V1, with a center tap for plate voltage. The grid coil connects to the corersponding grids and is similarly tapped.

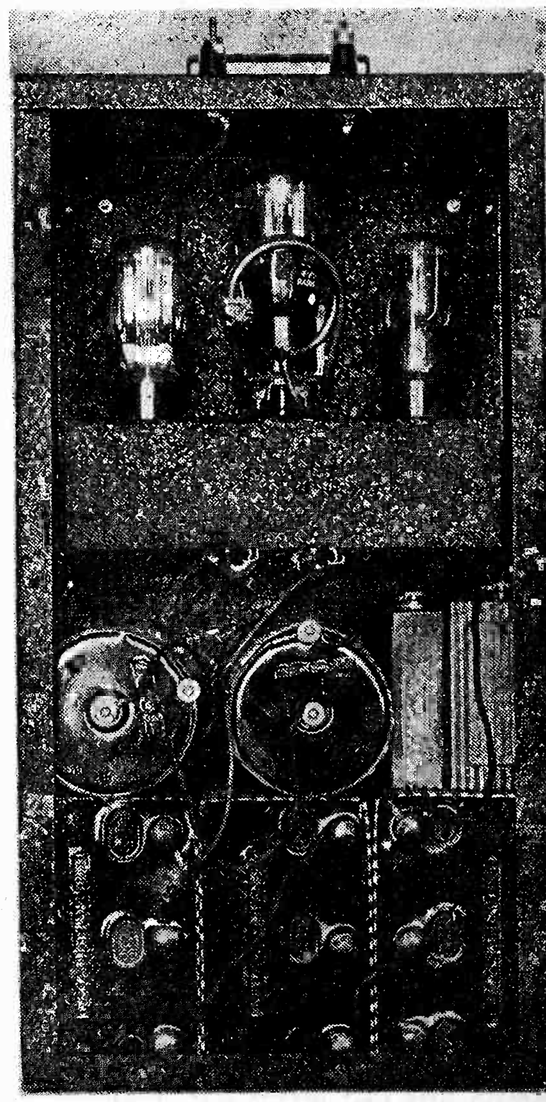
Let us throw the changeover switch to the receive position and see what happens. Tube V1 now acts as a self-quenching super-regenerative detector, with C4-R3 as the grid condenser-leak combination. Transformer T1, with primary P1 functioning, acts as an ordinary amplifying transformer, working into V2 as first audio stage. V2 in turn feeds into T2 and V3, which act together as a complete class B audio output stage, the output transformer T3 operating the earphones.

Now switch to the transmit position, and the same parts act altogether differently. V1 becomes a push-pull oscillator. Primary P2 of transformer T1 is cut in, and T1 becomes a microphone coupling transformer. The secondary of T3 is switched from the phones to the plates of V3, so T3 is now the modulation transformer.

In the receive position, R1 is a volume control on the received signals. In the transmit position, it is a mike gain control.

The whole idea works out perfectly, with

(Continued on page 22)



Interior view of Transceiver, showing unity-coupled coil and battery compartment.

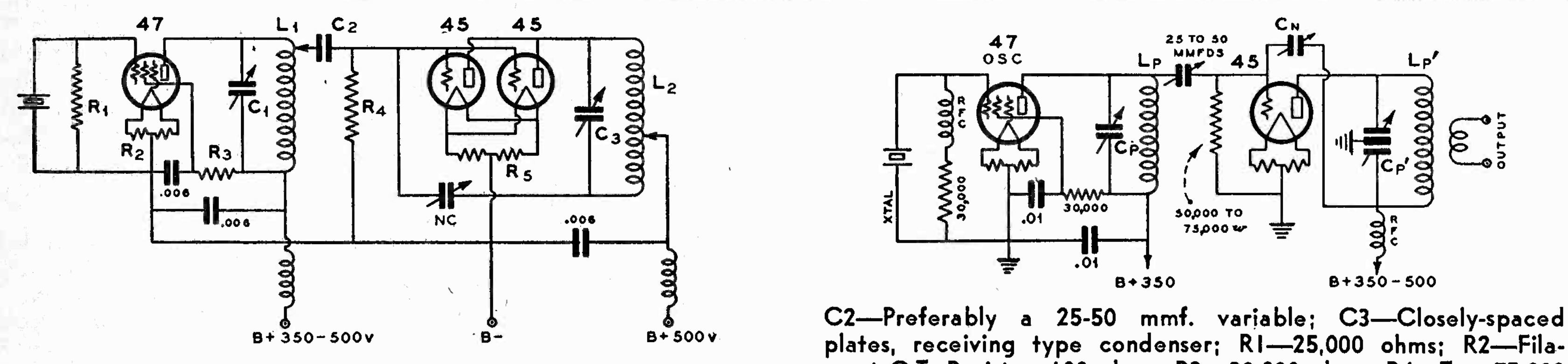
"The '45 Is Better R. F. Amplifier Tube Than the '46"

By W. W. SMITH, W6BCX

A CHECK-UP of the "W" cards on the wall of a typical CW and Phone amateur station revealed that of the cards received since the first of the year—excepting those from stations using self-excited transmitters—approximately 35% were from stations using "a pair of '46 tubes in the final amplifier. It was also found that three-fourths of the remaining 65% were using at least one '46 in the transmitter as a buffer.

Why the '46 has come into such general use as an RF amplifier is hard to understand. A pair of push-pull '46 tubes in class B makes a very economical and fine modulator, a set-up that is hard to beat for 25 watts or so of fairly respectable audio. But the only nice thing we can say about them as neutralized RF amplifiers is that gridleak bias can be used than a '45 of the same make operated under the same conditions. Apparently the '45s are pumped harder, probably because of their smaller envelope, and the fact that there is less metal within the envelope also seems to contribute to their "hardness". To obtain a given output at a given plate voltage, the lower plate impedance of the '45 allows us to do it with a higher ratio of load impedance to tube impedance, and correspondingly better efficiency. It is presumed, of course, that sufficient excitation is available in either case to allow its adjustment to the optimum value. We are referring here only to output efficiency. We may therefore say that the '45s in parallel, capacity coupled, two 75,000 ohm, 2 watt resistors in parallel should be used; a single 35,000 ohm resistor would get quite warm unless the excitation is kept low. By using '45s the grid choke ceases to be a problem when capacity coupling is used and we can economize on that potential source of trouble by simply leaving it out of the circuit. The amount of RF wasted across the resistor when no choke is used is very small, and the loss is justified, not only from a standpoint of economy, but also because of the stabilizing effect of a purely resistive load in the circuit.

When used as a buffer to isolate the final from the oscillator, the '45 provides better "buffing" action than a '46. Even slight changes in plate voltage or plate load cause



Left—47 oscillator capacitively coupled to a pair of 45s in parallel. Right—Single 47 to single 45. Constants: C1—100 mmf.; C2—Preferably a 25-50 mmf. variable; C3—Closely-spaced plates, receiving type condenser; R1—25,000 ohms; R2—Filament C.T. Resistor, 100 ohms; R3—30,000 ohms; R4—Two 75,000 ohms, 2 watt resistors in parallel. No grid choke is required; R5—Center-tapped filament resistor, 100 ohms.

without danger of the beginner burning them up by kicking out the crystal stage.

When its performance as an RF amplifier is compared to that of a '46, the lowly '45, which is again coming into its own for audio use, makes the '46 look pretty sick.

Comparing the two tubes we find the following in favor of the '45:

In spite of the fact that the '45 has a somewhat lower wattage filament, it also has a higher mutual conductance (measured at zero bias) than the '46 (grids tied together and considered as a single grid). The lower mutual conductance of the '46 is largely due to the greater "shadow" effect of the grid(s), which becomes quite appreciable in multiple-grid tubes. Because of its higher mutual conductance, the '45 actually requires fewer WATTS excitation than a '46 to drive it TO A GIVEN OUTPUT WITH A GIVEN EFFICIENCY. Though it takes more VOLTAGE SWING, we may say that the '45 is the easier to excite, because driving POWER, not voltage, is the criterion of ease of excitation.

The plate impedance of the '46 is several times that of the '45. Thus for a given efficiency in the output circuit (ratio of load impedance to plate impedance), much looser coupling must be used to the plate tank of the '46 (raise the load impedance). Then, to bring the output back up, the plate voltage must be run sky high, and high voltage spells "bad medicine" for '46 tubes. Although the interelectrode spacing and the spacing of the plate lead coming through the stem is much greater in the '46, it will not stand any more plate voltage than a '45. The gas content . . . not the spacing . . . limits the plate voltage that can safely be applied to a '46. Oddly enough, many '46s will turn more blue at a given plate voltage and input

> **I heartily endorse Mr. Smith's article in regard to the superiority of the '45 over the '46 tube. All of the reasons expressed in this article are logical and well founded. It is high time that we forget about the amplification factor of a tube and pay some attention to MUTUAL CONDUCTANCE, which is the only proper index of power amplification and also a real yardstick of tube merit.**
> **"JAYENAY"**

permits GREATER EFFICIENCY than is possible with a '46, both adjusted to a given output at a given plate voltage.

Because of its high grid impedance, the '45 may be more advantageously capacity coupled to the preceding stage than a '46 (presuming that we desire to clip right off the "hot" end of the plate tank of the preceding stage to avoid parasitics). The '46, with its very low grid impedance, requires an extremely small coupling capacity to give the preceding stage a sufficiently high load impedance, and most of the excitation is being wasted. The grid impedance of a '45 offers a very respectable load for most tubes, and the grid of a '45 can be capacity coupled on the lower frequency bands with almost as much efficiency and as great a transfer of energy as can be obtained with link coupling.

The optimum value of grid resistor being very high (between 50,000 and 75,000 ohms for a single tube), it is permissible to dispense with the grid choke in capacity-coupled circuits using a '45. The only precaution necessary is to make sure that the grid resistor is either of the carbon or metalized type (non-inductive). The temperature coefficient of the metalized type is lower, and therefore recommended in preference to the carbon type. The 2 watt sizes have ample heat radiation for a single '45. For a pair of

a noticeable change in the grid impedance of a '46. When using a '45, changes in the output circuit react but little upon the grid impedance. The difference between the two types of tubes in this respect was brought home strongly when a typical low-powered, 160-meter phone, using a '47 link coupled to a pair of '46s in the final was found to have such a bad case of frequency modulation as to be objectionable. The '46s were replaced with '45s, and the frequency modulation was cut down to a point where it could not be detected by the "zero-beat, beat-oscillator" method. At the writer's station, which ordinarily uses a class B linear to feed the antenna, no buffer is used between the modulated stage (originally a '46) and the crystal oscillator. When using the '46, UNSOLICITED reports of frequency modulation were numerous. Raising the value of bias resistor on the '46 to as high a value as could satisfactorily be used, helped matters only slightly. Operation being on 75 meters, the frequency modulation was just twice as bad as would have been the case on 160. As the modulated stage was run with very low input, and the crystal oscillator consequently provided sufficient excitation for class C operation of the modulated stage, it seemed a shame to resort to an extra tube merely to provide some buffing action. A '45 was substituted for the '46, and the first ten stations worked were ASKED to check for frequency modulation. Nine reported "none" . . . probably meaning that it was not noticeable. Theoretically ALL phone transmitters are afflicted with frequency modulation, though it may be only to a minute degree in the case of a transmitter using several buffers. One station reported "negligible" frequency modulation.

(Continued on page 18)

Farsnworth Cold Cathode Tube

(Continued from page 14)

The external magnetic field is unnecessary when the cathodes are properly curved instead of being plane. Their curvature can be calculated to focus the electrons automatically for specified anode and cathode voltages. This eliminates the nede of a DC supply for magnetic focusing.

The tube's theoretical output is twice that of an equivalent hot-cathode tube operated as a Class A amplifier. Its practical output is limited by the ability of the cathodes to withstand the high temperature to which they are subjected by bombardment from a rapidly increasing number of electrons. One test of a small tube showed an output of 100 watts of undistorted energy before the cathodes were destroyed by heat. Such destruction is prevented by means of resistors in the cathode leads. A small tube can be safely operated so as to deliver 45 milliamperes with 200 volts on the anode. It is to be noted that the tube operates as a current amplifier and that the amount of voltage amplificaion is dependent upon the resistance in the output circuit.

The theory of the tube's operation as a detector or modulator should be evident from the non-linear voltage-current characteristic and requires no elaboration here. It is especially sensitive in the detection of ultra-high frequencies.

IT IS a well known fact that any amplifier circuit generates oscillations when arranged to furnish an input voltage of proper magnitude and phase. Consideration of the manner in which Farnsworth's tube functions as an amplifier shows that it conforms to this requirement when connected to a resonant circuit which is tuned to a frequency whose half-period is equal to an electron's time of transit, as determined by the frequency of the oscillations applied to the cathodes.

But the great value of the Farnsworth tube resides in the fact that it is self-exciting, i.e., that it requires no external high frequency voltage when used as an oscillator. Aside from the energy which is required for the magnetic focusing field and which may not be needed eventually, the only external source of energy is that which maintains a positive potential on the anode. It apparently represents a new discovery in vacuum tube phenomena. Among engineers there is a difference of opinion as to its cause.

One plausible explanation is based on the assumption that there is no appreciable space charge effect in the tube when oscilaltions start. There are always some free electrons present in the inter-electrode space, if only those due to photoelectric emission from the cathodes. These are attracted by the anode when it becomes strongly positive but are prevented from immediately going to it by the longitudinal mangetic field. Their acceleration as they approach the plane of the anode causes a current to flow, through half the inductance coil in the tuned circuit, to one cathode. This provides an out-of-phase voltage drop which accelerates the electrons toward the other cathode with sufficient velocity to cause secondary emission therefrom. The emitted electrons then establish a current flow through the other half of the mid-tapped coil and cause a voltage drop in opposite phase so as to accelerate the electrons toward the first cathode which is thus caused to emit more secondaries. Repetition of this process quickly builds the current up to a point where it can be delivered to the output circuit without stopping the internal oscillations. The oscillating frequency is that to which the resonant circuit is tuned. This explanation has not been confirmed by physicists, but is presented only as a means for visualizing possible actions in the tube. When engineers disagree, the physicist must experiment.

Much work has yet to be done before standardized tubes will be available for experimental use. Television Laboratories Ltd. has licensed two factories for commercial production. But it will probably be a matter of some months before tubes are available for amateur use.

"The '45 Is a Better RF Tube Than the '46"

(Continued from page 17)

While on the subject of linear amplifiers, the '45 was found to be a better exciter tube than the '46 for the linear stage. The lower impedance of the '45 provides better RF "regulation", which is an advantage when working into a linear stage because the grid impedance of the linear varies under modulation. A low impedance driver is here desirable for the same reason that a low impedance driver tube is preferable to drive the grids of a pair of class B audio tubes. The matter of RF regulation is also important when using "grid current" grid bias modulation, a low impedance driver being preferable ahead of the bias modulated stage.

Utilizing a couple of rolls of chicken netting for the grid, the '46 has a somewhat higher grid-filament capacity than the '45. The lower grid-filament capacity of the '45 is especially advantageous at 10 and 20 meters. The small surface area of grid in the '45 also allows less oxide from the filament to collect on the grid, the action of which sometimes is responsible for erratic operation of '46s. The simpler construction of the '45 also makes it a "sturdier" tube from a mechanical standpoint. And, needless to say, the '45 costs considerably less than the '46.

The filament of the '46 pulls a bit more current than the '45, but the very high grid current drawn by the '46 when fully excited detracts from the emission available for plate current. Because the '45 pulls but very little grid current, as much emission is available for plate current as is available in the '46.

When much more than 25 watts input is applied continuously to a '46, the plate current has a tendency to slowly rise in value, until after a time it reaches a critical point where the milliammeter gets real active and proceeds to "bang the pin". It was found that when using high excitation and bias, and a fairly high plate voltage (to permit higher ratio of load impedance to plate impedance), that a '45 of good manufacture can be run continuously at 30 to 35 watts input all day long. The '45 under test was pulling 68 mils at 520 volts.

Because of its much lower mu, the '45 is much more stable in operation than the '46, being somewhat easier to neutralize. In addition, parallel operation seldom requires special precautions.

When keyed, a maximum of 650 volts at 75 mils per tube should be observed. When the tube is running constantly, as in a buffer, it is necessary to reduce the input power by one-third . . . either the plate voltage, current, or both being reduced. When used as a modulated amplifier, a maximum of 450 volts at 60 to 65 mils per tube should be observed.

If over 650 volts is used on a '45 and if the load is removed from the plate tank, the tube may possibly flash over in the base. This is usually aggravated by the fact that when the load is removed, the plate current drops to a very low value, allowing the plate voltage to soar to a still higher value, dependent upon the regulation of the power supply.

Accidents to the tube (due to this cause) can be prevented by using a tank condenser with NOT-TOO-WIDE SPACING between the plates. The condenser will flash before the tube will arc in the base, thus protecting the tube and warning the operator (provided he is close enough to hear the condenser "sing"). If a split-stator arrangement is used, a blocking condenser is advisable in order to prevent the DC from riding across the arc along with the RF. Receiving condensers will usually be satisfactory from the standpoint of not arcing across when the tube is running under normal load, and will protect the stem from flashovers. If less than 600 volts is used, the above precautions are unnecessary.

The '46 sometimes gives the illusion of being more easily excited than a '45 because when loaded to a GIVEN OUTPUT at a GIVEN PLATE VOLTAGE, the ratio of load impedance to tube impedance is lower. We have obtained ease of driving power from such an impedance ratio, but where, oh where, has our efficiency gone?

All the aforementioned statements are made with reference to neutralized RF amplifiers (working on the same frequency). As a frequency multiplier in the more-commonly used circuits, the '45 is a rather poor performer as compared to the '46. However, some work along that line points to the possibility of low mu tubes making very efficient frequency multipliers, when used in the proper circuits and under the proper conditions.

Summing up the relative merits we find:

Gridleak bias can be used on the '46 without danger of burning-up the tube, should the excitation fail without the operator noticing it.

Weighed against this lone advantage, we find the '45 easier to excite (to a given output with a given efficiency), permits better plate circuit efficiency, is cheaper, is more rugged mechanically, makes a better driver for a class B linear or bias modulated stage, is more stable in operation, will stand slightly more input without "going crazy", provides better "buffing" action, is better adapted to capacity-coupled operation, requires no grid choke with capacity coupling, and has lower grid-filament capacity.

Crystal Microphone Circuit for Turner

An improved hook-up for the Turner Type G Crystal Microphone is shown in Fig. 1. Due to its high impedance of approximately 80,000 ohms at 60 cycles, the microphone may be connected direct to grid and ground of the amplifier input tube. When so connected, it is necessary that a parallel resistance or grid leak of not less than 5 megohms be used. Using a resistance of lower value at this point will reduce the low frequency response.

