MODERN RADIO

EDITED BY ROBERT S. KRUSE

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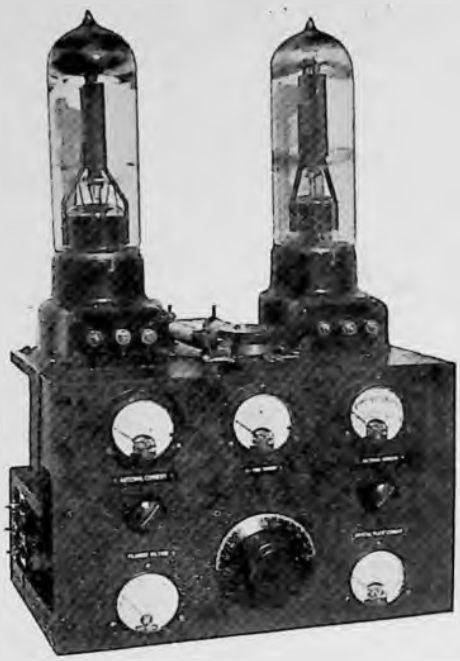
Number 9 March 20 cents

500 Watts from a Crystal Oscillator

By Boyd Phelps*



THE ½ KILOWATT TRANSMITTER

The overall size—tubes included—is only 10" x 15" x 24". The crystal holder is between the tubes, the grid chokes just behind it. Tank R. F. meter at top center with tank condenser dial just below. tuning knobs just below. Lower meters filament volts and plate current.

We frequently read of "power crystals". Just what does this mean? How much power can one get from a quartz plate?

In even the largest broadcast or short-wave transmitters the tube ordinarily used with a quartz crystal plate is of about the same size as the one which operates the loud speaker in the home radio set. The power output is a couple of puny watts and has to be amplified again and again by progressively larger tubes with various filament and plate supply voltages, more or less complete stage shielding and other careful precautions against feed-back via any one of a dozen or more routes. One frequently wonders if all the trouble, cost and complication is warranted.

Any worth-while simplification must get rid of most—or all—of the amplifier stages. There are only two apparent ways of simplification; one is to devise circuits to stabilize a high-power self-oscillator, the other is to obtain enough power for the crystal oscillator so it may feed the antenna directly. Some progress in the first method has been made recently, but very little appears to have been done on the second method. This paper is accordingly to describe some experiments of the writer at W2BP.

The most obvious way to get more power from a crystal oscillator is to increase the plate voltage. For example a type '11 (50 watt) tube may be supplied with as much as 150 Ma. at 400 volts before disastrous things happen —but at about that point (with the output a bare 15 watts) the vibration of the crystal becomes so violent that chips fly off the edge, also arcing and brushing occur at the crystal, the frequency begins to creep and often the crystal cracks or punctures. Apparently all this is due to excessive radio frequency voltage across (and current through) the crystal. This voltage was, of course, fed back from the plate circuit through the plate-grid capacity. It is easy enough to reduce the feedback by neutralizing, or with a screen-grid, or by tapping the plate connection part of the way down the plate coil—but obviously these schemes are nothing but oscillation-reducers and result in reducing the power available. This is a blind alley.

A COMPARISON OF 500 WATT SETS

	Usual Low-power Crystal Oscillator Plus Amplifiers	High-power Crystal Oscillator
Number of tubes	5 or 6	2
Kinds of tubes	2 to 4	1
Plate voltages	4 to 7	1
Screen voltages	Up to 3	None
Filament voltages	2 or 3	1
C voltages	2 low 1 high	1 low
Neutralizing points	2 to 4	None
Bypass and stopping condensers	10 to 24	2
Shielding	Probably	None
Tuning condensers before antenna	4 to 6	1
Resistors	Up to 10	1
Chokes	4 to 8	2
Plate supply	Complex	Simple
Cost		Much Lower

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It appeared to the writer that a much more hopeful procedure would be to withdraw r-f power from the plate circuit at so fast a rate as to give no chance for high r-f plate voltages to build up. If the plate load were increased until oscillation stopped, it should then be possible to raise the plate voltage above the normal crystal-oscillator values (above 250-400 volts) until crystal-brushing again appeared—then the power absorbing circuit could again be coupled more closely to draw off the excess power, after which the plate voltage could again be raised and so on until many kilowatts were obtained.

Here it was felt that speculation had begun to run wild but in the experiments conducted so far, and reported below,

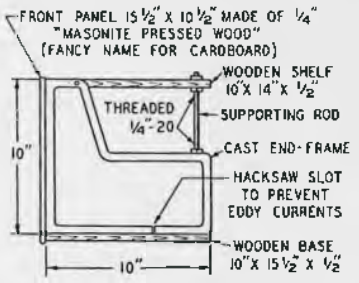

Fig. 3. End view of the ½ kilowatt frame.

a dependable 500 watt output has been obtained.

Preliminary experimentation was started with one type '11 (50 watt) tube and things happened along the lines predicted and hoped for. The next crystal oscillator (shown in the photographs) was accordingly built of a pair of Western Electric 212-D quarter kilowatt tubes connected in push-pull rather than parallel to permit further simplification by omitting plate chokes and stopping condensers. The resulting circuit (Fig. 1 and 2) is simplicity itself, and calls for not one expensive coil, condenser or resistor, besides dispensing with the usual power-supply complications. In the photographs the crystal holder is seen on top of the unit where it is connected directly between the grids of the tubes. Bias voltage is fed through two diameter cylindrical grid chokes wound with fine wire, between the chokes and the bias battery is a grid leak (see diagrams). A combination of this kind is very desirable in this type of transmitter. A grid leak alone may be used but this causes complete loss of bias, when oscillation stops during adjustment. Excessive non-oscillating plate current and hard starting result. Some small fixed

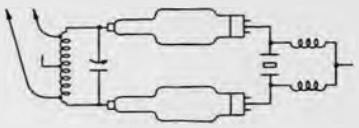

Fig. 1. The Basic Circuit.

bias is accordingly desirable to start operation at some reasonable place on the tube's characteristic curve. There must be SOME plate current and the bias may be between those prescribed for

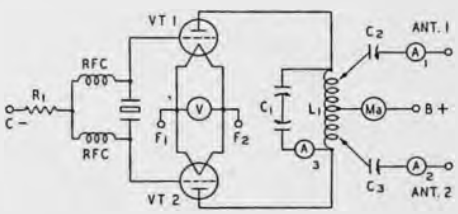

Fig. 2. The Complete Diagram of the 500 Watt Set

L1—Plate coil suited to the frequency (see note).
C1—Plate tuning condenser about .0001 mufd., 1500 volt type, preferably balanced to put rotor at zero r-f. voltage (see note).
C2 and C3—Antenna tuning condensers, .0005 receiving condensers double-spaced or .00015 low-power transmitting type.
A1 and A2—Antenna ammeters, 0-3 amp. r-f.
A3—Plate tank ammeter, 0-10 amp. r-f.
F1 and F2—Filament supply.
RFC—½" diameter chokes wound with one layer No. 36 double silk covered wire for 2½ or 3".
R1—Grid leak, 5000 ohms, 75 watts rating.

class A and class B work at the plate-voltage used, preferably nearer the latter. Further bias is obtained from the leak as soon as oscillation starts. A resistor in the negative plate-supply lead

NOTE—No costly and inefficient "High-C" construction is necessary for either stability or harmonic suppression. The stability is provided by the crystal, the harmonics are negligible because of the push-pull circuit, the method of bias and the process of adjustment.—Editor.

is an alternative way of obtaining bias. This is the familiar scheme used in the push-pull audio stage of broadcast receivers.

The Crystal Holder

The crystal holder, Fig. 4, has a metal shell threaded on the inside to take a carefully turned and ground screw-plug which forms the top electrode, the bottom electrode being a 1" plate screwed down to the insulating base and adjusted parallel to the top plate. The adjustable plug permits the use of crystals of different thickness and also, when slowly screwed up or down by means of the insulating hand-wheel, permits a gradual frequency shift which is easily followed by the receiving operator. In the 3500-4000 kc. amateur band some crystals are found which will oscillate while the airgap is increased to 1½ times the thickness of the crystal, with a frequency variation of 12 kc. though that is extreme and decreases the output, as shown in the curve of Fig. 5.

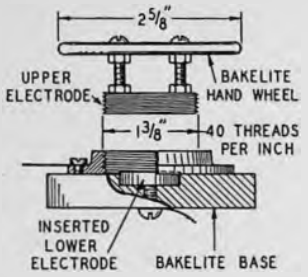

Fig. 4. Crystal holder for permitting smooth and rapid frequency-shifting. The dimensions may be changed at will. The threaded upper electrode had better be longer and the stationary shell higher than shown to permit cutting windows as explained in the text.

The metal shell surrounding the crystal is cut away on three sides and with the transmitter standing on a table before the operator it is easy to watch for the start of fireworks when making the first adjustments. The drawing unfortunately does not show exactly this construction.

Power Supply

As in any crystal oscillator a surprisingly small filtering system gives a pleasing note. This is in line with the accumulated evidence from a number of independent authorities to the effect that a 20% change in plate voltage ordinarily causes a crystal oscillator to shift its frequency by only a few parts in a million, which is negligible for most types of transmission except broadcasting. However, it is not recommended that a high-power crystal oscillator be plate-modulated to any considerable extent by either voice or plate-supply ripple. When it is correctly adjusted the oscillator works within close limits, stopping suddenly below a certain voltage and overloading the crystal above another voltage not greatly above the first. This point will presently become more clear—we hope.

