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CONVERTER SOLUTIONS

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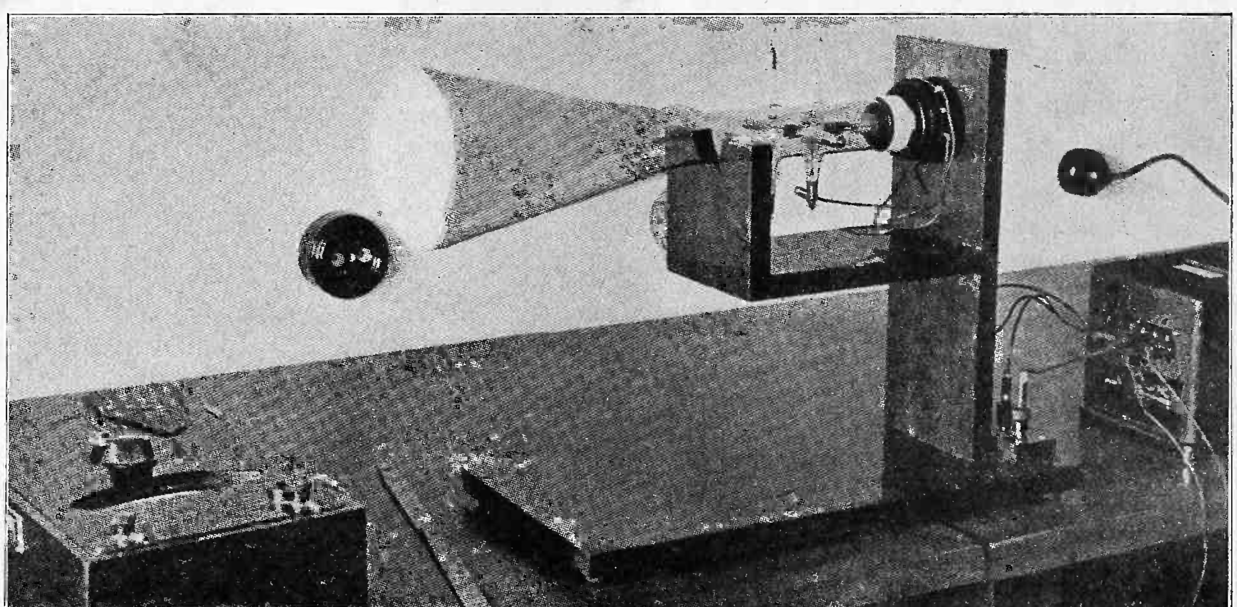
TENTH YEAR

New Photo-Electric Tube Announced

Signal Strength up as Sun Spots Decline

Light Beam Used for Sending Vision

Cathode Ray Scanning Gains Favor



The cathode ray oscillograph arranged for receiving television pictures. The image appears on flat, enlarged end of the tube. See pages 10 and 11.

Grid Current Alters Oscillator Frequency

Vacuum Tube Used as an Output Meter

Trade Proposes High Frequencies for Television

SHORT-WAVE CONVERTER-TUNER

LOOK AT YOUR WRAPPER

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Converter Solutions

Argument Presented for Separate Tuning

By Jack Tully

THE short wave converters now offered to the public consist principally of those with two tuned circuits, condenser ganged, r-f untuned if any is used ahead of the modulator, and switch control of band shifting. They may be grouped as follows:

1—Mixer and rectifier, with heater power also, for a-c operation; battery equivalent, which omits power.
2—Mixer, rectifier and intermediate frequency amplification; battery equivalent that omits power.
3—Mixer with plug for taking the heater and B power from the set.
4—Untuned r-f, mixer and rectifier; battery equivalent that omits power.
5—Untuned r-f, mixer and intermediate amplification; battery equivalent that omits power.
6—Mixer, with filament power for a-c operation, B voltage to be obtained from the set.
7—Untuned r-f and mixer, with B voltage to be obtained from the set.
8—Autodyne mixer and rectifier, with heater power also, for a-c operation; battery equivalent without power.
9—Autodyne mixer, with heater power, for a-c operation, B voltage to be obtained from the set.

A tenth possible classification, for a-c or battery use, would be the converter with only oscillator tuning, and untuned modulator; and an eleventh the same, except for an untuned r-f stage. But tuning of the modulator has become virtually standard, therefore all systems using untuned modulator are omitted.

Improvements Introduce Limitations

All of these types have their special advantages, all of them work, but the differences are worth considering, since the problem of satisfactory design of a converter to fill all needs and requirements has not yet been solved, and it is doubtful whether it is solvable.

This does not mean that converters are no good, for they may produce excellent results. It means simply that when you institute an improvement in one direction you run into a limitation that affects something else concerning the converter. Therefore astuteness in design is necessary. Some manufacturers now blissfully blossoming forth in the converter field have much experience ahead of them.

Let us consider the different devices in the order of their tabulation.

Take the mixer only, as covered by (1), (3), (5), (7), (8), (9), the presence or absence of rectifier having nothing to do with the radio frequency operation. It is assumed that the modulator and oscillator are both tuned, in all instances, as they should be for sensitivity and selectivity. In (8) and (9) the same tube is used as oscillator and modulator, in the other instances a separate tube performs each of these two functions. It is better always to have separate tubes, but for economy reasons the autodyne system can be excused, for it does work, but it generates generous harmonics, even though it can be just as sensitive as the separate method.

The mixer, then, consists of a circuit tuned to the incoming frequency, that of the transmitting station, and constancy governs this tuning, for nothing that takes place afterward should affect this circuit. For a given capacity condenser a given inductance is required and the frequency span is known.

Oscillator Requirements

With the modulator the situation is quite different. What the extreme frequencies of oscillator tuning should be will depend on the intermediate frequency. Suppose 1,500 kc is the intermediate frequency, the one to which your set is tuned when the converter is connected. Then, if the incoming frequency or transmission is, say, 6,000 kc, then the oscillator should be generating 7,500 kc. The difference is the intermediate frequency. If some other intermediate frequency is used, then the oscillator has to be redesigned accordingly. Suppose the intermediate frequency is 550 kc. Then the oscillator would have to be set at 6,550 kc for a transmission frequency of 6,000 kc.

As small condensers are used for tuning the average ratio over the bands to be covered will be not much over 2-to-1, so if the converter is to be effective starting at 1,500 kc, the modulator would tune from that frequency to 3,000 kc. For an intermediate frequency of 1,000 kc, then, the oscillator would tune from 2,500 to 5,000 kc. But the oscillator is of not much use after 4,000 kc, for the modulator can not tune to frequencies high enough to keep pace, since it stops at 3,000 kc, hence the oscillator should stop at 4,000 kc instead of at 5,000 kc. This can be accomplished by padding the oscillator, which consists of using principally a series condenser to cut down the capacity or, really, the ratio of maximum to minimum capacity, the inductance being selected on the basis of the required capacity. All padding resolves itself into the establishment of a particular capacity ratio, for the frequency ratio is the square root of the other.

Thus the first band may be covered, but notice particularly that it is on the basis of a selected intermediate frequency only!

Intermediate Frequency Fixed

In virtually all of the commercial converters there are two tuned circuits with condensers ganged. So soon as ganging is used it is necessary for the manufacturer to select the intermediate frequency. When that selection is made it is well to include intermediate frequency amplification in the converter, for the user's choice already is gone, and the extra sensitivity and selectivity become advisable. The set's r-f amplification can be disregarded, and considered only as a coupler to second detector, if two i-f stages are included.

In the other bands the percentage of difference between the oscillator and the modulator frequencies becomes less, so that fixed trimmed adjustments may be used for keeping the two circuits tracking tolerably. The absolute value of difference in frequency is the same, but the percentage becomes less because higher frequencies are being tuned.

Therefore we find that of the nine classifications, six require that the intermediate frequency be a particular one. But (4), (5) and (6) cover a mixer with a stage of untuned r-f ahead, so the same applies to them—no selection of intermediate frequency is offered therefore by any of the converters!

Really, when this situation obtains, no choice whatever is left, because even slight retuning is not practical to the user, since the tracking of the oscillator and modulator is upset to the same

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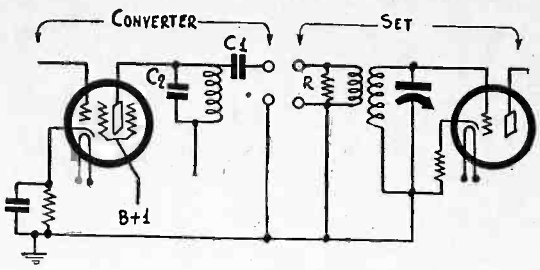

Fig.1

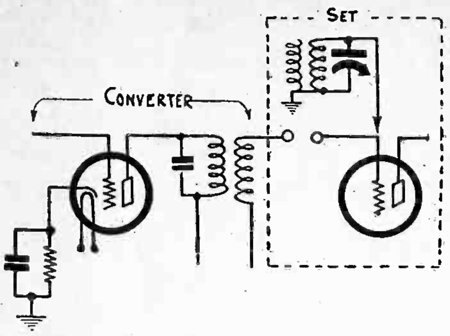

Fig. 2

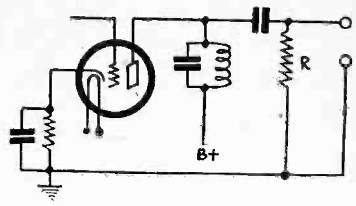

Fig. 3

If the output is tuned and loosely coupled to the set (Fig. 1), the tube may be screen grid, otherwise use a general purpose tube, omitting screen connection. Instead of connecting to antenna post, the output may go to the cap if the set is screen grid. (Fig. 2). A grid return is needed for the set tube. If not present, supply one, R in Fig. 3, 20,000 to 100,000 ohms.

(Continued from preceding page)

absolute extent that the intended intermediate frequency is altered.

Most Want to Hear Europe

Therefore, so soon as we tune both modulator and oscillator, and use a gang condenser, we can not alter the intermediate frequency. It may so happen that the intermediate frequency selected is one on or near which there is a powerful local, hence interference due to direct pickup of this local would make reception practical only when that station is off the air, unless detuning of the intermediate frequency in the set is resorted to, with the large sensitivity drop attendant on even slight detuning, or the direct interference is trapped out. To this end some manufacturers provide a wave trap to be inserted in the antenna circuit, to kill off direct interference from a station at or near the intermediate frequency.

Already we begin to notice that each advancing stroke introduces a new hazard. If we tuned only the oscillator, and had an untuned modulator, then we might select any intermediate frequency, for the limiting factor of tracking with a differential tuned circuit is gone—but so is some sensitivity and also the much-needed selectivity to penetrate for distance. The station jam on the broadcast band is not nearly so bad as on the short wave bands, so that without selectivity sufficient to kill off adjacent channel interference the likelihood of much reception of foreign countries is small. Most persons buy converters to hear Europe.

Question of Guarantees

The improvement noted is the one of convenience of single dial operation, and the penalty paid is that the selection of intermediate frequency is denied the user. This denial well may be consistent with excellent results, especially if a wave trap is used, and particularly when the converter is made by a set manufacturer, and used on a set of his own manufacture, and of a model produced at about the time the converter was produced, for it may be safely assumed the manufacturer is not putting out a converter that works at an intermediate frequency unfavorable to his own set.

There are many types of sets, various number of tubes and a great variety of sensitivity and selectivity, so that no matter what kind of a converter is manufactured, since it has to be used with a receiver concerning which the converter manufacturer has no knowledge, it follows that performance can not be guaranteed, since one manufacturer can not guarantee excellent performance of another's set. The converter is the known quantity, but of itself will not produce reception. The receiver is the unknown quantity. The two must be worked together. Therefore the combination is an unknown quantity, and it is not commercially practical to guarantee unknown quantities.

Perplexities of Short Waves

Most receivers are of the tuned radio frequency type and as such have a rising characteristic, that is, amplify more at the higher frequencies. So, in general, it is preferable for a manufacturer to select a frequency not too far removed from that exteme. A good compromise may be to select a frequency near or at the geometric mean of the broadcast band, and 1,000 kc represents that fairly well. But it is still a compromise, since the set with which the converter is used may be ten times more sensitive at 1,500 kc or may have an inverse characteristic, due to compensation by the manufacturer, whereby the sensitivity is 100 times as great at 550 kc as at 1,500 kc. Still, the intermediate frequency selection is denied. Therefore if such denial exists, there should be built-in intermediate amplification, and this may be made to provide sufficient gain so that it becomes relatively immaterial in what region the set is most sensitive. The added stage increases the sensitivity beyond what it would be at any intermediate frequency without that stage.

The vogue for single dial tuning enveloped the broadcast receiver users so that all commercial sets are of that type and nearly all kit sets as well. For tuned radio frequency it is all right. For superheterodyne use it is all right, for covering a single band. For multi-band coverage with supers—and all converters are of this type—it is better to have independent tuning, particularly as one control (that used in the modulator) is by no means critical, and may not tune out a strong station at any point of the dial, when the oscillator is set to give response from that station. It is on weak signals that the modulator tuning becomes important, and in the case of ganging it may be a case of mistuning, for it is difficult to make the two circuits track over various bands.

A manual trimmer across the modulator's main tuning condenser would help, in the case of ganged tuning, if the coils were so designed that they afforded tracking when the modulator trimmer was at half maximum capacity, so that subtraction and addition of capacity could be applied. But most trimmers are in circuits so designed that only addition is possible so the frequency can be only decreased, whereas some circumstances may call for increase.

The advantages of separate tuning make one wonder why the manufacturers have not recognized them, for when a person gets interested in short waves he has much to learn about tuning, geography, time differences, frequency and wavelength equivalents, skip distances and other eccentricities and tolerance of high noise level. He should be given every assistance toward attaining results. The single tuning control system does not assist him to get results. It simply enables him to rotate two condensers with one motion.

Separate Tuning

It is therefore submitted that, since tuning of oscillator alone is not quite satisfactory, and modulator must be tuned also, that all ganging systems require a particular intermediate frequency, and that for wide application and usefulness of converters, and hence their endurance in the radio field, depend on results much more than on convenience, so that each circuit should be separately tuned. This separate tuning may exist, as stated, in conjunction with ganging, if a trimmer and other constants are rightly chosen, or any other method may be used, even variometer adjustment of inductance, but separate tuning is important, almost vital. The choice of experimenters may be in favor of two separate dials, for they, above all, want the results, and not the convenience at the expense of results, while even the lay users could find no objection to two fruitful dials compared to one semi-barren dial. Besides, the modulator "dial" may be a knob.

As in all branches of radio we must apportion selectivity and sensitivity. In a converter this is done to a considerable degree in the coupling between modulator and oscillator. If the coupling is tight the signal is much louder, but the selectivity is much less and the oscillation always overloads the modulator. If the coupling is too loose there will be no signals, if it is too tight there will be not nearly enough selectivity, and the modulator will tune the oscillator. However, the coupling between aerial and modulator has to be tight, or there must be a large input, so the aerial may be as long as you can conveniently make it, and erected as high as you can erect it. All considerations of half-wavelength antennas, doublets and multiple doublets don't apply to short wave converters. No matter how much theory may be written on the subject, the fact remains that the tighter the coupling and the longer the aerial, the louder the signal! In fact ,unless these two are large, the signals will be few. This

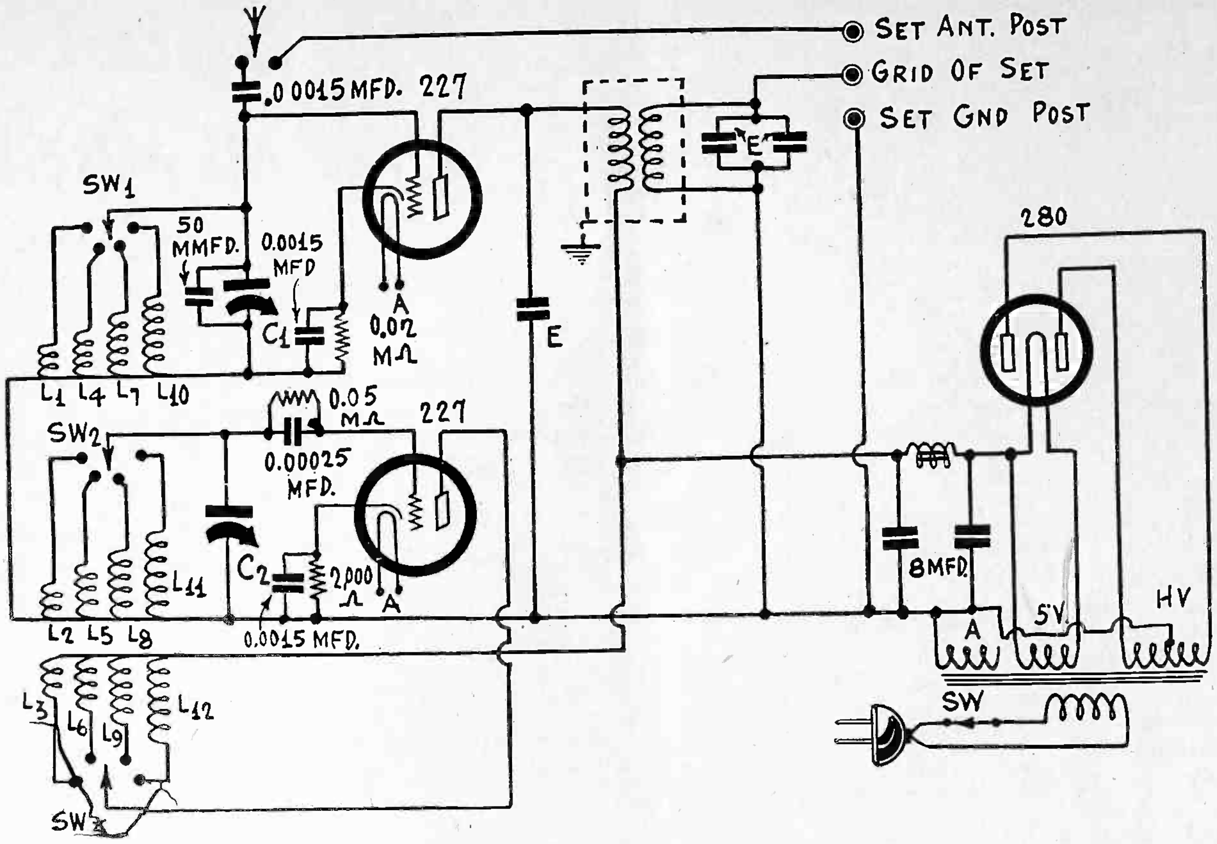

Fig. 4

Design of a converter, using separate tuning of oscillator and modulator, with a switch for band shifting. Any intermediate frequency may be used, 1,600 to 90 kc. or under.

is true although there is reduction in relative or apparent selectivity with a long aerial. The heightened modulator output helps because the output amplitude is proportional to the product of the modulator and oscillator r-f voltages.

Coupling Methods

The fact that the converter can not be considered wholly apart from the set is again brought home when one seeks a method of coupling the one to the other. Here the output tube and circuit of the converter, as well as the input circuit of the receiver, are of importance. Most receivers have a radio frequency transformer with primary in the antenna circuit and tuned secondary in the grid circuit. However, some sets have an untuned antenna stage, with an r-f choke coil or a resistor as the load, or if there is a transformer primary it has a resistance across it. These different load conditions, though the antenna is not connected in this circuit when the converter is used, present difficulties in coupling the converter to the set.

As for the tube, one of relatively low impedance is generally favored for untuned output, and that rules out the screen grid tube and brings in the general purpose tubes (227, 230, 201A, etc.). The intention is to put an inductive load on the output tube of the converter, and have a secondary or use a stopping condenser, so that when the antenna is removed from the set the output of the converter is connected instead. It has become popular to use a switch to throw the aerial from converter input to set input, but in the usual systems this leaves the converter's output load in parallel with the set's input and drops the input to the set when the converter is "off."

Since the primary winding of an antenna coupler may have a relatively low impedance, any attempt to tune the output of the converter would be nullified, unless account were taken of the receiver's input. Therefore the so-called matching of converter output to receiver input becomes a problem, particularly where r-f chokes or resistors are the set input load. Any primary means that the impedance is lower than the output and input circuits are coupled, because of the consequent parallel connection.

Tuned Output

However, if the converter output is tuned, then a high impedance tube may be used, provided the coupling to the set is loose, in which case also the connection to the set does not have the effect of short-circuiting the output. In Fig. 1, C1 is the stopping condenser, and for loose coupling should be small, while C2 is the condenser that tunes the output to the intermediate frequency. If C2 is large enough, and the coil it tunes is properly selected (e. g., a usual broadcast condenser and coil combination), then if C1 is 0.0001 mfd. or less, the coupling will be loose enough to render the output circuit relatively independent of the input circuit, except, of course, that C2 should be finally tuned when the coupling exists. By tuning C1 first with the coupling and then without it any change can be noted in the capacity required for the same frequency, and this serves as a check on whether the coupling is all right. If the difference is considerable, say a quarter of the dial, then C1 should be of considerably less capacity.