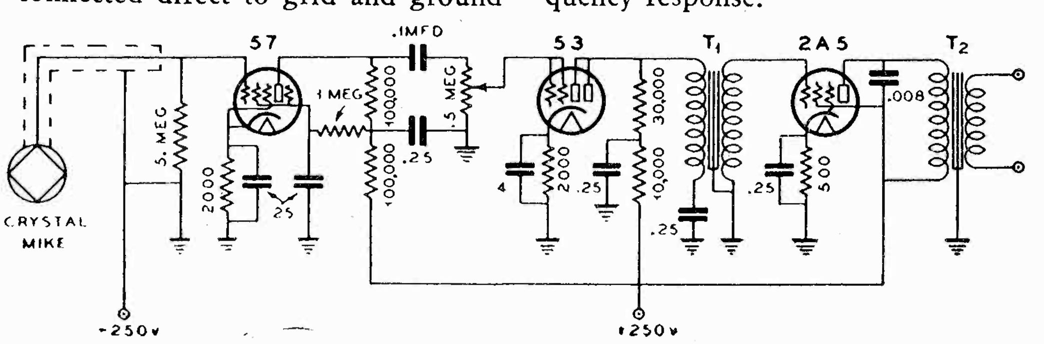


FIG. I

AMATEUR NEWS

Pacific Division Convention at Fresno, November 10 and 11

WESTERN amateurs are promised one of the most interesting and educational conventions yet held on the Pacific Coast when amateurs of Fresno, California, become hosts to their brother hams on November 10 and 11. The technical talks will be of more than usual interest. New ½-meter transmitters and receivers will be described and operated, all of the new tubes will be analyzed by tube engineers, new data on Pentode Transmitting Tubes will be given and contests of many and varied kinds will be staged.

Ralph A. Jack
Chairman, Pacific Division Convention

W6FPWexW6AOH, graduate Pacific University, Oregon, and four years post graduate work University of California, as Whiting research fellow in physics doing cathode ray oscillograph and high frequency work. First entered Ham radio at W6AHO portable. Conducted experiments for United States Forest Service on Radiophone. At the present time unit commander, unit 3 section 3, United States Naval Communication Reserve. President of Valley Radio Club. At present time operating W6FPW at home, W6YE at Fresno State College, W6KDS at Unit Reserve Headquarters.

It seems likely that the Ralph M. Heintz $50 prize for the best-operating ¾-meter transmitter will go to someone who attends the Fresno convention. The new ½-meter tubes should enable the contestants to build the ultra-high frequency rigs with comparative ease.

Grid modulation, 5-meter systems, directive antennas and new receiver circuits will be discussed, and some of the Coast's best known technical men will lecture at the convention. Jim Warner, radio operator on the "Southern Cross" on its flight to Australia, will give a thrilling account of the history-making event. Jack McCullough, J. N. A. Hawkins, Frank C. Jones, Chas. Perrine, Jr., and a number of other well-known amateurs will conduct technical sessions.

Prizes will be awarded for the best 5-meter stations. Other prizes will be awarded to those who present the best stunts.

Convention headquarters will be at the Hotel Fresno. The cost of convention tickets is $3.00. Reservations should be made now, through Mr. C. L. Kirkpatrick, W6DWE, Box 739, Fresno, California.

CALLS HEARD

At WICNU, Stamford, Connecticut

JULY 15 TO AUGUST 15—20 METERS

G's Heard on CW: G2DC, G2DI, G2DL, G2KB, G2KM, G2KY, G2LA, G2MA, G2MY, G2NM, G2OD, G2RF, G2WQ, G2XU, G2ZJ, G2ZJ, G5BD, G5FV, G5HC, G5JU, G5KT, G5KU, G5LC, G5MA, G5NF, G5NI, G5PL, G5QY, G5SH, G5SR, G5UF, G5US, G5WP, G5WY, G5XB, G5YH, G5YV, G6CJ, G6CL, G6HB, G6IR, G6IZ, G6JG, G6KI, G6LM, G6NJ, G6PK, G6QP, G6QX, G6RB, G6RV, G6TJ, G6TT, G6UF, G6UJ, G6VK, G6VP, G6WN, G6YA, G6YL, G6UT, G6ADE.

G's Heard on Fone: G5BJ, G6DL, G6PY.

GI's Heard on CW: GI2OY, GI5QX, GI5UR.

F5s Heard on CW: F3AK, F3BR, F8BF, F8BS, F8EF, F8FC, F8GG, F8JJ, F8RJ, F8TQ, F8UG.

F's Heard on Fone and CW: F8DR.

CT's Heard on CW: CT1AA, CT1AZ, CT1BG.

CT's Heard on Fone: CT1BY.

D's Heard on CW: D4BAR, D4BCC, D4BDR, D4BER, D4BFN, D4BHH, D4BIU, D4BKK, D4BKN, D4BMR, D4BUK, D4CAF, D4CET, D4CPJ.

EA's Heard on CW: EA2AD, EA3AN, EA3EG, EA5AF, EA5BJ, EA5BL, EA7FG.

PA's Heard on CW: PA0AX, PA0AZ, PA0CE, PA0DC, PA0FLX, PA0FX, PA0HG, PA0LL, PA0VB, PA0XF, PA0XG, PA0ZZ.

PY's Heard on CW: PY1DW, PY1IF, PY2BX, PY2CD, PY5AD, PY9AD.

ON's Heard on CW: ON4JA, ON4VC.

OK's Heard on CW: OK1JB, OK1LM, OK1PK, OK1WG, OK2DD, OK2HM, OK2MS, OK2PL, OK2SI.

All Heard on CW: EI1T, EI2D, EI5F, EI6F, EI8B, OE1FH, OZ7PU, YL2BB, HAF3H, EZ4SAX, K5AA, K5AF, K5AZ, NY1AB, NY2AB, VO8W, VO8Z, I1ID, I1TKM, I1UL, CX1CC, CX1FB, CX2AM, TI2RU, TI2TAO, TI3WD, LU1CA, LU1EP, LU1EP, LU3DH, LU9AX, SU1CH, SU1EC, SU1SJ, VQ4CRP, VP2BX, VP4AA, VP5AA, VP5AB, VP5PZ, HB9AF, HB9AQ, HB9AU, FM8BG, FM8DA, X1AA, X1AG, X1AY, X1CM, X2C, X1G fone, HC2JM, HC1FG fone, LA1F fone, LA3C, XZN2B, XOH2FJ.

Conditions as a whole not so good for DX. Most of the month signals were weak and only the high-power gang were coming through. Would like to see more reports from other W's and DX fellows in "RADIO" each month, so how about it, gang? The receiver is a SS Comet "PRO" with a Transposed Doublet.

Calls Heard by W3CCF W3SI, Charlie Myers, 48 West Main St., Mechanicsburg, Pa.

14 MC Band

J2CE, J2GX, J2HB, J2HI, J2HX, J2IN, J3DP, J5CC, ZS1H, ZS2A, ZS2D, ZS2H, ZS4T, ZS5X, ZS6AA, ZT1R, ZU1E, ZU1N, VK2BA, VK2EV, VK2MA, VK2XU, VK3DP, VK3HG, VK4DD, VK4GK, VK4RV, VK5FM, VK5HG, VK7JB, ZL2AC, ZL2CI, ZL2GN, D4BAR, D4BAU, D4BBN, D4BBU, D4BCC, D4BCK, D4BDR, D4BFN, D4BGG, D4BIU, D4BJF, D4BKK, D4BKN, D4BLI, D4BMJ, D4BPJ, D4BSR, D4BUF, D4BUK, D4CAF, D4UAG, D4UAO, F8EB, F8EO, F8EX, F8FC, F8GD, F8GG, F8JQ, F8KV, F8PZ, F8RJ, F8TP, F8TQ, F8UQ, F8VJ, F8VK, F8VP, F8VT, F8WB, F8XI, F3AD, CTIAA, CT1BY, CT1CB, CTICQ, CT1EC, CT2AP, CT2BK, CT3AB, EA1BB, EA2AD,, EA2AV, EA3EG, EA3AN, EA4AV, EA4BG, EA5AF, EA5BA, EA5BE, EA7AO, EA8CGG, OK1BC, OK1GK, OK1JK, OK1WX, OK2DD, OK2HM, OK2KP, OK2MA, OK2MS, OK2OP, PA0AF, PA0AZ, PA0CE, PA0CO, PA0DC, PA0FX, PA0HG, PA0JM, PA0KT, PA0LL, PA0LR, PA0MH, PA0PF, PA0QL, PA0QQ, PA0RP, PA0SD, PA0SM, PA0VB, PA0VG, PA0VK, PA0XF, PA0XG, PA0ZZ, LU1CH, LU6CR, LU6DG, HC1FG, HC1JW, HC1PZ, ON4AU, ON4BZ, ON4DX, ON4EN, ON4FE, ON4GU, ON4GW, ON4JB, ON4JE, ON4MAD, ON4MY, ON4PY, ON4CSL, OZ3J, OZ5R, OZ7HL, OZ8D, PY2BN, PY2BM, PY2BW, PY2BX, PY5AD, PY7IC, PY7IG, U1DC, U2PZ, FM8CR, FM8DA, FM8IH, SP1AR, SP1BC, SP1DC, SP1DE, HB9AQ, HB9AD, HB9B, HB9J, HB9W, HB9Y, HAF3D, HAF7A, HAF4D, I1TbM, I1KI, LA1X, LA1Z, LY1J, OE1CM, OE1ER, OE3FL, OH3NA, OH3NP, OH5OD, SU1EC, SU1EG, SU1SG, SU6HL, YR5AA, VQ4CRL, VQ4KTA, LU8DJ, LU2CA, OA4B, G2AV, G2BG, G2BH, G2BO, G2BQ, G2BS, G2BY, G2DC, G2DI, G2DL, G2DV, G2DK, G2GF, G2HF, G2HD, G2KM, G2LA, G2LC, G2MA, G2MC, G2ML, G2MR, G2NH, G2OA, G2OI, G2PN, G2QO, G2RF, G2SD, G2VX, G2WA, G2XS, G2ZJ, G2ZP, G2ZQ, G5BJ, G5BY, G5CV, G5FV, G5GQ, G5IZ, G5JU, G5MA, G5ML, G5MR, G5NF, G5NI, G5NJ, G5PH, G5QA, G5QY, G5RZ, G5SR, G5UC, G5UY, G5VB, G5VQ, G5WB, G5WR, G5WY, G5XB, G5XT, G5YH, G5YJ, G5YV, G6AC, G6BX, G6CL, G6CJ, G6CT, G6CW, G6DL, G6GS, G6GV, G6HP, G6IR, G6IZ, G6LI, G6LK, G6LM, G6ML, G6MY, G6NJ, G6OS, G6PY, G6QB, G6QC, G6QQ, G6QX, G6QY, G6RB, G6RL, G6RV, G6TT, G6UF, G6US, G6VK, G6VP, G6WY, G6XL, G6XQ, G6XS, G6ZR, G6ZU.

Fones

G2GF, G2SD, G5BY, G5CV, G5ML, G6DL, G6LI, G6PY, G6RL, F8VP, CT1BY, ON4AU, ON4BZ, PA0XF, EA1AM, EA3AN, HB9B, HC1FG I1UL, LU8DR, LA1G, OA4B.

Notes On High Frequency Crystal Holders

By ALBERT F. HOEFLICH

CRYSTAL oscillators, using plates ground to fundamental frequencies of from 6000 to 28,000 kilocycles, are becoming more popular all the time. The design and adjustment of the quartz plate mounting has an important effect upon the efficiency and output of the oscillator, especially at these high frequencies. Therefore a few pointers on this subect are in order.

In the first place, if the manufacturer has given any instructions, you should follow them carefully, as these instructions usually cover the case in hand very thoroughly. If the data is not included with the crystal, the following instructions will be found of value:

Be sure that the pressure on the top plate, or electrode, of the crystal mounting is correct. To check this adjustment, use the method described by the writer in July "RADIO". This method of checking the adjustment makes use of the law that the increase of efficiency and output of the crystal oscillator is approximately proportional to the amount of direct grid current flowing through the grid leak.

To make this test connect a DC milliammeter with a full-scale reading of about 5 ma, in series with the oscillator grid circuit. Then be sure that the top electrode of the crystal mounting is connected to ground, while the bottom is connected to the grid. In this condition the top plate may be moved about over the surface of the crystal without throwing the circuit out of oscillation. Adjustments can now be made on the circuit, and on the holder; observations of the meter readings giving an indication of oscillator efficiency, due to the correct adjustment of pressure, etc.

Crystal manufacturers use various shapes for the holder electrodes, but a series of tests for forty meter crystal plates has shown that the best size and shape of mounting electrodes depends upon the curvature of the crystal surfaces; i.e., the surface contours. Briefly, and without going into the technical side of the matter, a deeply curved crystal plate, which is not perfectly accurately ground, will give maximum output with small electrodes. A fairly flat crystal plate will give best output with a large plate and light pressure. An accurately ground crystal plate, evenly, but not deeply curved, will give maximum output with a plate that almost covers the full surfaces, and will work best with relatively firm pressure on the top electrode.

To sum the results of these experiments up, it is safe to say that the deeper the curvature of the crystal plate surface, the greater the pressure necessary for best output. This data applies to the X-cut crystals only, as these are almost invariably used for high-frequency work.

With regard to the X-cut 20-meter crystal plates it appears that the smaller electrodes have an advantage. In fact, 20-meter crystal plates frequently refuse to oscillate with electrodes larger than ⅜ inch square. The position of the electrodes on the crystal plate, and the applied pressure, also have considerable effect upon the strength of oscillation.

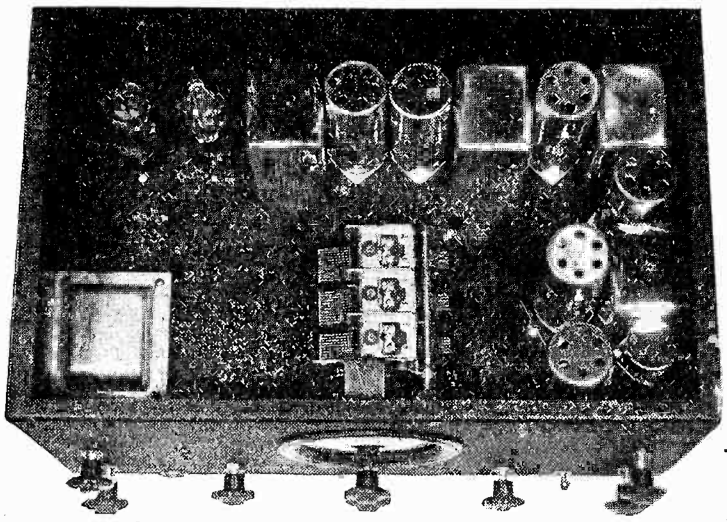
The correct mounting for high frequency crystal plates would, in the writer's opinion, have a large bottom electrode, a means for varying the applied pressure, and a system for substituting various top electrodes, each with a different surface area.

Analysis of the New Silver 5C Super

IT IS not at all difficult today to build amateur transmitters that will lay down good signals half way 'round the globe, and many thousands of such are in daily operation. The amateurs are, however, badly handicapped by receivers unable to render perfectly good signals readable at considerable distances under the variety of conditions under which they may be operated.

The majority of amateur receivers in use todav are the good old one RF stage regenerative detector, and one or two audio stages. These receivers are adequately sensitive, but provide signal selectivity which is almost purely a function of ear discrimination to beat notes of varying audio pitches, and their noise rejectivity is almost nil.

Because of these facts the superheterodyne is daily growing in favor. One such super which has proven popular in amateur and commercial circles, and has now been redesigned and improved for 1935 operating conditions, is described herewith. It is the McMurdo Silver 5C.



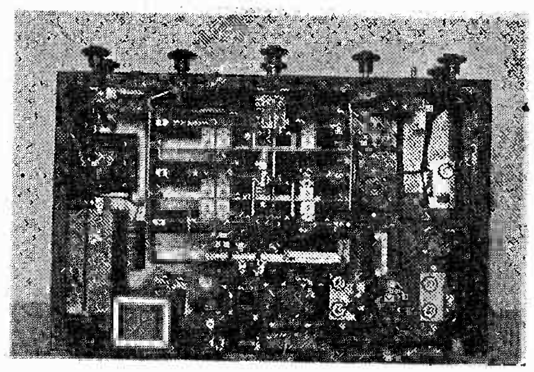


FIG. 2 (left): Inside the 5C shows a neatness and symmetry of layout.

FIG. 3 (right): The underside of the chassis is business-like.

Before considering this new receiver, it is well to review the essential specifications which must be met in the design of a good high frequency receiver. The initial requirements in undertaking such a design are extremely rigid. No single point may be neglected if a satisfactory receiver is to result. They summarize substantially as follows:

(a) Sufficient sensitivity to insure reaching the lowest possible residential noise level, which means about 1.0 microvolt.

(b) Absolute selectivity, for the ability to select one telephone station channel at a time without interference.

(c) Absolute 50 cycle crystal selectivity for CW code reception, with ability to shift the crystal circuit elimination notch to insure this absolute 50 cycle selectivity.

(d) An order of image selectivity adequate to eliminate interference from signals the image frequency (2 x IF) away from desired signals.

(e) Fidelity for telephone reception flat to cover the fundamental musical range of 30 to 4000 cycles, or flat to 4 to 6 db. over this range.

(f) Sufficient undistorted power output to give ample headphone or loud speaker volume without overloading the audio system.

(g) Lowest possible inherent noise level in order not to vitiate the necessarily high sensitivity.

(h) Full coverage of the entire wave range of 1500 to 23,000 kilocycles.

(i) Ample bandspread for easy, dependable tuning over amateur and commercial bands, coupled with "reset" dependability that assures ability to permanently log and calibrate receiver.

(j) Ease of operation and dependability.

In order to meet these general fundamental requirements many corollary requirements must be met.

If requirement (a) of sensitivity is to be satisfied in an all-wave superheterodyne, a first detector and oscillator of high gain will be needed, at least two IF stages, second detector, automatic volume control to minimize fading of weak stations, and two audio stages.

In meeting the selectivity requirement (b) two problems must be considered. Adjacent telephone channel selectivity will necessitate at least six tuned IF circuits as had in two IF stages. Obviously a single IF stage with its four tuned circuits, as now popular in some commercial receivers, will be insufficient for absolute 10 KC telephone selectivity. The second selectivity problem (d) is that of image, or repeat spot, interference. Initially this requires a high intermediate frequency in order to render the image rejection as simple as possible for the input circuits. In addition, with any logical choice of IF between 450 and 500 KC, 465 KC being the best average, a tuned RF stage will have to be used on short waves for image rejection, and it will also be necessary to insure a good signal to noise ratio.

The requirement (c) of 50 cycle CW telegraph selectivity necessitates either IF re-generation, which is not adequately helpful for noise rejection, or preferably a crystal filter. This crystal filter must be arranged so its "elimination notch" is available for rejection of unwanted carriers within a heterodyning frequency difference of the wanted signal. It must be so arranged that no noticeable loss of sensitivity or volume results when it is in use.

