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INSIDE FACTS ON AC

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RADIO WORLD
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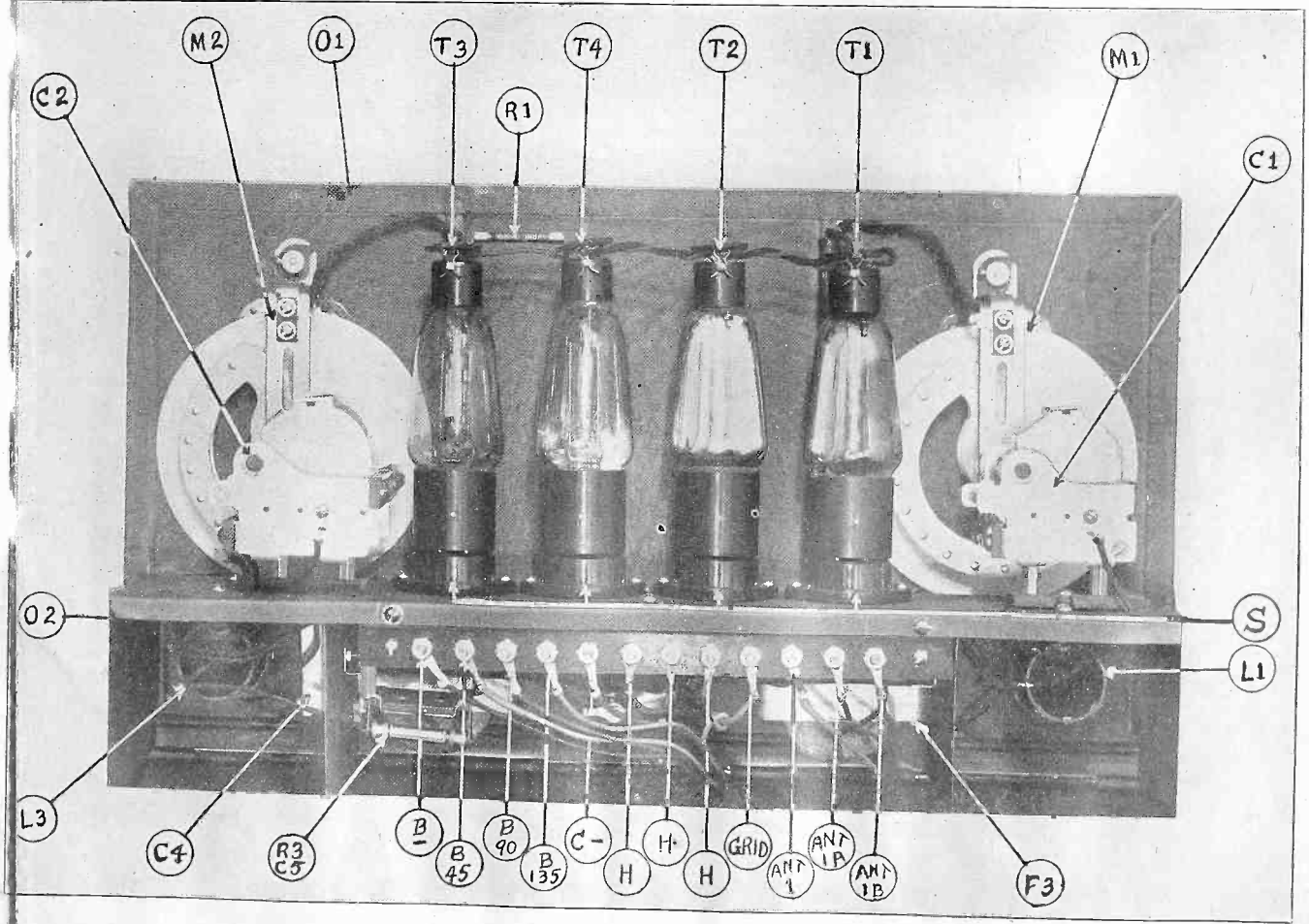
The First and Only National Radio Weekly
319th Consecutive Issue—Seventh Year

HUM ERADICATION

FLUCTUATION OF LINE VOLTAGE

FERRANTI POWER AMPLIFIER

FENWAY'S NEW AC CONCERTROLA



Rear View of the new Concertrola. Cl, .00025 mfd. condenser; C2, double condenser, each section .00025 mfd; L1, L2, L3, Fenway or home-made RF coils; T1, T2, T3, T4, McCullough AC tubes; M1, M2, Mar-co illuminated controls; C4, Electrad .5 mfd. condenser; C5, Electrad .0005 mfd. grid condenser; S, four sockets; 01, shielding case; 02, metal shelf built in case; F3, Ferranti or Fenway AF transformers; R1, 1½ ohm Carer fixed resisance. See Leo Fenway's article beginning on page 6.

EVERY FRIDAY at 5.40 P. M. (Eastern Standard Time) Herman Bernard, managing editor of Radio World, broadcasts from WGBS, the Gimbel Bros. station in New York, discussing radio topics.

"UNINTERRUPTED READER INTEREST
EVERY WEEK — EVERY YEAR

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Hum Eradication

By Brunsten Brunn

WHEREVER there is AC there is hum. It is present in every radio receiver whether the receiver be wholly or partly powered with AC. If the plate voltage is obtained from a B battery eliminator there is a certain amount of hum present. If the grid bias is also obtained from an eliminator there is more hum. And if the filaments are also heated with alternating current there is still more hum.

The total hum in the output of the receiver depends on how well the circuit has been adjusted and how well the rectified AC has been filtered. The apparent hum also depends on the design of the receiver or on the efficiency of the receiver on the lower frequencies.

A little audio hum in the output is not objectionable to most persons, any more than a slight phonograph scratch is objectionable. It is not noticeable except when no other sound emerges from the speaker. But hum which would pass unnoticed in the output of a loudspeaker would be intolerable when listening in with a head set.

Causes of Hum

When AC is present near a set, or in a set, there are many ways in which the hum will get into the signal, and it is difficult to stop up all the channels.

Suppose the receiver is DC operated throughout. There should be no hum, but there may be. If an AC line is near a grid wire there will be coupling between the two, mostly capacitive, and the hum will get into the signal that way. If this entrance is near the detector, or in the detector, the hum will be amplified by the audio amplifier, so that by the time it gets to the loudspeaker it may be of considerable intensity. But there is small chance that any wire will be close enough to cause any trouble. Shielding the entire set would be a remedy in this case.

If the set is regenerative, or oscillatory like a Super-Heterodyne, the hum from an AC line may get in by modulation, in which case coupling between the radio frequency tubes and the AC line would be the cause. Shielding would be a remedy in this case also.

Hum Through B Battery Eliminator

If the receiver is powered with an A battery and a B battery eliminator the hum enters the set directly by way of the plate voltage supply. Oscillation or over-regeneration in the receiver would intensify the small residual hum in the plate current to a point where it would be annoying when without regeneration the hum would be below audibility. More thorough filtering would be the remedy. Choke coils of higher inductance and bypass condensers of greater capacity should be used in the filter.

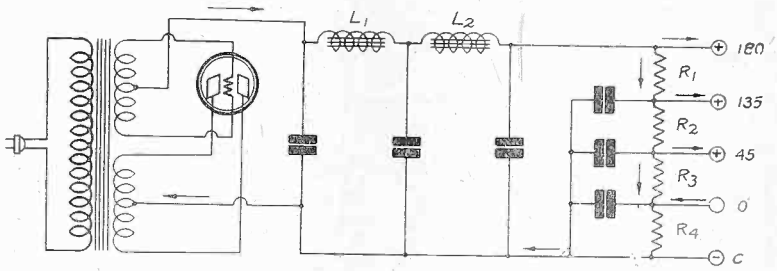

FIG. 1

HUM CAN BE REDUCED CONSIDERABLY BY CONNECTING THE THIRD CONDENSER IN THE FILTER TO THE FILAMENT, THAT IS THE POINT MARKED ZERO, INSTEAD OF TO MINUS C. THE THIRD CONDENSER IS JUST TO THE RIGHT OF L2. WHEN THAT IS DONE IT IS NOT NECESSARY TO USE THE CONDENSER ACROSS R4. THIS CONNECTION OF THE THIRD CONDENSER IS ALSO A REMEDY FOR MOTORBOATING IN MANY CASES. ARROWS POINT TO DIRECTION OF CURRENT FLOW.

The efficiency of any given filter depends largely on the amount of current that is flowing through the coils. This is due to two different things. If a heavy current flows through the choke coils the cores become saturated and the inductance or choking effect drops. Thus a given B battery eliminator may operate a five tube set without any noticeable hum but the same eliminator may not operate a 10 tube set without intolerable hum.

Also the by-pass condensers in the filter will not operate so effectively on a heavy current as on low current. When a heavy current is drawn it means that the resistance of the load on the filter is low, and a condenser of given capacity will discharge much more quickly through a low resistance than through a high. Hence there will be a greater voltage fluctuation when the resistance is low, or when a heavy current is delivered by the filter.

Common Impedance Causes Hum

The impedance of the B battery eliminator, looking from the set into the filter, constitutes a coupling device between all the circuits which are on the eliminator. A small residual hum in the DC output current will enter the signal by this means in one of the earlier tubes, either directly in the grid circuit or in the plate circuit, and this will be amplified until the final hum in the signal will be of audible intensity.

Fortunately the hum that gets into one stage may partially neutralize that which gets into another stage, so that this source of hum is not always so severe as it might be. But the common impedance may start oscillation or regeneration in the audio amplifier, and this action always intensifies the hum. The necessity of thorough filtering is apparent.

Effect of Grid Bias

When grid bias for the amplifier tubes is obtained from a voltage drop in a resistance the hum may be increased or decreased depending on how the circuit is connected and how many tubes derive their bias from the same resistor.

If a resistor is used for a single tube, as is common practice in the output stage, the hum is reduced. If the resistor has the proper value the hum introduced into the plate circuit by the residual hum is exactly balanced out by the hum introduced into the grid circuit. If another tube derives its bias from the same resistor the hum will in general be increased.

This shows the importance of using a separate grid bias resistor for each tube.

AC on the Filaments

When the filaments of the tubes are heated with AC, hum is introduced both by the grid effect and by the fluctuation in the emission.

The grid effect is due to the fact that the entire filament is not at the same potential and the voltage drop in the filament becomes a signal. This is reduced by balancing the filament circuit with respect to the grid return so that at any instant the grid effect is just as much positive on one side of the filament as it is negative on the other. This is accomplished by connecting the grid return to the midtap of the filament transformer, or better, to the midtap of a low resistance potentiometer connected across the

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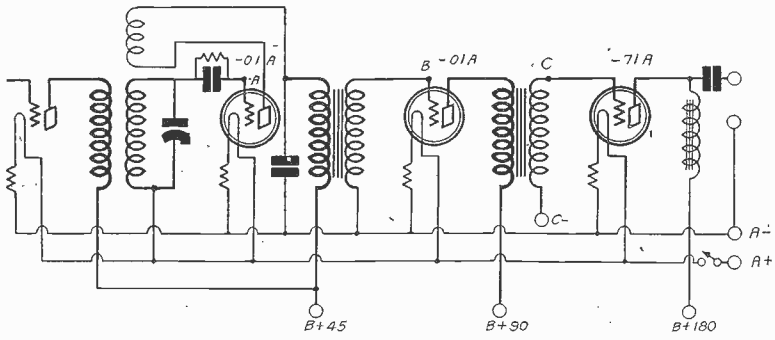
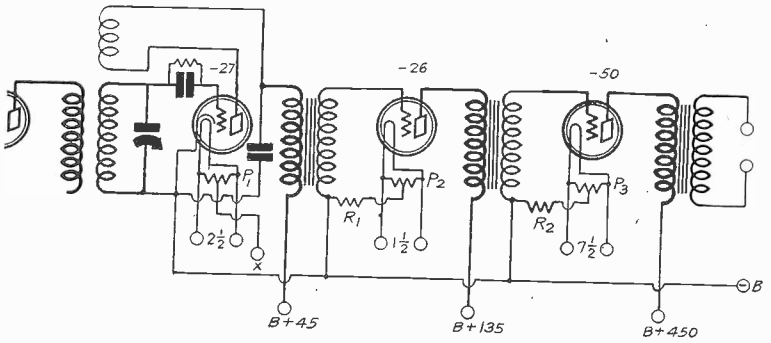




FIGS. 2 (TOP) AND 3

THE GRID LEADS MARKED A, B AND C IN FIG. 2 ARE VERY SENSITIVE TO HUM. IF A LINE CARRYING AC OR UNFILTERED RECTIFIED CURRENT RUNS CLOSE TO ANY ONE OF THEM HUM IS VERY LIKELY TO ENTER THE RECEIVER. A IS THE MOST SENSITIVE. ALSO IF THE GRID CIRCUIT OF THE RECEIVER IS OPEN AT THE LOW POTENTIAL SIDE THE CIRCUIT IS VERY SENSITIVE TO HUM. IN FIG. 3 (BOTTOM) HUM IS REDUCED IN AC HEATED TUBES BY USING INDIVIDUAL GRID BIAS RESISTORS R1 AND R2 AND INDIVIDUAL CENTER TAPPED RESISTORS P1, P2 AND P3 FOR THE GRID RETURNS. POINT X SHOULD BE CONNECTED TO EITHER A POSITIVE OR A NEGATIVE VOLTAGE WITH RESPECT TO THE CATHODE, DEPENDING ON WHICH GIVES LESS HUM.

(*Continued from preceding page*)
filament near the tube terminals. Accurate balance is essential, and it is best to balance each tube independently by a separate midtapped resistor for each tube heated with AC.

The hum introduced by the fluctuation in the emission is not serious because the variation occurs at 120 cycles, when the line frequency is 60 cycles. The time between maxima is so short that the filament temperature cannot vary much between current maxima, and therefore there is not much variation in the filament emission.

The variation from this source is more severe the higher the temperature of the filament, and therefore the filament current should not be any higher than necessary. In the "dull emitter" type of tube the temperature is comparatively low and therefore AC tubes are made with such filaments.

Take It or Leave It

There is little that the fan can do to eliminate the hum arising from fluctuation in the emission. The tubes are made and they have to be used as they are. The set designer can do no more. But the hum arising from the grid effect, which is the more serious, can be eliminated by a slight rearrangement of the circuit. If the receiver operates on a filament transformer with so-called center taps, and if these taps are not really in the center, all that is necessary is to use external center taps, that is resistors accurately tapped or potentiometers which can be adjusted experimentally until the hum is minimized.

Effect of Grounding

Much can be accomplished by suitably grounding the receiver and the power supply. The effect of grounding is mainly to eliminate electrostatic coupling through which the hum is introduced into the receiver. There is no one point in all circuits or eliminators which, when grounded, gives quietest operation. Usually the negative side of the B battery eliminator is the best. In other instances best results will be obtained when the center taps on the transformers are grounded, or the center taps on the resistors.

While experimenting with grounding for the elimination of hum great care must be taken that no two points be grounded at the same time. Such a mistake might prove disastrous. A circuit diagram of the receiver should be consulted to make sure that grounding one point will not short circuit something.

One Frequent Mistake

Sometimes a very slight mistake, easily remedied, causes hum. One frequent condition of that sort is careless connection of antenna and ground to the set, so that the aerial is connected to the ground post and the ground wire to the antenna post. As the filament should be at ground potential, the wrong connection puts it at a high radio frequency potential and the voltage drop across the turning coils is much less than it should be, causing the hum to be a large part of the signal voltage, instead of a minor percentage. Be careful about the antenna and ground connections.

Hum May Be Part of Signal

The hum heard in a receiver may not always arise in the receiver. Many broadcasting stations are notorious hummers. The radio wave that one of these stations radiates contains a 60 cycle of a 120 cycle hum as a modulation. When that is the case no amount of manipulation at the receiving end will help even a bit. The hum riding on a radio wave enters at the transmitter in the same way that it might enter a receiver through the power supply. There are three major sources of hum in a transmitter, one for each of the three voltages. The filaments of the tubes in most transmitters are heated with AC. If the filaments are not balanced to eliminate the grid effect, hum enters. Also the plate voltage is derived from motor-generators, the output of which may not be adequately filtered. In most of the high power transmitter the grid bias is also obtained from a motor-generator or a direct current generator. This voltage also may not be adequately filtered.

When a broadcast wave contains a hum at all times the cause of it lies in the transmitter.

Sporadic Hum

It often happens that the wave of a broadcast station contains a hum when the station picks up a program from an external source, but is humless when it picks up the programs from the main studio. In that case the hum enters by way of the line which leads the telephone signal to the transmitter. The line may run parallel with a power line for a considerable distance.

