CONSTRUCTIONAL ARTICLE ON SENSITIVE RELAY

RADIO WORLD

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The First National Radio Weekly

*671st Consecutive Issue—Thirteenth Year*

Better Results With Fewer Parts

*A Phonograph Oscillator*

Coils For Switch Converter

Directions For Using Generator 339

# ANALYSIS OF WESTON PHOTRONIC CELL

FEB. 2 1935 15c Per Copy


# "SAFETY-FIRST" SHORT-WAVE KITS

These Leonard kits contain complete parts; nothing else to buy, for building a 1 or 2 tube regenerative detector short wave and broadcast radio set tuning from 15 to 550 meters.

Many enthusiastic builders have registered reception from as far as India on these small sets. Simple instructions are furnished so that any one, young or old, can build it with no trouble at all.

## Features of the Kit:

All broadcast type vernier dial, complete set of 5 coils from 15 to 550 meters, chassis of heavy steel with black crackle finish as well as panel; silver contact regeneration control for smooth action; complete blueprints and instructions, all necessary wire, nuts, screws, etc.; all controls on front panel; special vernier to bring in those weak signals.

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Our Price ..... **$4.75**

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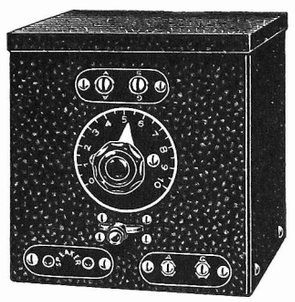
Our Price ..... **$6.50**
Either Kit Wired at Factory $1.00 Extra

# Federal 5 and 10 Meter Transceiver

**FEATURES:** A highly efficient wired transceiver which is gaining in popularity every where.
Designed for portable work as well as for stationary use.
A correctly engineered unit designed to give the service required of it.
Operation on five or ten meters by simply changing coils.
Five and ten meter coils provided with the unit.
Uses only parts made by the foremost manufacturers.
Performance limited solely by topographical location.
Is now in use by leading amateurs.
Weight only 6 pounds.
Adaptable for six volt, 2.5 volt and 2 volt operation.
Size 5½ x 5¾ inches.



The transceiver is mounted in a strong steel case which is finished in black crystal. All component parts are mounted on a steel cadmium finished chassis. Transmission and reception are done by the simple throwing of a switch.

Models: The 6 volt model uses a 76 and 41. This is ideal for use in motor boats, airplanes, automobiles, etc. A six volt battery lights the filaments, and either "B" batteries or 6 volt "B" eliminators supply plate voltage. As low as 90 volts will operate this unit. The 2.5 or A.C. model is suggested for stationary usage. Here we use a 56 and a 2A5. For this unit we supply an especially designed power pack which not only supplies the plate and filament voltages, but supplies microphone current. No batteries are needed. It may be well to mention that this unit and the 6 volt may be used interchangeably by inserting the proper tubes.

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**Model 601. For 6 volt operation (using 76 and 41 tubes, not supplied)**
**Your Price ..... $13.50**

**Model 602. 2.5 volt or A.C. operation (using 56 and 2A5 tubes, not supplied)**
**Your Price ..... $13.50**

**Model 603. For 2 volt (using 30 and 33 tubes, not supplied)**
**Your Price ..... $12.50**

**A.C. Power Pack for all electric operation of Model 602 Transceiver**
**Cat. No. 602P. Our price, less 80 tube ..... $5.50**

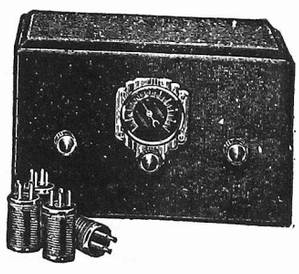
**Above four products are sold only in wired form.**

# Federal All-Electric 3 Tube A.C. — D.C. Short Wave Receiver

A new, wired deluxe complete short-wave set with the highest of efficiency.

Consistent world-wide reception is now within the reach of everyone's pocket. Through the use of the latest tubes a three tube set, self-powered from either A.C. or D.C. is made possible.

Thousands of these sets are now rendering excellent service. Amateurs, experimenters and short-wave authorities have proclaimed its merits. Points 12,000 miles distant have been heard consistently, some stations on loud speakers. Some favorites are London, Germany, Rome, France, Russia, etc. Though primarily designed for short wave, it very efficiently receives signals simply by the insertion of broadcast coils.



Latest type full vision Airplane Dial, 270° scale; latest type tubes (1-77, 1-43, 1-25Z5); 1-high efficiency plug in coil (set of 4), 15 to 200 meters; silver contact regeneration control finished chassis; crackled finished heavy steel cabinet; four section filter system, hum-less built-in power supply. Size 11¼ x 7¼ x 7¼ (overall).

Cat. No. C4003. Our Price (with 4 coils, less tubes) ..... **$13.95**
Two broadcast coils, extra 89c (both)

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# The Weston Photronic Cell

## How It Performs Its Self-Generating Service

***By W. N. Goodwin, Jr.***

THE Weston type 594 Photronic cell consists of an iron disc, ⅛ inch in diameter, with a film of crystallized selenium on it, on top of which a translucent lead film is sprayed. Electrical connections are made to the iron disc by pressure and to the lead film by means of "collector rings" on the periphery of the active disc. Figs. 1 and 2 show the dimensions of the cell.

The current output varies with the illumination on the cell and also with the external resistance connected to it. The output is linear for low resistances. Curves have been prepared to 250 foot candles, but tests on illumination up to the intensities of direct sunlight (from 10,000 to 15,000 foot candles), show the same linear response for very low circuit resistances, within experimental errors.

The output of the cell is not proportional to the illumination for relatively high external circuit resistances. This is a natural consequence, however, since the cell resistance decreases with increasing illumination and current output, as will be shown later, to such a value that its shunting effect becomes increasingly effective in determining the current output.

The current output of the average Weston cell is about 1.4 microamperes per foot-candle of illumination uniformly distributed over the sensitive surface, when connected to a relatively low external resistance.

### Current Output Per Lumen

The area of the sensitive surface is about 1.8 square inches so that the output of the average cell is about 120 microamperes per lumen.

A very interesting and useful property of the Photronic cell when connected to a low resistance external circuit, is that while it is desirable to distribute the light uniformly over the entire disc, the current output per lumen is almost independent of the area of the disc exposed. That is, a lumen of luminous flux concentrated on a circle, say ¾ inch in diameter, will result in nearly the same microampere output as a lumen uniformly distributed over the entire area.

This may be explained by the fact that the resistance of the unexposed portion is so high relative to the exposed portion that the shunting effect is negligible. A similar effect results when the cells are connected in parallel. The cells act to a close approximation as if they were independent, each supplying its quota of current proportional to the illumination incident upon it, and if, for example, the illumination on one cell is zero, it may be removed from the circuit with a relatively negligible effect upon the total current output.

### Resistance of Cell

This feature permits two or more cells to be used in different places, or directed in different directions, to obtain average intensities of illumination, or for other purposes.

The total current generated in the cell is a function of the illumination or radiant flux only, and is proportional to it. This current divides between an internal conducting path in the cell, and the external circuit if any, in accordance with the ordinary laws of parallel circuits.

The internal resistance of the cell is not a constant, but varies with the illumination or radiant flux, and also upon the leakage current through it. The cell resistance acts as a shunt to the external circuit.