In Fig. 1 R is the resistance sometimes included in a set so that the receiver will not squeal when a short aerial is used, but for converter coupling it normally represents quite a loser, and results would be better if the resistor were out. Likewise, merely a resistor or an r-f choke coil as the set's antenna load usually present a poor coupling situation when the converter is hooked up, because of too low an impedance.

Grid Return Needed

If the receiver has a screen grid tube as the first valve, then it is practical to connect the converter output to the grid circuit of the receiver, and wholly ignore the antenna coupling in the set, as shown in Fig. 2, where the primary is tuned. The secondary also may be tuned, if primary and secondary are loosely coupled. The grid clip is removed from the set tube and the converter output connected to the tube cap. At all hazards, a grid return must be established for the first tube in the set. This is done in Fig. 2 (transformer secondary), but if the converter output is untuned, or has a stopping condenser as in Fig. 3, then a resistor or another r-f choke may be placed in the converter output to establish the grid return.

It is recommended that with screen grid sets some system be used that picks up the grid directly, as just discussed, for even when the usual connection to set's antenna post is made under circumstances otherwise all right, the secondary is detuned a little, and ordinarily there is no manual trimmer on the seat to take care of this, since gang condensers with permanent trimmers are used.

The foregoing concerns all types classified in the category. The converter that derives all power from an a-c set is no different than the others in radio principle, but raises the question whether universal application exists, especially as 3.5 amperes more current are taken from a set's power transformer. The autodyne would require only 1.75 amperes, but few autodynes exist, and they have their limitations.

In line with what has been said previously, a converter design

(Continued on next page)

A Short-Wav

Unit May Be Used a

By Wayn

HERE is a dual short-wave device. It is a converter or a tuner, by the flip of a switch. Throw another switch and the antenna is transferred from the device to the receiver. The wave band shifting is done by switching also, the tuning condenser being moved to lower points on the secondaries. If a three deck, four throw rotary selector switch of the insulated shaft type is used (also called three point, four throw and triple pole quadruple throw, three of the four positions may be used on two decks for the band shifting, and the third deck used, as to two throws only, for the antenna switching, the two remaining throws on the third deck being blank.

It is clear that when the aerial is switched to the present device that the input is taken from the receiver, to that extent, and transferred to the primary of the modulator coil. The action of the

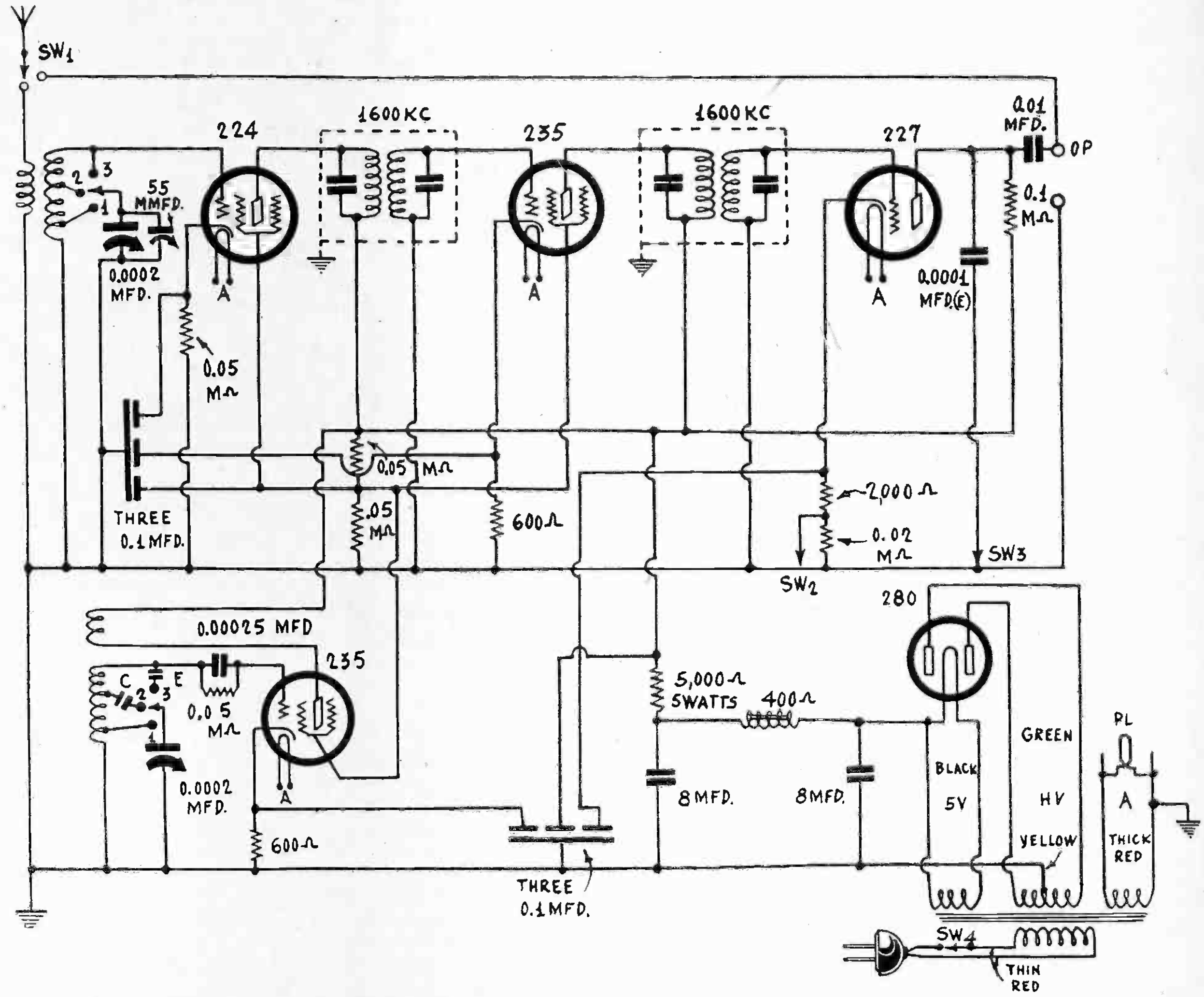

FIG. 1

What will you have? A short-wave converter? A short-wave tuner? Throw a switch and you have one or the other. On the tuner either earphones or a power amplifier may be used. An option is to plug into a set for audio amplification. Mixer coupling is effected by twisting together the modulator and oscillator control grid leads (to tube caps).

modulator and oscillator, the two circuits united through twisting together the control grid leads, results in a modulator output at the intermediate frequency, 1,600 kc, and the outfit is a converter if the 227 tube is biased for amplification, or a tuner if the tube is biased for detection. The output will handle either radio or audio frequencies.

Shorting Makes the Change

By putting two biasing resistors in series, one for amplification (2,000 ohms), the other for detection (0.02 meg., 20,000 ohms), the change from one point to another on the tube's characteristic curve is made simply by shorting out the larger value.

For detection, the output being audio frequencies, a plate bypass condenser is required. This is a detriment in the case of amplification, when we desire really to continue transferring radio frequencies, for we would be working on the converter principle. So an extra switch, SW-3, is included, to open the bypass condenser circuit. The same operation will open and close the two circuits if the switches SW-2 and SW-3 are in parallel. Switches of the snap type are commercially obtainable for that purpose.

If the device is used as a converter, the connections are: output post to antenna post of your receiver ground post of converter to ground post of receiver (where actual ground connection remains intact, aerial to the index of SW-1 and that switch thrown to the left, in Fig. 1.

Plugging into a Set

For utilization of the tuner, earphones may be connected across the output and ground posts, or the output post may be connected to the input of a power amplifier (P post of audio transformer, or to grid of first audio tube, if resistance or impedance coupling is used), or the audio amplifier of an existing receiver may be used, for tube economy, as perhaps only an extra 280 is needed, the rest of the tubes for the short wave tuner being taken out of sockets in the receiver. The connection then would be by a UY plug and cable lead (or UX, if the set detector requires such), the plate cable being the only one used.

As a tuner, that if, for use with external audio amplification only or for earphone reception, the system is autonomous, and is ratable in performance. As a converter, however, it is subject to the usual variations in performance that may be imposed by the receiver's lack of sensitivity. To get first-class results from a converter it is usually advisable to have a sensitive receiver, although in this case it is only necessary that the receiver be sensitive at or near the highest frequency that can be tuned in, which is almost always true. While the intermediate frequency would seem to be adamant at 1,600 kc, really 1,600 kc is simply the commercial designation for transformers that may be tuned considerably lower. Therefore if your set does not tune as high as 1,600 kc, and few sets do tune that high, adjust the intermediate frequency to meet the highest frequency of your set. This will slightly change the oscillator tuning

Coil Construction fo

(*Continued from preceding page*)

is presented that works well, and that is intended primarily for use with screen grid sets (Fig. 4). Any intermediate frequency may be used, from 1,600 kc down, including even 90 kc in a superheterodyne intermediate. If two separate dials are used they will not track for the first band (lowest frequencies or highest waves), will come closer to it on the next band, and will be near enough alike on the two other bands, no matter what the intermediate frequency.

The inductance for the oscillator's tuned circuit has to be selected on the basis of the highest intermediate frequency, 1,600 kc, because then the difference is greatest, and the dial setting should represent about half the capacity of the tuning condenser. As the intermediate frequency is lowered, the difference is reduced between modulator and oscillator frequencies, so the oscillator frequency has to be lowered (more capacity used). Hence there should be 1,600 kc leeway from the chosen dial point to maximum capacity. The leeway in the other direction should be equal to the difference between maximum and minimum modulator settings. The two settings for the first band 0.00015 mfd. tuning would represent 1,500 kc and 3,600 kc, a

Combination

Converter or Tuner

Brooks

characteristic, but that is no drawback, particularly as the modulator has a front panel trimmer across it, to take up discrepancies. As a converter squealing may result but is correctable by volume control adjustment of your set.

The System as a Tuner

The system is worthy of consideration as a tuner alone, even though it has only one stage of amplification. No credit for amplification is given to the modulator, for it is well known that the mixing process produces a loss, and no credit is given for amplification of a small order that takes place in the 227 even when a detector. However, the single intermediate frequency amplifying stage (requiring two transformers, one to couple to and the other from the amplifier tube) has such a high gain that squealing at the intermediate frequency is by no means impossible.

Just below the point of oscillation the amplification may be around 1,000, so by operating near that point the single stage is made extremely high gain. The coils are near enough together, despite shielding, to effectuate some feedback. The biasing resistor is made purposely high so there will be no oscillation trouble, but if more feedback is desired, all one needs to do is to use a lower value, to 400 ohms. The reason why 300 ohms are not recommended is that the full B voltage of a power transformer as used in five tube midget sets is supplied to all the tubes, around 275 volts, due to reduction in the 5,000 resistor. Higher value of biasing resistors are necessary in such instances of high plate voltage because the plate current does not increase with voltage increase nearly as fast as the requirement for negative bias increase.

Resistor Ratings

The resistor marked 5,000 ohms may consist of two 2,500 ohm units, or two 2,250 ohm units, if you have them, as the value is not critical, but should be greater, rather than less than, the specified value. The wattage is 5 watts. Other resistors may be 1 watt.

The voltages obtainable are: drop across 0.05 meg. (50,000 ohms) for biasing the 224 modulator, 7 volts, or thereabouts; across the separate 600 ohm biasing resistors, oscillator and intermediate, 3 volts; across the 2,000 ohm resistor alone in the second detector cathode, 4 volts; across the combination of the series resistors in that circuit, 2,200 22,000 ohms, 10 volts; plate returns in tuner, about 275 volts; screen voltage, 90 volts. An ordinary voltmeter will not measure accurately the voltage across the high value biasing resistors, or the screen voltage.

Coil Information

Using 1.25 inch diameter, the modulator coil may consist of 12 turn primary, 1/16 inch separation, and 25 turn secondary. The taps on the secondary are at the 16th and 21st turns from the grid end. The oscillator, on a separate form, same diameter, may consist of 15 turn tickler, ⅛ inch separation, 17 turn secondary, tapped at the 8th and 13th turns. The wire is No. 28 enamel.

If you desire to make the intermediate coils yourself, you should have shields for them, which may be copper or aluminum, and may wind 20 per cent. fewer turns than would be required for 0.00035 mfd. broadcasting tuning, on two tubings, one of them half the diameter of the other. Put the smaller winding inside and use it for the plates, the larger outside for the grids. Commercial coils are of the honeycomb type, machine wound, and hardly can be duplicated in the home workshop.

For 1 inch diameter tubing, put on about 100 turns of No. 31 wire, or any wire of about that size, and for 2 inch diameter, the outside row, put on 55 turns of No. 28 enamel. The condensers across the coils would be 20-100 mmfd. equalizers, which are of the compression adjustable type. The shield then should have around 3 inch diameter and totally enclose the coil assembly. Commercial coils, due to special winding, have about 2⅛ diameter.

LIST OF PARTS

Coils

Two two-winding coils, one for modulator, other for oscillator, as described.
Two 1,600 kc intermediate frequency transformers.
One power transformer as for a five tube midget set.
One B supply choke coil, 15 henries, 400 ohms d-c resistance.

Condensers

Two 0.0002 mfd. condensers, which may be gauged by means of a flexible coupler.
One manual trimming condenser, 55 mmfd. or thereabouts.
One 0.00025 mfd. fixed condenser with grid clips.
Two shielded blocks, three 0.1 mfd. in each block; total, six capacities; black is common, reds interchangeable.
Two 20-100 mmfd. equalizers (E), one used at full capacity for detector plate bypass.
One 0.00035 mfd. fixed condenser (C).
One 0.01 mfd. mica fixed condenser.
Two 8 mfd. electrolytic condensers.

Resistors

Four 0.05 meg. pigtail resistors (50,000 ohms).
One 0.1 meg. pigtail resistor (100,000 ohms).
Two 600 ohm pigtail resistors.
One 2,000 ohm pigtail resistor.
One 5,000 ohm 5 watt resistor.

Miscellaneous

One vernier dial with pilot lamp.
One chassis, 13½ inches wide × 7.75 inches front to back, × 3 inches high, with four UY and one UX sockets.
Antenna-ground post assembly.
Output post.
One rotary selector switch, three sections, four throws per section; shaft insulated; keyed knob.
One knob for dial.
One single pole double throw antenna switch.
One single pole double throw parallel switch.
One a-c line switch.
One a-c cable and male plug.

Short-Wave Converter

difference of 2,100 kc, so the oscillator from the selected point should tune from 3,100 to 5,200 kc, which it can easily do, as the ratio of frequency is only a little more than than 1.6 to 1. Since the two dials are separate, or the modulator has a knob, the oscillator overlap is of no consequence.

Modulator and oscillator are coupled inductively, therefore three windings are on each of four forms. For the modulator the secondaries may consist of 40, 18, 8 and 4 turns, respectively, and for the oscillator, 25, 15, 8 and 4 turns, respectively, the separation being ½, ¾, 1 and 1.25 inches respectively, between secondaries, the plate winding for the oscillator being at extreme of the tubing and consisting of half the number of turns on the oscillator secondaries, except for the two smaller coils, when plate and grid windings are equal. The separation between plate and grid windings is ⅛ inch. The wire is No. 28 enamel throughout, the diameter 1.25 inch.

The coil switch is of the three tier type, with four connections on each tier. The shaft is insulated from everything. Low capacity type switches make the coil data applicable. The switch is of the rotary type and must be of precision manufacture to be valuable.

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Short Wave Editor, RADIO WORLD, *145 West 45th St., New York.*

Please enroll me as a member of Radio World's Short Wave Club. This does not commit me to any obligation whatever.

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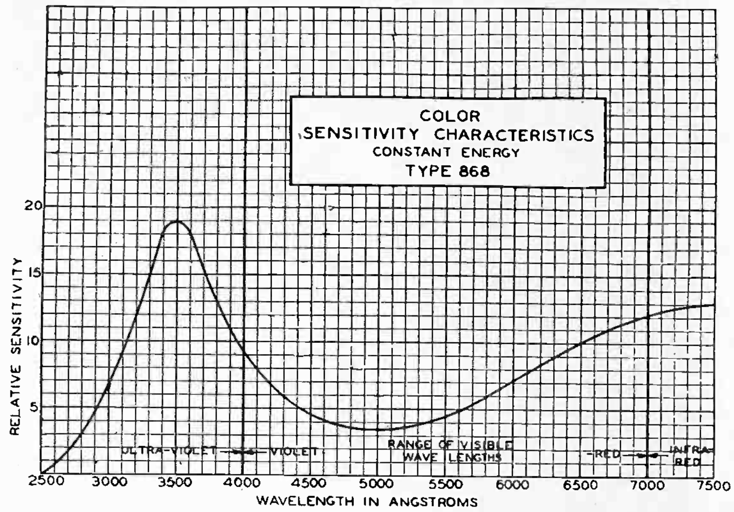
A New Phototube for H

Circuits for Using the Cell S

By Willian



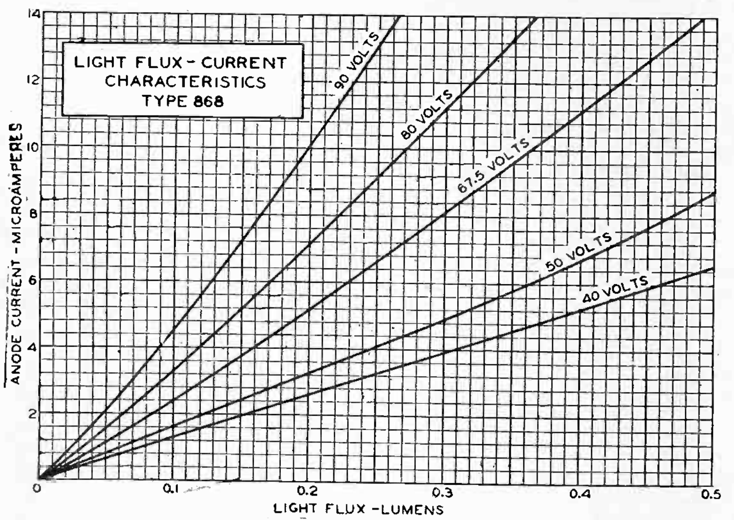


Fig. 1
Color sensitivity characteristic of the new Type 858 phototube.

Fig. 2
Light flux-current characteristic of the Type 868 phototube.

A NEW phototube, the 868, has been announced by RCA and Cunningham. This new tube is designed for use as light sensitive cell in home talking movie reproduction of the sound-on-film type and for many other applications where a light sensitive cell is required.

The new cell is of the caesium type and is sensitive throughout the entire visible spectrum, as well as in the ultra-violet and the infra-red. Its high sensitivity in the red and infra-red makes this cell particularly valuable when the source of light is in incandescent lamp, which is rich in the lights of longer wavelengths.

In Fig. 1 is a reproduction of the color sensitivity characteristic of the new cell, the curve having been taken under conditions of constant light energy entering the cell. As will be noted, the sensitivity is zero at 2,500 angstrom units, which is far into the ultra-violet. Then as the wave-length increases the sensitivity increases rapidly up to 3,500 angstrom units, where it reaches a maximum. Then it falls gradually to 5,000 angstrom units, where it reaches a minimum. This is in the blue-green region of the visible spectrum. As the wave-length increases still further the sensitivity increases again and reaches another maximum somewhere in the infra-red region.

Explanation of Variation

The increase in the sensitivity as the wave-length decreases beyond 5,000 angstrom units is due to the fact that short waves are more active photo-electrically than the long waves, just as the shorter waves are more active photographically than the long waves. The rapid drop in the sensitivity beyond 3,500 angstroms is undoubtedly due to the absorption of the light by the glass of the tube, as ordinary glass will not pass ultra-violet light. When it is necessary to utilize the ultra-violet in phototubes it is customary to use a quartz tube. For the same reason quartz lenses are used in photography by ultra-violet light.

The rise in the sensitivity characterized beyond 5,000 angstrom units is due to the peculiar responsiveness of the caesium coating on the cathode. When other alkaline metals, such as sodium and potassium, are used on the cathode, the maximum sensitivity falls at shorter frequencies, the sodium placing it near 6,000 angstroms and the potassium placing it in the violet.

Light Flux-Current Characteristic

In Fig. 2 are several curves showing the variation in the photo-electric current with light flux entering the 868 cell. They are for five different anode voltages. It will be noticed that the curves are very nearly linear, especially for the lower anode voltages. The linearity indicates that the tube will not introduce any distortion in the output of the cell and that the current is proportional to the quantity of light that enters the cell.

There is practically no time lag between the light entering the cell and the current and for that reason the cell is applicable to cases where the light fluctuates with extreme rapidity. It is rapid enough to follow faithfully the high audio frequencies in sound movie reproduction and also to follow the variations of light encountered in scanning a scene for television.