Hum and Low Note Efficiency

Some A C operated receivers are so designed that the bass note amplification is so low that the 60 cycle hum will not be noticeable. This perhaps is the easiest way of eliminating hum from the output of a receiver. It is equally effective whether the hum enters at the transmitting station or at the receiver. But this method is a makeshift, for it eliminates one of most desirable regions of the audible scale. A receiver unable to reproduce with full intensity the notes below 75 cycles cannot be classed at a high quality receiver. A little hum in the output is much preferable to the absence of the low notes.

Hum Greatest on Lower Waves

Any receiver is more likely to hum on the short waves than on the long. For example, the hum may not be noticeable between 550 and 400 meters but may be quite objectionable between 400 and 200 meters. Of course the increase in the amount of hum from 550 to 200 is gradual.

There are at least two reasons why the receiver should hum more on the short than on the long waves. In the first place the tuner is more selective on the long waves. Therefore the low notes are brought out more than the high. But as the audio amplifier remains the same the amount of hum may not be increased. Hence the hum will be low in comparison with the low-frequency signal notes at the long waves, and therefore it may not be noticeable.

But on the short waves the low notes are more nearly normal because the high frequencies are not suppressed so much. The hum therefore may be of about the same intensity as the signal notes of the same frequencies.

Another Reason For Hum

The other reason why hum may be more pronounced at the short waves is that the receiver is usually regenerative below about 400 meters. The regeneration is either intentional or incidental. In fact, the sensitivity of the receiver at the short wave end of the tuner is largely due to incidental regeneration.

When a receiver is regenerative or oscillatory any hum near the set is picked up as a modulation on the radio frequency wave, detected in the ordinary manner and amplified by the audio channel.

Often when there is a condenser in the antenna circuit below the input coil any hum which is picked up by the antenna from power line will enter the receiver

(*Continued on next page*)

Line Voltage Surges

No Serious Problem, Says Dr. Goldsmith

By Dr. Alfred N. Goldsmith

Chief Broadcast Engineer
Radio Corporation of America

LINE voltage, for some reason, brings to mind apartments and bathtubs. Of course line voltage means nothing in taking a bath. Yet the point is that the principal of varying pressure applies in both instances, and this is how:

The bathtub on the ground floor has more than normal water pressure. Consequently, it fills up rapidly. One must watch the tub for fear it may overflow. The fifth floor apartment, on the other hand, may lack water pressure. The tub fills slowly. Leave it running, and you return to find the tub still far from full. The third floor, again, has normal pressure. The tub fills at the expected pace. This is the *normal condition.*

It is well to observe, too, that the water pressure is affected by how many families are using the water at the same time. More drain on the water line means less available pressure, especially for those on the upper floors.

Why Voltages Differ

Now in socket-power radio, the same conditions obtain in electrical terms. If we are located say 1,000 feet from the step-down transformer on the AC power line, we may have excessive voltage or electrical presure. If 5,000 feet, we may have insufficient voltage or pressure. If 3,000 feet, we may have just the normal potential, as voltage or electrical pressure is termed. And since it is physically impossible to maintain the same potential over every section of an electrical distributing system, under all conditions of current drain or load, it becomes necessary to design socket-power radio sets, as well as other electrical equipment for *normal potential.*

But what about the excessive voltage and the insufficient voltage cases? Fortunately, it is very seldom indeed that real extremes are encountered in line voltage.

Range from 105 to 125 Volts

According to data recently presented by Mr. Cogger of the National Lamp Works, the average line conditions in the United States range from 105 to 125 volts. There is a small percentage of locations where voltages beyond these limits are found, but they appear negligible compared with the number of locations having values within the stated limits.

Studying the line voltage problem—if it may be called a problem—the Technical and Test Division of the Radio Corporation of America recently made recording-voltmeter runs at various locations in New York City and surrounding suburbs, during a period of several days in each location.

The average of the recorded graphs indicated a maximum fluctuation of voltage on any given line in this territory as 10 per cent or less. This applies to variations in voltage on a given line, due to changes in load conditions on that line. We can safely assume that this means a plus or minus 5 per cent variation, which comes within the requirements of most socket-power equipment.

Effect of Change of Load

So far, we are dealing with difference in line voltage among various supply lines, due to the fact that different power companies have the voltage regulators set to maintain voltage at different values. Thus the rated voltage on one line may be 110 volts, on another 115 volts, and so on.

In addition, however, there is a different class of line-voltage variation, in the form of the day to day and hour to hour change in the voltage on a given line in a particular home, due to changing loads on the line.

A survey indicates that this class of line-voltage variation generally does not exceed 5 per cent either way of the rated value of a given line. On supply lines fed from large power houses, such as in the metropolitan areas, the percentage of variation is often much less than this figure, or well within socket-power requirements.

Tube Life Shortened

Turing to the effects of line-voltage variation, we learn that excessive voltage results in a material shortening of the life of the AC Radiotron, without commensurate improvement in the performance. There may be more volume, perhaps, but it commands a relatively high price in more frequent tube replacements.

Sub-normal voltage results in loss of effectiveness of the tube, particularly when it has been in use for some time. The tone quality and the volume are noticeably impaired. The more distance and weaker signals drop down below the level of audibility. The general operation of the set, which depends on its tubes, is not satisfactory.

Obviously, the effect of line voltage variation is more noticeable in the case of radio tubes than in that of an incandescent lamp operating on the same lighting circuit. Whereas the incandescent lamp merely supplied light, which may have considerable range of intensity without inflicting hardships on the user, the radio tube must maintain reasonably constant amplification to prevent noticeable and even disagreeable variations in the reception provided by the receiving set.

Accuracy to 5% Required

For satisfactory AC tube operation, the receiver should be designed to supply the tubes within 5 per cent, plus or minus, of the required voltage. This calls for a properly designed power transformer in the first place.

In taking care of possible variations in line voltage, the power transformer of the receiving set should be provided with a line switch, connected to taps of the transformer primary, to bring the secondary voltages to within the requirements.

In the properly designed AC tube receiver, it is possible to tap the primary for line voltages from 105 to 115, and with another tap from 115 to 125. The AC Radiolas are provided with a "high-low" switch which serves this function. Thus on a line having a potential of 110 volts, the first switch position will provide proper operation of the tubes with 5 per cent plus or minus line-voltage variation. In the other position of the switch, there will be proper tube operation around 120-volt average line potential.

Where Experts Differ

In the case of lines having an average value in the neighborhood of 115 volts, there is some question as to the proper setting of such a switch. In cases where the line regulation is good, the lower voltage position could be employed.

In locations supplied by small power plants wherein large fluctuations in voltage may occur, the higher position would be preferable.

In instances where the receiver or kit as a non-adjustable power transformer, a resistance unit of proper value should be installed in series with one side of the power transformer input to bring the secondary filament voltages down to normal. The resistance should be capable of carrying the necessary current without serious overheating, and should be mounted in such manner as to be safe and in accordance with the Underwriters' requirements.

No Serious Problem

All in all, then, there is no serious line voltage problem. In most localities there is not enough variation even to worry about. In the relatively few localities where there is considerable variation, the condition may be met by a tapped primary in the power transformer or again by a primary resistance which may be taken care of by the set owner or the obliging service man. Thanks to our standardized lighting voltages therefore the tubes, the socket-power receiver are placed on a firm and lasting foundation.

The Hum on Short Waves

(*Continued from preceding page*)

as a signal because the voltage drop across the condenser will be high at the hum frequency. This shows the necessity of using a large condenser in the antenna circuit when the circuit is such that one has to be used.

The hum that would enter a receiver by this means would have a frequency of 60 cycles if picked up from an AC line and 120 if picked up from a DC line.

If the hum enters the receiver from the B battery eliminator having a half wave rectifier the frequency of the hum will be 60 cycles and if it enters by way of a full wave rectifier it will be 120 cycles.

If the hum enters by way of the filaments as a variation in the filament emission the frequency will be 120 cycles for current maxima occur at that rate. If the hum enters by way of the grid effect and an unbalanced filament the frequency will be 61 cycles.

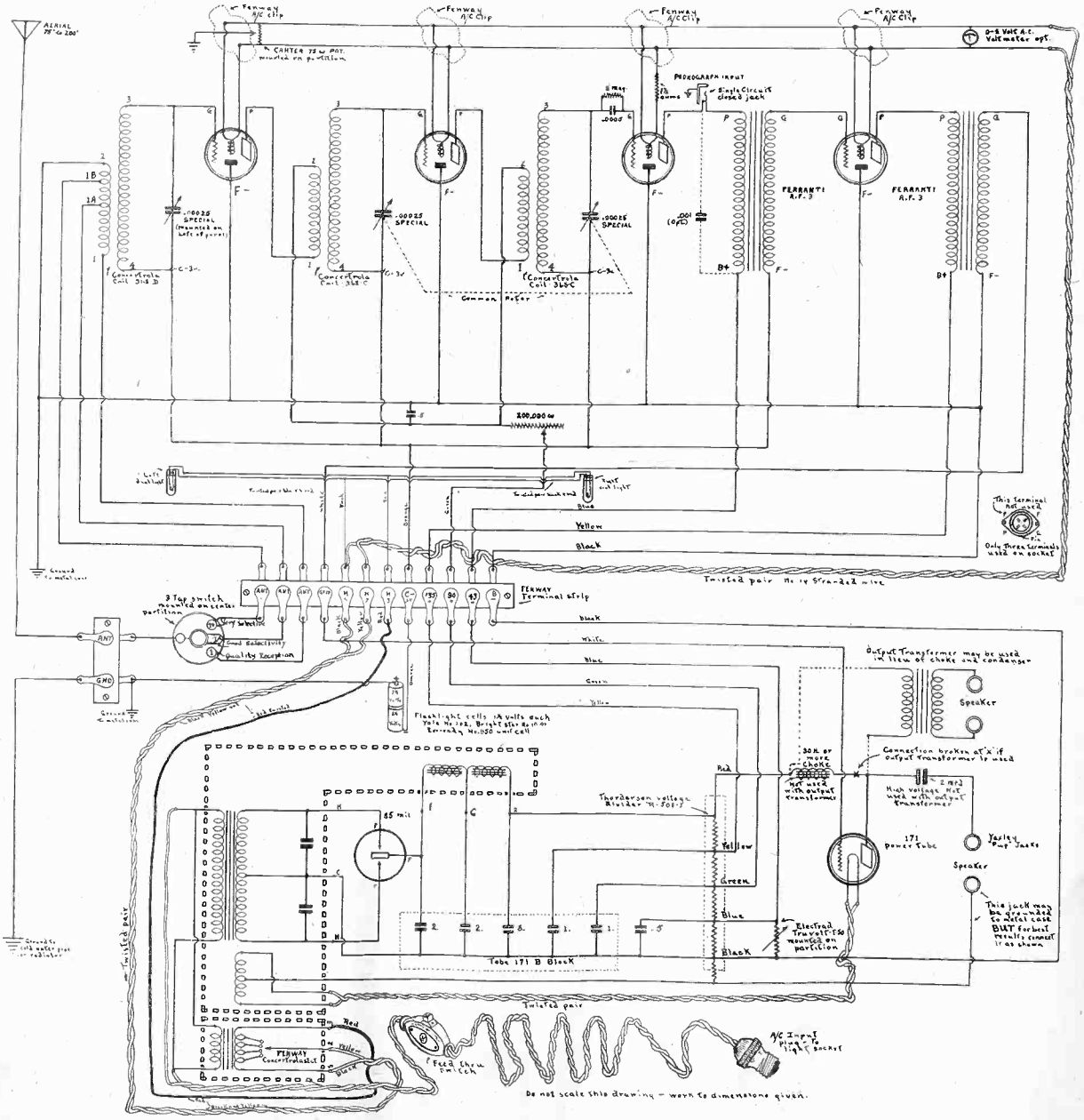
5,000 WATTS FOR KNX

Los Angeles.

KNX, the "Evening Express" station, 500 watts, has been authorized to use 5,000 watts. A new transmitter is being built.

Concertrola Substitutes in AC

By Leo



COMPLETE DIAGRAM OF CONCERTROLA RECEIVER AND POWER SUPPLY. (FIG. 1)

SUCCESS in set building is often accidental. Doctors, lawyers, dentists salesmen, clerks—men and women in all walks of life, who seldom fuss around with mechanical things, often succeed in building a good radio set. Sometimes, however, some of these people fall down on the job. They run into a snag. Their sets refuse to function satisfactorily. Whether or not the fault lies in the set builder, it is very discouraging to spend time and money constructing a radio receiver and get practically nothing in return but, say, a lot of trouble.

The road to building the Electric Concertrola, model F-5, will be shortened for the fellow who ordinarily falls down on the job, if he pays strict attention to the specifications given, and studies over the diagrams and pictures carefully. From the beginning he should realize that the writer works with him on his own set. In this way he is saved unneccessary mistakes and lost efforts.

The story of the Portable Concertrola has been told before—how the all-electric set idea began with a separate eliminator

Thrills for All Frills Design

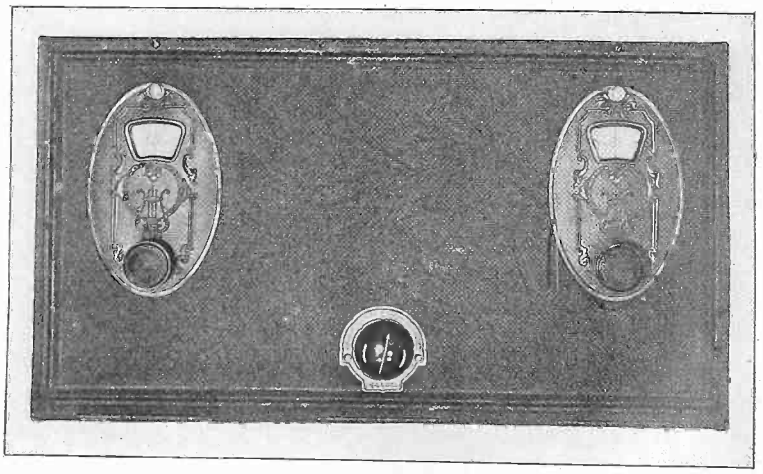
Fenway

LISTS OF PARTS
For Receiver

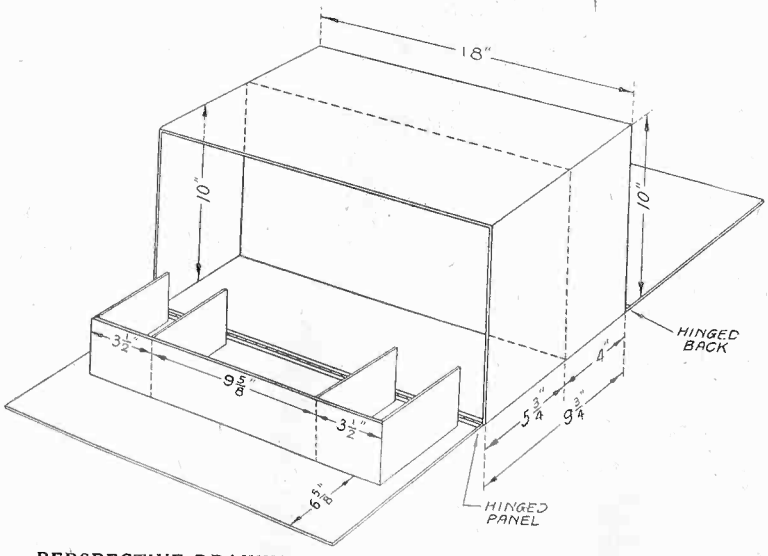
One Fenway metal cabinet with built-in metal shelf.
One Hammarlund or U. S. L. single .00025 mfd. condenser
One Hammarlund or U. S. L. double .00025 mfd. condenser.
Two Fenway or Ferranti Type AF-3 audio transformers.
Two Mar-co illuminated controls.
Two Fenway Concertrola coils, type 368C
One Fenway Concertrola coil type 368D.
One Electrad .0005 mfd. grid condenser with clips.
One Electrad 8 megohm grid leak.
Two Carter 1½ ohm fixed resistors.
One Carter 200,000 ohm adjustable resistor.
Four Fenway AC clips for heater type tubes.
One Fenway terminal strip, drilled and engraved.
Four McCullough or Kellogg AC tubes.
One —71 tube.
Twenty-five feet colored flexible wire.
One Electrad .001 mfd. condenser (optional in detector plate current).
Four Eby sockets.

LISTS OF PARTS
For Eliminator

One special Fenway power transformer for 280 rectifying tube or One Thordarson 171 compact.
One tobe 171 B block.
One Thordarson voltage divider type 171.
One Electrad Truvolt type T-50.
One Carter 75 ohm potentiometer.
One Fenway Concertrolastat (special heater transformer).
One Tobe 2 or 4 mfd. high voltage condenser.
One Thordarson R196 AF choke.
Four Yaxley pup jacks.
Two Fenway special eliminator sockets.
One 280 tube or one 85 milliampere or 135 milliampere gaseous full waver rectifier tube.



