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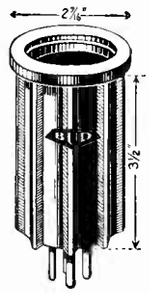

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THIRTEENTH YEAR

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Distortion Due to Filters

Unintentional Tuned Circuits Related to High Resistances

By Conrad L. Bradford

HE detector bypass condensers sometimes are selected on the added basis ding the elimination of oscillation in an ifier. The most usual condenser is the rom plate to ground, or, if the plate has -f and an a-f load, as in regenerative its, substantially across the audio load. w high this capacity should be will desomewhat on the nature of the load, o often the load is a high resistance a small capacity is desired. If the ity is large, then too much of the audio onent is bypassed.

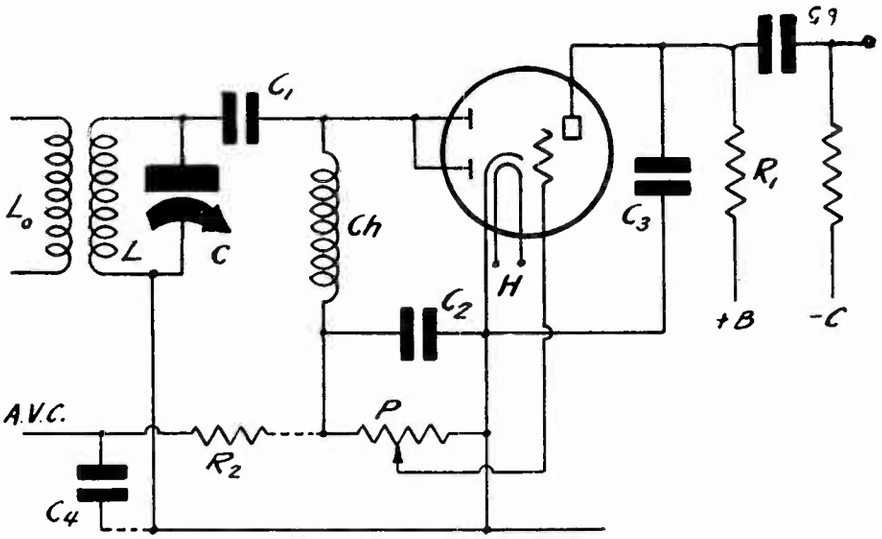
e may consider the combination of au- id radio as a radio-frequency wave, he low audio frequencies of modula- arer the zero axis of the wave, and h audio frequencies near the maximplitude of the wave. Then as a condenser is introduced to eliminate io frequencies, it may take out all of and, exceeding this intention, begin effective on the higher audio modula- requencies. Therefore attenuation of gher audio frequencies is not uncom- or this very reason.

20 Mmfd. Suggested

the resistance is a load of the order of 500,000 ohms, as it is quite often in a diode detector, being the rectifier load rather than the triode's "plate" load, the r-f bypass condenser, C2 in the diagram, should not be much more than 20 mmfd., but as this capacity is not readily obtainable commercially in fixed values, 50 mmfd. often is used as a compromise.

Resonance phenomenon is associated with these resistor-capacity circuits just as it is with r-f tuned circuits. Different values and combinations of values give different degrees of attenuation for particular frequencies or for different frequencies give different degrees, and thus when the curve is plotted of voltage against impedance, it is substantially the same as that of a tuned circuit resonance curve, using variable condenser and fixed inductance.

In the plate circuit the condenser may be higher, because the resistance is usually lower, seldom more than 250,000 ohms being used as load. The 55, for instance, may have as its plate circuit resistor R1 a value of 250,000 ohms, whereupon C3 may be 50 mmfd. without injury to the higher audio frequencies. But values of 0.0001 mfd., 0.00025 mfd., etc., are too high for either the diode-anode load circuit or the plate circuit, unless purposely introduced for their attenuating effects, to overcome high-audio-frequency accentuation such as sometimes accompanies pentode output tubes and saucer-sized speakers.



C2 and C3 should be of smaller capacity than usually met. This is because of their positions substantially across high resistances. If R2 is too high, in conjunction with a large capacity for C6, then a form of distortion may arise.

The Resistor as a Leak

Resistors that enter into the filter circuits used in conjunction with automatic volume control are commonly too large. Here another of the compromises necessary in radio must be introduced. It is possible that the signal may be so large as to exceed the sum bias on preceding amplifier tubes. Then grid current will flow. A high value of grid filter resistance would receive this grid current and produce a correspondingly high negative bias, overcoming the injurious effect. But a condenser has to be across this resistor, to remove the resistance's effect as an obstructor to the i.f. or r.f. Also, there are audio frequencies associated with the a-v-c circuit, for the rectified signal produces the a-v-c voltage. Therefore the condenser is made large enough to remove audio-frequency "feedback modulation." Now, when the high resistance functions as a leak, and the bypass condenser becomes in effect the grid condenser, we have the familiar situation of introducing grid blocking. This is a serious form of modulation, very distorting, and always overmodulates the tube, because

(*Continued on next page*)

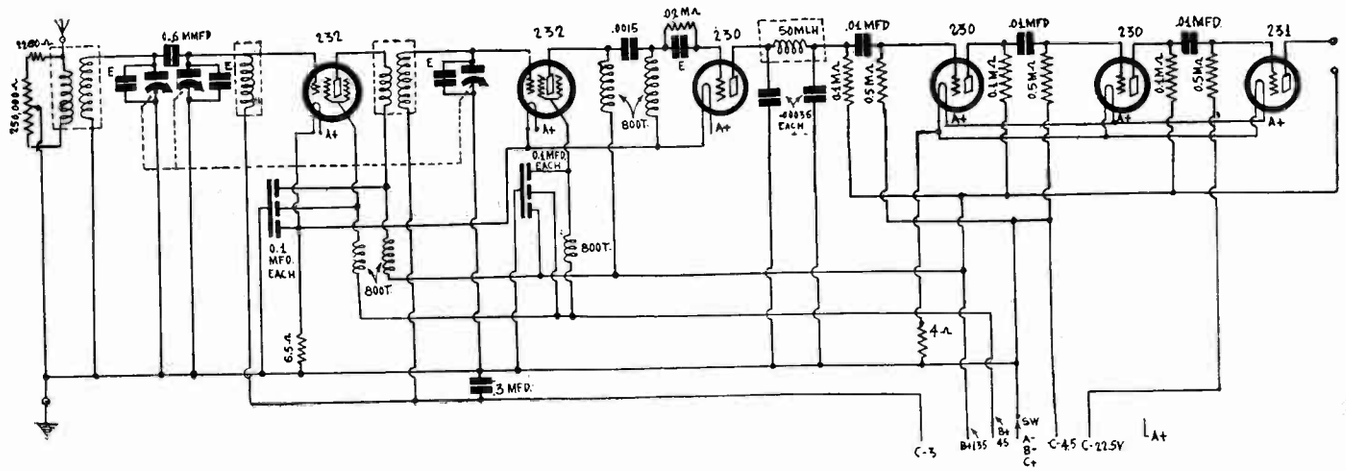
A Six-Tube Battery-Operated Set

By Thomas Wund

THIS six-tube battery-operated set has enough selectivity for ordinary purposes, and an abundance of sensitivity, built up very considerably at audio frequencies, for there are three stages of resistance coupled audio. This form of coupling is very economical on the B batteries, but no less than 135 volts should be used for the resistance-coupled stages, as the amount of practical gain depends considerably on the applied voltage, which might even be increased. The circuit uses a band-pass filter tuner and a tuned stage of r.f. following, hence a three-gang condenser would be used. The coupling betwen the second r-f stage and the detector is of the so-called untuned type, but really it is tuned, because the response is greater at the lower radio frequencies, to atone for the rising characteristic of t.r.f. Two r-f choke coils of around 800 to 1,000 turns, spaced apart about 1¼ inches, would give a good result.

The leak-condenser detector feeds into the audio channel.

If the two r-f tubes are 232, then 5.5 ohms may be their limiting resistor, but if the tubes are 34's, then the resistor should be a bit more than 8 ohms, provided A plus is 3 volts. The rest of the values are printed on the diagram as they should be used.



Sensitive battery-operated receiver, using a three-gang condenser. There are band-pass filter pre-selection and also peaked coupling to the detector for levelling the r-f amplification. The r-f tubes may be 232, when the filament limiting resistor would be as imprinted, but if the 34 tubes are to replace the 32's, then the limiting resistor should be a bit over 8 ohms.

Resistance-Capacity Selections to Avoid Distortion

(*Continued from preceding page*)

lower frequencies of oscillation are always stronger than radio-frequency values. And it is really oscillation, within the meaning of the word "oscillator," that it is generator, a non-rotating device for producing alternating current.

Hence the compromise, in view of the necessity for a large capacity (of the order of 0.05 mfd. up), is that the resistance should not be quite so high as commonly found. Values of 50,000 to 100,000 ohms would be suitable. Such, then, would be the range of R2.

When Motorboating Arises

The grid load resistor in the audio tube following the 55 should be large, and it is not unusual to have it larger than the load resistor on the diode. However, if grid current is produced, the larger the leak the greater the bias loss on the tube, therefore the circuit has to be designed so that even on a strong signal the audio tube under discussion would not draw grid current. Within this precaution, and the extra one that there should be no motorboating, the leak may be as large as one may readily obtain. A few megohms would suit the purpose.

If there is motorboating, that is a sign of audio feedback, or audio regeneration, and the frequency of most intense feedback is the frequency of the audibility of the motorboating. The word "motorboating" is unfortunate. It does describe the frequency most often met, that of a motorboat engine's explosions, a few a second, but depending on the audio circuit the frequency may be almost anything from a fraction of a cycle to tens of thousands of cycles per second. Hence a high-pitched squeal of continuous existence when the set is turned on may in reality be just a case of motorboating, and yet the frequency is very far removed from anything one might expect from the word "motorboating."

Using Less Resistance

It is always acceptable to lower the leak value to such as produces elimination of the motorboating. This remedy is sometimes attacked on the ground that too low an impedance is presented to the audio amplifier, low notes are attenuated, distortion is introduced, the time constant of stopping condenser and leak is too high, etc. All these objections overlook the effect of regeneration, and also ignore with simple insouciance the fact that no distortion is worse than motorboating, and even a measure of remedial application, if effective, is in the direction of the elimination of distortion. Ignoring the effect of obvious regeneration causes much advice that prevents service men and experimenters from introducing a simple and effective remedy for fear that something damaging to tone quality will be done.

Avoiding Saturation

P is a potentiometer, the load on the diode. This circuit, by the way, represents a tuned-radio-frequency set, with C1 a stopping condenser (0.0001 mfd. or less), and Ch a choke of 20 mlh or more, so the diode can be used. The circuit shows how a-v-c may be applied, assuming grids of controlled tubes returned to the left-hand horizontal extreme marked A. V. C., but in addition resistor-capacity filters would interrupt each grid return of a controlled tube. The values have been suggested, 50,000 to 100,000 ohms for the resistor, 0.05 mfd. for the condenser. It is not to be assumed, however, that a.v.c. is such a grand thing for t-r-f sets.

When P is turned so that small resistance is between grid and ground, the low frequencies are attenuated, hence in reality the 55 tube, and similar tubes with diode components, are best suited for a-v-c circuits, where there is not so much difference in the average audio amplitude that the arm of P has to be slid so near to ground.

The diode, by the way, biases the triode of the 55 (diode-biased-triode), hence an additional precaution is necessary, that is, to be careful to have the circuit such that the negative bias, compared to the plate voltage, is not so high as to saturate the tube (cut off the plate current). This is a very objectionable form of distortion. An easy remedy, and one preventing use of extremely low value of load resistance for the grid circuit, is to connect the right-hand side of P to a fixed resistor, the other side of this fixed resistor going to grounded cathode. A value of 50,000 ohms is suggested.