Rating and Characteristics of the Phototube

Anode supply voltage, maximum	90 volts
Anode current, maximum	20 microamperes
Static sensitivity	45 microamperes per lumen
Dynamic sensitivity at 1,000 cycles	40 microamperes per lumen
Dynamic sensitivity at 5,000 cycles	38 microamperes per lumen
Gas amplification factor	Not over 7.
Load circuit resistance	0.1 to 5 megohms
Maximum overall length	4.125 inches
Maximum diameter	1 3/16 inches
Window diameter	0.9 square inches
Bulb	T-8
Base	Small four prong
Cathode surface coating	Caesium

The sensitivity characteristics were taken with a Mazda projection lamp as the source, operated at a filament temperature of 2,870 degrees Kelvin, and one megohm load resistance in the test circuit. The sensitivity varies with the type of light because the color sensitivity curve is not uniform and because the energy distribution of the light depends on the type of lamp and on the temperature at which it is operated. The phototube has a small quantity of gas in the envelope, as this increases the sensitivity.

Definition of Units

Many terms which may not be familiar to radio fans have been used in this description of the new phototube, and for that reason it will not be out of place to define them.

An angstrom is a unit of length which is used for expressing very short lengths, especially those of wave-lengths of light. There are 100 million angstrom units in one centimeter, or ten billion in one meter. Hence a wave 5,000 angstrom units long is 0.0005 centimeter long.

Ultra-violet light is light having shorter waves than the shortest visible violet light wave. **Infra-red** light is light having waves longer than the longest visible red light.

Anode has the same sinificance in the phototube as it has in the thermionic vacuum tube. It is the positive or electron gathering element. **Cathode** also has the same significance, being the electron emitter.

Static sensitivity is the sensitivity measured with extremely slow changes in the light, or so slow that capacity effects have no chance to affect the current.

ne Talkies and Television

gested, Operation Explained

1. Jaffe

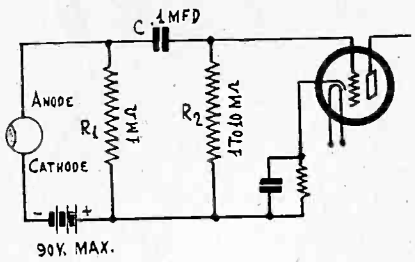


Fig. 3
A method of coupling the phototube to a thermionic amplifier when a separate battery is used in the phototube circuit.

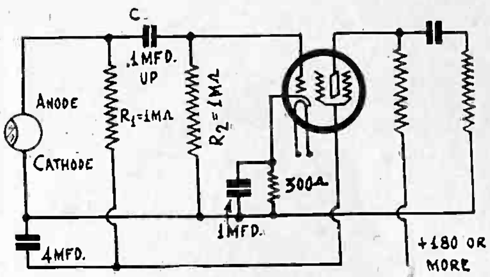


Fig. 4
The votage used on the amplifier tubes may be used to actuate the phototube if the circuit is arranged in this manner.

Dynamic sensitivity is the sensitivity measured with rapidly varying light.

The difference between static and dynamic sensitivity is the same as the difference between static and dynamic amplification of a thermionic vacuum tube.

Light flux, or **luminous flux,** is the quantity of light energy. The **lumen** is the unit of luminous flux. It is the light flux through one square centimeter on a sphere one meter in diameter when a source of unit intensity is located at the center of the sphere. The source of unit intensity is the standard candle. There is another definition of the lumen which makes it 10,000 times greater. This is the light flux from a source of unit intensity that flows through unit solid angle.

Practical Circuit

In Fig. 3 is a tpical circuit connecting a phototube and a vacuum tube amplifier. R1 is the load resistance on the phototube, in this case one megohm. C is a stopping condenser to isolate the grid from the high voltage and R2 is the usual grid leak. If the voltage drop in R1 is suitable for bias on the tube that follows it is not necessary to use C and R2, but the drop not only depends on the voltage of the battery in series with the load resistance and the phototube, but also on the light flux that enters the cell.

Suppose that the voltage in series with the tube is 40 volts and the load resistance is one megohm. If the flux that enters the cell is 0.2 lumen, the current is 2.6 microamperes, according to Fig. 2. The drop in R1 is then 2.6 volts, which would be satisfactory for a screen grid tube of the 224 type, or for almost any screen grid tube with the other voltages on the tube as usually recommended. With 90 volts in the phototube circuit and the flux the same as before, the drop in R1 would be 10 volts, which would be suitable for a 227 tube. Thus it is practical to choose such anode voltage and flux that would make the bias correct for almost any amplifier tube without the use of C and R2.

In case it is desired to use the same source of voltage for the phototube as for the amplifier tubes, the stopping condenser and grid leak should be used. Then R1 should be connected to B plus just as any plate coupling resistance, provided that the voltage does not exceed 90 volts. The return of R1 could be connected to the screen of an amplifier tube, on which the voltage is usually 90 volts or less. Fig. 4 shows a suitable circuit.

How Circuits Work

The manner in which the light values are converted into equivalent electric values can be explained by means of the curves in Fig. 2. Suppose we apply a voltage of 67.5 volts in series with a one megohm resistor and the phototube and that we arrange the components as in Fig. 4. Let the normal intensity of the light flux entering the phototube be 0.2 lumen and let this vary between 0.1 and 0.3 lumen. The light fluctuation amplitude, therefore, is 0.1 lumen. When the flux is 0.1 lumen the photo-electric current is 2.4 microamperes. The voltage drop in R1 is then 2.4 volts. At 0.2 lumen the current is 5.2 microamperes. Hence the change of 0.1 lumen changes the current 2.8 microamperes. The corresponding change in the voltage drop in R1 is 2.8 volts, which is the amplitude of the signal voltage resulting from the light variation.

On the other side we have a current of 8.1 microampere when the light flux is 0.3 lumen. Hence the change in the current due to a change in the light of one lumen is 2.9 microamperes. The corresponding change in the voltage across R1 is 2.9 volts. It will be noticed that the amplitude on increase is very nearly the same as the amplitude on decrease, the difference being only 0.1 volt.

This signal voltage would be sufficient to load up a screen grid tube. However, in the reproduction of home talkies it is not likely that such wide fluctuation in the light flux is possible. Hence the output voltage would be much less, and this would have to be compensated for by additional amplification in the electrical stage of the signal.

Volume Control Trouble

THE volume control in my set consists of a 500,000 ohm potentiometer in the grid circuit of the first audio tube. When the potentiometer is at full-on position everything is all right, but just so soon as I turn the control at all, using less resistance, I hear a howl, and no signal.—E. F. W., Seattle, Wash.

The potentiometer is defective. Try another one, or replace it with a fixed resistor to confirm the diagnosis.

Change in Amateur Phone Bands to Cut Interference

Considerable reduction of interference now caused by amateurs with aviation services will be brought about by changes in regulations for amateur operation, approved by the Radio Commission. Under the new plan, amateur telephone bands will be changed from 3,500-3,550 kc to 3,900-4,000 kc and from 14,100-14,300 to 14,150-14,250 kc.

Amateur radio telephone operation in these bands will be permitted only when operators hold licenses of the grade approved by the Secretary of Commerce for unlimited amateur radiotelephone operation.

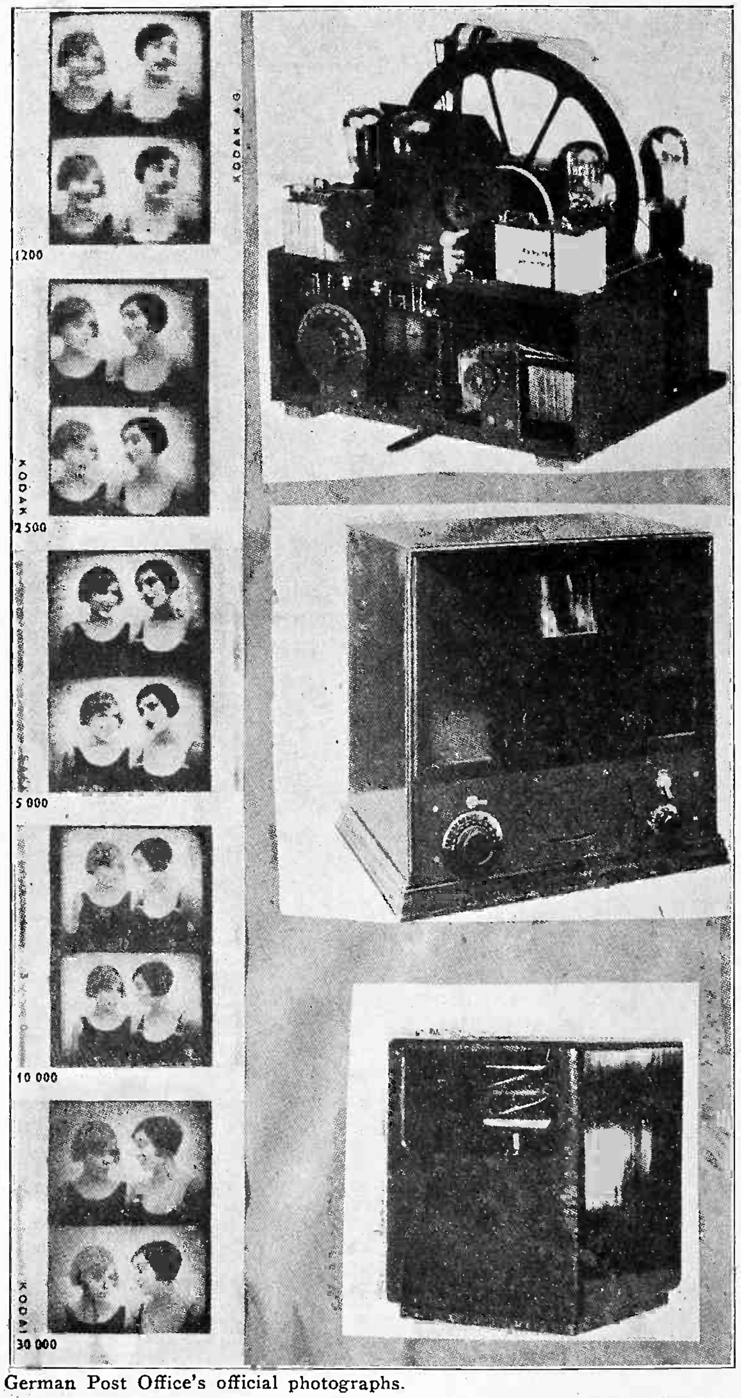
The new plan was first submitted to the Commission in May, 1931, by the American Radio Relay League, but was at that time disapproved by Albert Reiss, representing the Amateur Radiophone Association. But the Commission has received a telegram from Mr. Reiss stating that his association now approves the recommendations suggested by the League, and asking that his request for a hearing on the case should be withdrawn.

Germany Favors Ultra

Source of Light a Prese

Advance—Tests

By Heinrich Wirt



German Post Office's official photographs.

Increase in number of picture points improves the definition (left). The numbers of points used are given. Top right shows a television receiver chassis, center right, the cabinet view. Lower right shows a wheel containing a large number of mirrors set at different angles, used for reassembling the picture points on the screen into a picture. A point source of light is used. D is a diaphragm to confine the light beam.

Berlin, Germany.

DURING the last few years the problem of television has interested not only a few technicians who have been working on its development, but it has also attracted a large part of the public. The popular interest has been enhanced by the different radio expositions where television has been demonstrated so that each visitor could see for himself what has been accomplished up to this time. Also, there are already several regular television transmissions over a few broadcast stations such as the stations at Berlin-Witzleben, Koenigs Wusterhausen, and the short wave station at Doberitz. Anybody who has a suitable television receiver can pick up these signals. It is therefore of interest to all to know the present state of the development, with what fidelity it is possible to transmit images, what the outlook for further development is, and whether or when television can be made useful to the public. Therefore, in the following we shall give a resume of the present state of the art and speculate on the outlook for the further development.

Number of Points Increased

The transmission of pictures, as is well known, consists of breaking up the scene into a great number of picture points and sending them in rapid succession in a definite manner, each picture point occupying a very small fraction of a second. On the receiving side of the circuit these picture points are assembled in the order in which they are received. The greater the number of picture points per second, the greater the difficulty of transmission and the construction of the necessary apparatus. On the other hand, the greater the number of picture points per second, the clearer is the received image.

At the beginning of development of television apparatus a low number of picture points was selected, because this made the experiments simple. Later the number of picture points was increased as the apparatuses were improved, because the prime object of the development became greater fidelity of pictures.

Improvement at Doberitz

Experimental transmission from the station at Berlin-Witzleben since March 1929 and from Koenigs Wusterhausen since May 1930, conducted by the German Reichpost, have been based on 1,200 picture points per frame, in 30 lines, repeated 12.5 times per second. These gave a frequency band of 7,500 cycles per second, which therefore could be well sent over the regular broadcast channels without interference with neighboring channels. Naturally, with 1,200 picture points per frame it was not possible to reproduce all the detail carried in a normal film, but

Television Light

Television, transmitted experimentally on a beam of light, utilizing a wavelength of but a billionth of a meter, was successfully demonstrated here in the radio consulting laboratory of the General Electric Company, Dr. E. F. W. Alexanderson announced. This use of the ultra short waves, Dr. Alexanderson believes, opens the way to a new and valuable era in the art and promises to result in more distinct television pictures.

In the laboratory tests, the pickup device was of the conventional type such as used by Dr. Alexanderson in his previous television experiments. Instead of the electrical impulses being fed into a radio transmitter as heretofore, they were modulated into extremely high frequencies on a light beam from a high intensity arc. This beam was projected the length of the laboratory into a single photoelectric tube, which transposed the modulated light waves back into electrical waves. The electrical impulses reproduced the image by means of an ordinary television receiver.

"The work thus far is highly experimental, yet some day we may see television broadcast from a powerful arc light, mounted atop a single tower high above the city," Dr. Alexanderson said. "These modulated light waves will be picked up in the homes by individual photoelectric tubes or electric eye, instead of the present type wire antennae.

"Light broadcasting may have the same relation to radio broadcasting as the local newspaper has to the national newspapers. These light waves can be received at relative short distances only, perhaps ten miles. Each community could then have its light broadcasting system."

The greatest difficulty in television today, Dr. Alexanderson believes, is in the method of transmission. Radio waves usually follow several paths in travelling from the transmitter to the receiving station. Each day following a different path produces a different image so that a composite image is apt to be blurred. For this reason television has been tending toward shorter waves.

"The logical progress of this development," said Dr. Alexanderson, "is that in the future we shall explore still shorter waves, until we finally arrive at the light waves which we know travel in straight

Vaves for Television

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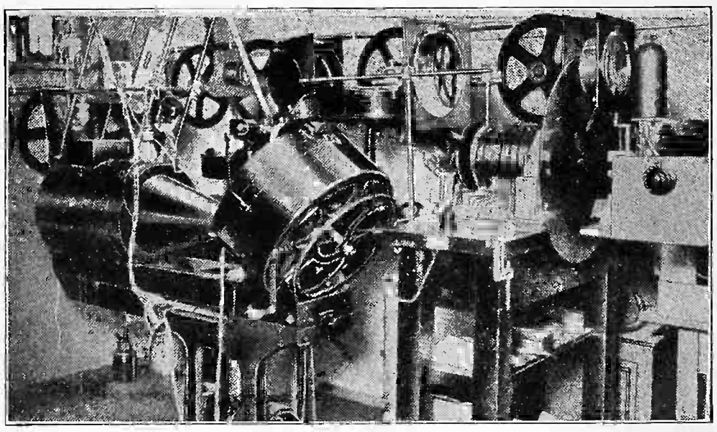

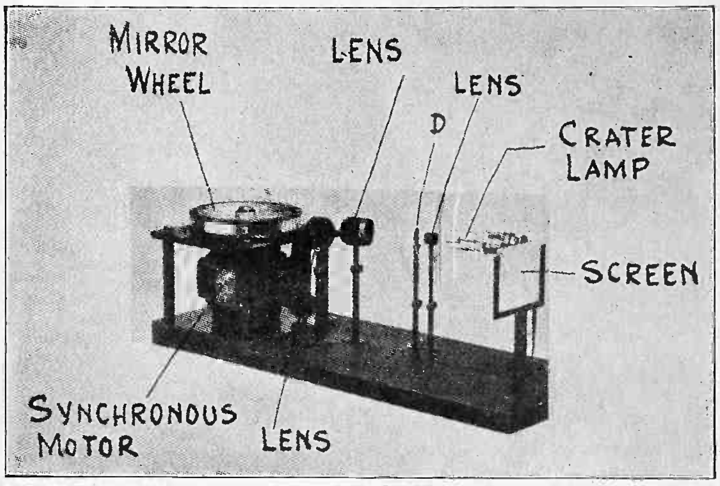

The television transmitting equipment of the German Post Office at Witzleben. At right is the Nipkow disc and the driving motor. At left foreground is a source of light.

only fairly clear and recognizable pictures of one or two heads of persons.

The reproduction of simple scenes by special films met with great difficulties. The observation of such crude television pictures is tiresome, because only with concentrated attention could the pictures be understood. The radio listener, therefore, would not develop any sustained interest in such transmission if it were introduced into practice. For the radio experimenter, on the other hand, such pictures would be both instructive and highly interesting, especially if he followed the pictures with receivers he himself had built.

The transmission from the short-wave station at Doberitz, which operates on 144 meters, has made use of a higher number of picture points, namely, 3,000 per frame, with 48 lines per frame, and 25 repetitions per second. This required a frequency band of 38,000 cycles per second. As a consequence the required apparatus is quite complex to build and the necessary receiver for this transmission is correspondingly more difficult to make. The reception is made more difficult because fading and reflection effects enter strongly.

The radio experimenter is hardly able to build for himself suitable apparatus for this reception.

Simple Scenes Practical

The fidelity of the 3,000 picture point images is about three times better than that of 1,200 picture point images. The treatment of simple scenes becomes possible, although these scenes are not to be compared with scenes of movie films. Only by increasing the number of picture points to 4,800 (60 lines per frame, 25 frames per second, and a frequency band of 60,000 cycles per second) does it become possible to reproduce normal moving picture film so as to make the scene recognizable. And even with this number of picture points, much of the detail in the picture is lost. It is necessary, therefore, to strive to increase the number of picture points still further.

Judging by this and by experiments in laboratories, it seems that to transmit satisfactory pictures it would be necessary to divide up the picture into 10,000 picture points, which would require a frequency band of 125,000 cycles. Thus it is out of the question to use broadcast frequencies for sending out the pictures, for the modulation of a wave with such a wide frequency band is possible only in the very short wave region, say in the band between 5 and 9 meters. Since the ultra-short waves spread out in straight lines, like light, only a very small territory could be served by a sender unless the transmitting antenna were raised as high as possible, for example, on a high tower.

Results on 7 Meters

Laboratory trials already made on 7 meters with 10,000 picture points, have resulted in satisfactory pictures. Further experiments must determine whether it is possible to transmit these pictures over considerable distances.

The development of parts for television receivers has not advanced satisfactorily. It is especially the lack of a suitable source of light which is holding up progress in this respect. However, recently there has been good progress in this direction and it is likely that further development of light sources will come, sources which will make it possible to get pictures one half meter square. The cathode ray oscillograph has been tried lately with good success. It has especially the advantages that it can be used with a large number of picture points and that it has no moving parts, except the movable cathode ray.

The problem of television has been solved. But before television can be introduced for general radio distribution, we must await the developments suggested above.

;eam Modulation

lines and which can be accurately controlled by such optical means as mirrors and lenses.

"When it was decided to take up experimentation on this subject Dr. Irving Langmuir of the research laboratory was consulted about the probabilities of being able to modulate to a source of light. Dr. Langmuir, who has done much research work with arcs, believed that this could be accomplished by using a high intensity arc. It was concluded that a most desirable light would be a high-intensity arc of the type where the light comes from the arc rather than from the crater. In the 10-ampere arc lamp used for the first test, most of the light comes from the crater, and comparatively little light is in the arc.

The lamp was used in such a way that the light from the crater was eliminated, and the arc used was therefore quite a weak source of light. The current from the standard television pick-up was superimposed upon this arc, and the light from the arc intercepted by a photoelectric tube at a distance of 130 feet. The photoelectric tube was then used to control our regular television projector. The television image transmitted in this way had the same sharpness of detail as the one ordinarily obtained without the interposition of the light beam.

In 1927 a picture three inches square on the screen was achieved by Dr. Alexanderson; in 1928 the first radio-television drama was broadcast from Schenectady; in the fall of 1929 a picture 14 inches square, not simply black and white like a silhouette but with all the gray shades for depth and detail, was produced; in 1930 Dr. Alexanderson sent television signals to Australia and back, and after traveling 20,000 miles, a rectangle still had four corners; and in the same year television first appeared as part of a regular performance at a theater in Schenectady with an image on a screen seven feet square.

Modulated light has also been used in many previous experiments by the General Electric Company. For instance, there is the talking beam of light that has been used at meetings and convention demonstrations, and the ship-to-shore communication of last summer with a talking light beam.