PANEL VIEW OF CONCERTROLA (FIG. 2)



PERSPECTIVE DRAWING OF FENWAY METAL CABINET (FIG. 3).

separate set and separate speaker; how it developed into a compact, portable, electric set which functioned entirely without batteries. You may or may not recall that an interested neighbor built one of the sets and then the demand for such an instrument grew in the far corners of the country.

And now for the rest of the story.

Standard Circuit

The construction of the model F-5 has been so contrived that an unskilled radio man can assemble and wire his own set in a few hours' time. Glance at Fig. 1. Notice how the Concertrola idea has avoided trick circuits by using a simple, standardized, common-place radio frequency circuit, which has been tried and not found wanting. Fortified with this device, the construction of the model F-5 swings into successful productivity.

A further glance at Fig. 1 will show that four McCullough or similar heater-type tubes are used in the set.

Notice how the grid returns are connected; examine the connections for the phonograph pick-up; notice the 1½ ohm fixed resistance in the detector filament; see that 75 ohm Carter potentiometer connected close to the first tube, used for balancing out the hum; the Carter 200,000 ohm adjustable resistance used for controlling volume and oscillation, did you ever see that before? Of course you did! Doubtless you are as familiar with this circuit as is the writer. You should be, it has been published in various forms hundreds of times.

But, because you have never been told that this is the Wonder Set, you have passed it by.

No one has ever related to you how this Wonder Circuit from New York, brings in Los Angeles like a local station; no one has ever spread before your eyes a swiftly moving panorama that takes you breathless from the jazz of Broadway to incredible programs broadcast from idol temples in far-off China. Bang; From 50,000 watt stations in Long Island to 5 watt stations in the Jungles of Malay. Whist! One moment you are listening to Havana, Cuba, the next second you are taking singing lessons from Milan, Italy.

Veracious Indeed

No one has ever told you that never in the palmiest days of civilization could you change your geographical location with such ease and abandon as you can with a set made with this Wonder Circuit.

As I said, no one has ever told you these things. If he did, he'd be a liar!

(*Continued on page 17*)

SG Gain Insurance

By Dudley Drake

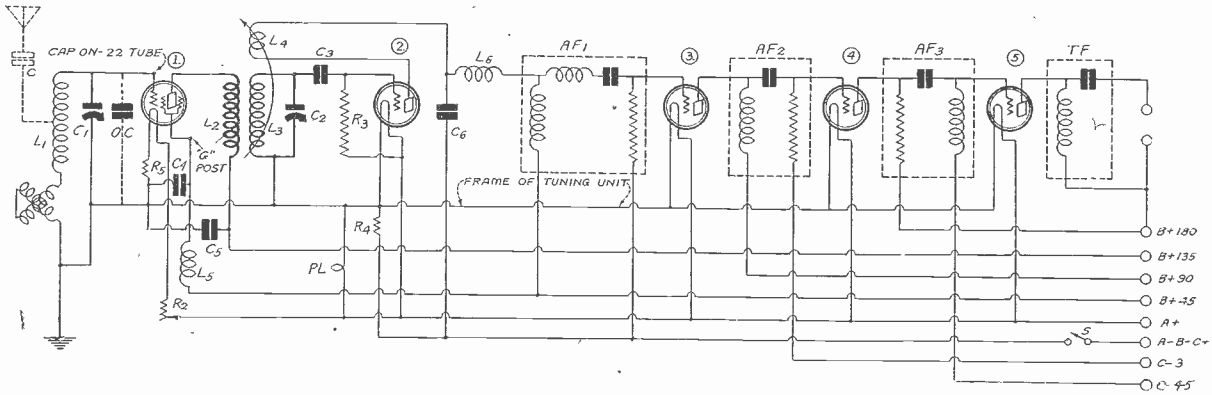


FIG. 1

THE CIRCUIT DIAGRAM OF THE NATIONAL SCREEN GRID FIVE, IN WHICH CECO TUBES ARE USED. CLOSE ADJUSTMENT OF THE PLATE, SCREEN GRID AND CONTROL GRID VOLTAGE IS NECESSARY, AS WELL AS A HIGH IMPEDANCE LOAD TO GET MAXIMUM SENSITIVITY OUT OF THE CIRCUIT.

AS a radio frequency amplifier the screen grid tube as no equal. One of these tubes with the slightest encouragement from the antenna will boost the elusive signals from a distant station to equality with the signals from the locals where an ordinary tube is used. It is difficult to cease wondering that one little tube should effect such a great change in the sensitivity of a receiver.

Some will doubt the efficacy of the screen grid tube as a radio frequency amplifier because their experiences with it have been disappointing. But the causes of their failure do not always lie with the screen grid tube. In most cases where the tube has not proved up to expectations the trouble has been that the fans have merely substituted a screen grid tube in the socket where a general utility tube should be. That is not the fault of the screen grid tube, which is a respecter of sockets to a high degree. It must have a berth especially prepared for it or it will sulk.

Not only will it not do as well as a general purpose tube in the same place but it will do very much worse. In most cases it will transform a fair receiver into a dud.

That's Different

But prepare a special berth for it with all the trimmings that befit such a high-bred piece of apparatus, and it comes into its own. It immediately perks up and comes to the front. It not only does what is claimed for it but it does more. It puts life into the set and makes it responsive to the faintest signals from remote points, and it satisfies the operator. That is a severe test for any tube.

But not all screen grid tubes perform according to promise. Some are only screen grid tubes in form and appearance. They are duds parading in lively costumes. Every time a fan buys a tube that has not a genuine pedigree he takes a long chance in which he stands to lose not only the price of the tube but also his confidence in the radio industry. And the fault is his own in nearly every case. He has merely permitted himself to be "gypped." Of course there may be a dud now and then among the pedigreed stock, but such freaks are backed up by a replacement guaranty.

What is a fitting berth for this aristocrat among the radio frequency amplifiers? A positive contact socket in which the voltage across the filament terminals is 3.3 volts, in which the voltage on the plate terminal is 135 volts, in which the voltage on the screen grid terminal (G post of socket) is 45 volts, and in which the voltage on the control grid (cap on tube) is about 1½ volts negative. The filament current delivered to the tube should be .132 ampere and the load impedance in the plate circuit should be the highest practical.

LIST OF PARTS

L1, L2L3L4, C1, C2, PL—One National Single Dial Tuning Unit BD No. 222 with No. 28 Illuminator (unit consists of drum dial, antenna and detector coils, two knobs, two tuning condensers, mounted on frame).

AF1—One National First Stage Impedaformer.

AF2—One National Second Stage Impedaformer.

AF3—One National Third Stage Impedaformer.

TF—One National Tone Filter.

C, OC—Two Aerovox .0001 mfd. moulded mica condensers.

C3—One Aerovox .00025 mfd. moulded mica condenser.

C6—One Aerovox .001 mfd. moulded mica condenser.

C4, C5—Two Tobe .5 mfd. bypass condensers.

1, 2, 3, 4, 5—Five General Radio sockets.

S—One Yaxley Switch.

R2—One Carter 20 ohm Rheostat.

L5, L6—Two National RF chokes, with two Lynch Equalizor mountings.

R3—One Lynch 2 meg. grid leak with single mounting.

R4—One Lynch No. 4/5 Filament Equalizor with single mounting.

R1—One Lynch 15 ohm Filament Equalizor with single mounting.

One—Bakelite front panel, 7 x 18 inches.

One—Bakelite subpanel, 10 x 17 inches.

Two extra knobs to match those on coil shafts, and to be affixed to rheostat and switch shafts.

One fuse clip or No. 45 Universal Peewee clip for cap of 222 tube.

One CeCo type RF22 tube; two CeCo type G for detector and first audio; one CeCo type A and one CeCo type F12A.

Small variations from these conditions are allowable but they should be consistent. For example, if the plate voltage is lowered the voltage applied to the screen grid should also be lowered and in proportion. The grid bias may also be varied by half a volt or so up or down without seriously upsetting the adjustment of the operating conditions.

Load It Up

The load condition is one of the most important. If the tube is driving an empty circuit it will do no work. It will do no more useful work than a horse pulling an empty wagon around a circle. So to get something out of the screen grid tube it must have a load.

The load on the circuit is the impedance in its plate circuit. A small primary on the coupling transformer is a small load, a large one is a heavy load. This simply means that the primary winding connected in the plate circuit of the screen grid tube should have many turns. The more turns for a given size of coil form the higher the amplification will be.

The National Screen Grid Five is an example of proper design for a screen grid tube amplifier. The number of turns on the primary, or L2 in Fig. 1, is almost as high as the number on the secondary. This coil is particularly adapted to the CeCo R-22 tube, provided that this tube is operated under the voltage conditions outlined above as the proper berth for the screen grid tube.

The proper grid bias for this tube is obtained from the voltage drop in the Lynch 15 ohm Equalizor R5 when the Carter 20 ohm rheostat R2 is set so that .132 ampere flows in the filament. This rheostat serves as a volume control. When more than five ohms of it is used the filament current will be less than normal. The grid bias also will be less than normal. Both the reduction in the grid bias and the filament current serve to reduce the amplification when required.

Boosting Selectivity

As the amplification mounts to high values the apparent selectivity drops. This is often a complaint in connection with screen grid tube operation. But the apparent drop in the selectivity need not be a disadvantage. The use of a tickler on the detector tube will more than offset it, and when the regeneration is high the

(*Continued on page* 19)

Definitions for Novices

Volt (*abbreviated "v"*).

Electrical pressure is measured in "volts" just as steam pressure is measured in "pounds per square inch." You can see steam when it escapes from a boiler, per safety valve, when the pressure is too great, and you can see electricity, in the form of lightning, when it escapes from a cloud during a thunderstorm, under similar conditions. An electrical pressure of one volt will cause electricity to flow at the rate of one "ampere" through a resistance of one "ohm." (*See* below).

Ohm (*abbreviated "ω"*).

This is a unit of electrical resistance. Metals have a low resistance, measured usually in ohms. Insulators have a high resistance, measured usually in meghoms (millions of ohms). There are many intermediate classes. Glass, glazed porcelain, sealing wax, ebonite and dry wood, for example, are good insulators, or bad conductors. A piece of dry wood 1 foot long and 1/16th inch square in section has a resistance of about 100,000 megohms.

Silver is the best known conductor and copper the next best. The resistance of a piece of copper 1 foot long and 1/16th inch square in section is about two thousandths of an ohm. Thus, the electrical resistance of copper is about one two hundred millionth of that of dry wood. The resistance of good conductors varies, as a rule, if the temperature is varied. The resistance of absorbent insulators is affected also by the amount of moisture present.

Ampere (*abbreviated "amp" or "∝"*).

In ordinary language the idea of a "rate" is conveyed by some such expression as "miles per hour" or "gallons per minute." An exception occurs in the case of ships, where the speed is measured in knots. A "knot" is a nautical mile per hour. Here one word is used to convey the idea of a rate—the rate of movement of a ship through the water. If this idea is fully grasped it should be easy to understand the ampere, which is the unit employed in measuring the *rate of flow* of electricity in a circuit. We could measure in other ways, but these are less convenient. It is more satisfactory to talk of amperes than of "trillions of electrons per second" (nearly 6½ million, million, million electrons per second = 1 ampere) hence the use of this term.

Ampere hour (*abbreviated "amp-hr"*).

This is apt to be very confusing. An "ampere hour" is a *quantity* of electricity—the quantity which is equivalent to one ampere flowing for one honr. Storage batteries absorb and give out electricity, and the *quantity* put in or taken out is measured in *ampere hours.* Quantity of electricity can be measured in electrons just as quantity of water can be measured in molecules, but these units are very much too small for convenient use. The pint or the gallon are more convenient for fluids, and the "ampere hour" is more convenient for electricity.

Note carefully that an ampere is a rate of flow, like "a gallon per hour," and that an "ampere hour" is a quantity, like "a gallon per hour for an hour."

Microfarad (*abbreviated "mfd" or "μf"*).

Electrical "capacity" is measured in microfarads because the basic unit, the farad, is much too large for convenience (1 microfarad = one millionth of a farad). Electrical capacity is capacity for holding electricity *qua* electricity, as in a condenser—not as in a battery, where the energy is stored in a chemical form (*See* condenser).

Condenser.

An arrangement for bringing charges of electricity (of opposite sign) close together, but without actual contact. Usually a condenser consists of two sets of conducting surfaces of copper, aluminum or tinfoil, separated by insulating material such as mica, paper or air. The quantity of electricity that can be got into an ordinary condenser is negligibly small by comparison with that which can be stored in a battery, and condensers are not used in this way. A condenser charged with electricity is analogous to a cylinder charged with gas, for the amount it will contain depends upon the pressure applied. A condenser of one microfarad capacity will contain one thirty-six-millionth part of an ampere hour at a pressure of 100 volts and twice as much at a pressure of 200 volts, and so on, until the insulator fails, which is equivalent to the cylinder bursting.

Microhenry (*abbreviated "mhy." or "μH"*).

The unit of inductance used in low frequency circuits is the Henry, and that used in high frequency circuits is the microhenry. One microhenry is equal to one-millionth part of a Henry. An ordinary radio tuning coil has an inductance of about 150 microhenries, and a low frequency choke has an inductance of about 10 million microhenries, *i.e.*, 10 Henries. All electrical circuits possess inductance, and the inductance of a circuit is proportional to the amount of magnetism it sets up when an electric current flows through it. Coils have high inductance, straight wires low inductance, and a wire doubled back upon itself has very low inductance.

An inductance coil or choke offers opposition to the passage of alternating currents, but not to the passage of a steady current.

Impedance (*measured in ohms*).

The effect of inductance depends upon the frequency of the current. If the frequency is zero, *i.e.*, if the current is a steady D.C. (as from a battery), the effect is nil, and if the frequency is high, the effect is great. Thus an inductance of 100 microhenries has an appreciable effect at radio frequencies (1,000,000 or so), but has a negligible effect at speech frequencies (1,000 or so). The term impedance is used to express the opposing effect of a circuit containing inductance (or inductance and capacity), and its use without reference to the frequency is, of course meaningless. As an example, the impedance of a standard loud speaker is 5,650 ohms at 525 cycles per second, 18,000 ohms at 1,000 cycles, and 33,000 ohms at a frequency of 1,700.

Choke.

A choke is a highly inductive winding used for the creation of potential differences or for limiting the flow of alternating current in a circuit. In radio reception there are high frequency chokes and low frequency chokes. The former consists of a large number of turns of fine wire wound usually on an air or non-magnetic core, and are used for preventing R.F. currents from passing to the A.F. circuits. The latter are wound on laminated iron cores, and are used in conjunction with condensers as an alternative to a pure resistance in low frequency amplifiers, and in filter circuits.

Frequency.

An alternating or oscillatory current flows alternately in opposite directions through the circuit. A complete cycle of alternation occurs when two reversals have taken place, and the current is again flowing in the original direction. The frequency is the number of cycles which occur in one second. The frequency of an ordinary electric lighting circuit is 50, speech current frequencies are of the order of 1,000 and radio frequencies of the order of 1,000,000.

Radiation.

In radio this means the throwing off of electro-magnetic waves from an aerial. All transmitting aerials radiate energy when transmitting, and all receiving aerials re-radiate some of the energy received. This re-radiation is of no importance in ordinary cases.

Re-Radiation.

A receiving aerial, when receiving, has feeble currents induced in it—currents which are identical in form with those of the transmitting aerial. Feeble as they are, these currents are capable of radiating energy, and they do, in fact, "re-radiate" some of that received from the transmitting station.

Oscillation.

This implies the existence of high frequency alternating currents in a circuit. Such currents created by thermionic valves, form the basis of modern radio telegraphy and telephony. In receiving circuits the valves may create oscillating currents if too much reaction is employed, and in such cases energy is radiated from the aerial. This causes a heterodyne whistle, which interferes with the reception of other listeners. It should be noted that this is a radiation effect, and not re-radiation, as is sometimes stated.

Kilowatt (*abbreviated K.W.*).

The electrical unit of power is the "watt." One kilowatt is 1,000 watts. A power of 746 watts is the same as one-horse power.

Counterpoise.

A counterpoise is an insulated metallic "earth" system used in place of, or in conjunction with, the ordinary earth connection. In transmitting stations its use makes for higher efficiency. In reception it makes possible very sharp tuning, and is also useful as an alternative where the true earth is "noisy" owing to leakage or induction, etc.

Grid Bias.

If the grid of an A.F. amplifying tube is inaudible when listened to by means of and distortion will result. If it is made sufficiently negative another kind of distion will become evident. For distortionless (A.F.) amplification, it is necessary to "set" the grid potential to a valve approximately mid-way between these limits, or, in other words, to give to the grid an appropriate "bias" in the negative direction.

Heterodyne.

Although an unmodulated carrier wave is inaudible when listned to by means of a broadcast receiver, two carrier waves are audible if nearly of the same wavelength. The reason is that one modulates the other by the method known as heterodyning. The pitch of the resulting audible note, the "heterodyne whistle," is determined by the difference in frequency of the heterodyning waves.