Adjustment

Please refer to Fig. 7 which attempts to show the process of adjustment. It is good sound practice to increase the plate voltage in small steps from a low value (500 or even 250 volts) until familiarity can be obtained. The process is then as shown in figure 6, trying to keep between the two curves, which in practice are represented by crystal brushing on one side and on the other side by unstable r. f. meter readings—or none at all. It is better at first to use too much antenna coupling (antenna clips near end of coil). Whenever too little power is being taken from the tank

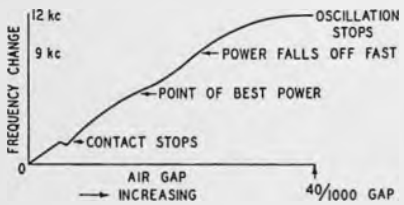

Fig. 5.—Action of the adjustable crystal holder on a good .030" crystal at 3900 kc.

circuit the tank meter reading will run up and the crystal will be in danger from too much feed-back voltage. The tank (current) must be down and the antenna current up before jumping to the next plate voltage, for it is safer to make errors by getting to the left of the curve—though one may only warm the crystal by a brief excursion to the right. The two curves obviously represent no definite boundaries and are drawn only to indicate the general tendency of effects. The two curves get closer to-

gether as the plate voltage is increased, because when the power output is very great only a very small part is wanted (or needed) in the grid circuit and the adjustment must evidently be more exact.

The transmitter described has mostly been used with small crystal chips, broken corners and other irregular shaped quartz plates having little value, as it was feared many mal-adjustments would wreck them in the process of finding out the characteristics of the "overloaded" crystal circuit. Actually ONLY ONE CRYSTAL FATALITY IS ON RECORD TO DATE and this happened when attempting to demonstrate the

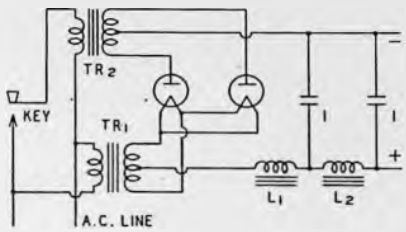

Fig. 6.

affair to some visitors (such things always seem to happen at such times) while the antenna was accidentally not connected to the transmitter to absorb the power. The set was started up with 1,000 volts on the plate. Fire played around on the none-too-flat crystal for some minutes while the dials were vainly turned, trying to find resonance in the incomplete antenna circuit. Under ordinary operating conditions 1,000 volts is used and a combination of 5,000 ohms and 45 volts in series in the grid circuit between the r.f. chokes and filament transformer mid-tap causes plate current of 800 milliamperes to flow when oscillating. The power line wattmeter then reads 750 watts. The tubes show no heating of their plates. From past experience the color is known to be quite noticeable when 200 watts is dissipated per tube so the dissipation might be assumed to be 150 watts per tube or less which by simple arithmetic indicates that 500 watts output must be going somewhere. As tank current is almost nothing and no heating can be found in the set after many minutes of continuous operation, we hope most of this half kilowatt is going into the antenna. The antenna current runs between 2 and 2.5 amperes which is a lot more than the tank current under these same operating conditions.

Reference to the antenna recalls that it may be run out of tune (while praying for the crystal) with a frequency-change of less than 400 cycles at 3900 kc. Attempting to imitate a high wind by "flopping" the antenna with a cord produced very little effect. However, to minimize any possible antenna troubles a simple antenna has been devised which has NEITHER SUPPORTS NOR GUYS IN ITS FIELD. It will be described in another issue of "Modern Radio".

Meanwhile, the original question—What is the limit of power obtainable?—cannot be answered at this time except to repeat that in theory there still seems to be no limit! Practically, however, much greater care must be exercised when attempting to obtain several kilowatts output from the crystal stage.

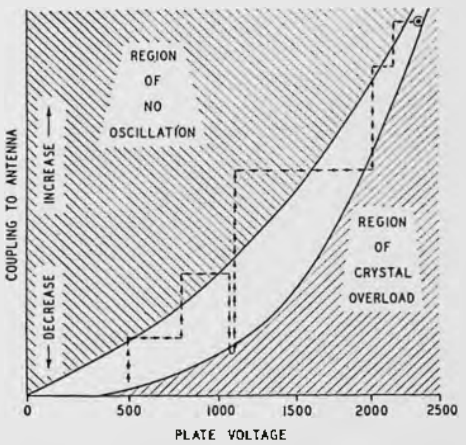

Fig. 7. The process of adjustment is one of cut-and-try, proceeding somewhat as suggested by the crooked line.

Other Tubes

For those not so fortunate as to be able to borrow 212D tubes there is suggested a pair of 849 tubes, arranged as in Fig. 1, for lower power (100 watts) use a pair of 845 tubes. The '11 type will do, but the power output is lower.

Results of Empire State Television Tests

By Far the Most Interesting Thing in Radio Today!

There is fun to be had from "looking in on" the so-called 5-meter radio talkies from Al's place, officially called the Empire State Building. These radio transmissions lay down a whale of a signal over a wide area, days, nights and Chinese holidays, without any of the usual horrible television fading, and with no very serious shadows behind hills—all of which agrees with amateur 5-meter experience of other years but fits poorly into the "quasi-optical" argument. One can also prophesy that very soon these signals will be heard trans-continentally and trans-oceanically, just as amateur 5-meter signals have been. Even now a California observer has been troubled by hearing a 5-meter station which transmitted some NBC material and then degenerated into "a lot of fool noises"—exactly a description of W2XK when it switches from WEAF to the sound-track of a Micky Mouse film just been fed into the W2XF sight-transmitter. Incidentally, on sunny days, the signal isn't too bad at Hartford, although 90 miles is well into the skipped distance for anything but a very good signal.

All this, plus the good quality of the pictures seen by various "lookers", makes one take Empire State seriously. Amateur-listeners, dealers and manufacturers may well look at both the picture and its portent.

EMPIRE STATE SCHEDULES AT TIME OF PRINTING

(As observed by Mr. Boyd Phelps)

Sight-channel, W2XF, 6.28 meters or 41 megacycles.

	E. S. T.
Carrier	2:00- 3:00 P. M.
Facsimile (twitterings)	3:00- 4:00 P. M.
Television	5:00- 6:00 P. M.
Silent	6:00- 7:30 P. M.
Television	7:30-10:00 P. M.
Facsimile	10:00-10:30 P. M.

Sound-channel, W2XK, 4.9 meters or 61 megacycles either transmits the sound-film noises to go with W2XF pictures, or else uses NBC material.

Generally both stations are silent on Sundays and holidays, also there are variations in the schedule.

Admittedly this is a New York City affair at the moment. Note—however,

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Published Monthly by MODERN RADIO CO. 101 Allyn Street Hartford, Connecticut

Business and Advertising Manager N. T. YOUNG Tel. 5-2733

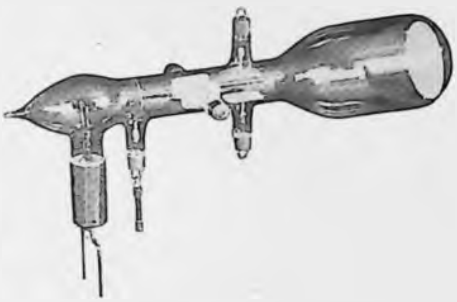
Contributing Editors—BOYD PHELPS, PERRY O. BRIGGS

Advertising and Subscription Representative for California, Washington and Oregon, Don C. Wallace, 4212 Country Club Drive, Long Beach, California

Entered as second class matter at the post office at Hartford, Conn. (permit application pending), June 20, 1931, under the act of March 3, 1879. Yearly subscription $2.00 in U. S. only, $3.00 in foreign countries including Canada. Single Copies, 20c.

Contributions not returned unless accompanied by stamped, self-addressed envelope.

that the transmissions are from sound-film which is quickly made and transported after an event. Thus the newsreel transmissions may be a prelude to direct-pickup, or else an attack against the movie-magnate-owned Columbia system. The latter is quite possible, for RCA now has the film sources and through its RKO affiliation has become a rival of the Warner brothers. While wearing Mr. Gernsback's cloak of prophecy one may as well continue and guess that the grandiloquently-named "Radio City" may serve as a point of origin for sight-sound programs to be sent about in film form to cities where experience shows local program sources to be insufficient. Whether the actual film is sent, or some method of instant relaying is devised, is not to be guessed



A cathode-ray tube by Von Ardenne. The picture appears in a spooky blue or green on the round screen at the large end.

now. The weak spot is that America does not go to the talkies for their own sake—but rather to be going somewhere.

The Transmitter

The transmitter at Empire State is some ways (280 feet?) from the antenna. The transmission line between, after many headaches, appears to be subdued and no longer mangles the pictures. The grapevine telegraph bureau reports that electrical and mechanical scanning have been used, but normal receivers seem to fit the scanning-order. As to power—one may guess. The license says 5 kilowatts, rumor says 1½ and the signal sounds like 50. The receiver is the main interest anyway.