The Effect of Grid

It Introduces High Minimum Ca

By Bru

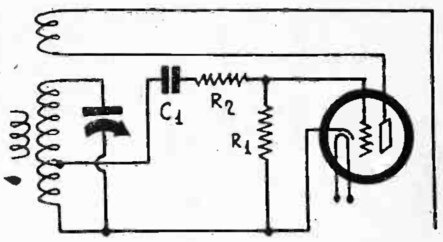

FIG. 1
In this simple oscillator the grid current introduces a large minimum capacity and also instability of frequency.

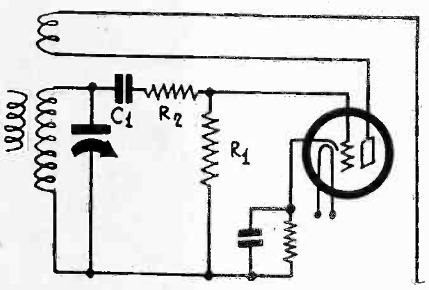

FIG. 2
The use of a stopping condenser and grid leak reduces grid current, stabilizes the frequency, and cuts capacity.

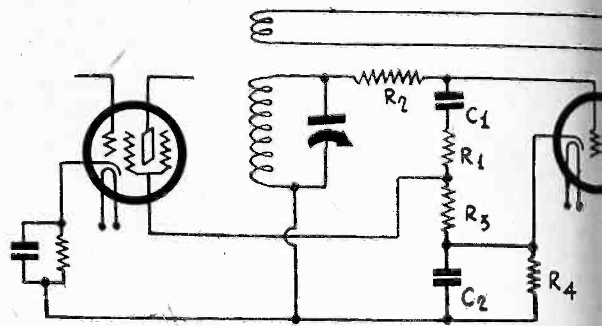

FIG. 3
The effect of the grid leak and stopping condenser in this circuit is the same as that shown in Fig. 2.

The grid ha
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THE effect of grid current on the performance of receivers is not generally given the consideration it deserves. This is especially true in the case of oscillators in superheterodynes and grid leak detectors. The amplitude of oscillation in most ordinary oscillators is limited by the grid current and at times this current is high, as will be appreciated when it is remembered that grid dip meters operate on grid current.

When grid current flows the grid to filament, or cathode, resistance is low, and this resistance is directly across the tuned circuit ahead of the tube. This decreases the selectivity of the circuit and also the sensitivity of the receiver. Another effect is to increase the effective capacity of the circuit, and this increase at times is quite large. One place where the increase in capacity is especially large and troublesome is in oscillators. When an attempt is made to connect the oscillator condenser on the same control as the r-f condensers, the increased capacity appears as a very high minimum capacity in the circuit which in many cases renders impossible the padding of the oscillator so as to track.

Value of Grid Resistance

It is often assumed that the grid to cathode resistance is infinite. But this assumption is valid only when the bias is so high that at no part during the input voltage cycle the grid assumes a positive value. This condition may be met in amplifiers but in oscillators it is difficult to satisfy. F. B. Llewellyn of Bell Laboratories has shown that for simple oscillators the ratio of the plate resistance to the grid resistance is very nearly equal to u-1, where u is the amplification constant of the tube. Suppose we have an oscillator in which the tube is a 227 type, which has a mu of 9. The plate resistance is then eight times larger than the grid resistance. The plate resistance of this tube is approximately 10,000 ohms and therefore the grid resistance would be only 1,250 ohms. This is far from negligible when connected across a tuned circuit. Undoubtedly, the mean value of the grid resistance during a cycle is somewhat higher than this even under the worst conditions. Indeed, it would have to be considerably higher or the circuit would not oscillate.

If we put a resistance R across a capacity C which is a part of a tuned circuit in which the inductance is L, the resonant frequency is diminished by an amount depending on the ratio of L/C and on the square of the resistance. If F is the resonant frequency of the circuit when the resistance is across C, Fr the resonant frequency when there is no resistance across the condenser, and if $n = L/CR^2$, then $F = Fr\ (1 - n)^{1/2}$. If n is greater than unity the oscillation is imaginary, which means that no oscillation will occur if n is larger than unity.

Typical Values

In many tuners the inductance of the coil is 245 microhenries. If this is to tune just to 1,500 kc, the minimum capacity in the circuit should be 46 mmfd. The ratio L/C is therefore 5.32 times a million and the square root is 2,310. The resistance across the condenser must not be less than this. Let us suppose that it is 5,000 ohms and that oscillation still occurs. The value of n is then 0.462. Therefore $F = Fr\ (1 - 0.462)^{1/2}$ or 1,110 kc. This frequency reduction would be brought about by adding 38 mmfd. to the tuning condenser without the resistance across it. That is, the grid resistance in this case adds 38 mmfd. to the minimum capacity. Let us see what it adds to the maximum capacity.

If the tuning inductance is 245 microhenries and the maximum capacity is 350 mmfd., the lowest frequency is 543 kc. In this case the ratio L/C is 0.7 times a million. Hence $n = 0.028$ and F turns out to be 535 kc. This is only a reduction of 8 kc, which is brought about by a change in capacity of 10.5 mmfd. Therefore the resistance across the tuning condenser introduces more capacity at the high frequency end of the tuner than at the low frequency end. It is equivalent to adding a certain small capacity across the tuning condenser.

Effect of Grid Leak

A resistance connected across the tuned circuit externally has the same effect as the internal grid resistance. For example, when we connect a grid leak from the grid to the cathode, this resistance is directly across the tuning condenser and it is in parallel with the grid resistance. If there is a large condenser in series with the grid leak the case is not materially changed, because the condenser would have to be extremely small before it would affect the situation. If the resistance is connected from the grid to the top of the tuned circuit the effect is entirely different for in that case the resistance increases the effective resistance across the tuned circuit.

Although a grid leak connected from the grid to the cathode decreases the shunt resistance, it may still be used to advantage and to increase the grid resistance at that. If there is a condenser in series with the grid return and if the leak is the only conductive path from the grid to the cathode, the grid current cannot rise to as high values as before. As soon as grid current begins to flow a steady voltage drop is established across the leak and this will buck the tendency for the grid to go positive. In fact, if the grid is of the order of quarter megohm or higher the grid cannot go positive by more than a small fraction of a volt and the internal grid resistance remains so high that the external shunt practically determines the resistance across the tuned circuit. When this shunt is 250,000 ohms or more the increase in the effective capacity is very small.

Series Connection of Leak

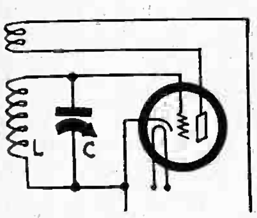
The leak can just as well be connected in series with the grid lead and in this case it will be just as effective in limiting the flow of grid current and it will be still more effective in holding the tuning condenser capacity to its proper value. Therefore in an oscillator, as well as in a detector, the grid leak and condenser should be connected in parallel with each other and in series with the grid lead, except when for special requirements it is necessary to depart from the rule.

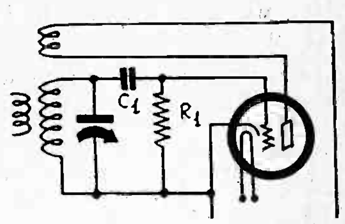
The treatment of the oscillator so that no grid current flows,

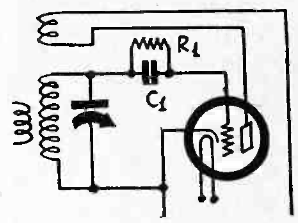
urrent on Oscillators

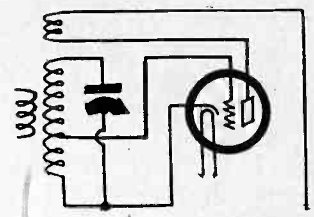
city and Frequency Instability

n Brunn









returned to coil to mini- e consider- nt effect.

FIG. 5
The methods of stabilization used in Figs. 2 and 4 have been combined. A series resistance R2 has been introduced.

FIG. 6
Grid bias on an oscillator tube is advantageous. The treatment illustrated here improves the oscillator.

FIG. 7
Grid current is limited by R2, which also limits the amplitude. A method of virtually constant coupling.

or so that there is a minimum shunt resistance across the condenser, becomes of first importance when designing superhetrodynes in which the tuning condensers are put on the same control. As a first condition, the oscillator inductance must be less than the inductance in either r-f circuit. Assuming the same minimum capacity in the oscillator and in the r-f circuits and an intermediate frequency of 175 kc, the oscillator inductances should be 80 per cent. of the inductance in the r-f circuits. If the minimum capacity in the oscillator is less than the minimum in the r-f circuits, it is always possible to add enough to make them equal, which is a better procedure than to change the nductance.

If the minimum capacity in the oscillator circuit is greater than in either r-f circuit it is not always possible to make the oscillator track with the other circuits. If the inductance of the oscillator be reduced until the oscillation frequency is 175 kc higher than the signal freqency when the tuning condensers are set at minimum, there will not be enough inductance at the lower frequency end of the dial. Instead of calling for a series condenser here to make the oscillator frequency right it would be necessary to add an inductance. But, of course, this could not be done, for it would throw the adjustment out everywhere else.

Padding Problems

When the minimum capacity of the oscillator is too high, the best that can be done is to make the series padding condenser nfinite, that is, to short circuit it, and then adjust the inductance when the condensers are set at maximum until the oscillator frequency is 175 kc higher than the signal frequency. If the minimum capacity should happen to be just right, the padding obtained by this method would not be far out anywhere, but if it is still too high there would be no tracking at the high frequency end. It is absolutely necessary to decrease the minimum capacity in the oscillator circuit, or there is little hope of getting good tracking throughout.

The addition of a resistance in series with the resonant circuit s effective in reducing the added capacity effect for three reasons; first, it adds to the resistance in shunt with the condenser; second, it tends to prevent the grid from going excessively positive and hence to keep the grid resistance high, and third, it limits the amplitude of the oscillation which in turns prevents the grid from going very much positive. Of course, if this series resistance is too high, oscillation will not occur. Hence the choice is a compromise.

Typical Oscillators

In Fig. 1 is a tuned grid oscillator of the simplest type, in which L and C are supposed to determine the frequency of oscillation. As a matter of fact, the frequency generated will be much lower than the natural frequency of L and C. There s no bias on the grid and for that reason the operating point s at zero bias. The oscillation swings the voltage both positive and negative about this value, and during the positive swing the grid resistance is very low. This circuit can be improved somewhat by using the regular grid bias resistance called for by the tube when it is used as an amplifier. But even this does not reduce the effect of the grid resistance sufficiently for many purposes.

The credit in Fig. 2 is an improvement over that in Fig. 1 in that grid current is prevented by the stopping condenser C1 and the grid leak R1. The grid voltage cannot swing far positive now because as soon as grid current begins to flow the drop in R1 will buck it. Therefore R1 will maintain the grid voltage near zero during the positive swing of the oscillating circuit. This circuit can also be improved by applying a negative bias. In this case grid current will only flow during a small part of the signal swing, and the current that does flow will be kept down by the grid leak.

Series-Connected Leak

The circuit in Fig. 3 is an improvement over that in Fig. 2 because in this case the grid leak is connected in series with the grid resistance. As far as the limitation effect is concerned it is the same in both circuits for the same value of grid leak. It is true that the stopping condenser to a large extent nullifies the effect of R1, but it has a corresponding effect in Fig. 2.

Another method of reducing the effect of the grid resistance is illustrated in Fig. 4. In this case the grid is connected only across a portion of the tuning coil. The grid resistance, therefore, whatever it may be, is connected across only a part of the tuned circuit rather than across the whole. The effect of the grid resistance is correspondingly reduced. The effect can be reduced still further by treating the circuit as in Fig. 5, in which the coil is tapped just as in Fig. 4 and in addition the grid condenser and leak stabilizer is used. In Fig. 5 it is not really necessary to use the tap on the coil because if the resistance R2 is chosen high enough the same effect will be obtained. The grid connection would then be made to the top of the tuned circuit as in Fig. 6. In this circuit the effect of the grid resistance is still further reduced by using a grid bias.

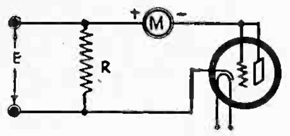
More Computations

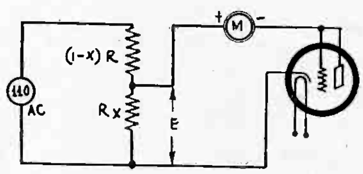
Let us see what the effect of the grid and external resistance may have on the frequency of the oscillator in Fig. 6. Let us assume that R1 is 100,000 ohms, that R2 is 5,000 ohms, and further let us assume that the grid current is limited so that the resistance is not more than 10,000 ohms. The effect of C1 may be neglected. The resistance of 100,000 ohms in parallel with 10,000 ohms is 9,900 ohms. This is in series with R2, which is 5,000 ohms. Hence the total resonance across the tuning condenser is 14,900 ohms. Now if the inductance of the coil is 245 microhenries and the capacity at minimum is 46 mmfd., the value of n in the formula given previously is 0.024 and therefore the frequency is 1,484 kc, a reduction of 16 kc. This is equivalent to adding a capacity of nearly 1 mmfd., which is quite negligible. And the conditions assumed were extreme at that.

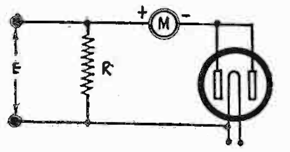
Measuring the Out

A Diode Rectifier or Vacuum

By Burton







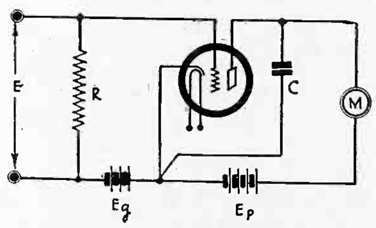


FIG. 1 (top left)
An output meter in which a diode made of a three element tube is used as rectifier and a milliammeter is used as deflection indicator. R should have the value of the best load resistance of the output tube.

FIG. 2 (top right)
When the voltage to be measured is higher than that covered by the calibration of the output meter, a fraction of the output voltage can be measured as indicated here.

FIG. 3 (bottom left)
A 280 type rectifier can also be used if connected as in this manner. There is virtually no difference between this circuit and that in Fig. 1.

FIG. 4 (bottom right)
One of the best ouput meters is that based on the grid bias detector. The bias Eg is adjusted until the reading on the meter M is very small or just zero when R is short circuited.

IT is frequently asserted that a certain change in a circuit increases the volume 100 per cent. Perhaps it does, but who can tell? Perhaps the change is only 5 per cent., or maybe it is as much as 500 per cent. If the ear is the sole judge, one guess is as good as another and all the statement can mean is that there has been an increase in the volume.

The only way to express numerically whether there has been an increase or a decrease is to measure the output before and after the change, either in absolute or in relative units. To do this we need an output meter of some kind.

Any detector may be converted into an output meter provided that we calibrate it. This detector may be a diode, a grid bias detector, a crystal, a copper oxide rectifier, or any other.

In Fig. 1 we have a simple diode rectifier made of a three element heater type tube. The alternating voltage E to be measured is connected across a resistance R, which is then connected to the tube in the manner indicated. The rectified current will be indicated by the direct current milliammeter M. For every value of E there will be a definite reading on the meter M and that reading will be a measure of the voltage. If we have an alternating current voltmeter we can connect this across R and different voltages may be impressed. Thus we can get a calibration curve between the alternating voltage impressed and the reading on M.

Using Fixed Voltage

If we do not have an a-c voltmeter but only a source of high voltage, say 110 volts, we can still calibrate, provided that we have different resistances of known value. This is illustrated in Fig. 2. The voltage across all of R is always 110 volts, or whatever we have. Let us connect the tube across a portion Rx of the total resistance. The input E to the tube is then the drop in Rx, and by simple proportion we have $E = 110x$. This holds, provided that the value of R is small compared with the resistance of the tube, a condition not difficult to meet. Since x may have any value from zero to unity, we have a means of impressing any known voltage from zero to 110 volts. For accurate work we should know the exact value of the line voltage but for comparative work we may assume it to be 110 volts. The values of the two resistances Rx and $(1-x)R$ may be measured with a battery and the meter M, or with an ohmmeter. Note that the sum of the two resistances is always equal to R. That is, R is a potentiometer of fixed resistance and we only tap it at different and known points.

After we have calibrated the meter, that is, after we have found a reading on M for every value of E, we can use the instrument for measuring output voltages. Incidentally, the resistance used should be non-inductive. This does not mean, however, that a wire-wound resistance such as those used in voltage dividers cannot be used.

Instead of using a three element tube, a 280 rectifier tube could be used just as well. The connection of this tube is shown in Fig. 3. The plates of the tube are tied together. Of course, it is necessary to provide a suitable filament voltage for this tube, just as this is necessary when any other tube is used as rectifier.

Grid Bias Detector

A grid bias detector can also be used for measuring output. One circuit of this type is illustrated in Fig. 4. Here E and R have the same significance as in the preceding circuits. Eg is a bias voltage which places the operating point of the tube where detection or rectification is good. This voltage is best provided by a small battery. The bias should be adjusted so that the plate current is about 0.1 milliampere when the signal voltage E is zero. As a voltage is impressed across R the plate current will increase, and this increase is a measure of the alternating voltage E. If the voltage to be measured is high, the bias may be increased until the plate current is practically zero when no a-c voltage is impressed. The increase in the plate current is then practically the same as the current itself, so that the reading on M is a measure of the alternating voltage. This instrument can be calibrated in just the same way as the preceding circuits. Condenser C may not be necessary but if it is used it should be about one microfarad.

Using A-C Milliammeter

In case an alternating current milliammeter is available, this can be used for measuring the output of a receiver. A suitable circuit for this is shown in Fig. 5. The tube shown in this circuit is the power tube of the set. Ch is a choke coil of high inductance value, say 30 henries or more. C is a stopping condenser of large capacity, say 4 mfd. or more. R is a resistance which should be adjusted to the proper load resistance of the power tube. For a 245 it should be 4,000 ohms and for a 247 it should be 7,000 ohms. The range of the alternating current milliammeter should be suitable to the tube involved, or to the signal that will be obtained.

The output power in this case is the product of the current squared and the resistance R. Suppose that the current is 5 milliamperes and the resistance is 7,000 ohms. The power then is 175 milliwatts. Since the maximum undistorted output of this tube, that is, the 247, may be of the order of 5 watts, the current that may be expected is 26.7 milliamperes. An a-c galvanometer having a maximum deflection of 115 milliamperes, a common instrument would be suitable for this circuit. This meter is not calibrated in milliamperes but the scale is divided into 100 divisions and the deflection is proportional to the square of the current. Thus relative values of power are obtained by multiplying the deflection by the resistance R. Or, since the resistance for any one tube remains constant, the relative power is proportional to the deflection. For this reason this instrument is very convenient for measuring relative power output. If the deflection is twice as great in one case as in another it can be said that the volume in one case is twice that in the other.

Matching Impedance

It is assumed that the signal consists of a pure tone of steady amplitude. If the output from a broadcast signal is measured the output will vary continually. This applies to the other output meters as well.

When measuring output with any one of the circuits in

put of a Receiver

Tube Voltmeter May Be Used

Williams

Figs. 1 to 4 the load resistance on the output tube should be equal to the optimum load resistance for the tube involved. This can be provided by making R in each case equal to the output resistance of the tube. If it is not practical to make it as high as this condition demands, R may be made smaller and a series resistance connected between the tube and the calibrated voltmeter. Then only a portion of the output is measured directly. Fig. 2 illustrates this arrangement, which is applicable to all the circuits. R in this case should be equal to the optimum load resistance of the tube but Rx may be only a small fraction of this.

Suppose, for example, that R is 7,000 ohms and that Rx is 1,000 ohms. Then E will be 1/7 of the total voltage. Suppose we have calibrated the output meter on 110 volts when Rx is 1,000 ohms and R is 7,000 ohms. Then any other voltage impressed across the whole R will be divided in the same ratio, that is, 1 to 7. To get the total output voltage of the tube we would multiply the voltage indicated by the meter by seven. The circuit in Fig. 6 shows an arrangement suitable for a 247 pentode output. The rectifier terminals would be connected across E. The condenser in series with the load resistance is used to prevent direct current from entering the voltmeter circuit. While the condenser is specified at 4 mfd., a larger one could be used to advantage, especially when the frequency of the tone is low. For the standard test frequency of 400 cycles per second 4 mfd. is large enough.

Copper Oxide Rectifier Meter

Copper oxide rectifier meters often come with an internal resistance of 4,000 ohms. Such a meter will give directly the output voltage when connected, through a large condenser, across the output of a 245 type amplifier, assuming that there is no other load on the amplifier. A meter of this type is rather limited in its application, but of course it is always possible to connect an external multiplier resistance when the required load resistance is higher than 4,000 ohms.