Transformer.

There are two kinds used in radio, R.F. and A.F. The former consists of many turns of fine insulated wire wound upon a laminated iron core, and is used for passing energy from one circuit, the primary, to another, the secondary; while at the same time changing the pressure or voltage. The voltage ratio may vary from 1:1 to 1:40 or thereabouts in practice, but 1:2, 1:4 and 1:6 are more normal values. A high ratio transformer must be followed by a power tube, if strong signals are to be received without distortion.

Quality First, Volume

Rating of AF

By James H. Carroll

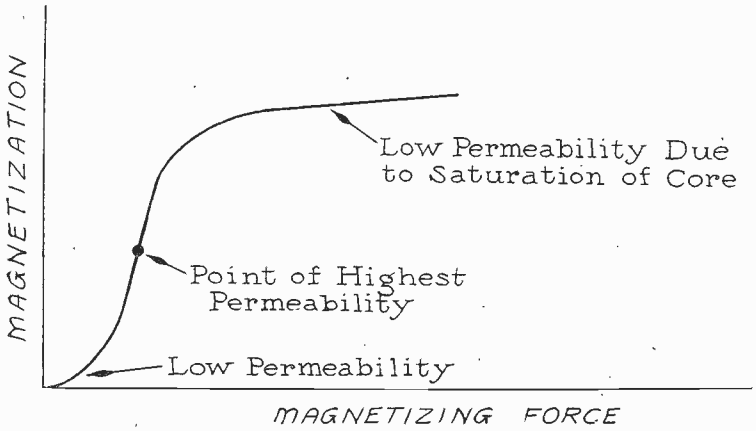


FIG. 1
THIS SHOWS PART OF A TYPICAL MAGNETIZATION CURVE OF TRANSFORMER STEEL. AN AUDIO TRANSFORMER SHOULD BE OPERATED WITH SUCH PRIMARY CURRENT THAT THE OPERATING POINT ON THE CURVE FALLS ON THE POINT OF HIGHEST PERMEABILITY. IF CURRENT IS EXCESSIVE THE OPERATING POINT FALLS ON THE LEVEL OR SATURATION REGION OF THE CORE. LOW AMPLIFICATION AND DISTORTION WOULD RESULT FROM OPERATING WITH TOO MUCH PRIMARY CURRENT. SOMEWHAT SIMILAR RESULTS WOULD BE OBTAINED IF THE PRIMARY CURRENT WERE NOT ENOUGH.

THE audio frequency transformer has made great strides toward perfection during the past three years, due to concentrated research and experimentation by leading engineers.

The prime function of the audio frequency transformer is to take the energy passed on to it from detector or audio tube and pass it on to the next one so that it not only is an accurate reproduction of the signal received from the broadcasting station, but also amplified as much as possible without distortion.

The vital performance is that the most faithful reproduction of all frequencies be obtained. The degree of amplification throughout the whole stage, while important, is a secondary consideration now.

Among radio fans are many sects, so to speak, with decided audio frequency favorites.

Many will not have anything but resistance coupling; others favor impedance; still others like a combination of both, or a combination of the one and the other, together with a transformer; then there is the great army that sticks to transformer coupling.

At present an old favorite, push-pull audio, is coming back. This is a very faithful means of reproduction, especially in these days of high voltage and super power tubes. Very fine results may be had from a properly designed system of this kind, using types —50, —10 or —71 tubes with rated voltages.

Taking the transformer field as a whole among the hundreds of different makes and types, there is unquestionably a difference in performance and tone quality. Some few may give better results than others—some will give greater amplification with a tendency toward distortion or overloading, while others may give equal amplification but with better tone quality, while still others may be lacking in both factors.

Much of this is due to the circuit used, the tube impedances or the amount of "kick" in the front end of the circuit that it built. It is unfair to condemn a transformer without taking into consideration all these angles, for, while on type might not work to your satisfaction in your proposed hook-up, it might work beautifully in the other fellows of different characteristics throughout.

It is also expecting too much of an old type transformer to ask it to deliver present-day results under the load delivered by improved tubes, better circuits and auxiliary parts, together with greater power. That is why it is best to buy new transformers, suited to your use in the new receiver, than to try to use the old ones that have given yoeman service in many of your experimental circuits.

Grid Must Stay Negative

In weighing the merits of the audio frequency transformer for our uses, let us first consider its construction with regard to its capability to handle the current which passes from the plate circuit of the tube to the transformer primary.

One end of the secondary is connected to the grid of the next tube and the other end to negative C, so that this following tube operates on the most effective point of its characteristic. A good audio transformer meets this need.

The capabilities of our modern audio frequency amplifier tubes, power tubes and super-power tubes are wasted if the audio frequency transformers are not able so to operate in conjunction with the tube characteristics that faithful reproduction flows smoothly through the output.

The variation of current through the plate circuit must truly follow the variation of voltage applied to the grid circuit. To make this possible, the grid must be kept from becoming positive, for where the grid is positive, grid current flows producing distortion.

Limit to Desired Swing

Increasing the grid signal voltage causes an increase in response in the plate circuit, and vice versa. Here there is a limiting swing to the grid.

At the upper end of the swing is the maximum grid voltage—that which, in association with the grid bias used still keeps the grid negative.

The design of the audio frequency transformer, therefore, should provide for the most efficient possible use of the amplification furnished by the tube, without distortion; therefore the transformer and tube combination should function so that the response is relatively the same at all useful audio frequencies, the main difficulty in perfecting the transformer centers practically on this.

Another of the obstacles to be overcome in design arises from the characteristic of the tube working with the transformer, since this characteristic depends upon the load impedance, or primary, in the plate circuit.

Unfortunately, this impedance of the transformer primary winding is not a constant property. It depends not only on the resistance of the winding but also on its inductance, which is a measure of the magnetic field produced by the winding. By means of this magnetic field the energy is induced in the secondary circuit. This effect produced in the plate circuit by the transformer inductance is in turn dependent on the frequency of the current traveling through it.

Choke Coil Analogy

There is a close analogy between the transformer action and that of a choke coil, the transformer primary winding acting as a choke coil to prevent the passage of varying currents and also in smoothing them out. The transformer's action varies as the frequency, yielding

Next, Public's New Transformers

Contributing Editor, Associate, Institute of Radio Engineers

a lesser impedance with very low frequencies, while at high frequencies its impedance rises to greater values. As the amplification factor of the tube depends upon the impedance in the plate circuit, it follows that the overall amplification will vary with the frequency.

It is therefore necessary to design the transformer so that the primary winding has a high inductance. The inductance may be so arranged that the primary impedance is about three times that of the tube at a low frequency. The amplification above this point should remain practically constant over the whole stage, while below the measured frequency point it will fall away quickly. This is about the happy medium and as close as we can approach to the ideal at present.

A suitable audio frequency transformer should show a good frequency characteristic and its chart should show that with a frequency change of from 30 to 10,000 cycles it should amplify all the audible frequencies with relatively equal intensity.

Several Fine Makes

The greater the variation in the transformer, the less suited it is for your purpose—true reproduction. Fortunately, the several modern makes of audio frequency transformers meet the requirement well.

As to transformer ratios, the high ratio transformer in general, will give greater volume than a low ratio transformer, unless the high ratio is due to a skinny primary. The use of high ratio transformers is not always desirable, and the medium ratio is in more general use, because distortion is more readily avoided and the reduced amplification at high frequencies balances the gain at low frequencies to produce even response. So that the low frequencies be fully covered by the transformer, its primary inductance should be considerably greater than 10 henrys. This higher inductance, however, cannot well be obtained unless a greater number of turns are used on the primary and for the given transformer ratio the number of primary turns must go up proportionately. Also a large core is needed. Hence, the growth in size of the up-to-date transformer. Core saturation is rendered less likely.

Among the transformers that have passed through the authors hands recently and that he has had the opportunity of testing, charting and using under actual load, are, the new Karas, type 28, the regular Karas Harmonik, the new Sangamo line, just placed on the market, the Tyrman audio transformers, The Farranti line, the Silver-Marshall and the Victoreen 112.

No Distortion

All these operated without distortion under the heavy loads and showed a practically uniform amplification for all frequencies and intensities within the broad-

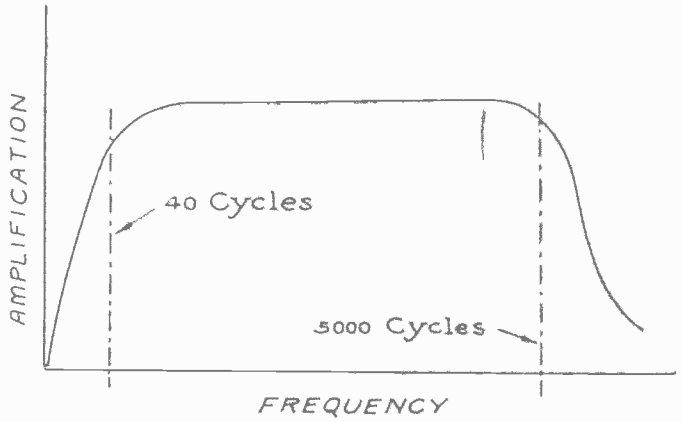


FIG. 2
THE AMPLIFICATION CHARACTERISTIC OF A CERTAIN AUDIO TRANSFORMER SHOWING A RAPID DECREASE OF THE AMPLIFICATION ABOVE 5,000 CYCLES. THIS FALL IS TO ELIMINATE BACKGROUND NOISE. AT THE LOW FREQUENCY END THE AMPLIFICATION REMAINS HIGH DOWN TO 40 CYCLES. A LARGE INDUCTANCE PRIMARY AND LACK OF CORE SATURATION ACCOUNT FOR THE HIGH LOW NOTE AMPLIFICATION.

cast range, at the same time delivering the maximum power obtained from the tube used at the pre-determined maximum intensity of input. It goes without saying that these tests were up-to-date, the 112, 171, 210 and the new 250 tubes being used in single, double and push-pull combinations.

The transformers named were also taken apart and examined thoroughly with an eye to all the details of construction.

The Sangamo transformers showed fine choice of turns ratio and transformer constants and a careful selection of high-class materials, resulting in a distortionless transformer capable of delivering exquisite tonal quality. These transformers, charted, yielded almost an ideal curve.

The Ferranti transformers are beautifully and wonderfully constructed, also—a job of skill and precision. They charted perfectly and under actual test reproduced frequencies, without trace of distortion, ranging from 15 to approximately 20,000 cycles, all these tests giving true speech reproduction, with the musical tones sweet and melodious. These transformers are also shielded in their beautiful glossy black cases.

Large Volume

The Karas line showed a remarkable curve, with a flat top characteristic. The flux density and inductance answered all the requirements. Under actual load in many differing type circuits, these transformers also gave a consistent performance with pure, sweet tone, and astonishing volume.

The new Tyrman audio frequency transformers, used in the "Tyrman 70" and other circuits, present a striking example of the modern large transformer capable of handling any load, yet with true tone and quality. They answer the exacting demands of present outputs. They are well shielded.

The well-known Silver-Marshall transformers are splendid examples of outstanding instruments. Charted by the author, the frequency line shows a practically ideal curve. A sharp cut-off above the limit of the musical range minimizes any tendency toward oscillation at high frequencies. The noise level is also reduced at all frequencies. In actual operation, the tone is clean-cut, sweet and melodious and the low notes are brought forth at full value.

Expert Design

The Victoreen 112 is an example of modern design in heavy power reproduction, with one of the best cores used in any transformers, and with a low ratio, for finest quality. Designed by John Victoreen for perfect quality. Wide tonal limits were amply allowed for in expert design, and absence of distortion provided for by the proper combination of core and turns ratio. The 112 is a unit consisting of two transformers built into a single case.

These, therefore, are the qualifications of the good transformer, with a few examples of the modern makes answering these requirements. You cannot go wrong with any of these. There are, of course, other good types of audio frequency transformers, but the author cited those examples of fine transformers with which he is experimentally most familiar.

New Plan to Keep Assigned

By J. E. Anderson

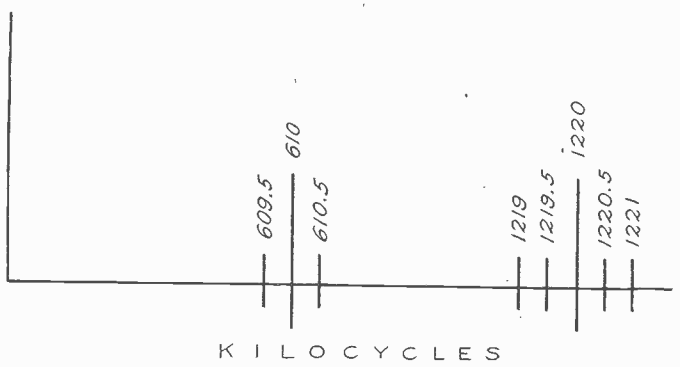


FIG. 1
THIS ILLUSTRATES ONE CASE IN WHICH TWO STATIONS, BOTH STAYING WITHIN THE ALLOWABLE FREQUENCY VARIATION LIMIT, MAY CAUSE A BEAT FREQUENCY OF 1,500 CYCLES. THE 610 KC STATION MAY OPERATE ON 610.5 KC. THE 1220 KC STATION MAY OPERATE ON 1219.5 KC, WHICH WOULD BEAT WITH THE SECOND HARMONIC OF 610.5 KC AND PRODUCE A FREQUENCY OF 1,500 CYCLES. LIKEWISE IF THE 610 KC STATION OPERATED ON 609.5 AND THE 1220 KC STATION ON 1220.5 KC, THE BEAT WOULD BE 1,500 CYCLES.

FREQUENCY stabilization seems to be the keynote to the successful operation of many stations without mutual interference. If any more stations are to be added to those already in operation it is imperative that the various stations be held very closely to the assigned frequencies. Indeed, if many stations now in operation are to remain on the air a greater stabilization is necessary than is now technically practical.

The Federal Radio Commission now requires that any station remain within 500 cycles of the assigned frequency. That is as well as can be done at the present time, but it is not good enough. If one station strays 500 cycles off in one direction and another station assigned to the same frequency strays off 500 cycles in the opposite direction the two will beat, if operating at the same time, at a frequency of 1,000 cycles. Since the frequency of neither of these two stations will stay constant, the frequency of the beat may have any value betwen zero and 1,000 cycles and the beat is likely to vary continuously, giving rise to a very unpleasant growl or wail.

Adjacent Channels Would Interfere

But the interference between two stations nominally operating on the same frequency is not the only disturbance which results from this allowable frequency variation. Two stations operating on adjacent channels might beat at a frequency of 9,000 cycles, which is a very high pitched squeal but nevertheless audible. It is much more easily audible than the 1,000 cycle beat which is the normal beat between two stations operating on adjacent channels.

There is still more interference possible within the 500 cycle limit. . A station operating on the second harmonic frequency of that of another is allowed a deviation of 500 cycles and so is the station operating on the first harmonic. But every receiver will double the frequency of the lower of these two stations, and if the lower frequency station strays off 500 cycles the second harmonic frequency strays off 1,000 cycles. Thus if the two stations stray off in opposite directions there is a possible beat of 1,500 cycles. The actual beat frequency heard may have any value between zero and 1,500 cycles. This beat is very often heard because stations have been assigned to operate on frequencies which are just twice the frequencies of another station operating in the same locality.

Proposed Limitation of Fluctuation

It has been proposed that as soon as the art of frequency stabilization has been developed to the point where it is possible to hold the frequency of any station within 25 cycles of the assigned frequency the limit be set at 30 cycles above or below the nominal frequency. Even that would not be sufficient, because any two stations operating on the same assigned frequency might beat at a frequency of 60 cycles. That beat would not be any more pleasant to hear than the 60 cycle hum from the power lines.

With this limitation on all station frequencies the possible beat frequency between one station and another station operating on the second harmonic frequency of the first would be 90 cycles. That would be a very objectionable disturbance.

And we cannot even hope for as close stabilization as that for some time to come. While it now is technically possible to hold a station within 25 cycles the equipment necessary is far from simple. As long as any station cannot expect to keep its frequency assignment longer than three months, it would be unreasonable to demand the installation of expensive and complicated stabilization equipment.

A Proposed Solution

Alfred H. Grebe, pioneer radio manufacturer and broadcaster, has proposed that a high-power transmitter, capable of being received in every section of the country, be erected for the transmission of standard frequencies against which any station could check its own frequency at any time. This standard frequency station would be under the supervision of the Bureau of Standards, which would keep the frequency, or frequencies, constant to the highest possible degree.

To a certain extent this is done now but the service is intermittent and is not available in all sections of the country for lack of radiated power.. What is needed is power enough to reach every station operating, and continuous operation so that any station could check its frequency at any time during operating hours.

This standard frequency station would require a channel which is now needed for some other service. But it is difficult to think of any service which would be of more value to all concerned than this standard frequency station.