The currents and resistances are related in accordance with the following equation:

$$I = \frac{E\, i_o\, r}{R\, r}$$

(*Continued on next page*)

### TABLE OF WESTINGHOUSE PHOTO-ELECTRIC CELLS

[TEXTUAL DATA ON THESE CELLS WERE PRINTED LAST WEEK]

| *Type(*) Number* | *Description* | *Spectral Region. Maximum Response* | *Typical Sensitivity. Microamps. per Lumen* | *Maximum Operating Voltage* | *Active Service* | *Maximum Current Microamps* | *Glass Bulb* | *Base No.* |
|---|---|---|---|---|---|---|---|---|
| DSR-10 | Vacuum | Ultra Violet | .... | 500 | U | 2.5 | Corex | 410 |
| SR-50 | Vacuum | Deep Red and near Ultra Violet | 12. | 500 | CsO-AgO | 20. | Lime | 410 |
| SR-51 | Vacuum | Violet | 12. | 500 | CsO-AgO | 20. | Lime | 410 |
| DSR-58 | Vacuum | Violet | 12. | 500 | CsO-AgO | 20. | Lime | 412 |
| DSR-59 | Vacuum | Violet | 12. | 500 | CsO-AgO | 20. | Lime | 412 |
| SK-60 | Argon | Deep Red and Ultra Violet | 45. | 90 | CsO-AgO | 20. | Lime | 410 |
| SK-61 | Argon | Violet | 45. | 90 | CsO-AgO | 20. | Lime | 411 |
| DSK-68 | Argon | Violet | 45. | 90 | CsO-AgO | 20. | Lime | 412 |
| DSK-69 | Argon | Violet | 45. | 90 | CsO-AgO | 20. | Lime | 412 |

**Tubes without the letter "D" in the type number are carried in stock, and are "standard," and their physical characteristics are fixed.*

(*Continued from preceding page*)

where I = external current output
E = illumination on cell
$i_{is}$ = total current generated per unit illumination, which is equivalent to the current through an external circuit of negligible resistance
r = internal resistance of cell for illumination E and external resistance R
R = external resistance
$i_c$ = internal current in cell

The capacitance between the sensitive surfaces in the cell is in parallel with the internal resistance *r* for currents generated by pulsating light.

## Effect of Temperature

Changes in temperature have very little effect, if any, on the total current generated in the cell, and as a consequence the effect upon the external current output is small for low external resistances.

The internal resistance of the cell, however, is greatly affected by changes in temperature, which in turn affects the current output in external circuits having relatively high resistance.

The internal resistance of the cell varies with temperature and so does the voltage generated across the cell.

For this reason it is better to use the current characteristics of the cell for measuring purposes rather than voltage or resistance, unless the temperature is reasonably constant.

## Angle of Incidence

The effect of illumination upon the response of the cell surface alone would be constant if the absorbing and reflecting properties of the surface were constant for all angles of incidence. Actually these properties vary somewhat in the Photronic cell, especially as the angle approaches 90°. Further, there is a reduction in response due to the shadow cast by the rim of the case, and to the reflection from the surfaces of the glass.

If, for example, it is desired to measure the illumination at the center of a hemispherical source of luminous flux, uniformly distributed, it can be shown that the Photronic cell will indicate about 76% of the true value. If the luminous source is a zone of a sphere included within an angle of incidence of 50°, then the cell will indicate about 90% of the true value.

This effect of the angle of incidence is not so serious as it would appear at first thought for the reason that all surfaces exhibit similar effects when illuminated at various angles. For example, a printed page does not have the same brightness to the eye, when illuminated by light reaching the paper from angles other than perpendicular to it, and the reduction in brightness, and therefore in the ease of reading for many kinds of surfaces corresponds quite closely to the cell output. That is, the cell actually gives an indication of the visual effectiveness of illumination in most practical cases.

## Series and Parallel

The effect upon output of grouping cells in series or in parallel follows the same general laws as for voltaic cells, remembering of course that the resistance is not constant, but is a function of both current output and intensity of illumination.

Since the Photronic cell resistance for low light intensities is relatively large, there is no practical gain in current output by connecting the cells in series, since each cell adds resistance in the same or nearly the same proportion as it adds e.m.f. However, when connected in parallel, the combined internal resistance diminishes and greater output of current is obtained.

If cells are to be used on open circuit, where no current is drawn from or passed through them, as for example, when they are connected to the grid of a thermionic tube, they may be connected in series and their combined electromotive force will be the sum of the electromotive forces of the cells.

The best number of cells to use in parallel for any particular requirement depends upon the intensity of illumination and sensitivity and resistance of the indicating instrument available, and is usually best determined by experiment.

The Photronic cell has no dark current and no drift, that is, it is not subject to erratic or non-reversible changes. It has, however, a property which may be called fatigue. When the cell is first exposed to a luminous source, the indications gradually reduce with time and in a few minutes reach a constant value. When relatively high accuracy is desired, it is better to wait a few minutes before taking readings.

## Safe Temperature Limit

The Photronic cell should not be exposed to temperatures higher than 50° C. (122° F.) as changes in sensitivity may result if this temperature is exceeded.

Care must be exercised when the cell is exposed to radiation containing a large proportion of infra-red or heat rays as the cell absorbs this energy which may raise the temperature unduly. For example, the radiation from tungsten filament sources consists largely of infra-red rays, and when large luminous intensities from such sources or sunlight are being measured, for example 500 foot-candles and higher, it is advisable to expose the cell only long enough to obtain a reading, unless water or special glass infra-red filters are used.

Moisture has a very harmful effect upon these cells, setting up an electrolytic action, giving rise to a "dark current," which, with time, the cell diminishes in sensitivity to light, especially at high light intensities. The functional characteristics are under these conditions akin to the "Becquerel type or photo voltaic cell."

Tests indicate the response of the Photronic cell remains constant to a relatively high degree of accuracy, provided no accidental mechanical damage has occurred, or that it has not been subjected to excessive temperatures or to a high voltage, or to moisture.

The cell is not damaged by exposure to intense illumination, unless of course this results in excessive temperature, or to the continued action of moisture. For this purpose, the cell should be mounted in a thoroughly dried and hermetically sealed case, especially for use in sunlight.

## Spectral Sensitivity

The relative spectral sensitivity of the Weston Photronic cell for a circuit of relatively low resistance naturally differs without a glass window, or with a quartz window so as to give the ultra-violet sensitivity in addition to the visible and infra-red. The effect of a glass window which absorbs most of the ultra-violet radiation has been plotted.

The standard eye sensitivity curve was plotted in comparison. It will be noted that the cell curve has a single peak in the yellow at a wavelength of 580 milli-microns, whereas the eye is most sensitive in the yellow-green at 555 milli-microns. The cell is more sensitive than the eye in the blue and red regions, and its sensitivity extends well into the ultra-violet and infra-red.

Wavelengths in the curves are given in milli-microns (0.000001 milli-meter). The Angstrom unit (0.0000001 mm.) which is one-tenth as large, is frequently used for wavelength measurements. For example, 400 milli-microns is equal to 400 Angstoms.

The manufacturers of these cells can furnish quartz windows in the place of glass for use with ultra-violet measurements.

## Absolute Spectral Sensitivity

The absolute spectral sensitivity of these cells are not the same for all cells, but varies somewhat as a result of unavoidable variations which occur during their manufacture.