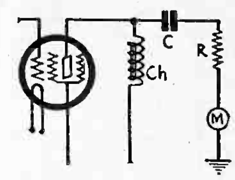
One of the best output meters is the grid bias detector shown in Fig. 4. This has virtually an infinite resistance and is therefore an ideal voltmeter. The resistance R in this circuit should be made equal to the load resistance of the tube, and no other load should be used on the tube. In case the output voltage is too high for the rectifier tube, the grid circuit of the detector can be connected across any part of R. For example, suppose the calibration of the voltmeter covers only a range of 10 volts and the output voltage may be of the order of 100 volts, in that case the grid circuit of the tube should be connected across only 1/10 of R, and each value should be multiplied by 10.

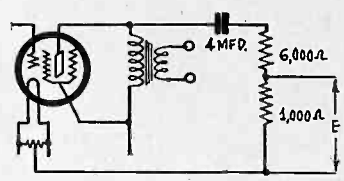
The meter in Fig. 4 can also be used to measure the voltage across the voice coil of a dynamic speaker. In this case R is omitted and the grid circuit in connected directly across the voice coil. The voltage developed across the voice coil, even for fairly large values of output, will be low. Hence it is advantageous to have the meter calibrated over a low voltage range, say from zero to 10 volts. But the voltage across the voice coil will not give the power delivered to the speaker unless the current in the voice coil is measured at the same time the voltage is measured. For comparative values at one frequency it is sufficient to regard the square of the voltage as the power. This will give correct relative output values, provided that the frequency does not change.

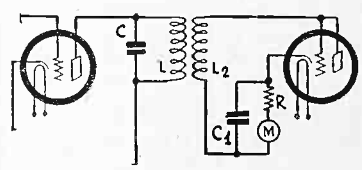
Keeping Direct Current Out

Whenever a rectifier voltmeter is connected to an output tube it is necessary to eliminate direct current, and this may be done with a large stopping condenser as suggested. It can also be done with a transformer. A condenser is the simpler and more reliable.

In case it is desired to study the radio frequency amplification only a diode detector operating on the carrier can be used. One way of doing this is illustrated in Fig. 7. A coil L2 is coupled to a coil L, which forms a part of a tuned circuit. The carrier current in LC will induce a voltage in L2 and this will cause a direct current to flow in the diode circuit. C1 is a by-pass condenser used only to improve the detecting efficiency and R is a meter to limit the rectified current until it is suitable to the meter M used. To limit the power taken from the tuned circuit M should be a sensitive milliammeter, say 0-1 milliampere. The deflection on M will follow the mean amplitude of the current in the tuned circuit and will indicate the effect of changes in the radio frequency amplifier. For example, it will show whether the amplification is increased or decreased by changes in grid bias, plate voltage, filament voltage, degree of coupling, change of coils, and so on. It will also show changes in signal intensity due to fading and other effects.







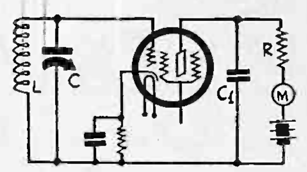


FIG. 5 (top left)
The direct current must be kept out of the output meter and one way of doing this is shown in this circuit. In this particular case M signifies a thermo-coupled type of meter, but the a-c voltage across R may be measured with one of the preceding meters.

FIG. 6 (top right)
The output voltage may be measured by measuring the value of a known fraction of it as in this case, where E is 1/7 of the total.

FIG. 7 (bottom left)
The carrier voltage may be measured with a diode rectifier by this method.

FIG. 8 (bottom right)
The regular rectifier in the receiver can also be used for measuring the carrier voltage by connecting a milliammeter in the plate circuit of the detector. The increase in the reading on M due to the signal is a measure of the signal intensity.

It is not necessary to set up a separate tube for observing this change when a grid bias detector is used, because the detector tube itself can be used as the rectifier. How this is done is shown in Fig. 8. The tube here is supposed to be the regular detector and LC is the tuned circuit ahead of it. R is the coupling resistance and C1 the regular by-pass condenser. The only thing that need be done is to insert a 0-1 milliammeter M in the plate circuit as indicated. This may be either above or below the coupling resistance. It is not advisable to insert the meter by plugging a circuit tester into the socket.

If the detector has been adjusted for best detecting efficiency a signal voltage impressed on the control grid in the regular way will increase the plate current. The increase as indicated by the meter is a measure of the strength of the signal.

Source of Signal

It is not practical to depend on broadcast stations for the source of signal except when a rough estimate of the output is desired, because the output changes continually, both when the audio component and the carrier are measured. When measuring radio gain it is best to have an unmodulated carrier, obtained from a laboratory oscillator, or a carrier modulated with a tone of constant amplitude. Likewise, when studying the output of the audio amplifier, it is best to have a tone of constant amplitude and frequency, which can also be supplied by a laboratory oscillator. Suitable oscillators have appeared several times in RADIO WORLD, the latest thing in the Jan. 2nd., 1932, issue.

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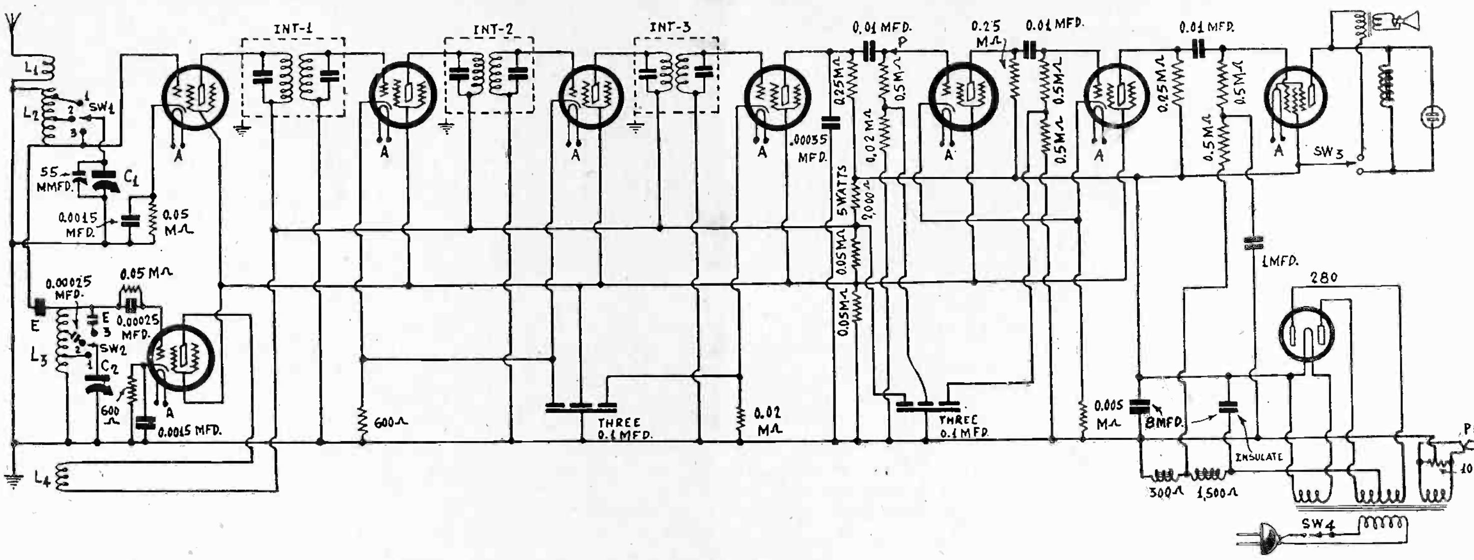


FIG. 981

Short-Wave Superheterodyne

PLEASE show a stabilized three stage resistance coupled audio amplifier, working into a pentode output tube, with television terminals, the amplifier preceded by a short wave superheterodyne that will also tune in regular short wave stations, besides television.—H. D. G., Beacon, N. Y.

The requested circuit is shown in Fig. 981. If single control of tuning is to be used, at least a modulator trimmer is advisable, and the padding may be done in the oscillator circuit as shown. It is not known what intermediate frequency you will use, but assume, since you want short-wave reception only, that it is 1,600 kc. Then the condenser E in the oscillator circuit is a 20-100 mmfd. equalizer set at a maximum, and the other padding condenser may be 0.00025 mfd. The coil data then would be, for the modulator, L1 = 20 turns, L2 = 45 turns tapped at fifth and tenth from the grounded end, and for oscillator, L3 = 25 turns tapped at 5th and 12th from the grounded end, L4 = 17 turns. The stabilization of the audio amplifier is effectuated by using resistor-capacity filters in the three grid circuits and also by using a common biasing resistor of 0.005 meg. (5,000 ohms) in the first and second audio stages. This resistor introduces negative feedback that aids in the elimination of motorboating. The switch, SW-3, puts speaker or neon lamp in circuit. The output choke coil is 30 henries. The intermediate frequency transformers should have plate condensers out of circuit when the transformers are being peaked, and then a signal tuned in and grid condensers adjusted for maximum response. Then the grid condensers are disconnected, the plate condensers connected, and the plate condensers adjusted for maximum response. Then the grid condensers are re-established without further test. The response will be a little less, but there will be a band pass filter intermediate tuner.

* * *

Battery Resistance Compensation

IN constructing a meter board I have made suitable arrangements for testing voltages and currents, both a-c and d-c, and now I am stumped regarding the resistance measurement. I have made provision for a 4.5 volt battery, with series resistor, and would like to know how to compensate for the voltage difference as the battery ages, so that the resistance measurements will be right even when the battery is old.—H. D. E.

As the battery ages or is used, the resistance of the battery increases. Therefore, if you use a potentiometer or other device to alter the voltage it will be only in the direction of reduction, unless the resistance calibration is made in the first instance for less than 4.5 volts the potentiometer will do no good. Also, since added resistance, due to the battery, is actually the cause of the changing condition, whereby the voltage seems to be different, the potentiometer or other device is mostly a means of kidding yourself by making the meter seem to read zero resistance at full-scale. The no-load voltage across the battery is actually the same all the time, the current drain simply making the battery resistance readable on the resistance scale. That is, when current flows, the resistance effect shows up as if it were a battery voltage diminution. Compensation might be possible if the current were constant, but such constancy can not exist except by confinement to one particular reading. We recommend, therefore, that you omit all efforts at compensation. Then as the battery resistance increases, that resistance can be read on the scale, and deducted from the apparent reading. Or, if you will replenish the battery so soon as its resistance becomes readable, you will be playing safe, also.

* * *

Measuring Device

AT present I have a set analyzer that I built and it is rendering excellent service. Now I desire a separate device that will measure voltages and currents, both a-c and d-c, and that will measure also resistance, 0-10,000 and 0-100,000 ohms, and capacity from 0.1 mfd. to 10 mfd. Can some provision be made for measuring the capacity of electrolytic condensers?—O. T. Malone, N. Y.

We are working on a device that will measure 10 volt, 100 volt and 250 volt ranges, a-c and d-c, also 1, 10 and 100 milliamperes d-c and 1 ma a-c, with 0-10 volts and 0-100 volts output meter measurements, and by connection to the 110 volt a-c line capacities in the range you state. The device will not measure the capacity of electrolytic condensers, however, because a-c can not be applied to them. A rectifier would have to be built in, and that you can include, if you desire. The output meter will have an impedance adjuster for voice coil measurements, that is, so the meter can be used, if desired, at the voice coil. The meter output impedance will be 7,000 ohms, which makes it serviceable for pentodes. A single meter will be used. It has a built-in rectifier. Watch for the article concerning the construction of this valuable measuring device.

* * *

Cross-Modulation

HAVING built a small a-c set, five tubes, I am surprised at the sensitivity. However, the selectivity is not as good as it might be. Sometimes a powerful local can be heard faintly when another powerful local 50 kc removed is tuned in. This, I believe, is called cross-modulation. I have a standard hookup, using the full B voltage on the plates of the r-f tubes, some 250 volts, with volume control in the common cathode circuit of the two r-f tubes. The detector is a 224, the output tube a 247, and the rectifier a 280.—J. K. S., Roanoke, Va.

Put a 5-watt resistor, of 2,000 to 3,000 ohms in series with the common plate returns of the r-f tubes, that is, interconnect the plate returns, and interpose the resistor from the joint to maximum B plus. Then the B current for the r-f tubes will flow through the resistor, and the B voltage will be dropped to below 200 volts. Put a fixed condenser of 0.0005 mfd. or higher capacity from the plate returns to ground. Be sure that you have a sufficiently large value of limiting resistor in series with the volume control. Up to 1,000 ohms may be used. It is not uncommon to encounter cross-modulation when the plate voltage is too high on the r-f tubes, especially when the screen voltage is held virtually constant. Use of such resistor is shown in Blueprint No. 627, which otherwise conforms to your circuit.

TRADE MOVES FOR STANDARDS IN TELEVISION

Working toward early and orderly development of television, recommendations of television frequency assignments and engineering standards are being made by the Radio Manufacturers Association to the Federal Radio Commission for consideration at the International Communications Conference next May in Madrid. The engineering proposals were drafted at a recent meeting of the television committee, of which D. E. Replogle is chairman, and were transmitted to the Radio Commission at Washington by Dr. C. E. Brigham, chief of the association's engineering division.

Summary of Proposals

Chairman Replogle has issued the following summary of the television engineering proposals:

"From data secured it is apparent that the present television wavelength assignments are inadequate to give satisfactory television broadcasting service.

"1st—Because of interference between stations at distant points.

"2nd—Because of phantom images and fading set up by reflections of television signals from the Heaviside layer. These reflections arrive at a different time from the ground wave of the transmitting station, which causes several images to appear and shift back and forth except in areas close to the broadcasting stations. These are quite annoying and when present entirely upset the detail of the received pictures.

"3rd—The narrow channels of 100 kc, while wide in comparison with voice channels, are still too narrow to permit satisfactory picture transmission.

"4th—In the spectrum assigned to television there are too few channels to assign to sufficient television stations adequately to supply one city without considering the many cities that will want service. This has become quite apparent and there has been a definite search for other channels in the ether not now occupied that can be used for television.

Spurred by Conference

"This search for new channels during the past year has brought to light sufficient data to make necessary the calling of a special meeting of the television section of the general standards committee to consider the request for television bands that can be expected to meet requirements in this art for the next five years. It was necessary to make these requirements at this time because of the start of the International Radio Conference in Madrid, Spain, next Spring, which will set the various international radio channels for the next five years.

"At the committee meeting the following television interests were represented: Radio Corporation of America, Jenkins Television Corporation, Philadelphia Storage Battery Co., U. A. Sanabria, Baird Television Corporation of England, Short-wave & Television Labs., Radio Pictures, Freed Radio & Television Corp., Stromberg Carlson Telephone Manufacturing Co. and the Kolster Radio Company.

Want to Use Higher Frequencies

"After a presentation of the facts the following recommendations were made to the Federal Radio Commission through the engineering committee:

"1st—The desirability of securing continuous band from 35 to 80 megacycles exclusive of the amateur band (56 to 60 megacycles).

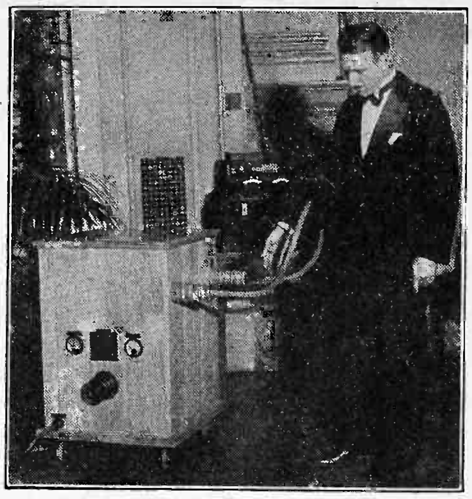
"2nd—That sound be permitted on channels assigned for visual broadcast when and only when accompanying visual programs.

"3rd—That a channel width of 2,000 kc. be allowed for experimental television transmission because of the width of the sideband necessary to convey pictures of adequate detail and because of the space required for the synchronizing signal and associated sound programs and for a wide band between adjacent television channels to allow for inaccuracy in the maintainance of television transmitter frequency and to permit the easier construction of high fidelity receiving sets for television and sound.

Calls Recommendations Important

"These recommendations are considered of greatest importance. They show first the trend of television development for the next few years, namely, toward the use of the shorter waves hitherto believed unusable and for the possibilities of sight and sound broadcasting. The discussion at the meeting also revealed the fact because of the non-interference of the transmitted wave on these frequencies, it will be possible to pass hundreds of transmitting stations throughout the United States without objectionable interference."

FEVER MACHINE



(Acme)

The treatment of rheumatism by short-wave radio was discussed during a symposium on electricity in modern medicine before the Science Forum of the New Electrical Society at the Engineering Auditorium in New York. A portable electric artificial fever producing machine constructed as a short-wave radio transmitter was exhibited by Albert B. Page (above).

FINDS SIGNAL STRENGTH UP 400 PER CENT.

Washington.

Dr. Harlan T. Stetson, director of the Perkins Observatory of Ohio Wesleyan University, before a meeting of the American Astronomical Society recently announced the results of his latest observations on the relation between sun spots and radio reception.

Corroborates Himself

These agree with his former conclusions based on data collected in Cambridge, Mass.

His latest data were collected at Delaware, Ohio, by nightly observation of the signal strength from WBBW, Chicago, Ill., about 300 miles distant. During the past year, he stated, the sun spots have decreased about 50 per cent. and at the same time the improvement in the signal strength has been about 400 per cent. Since the results obtained in Ohio and Massachusetts are the same, although the distance between the observation points and the direction of wave travel was different, Dr. Stetson concluded that the effect is general.

Effect of Meteors

A. M. Skellett, of the Bell Laboratories in New York, presented another paper on the effect of meteors on radio. During the period of Leonid meteor showers in August and November there was considerable interference with transatlantic reception of short waves, and during the height of the meteor shower connection with England was impossible. Mr. Skellett stated, however, that the meteors may not been been responsible because during the same time there was a considerable magnetic disturbance. Mr. Skellett's theory is that as the meteors enter the atmosphere they ionize the air and so change the position of the Kennelly-Heaviside layer.

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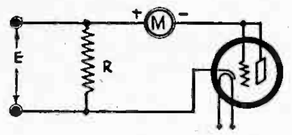
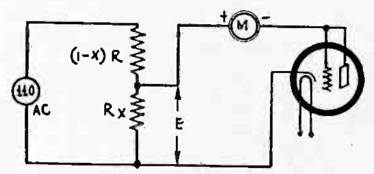
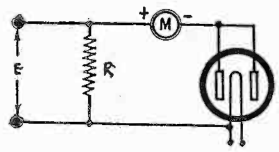
Measuring the Out

A Diode Rectifier or Vacuum

By Burton







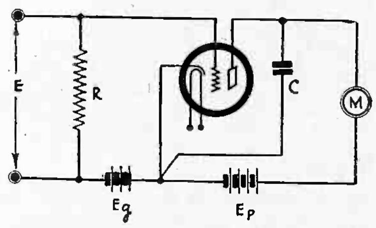


FIG. 1 (top left)
An output meter in which a diode made of a three element tube is used as rectifier and a milliammeter is used as deflection indicator. R should have the value of the best load resistance of the output tube.

FIG. 2 (top right)
When the voltage to be measured is higher than that covered by the calibration of the output meter, a fraction of the output voltage can be measured as indicated here.

FIG. 3 (bottom left)
A 280 type rectifier can also be used if connected as in this manner. There is virtually no difference between this circuit and that in Fig. 1.

FIG. 4 (bottom right)
One of the best ouput meters is that based on the grid bias detector. The bias Eg is adjusted until the reading on the meter M is very small or just zero when R is short circuited.

IT is frequently asserted that a certain change in a circuit increases the volume 100 per cent. Perhaps it does, but who can tell? Perhaps the change is only 5 per cent., or maybe it is as much as 500 per cent. If the ear is the sole judge, one guess is as good as another and all the statement can mean is that there has been an increase in the volume.

The only way to express numerically whether there has been an increase or a decrease is to measure the output before and after the change, either in absolute or in relative units. To do this we need an output meter of some kind.

Any detector may be converted into an output meter provided that we calibrate it. This detector may be a diode, a grid bias detector, a crystal, a copper oxide rectifier, or any other.

In Fig. 1 we have a simple diode rectifier made of a three element heater type tube. The alternating voltage E to be measured is connected across a resistance R, which is then connected to the tube in the manner indicated. The rectified current will be indicated by the direct current milliammeter M. For every value of E there will be a definite reading on the meter M and that reading will be a measure of the voltage. If we have an alternating current voltmeter we can connect this across R and different voltages may be impressed. Thus we can get a calibration curve between the alternating voltage impressed and the reading on M.

Using Fixed Voltage

If we do not have an a-c voltmeter but only a source of high voltage, say 110 volts, we can still calibrate, provided that we have different resistances of known value. This is illustrated in Fig. 2. The voltage across all of R is always 110 volts, or whatever we have. Let us connect the tube across a portion Rx of the total resistance. The input E to the tube is then the drop in Rx, and by simple proportion we have $E = 110x$. This holds, provided that the value of R is small compared with the resistance of the tube, a condition not difficult to meet. Since x may have any value from zero to unity, we have a means of impressing any known voltage from zero to 110 volts. For accurate work we should know the exact value of the line voltage but for comparative work we may assume it to be 110 volts. The values of the two resistances Rx and $(1-x)R$ may be measured with a battery and the meter M, or with an ohmmeter. Note that the sum of the two resistances is always equal to R. That is, R is a potentiometer of fixed resistance and we only tap it at different and known points.