No Waste of Channel

It would not be necessary to take one of the broadcasting channels for this purpose. But even if one were chosen it would not be necessary to waste the channel as far as broadcasting is concerned for the radiated standard wave could well be modulated. In fact one of the high-power existing stations could be utilized for the purpose, preferably one located near the geographical center of the United States.

While only one standard frequency would be radiated by this method all stations could use it for checking their frequencies by simple and well-known methods.

Another Solution

There is another way in which the central standard frequency station idea could be applied and that is by impressing all the broadcast frequencies on a single high frequency carrier and by radiating this modulated carrier at very high power.

Every broadcast station would tune in the high frequency carrier and pick out the particular broadcast frequency assigned to it. The frequency selected could then be used to control the frequency of the local oscillator just as a broadcast frequency is controlled now by a master oscillator or quartz crystal. The control of the frequency could be effected without any variation.

The various broadcast frequencies impressed in the high frequency carrier could be obtained from a single standard oscillator by selecting suitable harmonics and amplifying them to the required degree. If that were done there would be no beat frequency possible between two stations operating on the same channel or between two stations one of which operated on the second harmonic of that of the other.

Variation Permissible

If all the broadcast frequencies were obtained from a single source it would make little difference whether the fre-

All Stations on Their Frequencies

Technical Editor

quency of the source were held constant or not, except as a deviation would cause interference with other services which were not on the standard.

Although it would not be necessary to hold the primary standard to a high degree of constancy there is no technical reason why it should not be held constant to at least one part in one million. Equipment is available whereby the frequency of an oscillator can be held to such constancy and it is not so complex that it could not be installed in the laboratory of the standardizing transmitter.

Even the high frequency carrier itself could be held to the same high accuracy and by the same means. A deviation in the frequency of the high frequency carrier would not affect the efficacy of the standardization if the modulating frequencies were held constant, unless the deviation should be so great as to detune the receiver used for picking up the standard frequencies by the broadcast stations.

The Standard Oscillator

Since the broadcast channels are spaced 10 kc apart a suitable frequency for the primary standard oscillator would be 10 kc. The first broadcast frequency to be impressed on the higher frequency carrier would then be the 55th harmonic of the frequency of the standard, which would be a frequency of 550 kc. The next would be the 56th harmonic which would be the 560 kc broadcast frequency. The last in this series would be the 150th harmonic which would give the 1,500 kc broadcast frequency. Altogether there would be 96 harmonics to be selected, amplified and impressed on the high frequency carrier.

Simplification might be effected, since it would not really be necessary to transmit harmonics which were multiples of some other transmitted harmonic. For example, if the 55th harmonic is transmitted the 110th could be obtained from that by doubling. Thus it would be necessary to transmit only the harmonics from the 55th to the 75th.

Keeping Standard Constant

The standard frequency could be generated by an oscillating quartz crystal ground accurately to give the required 10 kc frequency. To hold this frequency constant to a very high degree it would only be necessary to keep it at a constant temperature, a constant oscillating amplitude and constant damping.

All these factors could be regulated automatically. A constancy of two parts in 3,000,000 could be maintained. This would mean that the highest broadcast frequency, 1,500 kc, would not vary by more than one cycle. This constancy is ten times greater than would be necessary, assuming that a deviation of 10 cycles would cause a possible beat interference of 20 cycles with a station not operated from the same frequency source, but from a source of equal constancy and accuracy.

Canada, for example, might choose to operate all Canadian stations from a central standard different from that used in the United States. Likewise Mexico might choose a different standard. The stations on any one national standard would not mutually interfere even if the standard varied. But the stations in one country would interfere with those in another unless each standard was accurately adjusted absolutely and held constant.

Perhaps the day will come when an international frequency standard will be maintained in the Bureau Internationale des poids et mesures in Paris where the more fundamental standards of mass and length are now kept. From this international standard all national prototype frequency standards could be obtained.

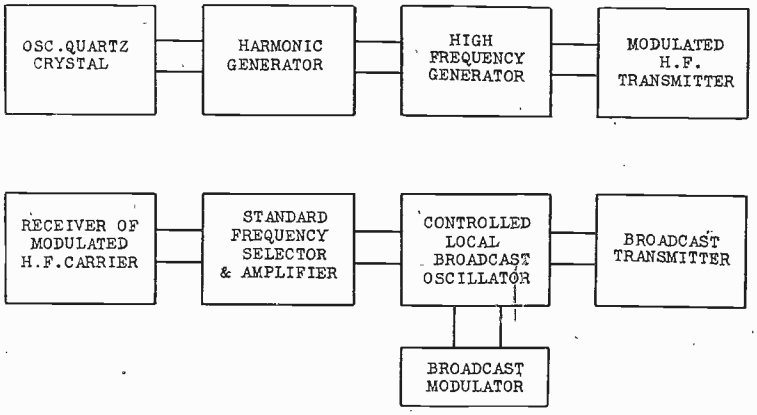


FIG. 2

THIS DIAGRAM SHOWS IN SCHEMATIC FORM HOW A BROADCAST STATION COULD BE CONTROLLED FROM A STANDARD FREQUENCY SOURCE GENERATED AND TRANSMITTED BY A CENTRAL STATION. UPPER SCHEMATIC SHOWS THE STANDARD FREQUENCY TRANSMITTER FROM THE PRIMARY FREQUENCY REGULATOR, THE QUARTZ CRYSTAL OSCILLATOR, THROUGH THE HARMONIC AND HIGH FREQUENCY GENERATORS TO THE HIGH FREQUENCY TRANSMITTER. THE LOWER SCHEMATIC SHOWS THE BROADCAST STATION AS CONTROLLED BY THE STANDARD FREQUENCY PICKED UP BY A HIGH FREQUENCY RECEIVER.

U.S. Plans Farm-Home Programs for Summer

Washington.

As the 1927-28 Winter broadcast season closes, 135 commercial and college radio stations are cooperating with the United States Department of Agriculture in broadcasting educational farming and homemaking features.

The Winter release schedule of the Radio Service of the Department will terminate on April 30. A summer program, including four features—Housekeepers' Chats, Farm Flashes, the Farm News Digest, and the Agricultural Situation—will be carried by most of the cooperating stations.

Plans now are in the making for the 1928-29 Winter season program of the department.

The experience of the past two years—the first two years of the Radio Service—will guide the preparation of next season's program, according to Morse Salisbury, chief of the Service. One important change will provide listeners of each major agricultural section with broadcasts of farming information specialized to fit farming conditions peculiar to their region.

Commenting on the growing appreciation of radios possibilities as an educational medium, Salisbury pointed to the results of a 1927 survey among farmers of two Kansas counties. Federal and State Extension workers report in the summary of the survey, just published, that 34.8 per cent. of the 188 farmer radio listeners interviewed in Sedgwick and Clay counties, Kansas, adopted improved farming practices as a result of information obtained over radio.

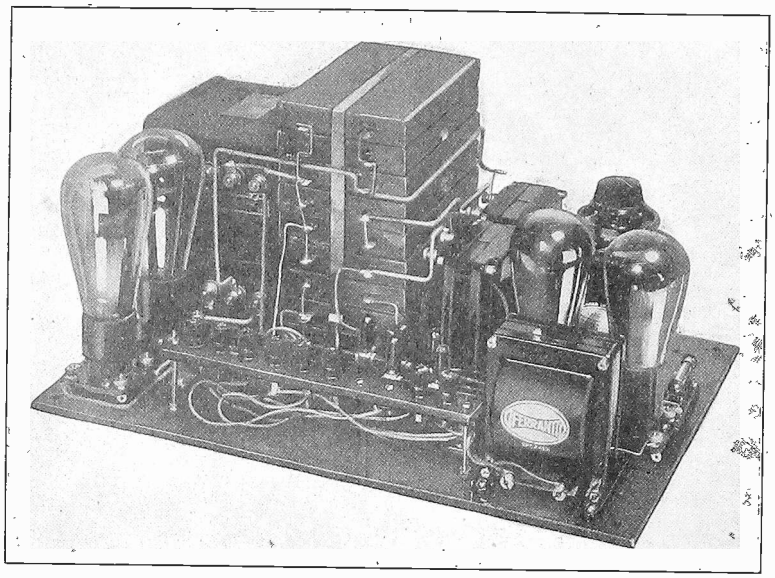
The Extension workers talked with 532 farm families in the two counties. They found that 188 of the families had radios. Radio broadcasts received on these sets had caused directly the adoption of 156 different improved farming and homemaking practices—5.9 per cent. of all improved practices adopted on the 532 farms in the 9 years since Extension work was inaugurated in the two counties.

"Considering the fact that radio has been at work in these communities for not more than 5 years, and extensively—as measured by the number of farm-owned receiving sets—for much less than that period," said Salisbury, "these statistics indicate that radio is now and will increasingly be a most effective means of agricultural education."

The programs are very popular.

A Realistic Push-

By P. W.



VIEW OF THE CONSTRUCTED CIRCUIT, BEFORE THE COMPLETED JOB IS PUT INTO THE CASH BOX.

FOR best tone quality and reproduction real power output from the audio frequency amplifying system is essential. Each passing month sees the idea of amplifiers with plate voltages of from 300 to 400 volts gaining in favor.

No doubt the standard two stage amplifier with a —71 in the output socket has a distinct place and usefulness of its own. On the other hand, no one with an ear at all critical can deny that an amplifying system using either a single —10 tube, or better yet, a pair of —10s in push pull, is much superior in quality, definition, and in the strongly knit background in musical programs.

Certain notes in the audible frequency range call for much more power than others, if they are to be reproduced to best advantage. This is particularly true on the bass side of the frequency scale, where well above average power is required to boom out at their full value the kettle drum or the lowest notes of the bass horns.

Bass at Full Value

One frequently hears it said by radio critics that most commercial sets are capable of reproducing only about 65 to 70% of an orchestral program transmitted by a modern, well equipped broadcasting station. Let the average radio listener hear a power amplifier with —10 tubes and a good speaker, and he hears, perhaps for the first time, the bass music that is so lacking with the conventional set with the standard audio amplifier calling for a maximum of 135 to 180 volts on the plates of amplifier tubes.

Granting that well designed transformers are used in the amplifier, the limiting factors in determining tone quality are tubes and applied B voltages. The final determining factor can be summed up in the maximum undistorted milliwatts output of the amplifying tubes used, for it goes without saying that we are only interested in undistorted output. Consider the —71 power tube in comparison with the —10 and the reason for the advantages of the —10 amplifier is not far to seek.

The —71A power tube has a maximum undistorted milliwatts output of 700. The —10 tube has a maximum rating of 1,540 milliwatts, or more than twice as much as the tube employed in the majority of receiving sets today. With the —10 tube one has double the undistorted power output available, and roughly speaking, twice as much efficiency in covering the frequency range effectively, and when used in push pull due to elimination of even harmonics, two of these tubes will give nearly four times as much output without distortion as a single —10 tube or nearly eight times as much as a single —71 or —71A.

Easily Constructed

In the Ferranti —10 Push Pull AC Power Amplifier is found a unit which will give admirable results, and one that is at the same time easy and convenient to construct from standard parts, all of them readily available. The amplifier eliminator is quite compact, the cash box container measuring 12x16x7½ inches. The cash box may be purchased at any well stocked stationery or hardware store for about $2.50. The cash box serves the double purpose of shielding and providing a convenient container.

The entire unit is mounted on a bakelite base 15½x11x3/16 inches. With the parts mounted as indicated in the photograph of the unit out of its container, the wiring will prove comparatively simple.

The circuit for the combined power amplifier eliminator calls for a pair of —10 tubes in push-pull, with an eliminator system supplying all voltages to the push-pull, power amplifier, and in addition B voltages up to 90 for the set, as well as a negative grid bias of 4 volts. An Abox A eliminator will be found satisfactory by those who desire to supply A current from the light socket for the filaments of tubes in the receiving equipment.

Only Essential Parts Used

In designing the —10 Power Amplifier Eliminator, consideration has been given to satisfactory operation and fine tone quality. Only essential parts have been specified, which in all cases are ample for service requirements.

Used with good receiving equipment, and with an efficient first stage of audio, the Ferranti 210 Push-Pull Power Amplifier gives unsurpassed quality of reproduction. Reproduction is extraordinarily well rounded, with emphasis properly expressed throughout the entire range of audio frequencies. There is full bass, too, affording elusive low notes which are likely to be lacking or poorly reproduced with the conventional two stage amplifier with 180 volts maximum B voltage.

Assembly

Assemble all parts except the resistance and connection kit, as shown in the photograph of the unit removed from the cash box container. Do all the wiring possible before mounting the resistance and connection strips. Next attach the wires to the resistance kit and make necessary connections to the binding post strip. Now complete the condenser connections and check all wiring.

When the unit is completely wired, connect to the 110 volt AC service line and turn on the power, making sure to have a 3 ampere fuse in series with supply lead. If all goes well, check all voltages and insert the tubes one by one; otherwise check all connections and parts until any fault is found and remedied.

Next connect the eliminator to the set and the plate of the first audio tube in the receiver to the input post of the amplifier. Adjust all voltages by means of

Six Fine Hints on Success B Supply

There is nothing complicated about building a B power unit. Given good components and a reliable rectifier, it is simply a question of proper mounting and wiring.

(1) Remember, you have a transformer at one end and choke coils at the other. Both have AC flux. Therefore, guard against interacting fields which may cause excessive hum. Provide sufficient separation.

(2) Use rubber-covered wire rather than bus bar. There is high voltage in the B-power unit. It is well to insulate against it.

(3) Ground all metal cases of transformers, chokes and condensers. It is well to place an electromagnetic shield, such as sheet iron or roofing tin, over the entire B power assembly to prevent stray energy.

(4) When motorboating is encountered, try a larger condenser for the "tank", or last filter condenser. Values as high as 12 mfd. will be found to stop many cases of motorboating, as well as improve tone quality particularly for the sustained bass notes.

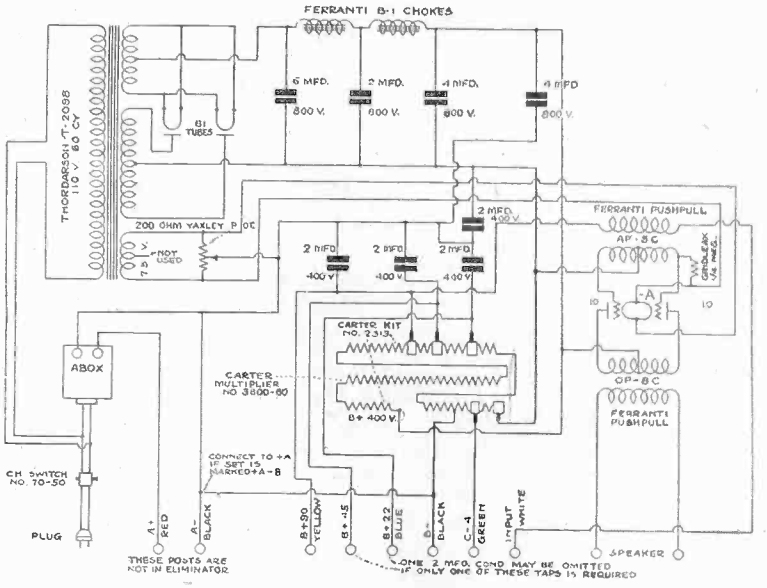
(5) Also try an audio choke in each plus B lead from radio power unite to audio

Pull Power Amplifier

Underwood

LIST OF PARTS

Two Ferranti type B-1 chokes.
One Ferranti type AF-3c audio transformer.
One Ferranti type OP-8c audio transformer.
Two Parvolt 2 mfd. 800 volt series B condensers.
Three Parvolt 4 mfd. 800 volt series B condensers.
Three Parvolt 2 mfd. 400 volt series A condensers.
One Carter No. 2313 resistance kit with multiplier No. P 3800-60.
One Thordarson T-2098 power transformer.
Four Benjamin Red Top No. 9040 sockets.
One Yaxley 200 ohm No. 200 potentiometer.
Nine Eby binding posts marked Input, Minus C 4½, Minus C 40, B minus.
B plus 22½, B plus 45, B plus 90, and Speaker.
One ¼ megohm grid leak with mounting clips.
One Cutler-Hammer 70-50 switch for inserting in AC feed line.
One steel cash box 12x16x7½ inches.
One Bakelite panel 15½x11x3-16 inches.
One Bakelite strip 8¼x1x⅛ inches.
One Yaxley cable and plug No. 660.
Six angle brackets ¾x½ inch for mounting Carter kit and potentiometer.
Brass strip ½x1-32x20 inches, for mounting condensers.
Two screws 1½x6-32 thread with 3 nuts each for mounting connection strip.
Two screws 2x6-32 thread, with 5 nuts each for mounting Carter resistance kit and multiplier.
Thirty screws ½x6-32 thread, with nuts for mounting parts.
Eight screws ¾x6-32 thread, with nuts for mounting sockets.
One Abox "A" eliminator.
Flexible rubber covered.
One CeCo type 12A tube.
Two CeCo type L10 tubes.
Two CeCo type R81 tubes.