The Receiver

Over most of New York reception with a neon lamp and scanning disc seems possible with no more than a detector followed by two audio stages with the high-quality couplings described in the free circulars of International Resistance Co. The 120 hole disc is not easily made but until commercial ones appear folks are making their own or using the commercial 60-hole two-turn-spiral discs which ruin the picture by cutting it up

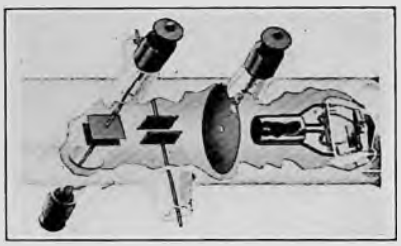
Another type of Von Ardenne tube.

and shuffling it but allow the parts to remain nearly undamaged and thus permit other problems to be studied. The sound-receiver and sight-receiver are no easy job, but the sight one is vastly the tougher because of the big frequency range. The first rush toward super-regeneration has given way to a variety of double and triple detection receivers with flat intermediate-frequency amplifiers using coupling which combine resistance-capacity with inductance. It is also found that signal-frequency gains are possible with normal screen-grid tubes.

The RCA receivers are reputed to center about a cathode ray tube built in the large Corning Glass envelope, which admits a 9 inch screen, on which appears the picture of ordinary sound-film proportion—height .748, width .878, or about 5 x 6 inches. The auxiliary equipment is discouraging. Merely to produce the electron-jet and center it to produce a bright light-point about 1/16 inch across at the center of the screen requires: low filament voltage, focusing cylinder voltage around 300 (there are other ways) and accelerating disc voltage around 2000. Then the jet must be wiggled one way 24 times per second, and transversely 120 times as fast. The wiggling waves, which are applied to the deflection plates, must be of correct frequency, phase and WAVE FORM—and the form is one tending to raise the deuce in a radio receiver. Accordingly one has assorted plate supplies, two special

oscillators with odd wave forms, and a variety of shields and filters. The special oscillators provide only low voltages and must be amplified, or else one must use a two-stage cathode ray tube, first deflecting a low-speed jet and then speeding it up to secure enough impact to make the screen glow brightly. The distortion possibilities are many.

Even now one has but a woven rectangle of light, painted by the wiggling electron jet. Next the jet speed must be modulated in accord with the scene on the distant movie film. This requires



The vital machinery at the small end. Electrons from the filament focussed by the surrounding tube, are attracted to the accelerating disc and some dive through the central aperture, then between the two pairs of deflection plates to which the deflection-frequency a.c. voltages are connected. The wiggling ray cross-hatches the screen with fluorescent lines, the intensity changing as the jet speed is modulated in accordance with the light seen by the distant electric eye as it stares through the scanning equipment at the movie film.

superimposing the a.c. output of the receiver on some electrode of the tube, perhaps through a high-mu 1000 volt tube with indirectly heated cathode to prevent filament-ripple overlays. (An 841 serves experimentally.)

Again—all speed changes involve a focus change—the dot changes size as

An engineer's nightmare—waveforms such as used by the cathode ray deflection plates; and noisily resented by nearby radio receivers.

well as brilliancy. Additional devices—too numerous to describe—are used to combat this. The simplest is a separate metallic coating run at about 3000 volts.

All this machinery, and two radio receivers, easily account for the 24 tubes reported to be used in RCA's experimental sets, and renders it likely that they will cost at least the $750 introductory price at which guesses are aimed.

Beginner's Receivers

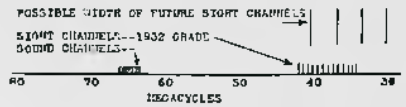
The beginner will first wish to HEAR the signal. A detector-audio receiver has been suggested, and if built it should base on an a.c. screen-grid tube whose input circuit uses a 1½ inch turn of wire tuned by a .000025 midget vernier-dial driven. The regeneration control is best made as in National's SW-5, in fact one of those receivers is readily modified for the purpose. For sound alone nice work has been done with an HY-7 superheterodyne with the detector tuned circuit cut down and the oscillator run at 3 or 4 times the signal frequency. Naturally the i.f. selectivity spoils the picture. In any case the household antenna can be coupled inductively or conductively, avoiding over-close coupling. Ranges are checked by oscillating the detector and using a General Radio wavemeter in the familiar Judson click-method. Recall though that the circuit is detuned greatly with the oscillation control and work near the no-oscillation point.

Following Schedule Changes

While RCA will certainly welcome reports from observers, they will probably be unable to advise of all transmission changes, hence the "looker in" should use his ingenuity in following changes of wavelength, picture frequency and number of scan-lines. The following is a method used by Mr. Boyd Phelps with invariable success in quick analysis of television signals. Receivers based on the information gained have invariably worked.

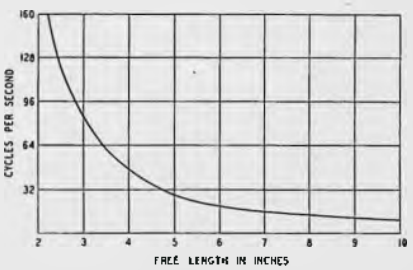
High precision is not needed. The "whine frequency" of the signal is first determined by comparison with any available audio standard—crystal-controlled beat-oscillator as first choice—but ranging on down to the family mandolin or piano. A piano is really a very decent frequency standard. In the case of the Empire State signals the whine is at 2880 cycles, which is the product of scan-lines times pictures-per-second. One might—at great cost in

time and $$$$$—make many discs and try all of them at various speeds—but there is a simpler way. One determines the picture-rate directly as follows. A steel strip is clamped in a hand-vise and the free length changed until it seems to stand still when illuminated by a neon lamp driven by the signal to be analyzed. The reed is now in tune with the picture-rate. (The reed used by Mr. Phelps was



Nice fresh puzzle for the Radio Commission—the allocation of sight-sound channels in pairs.

no more than a Starret 8 inch hacksaw blade.) Now it is necessary to calibrate the reed, which is done by starting with a short length and comparing against the family piano (middle C is 256 per second), using the easily audible beats between piano and reed to adjust the latter by. Below 300 cycles it is better to use piano notes 1, 2 or 3 octaves above the reed which beats easily with such notes as it has strong harmonics. A fairly decent curve is obtained. In Mr. Phelps work check-points were wanted. The local power system wanders as to frequency, hence a 60 cycle point was obtained by feeding a neon lamp from a radio receiver tuned to an amateur station with a strong plate-supply ripple due to a network known to serve many



Calibration of the hacksaw frequency meter.

electric clocks—and therefore probably fairly correct. The reed was adjustod to "stand still" by this lamp, its length measured, and the point marked on the curve.

An amateur movie projector without film then had its motor speed adjusted so that when aimed at the motor disc its flickering light caused 2, 3 and 4 spokes to appear—corresponding to 30, 20 and 15 shutter-openings per second. In each case the reed was held in the flickering beam and the length adjusted for "standstill"—the motor speed being meanwhile checked against the distant station's neon light. The points all fell neatly on the original curve.

In the case of the Empire State transmissions 24 came out as the picture rate and 2880/24 is the scan-line number of 120.

If such a measurement as this gives outrageous results such as 120.3 lines, there should be no difficulty in the mind of anyone able to unravel amateur radiograms, or listen to shortwave broadcasting with enjoyment.

THE PUSH-PULL OSCILLATOR

Having been long-time-since of the notion that push-pull oscillators will get no further down on wavelength than "straight" ones we are pleased and amused to find in the January issue, "Proceedings of the Institute of Radio Engineers", an article by W. H. Wenstrom ("Regenerative Ultra-Short-Wave Oscillators") in which it is shown that they not merely get no further down but are less efficient to boot. Incidentally we are somewhat surprised to find that the editor's work with Phelps seems to have carried the regenerative oscillator as far down as anyone has taken it—41 Cm. It can be taken farther. The circuit is the familiar DeForest Ultraudion, dating around 1910 or some such thing, although attributed to Gutton-Touloy and 1927.

Reverting—push-pull oscillators can claim one thing—less choke-coil grief. However, when that's licked the old Ultraudion, single-sided, is still the best 5 meter bet as a simple oscillator.

Seeing Power Factor Action

By John L. Reinartz*

Nôw that we have the $2.85 oscilloscope all made†, and have tried out the stunts shown in the February issue, let's introduce another low-priced stunt which will be very useful when we start to make good the promise to let you "see" key thumps and motorboating.

Power factor measurements have always had the interest of the radio amateur, and have been much argued over in conventions and in print. While much of the worrying has been over r.f. circuits, the effects are the same at low frequencies. We will now take a look at the power factor business in a 60 cycle circuit, because it is slow enough to be in synchronism with our motor and will therefore show a steady picture which will mean something to us. If the motor and the circuit frequency did not agree we would have a jumble of moving light for our pains.

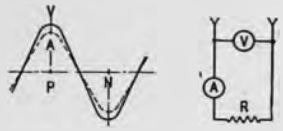


Fig. 1, in Phase Unity Power Factor.

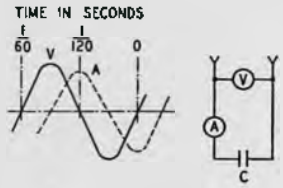


Fig. 2, Leading Zero Power Factor.

Fig. 3, Lagging Zero Power Factor.

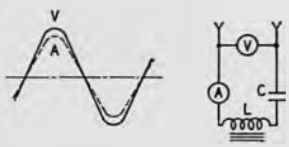


Fig. 4, Resonance Unity Power Factor.