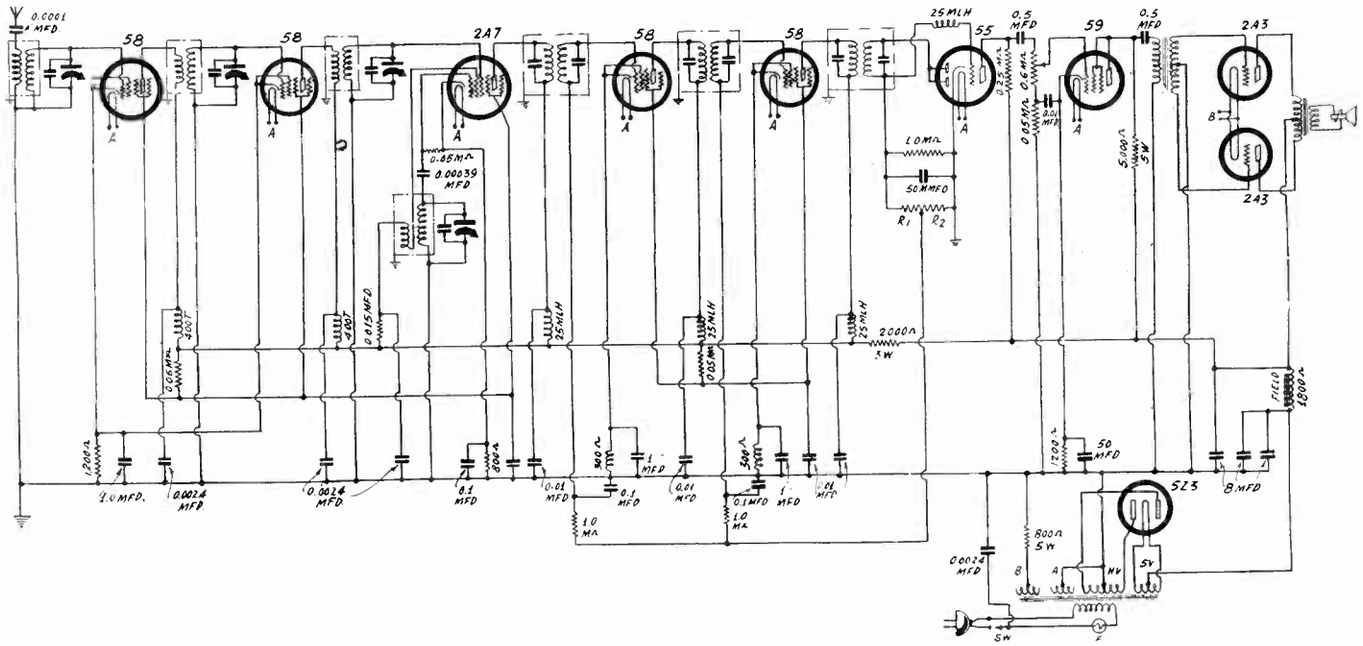
Doubling Up

Another point that might be mentioned in connection with P under any circumstances is that C2, previously recommended to be smaller than usually met, is only across the total resistance, hence acts in desired fashion for the diode load resistance. But as any selected part or total of P is also the load resistance of the grid circuit of the 55 triode, if it is desired to keep r.f. out of the triode to simplify oscillation stoppage in the i-f or r-f amplifier ahead, there would be small contribution in this direction unless the arm were at left (maximum input) or at right (no input). So it would be practical to halve the recommended capacity, and put one of each this value between arm and "hot" side of P and the other between arm and grounded cathode side of P.

The Avoidance of Saturation

Adjustment of Superheterodynes for Undistorted Reception

By Lee Marker



There is likely to be too much amplification in a circuit like this, and the triode of the 55 may choke up, particularly if a long antenna is used. If automatic volume control is too effective, strong signals will be too greatly diminished in volume. Remedies for these conditions are discussed in the text.

A POWERFUL superheterodyne develops enormous amplification, sometimes more than the circuit is able to take care of, therefore on strong signals there may be severe distortion. This arises from driving the tubes beyond their normal operating limits, reducing the plate current to practically zero, or, if the tubes work the other way, running up the plate current dangerously, due to grid current.

The tube may work either way. A normal amplifier tube has a negative bias of self-biased type. But the signal, when introduced, bucks the bias, and if large enough, of course exceeds the negative bias and causes the operation of grids at a positive bias. This increases the plate current. The common cathode-biased method produces this result. The modulation is said to be upward, meaning that increase in signal amplitude increases the plate current.

The grid-leak-condenser detector works in the opposite direction, as does the diode-biased triode. That is, increased signal amplitude increases the negative bias, hence decreases the plate current. The modulation is said to be downward. It must not be assumed that either way is superior to the other as a safeguard against saturation of the current-capabilities of the tube in either direction. A tube may be said to be saturated when it yields practically nothing, or introduces large distortion. Thus saturation would exist when all the electrons from the cathode are bombarding the plate, or when the bombardment is practically cut off. The saturation condition spells one extreme or the other, or operation close to the extreme.

A 10-tube circuit like the one diagramed easily might develop so much amplification as to cause the saturation condition; also it is possible that if automatic volume control is introduced too strongly that the sensitivity would be less than desired on strongest signals, an opposite condition, yet just as likely to be encountered.

Neglecting the tuner itself—the radio-frequency amplifier and local oscillator—even though some remedies conceivably might be focussed there, we may look to the intermediate amplifier for sustaining sufficient amplification, enough but not too much.

To avoid an overdose of a.v.c it is practical to take off less than the full rectified signal voltage for a.v.c. action, by using two resistors instead of one, and making the a.v.c. connection to the tap. That is, the grid returns of the controlled tubes, interrupted by resistor-capacity filters, are led to the tap, so that the augmentation of the negative bias derived from the cathode resistors of the controlled tubes is limited. The proportion may be made whatever one finds necessary. For instance, to use half the rectified voltage for a.v.c. the two resistors, R1 and R2, would be equal. The larger R1 is compared to R2 the less the a.v.c. action.

This problem of sustaining sufficient sensitivity is one easy to solve.

When the amplification is too great the problem is, in a sense, the same as before, because the set loses sensitivity on loudest signals, the triode of the 55 choking up, as it were. On weak signals there is no trouble, only excellent enjoyment of the fine sensitivity, but some sacrifice or allowance has to be made to give the strong signals their right-of-way in the circuit.

The 55 triode is diode-biased, meaning that the diode load resistor is also the grid resistor for the triode, or the input load. If any trouble is encountered on strong signals, whereby the receiver seems to choke up, a sign of saturation, the remedy would be to have the load resistor a potentiometer, with grid of the triode connected to the arm. Thus, if the arm were at position of extreme sensitivity, there still could be choking, but a turn of the control would eliminate it, and the great sensitivity to weak signals would be preserved.

But if it is desired not to make choking possible at all, though the remedy be at hand on the front panel, then the load resistor marked 1.0 meg, in the common diode-triode circuit of the 55, also may be constituted of two separate units, the grid tied to the tap. The same proportionality applies as before.

Hams Flock to 5 Meters

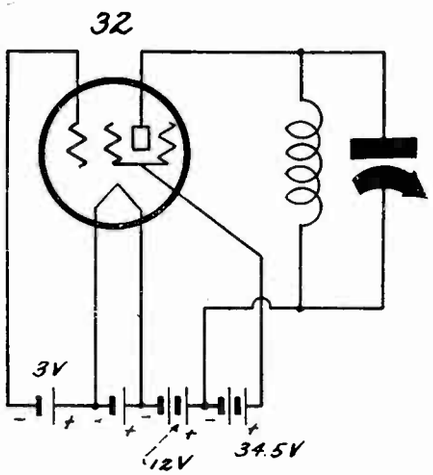
Amateurs are greatly delighted with five-meter work. There has been, and still is, a large demand for transceivers in this field. Few of the amateurs, as a rule, desire to build their own receivers. It is the transmitter that they do like to build. But when the device is a small combination receiver and transmitter and a commercial product it seems to be acceptable not to do any too much building, if one can raise the money with which to buy the device, and prices are low.

The distances covered at these short waves is small indeed, but the hams have the time of their lives in "neighborhood" conversations. The two-way communications over eight or ten miles usually are O.K. with the hams, although from elevations greater distances are attainable.

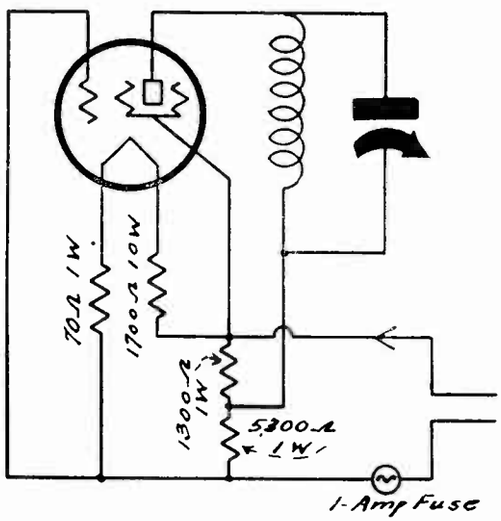
The Dynatron Oscillator

Simplest Circuit Applied to 22, 32, 24 and 24A Tubes

By Wendell Cummings



The 32 tube used as dynatron oscillator.



The circuit for "universal" use.

THE simplest means of generating alternating current is by use of the dynatron. The dynatron may be used as local oscillator in a superheterodyne, also as signal generator, which is about the same thing, except that modulation is present, and the device is used directly for measurements.

The use of the dynatron principle is limited to certain screen grid tubes, those not having suppressor elements. Therefore the 22, the 32, the 24 and the 24A are suitable. The potentials are arranged so that the screen voltage is critically higher than the plate voltage. Roughly, the screen voltage should be a little more than twice the plate voltage.

Negative Resistance

When a tube is used this way, oscillation results from secondary emission. This consists of the passage of electrons from the plate to the screen, after the electrons have struck the plate in their course from the cathode. In the 32 and 22 tubes the filament is the cathode or electron emitter. In the 24 and 24A the cathode is the indirectly-heated extra element.

Measurement will confirm the fact that as the voltage is increased in the plate circuit over a narrow limit (until oscillation stops) that the current through the plate circuit decreases. The same is true of the screen circuit. We are familiar with the fact that as voltage is increased, current increases. That is the general rule. The condition is described as positive resistance. When the opposite is true the condition naturally is described as negative resistance. Therefore negative resistance may be defined as that condition of a circuit which is present when increase of potential decreases the current, or when decrease of potential increases the current.

The Circuit Voltages

Negative resistance long has been familiarly associated with oscillation. We are told that a tube oscillates when the radio-frequency resistance is negative. Commonly we find a feedback winding, so connected that the phase reversal in the tube itself is overcome, meaning that the tickler is connected backward so that the oscillation will go forward. Only the oscillation current is concerned.

However, if a tuned circuit is put in the plate used as the plate load, and the voltages of the identified tubes are such that the resistance is negative, a tube capable of dynatron performance will oscillate at frequencies approximately determined by the natural frequency of the tuned circuit. That is, besides the negative resistance set-up there must be a tuned circuit. It might even consist of a resistor and a condenser for an audio-frequency oscillator, but we are at the moment confining ourselves to radio-frequency or intermediate-frequency oscillators.

The circuit and the voltages for the 32 as a battery-operated tube are shown at left in the illustration. The grid is not accounted for in any particular way because it does not directly enter into the performance.

Dynatron Is Unstable

If there were no grid, the tube would oscillate just the same. This much may be inferred from the fact that the grid is practically shorted. It is shorted to oscillation frequencies, and has only a biasing voltage. Even this is not needed but is included to limit the plate current a bit. If this bias is increased too much there will be no oscillation, due to the limitation of secondary emission, or its practical prevention, by the reduction effect of the bias on total current.

Now, the dynatron as such is unstable. Practically all scientists who have made a special study of oscillators have commented on this. Yet the dynatron has been advanced by others as something possessing a high degree of stability. Particularly does this idea prevail in amateur circles. But there is really nothing to it. The dynatron, when set for a particular frequency, generates one frequency now, a little later another frequency, etc., the change being small but fairly rapid and within audio-frequency limits.

Suppose that the intended frequency of generation is 100 kc. Then if the change is within the audio limits it will be 10 kc. This is a stability, if such it may be called, of 10 per cent. Actually, the dynatron is better than that, but around 3 or 4 per cent. would be an average rating.

Instability Called Stability

The argument is sometimes advanced in favor of the dynatron that it is stable because if the battery voltages are held constant, the surrounding temperature is constant, and the load constant, that the frequency will be constant.