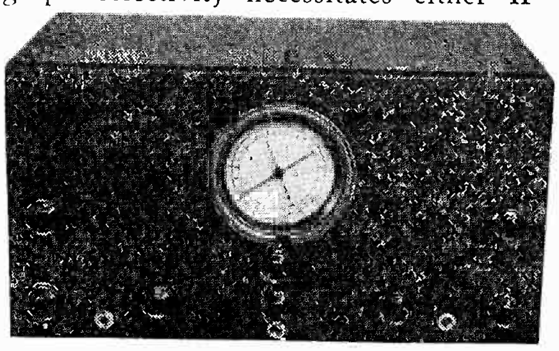


FIG. 1—The new Silver 5C receiver.

The requirement of good audio fidelity for telephone reception (e) necessitates good audio design and compensation for RF-IF side band cutting. It will also necessitate a diode,, rather than a three-element triode, second detector for elimination of second detector distortion. The audio amplifier should consist of two high gain audio stages, preferably a triode first stage and a high gain pentode output stage. The output, insulated from DC must be quickly available for headphone or loud spekaer operation.

Good power output, requirement (f) will involve at least three watts undistorted output for loud speaker volume without distortion. It can be had from a well designed two-stage audio amplifier with pentode output stage, not skimped on transformer size or available voltage.

Requirement (g) of low inherent noise, is most stringent. Noise inherent in a receiver design may originate in a number of ways, but assuming competent design and high quality tubes and parts, it may be localized. The frequency conversion effected by the first detector and oscillator will always produce some tube hiss,, which can be minimized by operating these circuits at as high a signal level as possible. This can be effected on weak signals only by the use of a single tuned RF stage preceding the first detector which will not only eliminate image interference as previously indicated, but from which sufficient amplification can be obtained to allow frequency conversion to occur, even on very weak signals, at a level sufficiently high to swamp oscillator hiss. With this done, the remaining noise will be entirely a function of overall gain, showing up thermal agitation noise in input circuit and in input tube. This is the final limitation of usable gain or sensitivity in a radio receiver. The answer is to strive for a sensitivity of between ½ and 1½ microvolts absolute—more than this results only in excessive noise with no gain in signal pickup, while less than this loses signals that could be copied under favorable local noise conditions. The question arises that if one RF stage is a help, why not use two? Assuming good coil and tuned circuit design, one RF stage satisfies the requirements of image selectivity and noise.

Requirement (h) of full coverage is vitally important. Full coverage includes all frequencies from 1500 KC to about 23,000 KC, the limits of the American amateur, commercial and broadcast bands at which a superheterodyne may advantageously be used, including all services such as police, amateur, airport, ship, telephone and broadcast—three bands are needed for this full coverage.

Band spread tuning (i) as an absolute necessity on any full-coverage high-frequency receiver. It can be provided in a number of ways, that of separate low capacity tuning capacities shunting the necessarily fairly large main tuning condensers. This method is simple and cheap, and hence most desirable. An ideal arrangement is that shown herewith—a single calibrated airplane type dial with two pointers actuated by a single push-pull tuning knob operating on two separate gang tuning condensers through a positive cone clutch with smooth, easy, automatic take-up belt drive. The degree of band spread desired is a matter of the service to be effected. In the 5C receiver, it may be adjusted to suit individual needs by simply removing rotor plates from the band spread tuning condensers. It is initially set at slightly over 100 degrees for the 160-meter amateur band.

Requirement (j) of ease of operation and dependability covers much territory. In terms of controls, it necessitates as many, but no more than all those necessary of obtain maximum possible results at all times. There should be one single tuning control, with, of course, a calibrated dial, having smooth, positive and easy adjustment and with easily readable main and band spread tuning ratios. Both actual tuning ratios should be between 8:1 and 10:1 for simple, easy finding and ability to tune for proper tone quality of short wave telephone or broadcast stations. These two ratios are essential if best results are to be had easily, the second (band spread) ratio being essentially band spread tuning—fine enough to be easily operated with the actual 50 cycle crystal selectivity available. A volume control should be provided, and a tone control to meet individual tone tastes and for noise reduction, and, of course, a solid, substantial and trouble-free wave-chaneg switch. In addition to this, an audio beat oscillator is essential for CW reception. A choice of manual and automatic volume control is essential, necessitating a separate IF sensitivity control (manual volume control) and audio' ((AVC) volume control. A crystal switch, crystal phasing control and audio beat oscillator pitch control are necessary (these last two are also "elimination notch" controls). A send-receive switch to prevent receiver blocking and paralysis is vital for use in the transmitting station.

Upon reviewing these general requirements, we find that a high-quality high-frequency radio must have the following tube and circuit functions:

1. *Tuned RF stage on all bands.*
2. *First detector and oscillator, preferably in a single tube of high conversion gain and good frequnecy stability such as the 2A7 or 6A7 electron coupled oscillator-first detector.*
3. *Two IF stages for adequate adjacent channel selectivity, operating at 465 KC to insure complete image rejection in conjunction with the tuned RF stage. Necessarily air tuned to insure permanent retention of initial alignment, sensitivity and selectivity and dial calibration.*
4. *High efficiency crystal circuit for 50 cycle CW telegraph selectivity with variable elimination notch.*
5. *Automatic volume control of extended range to effectively minimize effects of fading on weak and strong signals alike. Optional manual volume control for telegraph reception at the turn of a switch.*
6. *Audio beat oscillator for CW reception.*
7. *Diode second detector for minimum distortion and adequate output.*
8. *First audio stage for voltage amplification and gain to precede output stage.*
9. *Class A (preferably pentode) audio power output stage, developing 3 watts undistorted output, insulated against DC for headphone and loud speaker operation.*
10. *Dependable, trouble-free power supply turning out adequate power for operation of the entire receiver without undue heating or strain on its components.*
11. *Large enough loud speaker to insure good fidelity over fundamental musical range and good electric-to-sound conversion efficiency in order not to waste in conversion audio power previously developed.*

To leave much unsaid in order to conserve space, a receiver to embody all of the above important features will need eight tubes, which may be '58 tuned RF stage, 2A7 electron coupled oscillator and first detector, two '58 IF amplifiers, '55 diode second detector, diode automatic volume control and Class A triode first audio stage, two 2A5 pentodes, final audio stage, and one '80 rectifier.

The completed receiver is illustrated with its dynamic speaker in Figures 1, 2 and 3, while its circuit diagram appears in Figure 4. At the center of the chassis is seen the three-gang tuning condenser with its calibrated airplane dial which tunes the '58 screen grid tuned RF stage, and the 2A7 first detector-electron coupled oscillator circuits. At its right from front to rear, are the polished aluminum shields housing the '58 RF amplifier and 2A7 first detector-electron coupled oscillator tubes, while just to the right of these tube shields is the crystal circuit, and crystal holder. From right front to left rear, the shields and tubes are: First IF transformer, '58 first IF amplifier, second IF transformer, second '58 IF tube, third IF transformer, '55 diode second detector, diode AVC and triode first audio tube, '58 electron coupled audio beat oscillator tube, beat oscillator coil and condenser—assembly in shield similar to that used for IF transformers, 2A5 Class A pentode power output amplifier, '80 rectifier tube, and at the left front the power transformer.

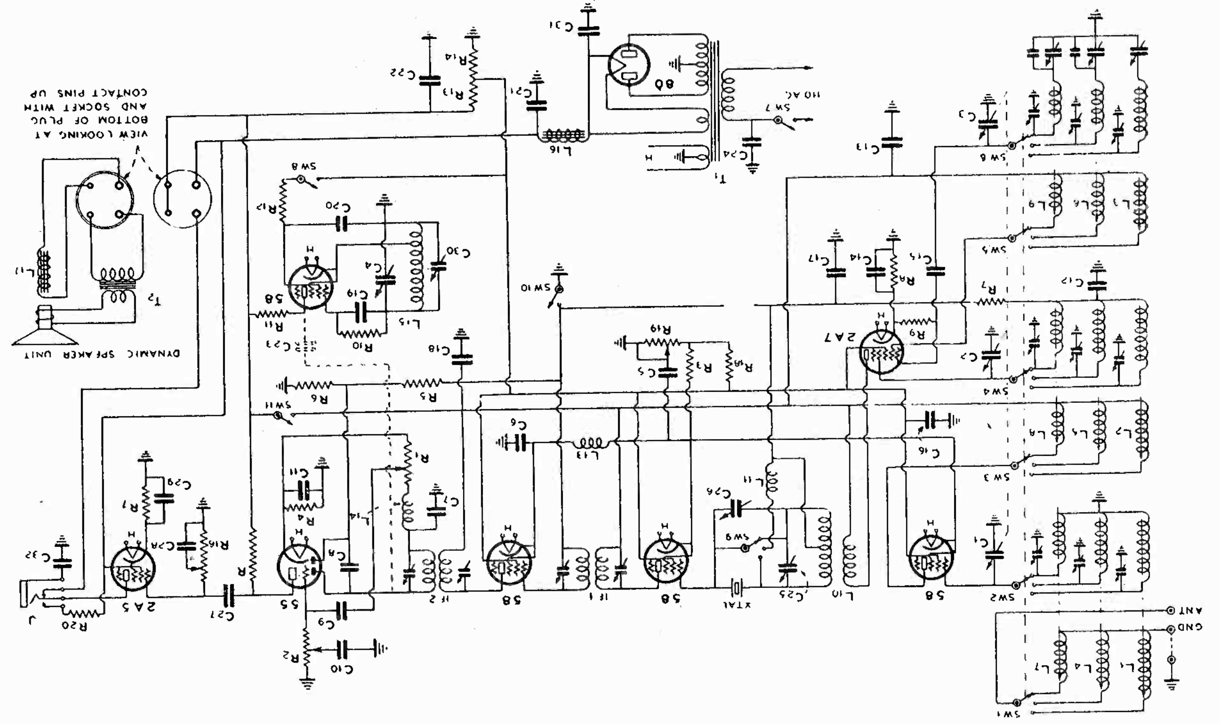


FIGURE 4. Circuit diagram of the Silver 5C receiver.

The controls are, upper left, down and to right: Beat oscillator pitch tone control; noiseless, tapered volume control and on-off switch, headphone jack, tone control and manual AVC switch; lower center, three-position wave change switch, below it the beat oscillator toggle switch, sensitivity or manual volume control, send-receive toggle switch, crystal switch, and, upper right, crystal phasing control. Immediately below the airplane "watch dial" is its tuning knob, pushed in for main tuning, pulled out for band spread. The airplane dial has a large 180-degree scale, giving excellent dial spread

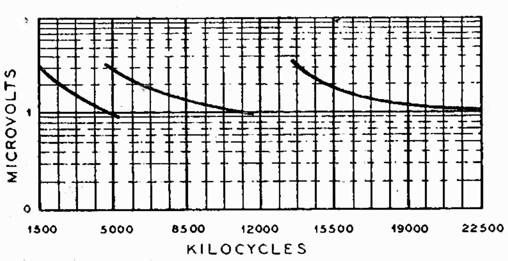


FIG. 5

FIGURE 5. Sensitivity as measured on a typical 5C receiver. The saw-toothed effect of this curve is due to the fact that it is really three curves shown on one sheet indicating the sensitivity of the three separate bands of the receiver. The 3:1 variation observed in each range is due to the variation in LC ratio over the ranges. The absence of absorption humps, due to deleterious natural periods of adjacent coils is absent in this receiver.

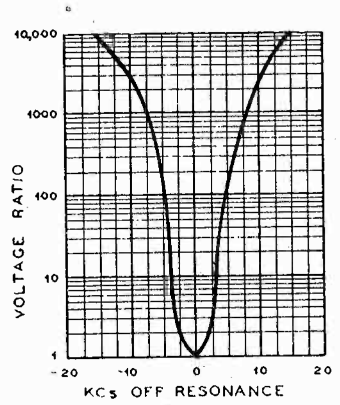


FIG. 6

FIGURE 6. Selectivity as measured at 6000 kc. This shows the selectivity without crystal at its worst since the adjacent channel contribution of input tuned circuits is negligible at this frequency and the selectivity is essentially that of the i.f. amplifier alone, as in all short wave superheterodynes. The switching in of crystal will narrow this curve to 50 cycles.

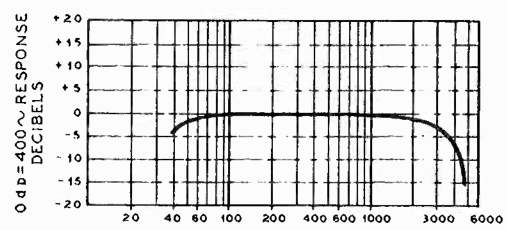


FIG. 7

FIGURE 7. Fidelity antenna to speaker as measured on a 5C with crystal out. The rising high frequency characteristic of the speaker compensates for the 6 db. drop of 4,000 cycles, which, however, is of no consequence on speech reception, being rather an academic consideration of high quality broadcast receiver design.

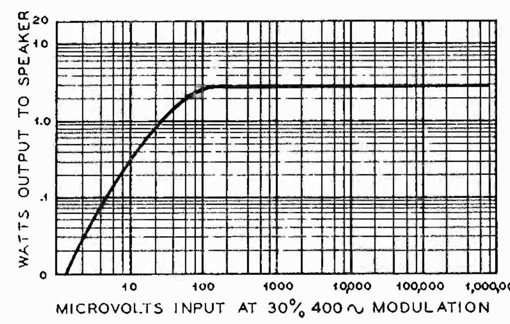


FIG. 8

FIGURE 8. This curve indicates the automatic volume control action of the receiver, showing how the output rises constantly with increasing signal input up to 100 microvolts and then levels off to the maximum output of three watts. For all practical purposes, as can be seen from the relative increments at the left, the volume may be said to be held constant for all signals of 20 microvolts or stronger since the ear will not accurately discriminate between signals of .6 of a watt and 3 watts, as is best indicated by the sound sensation graduations at the left of the curve.

A Five-Meter Transceiver

(Continued from page 16)

the tubes performing their dual functions just as efficiently as if the receiver and transmitter were separate units.

Two binding posts are provided on the top of the case for antenna or feeder connections. Best results were obtained with a quarter-wave antenna, consisting of a four-foot length of aluminum tubing, fitted at one end with a threaded brass insert that screws directly to one of the stand-off insulators. An eight-foot, half-wave antenna has also been found good. The four-foot tube is convenient because it is shorter. It is especially valuable when used on a car in motion, because it whips around less.

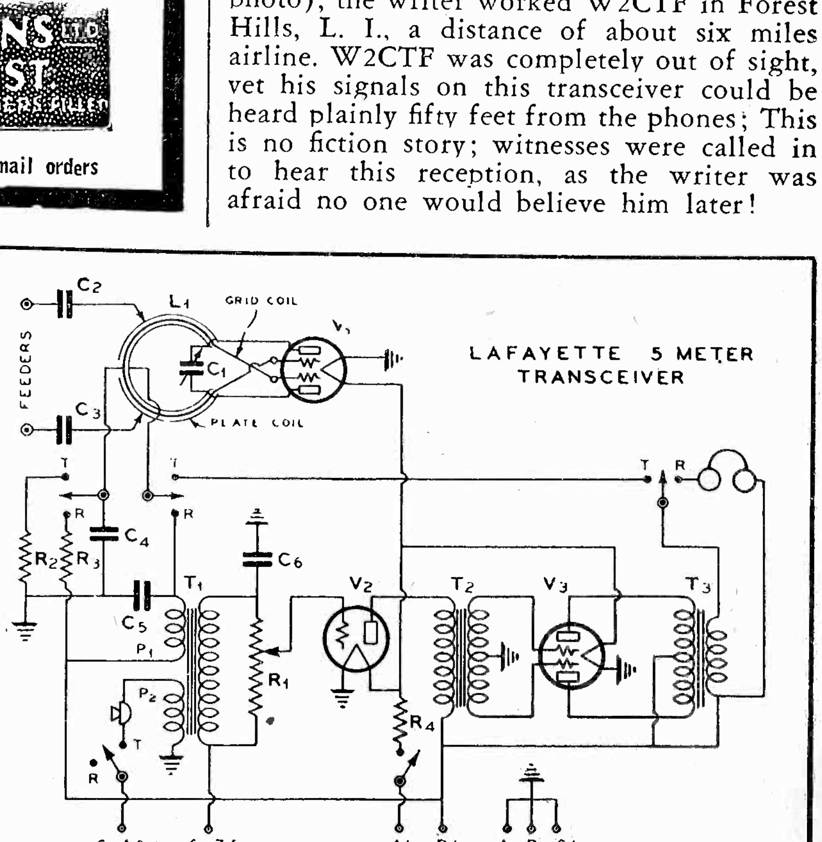
For power supply, dry batteries are used throughout. Two standard No. 6 dry cells light the filaments. Three 45-volt B batteries energize the plates. A 7½-volt C battery furnishes bias for V2. A separate 4½-volt C battery is used for microphone current, one of the switch sections opening this circuit when the transceiver is in the receive position. A single set of batteries withstood two months of experimental service, and still seem to be all right.

As for actual results, the five-meter band is full of surprises, the right kind of surprises. Although these waves are supposed to be of the quasi-optical type, and a receiver and a transmitter must be practically within sight of each other for communication, the writer has worked more than ten miles "blind" between 100 Sixth avenue, New York, and some of the outlying sections of the city. Some of the contacts were made with stations apparently blanketed by steel buildings. In fact, one QSO was accomplished with this transceiver on the fifth floor of a 17-story steel building, and the other station about three miles uptown! One of the beautiful features about a transceiver like this is that you can pick it up and move on, if one location isn't so good, and if another looks better.

The owner of a car can spend whole months running around with this transceiver. A favorite trick of five-meter operators is to look up the address of sime five-meter ham, drive around the corner from him and then "QSO him" over the air. The strength of the received signals is not always an indication of the transmitter's location. During one test made from the roof of 100 Sixth avenue shown in an accompanying photo), the writer worked W2CTF in Forest Hills, L. I., a distance of about six miles airline. W2CTF was completely out of sight, yet his signals on this transceiver could be heard plainly fifty feet from the phones; This is no fiction story; witnesses were called in to hear this reception, as the writer was afraid no one would believe him later!

Parts List for the Lafayette Transceiver

C1—15 mmf. midget.
C2—.002 mfd. mica.
C3—.002 mfd. mica
C4—.00025 mfd. mica.
C5—.004 mfd. mica.
C6—.00005 mfd. mica.
R1—1 megohm.
R2— 5000 ohms.
R3—200,000 ohms.
R4—1.5 ohms.
L1—Tank coil as described.
T1—Special Lafayette double primary transformer.
T2, T3—Class C AF transformers.
V1, V3—Type 19 tubes.
V2—Type 30 tube.



Decibels—Technique and Practical Application

By BERNARD EPHRAIM, E.E.*

IN TWO PARTS—PART I

THIS discourse aims to give the man with limited mathematical training the ability to make use of the decibel as he needs it in his work. To this end the explanations are detailed and complete. The exposition avoids involved mathematical terms and phrases whenever possible. No extra books, tables or reference data are needed; nor need one be very familiar with logarithms or the tiresome study of algebra, because all of the mathematics necessary for a thorough understanding of this discussion is supplemented in the subsequent paragraphs.