After we have calibrated the meter, that is, after we have found a reading on M for every value of E, we can use the instrument for measuring output voltages. Incidentally, the resistance used should be non-inductive. This does not mean, however, that a wire-wound resistance such as those used in voltage dividers cannot be used.

Instead of using a three element tube, a 280 rectifier tube could be used just as well. The connection of this tube is shown in Fig. 3. The plates of the tube are tied together. Of course, it is necessary to provide a suitable filament voltage for this tube, just as this is necessary when any other tube is used as rectifier.

Grid Bias Detector

A grid bias detector can also be used for measuring output. One circuit of this type is illustrated in Fig. 4. Here E and R have the same significance as in the preceding circuits. Eg is a bias voltage which places the operating point of the tube where detection or rectification is good. This voltage is best provided by a small battery. The bias should be adjusted so that the plate current is about 0.1 milliampere when the signal voltage E is zero. As a voltage is impressed across R the plate current will increase, and this increase is a measure of the alternating voltage E. If the voltage to be measured is high, the bias may be increased until the plate current is practically zero when no a-c voltage is impressed. The increase in the plate current is then practically the same as the current itself, so that the reading on M is a measure of the alternating voltage. This instrument can be calibrated in just the same way as the preceding circuits. Condenser C may not be necessary but if it is used it should be about one microfarad.

Using A-C Milliammeter

In case an alternating current milliammeter is available, this can be used for measuring the output of a receiver. A suitable circuit for this is shown in Fig. 5. The tube shown in this circuit is the power tube of the set. Ch is a choke coil of high inductance value, say 30 henries or more. C is a stopping condenser of large capacity, say 4 mfd. or more. R is a resistance which should be adjusted to the proper load resistance of the power tube. For a 245 it should be 4,000 ohms and for a 247 it should be 7,000 ohms. The range of the alternating current milliammeter should be suitable to the tube involved, or to the signal that will be obtained.

The output power in this case is the product of the current squared and the resistance R. Suppose that the current is 5 milliamperes and the resistance is 7,000 ohms. The power then is 175 milliwatts. Since the maximum undistorted output of this tube, that is, the 247, may be of the order of 5 watts, the current that may be expected is 26.7 milliamperes. An a-c galvanometer having a maximum deflection of 115 milliamperes, a common instrument would be suitable for this circuit. This meter is not calibrated in milliamperes but the scale is divided into 100 divisions and the deflection is proportional to the square of the current. Thus relative values of power are obtained by multiplying the deflection by the resistance R. Or, since the resistance for any one tube remains constant, the relative power is proportional to the deflection. For this reason this instrument is very convenient for measuring relative power output. If the deflection is twice as great in one case as in another it can be said that the volume in one case is twice that in the other.

Matching Impedance

It is assumed that the signal consists of a pure tone of steady amplitude. If the output from a broadcast signal is measured the output will vary continually. This applies to the other output meters as well.

When measuring output with any one of the circuits in

put of a Receiver

Tube Voltmeter May Be Used

Williams

Figs. 1 to 4 the load resistance on the output tube should be equal to the optimum load resistance for the tube involved. This can be provided by making R in each case equal to the output resistance of the tube. If it is not practical to make it as high as this condition demands, R may be made smaller and a series resistance connected between the tube and the calibrated voltmeter. Then only a portion of the output is measured directly. Fig. 2 illustrates this arrangement, which is applicable to all the circuits. R in this case should be equal to the optimum load resistance of the tube but Rx may be only a small fraction of this.

Suppose, for example, that R is 7,000 ohms and that Rx is 1,000 ohms. Then E will be 1/7 of the total voltage. Suppose we have calibrated the output meter on 110 volts when Rx is 1,000 ohms and R is 7,000 ohms. Then any other voltage impressed across the whole R will be divided in the same ratio, that is, 1 to 7. To get the total output voltage of the tube we would multiply the voltage indicated by the meter by seven. The circuit in Fig. 6 shows an arrangement suitable for a 247 pentode output. The rectifier terminals would be connected across E. The condenser in series with the load resistance is used to prevent direct current from entering the voltmeter circuit. While the condenser is specified at 4 mfd., a larger one could be used to advantage, especially when the frequency of the tone is low. For the standard test frequency of 400 cycles per second 4 mfd. is large enough.

Copper Oxide Rectifier Meter

Copper oxide rectifier meters often come with an internal resistance of 4,000 ohms. Such a meter will give directly the output voltage when connected, through a large condenser, across the output of a 245 type amplifier, assuming that there is no other load on the amplifier. A meter of this type is rather limited in its application, but of course it is always possible to connect an external multiplier resistance when the required load resistance is higher than 4,000 ohms.

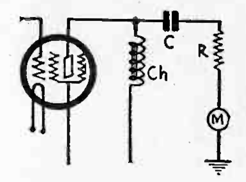
One of the best output meters is the grid bias detector shown in Fig. 4. This has virtually an infinite resistance and is therefore an ideal voltmeter. The resistance R in this circuit should be made equal to the load resistance of the tube, and no other load should be used on the tube. In case the output voltage is too high for the rectifier tube, the grid circuit of the detector can be connected across any part of R. For example, suppose the calibration of the voltmeter covers only a range of 10 volts and the output voltage may be of the order of 100 volts, in that case the grid circuit of the tube should be connected across only 1/10 of R, and each value should be multiplied by 10.

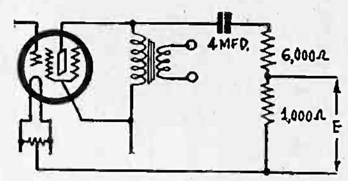
The meter in Fig. 4 can also be used to measure the voltage across the voice coil of a dynamic speaker. In this case R is omitted and the grid circuit in connected directly across the voice coil. The voltage developed across the voice coil, even for fairly large values of output, will be low. Hence it is advantageous to have the meter calibrated over a low voltage range, say from zero to 10 volts. But the voltage across the voice coil will not give the power delivered to the speaker unless the current in the voice coil is measured at the same time the voltage is measured. For comparative values at one frequency it is sufficient to regard the square of the voltage as the power. This will give correct relative output values, provided that the frequency does not change.

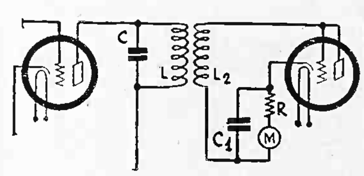
Keeping Direct Current Out

Whenever a rectifier voltmeter is connected to an output tube it is necessary to eliminate direct current, and this may be done with a large stopping condenser as suggested. It can also be done with a transformer. A condenser is the simpler and more reliable.

In case it is desired to study the radio frequency amplification only a diode detector operating on the carrier can be used. One way of doing this is illustrated in Fig. 7. A coil L2 is coupled to a coil L, which forms a part of a tuned circuit. The carrier current in LC will induce a voltage in L2 and this will cause a direct current to flow in the diode circuit. C1 is a by-pass condenser used only to improve the detecting efficiency and R is a meter to limit the rectified current until it is suitable to the meter M used. To limit the power taken from the tuned circuit M should be a sensitive milliammeter, say 0-1 milliampere. The deflection on M will follow the mean amplitude of the current in the tuned circuit and will indicate the effect of changes in the radio frequency







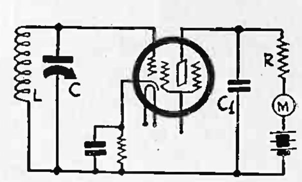


FIG. 5 (top left)
The direct current must be kept out of the output meter and one way of doing this is shown in this circuit. In this particular case M signifies a thermo-coupled type of meter, but the a-c voltage across R may be measured with one of the preceding meters.

FIG. 6 (top right)
The output voltage may be measured by measuring the value of a known fraction of it as in this case, where E is 1/7 of the total.

FIG. 7 (bottom left)
The carrier voltage may be measured with a diode rectifier by this method.

FIG. 8 (bottom right)
The regular rectifier in the receiver can also be used for measuring the carrier voltage by connecting a milliammeter in the plate circuit of the detector. The increase in the reading on M due to the signal is a measure of the signal intensity.

amplifier. For example, it will show whether the amplification is increased or decreased by changes in grid bias, plate voltage, filament voltage, degree of coupling, change of coils, and so on. It will also show changes in signal intensity due to fading and other effects.

It is not necessary to set up a separate tube for observing this change when a grid bias detector is used, because the detector tube itself can be used as the rectifier. How this is done is shown in Fig. 8. The tube here is supposed to be the regular detector and LC is the tuned circuit ahead of it. R is the coupling resistance and C1 the regular by-pass condenser. The only thing that need be done is to insert a 0-1 milliammeter M in the plate circuit as indicated. This may be either above or below the coupling resistance. It is not advisable to insert the meter by plugging a circuit tester into the socket.

If the detector has been adjusted for best detecting efficiency a signal voltage impressed on the control grid in the regular way will increase the plate current. The increase as indicated by the meter is a measure of the strength of the signal.

Source of Signal

It is not practical to depend on broadcast stations for the source of signal except when a rough estimate of the output is desired, because the output changes continually, both when the audio component and the carrier are measured. When measuring radio gain it is best to have an unmodulated carrier, obtained from a laboratory oscillator, or a carrier modulated with a tone of constant amplitude. Likewise, when studying the output of the audio amplifier, it is best to have a tone of constant amplitude and frequency, which can also be supplied by a laboratory oscillator. Suitable oscillators have appeared several times in RADIO WORLD, the latest thing in the Jan. 2nd., 1932, issue.

A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. Answers printed herewith have been mailed to University Members.

Radio University

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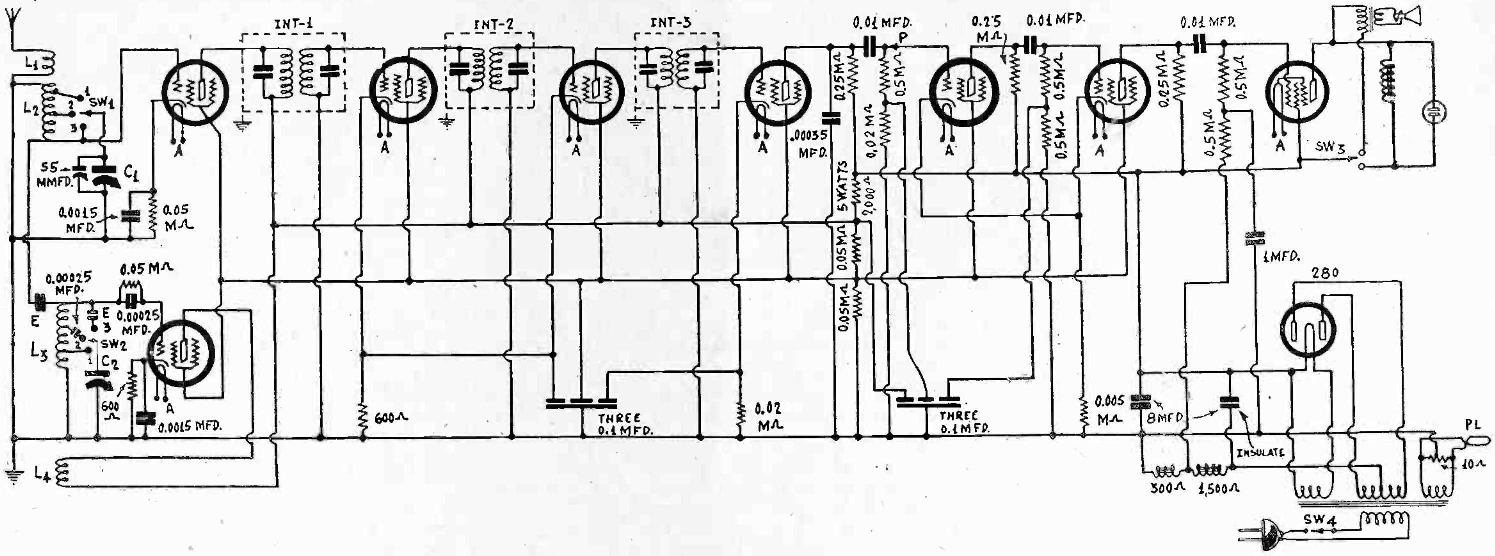

FIG. 981

Short-Wave Superheterodyne

PLEASE show a stabilized three stage resistance coupled audio amplifier, working into a pentode output tube, with television terminals, the amplifier preceded by a short wave superheterodyne that will also tune in regular short wave stations, besides television.—H. D. G., Beacon, N. Y.

The requested circuit is shown in Fig. 981. If single control of tuning is to be used, at least a modulator trimmer is advisable, and the padding may be done in the oscillator circuit as shown. It is not known what intermediate frequency you will use, but assume, since you want short-wave reception only, that it is 1,600 kc. Then the condenser E in the oscillator circuit is a 20-100 mmfd. equalizer set at a maximum, and the other padding condenser may be 0.00025 mfd. The coil data then would be, for the modulator, L1 = 20 turns, L2 = 45 turns tapped at fifth and tenth from the grounded end, and for oscillator, L3 = 25 turns tapped at 5th and 12th from the grounded end, L4 = 17 turns. The stabilization of the audio amplifier is effectuated by using resistor-capacity filters in the three grid circuits and also by using a common biasing resistor of 0.005 meg. (5,000 ohms) in the first and second audio stages. This resistor introduces negative feedback that aids in the elimination of motorboating. The switch, SW-3, puts speaker or neon lamp in circuit. The output choke coil is 30 henries. The intermediate frequency transformers should have plate condensers out of circuit when the transformers are being peaked, and then a signal tuned in and grid condensers adjusted for maximum response. Then the grid condensers are disconnected, the plate condensers connected, and the plate condensers adjusted for maximum response. Then the grid condensers are re-established without further test. The response will be a little less, but there will be a band pass filter intermediate tuner.

* * *

Battery Resistance Compensation

IN constructing a meter board I have made suitable arrangements for testing voltages and currents, both a-c and d-c, and now I am stumped regarding the resistance measurement. I have made provision for a 4.5 volt battery, with series resistor, and would like to know how to compensate for the voltage difference as the battery ages, so that the resistance measurements will be right even when the battery is old.—H. D. E.

As the battery ages or is used, the resistance of the battery increases. Therefore, if you use a potentiometer or other device to alter the voltage it will be only in the direction of reduction, unless the resistance calibration is made in the first instance for less than 4.5 volts the potentiometer will do no good. Also, since added resistance, due to the battery, is actually the cause of the changing condition, whereby the voltage seems to be different, the potentiometer or other device is mostly a means of kidding yourself by making the meter seem to read zero resistance at full-scale. The no-load voltage across the battery is actually the same all the time, the current drain simply making the battery resistance readable on the resistance scale. That is, when current flows, the resistance effect shows up as if it were a battery voltage diminution. Compensation might be possible if the current were constant, but such constancy can not exist except by confinement to one particular reading. We recommend, therefore, that you omit all efforts at compensation. Then as the battery resistance increases, that resistance can be read on the scale, and deducted from the apparent reading. Or, if you will replenish the battery so soon as its resistance becomes readable, you will be playing safe, also.

* * *

Measuring Device

AT present I have a set analyzer that I built and it is rendering excellent service. Now I desire a separate device that will measure voltages and currents, both a-c and d-c, and that will measure also resistance, 0-10,000 and 0-100,000 ohms, and capacity from 0.1 mfd. to 10 mfd. Can some provision be made for measuring the capacity of electrolytic condensers?—O. T. Malone, N. Y.

We are working on a device that will measure 10 volt, 100 volt and 250 volt ranges, a-c and d-c, also 1, 10 and 100 milliamperes d-c and 1 ma a-c, with 0-10 volts and 0-100 volts output meter measurements, and by connection to the 110 volt a-c line capacities in the range you state. The device will not measure the capacity of electrolytic condensers, however, because a-c can not be applied to them. A rectifier would have to be built in, and that you can include, if you desire. The output meter will have an impedance adjuster for voice coil measurements, that is, so the meter can be used, if desired, at the voice coil. The meter output impedance will be 7,000 ohms, which makes it serviceable for pentodes. A single meter will be used. It has a built-in rectifier. Watch for the article concerning the construction of this valuable measuring device.

* * *

Cross-Modulation

HAVING built a small a-c set, five tubes, I am surprised at the sensitivity. However, the selectivity is not as good as it might be. Sometimes a powerful local can be heard faintly when another powerful local 50 kc removed is tuned in. This, I believe, is called cross-modulation. I have a standard hookup, using the full B voltage on the plates of the r-f tubes, some 250 volts, with volume control in the common cathode circuit of the two r-f tubes. The detector is a 224, the output tube a 247, and the rectifier a 280.—J. K. S., Roanoke, Va.

Put a 5-watt resistor, of 2,000 to 3,000 ohms in series with the common plate returns of the r-f tubes, that is, interconnect the plate returns, and interpose the resistor from the joint to maximum B plus. Then the B current for the r-f tubes will flow through the resistor, and the B voltage will be dropped to below 200 volts. Put a fixed condenser of 0.0005 mfd. or higher capacity from the plate returns to ground. Be sure that you have a sufficiently large value of limiting resistor in series with the volume control. Up to 1,000 ohms may be used. It is not uncommon to encounter cross-modulation when the plate voltage is too high on the r-f tubes, especially when the screen voltage is held virtually constant. Use of such resistor is shown in Blueprint No. 627, which otherwise conforms to your circuit.

TRADE MOVES FOR STANDARDS IN TELEVISION

Working toward early and orderly development of television, recommendations of television frequency assignments and engineering standards are being made by the Radio Manufacturers Association to the Federal Radio Commission for consideration at the International Communications Conference next May in Madrid. The engineering proposals were drafted at a recent meeting of the television committee, of which D. E. Replogle is chairman, and were transmitted to the Radio Commission at Washington by Dr. C. E. Brigham, chief of the association's engineering division.

Summary of Proposals

Chairman Replogle has issued the following summary of the television engineering proposals:

"From data secured it is apparent that the present television wavelength assignments are inadequate to give satisfactory television broadcasting service.

"1st—Because of interference between stations at distant points.

"2nd—Because of phantom images and fading set up by reflections of television signals from the Heaviside layer. These reflections arrive at a different time from the ground wave of the transmitting station, which causes several images to appear and shift back and forth except in areas close to the broadcasting stations. These are quite annoying and when present entirely upset the detail of the received pictures.

"3rd—The narrow channels of 100 kc, while wide in comparison with voice channels, are still too narrow to permit satisfactory picture transmission.

"4th—In the spectrum assigned to television there are too few channels to assign to sufficient television stations adequately to supply one city without considering the many cities that will want service. This has become quite apparent and there has been a definite search for other channels in the ether not now occupied that can be used for television.

Spurred by Conference

"This search for new channels during the past year has brought to light sufficient data to make necessary the calling of a special meeting of the television section of the general standards committee to consider the request for television bands that can be expected to meet requirements in this art for the next five years. It was necessary to make these requirements at this time because of the start of the International Radio Conference in Madrid, Spain, next Spring, which will set the various international radio channels for the next five years.

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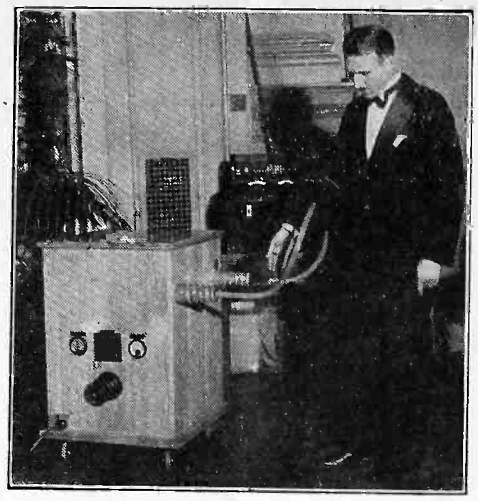

(Acme)

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His latest data were collected at Delaware, Ohio, by nightly observation of the signal strength from WBBW, Chicago, Ill., about 300 miles distant. During the past year, he stated, the sun spots have decreased about 50 per cent. and at the same time the improvement in the signal strength has been about 400 per cent. Since the results obtained in Ohio and Massachusetts are the same, although the distance between the observation points and the direction of wave travel was different, Dr. Stetson concluded that the effect is general.

Effect of Meteors

A. M. Skellett, of the Bell Laboratories in New York, presented another paper on the effect of meteors on radio. During the period of Leonid meteor showers in August and November there was considerable interference with transatlantic reception of short waves, and during the height of the meteor shower connection with England was impossible. Mr. Skellett stated, however, that the meteors may not been been responsible because during the same time there was a considerable magnetic disturbance. Mr. Skellett's theory is that as the meteors enter the atmosphere they ionize the air and so change the position of the Kennelly-Heaviside layer.