This is a complete definition of instability, although given backwards. A stable oscillator is one generating only a particular frequency when set to generate one frequency, despite changes in terminal voltages and load conditions.

Any tube is stable as an oscillator when the causes of instability are removed. How to keep battery voltages always the same is indeed a problem. It is a harder problem to solve than to make the tube operation relatively constant regardless of those changes. For instance, the B battery has resistance, the current drawn changes, hence the obtainable B voltage changes. The load itself changes, hence the current changes, hence the B voltage changes.

It may be said that the battery voltage in a strict sense does not change, being the result of a chemical action remarkably constant in nature, but that the drop in the resistance of the battery does change, hence the voltage obtainable from the battery circuit changes. This is a small point. What we get differs and what we get counts.

Stabilization of Dynatron

The fact that the dynatron is unstable does not preclude its use. In systems where

the accuracy is not expected to be more than 3 or 4 per cent., of course instability of the same order is tolerable. But the dynatron, like any other tube, can be stabilized. A method has been shown recently where a dynatron is worked in conjunction with a diode rectifier, the rectified current acting upon a load resistance in the grid circuit of the dynatron, hence the bias changes with amplitude of oscillation. This device stabilized the dynatron wonderfully.

The method might even be applied to the circuit herewith. Since it is desired to put some oscillation voltage on the diode of a tube for rectification, the grid-to-filament circuit of the 32 may be treated as the diode that it really is, with grid the anode and filament the cathode. Thus connecting a fixed condenser from plate to grid would supply oscillation voltage to the anode, and a leak from grid to ground would serve as the load resistor or leak. No biasing battery would be necessary. None is, anyway. The method is suggested, but has not been tried in this way.

The simplicity of the dynatron is quite attractive. First, the batteries may be of low voltage, provided the proportion of B voltages is correct. The method may be tried experimentally to ascertain the right voltages. The diagram suggests 46.5 volts, but oscillation may be present when the maximum B voltage is less than that. Even the filament voltage may be 1.5 volts, using a single cell, instead of 3 or more volts with a limiting filament resistor.

A "Universal" Type

The circuit at right is applicable to a. c. and d. c. use. The a. c. may be of any commercial frequency. When a. c. is used thus, of course, there is hum modulation. In the other use of this diagram and for the one at left for batteries, no modulation is introduced.

Negative bias has been included in the "universal" model just to show how it is done. The line voltage is applied to the series chain consisting of the filament of the tube (normal resistance 33 ohms), a 70-ohm resistor and a 1,700-ohm resistor, the last-named 10 watts. The smaller resistor is put in the negative leg, the other in the positive leg. The a. c. is positive during one alternation, or half a cycle, and only during this period does the tube oscillate. During the other alternation the plate and screen are negative in respect to cathode and no current flows.

Hence the condition of a. c. on the plate may be said to constitute the tube a half-wave device. Here it is a half-wave oscillator. During that alternation when the plate and screen are positive in respect to cathode, negative filament is positive in respect to grid return, hence we have the peculiar condition of a. c. developing a negative bias on the tube. Ordinarily a. c. would have no biasing effect, because the average voltage difference is zero, in respect to the axis. With the half-wave condition the average is finite, the root-mean-square value of the alternation voltage.

Other Resistance Values

To apportion the B voltage during the effective alternation two unequal resistors are used. Note that the screen is returned to that side of the line which is positive during tube action. The plate is returned to a point lower down on the voltage scale. This gives the plate the necessary lower B voltage, or, if the values do not turn out just right for the tube you use, the lower resistance may be increased or decreased. The bleeder current through the values stated will be about 150 milliamperes. Higher resistances would result in lower bleeder, resistance proportioned maintained. It should not be necessary to include bypass condensers.

Having constructed a dynatron, it is easy to ascertain whether the circuit is stable or unstable, or, rather, confirm its instability. If the frequency generated is in the broadcast band, beat with a t-r-f receiver bringing in that frequency. A few turns of wire around the tube will act as sufficient coupler, extreme end wrapped around the aerial used on the set. Let the beat be finite. Note its pitch. Listen to the note change its pitch. That denotes instability. If zero beat is attempted, note that the beat becomes audible and rises and falls in pitch some 500 cycles. This also shows instability.

If the frequency generated is lower than a broadcast frequency, use an harmonic of the dynatron to beat with the station. Or, if high frequencies are concerned, pick up a high-frequency station that has transmitter frequency crystal-controlled, and repeat the former test.

Other Tubes

It may be that oscillation will be absent, but the remedy of voltage adjustment has been cited. Just what the voltages should be cannot be precisely told in advance, because they depend to an extent on the amount of gas in the tube. However, the proportion as read from curves is given in voltages as 67.5 and 31 volts for screen and plate respectively, for the 24 tube.

There are other tubes that have this inherent d-c negative-resistance characteristic. One of them is the neon tube. This has been used in test oscillators to supply modulation, that is, an audio frequency introduced into the separate radio-frequency oscillator, so that the result of introduction of the r-f oscillation frequency for measurement purposes can be heard. The method is to connect one terminal of the neon tube to the source of voltage (which should be d. c.), put a series resistor between the other end of the tube and the other line terminal, and put a condenser across either the tube or across the limiting resistor, but not across both. Then the circuit will oscillate, or generate audio frequencies, provided the time constant is suitable for audio. For instance, 2 meg. may constitute the limiting resistor, and across it may be put any capacity from 0.0001 mfd. to 0.001 mfd., and for slower period of oscillation, higher resistance or higher capacity may be used. The figures just given apply to acceptable tones for modulation.

If the condenser is put across the lamp the amplitude will be smaller and the frequency just a trifle lower, which assumes the average lamp resistance is a trifle less than that of the limiting resistor. If the limiting resistor is made much higher, transferring the condenser from across the resistor to across the lamp might increase the frequency.

The most striking fact about the condenser location is that the strength of the signal is many times greater when the resistor has the condenser across it, for then of course the condenser does not act as a bypass across the lamp.

The 885, 83 and 82

The negative resistance characteristic is present also in the 885, a special tube for use in conjunction with cathode-ray oscillograph purposes for faithful production of the sweep voltage, and in the 82 and the 83 rectifiers. The surrounding circuits of the 82 and 83 therefore should be such as to avoid creating oscillation where none is wanted, that is, when the tubes are used as rectifiers.

The negative resistance characteristic applicable to the dynatron as found in the screen grid tubes applies to frequencies up to quite high ones, say, 30 mgc, but the neon tube has not yet been made to oscillate at frequencies much above 100 kc in any reproducible circuit, for as the frequency is increased the amplitude or strength decreases. When the tube, once oscillating, stops oscillating, the illumination moves to another position and dims a bit. Thus the tube some day will be applied perhaps to phase-shift measurements.

The voltage applied must be sufficient to make the neon tube strike. Around 70 volts are minimum. The size or wattage of the tube is of no importance. The tiniest neon tubes made are occasionally used as modulators in signal generators.

Usually the voltage would be 90 volts if batteries are used, 110 volts if the d. c. line is the supply. On a. c. supply the neon tube may not act as generator.

GRID CIRCUIT IMPEDANCE SHRINKS AT HIGH FREQUENCIES

Always there are problems ahead for tube engineers. Sometimes these engineers produce a tube in advance of the actual demand for it, but knowing that its uses will be important and manifold. Just now there is at least a technical requirement for tubes that do better work at the higher frequencies of all-wave coverage. Not the ultra frequencies are in mind now, but only those frequencies running up to 20 megacycles.

Losses Start at 10 Mgc

The losses start in fairly severely at 10 megacycles in the systems and tubes now used, and various devices are used in an attempt to make up for these losses. So extra t-r-f stage or stages may be included for these higher-frequency bands. This at least is a recognition of a condition, though not the complete or simplest solution of the problem. The introduction of more coil systems, with extra cramping, is not the best solution. The production of circuits and tubes that do not suffer these high-frequency losses would be more important.

For instance, take a screen grid tube. The grid circuit impedance may be of the order of megohms for low frequencies and if the frequency is low enough, the grid circuit resistance may be high enough to be treated as infinite. At least that phrase is encountered with the grid circuit is tuned.

The Shrunken Impedance

What a long road it is from the actual impedance in the grid circuit at 20 mgc compared to infinite impedance may be gleaned from the fact that, due to a combination of conditions, including coil, socket, tube, base, etc., the grid impedance is around 200,000 ohms. This is considerably less than the plate impedance. This condition even changes the nature of the circuit. When a tube is treated as an oscillator, this shift of impedance relationships even changes the nature of the oscillator. For high frequencies therefore the tuning seems better adapted to the plate circuit.

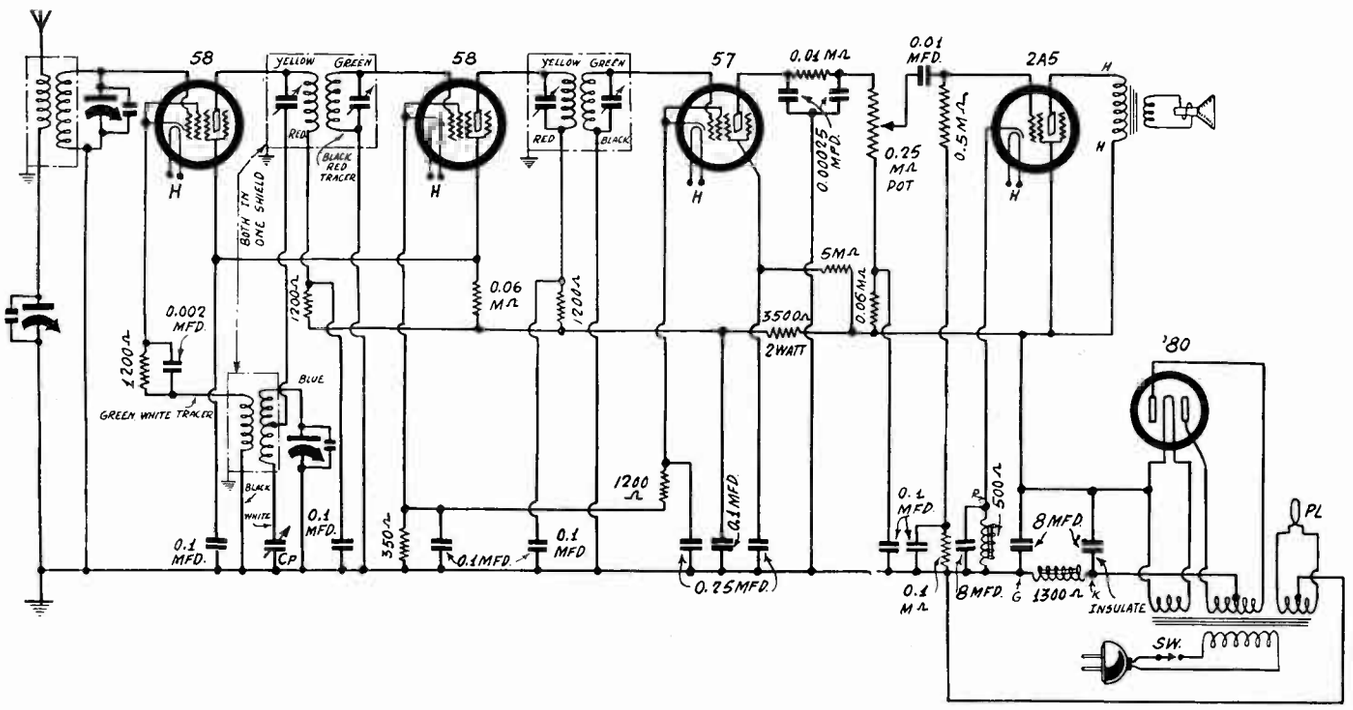
6 AMPERE CHARGER TUBE

National Union Radio Corporation of New York announced a new 6 ampere rectifying tube for use in multiple battery chargers. Used extensively in the automotive and radio fields as a rectifier for multiple battery charging, the tube is commonly referred to as a Tungar.

Hum in Negativ

Capacity Between H-V Secondary and Groun

By Luke



The choke marked 1,300 ohms, to lower left of the 80 rectifier, is in the negative leg. The 2A5 bias is obtained from a 500-ohm tap on the same winding.