Evolution of the Decibel

A FEW years ago it was customary to measure the transmission loss or gain in an audio-frequency system (telephone line) by a measurement known as the "standard cable mile." This reference represented the loss due to one mile of open wire old-type No. 19 gauge cable when connected to a special reference circuit arranged for making transmission measurements. The "standard cable mile" was actually an artificial cable of certain resistance and capacity designed to either increase or decrease the number of standard mile units while making a test. The survey consisted of making comparisons of the volume of sound received over a given number of miles. This gave a rough indication to the transmission loss or gain. While the "standard cable mile" served its purpose it had a number of disadvantages. Of the most important were, first, that the attenuation constant varied for different frequencies; second, that the transmission measurements could only be made at only one frequency and yet maintain any great amount of accuracy; and third, the unit was largely meaningless unless the frequency attenuation constant was computed and measured at the same time the standard measurements were being carried out.

For a long time the "standard cable mile" was used as a measurement until some better method was finally adopted. This led to the dropping of the old standard and substituting in its stead an arbitrarily selected unit. This new unit, called the DECIBEL (abbreviated DB), has many of the characteristics of the old "standard cable mile", but fortunately has none of its disadvantages. The greatest difference between the old measuring unit and the new decibel is, that in the latter, the attenuation characteristic does not change at any or at all frequencies, while in the former, each frequency had a different attenuation constant. The decibel always represents a fixed percentage increase or decrease in power no matter what frequency is involved.

The decibel unit used in radio engineering, and now virtually universal in all power and energy measurements, is actually a unit of amplification expressed as the common logarithm of a power or energy ratio. One decibel is 1/10 of a bel. One bel or 10 decibels indicates an amplification by 10, the common logarithm of 10 being 1. Similarly, 2 bels or 20 decibels means amplification by 100; 30 decibels means amplification by 1000 and so on. It is well to remember that an attenuator (losser network of resistances) equating to 10 decibels the output power will always be one-tenth of the input power. Mathematically, the power ratio for 1 decibel may be expressed as

$$\frac{P_1}{P_2} = 10^{.1} \text{.....................} (1)$$

Where P_1 is the power input; P_2, the power output. The number of decibels really represents a power gain or loss depending upon whether the relation P_1/P_2 is greater or less than 1.

Expressions for various power ratios are now commonly employed in communication engineering at audio and at radio frequencies. To express a ratio between any two amounts of power, it is convenient to use units on a logarithmic scale based on the Briggs System of logarithms. This system is now in general use for all practical purposes. A logarithmic scale facilitates making conversions in positive or negative directions between the number of decibels and the corresponding power, voltage and current ratios.

The Logarithmic Table

A TABLE of logarithms is presented in Fig. 1. This table does not differ essentially from any other similar table except that here no proportional parts are given and the figures are stated to only three decimal places; this arrangement has been found to be satisfactory for all practical purposes. A complete exposition on logarithms is without the scope of this paper, however, the very essentials together with the practical use of the tables and their application to decibels is given herewith. Thus, a person need not be concerned with the study of logarithms other than their direct employment to decibels; this salient point completely simplifies more than half of the mathematical pre-requisites needed for this discussion.

The logarithm of a number usually consists of two parts: a whole number, called the characteristic, and a decimal called the mantissa. The characteristic is the integral portion to the **left** of the decimal point (see examples below), and the mantissa is the value placed to the **right.** The mantissa is all that appears in any table of logarithms. In the logarithm the mantissa is independent of the position of the decimal point, while on the contrary the characteristic is dependent only on the position of the number with relation to the decimal point. Thus in the following examples:

	Number		Logarithm
(a)	4021.	=	3.604
(b)	402.1	=	2.604
(c)	40.21	=	1.604
(d)	4.021	=	0.604
(e)	.4021	=	−1.604
(f)	.04021	=	−2.604

It will be seen that the characteristic is equal, algebraically, to the number of places minus one, which the first significant figure of the number occupied to the left of the decimal point. In (a) the characteristic is 3; in (b) 2; in (d) 0; in (e) −1; and in (f) −2. The following should be remembered: (1) that for a number greater than 1, the characteristic is one less than the number of significant figures in the number; and (2), that a number wholly a decimal, the characteristic is negative and is numerically one greater than the number of ciphers immediately following the decimal point. Notice (e) and (f) in the above examples.

Finding a Logarithm

TO find a common logarithm of any number simply proceed as directed herewith: Suppose the number to be 5576. First, determine the number of figures there are to be in the characteristic. An inspection will show that this number will be 3. This figure is placed to the LEFT of a decimal point. The mantissa is now found by referring to the logarithm table in Fig. 1. Proceed by selecting the first two numbers which are 55, then glance down the N column until coming to these figures, advance to the right until coming in line with the column headed 7, the number will be 745. (Note that the column headed 7 corresponds to the **third** figure in the number 5576.) Place the mantissa 745 to the RIGHT of the decimal point making the number now read 3.745. This is the logarithm of 5576. IMPORTANT: Do not consider the last figure, 6, in the number 5576 when looking for the mantissa; in fact, disregard all figures beyond the first three when determining the mantissa, however, be doubly sure to include **ALL** figures when ascertaining the magnitude of the characteristic.

Practical applications applying the logarithm to decibels will follow. Other methods using the logarithm will be discussed as the subject develops.

Three Place Logarithms

N	0	1	2	3	4	5	6	7	8	9
00	000	000	000	000	000	000	000	000	000	000
10	000	004	008	012	017	021	025	029	033	037
11	041	045	049	053	056	060	064	068	071	075
12	079	082	086	089	093	096	100	103	107	110
13	113	117	120	123	127	130	133	136	139	143
14	146	149	152	155	158	161	164	167	170	173
15	176	179	181	184	187	190	193	195	198	201
16	204	206	209	212	214	217	220	222	225	227
17	230	233	235	238	240	243	245	248	250	252
18	255	257	260	262	264	267	269	271	274	276
19	278	281	283	285	287	290	292	294	296	298
20	301	303	305	307	309	311	313	316	318	320
21	322	324	326	328	330	332	334	336	338	340
22	342	344	346	348	350	352	354	356	358	359
23	361	363	365	367	368	371	372	374	376	378
24	380	382	383	385	387	389	390	392	394	396
25	397	399	401	403	404	406	408	409	411	413
26	415	416	418	420	421	423	424	426	428	429
27	431	433	434	436	437	439	440	442	444	445
28	447	448	450	451	453	454	456	457	459	460
29	462	463	465	466	468	469	471	472	474	475
30	477	478	480	481	482	484	485	487	488	490
31	491	492	494	495	496	498	499	501	502	503
32	505	506	507	509	510	511	513	514	515	517
33	518	519	521	522	523	525	526	527	528	530
34	531	532	534	535	536	537	539	540	541	542
35	544	545	546	547	549	550	551	552	553	555
36	556	557	558	559	561	562	563	564	565	567
37	568	569	570	571	572	574	575	576	577	578
38	579	580	582	583	584	585	586	587	588	599
39	591	592	593	594	595	596	597	598	599	601
40	602	603	604	605	606	607	608	609	610	611
41	612	613	614	616	617	618	619	620	621	622
42	623	624	625	626	627	628	629	630	631	632
43	633	634	635	636	637	638	639	640	641	642
44	643	644	645	646	647	648	649	650	651	652

* c/o "RADIO".

45	653	654	655	656	657	658	659	659	660	661
46	662	663	664	665	666	667	668	669	670	671
47	672	673	673	674	675	676	677	678	679	680
48	681	682	683	683	684	685	686	687	688	689
49	690	691	692	692	693	694	695	696	697	698
50	699	699	700	701	702	703	704	705	705	706
51	707	708	709	710	711	712	713	713	715	715
52	716	716	717	718	719	720	721	722	722	723
53	724	725	725	726	727	728	729	730	730	731
54	732	733	734	734	735	736	737	738	738	739
N	0	1	2	3	4	5	6	7	8	9

Three Place Logarithms

N	0	1	2	3	4	5	6	7	8	9
55	740	741	741	742	743	744	745	746	747	747
56	748	749	749	750	751	752	752	753	754	755
57	755	756	757	758	758	759	760	761	761	762
58	763	764	764	765	766	767	767	768	769	770
59	770	771	772	773	773	774	775	776	776	777
60	778	778	779	780	781	781	782	783	783	784
61	785	786	786	787	788	788	789	790	791	791
62	792	793	793	794	795	795	796	797	798	798
63	799	800	800	801	802	802	803	804	804	805
64	806	806	807	808	809	810	810	811	811	812
65	813	813	814	814	815	816	816	817	818	818
66	819	820	820	821	822	822	823	824	824	825
67	826	826	827	828	828	829	829	830	831	831
68	832	833	833	834	835	835	836	837	837	838
69	838	839	840	840	841	842	842	843	843	844
70	845	845	846	847	848	848	849	849	850	850
71	851	851	852	853	853	854	854	855	856	856
72	857	857	858	859	859	860	860	861	861	862
73	863	863	864	865	865	866	866	867	868	868
74	869	869	870	871	871	872	872	873	873	874
75	875	875	876	876	877	877	878	879	879	880
76	880	881	882	882	883	883	884	884	885	885
77	886	887	887	888	888	889	889	890	891	891
78	892	892	893	893	894	894	895	896	896	897
79	897	898	898	899	899	900	900	901	902	902
80	903	903	904	904	905	905	906	906	907	907
81	908	909	909	910	910	911	911	912	912	913
82	913	914	914	915	915	916	917	917	918	918
83	919	919	920	920	921	921	922	922	923	923
84	924	924	925	925	926	926	927	927	928	928
85	929	929	930	930	931	932	932	933	933	934
86	934	935	935	936	936	937	937	938	938	939
87	939	940	940	941	941	942	942	943	943	944
88	944	945	945	946	946	946	947	947	948	948
89	949	949	950	950	951	951	952	952	953	953
90	954	954	955	955	956	956	957	957	958	958
91	959	959	960	960	960	961	961	962	962	963
92	963	964	964	965	965	966	966	967	967	968
93	968	968	969	969	970	970	971	971	972	972
94	973	973	974	974	975	975	975	976	976	977
95	977	978	978	979	979	980	980	980	981	981
96	982	982	983	983	984	984	985	985	985	986
97	986	978	987	988	988	989	989	989	990	990
98	991	991	992	992	993	993	993	994	994	995
99	995	996	996	996	997	997	998	998	999	999
00	000	004	008	012	017	021	025	029	033	037
N	0	1	2	3	4	5	6	7	8	9

Power Levels

IN the design of radio devices and amplifying equipment the power level is taken at six milliwatts (.006w.). This corresponds to the arbitrary reference level of ZERO DECIBELS. All power levels above the reference level are designated as PLUS quantities, and below as MINUS. The figure always being prefixed by a plus (+) or minus (—) sign commanding the direction in which the quantity is to be read.

It is unfortunate that all reference levels of zero decibels do not represent a power of six milliwatts; of course, this leads to confusion. However, conversions are easily made from one reference level to another by simply adding or taking away the necessary amount of units from the scale in question; then these values, or conversions, are compared to the six milliwatt, zero decibel level. Some power levels used in allied engineering fields are:

RADIO BROADCASTING
0 DB = 6.0 milliwatt at input to 600 ohm load

N. B. C. SYSTEM
0 DB = 12.5 milliwatt at input to 500 ohm load

TELEPHONE
0 DB = 2.4 milliwatt at input to 600 ohm load

SOUND PICTURES
0 DB = 6.0 milliwatt at input to 600 ohm load

ACOUSTICS (Acoustic Soc. Amer., new stds.)
0 DB = 1×10^{-16} watts per sq/cm (this is equal to 0.207 millibar sound pressure.)

Power to Decibels

IT IS sometimes customary to designate an amplifier having an output of 15 watts to be 14.994 watts above the zero level of 6 milliwatts. This power corresponds to a gain of approximately 33 decibels above the reference datum. Should there be a loss or gain in an amplifier or in an attenuating network, the decibel value would be either PLUS or MINUS according to the direction of amplification or attenuation.

The power output (watts) of any amplifier may be easily converted to decibels if the input and output impedances are equal. The following methods explain the technique in detail:

ILLUSTRATION: An amplifier using a 2A5 tube is said to deliver an undistorted output of three watts. How much is this in decibels?

The formula for solving this problem is:

$$\text{Ndb} = 10 \text{ Log}_{10} \frac{P_1}{P_2} \quad \text{.....................}(2)$$

Where Ndb is the desired power level in decibels; P_1, the output of the amplifier; and P_2, the reference level of 6 milliwatts. The subnumeral, 10, affixed to the Log, indicates that the logarithm is to be extracted from a table based on the exponent of a power to which 10 must be raised in order to produce a number.

SOLUTION:

$$\frac{P_1}{P_2} = \frac{3}{.006} = 500$$

and Log 500 = 2.69

therefore 10 × 2.69 = 26.9 DECIBELS

By substituting other values for those in the solution, any output power may be converted into decibels PROVIDED that the decibel equivalent is ABOVE the zero reference level or the power is NOT LESS than 6 milliwatts.

A slightly different procedure must be followed to determine the decibel equivalent of a power BELOW the 6 milliwatt reference datum. Here, as in the illustration above, the same formula is applied, but, involving slight mathematical modifications.

To solve most all problems to which the solution will be given in minus DBs, a simple understanding of algebra is required. Follow carefully these fundamental processes: To add algebraically, it is of cardinal importance to observe the plus and minus signs of expressions. (Do not confuse these signs with decibels.) In the succeeding illustrations notice that the result was caused sometimes by addition and other times by subtraction.

a	b	c	d
+2	—4	—4	+4
—4	—2	+2	+2
—2	—6	—2	+6

The terms arranged in **c** are most often used in decibel calculations.

When a solution to a problem involving logarithms will be in minus DBs, note particularly that the characteristic of the logarithm will be prefixed by a minus sign (—). This sign only effects the characteristic while the mantissa remains positive. The mantissa always remains thus, no matter what direction the solution brings the decibel. A prefix —1 to a logarithm means that the first figure of the number will be the **first place** to the **right** of the decimal; —2, will occupy the second place to the right, while a cipher fills the first place; —3, the third place with two ciphers filling the first and second places, and so on.

To multiply a **minus** characteristic and a **positive** mantissa by 10, each part must be considered separately, multiplied by 10, and then the products added algebraically. Thus in the following example:

10 × —1.9 = —1 ANSWER

10 × —1. = —10
10 × .9 = +9

—1 (adding algebraically)

Combining all the preceding mathematical processes the following examples demonstrate how to apply the aforegoing technique to decibel calculations.

ILLUSTRATION: An amplifier using a 199 tube has an output of 5 milliwatts. How much is this in decibels?

SOLUTION: By Equation (2)

$$\frac{P_1}{P_2} = \frac{.005}{.006} = .83$$

Log .83 = —1.9 (act. —1.920)

Therefore 10 × —1.9 = —1 DECIBEL
(10 × —1 = —10; 10 × .9 = +9; adding the products algebraically = —1)

By substituting other values for those in the above solution, any power output BELOW 6 milliwatts or the zero reference level may be converted to decibels.

Determining DB Gain or Loss

IN using amplifiers it is a prime requisite to know the decibel gain or loss when the input and output powers are known. To determine the gain or loss in DB, the following examples are given:

ILLUSTRATION: An intermediate amplifier is being driven by an input power of .2 watts; after amplification, the output is found to be 6 watts. If equal impedances are assumed the gain in decibels will be given by the following equation:

$$\text{(gain) Ndb} = 10 \text{ Log} \frac{Po}{Pi} \quad \text{..........}(3)$$

Where Ndb is the number of decibels gained; Po, the output power; and Pi, the input power.

SOLUTION: By Equation (3)

$$\frac{Po}{Pi} = \frac{12}{.2} = 60$$

Log 60 = 1.77

Therefore 10 × 1.77 = 17.7 DECIBELS GAIN.

In the above illustration should there have been a loss in decibels instead of a gain, it would only have been necessary to invert the power input and output ratios in the fraction Po/Pi to Pi/Po.

ILLUSTRATION: A certain frequency was being partially attenuated during amplification which caused the power output at this frequency to drop from 12 to 9 watts. What was this loss in decibels?

A simple solution is given by the equation

$$\text{(loss) Ndb} = 10 \text{ Log} \frac{Pi}{Po} \quad (4)$$

Where Ndb is the number of decibels lossed; Pi, the input power; Po, the output power.

SOLUTION: By Equation (4)

$$\frac{Pi}{Po} = \frac{9}{12} = .75$$

Log .75 = —1.8

Therefore 10 × —1.8 = —2 DECIBEL LOSS

Since 12 watts correspond to approximately 33 decibels, a loss of 2DB is therefore in the negative direction making the output level be PLUS 31DB during amplification.

Amplifier Ratings

POWER amplifiers used for either public address work or for low-powered modulators are usually rated as having a certain power output in watts together with a certain gain in decibels. The power output is meant to signify the actual wattage delivered to the output terminals, while that of the rated gain is the difference between the number of decibels exciting the input and the number delivered to the output. An amplifier having a power output of 14 watts with a rated gain of 104 decibels does not mean that there are 104 decibels delivered at the output terminals. However, it does mean that the difference between the input power level, which is in minus decibels, to that of the output power level, plus, is 104DB. Actually, this amplifier has only an output of approximately 34 decibels above the zero reference datum, but is capable of amplifying powers from a minus 70DB level.

The technical specifications or rating on power amplifiers given by engineers and custom-builders contain only the most meager of information. In general, the details only encompass the overall gain in decibels, the power output in watts, and the value of the input and output impedances. This complement is incomplete as there should have been included the input signal level in DB, the input signal voltage, and the power output level in decibels. Since none of these specifications are given, each may be calculated by various formula. The procedure to follow in computing any of these unknown values is systematically carried out in these papers under random topic headings.

Should the specifications on amplifiers had included only the input and output signal levels in decibels, it then would be necessary to know how much these values represented in power. The methods employed to determine power levels are not similar to those used in previous calculations. Caution should therefore be taken in reading the following explanations with particular care and attention being paid to the minor arithmetical operations.

The Anti-logarithm

TO determine a power level from some given decibel value, it is necessary to invert the logarithmic process formerly employed in converting power to decibels. Here, instead of looking for the log of a number it is now necessary to find the anti-logarithm or number corresponding to a given logarithm.

In deriving a number corresponding to a logarithm it is important that these simple rules be committed to memory: (1) that the figures that form the original number from a corresponding logarithm depend entirely upon the mantissa or the decimal part of the log; (2), that the characteristic only serves to indicate where to place the decimal point of the original number; and (3), that if the original number was a whole number the decimal point would be placed to the extreme right.

The procedure of finding the number corresponding to a logarithm is explained as follows: Suppose the number to be 3.574. First, search in the table under any column from 0 to 9 for the numbers of the mantissa 574. If the exact number cannot be found, look for the next lowest figure which is nearest to, but less than, the given mantissa. After the mantissa has been located simply glance immediately to the left to the N index column and there will be read the number, 37. This number comprises the first two figures of the number corresponding to the anti-log. The third figure of the number will appear at the head of the column in which the mantissa was found. In this instance the number heading the column will be 5. If the figures have been arranged as they have been found the number will now be 375. Now since the characteristic is 3, there must be four figures to the LEFT of the decimal point; therefore, by annexing a cipher the number becomes 3750; this is the number that corresponds to the logarithm 3.574. If the characteristic was 2 instead of 3, the number would be 375. If the logarithm was −3.573 or −2.574 the anti-logs or corresponding numbers would be .00375 and .0375 respectively. After a little experience a person can obtain the number corresponding to a logarithm in a very few seconds.