THE WIRING DIAGRAM OF THE AMPLIFIER B SUPPLY.

the sliders on the resistance strip. A direct current voltmeter is required for this checking.

Ground Negative

The negative B of the eliminator must be connected to negative B of the receiver and the negative must be grounded to prevent hum.

If motorboating results this usually can be remedied by adjusting the capacity across the B and C taps.

The Ferranti 210 Power Amplifier-Eliminator can also be constructed as a straight amplifier, using one 210 tube, if desired. In this case type AF-3 and OP-1 transformers are substituted for the AF-3C and OP-8C and the wiring changed accordingly.

Line Voltage Gauge Announced by DeJur

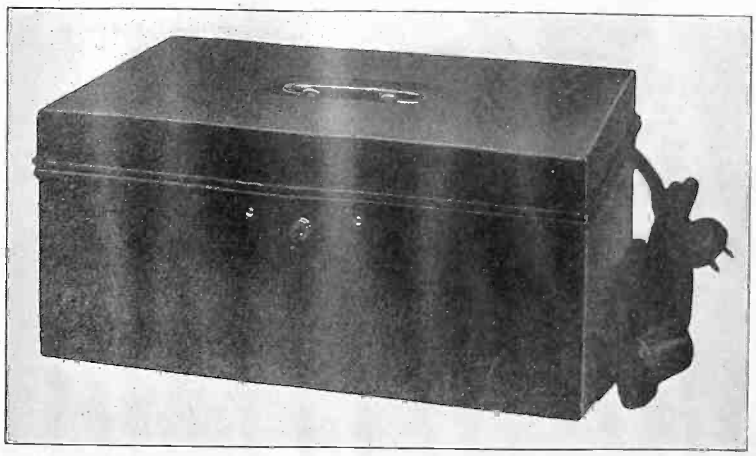
The laboratory of the DeJur Products Co., announces the develpment of a new AC line voltage regulator which solves permits the determination of the actual AC line voltage input into the AC electric receiver, B eliminator or power amplifier, by means of an 0 to 150 AC voltmeter.

The line voltage control is in the form of a high wattage variable resistance, which is varied until the desired AC voltage input value is indicated on the meter. A male plug is provided whereby the unit can be connected to the house power supply, and a female plug is provided for connection to the AC receiver, B eliminator or power amplifier input transformers.

In Building

amplifier, together with 2 mfd. condenser between each plus B lead and minus B. In the RF end, try RF chokes in the plus B lead, with a .1 mfd. condenser shunted across the plus RF plate lead and the minus B.

(6) Avoid overloading the gaseous rectifier, either through excessive transformer voltage or excessive drain. Overload can be handled by the present-day Raytheon tubes for a short period, but tube life is materially shortened.



A CASH BOX OBTAINABLE IN ALMOST ANY HARDWARE STORE IS USED AS THE CONTAINER. WHEN THE SUPPLY IS IN OPERATION, HAVE THE LID AT LEAST PARTLY OPEN, TO AFFORD VENTILATION.

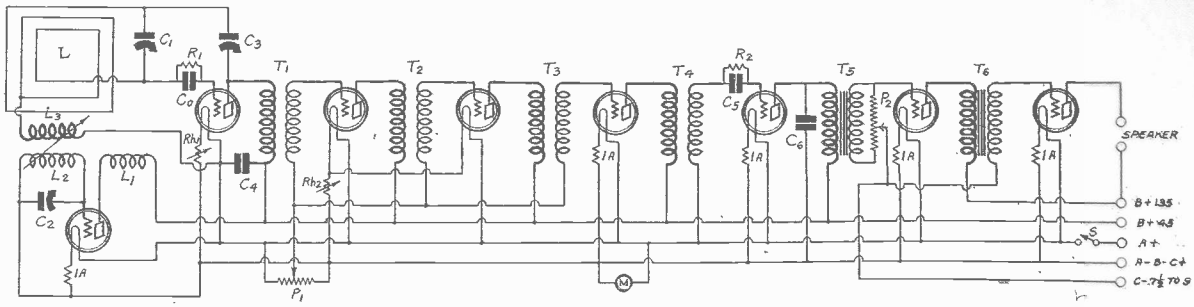


FIG. 615

THE CIRCUIT DIAGRAM OF AN EIGHT-TUBE SUPER-HETERODYNE SUITABLE FOR A PORTABLE RECEIVER. ADEQUATE VOLUME CONTROL INDEPENDENT OF THE TUNING IS A FEATURE OF THIS CIRCUIT. IT HAS A REGENERATION CONTROL C3, A VARIABLE PICK-UP BETWEEN L3 AND L2, A RHEOSTAT, RH1, IN THE FILAMENT CIRCUIT OF THE FIRST DETECTOR, RHEOSTAT RH2 IN THE FILAMENT CIRCUIT OF THE FIRST TWO IF TUBES AND TWO VOLUME CONTROL POTENTIOMETERS

Radio University

A QUESTION and Answer Department conducted by RADIO WORLD, by its staff of experts, for University members only.

When writing for information give your Radio University subscription number. Be sure to put number on outside of envelope and at head of letter, also!

PLEASE PRINT a diagram of an eight tube Super-Heterodyne having regeneration in the loop and in which the volume can be controlled adequately without detuning. The circuit must be sensitive and suitable for a portable receiver.

ORRIN MASTERSON,
San Francisco, Calif.

(1)—See Fig. 615 for this circuit.

* * *

CAN I USE the screen grid tube in my RF amplifier without making any changes in the circuit?

(2)—If any changes are necessary, please tell what they are.

OSCAR LARSON,
Duluth, Minn.

(1)—You cannot use the screen grid tube without changes in the circuit.

(2)—The primary on the three circuit coil you have does not have enough wire to make the tube effective. Put about three times as many turns on the primary as you have, or else get a new coil which has been made especially for this tube. You must also put in a new filament ballast. Connect the ballast in the negative leg of filament in place of the ballast you now have. You must also change the connection to the grid post on the socket. Socket A post goes to B plus 45 Cap of tube to tuning condenser stator and to grid and coil.

* * *

FOR TWO YEARS I HAVE used the 5-tube Diamond of the Air and it has given fine results both as to volume and quality. Recently a crackling, static-like noise appeared which I have been unable to locate. It is so bad at times that I am forced to turn the set off and at other times it is barely noticeable.. I know it is not real static for a friend of mine does not have the same trouble on the same kind of set. Could you tell me what the cause is and how it can be remedied?

LAWRENCE DAVIS,
Philadelphia, Pa.

(1)—The noise may be due to a defective electrical appliance in your own home or in the home of a neighbor. Anything electrical that has moving contacts might be at fault. The trouble may also originate in a power line nearby, in which case a defective insulator might be the cause. It may also be that your own or your neighbor's antenna is swinging and scrapes against a piece of metal or a wet wall. If the trouble stops when you disconnect the antenna it is of external origin. If not, it originates in the set. If the trouble is of outside origin there is nothing to do except find the defective device and then fix it. If it originates in the set the receiver needs an overhauling. Grid leaks and plate resistors should be replaced experimentally.

* * *

WHICH IS THE BETTER loudspeaker, an exponential horn with a good unit or a cone type speaker?

(2)—I am using a —10 type tube with 350 volts on the plate in my receiver. I use the secondary of an old audio transformer for output choke and a 2 mfd. condenser in series with the speaker. The low tones do not come out as they should, and there seems to be considerable overloading on even moderate volume. Can you tell me the probable cause?

GEORGE EGBERT,
Salt Lake City, Utah.

(1)—There is little difference if comparison is made between two, each the best in its class.

(2)—The low notes do not come through because the condenser in series with the speaker is not large enough and because the effective inductance of the choke is too low. The heavy plate current through the choke saturates the core. The overloading is undoubtedly due to insufficient effective plate voltage. There is too much drop in the choke coil.

* * *

CAN THE SCREEN GRID Diamond, four-tube model, be built with one screen grid tube, two —99s and one 120? I wish to make a portable receiver according to the four-tube screen grid Diamond hook-up.

JOHN CROFT,
Butte, Montana.

(1)—Sure, it will make a good portable receiver, but subject to the volume limitations of the 120 tube.

* * *

MY RECEIVER will not tune in the longer wavelength stations. WEAF, for example, comes in at hundred on one condenser and on the other it does not have a maximum at all, but seems to be just beyond the 100 mark. WJZ comes in all right but one condenser tunes in a few divisions below the other. How can I remedy this condenser without rebuilding the receiver?

(2)—Could this condition be due to improper filament voltage?

(3)—Do you think that a different grid leak or different condenser would help to bring in the higher wave stations?

CHESTER A. STRUTT,
Newark, N. J.

(1)—All you need to do is to add a few turns on the secondaries of the RF transformers. Add 10 turns to one and 8 to the other. The coil which is across the condenser which does not tune in WEAF should have the 10 turns.

(2)—No.

(3)—The grid leak and condenser have a negligible effect on the tuning in this case. Do not change.

RECEIVER DATA TOLD BY FENWAY

(*Continued from page 7*)

Or a shielded-grid expert. Folks don't rave about this circuit any more than they get excited about the Suwanee River, and yet, when popular tunes are forgotten the Suwanee River sings on, or flows on, as you like it. Some day, doubtless, you'll learn from this copy of RADIO WORLD, which contains the diagram in Fig. 1. You'll study the receiver diagram very carefully. When you're sure that you know it by memory, you'll study the A-B-C power plant. The Thordarson company has spent thousands of dollars in showing set builders how to build this eliminator and power amplifier. RADIO WORLD, has published many, many diagrams of it. Trained experts, like J. E. Anderson, H. B. Herman, and others, have all expressed views regarding its efficiency.

New Speaker Connection

Little need be said by me, save, possibly the fact that I connect the loudspeaker terminal, which ordinarily goes to the -B, to the 2,000 ohm resistor in the grid return circuit of the power tube. This improves quality and boosts up the volume a lot. The complete eliminator is constructed in the rear of the special triple-shielding case. There is ample room in this case for all the parts without crowding. The shielded partition between the eliminator and the set prevents interaction.

Notice that all leads or wires go to a terminal strip. This strip measures 5/8 inch wide by 8¾ inches long, made of 1/8 inch bakelite. Twelve holes are drilled in this, 3/16" apart. Two small brackets hold this strip to the chassis.

Next, the three-point antenna switch. Ordinarily this switch would be shown located in the set apartment and set diagrams, but since the switch is mounted on the middle partition, and because the aerial comes into the set via the eliminator, it is only proper that it should be shown as part of the power plant.

The feed-through switch, which connects or disconnects the line with the set, is shown *outside* the metal case. This is as it should be, since it keeps the AC out of the set, if not out of the eliminator.

Careful Shielding

The location of the heater transformer is very important. Notice just how it is placed. Cast an eye at the two flashlight cells, which furnish the grid bias current for the RF stages. Notice how they are held in place. The "clips" for this purpose are made from the extra metal pieces which come with the Marco dials.

Fig. 3 gives demensions for the triple-shielded case. This case is "that something different" which set builders always expect to find in a new set. It is the result of much experimenting with shielding cases. One need only remember the Fenway Super, back in 1925, to realize that the writer has exercised due diligence in perfecting shielding boxes for radio sets. Properly made, and finished in russet-gold crinkle (which should be baked on at high temperature), this case is rather easy to look at, and its features, which were outlined in last week's article, soon become obvious to the set builder.

Coil data and other interesting points of this five receiver will be discussed next week, issue of May 12.

Why Static is Small On the Short Waves

By Roger St. John Barrett

One of the advantages of short wave reception is the comparative freedom from static disturbances. This in part accounts for the small transmitted power required to communicate over long distances on these waves. The signal that is received can be amplified both at radio and at audio frequency to a much higher degree than is possible at the longer waves before the noise level comes up to the signal.

There are at least two reasons why there is less static in the signals received on short waves. The first is that there actually is less static disturbance at short waves. The second is that the signal constitutes a narower band than it does at the longer waves. Absolutely of course the width of a broadcast wave is the same, namely 20,000 cycles, but relatively it is very much narrower.

At a broadcast frequency of 600 kc the width of 20,000 cycles is 3.3% of the carrier frequency. At a short wave frequency of 20,000 kc the width of the signal band is only .1% of the carrier. This means that for the short waves a higher effective selectivity is required, and one of the most effective ways of reducing static disturbances is to increase the selectivity.

Greater Effective Selectivity

At the longer broadcast wavelengths the selectivity cannot be increased to the required extent because the sidebands would be cut to a point where high note suppression would be ruinous to fidelity.

The relative absence of static from the short waves indicates that natural discharges between clouds and the ground, between cloud and cloud and between various layers of the atmosphere are of a periodic nature, just like the discharge of an old type spark transmitter.

While all spark discharges are broad and cover practically all wavelengths, the discharged energy centers about the natural frequency of the tuned circuit associated with the system. At frequencies very remote from the natural frequency there is very little energy and it is not capable of giving rise to much disturbance in receivers tuned to those frequencies.

Another reason, possibly, why there is not so much static-like noise in signals received by short waves is that the wave is usually not received by the so-called ground wave, that is by the wave which clings to the ground. This wave is quickly attenuated at high frequencies and does not reach more than a dozen miles from the transmitter. The wave actually received is the sky wave, that is the wave which is reflected down from the Heaviside layer.

Most Noise Man-Made

Most of the noise accompaning a signal in a broadcast receiver is man-made and orginates near the ground. This noise is not picked up when the sky wave is received. If the short wave receiver were made so sensitive that it picked up the ground wave there would undoubtedly be more man-made noise accompanying the signal than on the broadcast waves. But if we had to depend on the ground wave for receiving the short waves there would be no need of worrying about the man-made noise for reception would not be practical on the short waves. The sky wave hurdles all the man-made noise and it is not absorbed by the ground, and therefore it reaches the short wave receiver free of much disturbance and with considerable intensity, if it reaches it at all.

Some operators of short wave receivers have complained that no signals can be received with their receivers, even when they are in good working condition. They forget that there are not so many broadcast stations working on short waves as on the broadcast waves, and that the stations are not so crowded as they are in the broadcast band. Also the stations which do operate are not on the air at all hours of the day. But still there are so many stations operating that any one with a short wave receiver should have plenty to select from.

Obtain List of Stations

Any one operating a short wave receiver should procure a list of the stations which operate, as well as a schedule of operation. Knowing at what hour and at what frequency a given station operates there should be no difficulty in picking it up with even the simplest receiver, provided of course that the receiver is not located in a dead spot with respect to the desired station.

If the sky wave of the station desired is 200 miles overhead at the point there is little hope of bringing it down.

It will come down of itself a few hundred miles away, there to entertain the operators of receivers in that locality. Those located in a dead spot with respect to a given station will do better by selecting a station the wave of which comes down to the ground near the receiver. Those located in a dead spot with respect will have an unlimited list of stations to select from. There are over 16,000 amateurs in the United States alone, most of whom are continually "talking" with one another. There is also a host of amateurs in every foreign country, all using the same code language. Some of the "talk" of course will be in a foreign tongue, but that lends greater interest to the signals.

World at Command

Although there are thousands of amateur radio operators using the short waves, their signals form only a small fraction of the total traffic on the short waves below 200 meters. Thus the man who owns a short wave receiver with a set of plug-in coils, like the Karas short wave receiver, has a whole world of radio communication at his command. And it is a busy and interesting world.

[*Those desiring a complimentary blueprint of the Karas Short Wave Receiver may obtain one by addressing a request to* RADIO WORLD, 145 *West 45th Street, New York, N. Y.*]

Long Leak Used With 210 on Short Waves

For long distance short wave reception where a 210 tube is employed as a detector, the grid leak to handle the grid current is often 6 inches long. The RF choking ability of a long resistor is much better than that of a short one. This type of resistor also keeps the tube from paralyzing while the transmitter is being used, whereas the usual type of short resistor requires a second or so to start the tube oscillating.

The sensitivity and stability of a receiver are increased with this grid leak.

A THOUGHT FOR THE WEEK

"A PLAGUE o' both your houses!" as the wounded Mercutio remarked somewhat heatedly of the Montagues and Capulets. And so it might be said of those folk at Washington who, if agin 'em will swear at the so-called inefficiency of the members of the Radio commission, who, if with 'em, will smugly declare that all is well and that things are just as they should be. Who'll point out a middle course and help the poor, war-torn commissioners to see the light and thus end the conflict that adds murkiness to the already overcharged air and bring decent order out of noisy chaos!

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EDITOR, Roland Burke Hennessy
MANAGING EDITOR, Herman Bernard
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1 Inch		10.00
Per Agate Line		.75

Time Discount

52 consecutive issues	20%
26 times consecutively or E. O. W. one year	15%
13 times consecutively or E. O. W.	12½%
4 consecutive issues	10%

WEEKLY, dated each Saturday, published Wednesday. Advertising forms close Tuesday, eleven days in advance of date of issue.