LOCATION of the B supply choke in the negative leg of the rectifier has become exceedingly popular during the past few years. Especially is the device used where part of the d-c drop in this choke is used for biasing the power tube or tubes. It is an easy way of obtaining semi-fixed bias, which increases the power output and also improves tone. Semi-fixed bias may be described as that type which arises from flow of all the B current in the set through the biasing device.

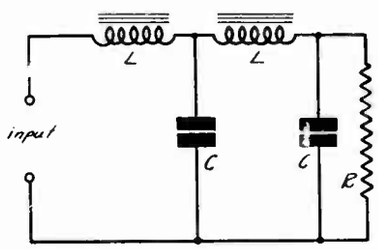
There are two possible objections to the negative-leg method. One is that if the bias for the power tubes has to be much more than 20 volts, as 60 volts on 2A3's, the total drop will not be sufficiently large compared to the drop used for biasing, hence there will be hum, unless very special precautions are taken. Moreover, any capacity between the secondary of the power transformer and ground will serve as a suitable impedance for the development of hum that the filter cannot remove, because the filter condenser impedances are low in comparison.

Body Capacity

The remedy for the high-bias method, where negative-leg choke is introduced (and it is commonly the speaker field), is to institute capacity-resistor filter proceedings. Interrupt the grid return with a large resistor (0.1 meg. up) bypassed to ground by a very large capacity (8.0 mfd. up). This will help a great deal.

For the hum condition that the capacity of the secondary introduces, one remedy would be to ground positive of the rectifier, but this is not so choice a selection in a sensitive receiver, as the grid returns, hence usually the chassis, are lifted to a semi-hot radio-frequency potential, and there might be a small modulating effect, like a click, due to body capacity, when one touches the chassis, or escutcheon, as in tuning, especially if the finger is moist. And in short-wave or all-wave sets this body capacity condition may be accentuated, even without the click. The detuning effect would show up.

Of course, the choke might be transferred to the positive leg, which would be a complete solution were no biasing tied in with it. The first diagram shows a receiver with choke in the negative leg, identified as such because instead of B minus, the center tap of the high-voltage secondary, being directly grounded, the current is led through the choke, the other end of which choke is grounded.



Choke input may be used by this change from the preceding diagram, requiring a separate biasing resistor for the 2A5.

Choke Input

However, in the diagram self-biasing is used, for not all the B current, but only the current of the power tube, flows through the choke section for biasing. Yet the method is consistent with negative-leg position for the B choke proper, though if the B choke were lifted to the positive side, the biasing section of the choke could not remain where it is, for there then would be a short circuit. A fixed resistor would have to be found for biasing, 500 ohms to 400 ohms, and the total choke used in the positive leg. Only two condensers would remain in the filter, the ends of the choke being the positions for them, for when the total choke is tapped, all the winding on one core, inclusion of a capacity across the midsection does not seem to help any, and sometimes actually increases the hum.

Or, an arrangement may be used which is suggested by the small second diagram, where the L at left is the smaller part of the choke and the L at right the larger. This constitutes choke input, and improves the regulation considerably, though lowering the voltage. C and C are the capacities. The chokes are assumed in the positive leg.

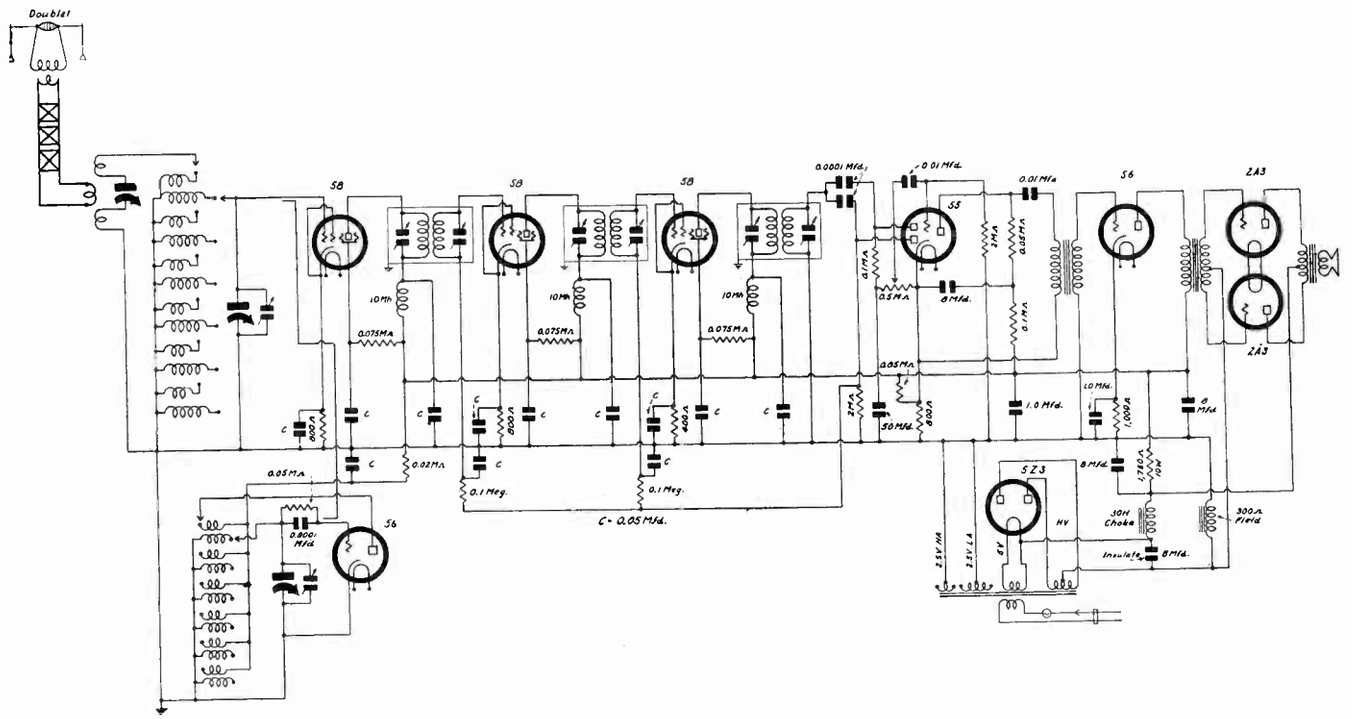
Splitting Up Two Chokes

If there are separate chokes, the capacity effect referred to may be overcome by putting one choke in the positive leg, the other in the negative leg, the only reason for the

ve-Leg Chokes

id Picks It Up—Remedies for Filter Systems

C. Cross



This all-wave circuit, with provision for doublet antenna, illustrates a remedy for hum conditions due to choke in the negative leg only, by distribution in negative and positive legs of two chokes. By the negative leg method for a 300-ohm field the bias on the 2A3 power tubes is obtained.

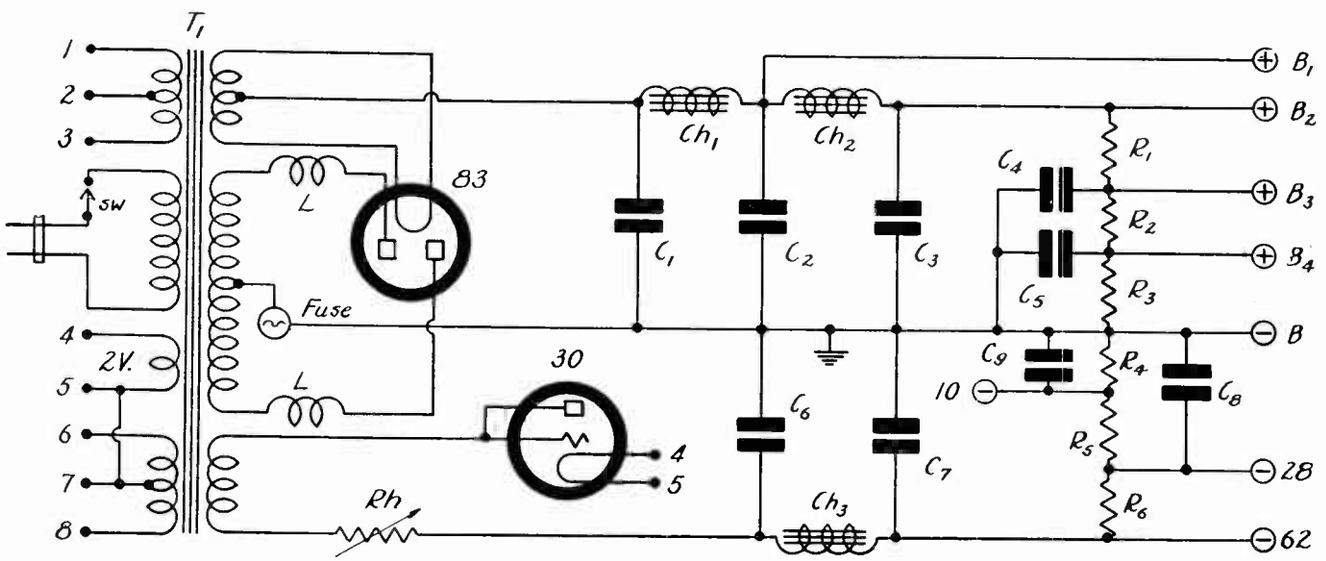
partition being that the negative-leg choke is assumed to carry the biasing adjunct. Otherwise the positive leg would be acceptable.

Using the total current for biasing the last tubes or tube is favorable to tone because the impedance is lower, the negative feedback is less, and indeed due to circuit conditions the feedback may be slightly positive, which is swell for an audio system, and makes for splendid tone. However, omitting the drawback that the resistor would have to be of high wattage and resistance, a wire-wound resistor could be put in the negative leg, the choke in the positive leg. Then this biasing method applies.

Improving Regulation

A fact not to be ignored is that biasing

(*Continued on next page*)



There is much to commend the inclusion of a separate C supply rectifier. The B rectifier choke is in the positive leg, the C choke in the negative leg.

(*Continued from preceding page*)

when derived from the total current in this series manner necessitates a high d-c resistance of the choke or speaker field. Therefore, the impedance will be rather low. Moreover, the regulation will not be good. It is not possible to have a very high d-c resistance through which is passed changing value of current and still have excellent regulation, unless a special regulator tube is used, or some other such device. All the current systems for well-regulated B supplies, including those possessing the special rectifier tubes, the mercury-vapor 83 and 82, have low d-c resistance chokes.

A way out is to provide a rather large bleeder and obtain the bias from the bleeder network. Thus at a voltage suitably above ground the cathode of the biased tubes would be connected, B minus to the low end of the resistor, usually grounded.

For this method to be used, as the hum is larger the larger the current, the filtration has to be increased to overcome the condition, and still have no more hum than, say, 5 per cent.

Separate C Supply

Another method, in the direction of keeping down the hum, and also improving the tone, is to use a separate C supply. In commercial receivers such a device is almost never found, and in kit-sets likewise, although no doubt in years to come many receivers will be equipped with a separate rectifier type C supply.

The third diagram shows a double rectifier. The 83 is the B supply rectifier. A 30 tube is the C supply rectifier. A small pilot lamp, such as used on dial in radio sets, may be used as the fuse, and two such lamps used, one each in series with the B return of push-pull output tubes. The reason for protection, indeed double protection, is that if the C supply tube gives out, the output tubes work at high B voltage and no bias, and these tubes themselves may burn out, and the rectifier as well, but the pilot-lamp fusing protects them. The fuse in the negative leg may be a 1 ampere fuse, if desired, to keep the resistance of this element low.

The rectifier tube for C supply has a 2-volt a-c filament excitation, with a separate small choke, any small one, even the secondary of an audio transformer, for Ch3. The associated condensers C6 and C7 need not be more than 1 mfd., since the current is very small indeed. The actual biasing does not put any current demand on this small rectifier. The 2-volt winding (4 and 5) is connected in the power tube circuit by joining one side of this winding to the center tap of the power tube supply (7 of the winding 6, 8).

Chokes on Separate Cores

In the C supply rectifier the choke and whole filter system are in the negative leg, but there will be no hum trouble in this instance, due to the extremely low capacity of the secondary to ground. The rheostat Rh, some 100,000 ohms, may be used to adjust the biasing voltage.