Converting Decibels to Power

IT IS always convenient to be able to convert a decibel value to a power equivalent in order to determine the ratio differences. The formula used for converting decibels into watts is similar in many respects to Equation (2), the only difference being that the factor P_1, corresponding to the power level, is not known. The mathematical expression for converting decibels into power is usually written as

$$\text{Ndb} = 10 \text{ Log } \frac{P_1}{.006} \qquad (5)$$

In practice it has been found that it is too difficult to explain the solution to the above equation on account of the expression being written in the reverse. However, by re-arranging the various factors, the expression can be simplified to permit easy visualization, thus

$$P = .006 \times \text{anti-log } \frac{\text{Ndb}}{10} \qquad (6)$$

Where P is the desired power level; .006, the reference level in milliwatts; Ndb, the decibels to be converted; and 10, the divisor.

To determine the power level, P, from a decibel equivalent simply divide the decibel value by 10 and extract the anti-logarithm of the quotient, then take the number comprising the anti-log and multiply it by .006; the product gives the power level of the decibel value.

ILLUSTRATION: The output power level in a certain low-powered amplifier was said to be PLUS 27.6 decibels. How many watts does this value represent?

SOLUTION: By Equation (6)

$$\text{Ndb} = \frac{27.6}{10} = 2.76$$

Anti-log 2.76 = 576
.006 × 576 = 3.456 WATTS

Another example will illustrate how the above operation is carried out when the decibel value is NEGATIVE.

ILLUSTRATION: A popular make of two-button microphone is said to have an output level of −40DB. Express this value in milliwatts.

SOLUTION: By Equation (6)

$$\text{Ndb} = \frac{-40}{10} = -4$$

Anti-log − = .0001
.006 × .0001 = .0000006 or .6 Microwatts

IMPORTANT: In all problems dealing with the conversion of MINUS decibels to power it often happens that the decibel value −Ndb, is not always equally divisible by 10. When this is the case, the numerator in the factor −Ndb/10 must be made evenly divisible by the denominator in order to derive the proper power ratio. Note that the value −Ndb is negative, hence, when dividing by 10, the negative signs must be observed and the quotient labeled accordingly. Always remember that from the negative quotient the anti-log must be extracted.

To make the numerator in the value −Ndb equally divisible by 10, proceed as follows: Assume −Ndb to be the logarithm −38 with a zero mantissa, hence, in order to make −38 divisible by 10 simply annex as many units as is necessary from the zero mantissa and add them to the −38 until the figure can be equally divided. An examination will show it was only necessary to add two units to bring −38 up to −40. CAREFULLY NOTE that every unit borrowed from the zero mantissa must be returned to it as a positive quantity multiplied by 10. Thus, the two units borrowed to bring −38 up to −40 is returned as 20, making what was a zero mantissa now have a value of 20. The numerator −Ndb, now becomes −40.20; this figure can now be equally divided by 10.

While the above discussion applies strictly to negative values the following examples will clearly show the technique to be followed for most all practical problems.

ILLUSTRATION: The output level of a popular velocity ribbon microphone is rated at −74DB. What is this equivalent in milliwatts?

SOLUTION: By Equation (6)

$$\frac{-\text{Ndb}}{10} = \frac{-74}{10} \text{ (not divisible by 10)}$$

Routine,

−74	mantissa	
+6	60	(6 × 10)
−80	60	

$$\frac{-\text{Ndb}}{10} = \frac{-80.60}{10} = -8.6$$

Antilog

−8.6 = .00000004
.006 × .00000004 = .000000000240 or
240 MICRO-MICROWATTS

In the next example a somewhat different arrangement will be found from that of the above illustration. However, while the solution is substantially the same, particular attention must be given to the method of adding the mantissas.

ILLUSTRATION: A low-powered amplifier has an input signal level of −17.3DB. How many milliwatts does this value represent?

SOLUTION: By Equation (6)

$$\frac{-\text{Ndb}}{10} = \frac{-17.3}{10} = -2.33$$

−17	.	3
+3	.	30
−20	.	33

(the mantissas were added as 30 plus 3, and NOT .3 plus .30)

Anti-log −2.33 = .0398
.006 × .0398 = .0002388 or .24 MILLIWATTS

Calls Heard at Radio W1DDO

CM2DO, CM2GR, CN8MP, CX2AM, D4BBN, D4BGT, D4BHH, D4BNK, EA1BC, EA3BV, EA3EG, F3BR, F3DM, F3DN, F8EC, F8FC, F8VK, F8WK, F8ZF, FM4AA, FM8BG, G2BM, G2HG, G2LA, G2XU, G2ZJ, G5KU, G5ML, G5UC, G5VB, G5VH, G5WP, G5WZ, G5YV, G6GV, G6HB, G6VK, HAF3D, HAF3H, HAF4H, HB9AQ, HC1FG, HC1PZ, HC2JM, HJ5ABG, HJAW, HP1A, K5AA, K5AF, NY1AB, NY2AB, LU1EP, LU2AM, LU3DE, LU3DD, LU4DJD, LU4FO, LU6DJK, LU6ER, ON4ABC, ON4DX, ON4FE, ON4GW, ON4HBP, ON4MAD, ON4RX, OK1AZ, OK1JB, OK2HM, PA0SD, PA0XG, PA0XR, PA0ZK, PA0CE, PA0PA, PY1AW, PY1IF, PY1IX, PY2BX, PY2CD, PY2IB, PY9AH, TI2KF, TI2TAO, U1NP, VE4CD, VE4GQ, VE4TJ, VE4TO, W6AWA, W6BAM, W6EBM, W6EGH, W6FNY, W6IQ, W6HML, W6KNF, W6LFL, W7AYQ, W7BCE, W7BRU, W7CGR, W7DRJ, W7VY, VP2CD, VP2BX, VP4AA, VP4TC, VP5AB, VP5CC, VP5JB, VP5PZ, VQ4CRP, X1LB, X1AG, XOH2FJ, XZ4F.

On 14 MC Phone

CM2QY, CM2RA, CM2SV, CM6XS, G5BY, G5BJ, G5ML, HC1FG, HI7G, H18X, K4SA, LU1PD, LU8DR, ON4MAD (?), X1G, X1AA, TI3WD, W6CNE, W6FFN, W6KS (?), W7ARK.

All these calls were heard on the 14 MC band from August 14 to September 5. Conditions on "20" were fair.

Respectfully submitted,
"Bob" Ruplenas, W1DDO.

Radiotelephony for Beginners

By "LINEAR"

A Complete Instruction Course
PART I

THE TRANSMISSION of intelligence from one point to another by means of the human voice is a much more complex process than the transmission of code signals and calls for a somewhat more technical knowledge on the part of the operator. The successful operator of a Radiophone station must know a great deal about the transmission of CW signals in addition to a knowledge of the fundamentals of sound amplification and modulation. The average CW transmitter can stand a reasonble amount of mal-adjustment without seriously affecting the quality or intelligibility of the received signal. On the other hand, a phone station must be properly designed and adjusted, otherwise various forms of undesired distortion and interference will arise.

To the layman, a phone transmitter may seem very complicated, but all types can be grouped into several components which, in themselves, are relatively simple.

The average phone transmitter can be divided into three major components: (1) The portion that generates and amplifies the radio frequency carrier wave. (2) The portion that converts the sound waves from the operator's lips into electrical waves and then amplifies these audio frequency waves. (3) The portion of the transmitter that takes the amplified audio frequency voice currents and mixes them (modulation) with the radio frequency carrier waves in such a manner that the power output of the phone transmitter varies in exact accordance with the variations in sound pressure applied to the microphone.

While the carrier itself has no effect on the loud-speaker at the receiving station, any variation in the carrier is detected and it is this variation which is turned back into sound waves by the loud speaker. Thus it is seen that the variations in the carrier output are important, not the characteristics of the carrier itself.

A study of the fundamental principles of Radiotelephony will materially aid the operator in obtaining satisfactory results. It will further help him avoid most of the common troubles which are so often encountered by the newcomer in the field.

Modulation Fundamentals

IN GENERAL, all communication systems utilize audio frequency waveforms. These can be pure tones and square-topped waves, for use in code transimssion, on either land lines or over radio circuits. Or these waveforms can be quite complex, for conveying telephonic speech directly, without translating the intelligence conveved into the dots and dashes of the telegraphic or radio codes. The range of audio frequencies required to transmit the intelligence varies from a few cycles per second to 10,000 cycles, depending on whether telegraphic or high-quality telephonic speech is used. For amateur purposes, an audio frequency range of from 200 to 2800 cycles per second will provide intelligibility, although fully-natural and pleasing reproduction of the transmitted speech requires a range of from at least 100 cycles to 4000 cycles. True high fidelity reproduction of speech means that all audio frequencies between 80 and 8000 cycles are faithfully reproduced at the receiving point. Whereas this order of fidelity is all too rare in amateur practice, it should nevertheless be encouraged because high fidelity makes an R2 phone signal intelligible. Thus high fidelity is a distinct advantage in working that elusive DX, especially if the receiving operator speaks a foreign language and has difficulty in understanding the particular variety of English you happen to speak.

Communication systems have two essential features, whether land lines or a radio circuit are used between the transmitting and receiving points.

1. *A means of transferring energy from the transmitter to the receiver. A land line system utilizes the flow of current through a conductor. A radio system utilizes electro-magnetic waves, propagated through the ether.*
2. *A means of "moulding" the transferred energy in accordance with the intelligence conveyed. This is the modulation, and the portion of the transmitted signal which actuates the receiving device, whether it is a loudspeaker or telegraph sounder.*

In the transmission of telegraphic signals over a radio circuit, the carrier is radiated only during the "mark" period. The "space" is obtained and defined by an absence of the carrier. On the other hand, when telephonic communication is used on a radio channel, the carrier remains on between syllables and words. The audio signal periodically augments and reduces the amplitude of the carrier, but the average amplitude of the carrier remains constant. Inasmuch as it is the VARIATION of the carrier, and not its absolute value, that conveys the useful signal, many amateurs and experimenters have wondered why a transmitter could not be arranged so that no carrier is radiated except when an audio signal is present, and the carrier amplitude increased from zero to maximum, then down to zero with each audio impulse. Such a system would enable small tubes to give a tremendously high modulated output. It also would permit the use of smaller modulator tubes, whose economies are greatly to be desired. Such transmitters have been built but they have so many offsetting disadvantages that it may require some time before they are applied to amateur practice. Certain commercial telephone circuits use this type of modulation, termed "Suppressed Carrier Single Sideband," but it is not very widely used because of the difficulty in obtaining satisfactory speech quality. The principal reason for the difficulties involved in Suppressed Carrier systems lies in the inability to maintain the oscillator in the receiver in exact synchronism with the oscillator in the transmitter.

The Sideband Theory

THERE ARE two ways of visualizing the effect of amplitude modulation on a radio frequency carrier. First, the audio frequency modulating signal alters the amplitude of the carrier wave so that the envelope, or outline, of the carrier wave conforms to the audio signal applied. It is assumed, in this case, that the carrier wave remains perfectly constant in frequency and in average amplitude. This concept of a modulated carrier is quite useful until one starts to analyze the distribution of power between the carrier and the audio frequency speech components.

The second conception is based on the fact that any complex modulated wave can be resolved into its component frequencies and their harmonics. Thus, when a modulated carrier is analyzed, it is found that the original carrier is present, plus two groups of sum and difference frequencies, which have been named the upper and lower sidebands. These sidebands are generated in the transmitter by the familiar heterodyne process, which is commonly used in superheterodyne receivers. Thus one sideband consists of waves whose frequencies equal that of the carrier PLUS that of all the individual audio components, and the other sideband consists of waves whose frequencies equal that of the carrier MINUS all the audio components. In other words, the carrier and the audio signal were HETERODYNED together into a group of BEAT FREQUENCIES by the detecting action of the modulated amplifier.

DETECTION and MODULATION mean much the same. In fact, the detector in the receiver which receives the modulated wave and turns it back into an audio frequency wave which is applied to the loudspeaker, repeats the heterodyne action of the radiophone transmitter and completely reverses the process. In the receiving detector (or audio de-modulator, as it is sometimes called) the incoming carrier BEATS with the incoming sidebands and thus the sum (or difference) frequencies between the two become an exact equivalent of the original audio frequency modulating signal, which can now actuate the loudspeaker. When a suppressed carrier system is used a local oscillator must be provided in the receiver in order to re-supply a carrier wave for the incoming sideband (or sidebands, when both are used) to heterodyne with, in order that an audio beat frequency can be obtained to reproduce the signal. It will be seen that the local oscillator must maintain exactly the same frequency as the oscillator used at the transmitter, which was modulated to produce the transmitted sideband. If the frequency of the receiver oscillator drifts slightly, it will not only change the pitch of the fundamental tones in the transmitted speech, but will also shift the frequencies of all the overtones in such a manner that they will no longer be integral harmonics of their associated fundamental tones. The resulting distortion and quality impairment will utterly destroy the intelligibility of the channel. A drift of only a few cycles is sufficient to make most speech absolutely unintelligible, and it is almost impossible to maintain high frequency oscillators sufficiently close together without extensive frequency stabilizing equipment.

Let us therefore eliminate any consideration of suppressed carrier modulation systems until such time as cheap filters and stable oscillators are available to the amateur.

The sideband theory quite satisfactorily explains the interference which occurs when two phone stations use carrier frequencies that are close together. The carrier takes up practically no room in the frequency spectrum, but each sideband contains all of the audio signal components so that the modulated signal requires a frequency band twice as wide as the highest audio modulating frequency. If the transmitter responds to all audio signals impressed on the microphone between 100 and 4000 cycles per second, then the band width extends 4000 cycles below the carrier and 4000 cycles above the carrier frequency. This 8000 cycle band will cause some interference to any other sta-

(Continued on Page 83)

All-Wave Receiver Circuit Tracking

By FRANK C. JONES

A LARGE number of the new superheterodyne receivers use a stage of tuned radio frequency amplification as a means of improving the signal-to-noise ratio and to reduce image interference. This means three tuned circuits, one of which is detuned by the intermediate frequency of 465 KC, or some such value. For simplification of tuning adjustment, these circuits should track so that a single dial control may be used without resorting to panel-controlled trimmers. If a band-spread control is used, it should control all three circuits simultaneously, either mechanically or by means of a three-gang trimmer condenser. Unless this is done, the image ratio will be poor and the signal-to-noise ratio and sensitivity will also suffer badly.

Tracking the detector and r.f. circuits does not offer any great obstacles, since the coil inductances can be made equal for each band; the tuning range is the same for each circuit, and individual mica trimmer condensers can be used to compensate for unequal circuit fixed capacities.

Tracking the oscillator circuit to the other two circuits is a different problem. The oscillator, for example, works at 450 KC higher frequency than the other two tuned circuits and has to maintain that difference over each tuning range. The range of from 15 to 550 meters is usually split up into four or five bands by means of a multi-section switch. This means a different set of tracking calculations for each band, since the tuning ratio of the oscillator to the signal frequency circuits is different for each band. By the proper proportion of circuit constants, the three tuned circuits can be made to track within less than one-half of one per cent, which is ample for coils of relatively high "Q" or efficiency.

Calculation of the inductances and capacities for an all wave receiver are exact, but some of the values used in the calculations are necessarily approximate due to the circuit layout and type of switching used. The easiest system is one in which each band has its own set of coils with the switching done on the grid end of each coil. The circuit fixed capacities can be fairly closely approximated, and by having individual trimmers on every coil, very good tracking can be obtained. In one super, image ratio measurement at 75 meters gave a value of 4500 and in another similar receiver which had not been tracked properly, a ratio of less than 1000 to 1.

In Fig. 1 is shown the usual coil and tuning condenser with the circuit and tube shunt capacities C_O and the oscillator series padding condenser C_S. The value C_O includes the added trimmer condensers. THE RF oscillator and detector tuning condensers could be a three gang 18 to 360 uufd. condenser without trimmers. The tube capacities, primary windings, wiring and switch capacities can be lumped up to a value of 30 uuf, part of which is in the coil trimmer condenser. This gives a minimum of 48 uuf. and a maximum of 390. A coil of 220 microhenrys inductance will tune from about 540 to 1510 KC using the familiar old formula

$$f = \frac{1}{2\pi\sqrt{LC}}$$

The oscillator would have to track by a difference of the intermediate frequency used, which might be 450 KC. This circuit should then tune from about 990 to 1960 KC, which is a smaller range or ratio. The detector and RF have to cover a frequency range of 2.8 to 1, while the oscillator covers a range of 1.98 to 1. To track the oscillator as nearly perfectly as possible, both the tuning capacity ratio and the value of inductance have to be reduced. Several values of L, C_O and C_S in the oscillator will give correct tracking at the high and low frequency ends of the tuning condenser but not in the middle portion. By a series of substitutions of values the final results work out with a value of C_S of 450 uufd an oscillator inductance of 121 uh. and C_O of 62, 18 + 44 uufd.

Checking this

$$f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{121\times10^{-6}\left(\frac{[360+44]\times450}{360+44+450}\right)\times10^{-12}}} = 990\text{ KC}$$

At the other end

$$f = \frac{1}{2\pi\sqrt{121\times10^{-6}\times\left(\frac{450\times62}{450+62}\right)\times10^{-12}}} = 1960\text{ KC}$$

At the middle

$$f\ det = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{220\times10^{-6}\times(120+30)\times10^{-12}}} = 875\text{ KC}$$

At the middle

$$f\ osc = \frac{1}{2\pi\sqrt{121\times10^{-6}\left(\frac{[120+44]\times450}{120+44\times450}\right)\times10^{-12}}} = 1324$$

which gives a value of 449 KC difference, well within the limitations desired. The ratio of oscillator to detector inductance was .55 for the broadcast range coils.

The other coils are figured in a similar manner. The next RF and detector coils should tune from about 1460 KC to 4000 KC in order to provide a slight overlap. The oscillator coil should cover from 1910 to 4450 WC or a ratio of 2.33 to 1 as against 2.74 to 1 for the other two circuits. The oscillator has to cover a little greater range in proportion this time so the padder condenser C_S would be greater. An RF and detector coil of 30 microhenrys will tune from 1460 to 4030 KC with a minimum total capacity of 52 and a maximum of 394 uuf. This allows 34 mmfd for miscellaneous capacities, including trimmer, as against 30 in the broadcast band. The tuning condenser minimum is still 18 uufds.