CLASSIFIED ADVERTISEMENTS

Ten cents per word. Minimum 10 words. Cash with order. Business Opportunities, ten cents per word. $1.00 minimum.

Entered as second-class matter March 23, 1922, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

BOBKER IN NEW POSITION

Henry Bobker, long known as one of the livest wires in the tube game, has joined the staff of Cable Supply Company, Inc., 31 Union Square, New York City, makers of the well-known line of "Speed" super-emission radio tubes. Here he has charge of the neon sign division. Mr. Bobker is known all over the country and possesses the friendship and confidence of thousands of dealers and jobbers of the highest rank. —J. H. C.

Service Men Members Welcomed by McCord

About as good a test of any, if one is to determine the expertness of a radio technician, is to have him do service work, especially outside his own shop, on miscellaneous receivers, factory-made and custom-made, AC and DC. First, he has to find out what's wrong, then he has to fix it. While the formula is trite and simple, as expressed in words, it's often novel and difficult, as expressed in work.

Therefore if a man is a good service and repair worker he will naturally be all the better custom set builder, and perhaps will find himself better paid.

It behooves all of us interested in the formation of an organization of custom set builders, national in scope, to think seriously of what the qualifications for membership should be.

A man should be an expert, say many, and that is reasonable. But he may be an expert as a custom set builder and as a repairer of his own handicraft, while a complete failure in tackling the difficult problem of getting defunct or defective sets to percolate. Something therefore should be said in favor of the service man, and qualifications so established as to leave wide room for his entrance into the choice ranks of the new organization, soon to be legally formed.

Prospective Progress

At present the inauguration of the organization looms boldly in the Summer foreground, but the objective will not be reached for several weeks, because organizing a club is something like taking a camel ride in an Arabian desert. You see something right ahead of you, shoot out your hand to grasp it—and your guide laughs as you catch nothing. That's somewhat exaggerated, but it gives you the idea. As in the desert of sand, in the desert of organization under the highly complicated conditions of to-day, there's many a mirage. The object is to be sure there's something firm and solid before you even grab for it. We have that already, and yet we're proceeding slowly.

Several hundred answered the questionnaires published in previous issues of RADIO WORLD. These will be the first ones to receive examination papers, wherein questions will be asked that are addressed to the radio technical knowledge of the applicant. Those who pass the examination will be recommended by the Board of Examiners to the Membership Committee for acceptance, but the Membership alone will have executive authority, the Examiners having merely recommendatory or advisory power.

Those upon whom it is decided to confer the benefit of membership will receive notice to that effect, and will be asked to co-operate along lines to be laid down.

Certificate and Card

After the inauguration of a member has been completed, he will receive a large certificate of membership, of diploma size, and suitable for framing. On this will be a serial number. Also he will get a small membership card, with the same number inscribed thereon.

The large membership diploma is suitable for framing and exhibition. The small card is intended as a means of personal identification and citation in the event the rightful holder of the card is seeking economic advantages to which his membership and calling rightfully entitle him.

The answers to the questionnaires show that it is the desire of those who answered to have a corporation formed, and plans are now afoot to comply with that expressed will.

Lofty Purchase

A Board of Directors, as well as a list of officers, will be voted on, and such steps taken as to insure the conduct of the corporation for the benefit of its members, and to avoid use of the corporation for any partisan, selfish or ulterior object.

One of the proposals to be considered by the Board of Directors will be the authorization of shares of stock and distribution thereof, including the award to each member of stock representing his membership. Hence each member would be a stockholder in the corporation and as such would be entitled to his share of profits accruing from the conduct of the corporation—McCord

SOME NEW APPLICANTS

Frank Lubanda, 611 Pear St. Reading, Pa.
Alfred Tarot, 571 Bird Ave., San Jose, Calif.
Henry L. Thibeault, 4 Lund St., Worcester, Mass.
Joseph J. Sedlake, 10517 Mt. Auburn, Cleveland, Ohio.
Edw. Campbell, Route No. 1, Grove City, Ohio.
Rollin D. Warnick, 441 West 45th St., San Quentin, Calif.
A. Racicot, Box 308, Parris Island, S. C.
G. A. Prodger, Pall Mall 575, London, Ont., Canada.
A. E. Marlatt, 2408 North 41st St., Seattle, Wash.
Carl Stegman, 180 16th St., Wheeling, W. Va.

Stations Get Extension of Licenses Till June

Washington

A blanket extension of all existing broadcasting station licenses until June 1 was ordered by the Federal adio Commission. A general order was also issued requiring stations to obtain authority from the Commission before moving their studios across State lines.

Following is the full text of the two orders, both of which bear the signatures of Judge Ira E. Robinson, chairman of the Commission:

General Order No 27.—All existing licenses to broadcast, subject to such modifications and extensions as may be appended thereto, are hereby further extended for 30 days to terminate at 3 a. m., June 1, 1928, unless otherwise modified.

General Order No. 28.—Under the Radio Law of 1928, approved by the President, March 28, 1928, it is specified that "Allocations shall be charged to the State, District, Territory, or possession wherein the studio of the station is located and not where the transmitter is located." In this particular it is hereby ordered that no broadcasting station shall move its studio outside of the borders of the State, District, Territory, or possession in which it is located, without first making written application to the Commission for authority to so move its studio, and securing written permission from the Commission for such removal. This order does not apply to transfers or removals of studios within the borders of the same State, District, Territory, or possession.

Unique Impedance Effect

By Hardlache Evans

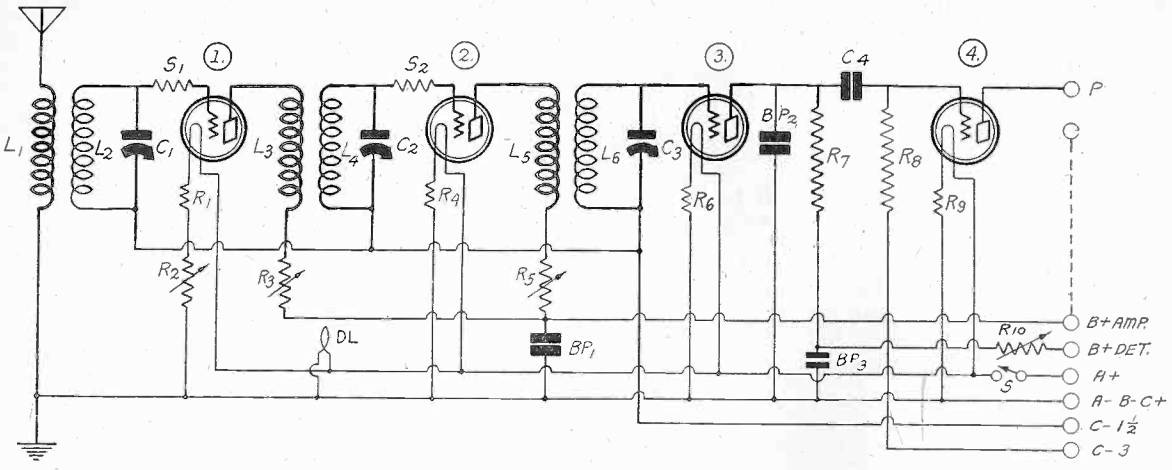

FIG. 1

RESISTORS R3, R5 AND R10 CAN BE USED IN PLACE OF TRIMMERS TO BRING THE THREE TUNED CIRCUITS INTO SIMULTANEOUS RESONANCE PROVIDED THAT THE THREE TUNED CIRCUITS ON THE COMMON CONTROL ARE REASONABLY WELL ADJUSTED TO EQUALITY.

ONE method of overcoming the lack of equality of tuned circuits controlled from a common point is to insert variable resistors in the plate circuits of the RF coupling transformers, that is in series with the primaries. At first glance it is not apparent why this should have any effect on the tuning but a little consideration will show why the resistors affect the tuning constants.

Referring to the first plate circuit in Fig. 1, it is observed that R3 is in series with L3. The primary coil exerts a certain detuning effect on the secondary tuned circuit to which it is coupled. This detuning effect depends on the AC that is flowing in the primary or on the total effective impedance in the circuit. If the resistance in the primary circuit were infinite the effect would be nil, for there would be no current flowing in the primary. The higher the impedance the less the effect and vice-versa. Hence if the secondary circuit is slightly off tune for a given setting of the variable resistor in the plate circuit, it can be brought in tune by either increasing or decreasing the resistance depending in which direction the tuning is off.

There is also a mutual effect on the tuning as far as the tube itself is concerned. The effective input capacity to a tube depends on the load impedance to some extent as well as on the plate to filament resistance of the tube. When the external resistance is increased, or when the effective plate voltage is decreased, the input capacity on the tube changes. Thus the first tuned circuit is affected by the change in the resistance in the plate circuit of the tube. But this effect is not large.

When the resistor inserted in the plate circuit is inductive and has some capacity there is an additional change in the tuning constants of the circuits, both of the first and the second.

What applies to R3 also applies to R5 in the second plate circuit. R10 also has a similar effect, though less, on the tuning of the detector input. Thus by means of the three variable resistors R3, R5 and R10 effects similar to those obtained with trimmer condensers or trimmer inductances can be obtained.

[*The construction of this receiver, intended to work into a power pack that has a transformer audio stage in it, was described last week, issue of April 28.*]

Choice of Tubes for National SG Five

(*Continued from page 8*)

sensitivity of the receiver will be still greater because the tickling increases the effective load impedance on the screen grid tube.

Since regeneration is highly desirable in the detector it is necessary to use a good amplifier tube for detection. A tube of high amplification factor like the CeCo type G tube is suitable. This is a high mu tube.

The third tube in the National screen grid five works into an inductive impedance of high value. Therefore this tube may also have a high amplification constant if a high voltage gain is desired. But a general purpose tube may be used with good results. Either a CeCo type G or a CeCo type AX is suitable, but the G tube is preferable.

The fourth tube works mainly into a resistance and therefore a high mu tube is the best to use. The CeCo type G is suitable.

The last tube in the circuit works into the loudspeaker, which is a low impedance device. Therefore the output impedance of the tube should also have a low value. This requires a comparatively low amplification constant. The CeCo type J-71 or F-12A meets the requirements.

Plate Voltage Adjustments

As has already been stated the plate voltage on the screen grid tube should be 135 volts. The voltage applied to the detector should be 45 volts, the same as that on the screen grid. A low voltage is applied to the detector because there is a negligible drop in the coupling impedance. The same holds true of the third tube, but the applied voltage here should be 90 or more since the signal voltage level is higher.

The plate voltage applied to the fourth tube should be 180 volts since there is a high drop in the coupling resistor. The same is applied to the plate of the power tube.

The grid bias on the first audio tube, that is the third in the circuit, need not be more than can be obtained from the voltage drop in the Lynch No. 4/5 Equalizor, which is about one volt. The bias on the grid of the next tube, the fourth in the circuit, should be considerably more, and should not be less than 3 volts. If the bias is increased beyond 4½ volts distortion is likely to occur in this tube.

The bias on the last tube should be between 40 and 45 volts.

[*Readers desiring a complimentary blueprint of the National Screen Grid Five may obtain one by addressing James Millen, care* RADIO WORLD, *145 West 45th Street, New York City.*]

CeCo Reduces Price of Five of Its Tubes

The C. E. Manufacturing Company, of Providence, R. I., maker of the CeCo line of tubes, and the largest independent tube manufacturer, announced a reduction in the price of five of the tubes of its extensive line.

Type F-12A, equivalent of the 112A, and type J-71A, equivalent of the 171A, formerly at $4.50 list price each, are now $3 each. Type M-26, and N-27, the AC tubes equivalent to the 226 and 326, and 227 and 327, formerly $3 and $6 each, respectively, are now $2.50 and $5 each. The other tube price reduction is for the R-80, full wave rectifier, equivalent of the 280 and 380, the price of which was $5.50 and is now $4.50.

"DOUBLE R" METERS

Our Complete Catalogue of Meters is Contained in This Advertisement

POCKET AMMETER

No. 1—For testing dry cells, 0-40 ampere DC scale pocket meter $1.50

POCKET AND PORTABLE VOLTMETERS

No. 8—For testing A batteries, dry or storage, 0-8 volts DC scale.....$1.65
No. 10—For testing A batteries, dry or storage, 0-10 volts DC scale..... 1.65
No. 13—For testing A batteries, dry or storage, 0-16 volts DC scale..... 1.65
No. 50—For testing B batteries, dry or storage, but not for B eliminators, 0-50 volts DC scale 1.65
No. 39—For testing B batteries, dry or storage, but not for B eliminators, 0-100 volts DC scale 1.85
No. 40—For testing A and B batteries, dry or storage, but not for B eliminators; double reading, 0-8 volts and 0-100 volts DC scale.. 2.25
No. 42—For testing B batteries, dry or storage, but not for B eliminators; 0-150 volts DC scale 2.00
No. 346—For testing B voltages, including eliminators. High ressitance water 0-300 volts DC scale 4.50
No. 347—Same as No. 346, except that scale is 0.500 volts 5.50
No. 348—For testing AC current supply line, portable, 0-150 volts 4.50

VOLTAMMETERS

No. 18—For testing amperage of dry cell A batteries and voltage of dry or storage A batteries, double reading, 0-8 volts, and 0-40 amperes DC.....$1.85
No. 35—For testing amperage of dry cell A batteries and voltage of B batteries (not B eliminators); double reading, 0-50 volts, 0-40 amperes DC .....— 2.00

PANEL VOLTMETERS

No. 335—For reading DC voltages, 0-8 volts..$1.65
No. 310—For reading DC voltages, 0-10 volts.. 1.65
No. 316—For reading DC voltages, 0-16 volts.. 1.65
No. 326—For reading DC voltages, 0-6 volts.. 1.65
No. 337—For reading DC voltages, 0-50 volts.. 1.65
No. 339—For reading DC voltages, 0-100 volts.. 1.75
No. 342—For reading DC voltages, 0-150 volts.. 1.75
No. 340—For reading DC voltages, double reading, 0-8 volts, 0-100 volts..... 2.25

(Panel meters take 2-5/64" hole)

PANEL AC VOLTMETERS

No. 351—For reading 0-15 volts AC.....$2.25
No. 352—For reading 0-10 volts AC..... 2.25
No. 353—For reading 0-6 volts AC..... 2.25
(See No. 348 under "Pocket and Portable Voltmeters.")

PANEL MILLIAMMETERS

No. 311—For reading 0-10 milliamperes DC..$1.95
No. 325—For reading 0-25 milliamperes DC.. 1.85
No. 350—For reading 0-50 milliamperes DC.. 1.65
No. 390—For reading 0-100 milliamperes DC.. 1.65
No. 399—For reading 0-300 milliamperes DC.. 1.65
No. 394—For reading 0-400 milliamperes DC.. 1.65

DC PIN JACK VOLTMETERS

No. 306—For Radiolas No. 25 and 28, 0-6 volts DC $2.50
No. 308—For No. 20 Radiola, 0-6 volts DC.. 2.50
No. 307—Desk type voltmeter with cord, 0-6 volts DC 2.50

6-VOLT A BATTERY CHARGE TESTER

No. 23—For showing when 6-volt A battery needs charging and when to stop charging; shows condition of battery at all times....$1.85

PANEL AMMETER

No. 338—For reading amperage, 0-10 amperes DC $1.65

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GUARANTY RADIO GOODS CO.,
145 W. 45th St., N. Y. City.

Please send at once your meters, catalogue numbers:

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for which I will pay postman advertised price plus few cents postage.

Name .....

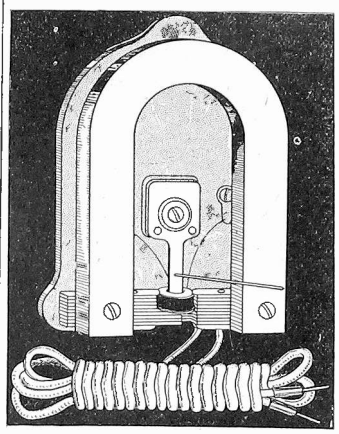
Address .....

City..... State.....RW-B28

ALL METERS SOLD ON FIVE-DAY MONEY-BACK GUARANTY

A Strong, Rugged Loud Unit

That Drives Any Cone Speaker and Reproduces Fine Tone at Great Volume!



This unit has a full floating armature, which means that armature is mounted so that it acts like a plunger between two sets of magnets or pole pieces. As the magnetization of the armature changes under the influence of the signal it plunges first toward one pair of pole pieces and then toward the other.

The large field magnet used insures a strong and permanent polarizing flux, which protects against loss of sensitivity from self-demagnetization to which some loudspeaker units are subject.

The cone driving pin is directly coupled to the full floating armature at that point on the armature where the force is greatest. This insures against loss of power through complicated levers.