In the B supply the choke is in the positive leg. In fact, there are two chokes. Although not specifically shown in the diagram, Ch1 and Ch2 are assumed to be on separate cores. Also note that B plus for the power tubes is taken from the joint, so that the filtration for the tuner and preliminary audio amplifier will be better, due to less current through Ch2.

Two of Staff Elected National Union Officers

S. W. Muldowny, chairman of the board of National Union Radio Corporation, announced that H. A. Hutchins, general sales manager, was made vice-president, as was George Ernst, general superintendent of factory operations. Dr. Ralph E. Myers was made first vice-president. Dr. Myers was vice-president in charge of manufacturing and engineering. H. R. Peters is president.

Station-Finders Use Low Fundamentals for Accuracy with Ease

The reason why station-finders are becoming popular is that they usually are tuned to low fundamental frequencies and the harmonics of these frequencies may be used for measurement. This is particularly handy if the receiver itself is frequency-calibrated. The question may arise: If the receiver is frequency-calibrated, what need does the station-finder fill? Well, the frequency-calibrated set will not be very accurate in its readings compared to actually-responsive frequencies, due to the variation factors costing much money to eliminate. Such elimination is not found in commercial receivers, as it involves too careful a treatment for production sets.

However, a station-finder may be constructed that operates on a low frequency range where it is easier to establish a high percentage of accuracy. A percentage of 1 would not be hard. Yet for fundamentals of high frequencies 1 per cent. would be going some, especially around 20 megacycles.

So if the low-frequency generator, as the station-finder is likely to be, will be accurate to 1 per cent., the same percentage accuracy is maintained in all the harmonics. Of course the absolute frequency difference increases with the increase in frequency to be measured, but the percentage is the thing that counts. The difficulties of maintaining the low-frequency percentage in the high-frequency fundamental field are very great, and the harmonic method therefore is a superior substitute.

However, some method must be used that identifies the harmonics, otherwise even with a frequency-calibrated set, some confusion would be introduced. There are at least five methods. All of them are mathematical and yet rather simple. They may be reduced to a scale calibration that affords just the service desired, without the user performing any mathematics.

Five-Stage, High-Gain Audio Amplifier

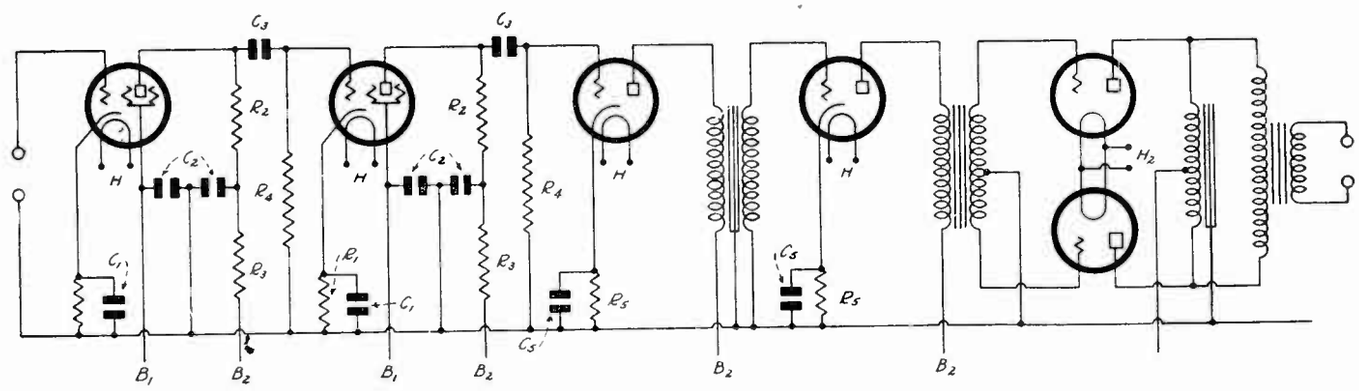
By Lester W. Woods

Sometimes tremendous audio-frequency amplification is desired. Perhaps a crystal microphone is being used, and large output is wanted. Here is a circuit that shows how to connect up a six-tube audio amplifier, where B1 represents 100 volts, B2 represents 200 volts and the voltage on the output (from cathode to B plus) is 300 volts or more.

The circuit is that of a five-stage amplifier, of which two stages are resistance-coupled and three are transformer-coupled. It is necessary that the transformers be put at suitable angles, to minimize back coupling, and that these coils be magnetically shielded to a close degree.

Values suggested are: R1, for the biasing resistors of both screen grid tubes, 5,000 ohms; R2, 250,000 ohms; R3, 100,000 ohms; R4, 2.0 meg.; R5, 1,000 ohms; C1, 2.0 mfd.; C2, 2.0 mfd.; C3, highest capacity obtainable in mica-dielectric condenser, not less than 0.01 mfd.; C3, 2.0 mfd.; C5, 2.0 mfd. The bypass capacities always may be made as large as practical, despite the definitely ascribed values, which are minima. If motorboating is present, reduce the value of the grid resistor R4.

It is intended a dynamic speaker be connected to output.



Circuit for a high-gain audio amplifier, for any use requiring extreme sensitivity, such as use of a crystal microphone, or construction of an amplifier for reproducing heat beats on the speaker, from carbon microphone pickup, or stetoscope pickup

Photo Cells for All Needs

Lazy or Bustling Purposes Served Impartially by "Electric Eye"

By N. L. C. Vingie

THE photo-electric cell is a device sensitive to light. The resistance of the cell changes with the quantity of light received. Therefore the current through the cell changes according to the amount of light. The more light, the more current. In this way it is clear that the photo-cell receives light and responds in different amount of currents. The light may be considered as alternating current. But the current through the lamp is direct current. Therefore the photo-cell is a rectifier of light.

Cells of different manufacture, and composed of different elements, behave differently. Some have a wider frequency range than others. Some have a purposely narrow frequency range but high sensitivity. Others have very low sensitivity. The cell therefore has to be selected for the purpose intended. Most of the uses for photo-cells in experimental work have to do with the light obtainable from electric bulbs. No wide frequency range is required, as the color or frequency of the light is about the same.

Sorting

Cells may be made so that they are not only narrow in response as to frequencies, but different cells are narrow in different parts of the spectrum. Therefore if light is cast upon an object and reflected into the cell, if the object is of the particular color to which the cell is sensitive the cell may be made to actuate some device which picks that particular object out of a line. This is color selection by photo-cell actuation. The method is used for close sorting of colors in various manufacturing processes.

The photo-cell has numerous applications to police work, although only a few are in actual practice. Somebody ought to make it his profitable business to co-operate with police departments to show them how electrical devices may be used for catching criminals, if not for crime prevention. Great deductive powers and strong doggedness are all right, but the electrical equipment would be just as dependable.

Suppose a woman was under suspicion of having committed a crime. Suppose some one was watching her home, and she was seen to leave. Suppose this some one had the authority to search her home, and wanted a warning of her return. Suppose she wore a red dress and photo cells for different colors were available to the detective. The photo-cell at the front door could be made to actuate a relay that would sound a warning to the detective.

That Garage Door

Suppose it were necessary in police work to know whether a certain man 6 feet 2 inches tall visited a certain apartment, and when. A photo-cell, which would be actuated by the interruption of a beam of invisible light, could be made to trip a time recorder. How? By placing the device near the door of the apartment, with beam so high that only a man 6 feet 2 inches tall, or thereabout, would interrupt the beam.

A row of cells, one atop the other, hidden in some unsuspected device like a coathanger, could be used for determining the height of any one who passed, also the time time when he did so, as one beam would be concentrated on each cell, and the height of the suspect would be determined by the highest beam that tripped the recording device.

But there are uses for photo-cells much nearer home. One of the favorite ones is to open a garage door. This is done by using the light from the automobile headlights. On a rainy night (and on a starlit night, too) a fellow does not feel like getting out of the car to roll back the doors or to pull them away from the hasps and bolts. If he feels this inconvenience keenly, he may motor-equip a sliding door, so that when he drives up the driveway with headlights full on, the light from his headlamps will actuate the cell, which will cause enough current to flow to operate a relay, which will turn on a switch to start the motor and unlatch the door and pull it back. The impact of the closing door could close another switch and thus complete the short operation while my lord drives into the garage.

Of course not any old door will do, but it has to be one that will respond to the motor. Therefore a sliding door is suggested. Also there should be juice in the garage, to run the small motor. If there is no such juice it is possible to carry it over from the house by a permanent or temporary electrical connection and outlet, which is a job for a licensed electrician. Or a motor generator could be used.

A possible objection would be that anybody could drive up to the garage and get in that way, thus, in effect, leaving the garage open all the time. Another objection would be that it would be just a night-time service, otherwise the sunlight would insure the door being open.

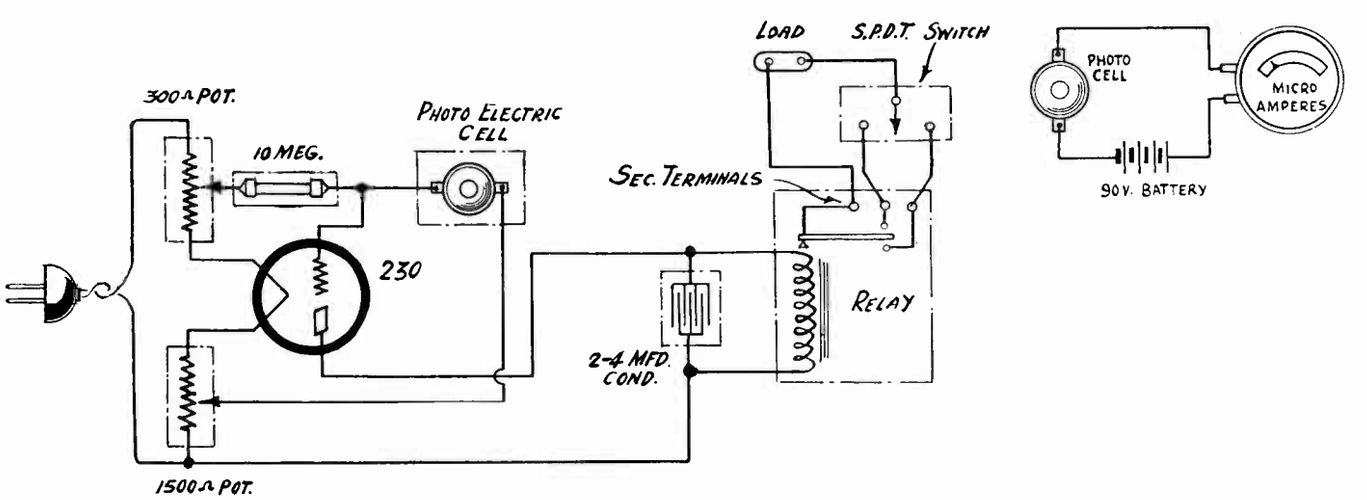
But it is not necessary to use a standard projection for the illumination. Since the cell may be of the color-sensitive type, the light from the automobile may be matched. A bright sidelight such as used before headlights were as bright as they are, would do, only this time the matched color pane would be use, and the door would open only in response to that color, like a faithful dog answering only to his master's call.

The Telephone Case

When one leaves the house and a telephone call is intended for the absentee, there being nobody else home, the caller gets a "no-answer" signal. But with a photo-cell device he might do better. The resident, when leaving the house, might turn a switch to put the photo-cell in operation. Then when a call comes in a light may shine, and operate a relay connected with the cell, thus to lift the receiver off the hook.

Now the caller might leave a short or long message, but the photo-cell could not take proper care of it, unless the variations in voice currents were made effective on something. This could be done by having the speaker's voice modulate the light that the telephone call had made to shine, and thus the current through the photo-cell would change according to the voice pattern,

(*Continued on next page*)



A photo-electric cell working into a 30 amplifier tube, which is powered from the a-c or d-c line. The output of the 30 feeds a winding the current through which throws the relay, to control whatever operation is desired when a switch is to be opened or closed. The circuit for calibrating the photo-cell is shown upper right.

(*Continued from preceding page*)

and a film passing behind the photo-cell could record the message.

When the absentee returned and found that there had been a message (noted from the film footage meter) he or she could develop the film, and, reversing the process by which the recording was made, hear the message.

Or, for greater simplicity, the message could be recorded on a phonograph record if a microphone were at the receiving end of the phone, connected to an amplifier with recording-head output. A business executive who had not been at the office all day (it was a nice day for golf) could visit the place just before supper and get all the telephone messages personally.