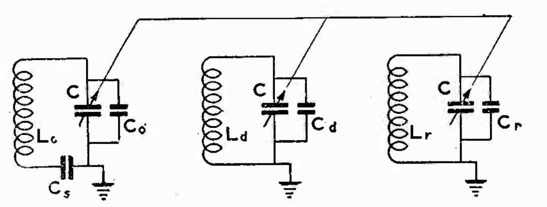


FIG. 1

Signal Freq. Range	R.F. or Detector Inductance per coil	No. of Turns	Osc. Inductance per coil	No. of Turns	C mfd.
540—1510	190	115t #30 Enam.	98.	65t #30 E.	.00045
1460—4030	24.8	34t #26 DSC	18.4	27t #26 DSC.	.0012
3500—9330 KC	4.2	13t #24 at 24 t.p.i.	3.65	12t #24 at 24 t.p.i.	.003
8 MC—21 MC	1.0	4¼t #24 at 24 t.p.i.	.95	4t #24 at t.p.i.	.006
Total	220.	Total	121.		

All on 1 inch Bakelite coil forms.
All trimmers are 5 to 25 mmfd.

The oscillator would actually cover from 1910 to 4480 KC and the values work out as C_S = 1200 uuf. C_O = 39 and L = 23 microhenrys.

The next coil range might be from 3500 to 9330 with a coil of 5.2 microhenrys, and a C_D of 38 mmfd. The corresponding oscillator range would be from 3950 to 9780. This works out to give an L_O of 4.6 microhenrys, C_S of .003 mfd, and C_O of 39 mmfd.

Similarly the next and shortest wave coil would cover from 8 MC to 21 MC with an inductance of one microhenry and a total shunt capacity C_D of 39.2 mmfd. The oscillator would cover the range of 8.45 to 21.45 MC with a L_O of .95 uh. a C_S of .006 and a C_C of 39½ mmfd.

These various values of C_O and C_D are easily obtained by means of individual trimmers on each coil circuit. The values of C_S can be fixed, of the type ± 3% mica condensers, and the coil inductances varied slightly by moving an end turn or two; or the coils can be wound to a fixed number of turns in a given winding length, and these C_S values made slightly variable by means of adjustable padders across fixed mica condensers.

It should be remembered that for high frequency oscillators, air trimmer condensers, and special mica condensers for C_S, are necessary to minimize frequency drift.

In some coil switching circuits, the coils are in series instead of using individual coil circuits. The proper values of industance for each section can be found by subtracting the other coil inductances as is done in the following example.

The presence of shielding and interwound primary circuits has not been considered except as to the capacity effects involved. Since the inductance of each coil would be reduced slightly by the presence of the shields, it might be necessary to add a turn or two to the largest coils, but this would not be necessary if all metal shields are kept at least ⅝ of an inch clear of all parts of each coil. Long leads should be avoided, especially on the short wave coil leads to the switches and tuning condensers.

Real Economy in Grid Circuit Neutralizing Of Single-Ended R. F. Amplifiers

By J. N. A. HAWKINS

MOST amateurs have, for years, preferred plate circuit neutralization, as shown in Fig. 1, which was originally invented by Hazeltine. This form of neutralization utilizes a split plate tank (whether split stator condenser or split coil) to provide the out-of-phase voltage which, when applied to the grid of the tube, cancels out the feedback voltage which is fed back through the grid-plate capacity of the tube itself. If this feedback voltage is not neutralized it will overwhelm the excitation voltage applied to the grid from the preceding oscillator or buffer stage and thus the amplifier under consideration would oscillate by itself, at a frequency determined largely by the industance and capacity of the plate tank. It is this undesirable oscillation that is prevented by the process known as neutralization.

A surprisingly large number of amateurs have never heard of the form of grid circuit neutralization invented by Rice, and which utilizes a split grid tank to provide the out-of-phase neutralizing voltage. The circuit of this method is shown in Fig. 2. Let us consider the relative advantages of each method. Let us also limit ourselves to a modern, link-coupled stage.

Fig. 1 shows the usual method of plate neutralization. The plate tank is split by grounding the rotor of the split stator tank condenser. This method of splitting the plate tank has so many advantages over the method which by-passes the center of the tank coil to ground, that the split condenser method only will be considered.

The grid circuit is rather simple. A single section tuning condenser is entirely satisfactory because one end of the condenser is at ground capacity, with respect to RF, when neutralizing in the plate circuit. The blocking condenser Cb usually has a low voltage across it, and thus it need not be of an expensive type. However, some users report a strange tendency for this condenser to blow up, although no satisfactory explanation for this trouble has yet been given.

The split plate circuit, on the other hand, is rather complicated and the split stator condenser is quite expensive, because it must be much larger in size than a single section condenser of the same overall capacity. The split stator condenser also has twice as many points of support for the stators and thus must have twice as many insulators as the single section type. At first glance it would appear that each of the insulators on the split stator condenser has only one-half of the RF voltage across it as has the insulators in a single section condenser, but this is not the case. Note that the amplifier tube's plate circuit is tapped across only one-half of the total plate tank, because the radio frequency filament return is to the center of the tank. Thus there is a voltage step-up across the whole condenser and coil and the total voltage across the tank is just twice that which is across the single section tank shown in Fig. 2, assuming equivalent operating conditions for the tube. Thus the spacing between rotor and stator plates in each section of the split stator condenser must be the same as in the single section condenser, *in spite of the fact that there are two sections in series. And in addition, each side of the split-stator condenser must have twice the capacity of the single section condenser in order to have the same effective capacity across the tank coil.* For example, 100 uufds per section, or a total of 200 uufds of a given plate spacing, is required in order to equal 50 uufds of the same plate spacing in a single section circuit. Thus the split stator condenser must cost at least FOUR times as much as a single section condenser which would do the same job, if the necessity for splitting the plate tank were eliminated.

The radio frequency choke in the plate voltage lead to the center of the plate coil usually has very little work to do, but sometimes it has much to do, as evidenced by the number of chokes that go up in smoke when something becomes detuned or deneutralized. This choke must be husky enough to carry the total plate current. Receiving type chokes are usually too small and an expensive transmitting choke must therefore be used.

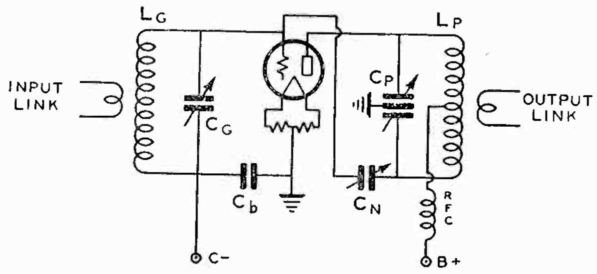


FIG. 1
Plate, or Hazeltine Neutralization.

Plate circuit neutralization has another important disadvantage. As shown above, the tube is connected across only half of the plate tank. Thus the impedance across the whole tank is four times the impedance across an equivalent single ended tank. This means that, for inductive coupling to the load, whether it be the antenna or a succeeding amplifier stage, a four-to-one step-down must be added to whatever ratio of transformation would be used out of the simpler single section plate tank. Extreme ratios of transformation reduce coupling efficiency, no matter what particular type of coupling is used, especially when coupling fairly high powers, due to the corona loss in the air caused by the high RF voltages present across the high impedance of the split tank. This also requires the use of twice as much insulation in the tank coil supports.

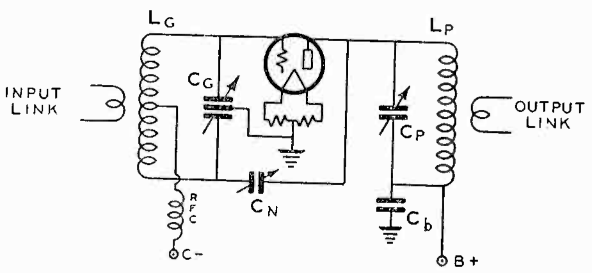


FIG. 2
Grid, or Rice Neutralization.

The neutralizing condenser and the grid-to-plate capacity of the tube in series act as one small condenser shunted across the main plate tuning condenser. Thus each has one-half of the total tank RF voltage across it. And the neutralizing condenser must be insulated and spaced for the same voltage which is across each half of the split-stator tank condenser, or the same voltage that would be across a single ended condenser if plate neutralization were not used. This usually amounts to about four times the plate voltage, in a Low-C, CW transmitter. For phone use the breakdown voltage would have to be eight to ten times the plate voltage, under the same conditions of extremely low C. However, a phone transmitter, plate modulated, should not have too-low C, otherwise the linearity of the class C stage will suffer.

Let us now consider the advantages and disadvantages of grid circuit neutralization, as shown in Fig. 2. Note that the split stator condenser has been transferred to the grid circuit. This effects a real economy because a much lower voltage is across the grid tank and the break-down rating of this condenser need only be about one-fourth to one-sixth of the rating of a similar condenser in the plate circuit. The RF choke used to feed the DC grid bias into the center of the grid tank coil will almost never have to carry more than 25 to 50 mills of current, so that the small receiving type chokes are quite satisfactory. The grid coil itself must stand twice as much voltage across it as the grid coil used with plate neutralization. Nevertheless, this voltage is still quite small as compared to the RF voltages in the plate circuit. Rarely will the insulation in ordinary ceramic receiving coil forms be insufficient to prevent breakdown. Let us again consider the neutralizing condenser. Now it is in series with the tube capacity across the grid coil. The RF voltage across this condenser is only a fraction of what it was when plate neutralization was used. In fact, the DC plate voltage is now the highest voltage across this condenser, consequently a rating of from one-and-a-half to twice the plate voltage will usually be sufficient to prevent breakdown. By this time the reader should be convinced that the single section plate tank condenser will cost only about one-fourth as much as the split stator condenser required when plate neutralization is used. As a matter of fact, in some cases investigated, the split stator condenser cost between five and six times as much as compared with the same breakdown voltage cost in the single stator type, both condensers having the same overall effective capacity.

A high voltage, plate blocking condenser has been added in the grid neutralized stage, but, strange as it may seem, more 5000 volt .006 ufd. mica condensers have "popped" when used as grid blocking condensers, as shown in Fig. 1, than when used as plate blocking condensers as shown in Fig. 2. In any event, even the most expensive type of plate blocking condenser will not begin to use up the money saved for tuning and neutralizing condensers when grid circuit neutralization is used.

Congratulations, Mr. Rice, for your circuit. You invented it many years ago, but only recently have we learned to properly appreciate it.

These advantages of grid circuit neutralization are of no benefit to the man who uses a push-pull amplifier because he already uses a combination of grid and plate neutralization, and split stator condensers should be used in both plate and grid circuits.

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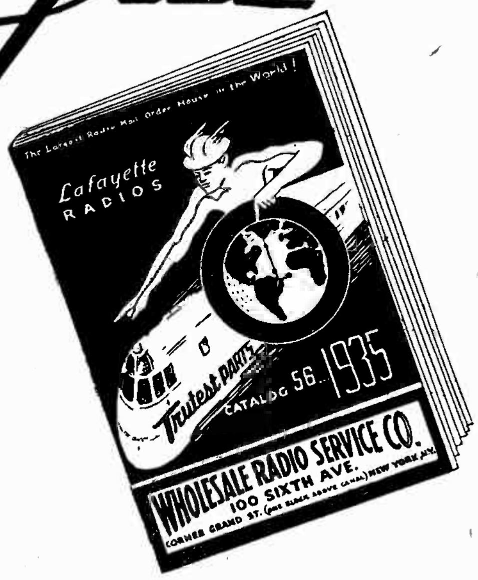

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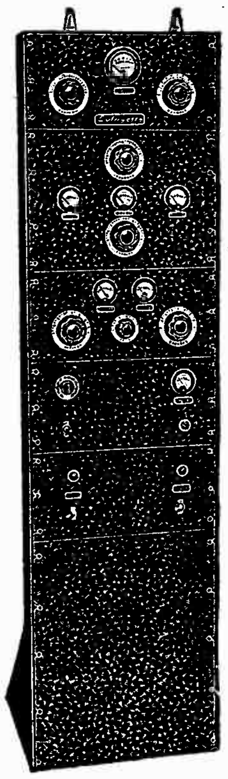

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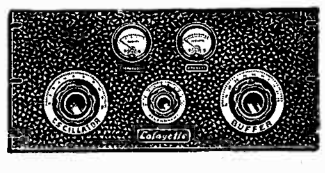

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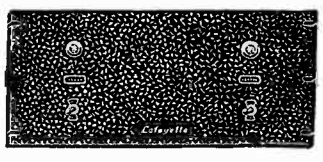

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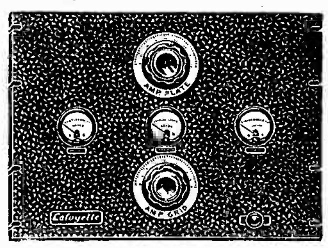

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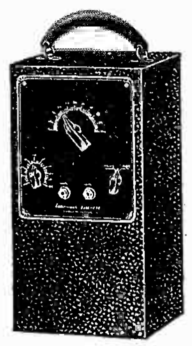

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(Formerly I.T.K.)

The Amateur's Legion of Honor

This department is edited by the President of the International Radio Fraternity, J. Richard Meloan (Jo) radio W6CGM-W6ZZGB, KERN.

All communications concerning the International Radio Fraternity, as well as inquiries from any amateur as to the Requirements for Membership, should be addressed to I.R.F. Headquarters, International Radio Fraternity, 715 S. Hope St., Los Angeles, Calif.

Forest Service Radio

W6CVL, ITK Brother up in the high Sierras, gives us some first hand information on the recently installed forest service radio system. Amid the tall pines at an elevation of 4000 feet and upwards Russ Hossack tells us that these forest service portable fone transmitters consist of two types, both AC and battery powered. The calls are SP-83, SP-84, SP-85 and M-23, M-24, M-25, operating on a frequency of 3445 KC just outside the 80-meter ham band. The "M" stations are AC, using 46 xtal, 46 buffer and a pair of 46s paralleled in the final with link coupling. The audio end consists of a balanced armature induction mike into a 59 pushing a pair of 46's class B for modulators.

Russ has been engaged in testing these rigs and operates station "M-23". They are on the air nearly every evening between 7:30 p.m. and 9:00 p.m., P.S.T. These stations have proved out to excellent advantage with consistent reports being received from all over the state of California, audibility R9, and with a good R7 in Colorado, no little distance. Many of these reports are for daylight reception. The rigs are operated in the Sequoia National Forest and W6CVL (M-23) is at Northfork, Calif., about 50 miles in an easterly direction from Fresno near Bass Lake.

Last minute news from CVL says that there are now 18 of these fone rigs in operation and they have just received a number of 9½-meter ultra-portables that are being tested. Fair results up to distances of 15 miles are reported, the mountainous terrain giving these portables some advantage over higher-frequency equipment. Needless to say, radio has proven invaluable to the Forest Rangers and without doubt will become far more extensive in use and a "Permanently new necessity."

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28 MC Contest Nears Close

REPORTS received indicate excellent 10-meter work at the beginning of the contest in July with results tapering to little if any during most adverse conditions in late August. At this writing the contest has not yet closed and certified reports have not yet been made by the contestants but some indications may be given in several letters received by Headquarters. Lloyd Jones W6DOB says: "Have heard W7AVV, W6DHZ, W4AJY, W6BXV, W3BWD, W6PT, W6CLH, W6IDF, W6BOQ. Have worked W7AVV and W6CLH so far (one watt input!)" A glance at this list indicates some transcontinental heard stations. Bill Ellsworth W1BZC has been on regular 28 MC skeds 6:30 p.m. and 9:00 p.m. EDST. Best DX worked has been W4TZ. The following were heard during June: W4AJX, W4BFH, W4EG, W4MR, W4TZ, W8HYZ, W8ICW, W9GFZ, W9KEP, W9NY and W9TH. From which list we recognize some live-wire ITK experimenters. As previously mentioned, this contest is for portable development, primarily, ,and a rather low power affair.

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New Members Order of ITK

WE WELCOME these new members to the fraternity as Degree men: W6BQP, W6DEC, W6GAT W6GWX, W6KGO, W6ALO, W3KJ, W6HLN, W7BRG, W1CSV, W9CJJ, W8GWY, W6ADB, W9CK, W8EBJ, W6AKH, W6HC, W8GKG, W6DUW, W8DGV, W6BZU, W6EZK W9APM, W4ZZQ, W8EQN, W1EER, W3BNH, W9ARE, W1FFL, W6SJ, W6BTN, W1FGM.

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New Members Sorority

THE Iota Rho Sigma welcomes these well-known women radio operators to its Sorority: W6DVH, W5PK, W6AET and W6HEG.

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Sorority News

W6HEG Harriet Gilbert was hostess to the September meeting of the Southern California ITK Chapter at her home. Attendance was unusually good and the refreshments served by W6HEG will long be remembered. A delicious variety of cakes with coffee were no little responsible for the meeting extending into the wee hours of the morning with no let-up in enthusiasm. Other YLs present were Florence Jones W6AET and a future IRS in the person of Marie Meloan Mrs. W6CGM.

W6EK Miss Flora Card won high honors at the Santa Barbara hamfest when she took first prize in the code contest against some well known male speed burners.

W6DHV Mae Amarantes, 475 S. 11th Avenue, San Jose, Calif., has been temporarily appointed IRS president subject to longer term of office. All YL, XLYs should get in touch with W6DVH if interested in becoming Sorority members and wishing information.

All Sorority sisters should report each month to their President. The news so collected will be published either in this department or in the official news bulletin, "The Lightning Jerker."

As soon as the IRS membership warrants, special Sorority pins will become available to members similar to those of ITK (And how the YLs go for those ITK pins!).

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New England Chapters Organizing

W1SK, Doc Stewart, State Chief of New Hampshire, reports an excellent reception to IRF principles by New England amateurs, particularly the old timers. Formation of five ITK Chapters are under way at the moment with the first organizing at Berlin, N. H., where they call themselves "The Old Men of the Mountains." W1ANP, W1BEO, W1HTH and W1CUN in Bethlehem are some of the men mentioned in advance reports from that sector. W1FFL and W1FGM also figure in the organization of these Chapters and about twenty others who have thus far been pledged. Amateurs of New Hampshire desiring to become IRF members should communicate at once with W1SK State Chief at Lancaster, N. H.

W1BZC Bill Ellsworth at Springfield, Mass., is also doing excellent work. ITK men in that Division should contact him. An East Coast IRF general meeting is planned for the near future, at which time it is expected that the IRF Vice President shall be nominated. W1BZC says, "I am more than convinced that IRF has a big future—nothing can stop it now."

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Central California Organizing Chapter

LED by W6BIJ Bud Hossack of Tulare and W6BIL George Maxey, preliminary meetings have been held in the Chamber of Commerce for the organization of a Central California ITK Chapter and IRF Official Club. Plans call for meetings to rotate between the principal towns, giving each community an opportunity to sponsor the monthly meetings. A Chairman from each city will also be selected to carry out this action. Thus far Central California amateurs have shown an excellent response to the IRF plan and realize that here is something that will give them local organizations that will not go the way of previous ordinary radio clubs. Many of the sixth district's best fone stations are included in this set-up. Amateurs in this portion of the state should QSO by air or letter W6BIL George Maxey at WPDA Police Radio Station, Tulare, California, for the latest news of developments and any information desired.