We will now review just a little theory before starting to "look" at the effects which cause us to be interested in power factor. First of all let us recall that in 60 cycle circuits, exactly as in r.f. circuits we have resistance, capacity and inductance. If we had a circuit like Fig. 1, in which only the resistance needs be considered then the current (dashed line A) will be in time with the voltage (solid line), rising and falling with it. We ordinarily say in a. c. work, they are "in phase". The resistor gets hot, and if we measure the heat we find that the same power is being used up as if d. c. were being used at the same voltage and current. Keep this in mind, as we will come back to it.

In Fig. 2 there is no resistance, no inductance, and only the condenser to consider. Now a strange thing happens; a very short time after the circuit is closed the current is actually AHEAD of the voltage that causes it, as shown by the time marks and the position of the A curve in Fig. 2. A bit later we will let you SEE this happen, and also show that, although the current and voltage are the same as in Fig. 1, the circuit is using NO POWER AT ALL.

In Fig. 3 we have only inductance. Now the current "lags" BEHIND the voltage. If the inductance really was without resistance the current would lag as much as shown and AGAIN we would have zero power. Note that in both Figs. 2 and 3 the current is one-quarter cycle out of step (out of phase), but in opposite directions—and thus it seems reasonable to expect that we could neutralize the capacity effect of Fig. 2 by using the inductance effect of Fig. 3.

---

* Electrical Laboratory of John L. Reinartz, 176 Wadsworth Street, So. Manchester, Conn.
† Page 4, "Modern Radio" for February.

Later on you will SEE this happening. For 60 cycles this can be done with a combination of (for instance) 1 microfarad of capacity and 7.04 henrys of inductance, giving us the condition of Fig. 4. (If the capacity is made larger the inductance must be made smaller in the same proportion. These effects are hard to understand until we have seen them—but that's just what oscilloscopes are for—and we have all the elements necessary to provide us with instructive entertainment, not of course without

A synchronous clock-motor equipped with the necessary mirrors as was explained in the February issue.

doing some work in the form of building a small addition to the oscilloscope. This we will proceed to do at once.

Let us now assemble as in Fig. 5 a neon lamp, (N), two pieces of copper tubing (T1 and T2), another piece of ground glass (S) and the synchronous motor mounted on a panel by virtue of a velvet vernier dial (see Fig. 6) so it can be revolved while it is running and the amount of such change can be accurately noted. The panel is mounted vertically on a base and the whole can be enclosed in a box made of whatever you have available in the form of thin wood or celotex with the panel becoming one of the sides. The box must be made as light proof as possible as we want to see the effects by the reflection from the mirrors on the motor and may wish to do this during daylight. We place the neon lamp so that it faces toward the mirrors (M) somewhat as shown in Figs. 5 and 6, keeping the break between the two plates of the lamp vertical so that the mirrors may throw separate images on the screen S. Of course these images will appear only when a plate is glowing at the instant when the rotating mirror passes through the proper position to throw the image on the screen. To make the timing more exact and to give us a definite point to watch we now mount the two pieces of copper tubing T1 and T2 (we don't care where you got it), and the paper screen. The main idea is to place the paper screen so that light does not come from the lamp directly to the screen and then to locate the copper tubes so that the light from lamp-plate P1 passes through T1 and the light from P2 passes through T2. If we had only one side of the lamp lighted we would then see a single bright spot on the screen PROVIDED that side of the lamp was either lighted steadily or else was blinking at the right moment so the

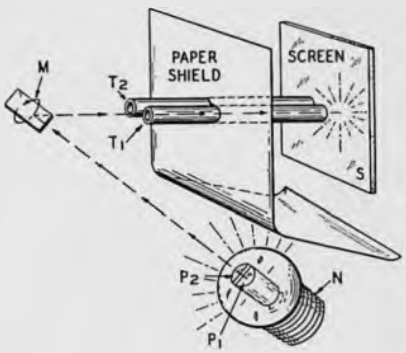


Fig. 5. The schematic arrangement of the parts. N is the neon lamp, whose plates P1 and P2 glow alternately when a.c. is connected to the lamp. M is the rotating mirror from which the light passes through the tubes T1 and T2, depending on which plate is glowing. A bright spot appears on the ground glass screen S at the end of the tube.

flash would be caught by the mirror at the moment when it could be reflected through the tube to the screen. If the lamp were blinking at the wrong time no light would get to the screen. We are going to make use of this fact to demonstrate by eye the effects that cause us to be interested in power factor—and we will also show that it can be measured even with so crude an instrument as we have assembled. We are now ready to see the results of our work.

We will begin by connecting 110 volts a.c. to both the motor and the neon lamp and amusing ourselves with the two light

spots on the screen, aligning the copper tubes and turning the motor by means of the dial until we have the brightest spot from one plate, then writing down

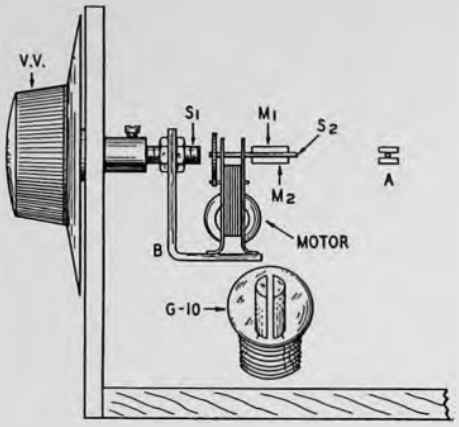
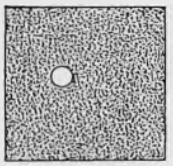


Fig. 6. Mounting of the synchronous motor to permit rotating the motor while it is running. The mirror-shaft S2 must align with the stub-shaft S1 which is held by the dial, and carries the bracket B. End view of shaft and mirrors at A.

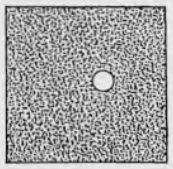
the dial reading and turning the motor until the other spot appears and becomes brightest, then writing down a second dial reading. These two are evidently the positive and negative peaks P and N in Fig. 1. The distance between these peaks is ½ cycle, or 180 electrical degrees. IF the mirror shaft ran 3600 r.p.m. it would take an exact half-turn of the motor dial and motor and therefore 180 electrical degrees would also be 180 dial degrees. This will probably not be your combination; all sorts of figures will come out in different oscilloscopes because they may have 1 or 2 mirrors, different motor speeds, different dial markings or even a geared-down mirror shaft like that shown in the photograph. Don't be disturbed—just make sure what dial-change is equal to 180 electrical degrees on YOUR dial and go on from there.

Anyway it is now time to so adjust the motor to the dial that you get a light beam through one of the tubes most brilliantly when the dial is set at zero as we will wish to start from scratch for all our subsequent experiments. We now take a one microfarad condenser of good make and connect it in series with the neon lamp. We find that the light spot on S has gone out and has appeared in the OTHER tube, we then turn the dial and find that we can make the spot show itself in tube number one again at almost exactly ½ of the dial-shift which we have previously discovered to be equal to 180 electrical degrees! The only possible explanation is that the TIME at which the plate blinks has been changed by 90 electrical degrees (almost)—which is to say ¼ cycle or 1/240 of a second. It has been moved FORWARD as is shown by the fact that we had to turn the motor AHEAD in the direction of rotation to catch up with the blink.

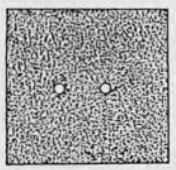
Now remove the condenser and instead connect an inductance in series with the lamp. Again the spot disappears and by trial we find that the motor must be turned BACKWARD to find it. This agrees with Fig. 3. Furthermore, if you used just 7 henrys and if the resistance of the condenser and the inductances by chance were alike in value



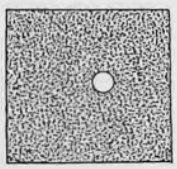
"—adjust the motor to get a light through one tube."



"—the light has appeared in the OTHER tube."



An intermediate setting.



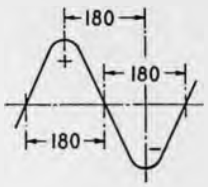
"—the motor must be turned BACKWARD to find it."

then you had to turn the dial the same number of degrees as was necessary when using the condenser. Nothing remained now except to prove finally that

the condenser and inductance effects are in opposition by putting the condenser and 7 henry inductance both in series

End view of a neon lamp crossing a dark room in a hurry, just to prove that the plates light alternately as shown in the next figure.

with the neon lamp. The result will be that the light remains without change! By looking up at a regular clock that



One type of neon lamp which may be used as an indicator. Plate 1 lights on the positive half of the cycle. Plate 2 lights on the negative half of the cycle. See also photo at head of this paper.

hasn't been turned into an oscilloscope we find that no more can be done tonight, so more later.

"I just bought a fifty-watter for 35 cents."

"What kind?"

"Mazda."

"Oh."

—The Key Wagger, Seattle.

COMING—

The "No Loss" Antenna.
The Unprofitable Class B Amplifier.
Better Short Wave Receivers.
High-grade Nothings.

Our Hates!

Orange neckties in March—and other times.

Onions—old and young.

The Lucky Strike announcer.

Newspaper blat of amateur radio stations that "chat with the world".

Cigarette burns on the furniture—and stubs on the floor.

Amos and Andyese—spoken by anyone, including Amos and Andy. Octavus Roy Cohen invented the argot, anyway—him too.