IMPORTANT NOTICE TO CANADIAN SUBSCRIBERS — RADIO WORLD will accept new subscriptions at the present rates of $6 a year (52 issues); $3 for six months; $1.50 for three months; (net, without premium). Present Canadian subscribers may renew at these rates beyond expiration dates of their current subscriptions. Orders and remittance should be mailed not later than February 15th, 1932. Subscription Dept., Radio World, 145 W. 45th St., New York, N. Y.

A THOUGHT FOR THE WEEK

ROY McCARDELL'S good old Jarr Family is once again attracting the wide attention of our public. Mr. McCardell, a recognized humorist of the American school, made the Jarr Family popular with millions of newspaper readers during the years when his amusing characters lived through the medium of his syndicated contributions to our big dailies. Now Julia Nash and Charles H. O'Donnell are heard over the air in a new Jarr Family series of humoristics. This is a Forhan's program and is being offered over WOR at 7:45 P.M. three times a week. Miss Nash and Mr. O'Donnell are noted players who have appeared successfully in vaudeville for a number of years. They belong to the division known as Big Time and their advent on the air in connection with the Jarr Family is an important event in broadcasting; as note the important time assigned them—7:45 P.M. A nationwide hookup is being arranged for their activities.

RADIO WORLD
Title Reg. U. S. Pat. Off.
The First and Only National Radio Weekly
Tenth Year

Owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.
Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager; J. E. Anderson, technical editor; J. Murray Barron, advertising manager.

Kaleidoscope

A vertical antenna is like oxygen to fading short wave signals. Commencing right now the short wave always will be more literally up in the air.

* * *

Radio telephone communication has taken on a wide variety. There are available the aircraft to ground interconnection while the airplane is in motion and the radiotelephone mutual convenience for sailing liners with fixed shore points anywhere. The thickest conversation can be transmitted so as to be understandable.

—A. B.

Ohmite Manufacturing Company, 636 North Albany Avenue, Chicago, announces the publication of a new stock list, Bulletin No. 10, which illustrates and describes Carbohm and Wirohm resistors. The Bulletin lists seventy-five different values of carbon resistors in both 1 watt and ½ watt sizes, as well as 42 different values of wire-wound resistors.

Code of Ethics Backed by Board

Washington

The Federal Radio Commission issued the following:

"The Commission believes that the American system of broadcasting has produced the best form of radio entertainment that can be found in the world.

"This system is one of which is based entirely upon the use of radio broadcasting stations for advertising purposes. It is a highly competitive system and is carried on by private enterprise. There is but one other system—the European system. That system is governmental. Under that system, broadcasting is conducted either by the government or by some company chartered by the government. There is no practical medium between the two systems. It is either the American system or the Europan system.

"The principal objection to programs under our system arises out of the kind of advertising that is allowed to be made a part of them.

"The Commission recognizes that the industry is young, that many policies must grow out of experience, and that some stations today are making efforts to constantly raise the standards of broadcasting, but the problem cannot be solved by a few stations.

Responsibility Is General

"There is not a single station that can escape responsibility. A heavy responsibility rests upon all chain companies. To-day, approximately 550 persons, firms or companies hold licenses which give them the right to use the air to its maximum capacity for radio broadcasting purposes. There are 123,000,000 people in the United States wholly dependent upon these few persons for their radio entertainmnt. Thir rights in this new art cannot be denied. And if their share of this form of entertainment can be received only at the expense of advertising statements or claims which are false, deceptive or exaggerated, or at the expense of programs which contain matter which would be commonly regarded as offensive to persons of recognized types of political, social and religious belief, then they are justified in demanding a change in the system.

"The good will of the listener is the station's only asset, and, therefore, this problem first should rest with the licensees of stations. The problem should not be taken out of their hands until they have had full opportunity to make the necessary corrections. If they decline the opportunity, or seizing it, fail, the matter should be treated with proper legislation.

Recommends Ethics Code

As an aid and a guide in the matter, the Commission commends to the licensee of each radio broadcasting station for his most serious consideration the following code of ethics which has been adopted by the National Association of Broadcasters. The Commission believes this code to be fair and just to the broadcaster and to the listener, and that it is an avenue by which the industry can regulate itself.

CODE OF ETHICS

"1. Recognizing that the radio audience includes persons of all ages and all types of political, social and religious belief, every broadcaster will endeavor to prevent the broadcasting of any matter which would commonly be regarded as offensive.

"2. When the facilities of a broadcaster are used by others than the owner, the broadcaster shall ascertain the financial responsibility and character of such client, that no dishonest, fraudulent or dangerous person, firm or organization may gain access to the radio audience.

"3. Matter which is barred from the mails as fraudulent, deceptive or obscene shall not be broadcast.

"4. Every broadcaster shall exercise great caution in accepting any advertising matter regarding products or services which may be injurious to health.

"5. No broadcaster shall permit the broadcasting of advertising statements or claims which he knows or believes to be false, deceptive or grossly exaggerated.

"6. Every broadcaster shall strictly follow the provisions of the Radio Act of 1927 regarding the clear identification of sponsored or paid-for material.

"7. Care shall be taken to prevent the broadsacting of statements derogatory to other stations, to individuals, or to competing products or services, except where the law specifically provides that the station has no right of censorship.

"8. Where charges of violation of any article of the Code of Ethics of The National Association of Broadcasters are filed in writing with the Managing Director, the Board of Directors shall investigate such charges and notify the station of its findings."

Television Not Ready, Says Aylesworth

By M. H. Aylesworth

President, National Broadcasting Company

Various interests already have placed television apparatus on the market. The broadcasting of television programs has been undertaken by others. But from the National Broadcasting System viewpoint, television is not yet ready for the general public.

While the company takes cognizance of the work being done in the receiver field, it does not believe that the time has arrived yet for visual broadcasting on a regular program basis.

And so, during 1931, N. B. C. engineers have continued their studies of television problems as applied to the sending of television signals, conducting numerous tests and investigations that must lead eventually to the inauguration of public television service on a high plane.

The television researches are being conducted by N. B. C. engineers from several points. Television transmitters have been operated at the Times Square Studio, in the R. C. A. Building, and more recently from the lofty top of the Empire State Building. The broadcasts are not intended at this time for the general public or even the television experimenters at large. They possess no entertainment value. Their sole purpose at this time is for the study of television transmission problems, particularly the influence of steel buildings on the propagated waves. The company aims to prepare a solid foundation for the healthy development of practical television in the future.

Every effort is being bent in this direction.

Station Sparks

By Alice Remsen

Echoes of Erin

(For Joe White, "The Silver Masked Tenor," WEAF every Friday, 2:30 p.m.

OH, the lovely hills of Erin—
I see them in my dreams!
The echoing hills of Erin,
Where golden sunlight gleams!

With a silver lake below them,
And green upon their breast,
And in their hair the fir-trees,
By winds of God caressed.

Oh, the echoing hills of Erin,
Are calling now to me,
But the lovely hills of Erin
I never more shall see.

—A. R.

* * *

Listen in to the Sweet Voice of Joe White singing those lovely Irish songs as only he can sing them. It takes an Irishman to put the longing and feeling, the pathos and sweetness into an Irish song. Such songs as "Killarney," "Kathleen Mavourneen" "The Minstrel Boy"—I love them all. They are truly songs that will never die—and Joe White is a past master in the art of putting them over.

* * *

Columbia Has Signed the "Original Radio Girl," Vaughn de Leath, and I am very glad to hear it, because now, probably, Vaughn will get the exploitation break she so richly deserves. Vaughn has plenty of personality on the air, a sweet voice and her own method of delivery, Columbia should have no difficulty in selling her very quickly to a commercial sponsor.

* * *

Arthur Tracey, "The Street Singer," who has been featured over the Columbia System for the past few months, will begin the new year with two new engagements. He will join the Pillsbury Pageant program, and also open at the Cafe de la Paix with Jacques Renard's orchestra. Knew the boy would make it sooner or later.

* * *

The Latest Station to Join the Columbia Broadcasting System is WMBD, Peoria, Ill. This makes ninety stations under the Columbia banner. Station WMBD is assigned to the 1440 kilocycle (208.2 meter) wavelength, and will take the full schedule of Columbia's sustaining programs.

* * *

Mildred Hunt Is The Latest N.B.C. singer to go over to Columbia. Mildred is signed to sing blues on the new Frostilla program, with an orchestra under the direction of clever Harry Salter. This program has several novel features, introducing comedy and an unconventional manner of weaving commercial announcements.

* * *

The National Broadcasting Company Has Signed Alice Joy, who jumped to radio stardom over night, on the Prince Albert program. Alice was formerly known as Frances Holcomb and under that name had a rather difficult time, (as a great many of us have had) convincing radio exec's that she was worth exploiting. But as nothing succeeds like success, Alice is now signed exclusively. Jolly good luck to you, dear girl!

* * *

The New Chesterfield Program Over WABC plans to give the radio listeners "Music That Satisfies"—a very good slogan, but one that gives us pause for reflection; is it possible to satisfy, even with music? I doubt it—but giving credit where credit is due, must say that Chesterfield tries and succeeds in a great measure; for when you hear the name of Nat Shilkret you are pretty certain to hear good music, while Alex Gray's name brings with it an excellent reputation as a songster. Each week-night at 10:30 p.m., WABC.

* * *

Now Comes Edgar Wallace With His Mysteries to give us more thrills on the Eno Crime Club programs. The Eno broadcasting activities will be extended to two nights, Tuesdays and Wednesdays, 9:30 to 10:00 p.m., WABC, when the thrillers will be given in two episodes.

* * *

The Glorious Contralto Voice of Delphine March never sounded so well as it did in "Mon Coeur Souvre A Ta Voix," from "Samson and Delilah," which she sang during the Bamberger Little Symphony concert, under the direction of Philip James, on the evening of December 26, over Station WOR. She sang with dramatic intensity, excellent interpretive ability and sweetness of tone.

* * *

Members of the Civic Light Opera were guest artists on the Footlight Echoes program, over WOR on Sunday, December 27. They gave a Gilbert and Sullivan program. Howard Marsh, though handicapped by a heavy cold, sang very well. He knows the microphone, and would be a very valuable man for a commercial sponsor, inclined toward musical comedy. Frank Moulan was a delight. His diction is perfect and his droll personality inimitable. Ruth Altman possesses a gorgeous contralto, with a fine depth and range; and the quaint little Japanese primadonna, Hitzi Koyke, did remarkably well in the "Kiss Duet," from "The Mikado," with Howard Marsh.

* * *

Sidelights

LEONARD JOY, N.B.C. musical director, is giving away his old phonograph records. . . . FRANK BLACK, N.B.C. director and arranger for the Revelers Quartet, earned his first cash singing at funerals and weddings in Philadelphia. . . . HELENE HANDIN, N.B.C. actress, was once a school marm at Woods Cross, Utah. . . . RAY PERKINS received a letter recently addressed to "The Clown Quince of Radio." . . . JAMES MELTON, N.B.C. tenor, stands six feet two and one half inches in his socks. . . . EDWIN M. WHITNEY once herded sheep on the slopes of the Rocky Mountains. . . . FRANK LUTHER, one of N.B.C.'s star tenors, has been a farm hand, singing evangelist, light opera singer and a New York night club entertainer. . . . LEIGH LOVELL, the Dr. Watson of N.B.C.'s "Adventures of Sherlock Holmes," was once a producer of Shakespearian plays in dear old London. . . . BOB HARING, Columbia conductor, of portly figure, has been on a diet since the New Year. . . . IRENE BEASLEY always wears a huge stone ring. . . . TONY WONS has brought out another edition of his scrapbook. . . . "THE STREET SINGER'S' first movie-short, "The Russian Lullaby," is playing on Broadway. . . . THEODORE FISHBERG, who plays the viola in Carl Fenton's orchestra, is also a member of the New York Philharmonic Symphony Orchestra. . . . HOWARD BARLOW wrote the beautiful musical signature used by Columbia for its "Stand-by" music. . . . ITO GUIZAR is busy learning to speak English. . . . ARTHUR JARRETT is 24 years old. . . . PETER DIXON received a new contract as a Christmas present from his sponsor. . . . VERA BRODSKY, WOR pianist, was a protege of the former Crown Prince of Germany. . . . MARY OLDS says that American men are becoming Continental in their manners. . . . BETTY VANDEVENTER "stop-watches" all her own programs. . . . VERONICA WIGGINS always carries a pocket full of dimes. She distributes them to apple-vendors, but never takes the apples. . . . NELSON EDDY, WOR violinist, is going to economize this year by using last season's resolutions all over again.

* * *

COMIC CUT

"Drink," said a prohibitionist friend of Richard "Sherlock Holmes" Gorden" is the greatest curse of the country. It makes you shoot at your wife." "Perhaps," replied Gordon, "but it also makes you miss her."

* * *

YOUNG CANADIAN PIANIST IN PIANO RECITAL

Harold West, young Canadian pianist, heard frequently over the air, gave a brilliant recital on the evening of December 15, at the Hotel Barbizon, under the management of the National Music League.

He opened with Brahms' Sonata, F sharp minor, Opus 2, and showed remarkable technique and expression, especially in the Andante movement.

His second group featured Chopin and proved that Mr. West thoroughly understands the use of the pedal. He did not over-emphasize—particularly was this noticeable during the Prelude in G sharp minor.

Rachmaninoff was represented by the colorful Etudes Tableaux, E flat major and B minor; Debussy by the graceful Reflets dans L'Eau; and Liszt, by his brilliant Rhapsody No. 13.

Modest and unassuming, the young pianist responded to enthusiastic applause and graciously gave several encores. His thorough musicianship, artistic expression and brilliant technique should carry Harold West far upon the road to musical success.

* * *

BiographicalBrevities

About Arthur Jarrett

Arthur Jarrett was born in Brooklyn, Ridgewood section. Both parents were stage professionals in the dramatic line, his grandfather playing "heavies" with Sothern. Arthur made his stage debut at the age of five, as the Indian boy in "The Squaw Man." His mother still has his regalia. Learned to play the ukulele when he was six. Jimmy Duffy taught him. The late Joe Schenck, his godfather, gave him vocal lessons. Today he plays six musical instruments and does Joe proud with his voice.

Toured vaudeville circuits throughout the country with his father and mother. Between vaudeville engagements he attended Public School 9 in Brooklyn. Clara Bow, Helen Twelvetrees and Dolores Costello were among his classmates. Earned his football letter at Erasmus High. At Brooklyn Prep he starred in three major sports. He picked up pin money by entertaining at various functions. Ambitious to be a lawyer, he matriculated at Fordham, but finally landed in the pit orchestra at the Coliseum Theatre. Wanted to be a radio announcer, applied for a job and was hired by a New York station, but when the musical director discovered he could play six instruments he advised Arthur to become a professional musician. He did. Joined Ted Weems' orchestra at Reading,

(Continued on next page)

STATION SPARKS

By Alice Remsen

(*Continued from preceding page*)

Pa., in 1927. Played the banjo and vocalised. Became popular for his "counter melodies." Was with Ted Weems for over three years. Joined Station WBBM as vocal soloist. A week later he received his first commercial date. Soon his sponsored broadcasts grew to six weekly. He began to attract a large following in Chicago. Was allotted three afternoon programs weekly over the Columbia chain.

Received offer from Gus Van to take the place of the latter's partner, and Arthur's godfather, Joe Schenck. Returned to New York, formed a team with Gus, but after while he tired of vaudeville and hurried back to Chicago and radio. One afternoon several Columbia officials in New York caught his program. Wires were immediately dispatched for him to come East. Commercial obligations confined him to Chicago until the latter part of November. Then he came to New York. His singing with Freddie Rich's orchestra is now gaining him increasing audiences. He is really a lyric tenor; refuses to be called a crooner. Is 24 years old, tall, broadshouldered and blue-eyed; weighs 185 pounds. Favorite tune is "Little White House at the End of Honeymoon Lane." Possesses a voice with sixteen note range, and sings two octaves—from middle to high C. Is a bachelor. Has a penchant for dogs and soft felt hats—also Italian cooking. Actually admires other ontstanding soloists on radio—which is unique in itself.

* * *

Frank J. Novak, Jr.

Frank J. Novak, Jr., the popular young orchestra leader, is a very elusive gentleman. After receiving several requests for his biography, I trailed him until I finally ran him down, but even that didn't do me any good. He was too modest to tell me anything about himself. At last I found his lifelong friend in the person of Gordon B. Clarke and painlessly extracted a few facetious facts about Frankie: In Chicago, on September 17, 1900, a boy was born to Mr. and Mrs. Frank J. Novak. They called him Junior. His Dad was a Chicagoan, but his mother was a Czechoslovakian, maiden name Elizabeth Czerny, a direct descendant of the Etude manufacturer, Carl Czerny, and so, before he was able to talk, Frankie could bat out a rhythm on his cereal bowl with the spoon —and did he make music! Anyhow his parents took him seriously and started to teach him music at the age of three.

At the age of four he appeared with a band in Chicago as a drummer boy. From then on nothing could stop him. By the time he was seven he was playing in concerts on bells, chimes and the violin, billed as Master Frankie Novak, the Most Versatile Junior Musician in the World.

1908 found him the official drummer boy of the Illinois Chapter of the Sons of the American Revolution. He, too, was a revolution, and still is.

Papa Novak ran a music store in Chicago and that gave Junior easy access to many instruments and with nothing else on his mind he learned to play them all. The shop was located in the international section of Chicago. Frankie overheard lots of languages, including Russian Polish, German, Bohemian, Slavish and occasionally English, so he learned them, including English.

When he was nine Frankie, with two transports bearing his instruments went across to Prague, where his uncle, Albert, V. Czerny, conducted the Bohemian National Conservatory of Music. There Frankie perfected his playing, especially on the piano, organ, violin and cello. He worked eight hours a day for four years. After all, an uncle can only put up with so much—so, Frankie was shipped back to the States in 1913. He went on concert tours throughout the West and Middle West; heard Guido Deiro, the accordionist, play one day and liked it, ran home and told Papa who reached up to a shelf and pulled down an accordion. In 1919 the saxophone rage was on—up went Papa's long arm again and down came a sax.

Novak, Jr., organized his first dance orchestra in 1920. In 1922, Ed Benson, big shot of the Chicago orchestra world, took him in hand and featured him with Paul Biese, Frank Westphal and Freddie Hamm. Later he re-organized his dance band and went into the Club Montmarte. In 1923 the family decided to move to Miami, Fla., so Frankie went along. He opened an office, went after the society biz——and got it. They liked him so much that the Miami Jockey Club lined him up in 1924 and kept him there for six consecutive racing seasons. He was at the Coral Gables Country Club and then came to New York. That was in 1930. Since then he has been heard via radio, at the Hotel St. George and on wax with Carson Robinson, Frank Luther, Lew Gold, with Victor, Columbia, Brunswick and others. He has a four-piece combination which is the biggest little band in the country. Piano, violin, guitar and bass viol primarily, but with Frankie in it—well it just stretches itself to what have you.

Frankie also has a sixteen-piece orchestra which has within it eight individual ensembles, each man doubling two or more instruments.

He is five feet seven in his shoes. He's a bundle of nerves and a pack of cigarettes. If you walk with him you run. He'd do well in a bunion derby. He's crazy about cheese blintzes. Recently signed the well-known life contract with a non-professional who has red hair. His ambition is to amass a fortune, not so much for himself as for a pet charity scheme. You'll hear him via the ether on three commercial accounts after the first of the year. His favorite sport is fishing off the Florida coast, where the poor little fish struggle with the big ones. He likes golf, too, and horseback riding, but is neither a bridge nor backgammon fiend.