The average cell at its maximum sensitivity, 580 milli-microns, produces a current in a low resistance circuit of 0.046 microampere per micro-watt radiant flux at that wavelength. That is, 100 on a relative spectral sensitivity curve represents 0.046 microampere per microwatt, and other points on such a curve have proportional values.

The maximum value, 100, on a visibility curve corresponds in absolute value to 621 lumens per watt at that wavelength, from which values at other wavelengths are computed.

## Effect of Circuit Resistance Upon Spectral Sensitivity

Spectral distribution of total current generated in the Photronic cell at any wavelength appears in the external circuit if the resistance is relatively low. If the external resistance is relatively large, however, the external spectral distribution of current does not follow this course, but the currents are modified by resistance and radiant flux.

## Filter to Compensate

When using the Photronic cell for illumination measurements it is strictly accurate only for light of the same character as that for which the cell was standardized unless a proper filter is used. This is because some portions of the spectrum of the illumination being measured, which affect the eye and cell differently, are effective in producing current, which causes an error.

Assuming that the cell is standardized for tungsten filament source at a color temperature of 3000° K, no correction is required for measurements where the illumination has the same spectral composition as sunlight. This is the result of an accidental relation between eye and cell sensitivities, and the relative spectral distribution of radiant flux from the two sources.

A filter has been developed to make the spectral sensitivity of the cell closely approximate that of the eye. When such a filter is used, the cell may be adjusted for any luminous source and used to measure the illumination from another of any color value, either monochromatic, or heterochromatic, to a relatively high accuracy.

## Frequency Response

When the cells are used in connection with meters or relays, the cell response is so much more rapid than it is possible to make the instrument with which it is in circuit. Under such conditions, it is considered for ordinary commercial uses as the cell being instantaneous. It is known by actual test that the response is sufficiently rapid to record the passage of a rifle bullet through a beam of light incident upon the cell.

Tests indicate that these types of cells are not suitable for use in telephotography, television or in audio frequencies such as are used, for example, in talking pictures.

The frequency response of the cell diminishes with increasing frequency due largely to the shunting effect of the internal capacitance of the cell, wihch is of the order of 0.5 mfd., and the response is approximately inversely proportional to this capacity. If the response at 60 cycles is assumed 100 per cent., that at 120 cycles will be about 58 per cent., that at 240

(*Continued on page 21*)

# Electron Theory of Photo Cells

## Why Incident Light Variations Produce Change

*By George Pierce*

ALL substances have the property of emitting tiny particles, each carrying a negative electrical charge, if vibratory energy of sufficiently high frequency is allowed to impinge upon their surfaces. The value of this required energy varies widely, depending on the nature of the substance and the character of its surface.

We may conceive of all substances as being composed of countless vibrating systems, each system in itself containing a nucleus carrying an excess of positive charges and about which tiny particles containing negative charges oscillate. These negative charge carriers are familiarly known as "electrons." These electrons oscillate about the nucleus in orbits of definite radii and at definite velocities, depending on the kinetic energy possessed by each electron. The greater the energy possessed, the wider will be the range of swing.

### Electrons Travel Farther

The character and properties of a substance may be considered to depend on the particular arrangement of these vibrating systems with respect to one another, the number and arrangement of the charges carried by the nuclei, and the number, velocity and orbital radii of the electrons oscillating about each nucleus. In the present instance, it is the oscillations of the electrons about the positive nuclei with which we shall be mostly concerned.

If additional energy is supplied to one of these systems, this energy is absorbed first by the electron or electrons spinning in orbits farthest removed from the nucleus—the "outer orbit." As a result of this increased energy, the electron or electrons are enabled to oscillate through greater distances. It is conceivable that sufficient energy may be supplied to enable these electrons to overcome the restraining influence of the positively charged nucleus. In this case, they will swing wide outside of the range of attraction of the nucleus and fly off as free electrons. If now we place the substance in a vacuum, it is possible to place a positively charged conductor close to it, and attract these free electrons to this conductor. Further, if means are provided to remove these electrons as fast as they accumulate, a constant stream of electricity may be maintained between the substance and the collector. We are supposing that sufficient energy is being constantly supplied to the substance to produce free electrons as described above.

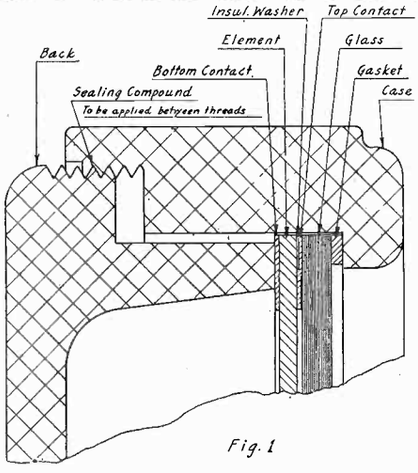



Fig. 1

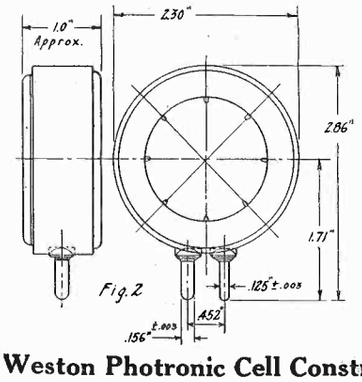



Fig. 2

**Weston Photronic Cell Construction**

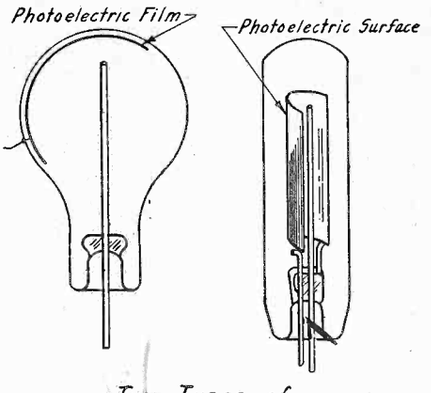
### Glow Discharge

The photo-electric cell is a device that is constructed to utilize light as the energy by means of which free electrons are produced. Light beams of equal intensity but of different colors or frequencies possess different amounts of energy. As an example, assuming equal light intensities, high frequency ultra violet rays contain more energy than the comparatively low frequency infra red rays. To produce useful photo-electric cells, then it is advantageous to choose a substance and process its surface so that a minimum of energy is required to release electrons therefrom. It is possible to carry this out so that photo-electric emission is accomplished with the use of light in the visible range.

In order to augment the number of electrons arriving at the collector, using a given light energy, use is made of another expedient. If particles of gas are present, between the cathode substance and the collector, some of the rapidly moving electrons collide with them. We remember that these gas particles are also made up of positively charged nuclei with their encircling electrons.

Provided sufficient velocity is attained by at least a portion of the electrons traversing the space, enough energy may be transformed upon collision with the neutral gas atoms to "excite" their most loosely bound electrons, that is, those swinging in orbits farthest removed from their respective nuclei. This "excitation" or "resonance" results in an increase of orbital radii. Almost instantly these excited atoms return to their normal state, giving up their recently acquired surplus of energy, in the form of radiant light.

This radiant light energy strikes upon the cathode surface and upon other gas particles, assisting in the production of additional free electrons. This excitation process may be increased to the point where the electron is enabled to fly off from the atom and traverse a path governed by the electric field in which it finds itself. The mechanics of this action are the same as in the case of the free electrons produced at the cathode surface by the light energy, when the transfer of kinetic energy upon impact is responsible. The gas atom thus deprived of an electron is left with one positive charge too many and consequently migrates toward the cathode under the influence of the existing electric field. In this state, the atom is said to be "ionized" and is referred to as an "ion."