Kidnaping Preventive

The photo-cell would be useful for prevention of kidnapings of the type practiced on the Lindbergh baby. If the window had a light beam (which could be invisible), the interruption of that beam by the kidnaper entering the nursery window from the ladder could sound a signal. The baby's life might have been saved and the kidnaper and his accomplices caught.

Sometimes small children—mere babies—get in trouble in their cribs but make no outcry. A button in the throat would be an example. But the child would wave the arms and kick. Interruption of a light beam cast at a certain level above the mattress would flash or sound a signal when baby was in trouble that way.

Since photo-cells record the quantity of light, and since methods recently have been perfected for selecting production cells of excellent uniformity, the light quantities can be calibrated in terms of the current. Therefore one can tell how many lumens. The conditions for fine light for reading are well known, and are imprinted on commercial types of meters, so that the illumination in rooms can be properly adjusted. If there is not enough light, the correction is easily introduced, if one has a scientific standard to guide one as to the quantity of light required. There might even be too much light, and the same sort of scientific advice is afforded by the lumen-meter.

Or, the problem may be merely one of economy. Suppose one owns a store. He has electric lights. He could find out (if that were true) that far too much bright line was striking the ceiling, and not nearly enough light reaching the counters. The only customers patronizing the ceiling are flies. And flies spend no money. Better lighting of the counters, and conserving the light wasted above, means reduction of expenses and increase in sales.

Are the Lamps Economical?

Certain types of imported lamps consume entirely too much juice for the amount of light they give. By measuring the lamp wattage, and comparing it with the illumination obtained, another factor entering into economizing in business and home is introduced.

The calibration of the cell at once gives rise to the use of the device as an exposure meter in photography. Every enthusiast in photography knows his camera at least to the extent of the lens. The amount of illumination required for certain speeds of exposure is usually on the camera, in other terms, however, f 6.3, f 4.5, etc. This expresses the ratio of the opening to the focal length. The photo-cell can be calibrated in terms of f 6.3, f 4.5, etc., so that merely exposing the meter to the sunlight (or electric light) will give you the correct information on the diaphragm setting required. Exposure meters, as well as lumen meters for determining the amount of light in terms of the required quantity for reading, sewing, etc., are on the market now.

The Circuit Diagram

The circuit herewith is one for a photo-cell and amplifier, the amplifier being necessary because the photo-cell is not likely to be sensitive enough for the purpose intended. The photo-cell is shown to the right of the 30 tube, which tube is the amplifier.

When a light is shone on the cell the current through the cell develops a bias on the 30 tube and the amplified counterpart of this change appears in the plate circuit of the tube, in which circuit is connected the relay. This consists of a winding of a few thousand ohms d-c resistance, or, in special instances, of much less d-c resistance, across which is a relay that responds to any changes in current when the change is 1 milliampere or more.

When this change takes place, as it will when a sufficient illumination is cast upon the photo-cell, the relay will be tripped. The device may be made to close or open a circuit, depending on which side the single-pole, double-throw switch is thrown.

At upper right is the diagram of the circuit for calibrating the relay. If known quantities of light are put in, the deflections of the needle on the microammeter may be recorded in terms of those light quantities.

Triode of 55 as High-Frequency Oscillator

The triode of the 55 is an exceedingly peppy oscillator. The tube is like the 56, also an excellent oscillator, but why the 55 triode should seem to be more violent in its oscillations, for equal conditions, is rather baffling however, since so many are interested in short waves, and moreover as one of the problems in a short wave super is to keep the oscillator going at frequencies as high as 20 mgc, at least the triode of the 55 may be tried for this purpose. Oscillations have been obtained to 32 mgc without any special effort, or, somewhat higher frequency than the limit found for the 56 with the same voltages, capacities, inductances, etc.

Of course one of the best oscilators, from the viewpoint of certainty of oscillation, where there is the least possibility of any oscllation, is the Hartley. This is shown at lower right in the diagram. The cathode is connected indirectly to a tap on the coil. The tuning condenser, which is padded, is put across the whole coil. For frequencies as high as those mentioned it is not necessary to resort to padding with Cp.

The coupling will be sufficient if the two diode plates of the 55 are united and attached to the control grid of the modulator (upper right-hand 58). Then the coupling is that primarily resulting from small capacity, although there is some electron stream also, not much, however, in the diode circuit.

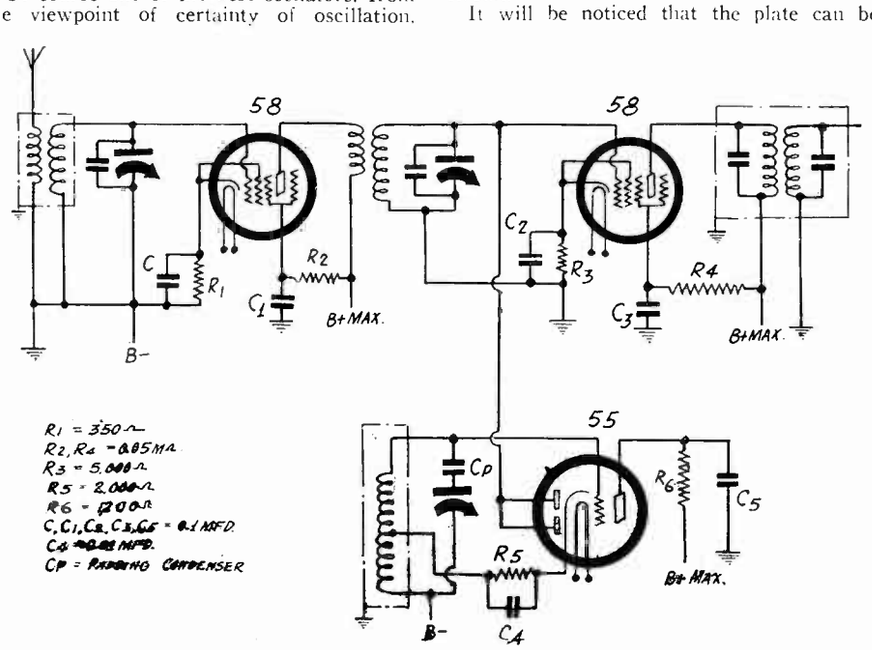
It will be noticed that the plate can be grounded. This helps stability. The total plate circuit may be regarded as that between cathode and plate return. Usually we find the cathode end grounded or lifted just a bit above ground, plate at a high r-f potential. Here the plate is at zero r-f potential and the height of the effective cathode voltage depends partly on the signal and partly on the bias from the resistor, R5, which affords the self-bias.

The constants of R5 and C4 must be carefully chosen. It is desired in this particular circuit to avoid grid current. If any flows, and these constants are too hgh, a shrieking emission takes place, an annoying form of modulation. It is suggested that R5 be 1,000 to 2,000 ohms, and that C4 be maintained within the safe limit, which would call for a condenser not more than 0.01 mid. The circuit, with this tube, has some peculiarities, including the squawking possibility mentioned, but the troubles are always of a small order, or can be made so, once one gets a circuit oscillating at frequencies which heretofore had defied attempts to introduce such oscillation.

Any who prefer the grid-leak-condenser type of oscillator construction may connect the cathode directly to the tap (omitting R5 and C4) and put the grid leak and condenser, as a parallel circuit, in series with the lead from the top of Cp, which is the high side of the grid coil, and the grid.

The effective conversion conductance is a bit lower when the elevated cathode method of oscillation is applied as here, but that is of no consequence, particularly in the light of the attainment of oscillations at high frequencies.

The 58 as a modulator is much more sensitive when R3 is somewhat under 1,000 ohms, instead of 5,000 ohms, and even as low as 300 or 400 ohms improves the sensitivity. But it is more important that the bias exceed the maximum amplitude of the input from the oscillator. If that input is limited to 2 volts or so, then the 300 to 400 ohms cited may be used.



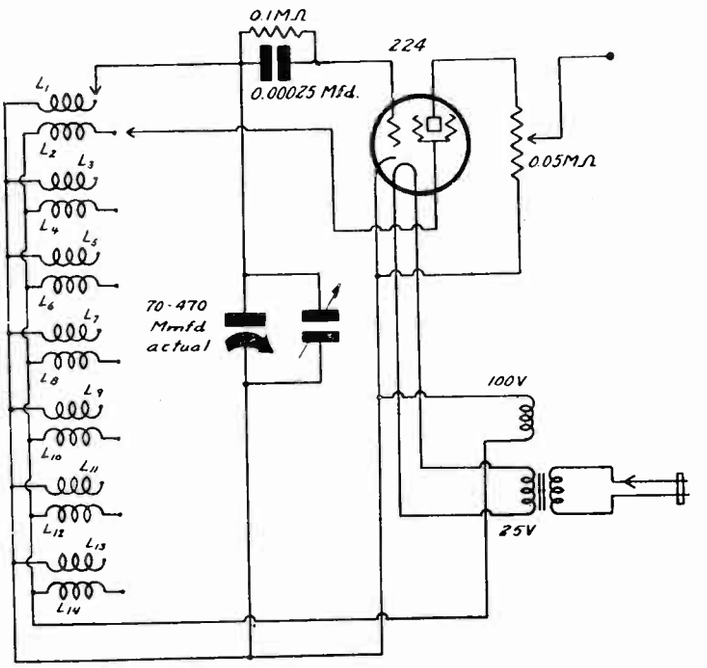
The 55 triode as an oscillator

Radio University

Oscillator

I HAVE a small power transformer, with a 2.5-volt winding and 110-volt winding. This I would like to use in a switch-type oscillator, to cover seven bands. Please show the diagram.—O. H.

Herewith is the diagram of such a circuit, using the 24 or 24A tube. The screen is used for feedback. Thus the plate may be returned to cathode, and some current will flow in the plate circuit, hence the oscillation voltage may be picked off here. The condenser used for tuning will not yield the frequency ratio you probably expect, due to the capacity of the switch. The minimum circuit capacity will be at least 70 mmfd. What the maximum will be depends on the maximum of the condenser, the capacity of the switch, and the general circuit capacity. If a trimmer is used on the tuning condenser it should be preferably a small one of the air-dielectric type. As you desire to cover some high frequencies (assumed from the seven bands) you could not well get away with a compression type condenser, as this will not stay put.



Switch-type signal generator.

* * *

Phase Shift

IS THE PHASE constant at high frequencies, or does it shift? Has there been any recent research on this?—T. W.

The phase shifts. We found that out when we tuned regenerative circuits, requiring for highest frequencies that the capacity of the throttle condenser be minimum for feedback, instead of maximum required for other bands. This also suggested that the regenerator changed type. It was a tuned-grid regenerator with throttle condenser feedback but may have turned into a Hartley or a Colpitts. A mathematical treatment of phase shift at high frequencies will be found in August, 1934, issue of "Proceedings of the Institute of Radio Engineers." In an article entitled "Phase Angle of Vacuum-Tube Transconductance at Very High Frequencies" F. B. Llewellyn, Bell Telephone Laboratories, N. Y. City, shows that the transconductance exhibits a phase angle when the transit time of electrons from cathode to anode becomes an appreciable fraction of the high-frequency period. Measurement shows that such a phase angle actually occurs and that its behavior is in general agreement with theoretical predictions.

* * *

Reference Level for DB

OFTEN I SEE the designation "DB up" or "DB down," and I would like to know what is the reference point. Unless there is a certain reference point I can't see that the expression means much.—T. E. W.

Decibels up or down refers to the power level in reference to a particular level. While it is true that there is no general standard of starting or reference point, there has arisen a fairly general acceptance for particular branches of work. If we take the case of attenuation of a signal generator that has constant current in a load, then we need no particular reference point, all changes being "down" from maximum. In power work, and in treatment of audio frequencies, for general use the level is coming to be accepted at 6 milliwatts. However, even this need not be taken for granted, as manufacturers of instruments that read the DB change state what is the reference point. One leading manufacturer uses the reference level just stated.

* * *

Condenser Connection

HAVING SOME rolled type of paper condensers, marked "outside foil" at one end, with a ring around the edge there, other end not marked, pigtails from each end, I am at loss to know what the difference is, and how to connect.—T. W. C.