* * *

SUNDRY SUGGESTION FOR WEEK COMMENCING JANUARY 10, 1932

Sun., Jan. 10: Footlight Echoes, WOR, 10:30 p.m.
Mon., Jan. 11: Ralph Kirbery, WEAF, 11:15 p.m.
Tues., Jan. 12: Minneapolis Symphony, WABC, 10:00 p.m.
Wed., Jan. 13: Sherlock Holmes, WJZ, 9:00 p.m.
Thurs., Jan. 14: Weaver of Dreams, WOR, 10:15 p.m.
Fri., Jan. 15: Singin' Sam, WABC, 8:15 p.m.
Sat., Jan. 16: Little Symphony, WOR, 8:00 p.m.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers concerning standard parts and accessories, new products and new circuits, should send a request for publication of their name and address. Send request to Literature Editor, RADIO WORLD, *145 West 45th Street, New York, N. Y.*

Ivan W. Brunk, East York St., Biglerville, Pa.
Cecil D. Brooks, 215 E. Magnolia Ave., Auburn, Ala.
Charles Horne, 5 Highland Ave., Houghs Neck, Quincy, Mass.
Kenneth McCarron (also catalogs), 445 N. 14th St., San Jose, Calif.
H. R. Brunelle, 163 Meadow St., Wilimansett, Mass.
Frank Conly (particularly mew products and developments) 986 So. Pennsylvania St., Denver, Colo.
J. H. Carlson, Registered Radiotrician, 1734 East 7th St., St. Paul, Minn.
Dave Alper ——— 670 Rockaway Ave., Brooklyn, N. Y.
Howard Trumveller, 925 Union St., Port Huron, Mich.
Donald Felix Gardner, 310 Bard St., Port Huron, Mich.
H. LeRoy Vasbinder, 207 Westfield Ave., Elizabeth, N. J.
Bruno Formeister, 1713 Julian St., Chicago, Ill.
R. Cohan, 122 Sumner Ave., Brooklyn, N. Y.
Herbert C. Keppen, 302 Delaware St., Tonawanda, N. Y.
G. Hitzert (also short wave and television), 3729 Olive Street, St. Louis, Mo.
Isadore Stengler, 156 Christopher Ave., Brooklyn, N. Y.
G. L. Dosland, c. o. Dosland, Conner & Mayfield, Suite 1812-100 N. LaSalle St., Chicago, Il.
James G. Sheller, 75-77 W. Chestnut, Washington, Pa.
Kurt R. Zumhagen, 3609A No. 17th St., Milwaukee, Wis.
Harry M. Narloch, 3808 Augusta Blvd., Chicago, Ill.
S. Matthews, 1339 W. Washington Blvd., Chicago, Ill.
Lee W. Snyder, 205 Villa Esta Ave., Macon, Ga.
Charles Wolmer, 2539 Central Ave., Chicago, Ill.
J. C. Erney, 2625 Shaker Rd., Cleveland Heights, Ohio.
J. H. Weaver, 102 S. Husbond St., Stillwater, Okla.

TRADIOGRAMS

By J. Murray Barron

Just 75 feet east of West Street, at 89 Cortlandt Street, New York, is housed "the largest strictly radio book and radio magazine department in the world," reports Blan, the radio man. Back numbers to 1924 are in stock.

* * *

Thomaston 'Lab., Inc., 135 Liberty St., has issued literature on precision electric acoustic apparatus. Among the quality products manufactured are audio transformers, power transformers, chokes and condensers.

* * *

Paul A. Kaber, formerly television engineer for General Electric Company, is now director of School of Television, Inc. The advisory board includes V. A. Sanabria, Leo Beck, and D. W. West. Elmer M. Rave, former instructor, U. S. Signal Corps Radio School, is dean. The school specializes in television mechanics, with sessions in morning, afternoon, and evening at 360 Seventh Ave., New York City.

* * *

Uncle Sam will take over present Vesey Street headquarters of Wholesale Radio Service Co., Inc., for part of the site for a new Post Office in New York. Large daylight sales rooms and service laboratories will be opened by Wholesale at 100 Sixth Avenue, about March 1.

* * *

Rudolph L. Duncan, of Radio Training Schools, Inc., has issued a very complete and attractively illustrated booklet outlining the various radio courses, which include a sound picture course. The address is 326 Broadway, New York City.

* * *

R. C. A. Victor Co., Inc., Camden, N. J., reports they have some interesting information for established service men located throughout the United States who can handle the R. C. A. Antenaflex systems.

* * *

The Northeastern Sales Corp., 5 Union Square, N. Y. City, is adding to its line of television parts, lenses etc., and has a booklet.

* * *

The kiddies and their folks were treated to an unuslaly fine series of demonstrations of television at Stern's department store, New York City. At one time there was no regular program on, only station call letters being visible so William Starkenstein, in charge, unexpectedly phoned the National Broadcasting studio and explained the situation. A special program was sent out. Great surprise and appreciation was expressed at the remarkable clearness and detail. Even the children could follow the various changes, from faces to animals, as a man winding his watch. A See-All Television outfit was used in the demonstration. The pictures were projected about 8 x 10 inches.

BROADCASTING STATIONS BY FREQUENCIES

1370 KILOCYCLES—*218.7 Meters*—(Continued from last week)

WRBJ	Hattiesburg, Miss	Hattiesburg Broadcasting Co.	10W	Do.
WHBQ	Memphis, Tenn	Broadcasting Station WHBQ (Inc.)	100W	Do.
KGFG	Oklahoma City, Okla	Oklahoma Broadcasting Co. (Inc.)	100W	Shares with KCRC.
KCRC	Enid, Okla	Enid Radiphone Co.	100W 250W-LS	Shares with KGFG.
WMBR	Tampa, Fla	F. J. Reynolds	100W	Unlimited.
KMAC	San Antonio, Tex	W. W. McAllister	100W	Shares with KONO.
KFJZ	Fort Worth, Tex	Margaret Meacham Hightower, Minnie Meacham Smith, and Mary Meacham, executrices of estate of H. C. Meacham, deceased.	100W	Unlimited.
KONO	San Antonio, Tex	Mission Broadcasting Co.	100W	Shares with KMAC.
KGKL	San Angelo, Tex	KGKL (Inc.)	100W	Unlimited.
KFLX	Galveston, Tex	George Roy Clough	100W	Do.
WGL	Fort Wayne, Ind	Fred C. Zeig (Allen-Wayne Co.)	100W	Do.
KGDA	Mitchell, S. Dak	Mitchell Broadcasting Corporation	100W	Do.
KFJM	Great Forks, N. Dak	University of North Dakota	100W	Do.
KWKC	Kansas City, Mo	Wilson Duncan, trading as Wilson Duncan Broadcasting Co.	100W	One-half time.
WRJN	Racine, Wis	Racine Broadcasting Corporation	100W	Unlimited.
KGAR	Tucson, Ariz	Tucson Motor Service	100W 250W-LS	Do.
KRE	Berkeley, Calif	First Congregational Church of Berkeley	100W	Shares with KZM.
KOOS	Marshfield, Oreg	H. H. Hansetly (Inc.)	100W	Unlimited.
KFBL	Everett, Wash	Otto Leese and Robert Leese, doing business as Leese Bros.	50W	Shares with KVL.
KVL	Seattle, Wash	KVL, Incorporated	100W	Shares with KFBL.
KFJI	Astoria, Oreg	KFJI Broadcasters, Inc.	100W	Unlimited.
KGFL	Raton, N. Mex	KGFL, Inc.	50W	Do.
KUJ	Walla Walla, Wash	KUJ, Inc.	100W	One-half time (C. P. only).
WRAM	Wilmington, N. C.	Wilmington Radio Asso.	100W	
WJTL	Tifton, Ga.	Ogelethorpe University	100W	

1380 KILOCYCLES—*217.3 Meters*

WSMK	Dayton, Ohio	Stanley M. Krohn, Jr.	200W	Shares with KQV at night.
KQV	Pittsburgh, Pa	KGV, Inc.	500W	Shares with WSMK at night
KSO	Clarinda, Iowa	Iowa Broadcasting Co.	500W	Shares with WKBH.
WKBH	LaCrosse, Wis	WKBH (Inc.)	1KW	Shares with KSO.
KOH	Reno, Nev.	The Bee, Inc.	500W	Unlimited.
KQV	Pittsburgh, Pa.	KQV Broadcasting Co.	500W	

1390 KILOCYCLES—*215.7 Meters*

WHK	Cleveland, Ohio. T-Seven Hills, Ohio	Radio Air Service Corporation	1KW	Unlimited.
KLRA	Little Rock, Ark	Arkansas Broadcasting Co.	1KW	Shared with KUOA.
KUOA	Fayetteville, Ark.	University of Arkansas	1KW	Shares with KLRA.
KOY	Phoenix, Ariz	Nielsen Radio & Sporting Goods Co.	500W	Unlimited.

1400 KILOCYCLES—*214.2 Meters*

WCGU	Brooklyn, N. Y.	United States Broadcasting Corporation	500W	Shares with WFOX, WLTH and WBBC.
WFOX	Brooklyn, N. Y.	Paramount Broadcasting Corporation	500W	Shares with WCGU, WLTH, and WBBC.
WLTH	Brooklyn, N. Y.	Voice of Brooklyn (Inc.)	500W	Shares with WSCH-WSDA, WCGU, and WBBC.
WBBC	Brooklyn, N. Y.	Brooklyn Broadcasting Corporation	500W	Shares with WFOX, WLTH, and WCGU.
KOCW	Chickasha, Okla	Oklahoma College for Women	250W 500W-LS	Unlimited.
WCMA	Culver, Inc.	General Broadcasting Corporation	500W	Shares with WBAA and WKBF.
WKBF	Indianapolis, Ind. T—Clermont, Ind.	Indianapolis Broadcasting (Inc.)	500W	Shares with WBAA and WCMA.
WBAA	West Lafayette, Ind.	Purdue University	500W 1KW-LS	Shares with WCMA and WKBF.
KLO	Ogden, Utah	Peery Building Co.	500W	Unlimited.

1410 KILOCYCLES—*212.6 Meters*

WRBX	Roanoke, Va	Richmond Development Corporation	250W	One-half time.
WBCM	Bay City, Mich. T—Hampton township, Mich.	James E. Davidson	500W	Unlimited.
KGRS	Amarillo, Tex	E. B. Gish (Gish Radio Service)	1KW	Shares with WDAG.
WDAG	Amarillo, Tex	National Radio and Broadcasting Corporation	1KW	Shares with KGRS.
WODX	Mobile, Ala. T—Springhill, Ala.	Mobile Broadcasting Corporation	500W	Shares with WSFA.
WSFA	Montgomery, Ala	Montgomery Broadcasting Co. (Inc.)	500W	Shares with WODX.
KFLV	Rockford, Ill	Rockford Broadcasters (Inc.)	500W	Shares with WHBL.
WHBL	Sheboygan, Wis	Press Publishing Co.	500W	Shares with KFLV.
WAAB	Boston, Mass.	Bay State Broadcasting Corp.	500W	
WHIS	Bluefield, W. Va.	Daily Telegraph	250W	

1420 KILOCYCLES—*211.1 Meters*

KGVO	Missoula, Mich.	Mosby's (Inc.)	100w	Daytime.
WTBO	Cumberland, Md.	Associated Broadcasting Corporation	100W 210W-LS	Unlimited.
WILM	Wilmington, Del. T—Edge Moor, Del.	Delaware Broadcasting Co. (Inc.)	100W	Do.
WPAD	Paducah, Ky	Pierce E. Lackey and S. Houston McNutt, doing business as Paducah Broadcasting Co.	100W	Do.
WEDH	Erie, Pa	Erie Dispatch-Herald Broadcasting Corporation	100W	Do.
WMBC	Detroit, Mich.	Michigan Broadcasting Co.	100W 210W-LS	Do.
WELL	Battle Creek, Mich	Enquirer-News Co.	50W	Unlimited.
WFDW	Anniston, T. Talladega, Ala.	Raymond C. Hammett	100W	One-half time.
WJBO	New Orleans, La	Valdemar Jensen	100W	Do.
KGFF	Shawnee, Okla.	D. R. Wallace (owner KGFF Broadcasting Co.)	100W	Do.
KABC	San Antonio, Tex	Alamo Broadcasting Co. (Inc.)	100W	Do.
KXYZ	Houston, Tex	Harris County Broadcast Co.	100W	Do.
KFYO	Abilene, Tex	T. E. Kirksey, trading as Kirksey Brothers	100W 250W-LS	Do.
WSPA	Spartanburg, S. C.	Virgil V. Evans, trading as The Voice of South Carolina.	100W 250W-LS	Do.
KICK	Red Oak, Iowa	Red Oak Radio Corporation	100W	Do.
WIAS	Ottumwa, Iowa	Iowa Broadcasting Co.	100W	Do.
WLBF	Kansas City, Kans	The WLBF Broadcasting Co.	100W	Do.
WMBH	Joplin, Mo.	Edwin Dudley Aber	100W 250W-LS	Do.
WEHS	Evanston, Ill.	WEHS (Inc.)	100W	Shares with WKBI and WHFC.
WHFC	Cicero, Ill.	WHFC, Inc.	100W	Shares with WKBI and WEHS.
WKBI	Chicago, Ill.	WKBI, Inc.	100W	Shares with WHFC and WEHS.
KFIZ	Fond du Lac, Wis	The Reporter Printing Co.	100W	Unlimited.
KFXY	Flagstaff, Ariz	Albert H. Scherman	100W	Do.
KGIX	Los Vegas, Nev	Los Vegas Radio Corp.	100W	Do.

(1420 *kilocycles continued on next page*)

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

1420 KILOCYCLES—*211.1 Meters*—(Cont.)

KFXD	Nampa, Idaho	Frank E. Hurt, trading as Service Radio Co.	500W	Unlimited.
KGIW	Trinidad, Colo	Leonard E. Wilson	100W	Do.
KGKX	Sandpoint, Idaho	C. E. Twiss and F. H. McCann	100W	Do.
KGGC	San Francisco, Calif	The Golden Gate Broadcasting Co.	100W	Shares with KFQU.
KXL	Portland, Oreg	KXL Broadcasters, Inc.	100W	Shares with KBPS.
KBPS	Portland, Oreg	Benson Polytechnic School	100W	Shares with KXL.
KORE	Eugene, Oreg	Frank L. Hill and C. G. Phillips, doing business as Eugene Broadcast Station.	100W	Unlimited.
WJMS	Ironwood, Mich.	Morris Johnson	100W	
WDEV	Waterbury, Vermont	Harry C. Whitehall	50W	
WAGM	Presque Isle, Me.	Aroostock Broadcasting Corp.	100W	
KFQU	Holy City, Calif	W. E. Riker	100W	

1430 KILOCYCLES—*209.7 Meters*

WHP	Harrisburg, Pa. T—Lemoyne, Pa.	WHP (Inc.)	500W / 1KW-LS	ares with WBAK and WCAH.[85a]
WBAK	Harrisburg, Pa	Pennsylvania State Police, Commonwealth of Pennsylvania.	500W / 1KW-LS	ares with WHP.
WCAH	Columbus, Ohio	Commercial Radio Service Co.	500W	Shares with WHP and WBAK.[85a]
WGBC	Memphis, Tenn	Memphis Broadcasting Co.	500W	Shares with WNBR.
WNBR	Memphis, Tenn	Memphis Broadcasting Co.	500W	Shares with WGBC.
KGNF	North Platte, Nebr	Great Plains Broadcasting Co.	500W	Daytime.
KECA	Los Angeles, Calif	Earle C. Anthony, Inc.	1KW	Unlimited.
WFEA	Manchester, N. H.	New Hampshire Broadcasting Co.	500W	
WHEC	Rochester, N. Y.	Hickson Electric & Radio Corporation	500W	Shares with WOKO.[85a]
WOKO	Albany, N. Y. T—Mount Beacon, N. Y.	WOKO (Inc.)	500W	Shares with WHEC-WABQ.[85a]

1440 KILOCYCLES—*208.2 Meters*

WCBA	Allentown, Pa	B. Bryan Musselman	250W	Shares with WSAN.
WSAN	Allentown, Pa	Allentown Call Publishing Co. (Inc.)	250W	Shares with WCBA.
WBIG	Greensboro, N. C	North Carolina Broadcasting Co. (Inc.)	500W	Unlimited.
WTAD	Quincy Ill.	Illinois Broadcasting Corporation	500W	Shares with WMBD.
WMBD	Peoria Heights, Ill	E. M. Kahler (owner Peoria Heights Radio Laboratory.	500W / 1KW-LS	Shares with WTAD.
KLS	Oakland, Calif	E. N. and S. W. Warner, doing business as Warner Bros.	250W	Daytime.

1450 KILOCYCLES—*206.8 Meters*

WBMS	Hackensack, N. J.	WBMS Broadcasting Corporation	250W	Shares with WNJ, WHOM, and WKBO.
WNJ	Newark, N. J.	Radio Investment Co. (Inc.)	250W	Shares with WBMS, WHOM, anud WKBO.
WHOM	Jersey City, N. J	New Jersey Broadcasting Corporation	250W	Shares with WNJ, WBMS, and WKBO.
WKBO	Jersey City, N. J	Camith Corporation	250W	Shares with WNJ, WHOM, and WBMS.
WSAR	Fall River, Mass	Doughty & Welch Electric Co. (Inc.)	250W	Unlimited.
WGAR	Cleveland, Ohio	WGAR Broadcasting Co.	500W	Do.
WTFI	Toccoa, Ga	Toccoa Falls Institute	500W	Do.
KTBS	Shreveport, La	Tri State Broadcasting System (Inc.)	1KW	Do.

1460 KILOCYCLES—*205.4 Meters*

WJSV	Alexandria, Va. T—Mt. Vernon Hills, Va.	Independent Publishing Co.	10KW	Do.
KSTP	St. Paul, Minn. T—Westcott, Minn.	National Battery Broadcasting Co.	10KW	Do.

1470 KILOCYCLES—*204.0 Meters*

WLAC	Nashville, Tenn	Life and Casualty Insurance Co.	5KW	Unlimited.
KGA	Spokane, Wash	Northwest Broadcasting System (Inc.)	5KW	Do.

1480 KILOCYCLES—*202.6 Meters*

WKBW	Buffalo, N. Y. T—Amherst, N.Y.	WKBW (Inc.)	5KW	Unlimited.
KFJF	Oklahoma City, Okla	National Radio Manufacturing Co.	5KW	Do.

1490 KILOCYCLES—*201.2 Meters*

WCKY	Covington, Ky. T—Crescent Springs, Ky.	L. B. Wilson (Inc.)	5KW	Shares with WJAZ and WCHI.
WCHI	Chicago Ill. T—Batavia, Ill.	Midland Broadcasting Co.	5KW	Shares with WJAZ and WCKY.

1500 KILOCYCLES—*199.9 Meters*

WMBA	Newport, R. I.	LeRoy Joseph Beebe	100W	Unlimited.
WLOE	Boston, Mass. T—Chelsea, Mass.	Boston Broadcasting Co.	100W / 250W-LS	One-half time.
WNBF	Binghamton, N. Y.	Howitt-Wood Radio Co. (Inc.)	100W	Unlimited.
WMBQ	Brooklyn, N. Y.	Paul J. Gollhofer	100W	Shares with WLBX, WCLB, and WWRL.
WLBX	Long Island City, N. Y.	John N. Brahy	100W	Shares with WMBQ, WCLB, and WWRL.
WWRL	Woodside, N. Y.	Long Island Broadcasting Corporation	100W	Shares with WMBQ, WLBX, and WCLB.
WSYB	Rutland, Vt.	H. E. Seward, jr., and Philip Weiss, doing business as Seward & Weiss Music Co.	100W	Unlimited.
WKBZ	Ludington, Mich.	Karl L. Ashbacker	50W	Do.
WMPC	Lapeer, Mich	First Methodist Protestena Church of Lapeer	100W	Do.
WPEN	Philadelphia, Pa	Wm. Penn Broadcasting Co.	100W / 250W-LS	Do
WWSW	Pittsburgh, Pa	William S. Walker	100W	Unlimited (C. P. only).
WOPI	Bristol, Tenn	Radiophone Broadcasting Station WOPI (Inc.)	100W	Unlimited.
WDIX	Tupelo, Miss	North Mississippi Broadcasting Corporation	100W	Do.
WRDW	Augusta, Ga	Musicove (Inc.)	100W	Do.
KGFI	Corpus Christi, Tex	Eagle Broadcasting Co (Inc.)	100W / 250W-LS	Unlimited.
KUT	Austin, Tex	KUT Broadcasting Co.	100W	Do.
KGKB	Brownwood, Tex	E. M., C. T., and E. E. Wilson, doing business as Eagle Publishing Co.	100W	Do.
KGIZ	Grant City, Mo	Grant City Park Corporation.	100W	Do.
KGKY	Scottsbluff, Nebr	Hilliard Co. (Inc.)	100W	Do.
WKBV	Connersville, Ind	William O. Knox, trading as Knox Battery & Electric Co.	100W / 150W-LS	Do.
KGFK	Moorehead, Minn	Red River Broadcasting Co. (Inc.)	50W	Do.
KPJM	Prescott, Ariz	A. P. Miller	100W	Do.
KXO	El Centro, Calif	E. R. Irey and F. M. Bowles	100W	Do.
KDB	Santa Barbara, Calif	Santa Barbara Broadcasters, Ltd.	100W	Do.
KREG	Santa Ana, Calif	J. S. Edwards	100W	Do.
KPQ	Wenatchee, Wash	Wescoast Broadcasting Co. Ct.	50W	Do.
WMIL	Brooklyn, N. Y.	Arthur Faske	100W	

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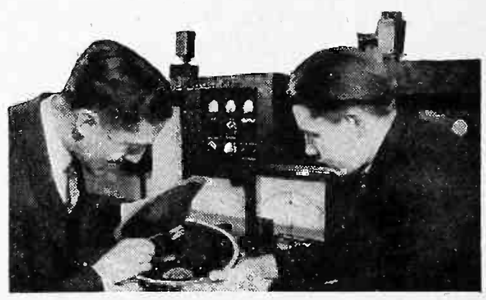

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