*Two Types of Photoelectric Cells*

**The manner in which commercial photo-electric cells (the I. R. E. standards call them phototubes) have been constructed is depicted in this sketch. In the first variety, the photo-active material has been coated on the bulb interior as a film, while in the second, the active material is deposited on a plate within the tube.**

### Effect of Collision

The ion is also exposed to collision with the free electrons moving in a generally opposite direction. In the event of such a collision, the electron may become reattached to the ion, assuming the orbital path left vacant by the original process of ionization and the combination again becomes a neutral atom. In the accomplishment of this action, the electron surrenders the energy acquired either in a previous collision or in the absorption of a light energy unit, or quantum, at the cathode surface. This released energy also manifests itself as light, and if the processes of ionization and re-combination are sufficiently numerous, the visible "glow discharge" is effected.

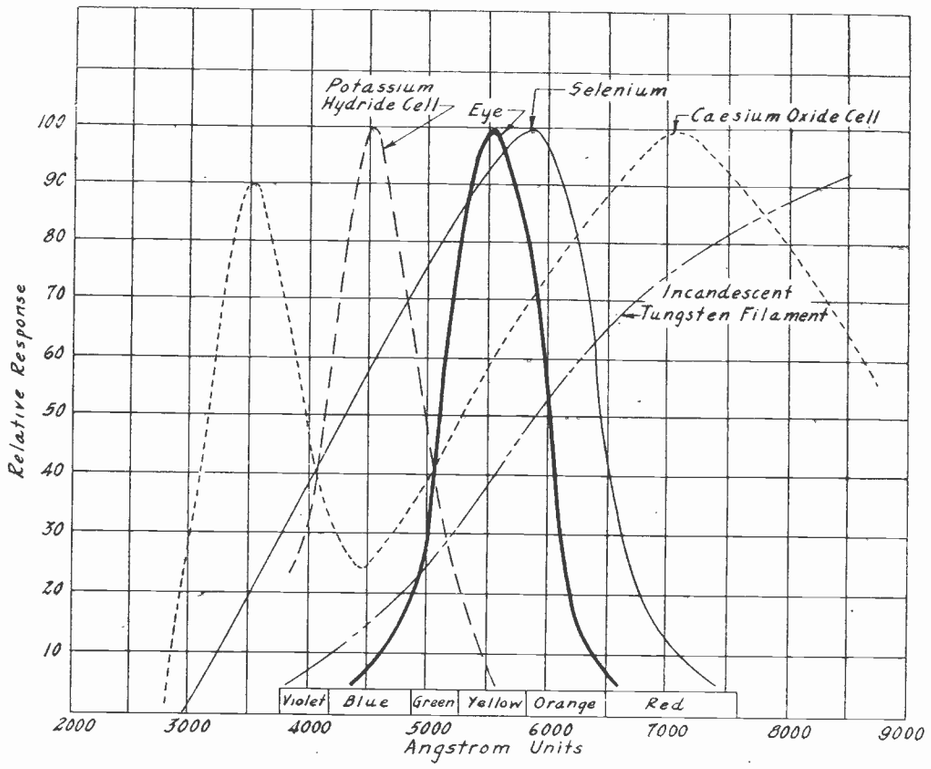
This cycle of ionization and re-combination may be completed many times before the gas ion finally arrives at the cathode. It is seen from above that the important element in excitation and ionization lies in the velocities of the charged particles. The potential gradient produced by the voltage applied at the anode is the motivating force. This force accelerates a particle according to known dynamic laws, depending on field strength, mass, charge, time or distance, direction, and initial velocity. Since the velocity is a function of acceleration acting through a time interval or through a certain distance, it follows that the average distance traveled between collisions is an important factor.

### The Mean Free Path

This average distance, referred to as

(*Continued on next page*)

# Chart of Sensitivities




**The various photo-sensitive substances are more or less affected by light of different colors. Thus, a potassium cell is most sensitive in the blue region, while a caesium cell finds its best ability in the red part of the spectrum. The spectroscopic sensitivity of the eye has been included for comparison with the various types of cells.**

(*Continued from preceding page*)

the "mean free path," can readily be seen to depend on the number of gas particles distributed in the space—in other words, the gas pressure. It must be appreciated that the foregoing phenomena are tremendously complicated and interdependent. Calculations concerning them must utilize distribution and probability laws, resulting in conclusions which are of an average or general nature.

As the anode voltage is increased we reach a point where resonance action is still dependent in large measure on the quantity of electrons liberated at the cathode by the incident light. Continuing to increase the anode voltage we reach a point where ionization is occurring at a rate sufficient to produce the glow discharge. When this point, called the "glow voltage," is reached, the electric field is strong enough to accelerate the ions to a point where they acquire sufficient velocity to produce free electrons by bombardment on the cathode. This renders the discharge self-sustaining as long as the anode is maintained at or above the glow potential. The current flowing is limited only by whatever external resistance happens to be present in the circuit, and is usually or great magnitude compared with the photo-electric current. Obviously, the light passing into the cell exerts practically no effect on this current, and the value of the cell as a valve is nullified. The ionization current will continue to flow if the light is entirely removed and can only be stopped by lowering or removing the anode voltage.

## Heightened Anode Voltage

It is well known that the metals of the alkali group—lithium, rubidium, sodium, potassium and caesium—possess the ability to emit photo-electrons under the influence of visible light. It was found also that the chemical combination of these metals with hydrogen was even more sensitive. As a result the common type of cell that is available is a gas filled one containing a collector anode in some form and characterized by an active cathode exhibiting the green-blue-purple surface of an alkali metal hydride. Unfortunately, the metals that are used are extremely active chemically, especially under the influence of the electric field and the incident light. These metals also have very low melting points. Hence great care must be taken in the preparation, evacuation and gas filling of these cells. The presence of even slight traces of chemically active foreign materials is sufficient to alter the cell characteristics in a short time.

In order to utilize the sensitivity of the cell to the fullest extent consistent with safe practice, the operating anode voltage is raised as close to the ionization potential as possible. Any change in this glow potential, with its correlated change in sensitivity, is apt to be serious where undistorted output at high frequency is required.

It has been shown how the gas pressure within the cell affects the glow potential. It so happens that the optimum gas pressure is a very low one—about two one-hundredths of one per cent. of normal atmospheric pressure. The smallest change in this gas pressure results in a change in the glow potential and therefore in the best operating potential. This makes accurate pressure measuring apparatus essential in the gas filling process.

## Example of Impurities

If the filling gas, generally argon, or the hydrogen used to form the surface of the active element, contains impurities two deleterious effects are noted. First the impurities unite chemically with the active surface, impairing its sensitivity. Second, as a result of this, the gas is both purified and reduced in pressure. These latter two effects change the glow potential, usually lowering it. It is easily possible to have the anode potential so adjusted that such a clean-up will cause the glow voltage to drop below the applied voltage, resulting in a "spill-over."

Complicated control apparatus is assembled to purify the argon and hydrogen and to regulate the pressure used in the cell. The exhaust positions must be carefully designed to facilitate easy removal of exhaust lines, as they quickly become contaminated with the hydroscopic alkali metal oxides. The vacuum required is of a high order, necessitating use of high speed oil pumps, water cooled mercury condensation pumps and freezing traps.