"Nothing down"—and a power of attorney on all you own.

Salesmen who run the thing loud.

Output pentodes.

Also—we weary of second-hand names like New England, New York, New Orleans, the imitation Londons, Parises, Romes, Athens, Berlins and all their pale ilk. Why bother with them when our own soil grows such bold names as Deep River, Eagle Pass, Quartzite, Grand Forks, Sand Prairie, Pawnee Rock, Council Bluffs, Loon Lake, Sioux Falls, and Imperial Valley?

The N. B. C. announcer who ran an N. B. C. advertisement into the Julius Rosenwald Memorial Service.

Saucer-sized "dynamic" speakers.

The long-winded advertisements from KFI.

Hum-m-m-m-m

In Broadcast and Shortwave Receivers

By L. W. Hatry, Associate Editor

Many an old A. C. operated receiver, and (whisper this) some of the new ones have more hum level than an unsuspecting ear will believe. Sometimes this hum can be got at.

Receiver hum nearly always comes into existence in the A. F. end. When it has an R. F. birth it directly modulates the carrier of a 'phone and thus identifies its birthplace.

The A. F. end of a receiver begins with the detector tube just as the R. F. end ceases with the detector tube, hence any suggestions for reducing hum level in either the r. f. or a. f. system must include the detector.

If the detector tube uses a grid-leak the problem is changed slightly since then the sensitivity of the A. F. system is multiplied by the operating amplification constant (mu) of the detector tube at the operating voltage. All of which means that the input of the A. F. amplifier (grid of detector) is sensitive to A. F. magnetic or capacitive fields three A. F. stages worth. So—

Any transformer-coupled A. F. amplifier not ending in push-pull tubes and having 3/1 A. F. transformers has an overall amplification constant of approximately 2,490 or 6,040 depending upon the mu of the final tube being 3.3 or 8. (See Fig. 1.) If push-pull amplification is used the overall amplification constant given can be divided by three generally. No wonder then sometimes a big hum difference is noticed if detector tubes are changed. And no wonder that at times shielding the detector tube and the grid-side of the grid-leak and detector prove wise precautions.

Fig. 1 depicts the audio amplifier, indicates how the gain figures are arrived at. The main fact immediately to assimilate is that .4 millivolt (.0004 v.) of A. F. on the detector grid will give 10 volts in the speaker, and 10 volts of hum is good loud hum.

Once the detector grid-circuit is eliminated from the hum-factors we move over to the plate-circuit. Here we work into the grid-circuit of the first A. F. tube and through the A. F. transformer. Overall gain only 310 or 750 (based as before) but nevertheless sufficient to prove bad as I have found in several cases. The hum started by the detector plate-circuit gets into it from the power-supply, is part of the B current. The path of this hum is through the A. F. transformer primary and the plate resistance (Rp) of the detector tube. Condenser C thus should be regarded as having two jobs: 1. to let detector A. F. currents around the B supply; 2. to short-circuit hum coming from the B supply so that it cannot go to the tube transformer circuit. Hum "originating" in the detector plate-circuit does not change volume or pitch if the detector grid is shorted to ground. This hum can be eliminated to a great degree by increasing the capacity of C from .5 or 1 to 4, or better 8, mufd. if

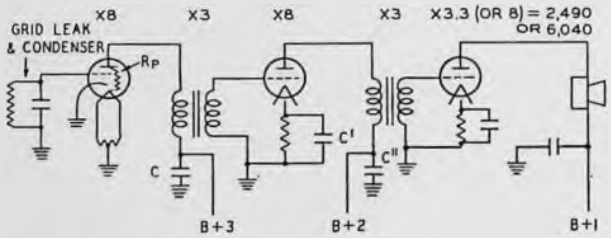


Fig. 1. The audio part of a set of a few years ago. Since we are interested in audio only the detector's tuned input circuit is not shown, for it disappears at audio frequencies.

the voltage divider is a potentiometer as in Fig. 2, but the cheaper and simpler rig is to connect a series resistor between the first A. F. B voltage and the detector circuit. If the A. F. voltage is 100 and the detector voltage is required to be 40 a series resistor suitable will be about 40,000 ohms. Such a resistor bypassed by 1 mufd. gets in as good licks against hum as 8 mufd. on the detector B voltage from the potentiometer tap. The scheme is shown in Fig. 2.

The next hum source works in the grid-circuit of the first A. F. tube and

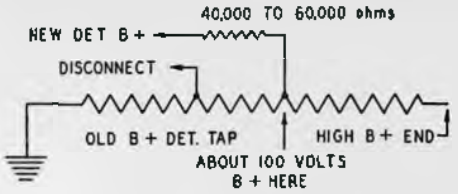


Fig. 2

hence into a gain of only 72 or 190. This suspicious character is the bias resistor R' (See Fig. 1), of 500 to 2500 ohms depending upon the number of tubes biased by the one resistor. Condenser C' by-passes this resistor for A. F. currents (and R. F. too sometimes) and occasionally is not built in the receiver. R' provides the bias because the plate current passing through it causes a voltage drop across it. Likewise hum in the B supply riding on the plate current also causes a voltage drop. Just as the bias voltage gets to the grid so does the hum voltage although not as easily because of the inductance of the A. F. transformer secondary. If C' is large enough, about 30 mufds. for a 2,500 ohm resistor, it will effectively bypass the hum.

Here I must interrupt to explain other phenomena that may occur. A receiver not equipped with this by-pass may have left handedly been saved from hum by ruining A. F. tone; for hum from the detector circuit is part of the A. F. signal and leaving off C' tends to kill bass amplification for the A. F. signal. (See page 18 for a detailed explanation of degeneration.)

Obviously 30 mufd. (or 120 mufd. if R' is 500 ohms) is both too costly and too bulky to be used. But for the simple labor of installing a resistor and 1 mufd. we can have a low-cost hum filter for the grid-circuit as shown in Fig. 3.

This brings our hum gymnastics down to the plate-circuit of the first A. F. tube. Here the hum is working into a gain not over 10 to 24. The B supply filter would need to be very terrible to send strong enough hum into such a small step-up and arouse much fuss. But if it did, an A. F. choke of 30 henrys should be interposed between the voltage divider and the condenser C". C" then should be at least 2 mufd.

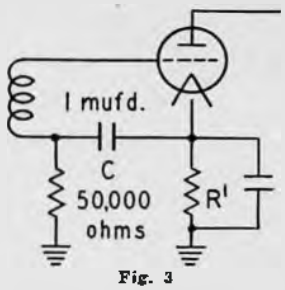


Fig. 3

So much in general for antique circuits. Remember that a power detector working into such a two-stage amplifier as that of Fig. 1 needs a Fig. 3 filter worse than does the first A. F. stage since it represents the earliest place in the line-up and hum from its bias resistor may be working into a gain of 800 to 1500, no small hazard.

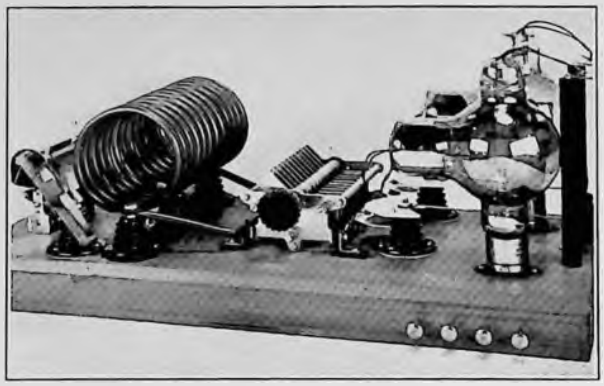
Later receiver design has taken full advantage of these facts. Several modern receivers will hum lustily if the power detector bias by-pass is removed and some will act roaringly if the first A. F. bias by-pass ceases working.

BROADCAST SCHEDULES OF RADIO STATION KUP
San Francisco Examiner

Sked	Service	Time (GMT—PST)		Frequency
A-1*	Press	0900	1:00 A.M.	6440 and 8350
B-1*	Stocks	1200	4:00 A.M.	6440 and 8350
C-2*	Press	1500	7:00 A.M.	6440 and 8350
D-1†	Weather	1648	8:48 A.M.	6440 and 8350
E-3*	Press	2100	1:00 P.M.	11340 and 16700
F-2‡	Financial	0030	4:30 P.M.	11340 and 16700
G-4*	Press	0300	7:00 P.M.	6440 and 8350
H-2†	Weather	0400	8:00 P.M.	6440 and 8350
S-S	Special schedule announced on 0300 GMT 7:00 P.M. Press.			

Note: *Daily except Sundays and holidays.
†Daily.
‡Daily except Saturdays, Sundays and holidays.

The staff at KUP stand continuous watch for calls on 36 meters between the hours of 4:00 P.M. and 8:00 A.M. PST. On 18 and 26 meters, 8:00 A.M. to 4:00 P.M. Also on 600 meters, 500 kc. distress.

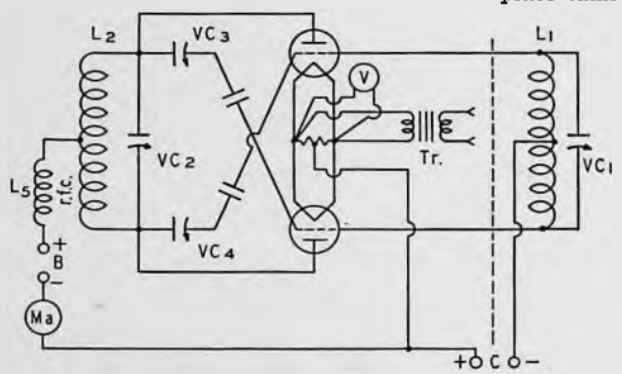


Mr. Chamberlain's 150 watt Ballantine-type cross-neutralized output stage for c. w.