The sturdy construction and heavy weight of the assembled unit prevent motion of the unit itself and insure that all the power is transformed into sound.

The armature is adjustable from an exposed knob in the back.

Apex, chuck and thumbscrew supplied with each unit!

This unit stands 150 volts unfiltered. With filtered output the unit has stood up to 550 plate volts continuously without damage.

Each unit is supplied with an apex, consisting of two metal plates, so that any type of airplane cloth or cone speaker may be built; also with each apex are supplied a threaded chuck and thumbnut for engaging the pin. The screw firmly grips the pin. Besides, a 60-inch cord with tips, is also supplied with each unit.

The Powertune Giant Unit, complete with apex, chuck, screw and 60" cord; total weight, 3 lbs. (Cat. No. 1098).....$3.75

SEND NO MONEY!

GUARANTY RADIO GOODS CO.,
145 West 45th St., New York City.

Please send me one cone speaker unit (Cat. 1098), as advertised, with apex. I will pay postman $3.75, plus few cents extra for postage. Your 5-day money-back guaranty is accepted.

Name .....

Address .....

City .....State .....

5-DAY MONEY-BACK GUARANTEE!

MEMBERS OF THE TRADE—Write for proposition on blueprints of 4-tube Diamond (standard tubes), 5-tube Diamond (standard tubes), and 4-tube Shield Grid Diamond (one SG tube). Guaranty Radio Goods Co., 145 W. 45th St., N. Y. City.

EVERY FRIDAY at 5.40 P. M. (Eastern Standard Time) Herman Bernard, managing editor of Radio World, broadcasts from WGBS, the Gimbel Bros. station in New York, discussing radio topics.

Take Your Choice of 7 Other Publications

For NEW RADIO WORLD Subscribers Ordering NOW

Radio World has made arrangements

—To offer a year's subscription for any one of the following publications with one year's subscription for RADIO WORLD—

RADIO NEWS or POULAR RADIO or SCIENCE AND INVENTION or BOYS' LIFE or RADIO DEALER or RADIO (San Francisco) or RADIO AGE.

This is the way to get two publications

—for the price of one!
—Send $6.00 today for RADIO WORLD
—for one year (regular price
—for 52 numbers)
—and select any one of the other
—nine publications for twelve months.

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—Present RADIO WORLD subscribers
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RADIO WORLD, 145 West 45th Street, New York City.
Enclosed find $6.00 for which send me RADIO WORLD for twelve months (52 numbers), beginning ..... and also without additional cost, Popular Radio, or Radio News, or Science and Invention, or Radio Dealer, or Radio (San Francisco), or Radio Age, or Boys' Life (or $10.00 for a two-year subscription to one address). No other premium with this offer.

Indicate if renewal.

Offer Good Until

May 30, 1928

Name .....

Street Address .....

City and State .....

The Radio Trade

Manufacturers Glad Over Service Course

Members of the Radio Manufacturers' Association are enthusiastic about the first vocational training course for service men, undertaken by the Association in conjunction with the vocational training school of the Essex County (N.J.) Board of Education. Here are the comments of four members of the Association:

H. H. Frost, Newark, N. J.—"Education would depend upon the man, but in general a high school education as a basis would be desirable. 30% of the time should be given to theoretical work and 70% to practical work. It is a little too early in the game to give any definite information as to future opportunities, but it looks like a big field."

W. L. Jacoby, Chicago, Ill.—"Service men should lead toward sales work. High school experience at least is desirable."

J. B. Hawley, St. Charles, Ill.—"Radio servicing should be a very good step toward greater opportunities in the radio engineering field and, therefore, greater compensation."

Ronald Webster, North Chicago, Ill.—"There should be a very good future for men of the right type in radio servicing, especially as this gives a good outlook on sales and engineering, also contact with the trade. Service work, we find, requires a considerable amount of salesmanship, especially in getting along with the trade, and building up good will."

Earl New President of Freshman Co.

At a recent meeting of the board of directors of the Charles Freshman Co. Inc., Clarence A. Earl was elected president and Charles Freshman, former president and founder of the business, elected chairman of the board.

Mr. Earl has been a director in the company for a year and has a good working knowledge of radio together with a genius for mercandising. He was one of the pioneers in the automotive industry, having formerly been vice-president of the Willys-Overland Company. During the war he received the commendations of the Government for his service in turning over one of the largest automobile plants in the country for the manufacture of gun carriages.

Receivers on Display

Kits Inc. has opened a new display room combined with testing laboratories at 135 Liberty Street, New York City. Under the direction of J. C. Bole and his associate engineers a widespread and unique service is at the command of custom set builders and fans. Accurate technical information on all problems and all types of circuits is available. Complete kits or parts for any circuit or power pack may be had at any time of night or day. The newest tested circuits will be on permanent exhibition and any fan or builder may come at night and thoroughly test out the hookup in which he is interested. The Tyrman 70 the H. F. L. Nine-in-Line and the Magnaformer 9-8 attracted visitors' attention. Further information may be had from the above concern by mentioning RADIO WORLD.

Subscribers: Look at the Expiration Date on Your Wrapper

We do not like to take your name from our subscription list without specific instruction to do so because many of our readers wish to keep a complete file of the paper.

Please, therefore, look at the subscription date stamped on your last wrapper, and if that date is earlier than the issue contained in the wrapper, please send check to cover your renewal.

In this way you will get your copies without interruption.

Subscription Dept., RADIO WORLD, 145 West 45th Street, New York City.

Quick Action Classified Ads

Radio World's Speedy Medium for Enterprise and Sales

10 cents a word — 10 words minimum — Cash with Order

Photophone to Reveal Presidential Aspirants

The candidates for President will be both seen and heard on the screen, throughout the country this summer, said David Sarnoff, president of the new RCA Photophone, Inc., a newly formed subsidiary of the Radio Corporation of America.

Photophones, or "talking movie" machines, are now being manufactured for use in theatres and public halls.

The first of these machines from the General Electric and Westinghouse laboratories will be installed within a few days in the demonstration studios of the Photophone Company at 411 Fifth Avenue, and regular shipments will follow declared Mr. Sarnoff.

Scope Is Wide

"Easily operated reproducing apparatus for use in theatres, schools and churches will be nationally available," said Mr. Sarnoff. "An entire opera, musical comedy or drama can be electrically recorded on the film, just as it is seen and heard, and then reproduced from the same film.

"Standard films without the sound can be used without any change in the machine. The only thing the operator has to do is to close one switch when he is projecting pictures with sound, and open it when he does not want the sound. Any type of 'talking film' can be used in the machine.

"The type of sound reproducer to be used will vary with the size of the room in which the pictures are to be shown. The reproducer embodies some remarkable new developments in acoustics.

Debates to be Reproduced

"The new device will be used not merely for single speakers, but even to stage debates on great national issues.

"Presidential candidates, photographed while speaking, can be shown the same

(*Continued on next page*)

(Continued from preceding page)

evening on the same film, one earnestly presenting one side of a national question the other eloquently presenting the other side."

All plans were being rushed, he said, to expedite deliveries of Photophone devices to theatres through the country so that the candidates for national offices might be seen on the screen, and heard as well, before the November Elections, thus bringing them more intimately in contact with the voters.

School Use Important

Photophone films will be supplied for use in these machines. In these films the voice or music is electrically recorded on the film at the same time that the photographs are made.

One of the important uses of the Photophone, said Mr. Sarnoff, will be in schools. Leading educators are being consulted as to educational subjects which should be covered in the photophone film service.

Service for home installation also is under consideration and brings in audio factors as used in radio.

EVERY FRIDAY at 5.40 P. M. (Eastern Standard Time) Herman Bernard, managing editor of Radio World, broadcasts from WGBS, the Gimbel Bros. station in New York, discussing radio topics.

FEATURES TO FASCINATE AND INFORM YOU

Up-to-date Topics Masterfully Treated—See Which Ones You Must Become Fully Acquainted With to Round Out Your Radio Knowledge and Experience

The following issues of Radio World, 15c each:

OCT. 29—The Victoreen Power Supply with Audio Channel, by J. E. Anderson; Beauty of Sound and Appearance in Reproducers, by H. B. Herman.

NOV. 5—Part I of a two-part article on The Fenway Electric Concertrola; The Lynch Five, by Arthur H. Lynch; The How and Why of 3-Ft. Cone, by James H. Carroll.

NOV. 12—The New Nine-in-Line Receiver, by John Murray Barron; Part II on how to construct the Electric Concertrola; Unbiased Facts About Underbiased Grids, by Roger C. Brooks; Data on Meters, by Frank De Rose.

NOV. 19—Part I on how to build the Improved Laboratory Model Super-Heterodyne (Silver-Marshall Jewelers Time Signal Amplifier), by E. R. Pfaff; Part III of a four-part article on the Electric Concertrola; New Model DC Set, by James H. Carroll.

NOV. 26—The Four Tube DX Fountain, by Herbert E. Hayden; concluding installment on the Fenway Concertrola; A Squealless 5-Tuber, by Joseph Bernsley; Secrets of DX in a Creative Receiver, by J. E. Anderson.

DEC. 3—How to Modernize the Phonograph, by H. B. Herman; Part I of two-part article on the Everyman 4, by E. Bunting Moore; Efficiency Data on 4 and 5-Tube Diamond (not Screen Grid Diamond), by Campbell Hearn.

DEC. 10—Seven-page article on the Magnaformer 9-8, the best presentation in the history of radio literature, by J. E. Anderson (this article complete in one issue); The Object of a Power Amplifier, by C. T. Burke, engineer, General Radio Co.; Constructional Data on the Everyman 4 (Part II): The 2-Tube Phonograph Amplifier, by James K. Carroll.

DEC. 17—Complete Official Call Book and Log; How I Tuned In 98 Stations in Six Nights with Magnaformer 9-8, by Thomas F. Meagher; Startling Facts About Harmonics, by H. B. Herman; The G.R. Amplifier and B Supply, by Stuart S. Bruno.

DEC. 24—The AC 300 (four tubes); How Service Men Cheat Radio Builders; Part I of two-part article on the Victoreen Power Supply with one audio stage.

DEC. 31—How DC Sets Are Converted to AC Operation, by W. G. Masson-Burbridge; Cures for Uncanny Noises, by J. E. Anderson; Part II of two-part article on the Victoreen with a Stage of Audio; Complete Driver for an AC Set, by Robert Frank Goodwin.

JAN. 7, 1928—The Shielded Grid Six, first national presentation of loop and antenna models of the new Silver-Marshall circuit, utilizing the new tubes of strong amplification, Part I, by McMurdo Silver; How to Build a Power Amplifier and 210 Push-Pull Unit, by A. R. Wilson, of General Radio Co.

JAN. 14—Assembly and Wiring of Shielded Grid Six, Part II, by McMurdo Silver; Meter Range Extensions, by Bramhall Torrence; Uses of B Batteries and Power Devices, by E. E. Horine, National Carbon Co.; A 5-Tube Set Costing but 2 Cents an Hour to Run, by Capt. Peter V. O'Rourke.

JAN. 21—Bias Resistor Fallacy Exposed, by J. E. Anderson; The Shielded Grid Six, Part III (conclusion); How the "Victory Hour," Reaching 30,000,000, Was Broadcast, by Herman Bernard.

JAN. 28—How to Build the AC Five, a Batteryless Receiver, by H. H. Chisholm; Technique of Home Television Machine, by Dr. E. F. W. Alexanderson; A Quality Analysis of Resistance Coupling, with Trouble Shooting, by Herman Bernard.

FEB. 4—Tyrman "70" with Shielded Grid Tubes (Part I of four-part article), by Brunsten Brunn; The Four Tube Shielded Grid Diamond, by H. B. Herman; Television's Stride, by Neal Fitzalan, Radio Vision Editor.

Any copy, 15c. Any 7 copies, $1.00. All these 15 copies for $2.00, or start subscription with any issue. Any 8 of these numbers sent as premium with NEW yearly subscription. No other premiums allowed.

RADIO WORLD
145 West 45th Street New York City

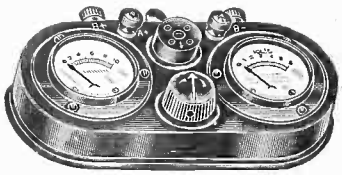
A Scientific Trouble-Shooting Test Set

Consisting of Tube Checker That Reads Filament Voltage and Plate Current; Extra Meter Reads Plate Voltage, including B Eliminator Voltages.

Only $10.00

The best inexpensive combination for trouble-shooting is a Double R Tube Checker, comprising a 0-10 D.C. milliammeter, a 0-6 D.C. voltmeter, a switch, a rheostat and a socket. Add a high resistance voltmeter (0-300 v.). With these it is advisable to use a plug, so that all you need do is remove a tube from a receiver that you're testing, put the plug in the empty socket and the removed tube in the socket of the tester. You can immediately find open any short circuits, broken or flimsy connections, reversed connections, etc. The Double R Cord and Plug, the Double R Tube Checker, and 0-300 high resistance voltmeter constitute the Scientific Trouble-Shooting Test Set.

The Biggest Value That $10 Can Buy



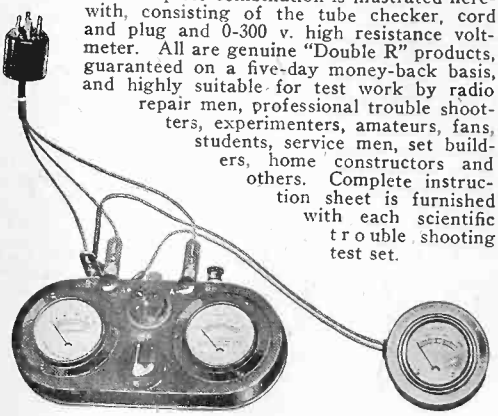
No. 210 Tube Checker consists of 0-6 volts D.C. Voltmeter, 0-10 D.C. Milliammeter, Grid Bias Switch, Rheostat, Socket, Binding Posts (with instruction sheet) in handsome moire case....$6.50

The cord terminals of the plug leads correspond with the binding posts of the tube checker. Now connect the 6-300 volts high resistance voltmeter from A+ to B+ posts and you get all necessary readings. You can test plate voltage from B eliminators, or any other B supply, D.C. plate current and D.C. filament voltage, as well as the efficacy of the tube, by throwing the grid bias switch, for the plate current should change within given limits, depending on the type of tube.

No. 346—High resistance voltmeter, for reading any and all DC voltages, including B eliminators, up to 300 volts. Portable type, full nickel finish, long connecting cords and tips $4.50

No. 21—Cord and plug, with markers and lugs that fit tube checker binding posts..$1.85

The complete combination is illustrated herewith, consisting of the tube checker, cord and plug and 0-300 v. high resistance voltmeter. All are genuine "Double R" products, guaranteed on a five-day money-back basis, and highly suitable for test work by radio repair men, professional trouble shooters, experimenters, amateurs, fans, students, service men, set builders, home constructors and others. Complete instruction sheet is furnished with each scientific trouble shooting test set.



Service Men! Custom Set Builders! Experimenters! Students!

Equip your testing outfit with the indispensable combination that constitutes the Trouble Shooting Test Set and Time-Saver. You quickly locate trouble while others flounder about.

WHAT YOU GET

One No. 210 tube checker, with 0-6 voltmeter, 0-10 milliammeter, socket, rheostat, binding posts and bias switch, all built in; one No. 21 cord and plug, and one No. 346 high resistance 0-300 v. voltmeter.

FOR ONLY $10

If You Want Complete Test Set, as Above, But With 0-500 High Resistance Voltmeter, price is $11.

SEND NO MONEY!

Our Five-Day Money-Back Guaranty Fully Protects You!

Many professional and other radio technicians require a 0-500 high resistance voltmeter, as part of their scientific trouble-shooting test set, so that they can test ALL power pack B voltages. They do a great deal of work with high voltage power packs, especially where a —10 or —50 tube is used in the output of a receiver. For them the 0-500 v. high resistance voltmeter, No. 347, is just the thing to include in the test set, instead of the No. 346 high resistance 0-300 v. voltmeter. The combination may be obtained with the 0-500 v. voltmeter, instead of the 0-300 v. voltmeter, at only one dollar extra. The 0-500 v. meter is exactly the same as the 0-300 v. meter, except for difference in maximum voltage reading.

Guaranty Radio Goods Co.

145 West 45th Street, New York, N. Y.

GUARANTY RADIO GOODS CO.,
145 West 45th Street, New York City.

Please send me at once, on a five-day money-back guaranty, one complete scientific trouble-shooting test set, consisting of one No. 21, one No. 210 and one No. 346, for which I will pay the postman $10, plus a few cents extra for postage.

☐ If 0-500 v. high resistance voltmeter No. 347 is preferred, put cross in square and pay $11, plus postage, instead of $10, plus postage.

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ALL METERS SOLD ON FIVE-DAY MONEY-BACK GUARANTY