The outside foil refers to the foil that is put on last in making the condenser. The identification is for the purpose of preferring this as the negative connection. Particularly is this important as some of the seemingly rolled paper type condensers are said to be quasi-electrolytic. It would seem they must be so, if the large capacities claimed for physically small units are a reality.

* * *

Reversing Coil Connections

WHEN AN R-F or i-f amplifier tends to be oscillatory and there is difficulty in correcting this, does it not help to change the connections to plate or grid windings of one or more transformers, so as to shift the phase, and thus possibly stop the trouble, due to elimination of inductive feedback between stages?—R. W. C.

This usually does no good, because the feedback is due to a combination of causes, being through capacity, resistance and inductance, of which inductance may be, and usually is, the smallest contributant. However, in an i-f amplifier it may be tried. Others who have tried it a great deal in troublesome amplifiers report that the value of the method is practically nil. In t-r-f systems, where there must be tracking, it is not advisable to have the coils connected differently, but highly advisable to follow the same method for all stages, because the inductance is different when the connection is different. Thus diversification would be tantamount to introducing unequal inductances, and would lead to an attempt to trim unequal inductive circuits with capacity, which can't be done very well. A much better plan is to improve the filtration. This may be done by introducing plate-leg chokes, bypassed by condensers, and particularly by greatly increasing the capacity of bypass condensers across r-f and i-f biasing resistors. Since the tube currents combine in the cathode, use a very high capacity here (2 mfd. suggested) and then usually the plate choking may be omitted.

* * *

Arrestor Value

LIGHTNING ARRESTORS aren't mentioned much any more. In years gone by the radio folk did quite a business in them. Are they of value?—G. C.

Yes, they are of value. Also underwriters' codes require their installation. Possibly a reason for the diminished attention paid to lightning arrestors is not so much doubt as to their efficacy, but rather the fact that installation of a radio set has not increased the lightning risk. This is no reason for dispensing with the lightning arrestor, and it should be used.

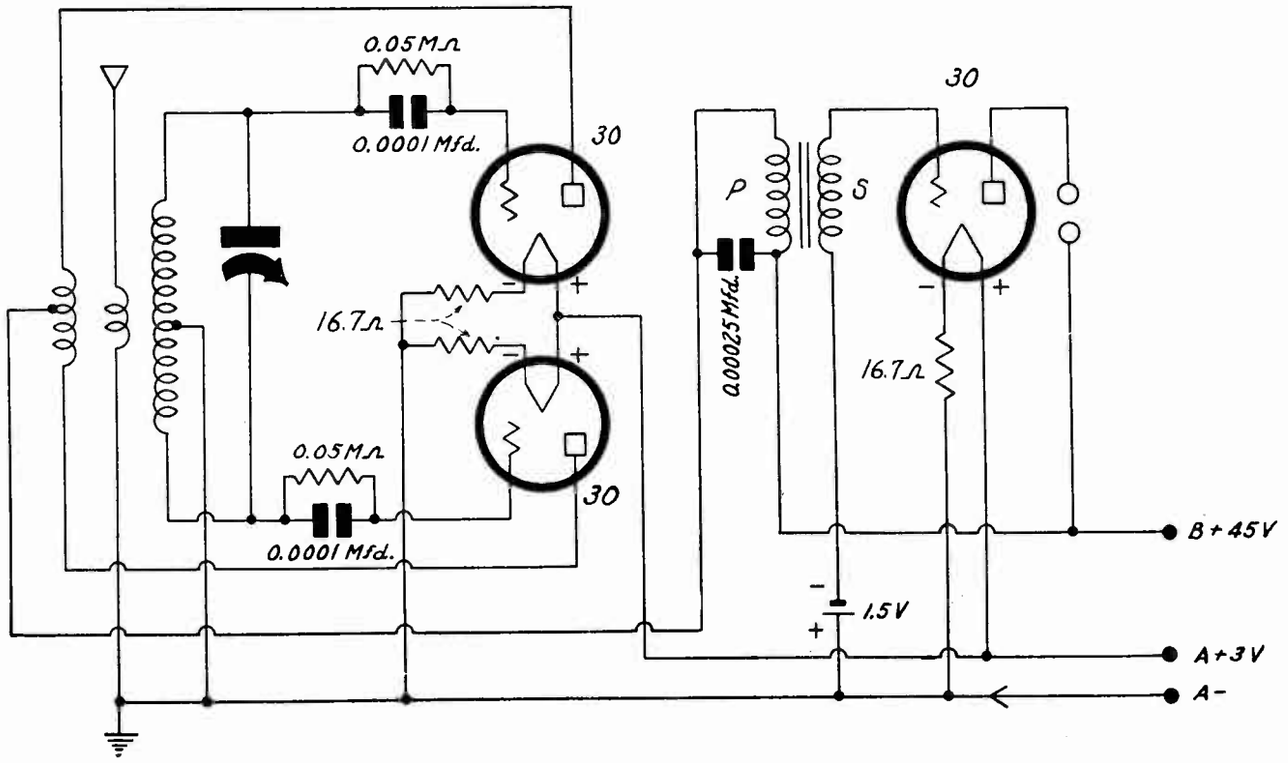
* * *

Power Radiation

ANOTHER NEWS ITEM has come forth about a company intending to make a device for transmitting power by radio. If you have not yet expressed yourself on this, will you kindly do so now?—F. W.

We do not see the practicality of power transmission by radio for commercial purposes. Comparing the power put into an antenna with the power obtained from a receiving antenna at any distance you like, makes us rather cold to the proposition. If anything much can be accomplished in this direction it must be on the basis of some method not yet generally divulged. All ex-

(*Continued on next page*)



Push-pull may be used in a regenerative detector. Introduce whatever form of regeneration control you prefer.

(*Continued from preceding page*)

perience in radio propagation seems to be against it.

* * *

Selective Fading

IS THERE ANY explanation for a peculiar distortion of music on short waves, occasionally experienced, and, strangely enough, experienced on about the same frequencies, though the stations are different, and even in different parts of the world? —J. Y.

We do not know just what you refer to, as the type of distortion you have in mind is not fully set forth. However, just as a chance, we might mention a peculiar type of fading that might fit into what you have experienced. This is known as selective fading. There will be a sharp attenuation of certain audio frequencies of the modulation envelope, related to the frequency of carrier transmission, the time of day or night, and the topography over which the wave travels on its earthward path. This selective fading consists of attenuation that increases and decreases, and skips around to various different relative audio frequencies. Hence, listening to an orchestra, the distortion is especially noticeable to one with a musical training. Most persons refer to it as poor modulation, but the assumption that all distortion heard in the set is due either to the transmitter or to the set is unfounded. Sometimes it is due to odd conditions in between, about which very little is known.

Penetration by Line

WILL AN A-C oscillation, put into the house line as carrier, penetrate all over the house, all over the block, or all over the neighborhood?—I. K.

The penetration will depend largely on the original intensity of the oscillation, on the degree of coupling between generator and line, and on the state of the line wiring. Where the wiring is exposed the antenna effect is increased, the coupling is closer, and the carrier penetrates farther. Where the line is shielded (as with BX, according to the electrical codes of large centers) the penetration of course will be less. With an average oscillation—a one-tube generator, using a small receiver tube—the penetration all over the building may be taken for granted, and if the line is the antenna, the coupling may be sufficient to affect all served from the same power company transformer. Caution should be exercised not to create oscillations of such nature as to interfere with licensed transmissions, and the reception thereof, as the method you discuss borders dangerously on one that requires a regular transmitting license, not to mention authority of the power company to use its lines.

* * *

What Determines Ip

A DISPUTE has arisen between two friends as to the operation of a screen-grid tube of the suppressor type. One say that the plate voltage decides the plate current, the other that the screen voltage decides the plate current. Which is right?—R. D. C.

The plate current is determined almost exclusively by the screen voltage, and not by the plate voltage; in fact, the plate current does not change much even if the screen voltage is reduced to zero.

* * *

Improving a Generator

I HAVE a small test oscillator useful on a.c. or d.c. The modulation on d.c. is due to a high leak. The selectivity at the higher frequencies of tuning is poor. The output is not very steady, either. What do you suggest?—C. L.

If you do not especially need modulation on d.c., the best course would be to reduce the leak to 50,000 or 100,000 ohms, whereupon the modulating effect of the leak will disappear, the output will be far more stable, and the selectivity better.

FORUM

EDITOR RADIO WORLD:

ON page 15 of the August 11th issue you publish a short note and a series of sketches in answer to a question about matching.

To quote: "The object of a transmission line is to transmit all of the energy from the source to the destination. Practically, this cannot be accomplished perhaps, but so nearly all may be communicated that matching or a proper transmission line with proper termination is the equivalent of conduction without loss."

The first sentence of this quote is of course true; the first phase of the second sentence is also true, namely, that one cannot transmit all of the energy from a source to a destination. However, nothing could be more untrue than the latter part of this paragraph.

There are two kinds of transmission problems. The first is the transmission problem where it is desirable to transmit as great a percentage of the input power to the load as is possible. In this case the problem is one of the transmission of power per se and of course the desirability of doing it efficiently is paramount.

In many cases, however, of energy transfer from one point to another or from one circuit to another, even quite close to each other in distance, the problem is not to transfer power efficiently. The power available may be so little, as in many cases of radio and high-frequency sources, that the problem is to get any power at all out of the source.

Source to the Load

To put it another way, the problem is not to get the power transferred from one part of the circuit to another with efficiency but the problem is to get the greatest maximum power from the source to the load.

Now, getting maximum power out of the source does not mean that the entire system will be efficient. But to get the maximum power out of a source to the load it is necessary that the impedance of the load be equal to the impedance of the source. The old familiar problem of how to connect dry batteries in series or in parallel or in series-parallel is the problem mentioned above. How can you connect batteries so that they will give out the maximum amount of power? The answer is, so connect them that their internal resistance equals the resistance of the load. When this is done, the efficiency of the system is only 50 per cent.

So with the problem mentioned in RADIO WORLD. It is desirable to have pass from the source to the load the greatest amount of power. Obviously that is what is desired. So then, in matching, one arranges the impedance of the load so that it equals the impedance of the source. Of course, where there are a source, a transmission line and a load, then one has the line impedance equal to that of the source and the load impedance equal to that of the line. In this case the maximum amount of power is given by the source to the line and the efficiency is 50 per cent. Then the line gives the maximum amount of power to the load and the efficiency is again 50 per cent., so that the load has in effect received one-fourth of the total power involved, the efficiency being 25 per cent., but in all events the desired result has been obtained, namely, that the maximum amount of power possible has been delivered from the source to the load.

Reflection Losses

The caption under the series of drawings is erroneous: "Representation of mismatching and matching of impedances, using as connecting medium a transmission line, which means a line free of losses." When impedances are matched between a source and a load with a line between it means the line is not free of losses.

Now, of course, in very long lines, efficiencies are not much less than those indicated above, but in any event the objective has been obtained, namely, the maximum amount of power has been delivered from the source to the load.

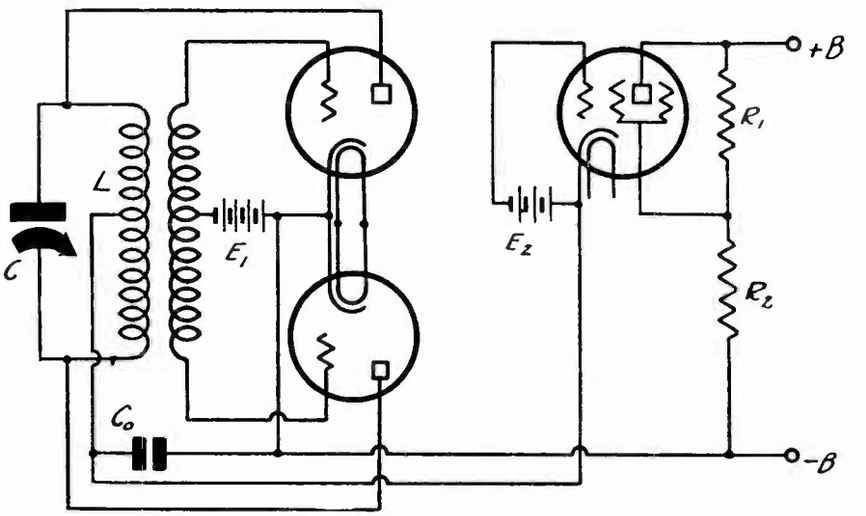
Reflection losses occur only in long lines where wave phenomena are distinctly at issue. When the power transmitted by the source to the transmission line takes on the character of wave phenomena, then that power delivered to the transmission line is a discrete amount of power handed to the transmission line from the source. This bundle or packet of wave energy has a discrete existence, then. It passes along the transmission line to the end of the line where, if the impedances are matched, it goes into the load. Half of the original power given to the line has been lost in the line and the remaining half is available to go into the load. If the impedances are not matched, then at the termination there will be reflection, namely, there is a discontinuity of impedance, and reflection occurs. But this idea of reflection pertains only in long transmission lines.