Better and Simpler

The accompanying photograph of a cross-neutralized push-pull 150 watt r-f. amplifier tells its own story as to accessibility and ease of handling. While we have highly adverse notions as to the use of such a stage as a portion of an amateur radiophone station, its use for c.w. transmission is a horse from another garage. For that purpose it is quite o. k. in every way and at all practical frequencies. The stage shown is so used at the station of its owner, Mr. Harold Chamberlain, of Connecticut.

The diagram, and the photograph should make all things plain, provided one notices that the inductors L3 and L4 are of the pancake type and are nearly invisible in the photograph because one is almost wholly covered by the plate tank coil L5 and the other is seen almost exactly edgewise. Note that the layout of the terminals is such that the A, B and C power comes in at the back, while the meters are in front, and at the same time the r-f. power flows into the grids from the right and goes out to the antenna at the left while dead-simple wiring is used both above and below the base. The absence of any control knobs on the neutralizing condensers VC3 and VC4 should not be taken too seriously as '52 tubes are rather easy to balance and it is satisfactory to move the plates with an insulating rod and finish by taking off the power and clamping the rotors.



Schematic diagram. The part to the right of the dotted line is in the preceding stage which employs '10 tubes, VC1 and L1 forming their plate tank. Since they are shunt-fed the grid bias is brought into the centertap of L1.

L2, VC2—Plate tank of 150 watt stage.

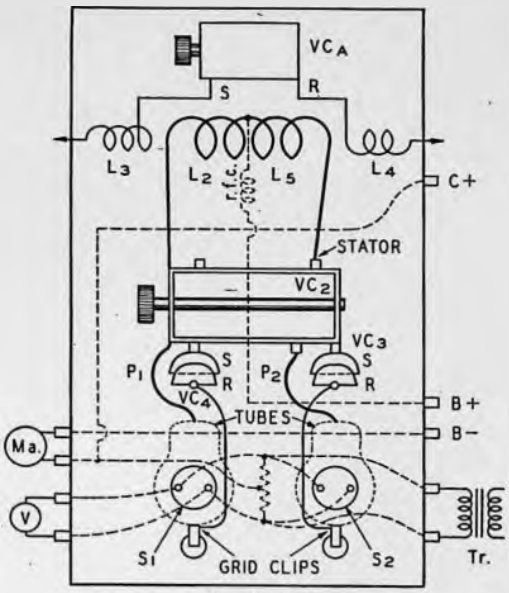
L5—r-f. feed choke for '52 plates.

VC3 and VC4—Cross-neutralizing condensers with rotors supported in standoffs and stators supported from frame and stator of VC2.

Lettering corresponds with layout. In photogram and schematic it will be seen that VC4 goes to the stator of VC2, whose rotor and stator are shown interchanged here.

Just in case anyone happens to care—our objection to class B output stages

for radiophones will be fully aired in a following issue where it will be shown that equal results can be had with far less costly equipment.



The Layout.

DON C. WALLACE REPRESENTS "MODERN RADIO"

Don C. Wallace, well-known in radio business and experimental circles throughout the country, has warmed to an old flame, the business of being manufacturers' representative.

He is representing Trimm Manufacturing, Shallcross resistors, Brooklyn Metal Stamping and "Modern Radio".

For "Modern Radio" Mr. Wallace handles advertising subscriptions and counter sales in Washington, Oregon and California. Any recent fogs reported between Long Beach, Calif., and Hartford, Conn., are probably the smoke from Don's activity converted to airmail. Radio organizations, banquets, clubs or conventions in the three states having "Modern Radio" in mind for any purpose should get into touch with Mr. Wallace.

TRADE NOTES

C. F. Burgess Laboratories, Inc., of 202 East 44th Street, New York City, have taken over the activities of Burgess Battery Company in the sale of Burgess Radiovisor Bridges (light-sensitive cells), vacuum contacts, vacuum contact relays, micro relays, light control units and other electronic devices, as well as the acoustimeter line of the Burgess-Parr Company.

Since the untimely death of Francis R. Ehle in an airplane crash several months ago, the International Resistance Company, of which he was President, has rearranged its staff.

Mr. Ernest Searing is the new president, Mr. W. G. Porter, vice-president in charge of sales and Mr. Harry Kalker, sales manager.

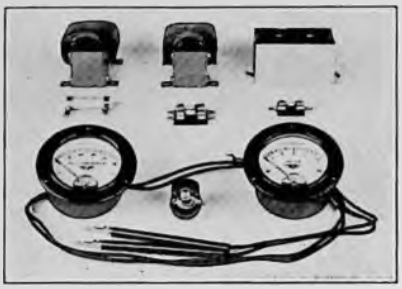
The Clarostat P 185 and P 180 series of volume controls is now equipped with a pry-off cover which may at will be replaced by another cover (called S 185) carrying a line switch. The effect is to reduce the number of varieties the repairman needs to stock. The 1932 Clarostat catalogue describes these devices, also the other rheostats and fixed resistors made by the firm. It may be had gratis from the manufacturer or from Allied Engineering Institute, 98 Park Place, New York City.

IT'S NOT A GRAFT

No, we don't agree that it is silly to test tubes every few months. A few low tubes let the plate supply voltage run up on the rest of the system, and shortly causes damage that costs much more than a tube. This is especially true of cheap sets which nearly all have bad regulation and small safety factors.

"Your lineup of future articles surely is alluring."

J. C. Lewis, W6ZBJ,
Santa Barbara, Calif.



A Tester for Electrolytic Condensers

By L. W. Hatry

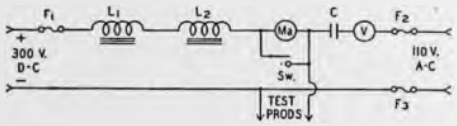
Because electrolytic condensers are relatively short-lived devices the modern service shop certainly cannot get along without a tester for electrolytic condensers. Do not take this to be a condemnation of electrolytics—present low prices justify their use in filter circuits where their relatively high losses are of little importance.

Electrolytics have two sets of troubles; the leakage goes too high, and they lose capacity. Both changes decrease the filtering efficiency of the condenser, consequently the only tester suitable for electrolytics must check leakage and capacity both—preferably at once.

Capacity checks are most easily done with a.c., whereas leakage tests are most easily done with d.c. It is safe enough to put a.c. on a paper condenser but this should not be done to an electrolytic condenser—it takes but a few seconds to damage the condenser and in 5 minutes it may be ruined. The tester accordingly must place on the condenser enough d.c. voltage so that any a.c. which is fed to it during the test will not be able to reverse the voltage. Since 110 a.c. has a peak voltage of 157 we must have at least that much d.c. voltage on the condenser for protection. Furthermore —since most electrolytics are intended for peaks in the region of 500 volts we may as well make the d.c. voltage high enough so that on the "plus" part of the a-c cycle we will run up to about 500 volts (a.c. plus d.c.). This brings us to the actual construction.

Notice the diagram. At the leakage current of the good electrolytic the average old Majestic or other 180 volt B eliminator will deliver 250 to 325 d.c. volts, or an average of 300 volts. 300 volts d.c. put in series with 110 volts a.c. will give a rippling d.c. voltage on the condenser with lows of 143 volts and peaks of 457 volts, which is just right the two chokes of the B-sub serve for the chokes in the diagram and keep the a.c. out of the d.c. supply. If the old condensers in the B are good, one of them will serve as the 4 mufd. required to keep the d.c. from shorting through all the lamps in the building.

The microfarad meter can be a Jewell 10 or 15 volt meter Pattern 54 or 78 with a resistor in series (not shown). This resistor will be in the region of 100 ohms and must be adjusted to allow full-



L1 and L2—Filter chokes, at least 30 henry at 25 Ma.
Ma.—100 Ma. d.c. meter.
Sw.—Meter protective switch.
C—4 mufd., 600 v. d.c. rating, paper condenser.
V—Microfarad meter or voltmeter used as microfarad meter, see text.
F1—⅛ amp. Littelfuse.
F2 and F3—1 amp. fuses.

scale deflection of the meter with the resistor in series across 110 volts. This combination will allow readings up to 8 mufd. in the circuit shown. It can be calibrated from good electrolytics as rough standards or from paper condensers. The process is so simple and has been so often described that no further talk is necessary. A standard microfarad meter may be used if allowance is made for the series condenser of 4 mufd. and is preferable. The milliam-

(Please turn to Page 20)

"MODERN RADIO'S" ANSWER FACTORY

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A—Letter with one question.....$ .50
No charge for small incidental pencil sketches.
B—Additional questions, each..... .25
C—Schematic diagrams of battery-driven receivers up to 6 tubes, transmitters up to 5 tubes, antennas (other than beam types), switching schemes, metering, and power circuits of reasonable simplicity..... .75
D—Matters such as given under C, where all constants are desired.... 2.00
E—A. C. or D. C. circuits—without constants 1.50
F—A. C. or D. C. circuits with all constants 3.00
G—Transmitter diagrams of greater complexity, bibliographies, operating instructions, analysis of complex operating difficulties in apparatus, and other questions not covered by the above will be estimated on receipt of a clear and complete statement of the problem.