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San Francisco Forming Large Chapter

UNDER the leadership of Division Chief Ronnie Martin W6ARD KUP, who is acting Chairman of the San Francisco Chapter, a meeting will soon be called which is expected to include 162 of the old timers in that area. Haste has been avoided in the plans for this Chapter. A solid foundation has been builded, upon which a local organization will rise. Amateurs in the Bay area who believe fraternalism is dead and that radio club meetings are merely DX and traffic contests, might well get in touch with Mr. Martin and discover the new deal in amateur radio.

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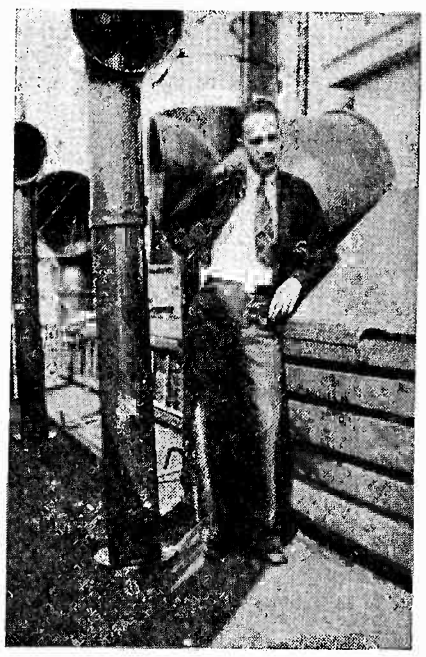
New International Headquarters

RAPID progress of the IRF movement has demanded that a regular headquarters office be established. Heretofore the executive business has been carried on from the homes of the chief officers, but the rate of growth of membership indicates that IRF shall soon have many thousands of members. In all parts of the world inquiries originate as to how other nations may carry forward the new deal of IRF. With 400 ITK Degree men in the United States alone, and the new Junior Membership open to all desirable amateurs, progress has already taken on the aspects of a gold rush.

For these reasons an office in downtown Los Angeles has been established as the International Headquarters at 715 Hope street. All amateurs in the southwest, as well as those touring, will find it most convenient to drop in for a visit. You are always welcome.

Within a short time these offices will be moved to larger quarters, providing a meeting or static room. Construction of an official IRF Headquarters transmitter is now under way.



Left: Kenneth Isbell, Radio W6BOQ Secretary-Treasurer IRF

CUTTING his teeth on an old rock crusher back in 1913 as W9AQA in Maywood, Ill., Kenneth Isbell has been an active amateur ever since. The first stations he owned were of the usual early type with slide tuners, catwhiskers 'n' everything, not to mention the profane use of fotograf plates for condensers. In about 1925 he became acquainted via radio with W9BPX of East St. Louis, Ill. (Now W6CGM) and thus the ITK plan was originated and born in the air lanes. Isbell had a cupl of high-power bottles, powered by 2000 volts of wet "B" batteries, to be sure he got pure DC!!!!

Since 1924 he has been a commercial radio operator and although he has been in the broadcast field most of the time has had some brass pounding on an arc transmitter and on a Morse wire. Migrating to California he became W6BOQ and is now employed at KFI-KECA.

The larger photo above shows Mr. R. G. Martin, San Francisco Division Chief of IRF.

Silver 5C Super

(Continued from Page 21)

for the narrow short wave bands on its large scales, and full spread on its 0-100 band spread scale.

The three wave ranges of the reeciver: 1500 to 4500 KC; 4000 to 13,000 KC; 9000 to 23,000 KC.

The low values of tuning capacity these ranges make possible for the four important amateur and the 31, 25 and 19 meter broadcast bands go far to explain the receiver's excellent sensitivity and volume on these important short wave bands. For example, it will be noted that the 31 and 25 meter broadcast bands (9500 KC and 11,800 KC) are covered by both of the last two bands. Actually, however, the third (yellow) band will give much better results on 31 and 25 meters due to the much lower tuning capacity in use, than will the fourth (orange) band.

The reason for the considerable overlap between the third and fourth bands is, first, that 23,000 KC represents the high frequency limit of the short wave spectrum today and tuning higher in frequency would yield few more stations while setting 23,000 KC as the top end of the fourth band allows the important 20 meter amateur and 19 meter broadcast bands to be tuned by a satisfactorily low value of tuning capacity to insure maximum sensitivity on this band. No attempt is made to take in the 10 meter band, since it is today so uncrowded that a simple regenerative receiver handles it well and cheaply.

On very short waves it is now posible to accurately measure the gain of the RF stage, and that its gain is quite considerable—from thirty to forty times—is evidenced by tuning in a weak station and then shifting the antenna lead-in from the RF stage primary to the detector primary, when a considerable drop in signal will be noted. This RF gain is very important, for it permits operation of the first detector oscillator at a high signal level in order to eliminate noise due to oscillator hiss, which becomes excessive when the first detector is forced to operate on a very weak signal. The additional selectivity of the RF stage also eliminates "repeat spot" or image interference, when any short wave signal can be heard at two points on the dial—the proper point, and a second point twice the IF away from the proper point.

From the circuit diagram of Figure 4, it will be noted that not only is each of the three tuned input circuits (RF, detector and oscillator) tuned by a separate section of the three-gang condenser, but each of the total of nine indiivdual circuits (three to each of the three bands) is individually padded or trimmed to insure accurate tracking throughout the entire tuning range of the set. In Figure 3, the high frequency trimmer capacities are seen close to the wave change switch, just above the separate short wave coils, where leads can be kept very short and direct. The three oscillator low frequency padding condensers are located just behind the oscillator coils on the rear coil shield positions in Figure 3. The combination of this total of twelve alignment trimmers (four for each wave band) insures not only the accurate tracking of all three circuits for maximum amplification and minimum noise, but the ability to maintain very accurate dial calibration for all four bands. This calibration accuracy is to plus or minus ½ of one per cent, or to less than 1/16 in. of error in dial scale reading, at worst, and represents an unusually high order of accuracy today.

It can be seen from Figure 4 that separate antenna primaries are used for all bands, with both ends brought out to antenna binding posts. Thus a doublet antenna may be used, or the conventional single wire antenna, if preferred.

The New 2B6 Tube

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large with respect to R_o, but small with respect to Rg in order to develop a large percentage of the available detector output voltage across the 2B6's grid to cathode.

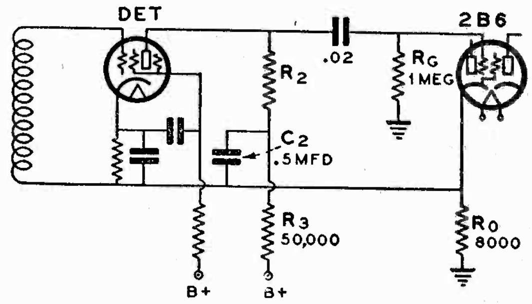

FIG. 6

Resistance Coupling for "High Gain" Connection

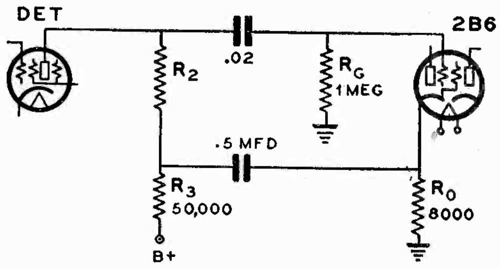

FIG. 7

Heater Voltage

IT IS important to operate a cathode type of output tube at or slightly above rated heater voltages. Early failure of life is often caused by low heater voltage. Furthermore, distortion increases rapidly if the temperature of the cathode is not hot enough to supply the peak current demands. The heater supply for the 2B6 should be a full 2.5 volts. It is much better to run slightly above than below the rated voltage.

Conclusion

THE principles involved in the 2B6's operation have only been generalized in this article. However, the tube's advantages are evident. The flexibility of the system permits general adoption in improved AC radios. Other applications naturally present themselves. The load characteristics make the tube admirably suited for modulators in small transmitters. Television problems of power amplification over wide frequency ranges are lessened by the use of 2B6.

REFERENCES:

(1) *Proc.*, p. 1163, *July 1932, Charles F. Stromeyer.*

(2) *Radio Engineering*, p. 12, *Aug. 1933, Charles F. Stromeyer.*

Radiotelephony For Beginners

(Continued from Page 26)

tions whose sidebands extend into this particular portion of whatever amateur band the transmitter is working in. Almost 90 per cent of the power in the radiated sidebands consists of the lower frequency audio tones below 1500 cycles per second. Thus the effective band width, as far as the interference is concerned, is only about 3000 cycles wide. However, do not labor under the false impression that the 10 per cent above 1500 cycles per second is not important. It improves the intelligibility and naturalness of the speech tremendously, even though none of the higher frequency sounds contain much power.

Power Distribution in a Modulated Wave

IT IS QUITE important to consider the power distribution in a modulater wave because this power distribution is closely related to the size of the modulator tubes required.

The amplitudes of the sidebands depend on the percentage of modulation; the higher the degree of modulation, the greater the sideband amplitude. It takes POWER to modulate a wave. Power must be expended in altering the amplitude of a wave. When a carrier is 100 per cent modulated by a pure audio tone, the power in each of the two sidebands equals one-quarter of the unmodulated carrier power output. Thus the power in both sidebands equals one-half of the carrier wave and, therefore, complete modulation increases the power output of the phone transmitter 50 per cent. If a class C radio frequency amplifier is plate modulated, the plate power input must therefore be increased 50 per cent in order to get a 50 per cent increase in output, because the plate efficiency remains constant during modulation. This 50 per cent increase in plate input is obtained from the modulator tubes in the form of AC. It is superimposed on the DC plate input in such a manner that the instantaneous plate voltage (and current) is alternately raised to twice the unmodulated value, and then reduced to zero. In order to swing the plate voltage of the class C amplifier from zero to twice normal, the modulators must alternately supply and absorb power. This involves energy storage during the time the plate voltage is below normal. This energy is stored in the Heising choke, or in the modulation coupling transformer, depending on whether capacitative or inductive coupling is used between the modulators and the modulated amplifier.

One hundred per cent modulation is approached only on the extreme voice peaks. Ordinary voice peaks should rarely be allowed to modulate a phone transmitter more than about 80 per cent, and the average modulation during the time that the operator is actually speaking will barely average 40 per cent. However, 100 per cent modulation CAPABILITY is essential if heterodyne interference with other stations is to be kept at a minimum.

All plate modulated RF amplifiers operate as class C amplifiers. In other words, they are biased to at least twice that value of DC grid bias which would reduce the plate current to zero, at the particular value of DC plate voltage used. This value of grid bias is termed "twice cut-off." Cut-off bias depends on the amplification factor of the tube and the plate voltage used. It is equal to the plate voltage divided by the amplification factor. The plate voltage is usually known, or can easily be measured with a voltmeter. The amplification factor of any tube can be found either in a table of tube

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Radiotelephony For Beginners

(Continued from Page 33)

characteristics or can be secured from the tube manufacturer. The grid of the tube must then be heavily excited by a buffer amplifier so that the power output of the stage will rise as the square of the plate voltage without any "dropping off" tendency as the instantaneous plate voltage approaches twice the normal value under modulation.

It is rather hard to define the amount of excitation power necessary because it varies over wide limits, depending on the particular type of tube used and the plate load impedance and plate voltage. However, the grid should be driven somewhat positive, as indicated by the flow of grid current, although the maximum value of the DC grid current will probably never exceed 15 to 25 per cent of the unmodulated plate current. The required excitation power varies inversely with the mutual conductance of the tube (see tube tables)). The higher the mutual conductance, the less grid driving power is required for a given output. Choose tubes with as high a mutual conductance as possible in order to economize on driving power.

Because the plate input to the class C modulated amplifier increases during modulation, and because the plate efficiency remains constant, it is evident that the plate dissipation of the tube will increase when audio modulation is applied. Therefore, some available plate dissipation must be held in reserve because the heat dissipation must increase up to 50 per cent for complete modulation.

Another reason for operating modulated amplifier tubes below their maximum rating is that the peak plate voltage and the peak plate current are doubled during complete modulation. Make certain that the insulation and gas content of the tube allow peak plate voltages of twice the unmodulated value to be applied. The filament emission should be sufficient to allow the normal plate current to double on the peaks without damage to the filament. If the filament emission is insufficient to allow the peak current to flow, the desired linearity of the amplifier will be affected, with consequent distortion. Ordinarily most transmitting tubes can be operated at three-quarters of their maximum rated plate current for radiotelephony, without damage to the filament or danger of non-linearity. Obviously this is based on the assumption that the circuit is efficient enough so that the plate loss is not excessive, at this value of plate current.

Low Level vs. High Level Modulation

THE HIGH LEVEL modulation system (which is most widely used by amateurs) consists of coupling the antenna directly to the modulated class C amplifier, without further amplification of the modulated wave. When a low-power stage is modulated and the modulated output then amplified with one or more linear amplifiers, the method is termed low level modulation."

Each system of modulation has its advantages, each has disadvantages.

A high level modulation system is relatively simple to design and adjust and is probably somewhat cheaper to build, for a given amount of carrier power. The class C modulated amplifier can easily be made 75 per cent efficient and 85 per cent plate efficiency can be secured with proper tubes and fairly high plate voltages. Class B modulators are usually at least 50 per cent efficient and in certain new tubes the plate efficiency is as high as 72 per cent, which means that small tubes can give high outputs when used as modulators or modulated amplifiers in a high leevl modulated transmitter. The prin-

(Continued on facing page)

cipal disadvantage in high level modulation is that a relatively large amount of audio power is necessary; in fact, it will generally amount to from 60 to 80 per cent of the RF carrier power output, in watts. High power audio amplifiers present some difficulties in eliminating stray feedback and in obtaining high fidelity; they also require rather expensive coupling transformers. The plate power required for the modulators often exceeds that required for the modulated radio frequency amplifier. Also the power supply must have good voltage regulation if the modulators operate in class AB or class B, because the plate current varies quite widely with the amplitude of the radio signal.

Low level modulation systems apply the modulation to some low power RF amplifier stage and thus very little audio power is necessary to obtain deep modulation. The modulated output from the low power modulated amplifier is then amplified in one or more class B or class B prime linear RF amplifiers before being radiated from the antenna. By modulating in a low power stage, all of the troubles of high power audio amplifiers are avoided. It is largely for this reason that this system is so widely used in broadcast transmitters and in high frequency telephone transmitters. However, the advantages are only half of the story. The amplification of a radio frequency wave after it has been modulated is rather inefficient, because the amplifiers must operate with constant DC plate input, but with variable RF output. The average power output of a linear RF amplifier must be such that it will increase 50 per cent without distortion, and the peak power output must equal four times the unmodulated value, during complete modulation. The plate input must remain constant and the output can be increased only by increasing the plate efficiency during modulation. Thus the amplifier is least efficient when unmodulated. In order to increase the average power output 50 per cent when amplifying a sine wave modulated carrier, the unmodulated plate efficiency must exactly double. In practice, the unmodulated plate efficiency of a class B linear RF amplifier is only about 30 per cent. Even the newer class B prime linear amplifier is only about 40 per cent efficient. Thus the available plate dissipation in the amplifier tube must be from 2 to 2.5 times the carrier power output, which necessitates large and expensive amplifier tubes compared with the small tubes permissible when high level modulation systems are used. For example, one type 354 tube can easily give 450 watts of carrier output when used as a class C RF amplifier with high level plate modulation (75 per cent plate efficiency). The same tube used as a linear class B amplifier in a low level modulation system can only give 67.5 watts of carrier output (30 per cent plate efficiency), and even when used as a class B prime linear amplifier it gives a carrier output of only 100 watts (40 per cent plate efficiency). The low plate efficiency also indicates that a large power supply, in proportion to the carrier output, becomes necessary when low level modulation is used.

The principal objection to low level modulation, especially for amateur use, is the critical nature of the adjustments necessary to obtain normal class B or B prime plate efficiencies together with linear and symmetrical 100 per cent modulation capability. Some form of well regulated bias supply is also necessary. Batteries or a motor generator are essential if distortion due to variations in grid bias during modulation is to be avoided. Cathode bias and grid leak bias, as well as the garden variety of B eliminator, can not be used.

Part II will appear in an early issue.

FORMS CLOSE ON THE 10th OF MONTH — RATES 10¢ PER WORD PAYABLE IN ADVANCE

CLASSIFIED RADIOADS

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BACK COPIES OF "RADIO", 25c each, some issues, can be secured from the New York office. Address your orders to Edw. J. Byrne, 253 West 128th St., New York City, New York.

FOR SALE—DeForest 571 Tube, 500 watts plate dissipation Will stand 350 mils at 4000 volts. Used only 20 hours. Guaranteed to be in perfect condition. Replaces the type 831 tube. Cost $200. Will sell for $39. Ronnie Martin, W6ARD, 125 Southwood Drive, San Francisco, Calif.

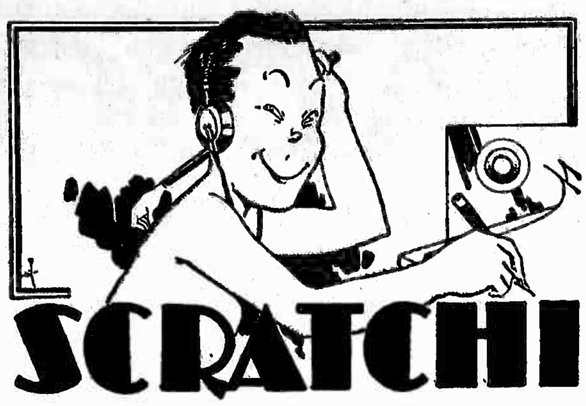
SURPLUS MATERIAL. Send for our list of bargains, surplus and used material covering motors, generators, vacuum tubes, receivers and parts. Heintz & Kaufman, Ltd., Tanforan Ave., South San Francisco, California.

CRYSTALS—80 or 160 Meters, Y-Cut, 1 inch square, .002% Accurate, Guaranteed, $1.50. Arthur Schuelke, 9255 Herkimer Street, Detroit, Michigan.

CRYSTALS—AT-Cut, 80 or 160 Meters, $6.00. Sent Air-Mail. Return C.O.D. if not satisfactory. W2GRG, Delawanna, New Jersey.

QSL's!???? Samples? Stamp! W8DED, Holland, Michigan.

HIGH TENSION glass entering insulators, reinforced glass can't break. 15-inch $1.00, 20-inch $1.10, prepaid. Special glass feeder spreaders seven inches long, 12 cents, prepaid, in lots of ten or more. HARING MANUFACTURING COMPANY. DEPT. M. 220 Ambler Street, Quakertown, Pennsylvania.



Osockme, Japan, Aug. 23rd, 1934.

Dear Sir Editor of "RADIO"
Gentleman:

I have make recent study of amateur radio textbooks to find knowledge of proper operating proseedure for ham station and find that such information are as conflicting as it are confounding. I make squint at The Radio Amateur's Code of Ethicks. It say many things which amateur should, should not, would not and cannot do. But many of its prinsiples are wrong. I have proceed make New Code of Ethicks of my own, which are based on facts and so I get right down to brass tax and give herewith my Code of Ethicks. (1) The Amateur is a Gentleman????? He never goes to a hamfest without throwing hot rolls at brother hams at next table, and he never forgets to put big lump of butter on such roll so that recipient thereof will have nice spot to remove from new suit when return home. (2) The Amateur is Loyal????? He never borrows a quartz crystal without returning some other crystal which have cracks like earthquake in it. (3) The Amateur is Progressive????? His station are clean like garbage can and only time when shack are cleaned out is when Inspector from Bored of Health make forced visit into shack with large shovel and shot gun. (4) The Amateur is Friendly????? He send slow and patiently only when he are green lid and cannot yet make use of fast twittering bug which would jump right up and bite ham operator on nose if such bug had a soul. (5) The Amateur is Balanced????? I are still looking for him. More safe to say that he once WERE balanced before he become radio ham.