The degree of vacuum is checked on a McLeod gauge several times in the evacuation of each cell. The bulbs are carefully washed before using and thoroughly baked on the pump before distillation of the alkali metal. The alkali metal is redistilled several times to insure its purity before admitting it into the cell. The temperature of the bulb must be kept as nearly constant as possible in order to obtain a uniform deposition over the useful surface. While there is no conclusive evidence that all or any of the above precautions are essential to best operation, they are necessary in any attempt to achieve uniformity.

## Handle With Care

Condensation of the alkali metal across the lead-in wires should be carefully guarded against in the process of manufacture. If a glow discharge is maintained across the cell for even a short time, sufficient heat may be generated by ionic collisions on the cathode to volatilize the metal or at least to dissociate the hydride. Leakage across the lead wires and decreased sensitivity will result from this occurrence. The speed with which this disintegration takes place depends on the intensity of the glow discharge.

Consequently, it is important to introduce resistance into the circuit to limit the current to a small amount in the event of spillover. If the precautions taken in the manufacture of these cells and some knowledge of their theoretical operations are known and appreciated, it is believed that users of photo-electric cells will regard them as delicate scientific instruments and handle them with the same care.

The voltage considerations are perhaps the most important to operators of these cells. In choosing the operating voltage of a particular cell, a compromise is effected at maximum light flux, between safety and sensitivity, the ionization potential being the limiting value. A study of current responses from cells of different ionization potentials indicates that the sensitivity is roughly proportional to the ratio of operating voltage to glow voltage.

## Sensitivity Considerations

For example, keeping the other conditions constant, the sensitivity of a cell with a glow potential of 300 volts operated at 250 volts is about the same as the sensitivity of a cell with a glow potential of 150 volts and operated at a voltage of 125 volts. In the first case, we have a safety margin of 50 volts whereas in the second case, this margin is half that. It may happen, however, that the gas pressure necessary to produce a glow potential of 300 volts will not be the optimum pressure to produce maximum sensitivity under the desired conditions of light, cell construction, etc. This may make further compromise advantageous. As an instance, on a cell of certain physical specifications used for sound picture work, it has been determined that an operating range of 200-225 volts and a glow point

range of 225-250 volts at 0.2 lumen gives most satisfactory results.

There are four main divisions in the uses to which the photo-electric cell may be applied. The simplest is the familiar light-dark relay. In this case, the chief considerations are light change and amplification. The second is the function where light of fixed color is changed in intensity at various frequency rates. The third application is one where the cell is used to measure variations in light frequency or color. This usually involves difficult problems of calibration and screening. The fourth use may be considered a combination of the second and third and involves concomitant changes in both light flux and light frequency at a variety of rates. This is the highest plane in which the photo-electric cell may be made to serve and it should not be attempted without a thorough physical and electrical knowledge of the phenomena involved. Each of the above applications requires cells of different characteristics.

### What to Ask About

It can be readily seen that a system of standard characteristics such as we apply to radio receiving tubes cannot easily be devised to fit the case of photo-electric cells. It would be impractical to measure and plot a full set of curves defining all the variables for each cell. The best that can be offered is a set of general data such as has been presented here. When cells are required for a particular use, very complete data are necessary. These data include information as to light intensities, kind of light, distances, screens, optical devices, amplification possible, output required, probable change in light flux and frequency of such change, preferred operating voltage, preferred shape and size of light beam and whether reflected, refracted, or directly transmitted, importance of linear current response with change in light flux, importance of response change with changing color of exciting light source, probable temperature during operation, time under load, and vibrations due to mounting.

As has been stated, sensitivity to light change, uniformity and life are of paramount importance. Sensitivity and uniformity can be achieved by the manufacturer provided the operating conditions are fully understood. Maintaining this sensitivity and uniformity over a period of time is squarely up to the operator. The commercial operator must be thoroughly acquainted with the care necessary to the use of photo-electric cells and, in addition, must carry into his work a measure of personal interest and professional integrity.

### Safety Margin

Where photo-electric cells are used on a commercial scale manufacturers and consumers may best cooperate. Such features as mechanical vibration, light systems, beam size, amplification circuits, etc., are provided for in the early engineering of apparatus and photo-electric cell. Probably the biggest single factor causing trouble in the field is the use of overvoltage with resultant spill-over or ionization in the cell. The importance of operating the cell with a generous safety margin cannot be over-emphasized.

A brief discussion of what we mean by sensitivity should be helpful. The actual current output in amperes under chosen light conditions is relatively unimportant although a high output usually connotes other desirable characteristics. In most applications, the output change with respect to light change is the important factor. It is this ratio which produces the voltage change applied to the grid of the first amplifier tube.

With the light constant, a small change in voltage across the cell will produce a small change in current and for small values of voltage, the characteristic follows Ohms Law. With constant voltage, but unvarying illumination, the conductance is proportional to the current. The characteristic conductivity measures the relative increase in current magnification due to unit increase in anode potential. Within wide limits, it is unaffected by light flux. It can be immediately seen that the resistance in the external circuit destroys the linearity of the current voltage characteristic across the cell, because of the voltage change on the anode due to the changing current through the external circuit.

### Distortion Index

We have learned that in the gas filled cell the current-voltage characteristic rises with increasing steepness as we approach the ionization potential. Consequently, the characteristic conductivity assumes larger values in the same proportion. If the cell is operated close to the ionization point serious distortion may occur in the case of speech amplification. Where external resistors of the order of several megohms are used, the farther below the ionization potential the cell is operated, the more faithful the reproduction will be but the lower will the sensitivity be.

The two quantities that interest the photo-electric cell user most are potential and light flux. The potential is readily understood when measured in volts. The light flux is more difficult to measure. This may be done roughly as follows. The incandescent tungsten lamp is a convenient source of light and is used in nearly all cases. These lamps are usually rated in watts. An emission of 10 lumens per watt may be considered an average figure for these lamps. The light flux in lumens falling upon a surface of area S is given by

$$L = \frac{L_o S}{4\pi r^2}$$

where $L_o$ is the emission from the source in lumens and r the distance. When a lens or slit is interposed it must be considered as the surface illuminated. The transmission losses through lenses and slits vary widely depending on the mechanical excellence of these apparatus.

The foregoing discussion of the principles of photo-electricity as applied to the photo-electric cell have not been meant to represent an exhaustive study of the field but rather a review upon which can be built a more comprehensive understanding of this study in preparation of the wide application of this apparatus in the early advent of television and telephoto equipment.

# New WWV Standard Frequency Schedule

The standard frequency transmissions are to undergo a change. It is announced by the National Bureau of Standards that the emissions from its station, WWV, in Beltsville, Md., near Washington, D. C., will henceforth have a new schedule and wider scope.

The transmisions will be made two days a week instead of the once a week and will be on three frequencies: 5000, 10000 and 15000 kc, instead of the former single frequency of 5000 kc. A series of experiments run by the Bureau in cooperation with a large number of independent organizations and persons who observed the signals at various places showed that service could be rendered at all distances in the daytime by the use of the three frequencies. With the use of 5000 kilocycles alone, it was necessary to have emissions at night to give service at distances greater than a few hundred miles from Washington. With the use of the three frequencies, no night transmissions will be necessary, hence are omitted.