If I may elaborate a bit further about this problem, the whole idea of matching in transmission is bound up closely with this thought. In a power transmission line the amount of power delivered by the generator or source is controlled by the amount of power asked for, one may say, by the load; that is, if more motors or lamps are turned on by the users of power, then the generator is affected and in answer sends out more power.

Radio Example

However, in the problem presented in your short article and in the problem where matching and reflection are involved, the changing impedance of the load has no control over the varying amounts of power required of the source. In other words, the latter phenomenon is one of wave phenomena. If, at the termination of the transmission line, the circuit is open or shorted, the generator is not aware of it. In terms of radio this means, of course, that the power sent out from a radio transmitter is not at all controlled by the number of radio receivers tuned to that frequency. The power radiated by the radio transmitter is a function of the arrangements at the transmitter. The power is radiated in bundles or packets, independent of the fact that there may or may not be radio receivers tuned to that frequency.

JAMES VAN PATTEN.



Design for a stabilized push-pull oscillator.

EDITOR RADIO WORLD:

I have tried the negative intercept method of measuring distributed capacity of coils for several years, and as your article in August 21st issue sets forth, it is not infallible. The new method, of applying a formula, certainly seems attractive. The distributed capacity of short-wave coils is very important, for reasons you state, that losses are introduced, and measurements enable reduction of such losses by providing a check on what the capacity is. If the capacity can be accurately computed, as it now can be by the formula you set forth, a worth-while contribution has been made. I'm for less and less distributed capacity, especially on short waves, and I believe you side with me.

THOMAS LEFFINGTON.

* * *

EDITOR RADIO WORLD:

Radio being radio is no reason why radio science should not more greatly extend itself in other directions. Acoustical aspects of radio may be extended. I would like to see radio magazines print data on the construction of "thinking machines," also devices for measuring the number of times per second that insects flap their wings, also increasing visibility of smallest objects of matter through photo cells, to aid the medical profession in their attempts to find cures for diseases where the germs have not been isolated yet because too small to be seen by known means.

ISIDOR J. FINKEL.

* * *

EDITOR RADIO WORLD:

The articles you have been printing lately deal considerably with trouble shooting. This is very important. One of the saddest things about radio work is that unless one is an engineer and employed constantly on tracking down varieties of troubles, the knowledge of how to get modern receivers working properly may escape you. Therefore the articles you are printing are of inestimable benefit.

LASFORD C. BROOKS.

* * *

EDITOR RADIO WORLD:

I suggest the arrangement shown in the enclosed diagram for a stabilized push-pull oscillator. The oscillator section is standard, fixed bias being used. This is pretty stable in itself. Then another tube is used in series with the B return of the oscillator, so that this voltage is picked up from the cathode of an extra tube used as a series limiting resistor. When the amplitude of oscillation rises, the drop in the extra tube increases, and thus reduces the B voltage on the oscillator to overcome this rise, and the steadying effect is introduced because the two systems work in the opposite direction.

LEO FURST.

CLEAR-CHANNEL STUDY ASKED

Washington

Convinced of the importance to rural listeners of the clear-channel stations, and evidently fearing that some policy is in the wind that is inimical to the numerous-clear-channel idea, thirteen stations have asked the Federal Communications Commission to appoint an "independent" engineer to conduct a study of clear channels, to last a year, and report back to the Commission. The thirteen suggest that an engineer from the Commission's staff would be fine.

Want Doubling-Up Stopped

What the stations ask at this particular time is that they be given an opportunity to be heard before the commission, through their engineering and legal representatives, to present the case in favor of the clear-channel investigation. The reasons prompting the request for the investigation were not actually revealed.

The proposed study would be statistical, as looking to the number of rural listeners almost wholly dependent on clear-channel stations for best programs, and in some instances for any programs, and also would have a technical scientific aspect, in that synchronization would be studied. During the period of the investigation, it is proposed, no two stations would be permitted to operate on the same frequency.

Cite Rural Situation

Without a large number of clear channels, and there are forty such channels allotted at present, eight to each of the five radio zones, the rural population would be heavily discriminated against in a favor of the population residing in the large urban centers, the thirteen stations assert.

These stations are:

WHM, Nashville; KFI, Los Angeles; WGN, Chicago; WJR, Detroit; WLW, Cincinnati; WOAI, San Antonio; WSB, Atlanta; WFAA, Dallas; WBAP, Fort Worth; WHAS, Louisville, KNX, Hollywood; WHAM, Rochester; WLS, Chicago.

Europe Not Ahead of Us on Television, Sarnoff Is Convinced

"I did not see anything abroad superior to developments along the same line in the United States," said David Sarnoff, president of the Radio Corporation of America, commenting on television, on his recent return from a six-weeks tour of France and England.

He said Germany, Great Britain, Holland and France are busy with television experiments, all aiming to make television commercially practical. The British Government recently appointed a commission of experts to study the subject.

While in London Mr. Sarnoff conferred with Guglielmo Marconi. They are friends of many years' standing and used to work together. He said Marconi's device for steering a ship in a fog by radio means might readily be used, when perfected, on all lightships outside any harbor in fog or heavy snowstorms.

5-METER MIKE-EARPHONE

A combination earphone and microphone will be issued from the Inglewood, Cal., factory of Universal Microphone Co. The device, for the 5-meter transceivers, will be fashioned similar to the French phone handsets and will weigh approximately nine ounces.

Station Sparks

By Alice Remsen

THERE are many old favorites and some newcomers scheduled for the three major networks this Fall. NBC, with its two outlets—the red and blue networks—has announced twenty-six programs, with more to follow. CBS, not to be outdone, has seventeen lined up, and assert that seventeen more sponsors have signed for time, but have not yet announced definite programs or schedules. Among the old NBC favorites to return are: Billy Batchelor, sponsored by Wheatena, August 27; Walter Winchell, sponsored by Jergens, September 2nd; Mohawk Treasure Chest, September 6th; Big Ben Dream Dramas, September 16th; Amos 'n' Andy, September 17th; Dangerous Paradise, same date; Warden Lawes, September 19th; John McCormack, September 19th; Albert Payson Terhune, in a series of dog dramas, September 23rd; Armco Iron Master, September 30th; Ivory Stamp Club, October 1st; Red Davis, October 1st; Ed Wynn, October 2nd; Smith Brothers, October 6th. Tony Wons changes his network, opening on WEAF September 2nd, with "The House by The Side of The Road," sponsored by S. C. Johnson; Dennis King and Katzman's Orchestra open for Enna Jettick Shoes, on August 22nd. "Roses and Drums" also changes its network, opening on September over WJZ, sponsored by the Union Central Life Insurance Co.; The Maybelline Co. will have a musical program broadcast from Hollywood, commencing September 16th; Gems of Melody will be sponsored by Father John's Medicine. . . . Over at CBS we find among the old favorites: Ward Baking Co., presenting Buddie Rogers and Jeannie Lang; Buck Rogers, on September 3rd; "Voice of Experience," September 10th; Whispering Jack Smith, for Ironized Yeast, September 11th; Edwin C. Hill, for Barbasol on September 17th; Bing Crosby, for Woodbury, September 18th; Burns and Allen, for White Owl Cigars, September 18th; Ex-Lax, with Block and Sully, September 24th; Lazy Dan for Old English Floor Wax, September 30th; "The Shadow" for Blue Coal, October 1st; Easy Aces, for Jad Salts, October 3rd; "The March of Time," October 5th and the Brillo program with Tito Guizar on October 7th. Campbell's Soup will present an hour's program from Hollywood, October 12th; and Roxy will open his first sponsored series for Fletcher's Castoria on September 15th. . . . Seems like a full fall schedule. . . . Ralph Kirbery opens on a commercial program September 6th; meanwhile he is pinch-hitting for Ray Heatherton on my "Castles of Romance" program Thursdays, and doing a good job, too; Ray is still on the Tuesday broadcast, but on Thursdays he has a program of his own at 12:15 on WJZ. . . .

The first broadcast ever made from the fiery crater of Mount Vesuvius will be heard here this Fall when NBC microphones pick up the hiss and rumble of the boiling lava and send the voice of the famous volcano to American audiences by short wave. . . . Jesse Crawford is back on the NBC networks Sundays at 11:15 p.m. from Chicago. . . . Robert Braine, NBC pianist, has composed a new suite for violin and piano; this distinguished musician has had more opportunity than many modern composers to hear his own works played. "SOS," best known of his compositions, has been played a number of times by Dr. Walter Damrosch, who has also played excerpts from Braine's grand operas, "Wandering Jew" and "Virginia." Braine's "Concerto in Jazz" was performed by Paul Whiteman at Carnegie Hall; Erno Rapee introduced his "Heroic Overture," and the Chicago Symphony Orchestra was the first to play his "Pasdeloupe of Paris." . . . Vernon Radcliffe, one of NBC's most competent dramatic directors, is of the opinion that Shakespeare is radio's most effective dramatist. The Shakespearian mode of writing was for the ear. No scenery was used in those early old Elizabethan productions. Director Radcliffe thinks that Shakespeare's lines gain in beauty and poetry with radio delivery—and I'm inclined to think he is right. . . .

Frank Crumit, in Columbia's "Quotes of the Week," says: "Radio is the ideal work for Julia and me. We're in New York weekends and in the country, where we can play golf and putter around the garden, during the week. Radio has all the allure of the theatre with none of the discomforts of road tours and none of the sameness of doing the same show night after night. Of course, if the right play comes along, we might be tempted." . . . Which is in the nature of an invitation to playwrights. I'd like to see Frank and Julia in a good musical again! . . . The new Campbell's Soup program will have but one commercial announcement during the show, made by a "chef." . . . Gene Stafford has been appointed manager of production and studios of the American Broadcasting System's WMCA network. He will also have charge of announcers. . . . Burt McMurtrie, new director of program operations of the ABS-WMCA network, has issued the following list of "Don'ts" to broadcasters: Don't smoke in the studios . . . Don't worry . . . Don't change your natural style . . . Don't fail to rehearse your show . . . Don't touch the microphone . . . Don't ad lib . . . Don't drink liquor, beer, milk or sour drinks before going on the air . . . Don't eat ice cream or a heavy meal within an hour of your broadcast . . . Don't go on the air if you don't live up to these don'ts . . . Which we think is a very appropriate closing to this column.

A THOUGHT FOR THE WEEK

THERE has been talk of late about a radical change in the business methods of the British Broadcasting Company. This talk indicates that perhaps England has grown a little tired of taking in money on the set license part of the deal with the public without tapping the great source of revenue that would accrue from sponsored programs. At any rate, without pretending to know about it we predict that the Britishers will stick to their usual conservatism and not lay themselves open to criticism should time be sold on the air to anybody at any time who happens to make the highest bids. Conservatism is still the keynote of Great Britain's utility business, as evidenced by the fact that the telephone and telegraph facilities of the nation still belong to the government in face of decades of striving on the part of private interests to bring them under private control.

James Kennedy to Run for Congress in New York

James A. Kennedy will run for Congress in New York City this year. Mr. Kennedy has been very active in New York political circles since his departure from the radio field. He was vice-president and sales manager of Arthur H. Lynch Inc. and later he became New York representative for the Jensen Manufacturing Company. Mr. Kennedy's brother, Martin, has been United States Congressman from the Yorkville (New York City) district for a number of years.

Biasing Resistors

Grid biasing resistors for cathode legs are specified in ohms, but the value is minimum, and for r-f and i-f amplifiers if one has a bit larger resistors these may be used. However, for power tubes resistor specifications for biasing should be followed closely.