I study over such rules with great and cautious care and I have make determined to myself practice such things as are preached. I look back at Ethick Rule No. 4 and grab hold of key with fist and send 300 times CQ. First contact come from ham in next block who wish for me to make relay of traffic for him. He say he are Ethical ham and he accept only such traffic which are of most important nature. He send me first message which read . . . "Fujiyama Grocery and Hardware Co., Self Addressed. Please send two pound butter, six eggs, one egg plant, two more eggs, two lumps sugar, four bottles cow juice, ten gallons Lydia Pinkam's extra strong Compound. Last night my wife give birth to a fine baby boy. Also a rat trap, door mat and a screwdriver."*

I read such silly message and file it where all other traffic of Scratchi station are filed . . . on hook No. 86, which are post-dated for year 1942, A.D. (After Depression).

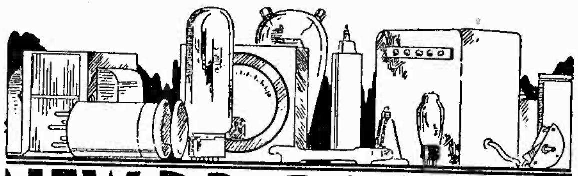
I wish give few friendly words of advice to bother hams. It seems to Scratchi that too much time are wasted with messages which are far too long and which could make send by slow freight just as fast as such traffic will reach destination via ham route. One of first things which Scratchi learn from recently graduated Correspondence Course are great slogan which say . . . "Be Breef." It give striking example of telegraph operator who also was station agent in small valley town. Such telegraph operator make send very long daily report to main office and chief operator give him severe roastpanning for making such long messages out from nothing. He send instructions to operator which say, "Be breef, be breef." Next day great flood come to town. Whole railroad washed away. Station house and telegraph shack take swim. Operator save his life by climbing telegraph pole. He make remember that each day he must send report to chief operator and he also make remember he must be breef. So he cut into telegraph line and send following breef message to chief operator. . . . "Where the railroad was, the river is."

I must make short for this letter, Hon. Editor, as I are writing this while waiting for train to take Scratchi to great New York Radio Show which open some time this week this month. I have receive free admission ticket to such show, which were sent me by old male order friend from Gyp Row in New York and he also send me personal mimeograph letter which are signed with rubber stamp and which say he expeck to see me at show in persons.

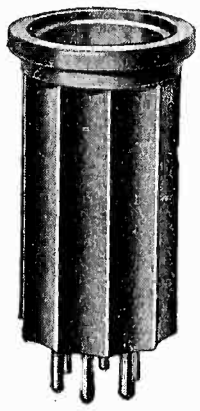
I shall make stop over at your office, Hon. Editor, and if you are not in such office when I make call I will look you up in County Jail Number One, which are where I also make my home by request each time I make visit to your city. Hoping you bring enough money with you to bail us both out, I am,

Your Adviser and Past Due Subscriber,
SCRATCHI.

RADIO BUYERS' GUIDE



NEW PRODUCTS



Specially Developed Dielectric Compound Used in New Hammarlund Short Wave Coil Forms

A REVOLUTIONARY dielectric compound of uncanny effectiveness, known as XP-53 is used in the new low priced, short wave coil forms that have just been released by the Hammarlund Manufacturing Company, 424 West 33rd treet, New York City.

This drastically different insulating material is a light tan color, or natural, thus promptly eliminating the usual color losses. Its other striking low loss properties, plus the unique design of the forms, create an exceptionally effective unit. The forms are groove ribbed for air spacing of windings. There are also flange grips, and neat meter-index inserts, for wave length indications. Another clever feature of the form is a threaded shelf molded inside, to permit mounting of a trimming or padding condenser, for tuning the coil to a fixed frequency, or for band spread arrangement.

The coil forms come with 4, 5 or 6 prongs.

Complete kits of coils already wound to cover the entire range of frequency from 17 to 560 meters are also available, using this excellent XP-53 material. One, known as the SWK-4 contains four, 4 prong, 2 winding coils, with a range of from 17 to 270 meters. Another, known as the SWK-6 kit, consists of four, 6 prong, 3 winding coils, with also a range of from 17 to 270 meters. Then, there is the BCC-4, which is a 4 prong, 2 winding coil, for the broadcast band, or from 250 to 560 meters, and last, there is one more broadcast coil, known as BCC-6, which is a 6 prong, 3 winding affair, also covering the 250 to 560 meter band. The secondaries of the 17 to 41 and 33 to 75 meter coils are of heavy silver plated wire, affording minimum skin resistance losses. The secondaries of the other coils are of heavy gauge enameled copper wire. The broadcast coils are bank wound litz.

46,390 Amateur Licenses

EVIDENCING the ever-widening interest in amateur radio throughout the United States, its territories and possessions, records just compiled by the Federal Communications Commission disclose that there were 46,390 valid amateur station licenses in existence at the close of the last fiscal year, June 30, 1934.

During the year 8,782 new station licenses were issued and there were 12,279 modifications, reissues and renewals. The figures follow:

Valid of record July 1, 1933		41,555
Issued during fiscal year, new and renewed		8,790
Total		50,345
Less cancellations	3,777	
Other deletions, due to death, etc.	153	
Revocations	25	
Total	3,955	
Valid of record close of June 30, 1934		46,390

Authorizations as amateur operators totaled 16,686; operator license endorsements for higher privileges 209; duplicates of lost or destroyed licenses 161, and special authorizations 15, making a grand total of 38,132 authorizations issued during the year, or well over 100 per day, relating to amateurs alone.

The CROSLEY Line Moves Forward

. . . again establishing new standards of quality, performance and beauty yet, according to CROSLEY policy
. . . priced within the reach of all . . .

THE three Crosley models shown here are merely examples of the outstanding quality, performance, beauty and value to be found in the Crosley line—from the history-making FIVER at only $19.99 to a magnificent all-wave console for less than one hundred dollars.

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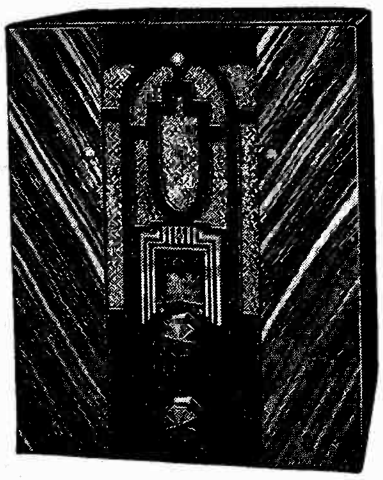
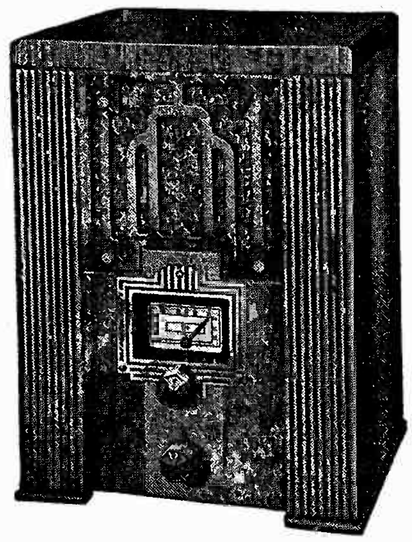


The FIVER

A history-making radio receiver, improved and perfected, and a greater value than ever. Superheterodyne, full floating, moving coil electro-dynamic speaker, beautiful cabinet, one dual purpose tube making it the equivalent of a 6-tube set. It covers the entire band of American broadcasting and top police band. Excellent tone. Highly sensitive. Where can you match it for only......

$19.99 COMPLETE



The DUAL FIVER DeLuxe

A 5-tube receiver having the performance of a 7-tube. Three gang condenser, automatic volume control (steady volume on distant stations), new and beautiful cabinet. A startling value in a long range, sensitive, beautifully toned receiver. Dual range for American broadcasts — all police calls, aviation and amateur reception................

$29.95 COMPLETE

• • •

THE Crosley line is replete with outstanding values and at prices within the reach of all—performance for every need. A. C.—D. C. and STANDARD BROADCAST models range in price from only $19.99 to $33.00, complete with tubes. DUAL RANGE models for all American broadcasts, including police, aviation and amateur reception, are priced from $29.95 to $47.50 in both table and console models, complete with tubes. Models for AMERICAN and FOREIGN reception, in table and console models, are priced as low as $39.95 and up to $79.50, complete with tubes. An ALL-WAVE chassis is incorporated in a table model at the low price of $79.50 and in a gorgeous console at only $99.50, complete with tubes.

The SIXTY-ONE A.F.

AMERICAN and FOREIGN Reception

Another smashing leader—a 6-tube American and Foreign receiver at only $39.95—the most startling radio announcement of the year. Covers standard band from 540 to 1750 Kc., short wave band from 5700 to 15,500 Kc. Gorgeous cabinet, illuminated airplane type dial—30 to 1 high ratio drive, continuous tone control, automatic volume control, three gang tuning condenser, full floating moving coil electro-dynamic speaker. Two dual purpose tubes provide 8-tube efficiency ....

$39.95 COMPLETE

• • •

YOU are strongly urged to study carefully the values of the radio receivers which compose the Crosley line—compare them with all other makes. Set for set, performance for performance, beauty for beauty, dollar for dollar, Crosley challenges the field. Don't judge these receivers by outward beauty alone—look at them from every angle, inside and out. Compare them point for point, tube for tube, value for value, and you will readily realize why it is that no dealer can afford NOT to handle Crosley. The line is exceptionally complete—from a five-tube set having six-tube performance and priced at only $19.99, complete, up to a gorgeous all-wave console priced under one hundred dollars. Don't fail to get in touch with your Crosley distributor at once.

Montana, Wyoming, Colorado, New Mexico and west, prices slightly higher.

THE CROSLEY RADIO CORPORATION

Home of "*the Nation's Station*"—WLW—500,000 watts—most powerful in the world—70 on your dial

CINCINNATI

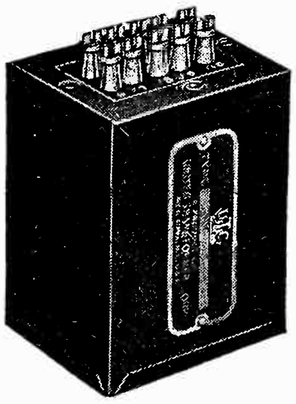
POWEL CROSLEY, Jr., *President*

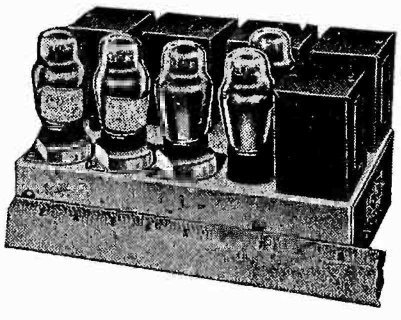
WHATEVER HAPPENS . . . YOU'RE *THERE* WITH A CROSLEY

CROSLEY RADIO

UTC

High Fidelity *Hiperm Alloy* Audio Components for Portable Pre-Amplifier and Remote Pickup Applications





4 stage pre-amplifier, gain over 140 DB,—output +22 DB.

Specifically designed for portable use.
Extremely compact and light in weight.
Smallest high fidelity transformers available.
Made possible through development of HIPERM ALLOY, a nickel iron alloy having extremely high initial permeability.

HIPERM ALLOY COMPONENTS USED IN HIGH GAIN 4 STAGE PRE-AMPLIFIER

		List Price	Net to Dealers Hams
HA-100	Variable impedance line to single 6C6 grid	$12.50	$7.50
HA-105	Cascade, single 6C6 plate to single 6C6 grid	9.00	5.40
HA-106	Input, single 6C6 plate to push pull 6C6 grids	11.00	6.60
HA-114	Push pull 6C6 plates to variable impedance line	12.50	7.50
HC-127	Hum bucking tapped filter and audio choke, alloy core	15.00	9.00
HP-123	Shielded plate and filament transformer for a portable pre-amplifier using 6 volt tubes	15.00	9.00

UTC *Niklshield* Audio Filter and Power Components

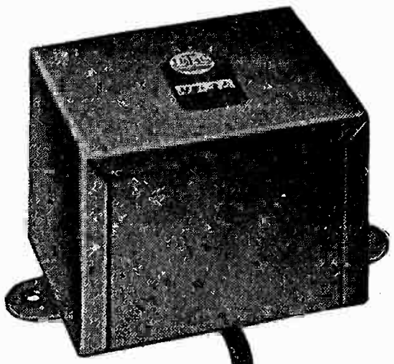
FOR THE SERVICEMAN, PUBLIC ADDRESS ENGINEER AND EXPERIMENTER

At Prices All Can Afford

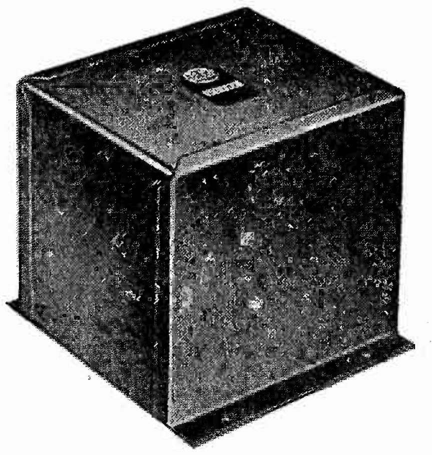
UTC Niklshield compact audio and filter units are designed for the discriminating radio manufacturer, experimenter, and professional public address engineer. Weight has been kept to a minimum and quality at a maximum for this grade of equipment. Only the finest of materials and the highest grade of workmanship is incorporated in the construction of all units.

A wide variety of input coupling, mixing, matching and output transformers are shown.

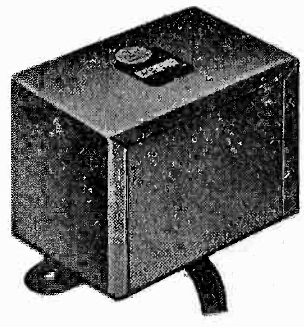
Write for NS-R Bulletin Describing These Units



NS-12, NS-29, NS-40, TYPES



NS-50, NS-51 TYPES



NS-1, NS-9, NS-37 TYPES

CLASS A INPUT TRANSFORMERS

		List Price	Net to Dealers Hams
NS-1	1 plate to 1 grid. 3½:1 ratio	$ 2.35	$ 1.41
NS-2	1 plate to 2 grids, split secondary. 2:1 ratio	2.50	1.50
NS-3	Push pull plates to push pull grids. 1.8:1 ratio	2.75	1.65
NS-5	Single or double button mike to 1 grid	2.50	1.50
NS-6	Single or double button mike to 2 grids	3.00	1.80
NS-8	Ribbon velocity mike to 500 or 200 ohms	3.50	2.10
NS-9	Mixing carbon mike, 500 or 200 ohm line to 500 or 200 ohm line	3.50	2.10
NS-10	Single plate and carbon mike to one or two grids	3.50	2.10
	CLASS A OUTPUTS		
NS-13	Push pull 250, 245, 59 triode or 71A plates to 8, 4, or 2 ohm voice coil	3.00	1.80
NS-15	Push pull 2A3 plates to 8, 4, or 2 ohm voice coil	3.00	
NS-17	Single 250, 245, 59 triode, 71A to 500, 8, 4 or 2 ohms	3.00	1.80
NS-19	Push pull 250, 245, 59 triode or 71A plates to 500, 8, 4 or 2 ohms	3.50	2.10
NS-20	Push pull 18, 20, 33, 41, 42, 2A5, 59 pentode, 89 triode plates to 500, 8, 4 or 2 ohms	3.50	2.10
NS-21	Push pull 2A3 plates to 500, 8, 4 or 2 ohms	3.50	2.10
NS-24	Push pull 250, 245, 59 triode, 71A to 4000 or 2000 ohms	3.25	1.95
NS-25	Push pull 18, 20, 33, 41, 42, 47, 2A5, 59 pentode or 89 triode plates to 4000 or 2000 ohms	3.25	1.95
NS-26	Single 26, 56, 27, 55, 77 triode or 864 plate to 500 or 200 ohms	3.00	1.80

CLASS B INPUT TRANSFORMERS

		List Price	Net to Dealers Hams
NS-29	Driver plate to 49, 53, 79 or 89 grids	2.75	1.65
NS-30	Driver 46 or 59 plate to 46 or 59 grids	2.75	1.65
	CLASS B OUTPUT TRANSFORMERS		
NS-32	Push push 46 or 59 plates to 8, 4, or 2 ohms	3.25	1.95
NS-33	Push push 49, 53, 79 or 89 plates to 5000 or 3500 ohms	3.50	2.10
NS-34	Push push 46 or 59 plates to 5000 or 3500 ohms	3.50	2.10
NS-36	Push push 46 or 59 plates to 500, 8, 4, or 2 ohms	3.75	2.25
	FILTER AND AUDIO CHOKES, FILAMENT TRANSFORMERS		
NS-38	Filter choke. 15 henrys 60 MA; resistance 240 ohms	2.00	1.20
NS-39	Filter choke. 20 henrys 90 MA; resistance 400 ohms	2.50	1.50
NS-41	Filter choke. 10 henrys 150 MA; 95 ohms	3.00	1.80
NS-42	Class B input choke Max. D.C. 175 MA	3.00	1.80
NS-44	Detector plate shunt choke. Max. D.C. 3 MA	2.25	1.35
NS-45	Pri. 115 A.C. Sec. 2½ V.C.T. 6A	1.75	1.05
NS-46	Pri. 115 A.C. Sec. 6.3 V.C.T. 3A	2.25	1.35
NS-47	Pri. 115 A.C. Sec. 2½ V.C.T. 12A	2.25	1.35
NS-48	Pri. 115 A.C. Sec. 5V 4A.	2.25	1.35
NS-49	Pri. 115 A.C. Sec. 7½ V.C.T. 3A	2.25	1.35
NS-50	Plate Transformer for small power tubes, Class A and B. Pri. 115 V.A.C. 60 cycles. Secondaries: 300-0-300 at 75 MA; 5 V.C.T. 3 A., 6.3 V.C.T. 2½ A., 2½ V.C.T. 6 A	7.00	4.20
NS-51	Plate transformer for push pull power tubes Class A and B. Pri. 115 V.A.C. 60 cycles. Secondaries: 400-0-400 at 125 MA; 2½ V.C.T. 5 A., 2½ V.C.T. 10 A., 5 V.C.T. 3 A	9.00	5.40

The UTC HIPERM ALLOY audio transformers are described in the new U-1000C bulletin. Send for your copy today.

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