Of the transmisisons now in effect, those on 5000 kc are particularly useful at distances within a few hundred miles from Washington, those on 10000 kilocycles are useful for the rest of the United States, and those on 15000 kilocycles are useful in the United States and other parts of the world as well.

This new schedule is to be placed into effect beginning February 1st, and will continue every Tuesday and Friday thereafter with the exception of legal holidays, until further notice. The three frequencies will be transmitted as follows (EST):

| | |
|---|---|
| Noon to 1 p.m. ..... | 15,000 kc |
| 1:15 to 2:15 p.m. ..... | 10,000 kc |
| 2:30 to 3:30 p.m. ..... | 5,000 kc |

The transmissions consist mainly of continuous, unkeyed carrier frequency, giving a continuous whistle in the phones when received by an oscillating receiver. For the first five minutes of transmission, the general call (CQ de WWV) and the announcement of frequency are transmitted. The frequency and call letters of the station (WWV) are given every ten minutes thereafter.

The accuracy of the transmissions is at all times better than one part in 5,000,000. From any of them, using the method of harmonics, any frequency may be checked. This method was detailed in RADIO WORLD on January 5th, 1935.

The Bureau of Standards is desirous of receiving reports on reception of these transmissions, especially because radio transmission phenomena change with the seasons of the year. The data desired are approximate field intensity, fading characteristics, which of the three frequencies is received best, and the suitability of the signals for frequency measurements. It is suggested when reporting on intensities that the following designations be used where the field intensity measurement apparatus is not used:

(1) Hardly perceptible, unreadable.
(2) Weak, readable now and then.
(3) Fairly good, readable with difficulty.
(4) Good, readable.
(5) Very good, perfectly readable.

Statements are also desired regarding the intensity of atmospherics and as to whether fading is present or not and if so its characteristics, such as time between peaks of signal intensity. Correspondence should be addressed to the National Bureau of Standards, Washington, D. C.

## Code for Transmissions of Standard Frequencies

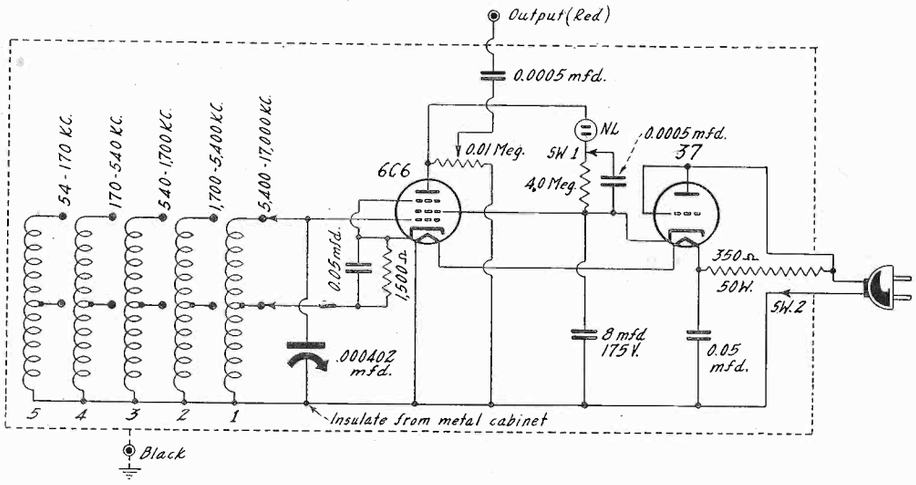
Since the standard frequency transmissions are announced in code, it is necessary for our readers who are not code-wise to be shown how to recognize these transmissions. All that is necessary is for the tyro to memorize the call CQ de WWV in code together with the numbers one to ten (zero). In code, the call sounds like this:

—·—· ——·— —·· ·
·—— ·——· ···—

# Five-Band Operation

## Of a Signal Generator, With Almost Unlimited High-Frequency Range

*By Herman Bernard*




**A radio-frequency oscillator, line rectifier and neon audio oscillator in a Signal Generator. Suggestions for construction and directions for use are given in the text. This circuit is known as the 339.**

THE 339 Signal Generator consists of a radio-frequency oscillator, a rectifier and a neon tube audio oscillator. Since there is d.c. on the plate there would not be any modulation, whether 90-125 volts a.c. or d.c. were applied, hence the neon tube is included, and may be switched into or out of audio oscillation by using or releasing the 0.0005 mfd. fixed condenser associated with it. A capacity being necessary for oscillation, removal of the capacity stops oscillation.

The r-f oscillator is a modified Hartley, operated so that little or no grid current flows. A front-panel switch is used for selecting one of five coils to cover the following bands:

(1) 5,400-17,000 kc
(2) 1,700-5,400 kc
(3) 540-1,700 kc
(4) 170-540 kc
(5) 54-170 kc

The front plate has corresponding numbers. The dial is frequency-calibrated for two ranges, with equivalent wavelengths given for the two. Only two sets of calibrations are needed because the dial, of the airplane double-pointer type, is decimal-repeating. This may be seen from a glance at the tabulation above. The calibration is for 54-170 kc and 170-540 kc, and metrical wavelength equivalents, the tuning condenser used without trimmer, and the adjustment of inductance made at the or very near the high-frequency end of each band, to cause the tuning to track the dial. This tracking will prevail only with a particular condenser (General Instrument Company). Then the two low-frequency ranges are read directly for frequencies, top outside tier, 54-170 kc, at position 5, and bottom outside tier, 170-540 kc, at position 4, for frequencies, equivalent wavelengths being in companion inside tiers. Actually, because of the adherence to round numbers of wavelengths, a few wavelengths omitted from the lower frequency band are instead calibrated on the higher frequency band, beyond the frequency calibration of that second or lower-frequency band, for readier determinations, but there is complete and accurate coverage nevertheless, and the transposition is not only helpful but practically necessary.

### Dial Reading

The dial is read as follows:

Position 5: 54-170 kc, read frequencies directly, top outside tier, also equivalent wavelengths directly, top inside tier, 5,500-1,800 meters.

Position 4: 170-540 kc, read frequencies directly, bottom outside tier, also equivalent wavelengths directly, bottom inside tier, 1,800-550 meters.

Position 3: 540-1,700 kc, read top outside tier and multiply by 10 for frequencies, but for wavelengths divide top inside tier by 10.

Position 2: 1,700-5,400 kc, read bottom outside tier and multiply by 10 for frequencies; for wavelengths read bottom inside tier and divide by 10.

Position 1: 5,400-17,000 kc, read top outside tier and multiply by 100 for frequencies, but for wavelengths divide top inside tier by 100.

The foregoing shows the decimal-repeating nature of the dial, possible because the frequency ratio is the square root of 10. The advantage is that the semi-circumference used for each of the two calibrated systems is the maximum possible, because the numbers are near the edge of the dial scale, hence the dial is easier to read and readings may be made more closely and accurately.

### Insulation Precautions

The oscillator proper is constructed on a metal chassis, but with tuning condenser frame insulated from that chassis, and also the connection between shaft of the condenser and hub of the dial insulated, otherwise the previous attempt would be shorted. This insulation of the dial mechanism from the condenser shaft is accomplished by means of a coupling bushing, that receives the condenser's quarter-inch shaft in the insulator's cup, and extends a short quarter-inch diameter shaft to the dial hub.