NOTES

1. Keep a copy of your letter, including diagrams, numbering questions 1, 2, 3, 4 and lettering diagrams a, b, c, d.
2. The right is reserved to return remittances for any questions which it is impossible to answer.
3. No attention will be paid to radiograms, telegrams or letters (other than those under class G) which are not accompanied by a remittance. Please use money order—loose cash may not arrive.
4. Address letters, "Modern Radio", 101 Allyn Street, Hartford, Connecticut.

(Continued from Page 18)

meter should be about 100 ma. maximum. It is read in the usual way.

The average electrolytic will have a leakage when new on the order of a ½ ma. per mufd. (4 ma. for 8 mikes) or less. Some sources of information say that leakage is allowable up to 2 ma. per mufd. but this means 16 to 48 ma. extra current for the receiver rectifier to supply and from 16 to 32 extra ma. to pass through filter chokes probably near core saturation anyhow; the serviceman should not in my opinion tolerate more than 1 ma. per mufd. Aged electrolytics being liable to eventual decrepitude should be suspected in any circumstances.

Finally, the serviceman, after building a tester such as this, will discover that the average electrolytic of the best brands is very ununiform as to capacity. He will also discover that electrolytics tend to show susceptibility to mechanical damage as well as shelf-decay. I suspect he will also come to the final conclusion that since "good" electrolytics are as bad as they are, that the cheaper ones must be avoided.

WAKE UP—UPPER MISSOURI VALLEY!

Our apology to the Missouri Valley—page 13, February—brought prompt response from the committee which handled the Rolla, Missouri, convention, also the one which was in charge of the Kaw Valley convention. Both of these outfits were innocent in the first place and had previously cleared up everything in prompt order. They were just confirming it.

Meanwhile the "Upper Missouri Valley" convention committee still doesn't seem to remember where it put the list of winners. This is a bit tough on the winners.

You can't have general prosperity until the man with the income of a thousand will buy 1,000 pairs of pants.—The Portico, Hartford Times.

THE METER-AMPERE MUDDLE

Since the effectiveness of a radio transmitter depends on the power which is actually radiated by the antenna—not the power fed to the antenna—it is reasonable to state the station's power in terms of radiated watts. Unfortunately we have no such thing as a radiation meter—though many an innocent antenna ammeter is called a "radiation meter"—and the only way to measure the radiated power is to go off a ways, measure the strength of the field and then figure back to the antenna.

It is convenient to make the field strength measurement at a distance of 1 kilometer, being sure to measure at several places on that circle and take the average. If we call this measured vertical field strength (in microvolts) "e", we can write

Meter-amperes in the antenna=
e (wavelength)/377

and also that,

Watts radiated=
1580 (Meter-amperes/wavelength)^2.

From this it is apparent that the effective height of the antenna is

Meter-amperes/amperes

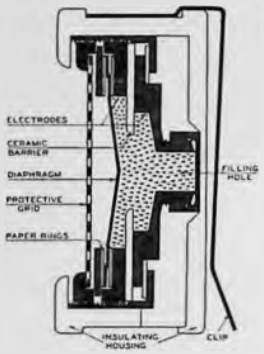
and also that the radiation resistance of the antenna is the watts radiated, divided by the current squared.

(Please turn to Page 22)

Allied Art

A LAPEL MICROPHONE

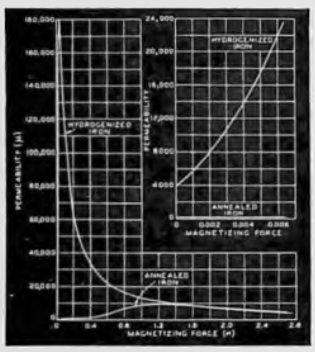
The line drawing, from an article by W. C. Jones in the February issue of Bell Lab. Record, is self explanatory. The mike is clipped to the lapel of the restless speaker who will not stay with the ordinary mike. The pickup is partly



through chest-wall vibration hence a filter is provided to reduce the booms and rumbles. We assume the equipment includes a legchain of the same length as the mike cord.

HYDROGENIZED IRON

In the same issue appears an enchanting story of a new form of iron, prepared in an atmosphere of hydrogen. Remarkable magnetic properties result. As seen from magnetization curve herewith the material is far more permeable than good annealed iron. More than that its hysterisis losses are materially below



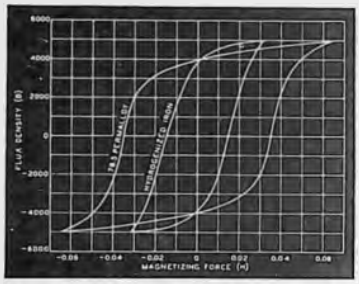
Magnetization curves of ordinary and hydrogenized iron.

those of even permalloy. This is shown by the hysterisis curves herewith.

The article is by P. P. Cioffi.

INTELLIGENCE FREQUENCIES

A very modest requirement in the way of "understandability" requires 3000 cycles to be well transmitted to make something that sounds a little like the "S" and "TH" in the English language—otherwise one can't tell "this" from "fish", both sounding somewhat like "fiff". There are a plenty of transmitters which make music sound reason-



The permeability curves.

ably well but will not stand such a simple test—will not make a whistle sound like a whistle or will not make the jingling of a bunch of keys sound like the real thing. Speech, if really good and clear, demands a first-rate "top end", fully as good as does music. To ask for good 3000 cycle transmission is very reasonable; we should ask for 5000.

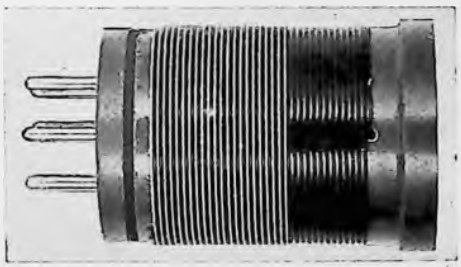
SCHOOL BELLS

My Father maintained a bell-ringing system at a boarding school which had seven or eight buildings. The system was based on an antique contact-making clock and a tremendous battery of Leclanche cells. The wire spans were long and the bells had never been good, even 20 years before. The annual maintenance allowance was about $5. There is nothing difficult in radio.

It Isn't the Coil

That's Wrong

Modern short-wave coil-forms allow one to make coils whose goodness is sufficiently high so that coil losses may be quite unimportant, compared to other losses of which less is heard. Indeed, improper circuit conditions frequently convert the advantage of the good coil into an altogether imaginary possession. This can become true especially in receivers having extremely low tuning capacity, such as the usual band-spread tuners, or even short-wave tuners not band-spread but tuned with condensers of 75 picofarads* and below. The reason becomes plain when one considers that



when the tuning condenser is set at its minimum capacity the circuit may still total as much as 40 to 50 picofarads of which the tuning condenser will be contributing no more than 10 picofarads. Consequently, if the tube socket, coil-socket, wiring insulation and so forth are contributing a poor grade of capacity the chap who bought the best tuning condenser and best coil-forms (or coils) would have wasted money. This defect can easily be detected in a plug-in coil outfit which has overlapping tuning ranges. Tune in a station near O on the dial, and then tune in the same station at 100 or thereabouts on the next smaller coil. The signal at O with the big coil should be louder (because the L/C ratio is larger) than the signal at 100 on the smaller. If on the contrary the signal at 100 is appreciably louder, then you can safely assume that the circuit is "high-loss" at minimum due to the poor grade of stray capacity made up of odds and ends of insulation distributed throughout the circuit.

And this effect is **decidedly more noticeable on modulated signals, which is to say for a non-oscillating condition in the detector circuits.** C. W. reception shows no loss in signal strength in cases where the loss is quite apparent on modulated signals.

Two kinds of good coil forms, illustrated by the National, one of R-39 low-loss material and Pilot's bakelite form ribbed to keep the wire away from the bakelite.

We can of course improve the entire circuit by better wiring and installing good parts; that is the efficient move. Or we can keep out of the region of poor performance if we discover such a region by making certain that the minimum capacity of the circuit is lumped chiefly in a good condenser such as a National midget of not less than 25 picofarads. (Short-wave tuning circuits average between 25 and 50 picofarads for the total minimum circuit capacity, about 10 picofarads of which can be allotted to the tuning condenser proper) Therefore if the receiver works well but shows the disadvantage explained earlier, increase the working minimum and alter the coils (or calibration) to fit. That is the easiest way out; it keeps the overall performance uniform by maintaining similar performance over the entire dial.

L. W. H.

---

* The picofarad is a short name for the micro-microfarad which by the simplicity of its abbreviation to pfd. eliminates possible misreading and confusion of the abbreviations for millifarad, microfarad and micromicrofarad.

Goulash

A POOR STANDARD

Our present way of showing fidelity (mis-called "quality") of audio reproduction of broadcasting receivers is somewhat worse than useless. Most of the "fidelity curves" which are so solemnly published are thoroughly misleading, for they merely show the electrical fidelity, which is to say they tell what goes INTO THE SPEAKER—whereas we are interested entirely in what comes out.

For example, a few years ago we had a set whose "boomy" reproduction made it a proverb—yet the set had a very acceptable fidelity curve "from input to speaker moving coil". Similarly this year we have a widely advertised midget which can be had in a substantial console or in a variety of cracker-boxes with saucer-sized speakers. In the console form tone is very good—in the miniature models the tone is just as defective as one would expect it to be—yet the same fidelity curve is supposed to apply to both!