The insulation is advisable because the return circuits are to one side of the line, and if common to the metal box would create the danger of application of the line voltage to the body, if, for instance, box and a grounded heat radiator of opposite potentials were touched, or if the box were touched to the radiator a fuse in the house line could be blown. This shorting would result if the generator's cable were inserted so as to communicate the ungrounded side of the line to the grounded radiator, or by similar opposition of polarity between external ground and the "hot" side of the line. This precaution should be taken, even if on some occasions a little plop may be heard if the generator is operating and one touches the box. This touching and the plop are harmless.

### The R-F Oscillator

The coil switching arrangement is perhaps too simple to require explanation, but it should be noted that the larger part of the winding goes between control grid and cathode, smaller part between cathode and grid return, except that high frequency coils may have small difference in number of turns between top and extremes.

The r-f oscillator is a 6C6. This is the 6.3-volt equivalent of the 57. The plate is connected through a potentiometer to zero d-c potential, but some current flows through the resistor, due to the presence of the plate in the moving electron field. Actually, the plate is used not as such but as a pickup element. The feedback arises from the positive potential on the screen, which thus is the real plate, and not used as a screen. The tube is essentially a triode, though not without a little effect from the suppressor.

Attenuation of r.f. is done by taking off so much of the oscillation voltage in the pickup circuit as desired. This is accomplished without detuning the generator, because the coupling is of the electron type, and besides is not overdone. However, the measured circuit would be affected for very low resistance between arm and ground, but the occasion will scarcely arise for use of so low an output, even for lining up sets having automatic volume control.

### Oscillation Pointers

Some trouble may be experienced concerning oscillation on the highest-frequency coil, and also modulation by the neon lamp on that coil and the next lower frequency coil. (These two are 5,400-17,000 kc and 1,700-5,400 kc). The oscillation is preserved on the highest-frequency coil by keeping the coil far enough from the metal of the cabinet, accomplished either by locating the coils in a stack on top the chassis, behind the switch, with smallest coil uppermost, which puts that coil about halfway between the upper and the lower planes of the box, or by mounting the coils on a

strip, the smallest coil kept away from the chassis by the form. Should oscillation be absent, or possibly present over part of the band for this coil, and absent for the other part, a remedy is to increase the value of the 0.05 mfd. condenser at right in diagram.

The failure of the neon lamp to oscillate is due to the voltage being insufficient to cause ionization.

### D-C Voltage High Enough

Certainly there is enough d-c voltage, around 100 or so, but if the r-f generator oscillates violently, or the potentiometer is of too high a value, the return of the lamp to the 6C6 circuit would be to a voltage too high from ground, hence the drop across the lamp would be too small. The limiting resistor, 4.0 meg., has nothing much to do with this. The remedy would be to use a smaller value potentiometer, or put two equal resistors across it and join the 0.2 meg. overmodulation protector to the joint. The value of the resistors is not very important, though they should be no less than 10,000 ohms.

The neon lamp will oscillate at audio frequencies whether the 0.001 mfd. condenser is across the lamp or across the 4.0 meg. But the oscillation is far stronger when the condenser is across the resistor. The tone or frequency is very slightly different. Any pitch desired may be achieved. Lowering the condenser value increases the frequency, increasing the capacity decreases the frequency. Or the resistor could be increased beyond 4.0 meg. to lower the frequency, decreased to increase the frequency, but should not be less than 0.1 meg.

### This 0.05 Mfd. Important

The neon lamp should be of the special type without limiting resistor built in, because otherwise the oscillation frequency is practically out of control, because a resistor is present across which no condenser could be put, nor could one put a condenser across the lamp, as the two lamp terminals are not accessible, only one. The other terminal is one end of a built-in resistor in the standard lamps.

The limiting resistor for the heaters is in the line circuit. Assuming 115 line volts, 6.3 volts for each heater, 0.3 ampere current, the limiting resistor would have to be 341 ohms. The commercial value used is 350 ohms.

By all means must a condenser be used from the set end of this resistor to the other side of the line, otherwise the circuit will oscillate poorly or erratically. This is the right-hand 0.05 mfd. capacity in the diagram. The limiting resistor is a common impedance to the oscillator and rectifier, and in all series heater circuits should be bypassed.

### Directions for Use

The line plug is connected to the 90-125-volt a-c or d-c line. If the line is a-c the plug may be connected either way. If the line is d-c the plug must be connected a particular way. There is no danger if the plug is reversely connected to d-c, but the Signal Generator will not oscillate then, so re-insert the plug the other way. The red-ringed jack at front is for connection to the circuit to be measured or peaked. The black post is for connection to ground, as the Generator was calibrated in such grounded condition. If no ground is used there will be a small resultant frequency change. In aligning all frequencies remove the antenna from the receiver. For intermediate frequencies connect Generator output to plate of the modulator. For higher radio frequencies connect Generator output to the vacated antenna post. If coupling is too strong, connect a short length of wire to the antenna post and wrap the wire from the Generator output (red) post around this, without conductive connection. For zero beating with stations, for checking or ascertaining the frequency of a station, as for station-finding and measuring, attach the aerial to the set and wrap the Generator output wire around aerial lead, a few turns. Connection of Generator output to antenna post, along with aerial, gives closer coupling, occasionally needed.

**Exploration of Frequencies:** If one has no idea of the frequency being measured, turn the Generator range selector switch to Position 1 (5,400-17,000 kc), and if no response is heard the unknown frequency is lower than 5,400 kc. Turn the knob to Position 2, and if still no response is heard the frequency is lower than 1,700 kc. If no response results on Position 3 either, the frequency is lower than 540 kc. If there is no response at Position 4 the frequency is lower than 170 kc, and if none at Position 5 the frequency is lower than 54 kc and cannot be measured, or Generator or receiver isn't working, or coupling is absent or too weak.

**Short Waves (Position 1):** If a response is heard at Position 1, denoting frequency is 5,400 kc or higher, and there is only one response in traversing the calibration (top outside frequency tier multiplied by 100) the frequency is read from the scale and multiplied as directed, and will be 5,400-10,800 kc. For unknown frequencies 10,800 kc up, there will be two or more responses in traversing the Generator dial. For frequencies higher than 10,800 kc the measurements are made by a confusion-eliminating harmonic system. The radio frequencies measurable in this way are almost without limit, although depending on the sensitivity and the frequency range of the system being measured. Taking a certain low level of receiver sensitivity, measurements to 85,000 kc (85 mgc) are readily practical. For multiple responses due to sweeping the Generator dial when band switch is set at Position 1 for 5,400-17,000 kc fundamentals, gain a response in the receiver due to any setting of the Generator. Read the Generator frequency, an harmonic of which is creating the response. Turn the Generator dial slowly until the next response is heard. It matters not if the Generator fundamental frequency is increased or decreased. Note the frequency of this second fundamental. Divide this difference into one of the read frequencies and the answer is the harmonic order of the **other** read frequency. Multiply this other read frequency by the harmonic order and the answer is the unknown frequency. Suppose one dial reading is 100 and the other is 110. Since the scale for Band 1 is to be multiplied by 100 the actual frequencies generated fundamentally are 10,000 and 11,000 kc. The difference is 1,000 kc. Divide 1,000 into 10,000, the answer is 10, so the unknown is the tenth harmonic (not of 10,000 but) of 11,000 kc. Hence 110,000 kc or 110 mgc is the answer. Suppose the difference, 1,000, were divided into 11,000, also a read fundamental. The answer is 11. So the unknown is the eleventh harmonic (not of 11,000 but) of 10,000, again 110,000 kc or 110 mgc. Always the answer must be the same, of course. Also when the method is applied to the alternate case, the harmonic order will be one higher or lower than in the first instance, because consecutive harmonics of different fundamentals are used. Let us take as the final example readings of 150 and 165, denoting 15,000 and 16,500 kc. The difference is 1,500. Divide 1,500 into one read frequency, 15,000, and the answer is 10, which is the harmonic order of 16,000 kc, so the unknown is 10 x 15,000 or 150,000 kc or 150 mgc. The wavelength is 3 meters. It can be seen therefore that frequencies higher than any that would be required to be measured are taken care of to a degree of accuracy depending solely on the accuracy of the scale's coincidence with the generated fundamentals.