Fortunately no one but the hopelessly credulous engineer or amateur is being fooled—the rest of us use our ears.

JELLYROLL IN THE ACT OF BEING HOT.

John Public wants a repair part like the one that burned out. One frequently can't get such a part because of the nearly complete absence of good manufacturer's cooperation with the repairman. However, one CAN do substitution intelligently and thoughtfully so the repair will last.

Bargain and bankrupt parts at give-away prices are largely the fault of the parts manufacturer. He agrees to furnish some set maker with—let us say—resistors of a certain size and precision. Naturally some are rejected during manufacture for being off on resistance, dimensions, appearance and the like.

These he hands on to the bargain house. The condenser manufacturer does the same thing with cartridges that are off capacity, ancient, or too moist to be reliable. Of course it would all be right enough if the buyer only could be made to believe that he is getting what he pays for—and not a bit more.

THE "1,000-OHM-PER-VOLT RULE"

At 1,000 ohms per volt a milliampere flows—from that one can quickly guess at the currents pushed through various off resistances by any voltage within reason: e. g., 67½ volts will obviously push a milliampere through 67,500 ohms. If the resistor is but 6,750 ohms then 10 Ma. will flow—if it is 3,500 we can make the rough guess that "about 20 Ma. will pass", because 3,500 is in the neighborhood of 1/20th of 67,500 ohms. Similarly the rule aids quick estimates of resistors to give a desired voltage drop: e. g., What's the resistance needed to give a 10 volt drop with 12 Ma. flowing. Well—1 Ma. will give 10 volts drop when made to flow through 10,000 ohms, therefore 12 Ma. will require 1/12 of 10,000 ohms, or something less than 1,000 ohms. This may be a good enough answer but a better one is possible by dividing by 12. This may be done mentally or with a dull pencil; either way the answer is 833.333333333 ohms which ought to be precise enough for anyone.

Volume Control

We stock Frost, Yaxley, Electrad and Centralab lines.

Order from their volume-control guides or give following information and we will furnish suitable control:

Resistance of old control, what it does in circuit (such as controlling screen, bias, antenna, etc.), if it has switch attached, length of shaft, length of bushing.

Above information preferred: Otherwise name of radio, model number, tubes used, whether control is single or dual, if control has switch.

Centralab volume-control data book in stock. Electrad volume-control folders in stock. Usual discounts to servicemen, dealers and amateurs. Over 300 different controls in stock.

Fixed Resistors

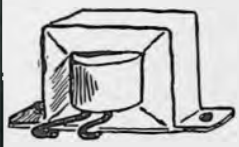
International Resistance Co. 1 watt, 30c list; 2 watt, 40c list, and auto suppressors. Electrad truvolt 25 watt, 50 watt, 75 watt sticks so useful for making up voltage dividers with extra clips—large stock. Usual discounts to servicemen, dealers and amateurs. Can be set to fit any divider problem. Measure resistance of dead sections and advise, we will send correct unit. Or state make and model number of receiver, voltages, and types of tubes.

Also the Polymet line of black enameled 10 and 20 watt resistor units. Ward-Leonard bleeders, line-voltage controls, transmitting transformer controls. For bias resistors, state number of tubes on resistor, type of tubes and voltages if possible. We will send correct wattage and resistance. Write for quotation on any item you need.

Hatry & Young

203 Ann St.
Hartford, Conn.

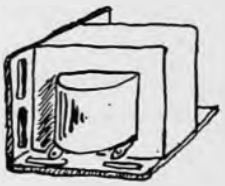
Replacement A.F.T's. New Low Prices



Style of All Replacement Types (See right.)

PUSH-PULL OUTPUTS

1—247 into voice-coil of Dynamic..List $1.45
2—247's into voice-coil.....List $1.18
1—245 into voice-coil.....List $1.28
2—245's into voice-coil.....List $1.18
As illustrated on left, excellent for midgets.
Larger transformers, cased, $3.60, $4.80 and $7.05 net according to grade—tone.
Sizes for one or two 250's, 210's, etc., from $2.10 to $7.05 net. Sizes suitable for high-grade or public address amplifiers as well as all kinds of repair work.
Also transformers for working into magnetic speakers from any of above tube combinations at $2.10 and up. Sizes for 112's and 117's in stock at similar list prices.



Optional Style of 3-1 A. F. $1.35, and P. P. Inputs $2.10.

OTHER AUDIO TRANSFORMERS

3—1 replacement A. F. Thor.....$1.18
Push-pull input transformer Thor.....$1.47
Above transformers available in styles of both illustrations, specify, at net prices given.
Cased transformers—3-1 at $1.50, $2.40, $3, $3.90, $5.90 net.
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Push-pull interstages $7.05
Grades for all purposes.

MICROPHONE TRANSFORMERS

Single-button Thor. $2.94
Double-button $5.90
Double-button best $11.76
Exceptionally complete line of Audio Transformers of all types. Usual discounts from catalog. List prices to service-men, dealers, amateurs and experimenters. Prompt service. Polymet, Pilot, Thordarson, Sangamo, Amertran.
Also replacement chokes 25-150 ma., power transformers for all tube combinations, including 250's, 281's, 484's. Net prices from 90c on chokes, $2.70 on transformers. Transmitting power transformers stocked. All types of filter condensers, etc. Try us—we have it.

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203 Ann St., Hartford, Conn.

Short Circuits

Who can forget the old-time stock-market price which was so high that edelweiss grew at the top?—Buffalo Courier-Express.

. ...

Standard Procedure for radio set manufacturers of great prominence:

1—Build up a large sales volume through jobbers.
2—Kick jobbers out.
3—Be horrified to find that the dealers go with the jobbers.
4—Step down while another manufacturer repeats the whole thing.

. ...

An honest man does not know how to protect himself from meddlesome government agents. The railroads must be honest.

. ...

Presumably Rudy Vallee has a court order requiring all other crooners to sing flat or sharp. At any rate they do —and in bad time to boot.

. ...

The birth rate is increasing in France. Presumably a way has been found to avoid paying the doctor—Hartford Courant.

. ...

Soviet Russia is finally getting around to the proof of the old rule that there is actually only one political principle—to get into office.

. ...

A bargain is any article which was so little worth its original price that it had to be offered for what it is worth.

. ...

Our compendium of useless information: Fred Harvey's electric plant at Grand Canyon, New Mexico, is run by Diesel engines.

. ...

By starting at the proper place along the Rio Grande one can get one-quarter of the way to any place in the United States before ever getting out of Texas.

"After reading several copies of Modern Radio I have been convinced of its value to me in amateur and radio engineering work."

James M. Sharp, W6FBU,
Stanford University, Calif.

. ...

"I am more than pleased with Modern Radio. After reading only half-way through Kruse's "antenna" article the way he handles the subject makes me want to give three cheers. Accept my best wishes."

Del Armstrong, W6ABH,
Oakland, Calif.

. ...

"I like Modern Radio first rate. I have only one kick to make, I did not get No. 3. I want it, if only to borrow and return it—promise—so I can take some notes from it."

Jack Provis, W7DD,
Idaho Falls, Idaho.

. ...

"Modern Radio looks good. Keep up the good work."

R. L. Kreise, W6AHG,
Alameda, Calif.

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New York City.

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VAPOR RECTIFIER TUBES

866 SPECIAL 90 DAY GUARANTEE $2.85

ODEON LO-RIPLE
Mercury Vapor Rectifier Tubes

Type	Filament Volts	Filament Amps.	Plate Inv. Peak Volts	Plate Amps.	Price
* 866 HEAVY DUTY	2.5	5	7500	.6	$ 4.50
** 81M	7.5	5	7500	.3	4.00
*** 866B	5	5	7500	1.2	7.00
872	5	10	7500	2.5	12.00
875	5	12.5	15000	2.5	25.00
869	5	20	20000	5.0	100.00

* THE HEAVY DUTY 866 is guaranteed to give the life of any two ordinary 866 tubes.

** This 81M Tube has a higher rating than any similar tube made.

*** The 866B is our own design as an intermediate between an 866 and an 872.

All Tubes guaranteed to reproduce low A. C. ripple.

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R. C. A. High Voltage Surge Proof Condensers

0.5 Mfd. Cap... $0.25
1.0 Mfd. Cap... .30
2.0 Mfd. Cap... .45
4.0 Mfd. Cap... .80

Utility Heavy Duty Power Transformer

85 Watts..... $2.25
Will handle 5 Heater Type Tubes.
One 280 and two 245 or two 247 Tubes.
Same in Metal Shell..... $3.00

New Loftin-White Direct Coupled Amplifier

Completely Wired Fully Guaranteed
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Model 247, (Pentode) $10.95

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Model 245—1-24, 1-80, 1-45.. $2.25
Model 247—1-24, 1-80, 1-247. $2.50

Rectifier Charger Bulbs

Six months guarantee.
.06 Amp..... $2.15
2. Amp., both contacts..... 2.15
5-6 Amp..... 3.85
15 Amp..... 6.85

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KEY
$10.50

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A separate unit for short-wave A. C. power supply. Power transformer has electrostatic shield between windings, R. F. Filter on Rectifier tube and special filter section, for humless operation. Separate 2.5 Volt Filament Supply. R. C. A. Licensed.

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