**Position 2:** If there was no response at Position 1, but response at Position 2, the unknown is in the 1,700-5,400 kc band. If only one response is heard the unknown is 1,700-3,400 kc, read directly. If there are more than one response the unknown lies between 3,400 and 5,400 kc, and is the highest read frequency that yields a response.

**Broadcast Band (Position 3):** If there was no response at Positions 1 and 2, and there is response at Position 3, the unknown is in the broadcast band. If only one response is heard the unknown is 540-1,080 kc, top outside tier multiplied by 10. If there are more than one response the unknown lies between 1,080 and 1,700 kc, and is the highest frequency that yields a response.

**Intermediate Frequencies (Position 4):** For 170-540 kc, if there was only one response the unknown is 170-340 kc, so read it directly (lower outside tier). If there are more than one response the unknown is equal to or higher than 340 kc, so read move the dial to the highest frequency that yields a response, and the unknown is thus determined. Wavelengths in meters are read directly on the lower inside tier.

**Position 5:** If the first response is at Position 5, none at Positions 1, 2, 3, or 4, the unknown is 54-170 kc and is read directly (top outside tier), and also may be read directly in equivalent wavelengths (top inside tier).

**Special Connection Advice:** Wherever a set manufacturer has given directions for connections contrary to those recommended above, follow the manufacturer's advice.

## City Maintenance Unit Has Own Coastal Call

The uses of radio for communication purposes are multiple. Another application of this utility is evidenced in the application of the Department of Plant and Structures of New York City for a renewal of its license to operate a private coastal service under the call letter of WKDX. It seems that the city of New York has its own radio station over which radio messages may be sent and received. Competition with private industry?

# Quality Television to Start

## Canadian Station, Using Peck System, to Open Next Month

***By Herman Bernard***

THE first television station in the world to offer quality television for public entertainment and education is being constructed by the Peck Television Corporation of Canada and is expected to begin operation in March at Montreal, P. Q. The general manager of the station will be Emile Fontaine, one of Canada's leading radio executives. The chief engineer will be Joseph Francis Dusek, an associate of William Hoyt Peck, inventor of the mechanical system that is featured by outstanding illumination of the projected picture.

Mr. Dusek has been working at the New York laboratory of the Peck Television Corporation for several months, and left for Montreal recently with the intention of giving the Canadians a startling treat.

### Difficulties in U. S.

The Peck Television Corporation is breaking the ice with quality television in Canada is the receptivity of the Canadian Government to such an endeavor, contrasted with difficulties in getting a television station going in the United States. These difficulties are said to concern both the policy of the Federal Communications Commission and the owners of transmitting and receiving patents having to do with the operations independent of television.

The Montreal station will operate around 7 meters, and will send out both sound and pictures. The sound will be on a channel sufficiently removed from the video frequency, or television, carrier frequency, to prevent interference with the picture due to the sound modulation, but close enough to enable tuning in both picture and sound on a single dial. This is possible because of the high carrier frequency, around 43 mgc, the television modulation extending to 150 kc, and the 10 kc sound modulation impressed on a separate carrier safely removed from the other.

The early transmissions from the station will be of 60-line pictures, but a few months later it is expected that 120 lines will be used. This will increase the detail and illumination.

### Receivers to Be Available

Mr. Fontaine is in charge of the radio department of the largest radio distributor in Canada, C. Robitaille, 320 Rue St. Joseph, Quebec, P. Q., and has therefore given thought to the supply of receivers to intended television observers. Mr. Fontaine now operates a regular broadcasting station for his company in Quebec.

An aspect of international rivalry exists in the erection of the station in Canada, as an American's inventions are being used, in the introduction for the first time of quality television broadcasts.

Several years ago a crop of television stations was operating in the United States and Canada, but flat wheels with pinholes in them were used for scanning, or the slightly better discs with lenses in front of the holes, and in both instances most of the small available light of a neon lamp was lost at the receiving end. Also the scanning at the transmitter, with flying spot, had some shortcomings, though the pickup method was not bad by any means. The absence of sufficient light in the receiving source of illumination, and the ruinous sacrifice of 75 per cent. of that small light, plus repetitive showing of uninteresting pictures, finally resulted in the disappearance of practically all these stations from the air. Hence there has been nothing much to see, and Mr. Fontaine recognized that the first move to get real television started was to inaugurate a station using a quality system, and have the programs possessed of entertainment value.

### 24 Pictures, as in Movies

The station will send out 24 pictures a second, hence a motor is necessary that will spin the scanning wheel 60 x 24 times per minute, or 1,440 revolutions per minute. Such a motor, of the synchronous type, has been invented by Mr. Peck. Leading motor experts had said such a synchronous motor was impractical or impossible, since synchronous motors had to be run at numbers of revolutions per minute in sub-multiple relation to the product of line frequency and time. If the line frequency were 60 c.p.s. the motor could operate, for instance, at 60 x 60 r.p.m., or 3,600 or, 7,200 alternations, which Mr. Peck divides by five, the supposedly impossible feat.

Although Mr. Peck is an outstanding optical expert, hence may not be supposed to be outstanding also in motor practice, he developed just the desired synchronous motor. It will be used at the station and also may be used in conjunction with receivers. The speed also may be doubled at the transmitter for the 120-line purposes of the future, the lenses on the receiving scanner being doubled instead of the motor speed.

At present Mr. Peck is exhibiting in his modern laboratories a well-defined picture, 11 x 14", on a screen, and therefore of sufficient size for home enjoyment. When 120 lines are used in the future, the picture size may be doubled for the same illumination, or may be retained at 1 foot at four times the present illumination. It is in the attainment of high degree of illumination that Mr. Peck had outstripped competitors, for he uses the optically concentrated light from an automobile headlamp, modulating this light with a device resembling a Kerr cell, that is, a scheme of polarized light resulting in beam-twisting.

### Competition Looms

The Canadian Government takes pride in the fact that it was first to help Marconi when he received the letter S, sent across the Atlantic from Poldhu, England. The receiving took place in St. John's, Newfoundland, December 12th, 1901, distance 1,800 miles. Hence the same Government desires to be the first to aid in putting quality television on the air for public use, and if the event is successful it will be historic, comparable to Marconi's feat.

However, the Canadian enthusiasts may have unexpected competition, as there is a plan afoot to surmount difficulties and erect a quality television station in New York City.

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## Short-Wave Converter Coil-Winding Data

MANY persons are interested in a means of building a device to work with their standard broadcast superheterodyne receivers to enable bringing in foreign and other short-wave stations. However, the radio receiver takes in the broadcast band only, and one could not receive the short waves. But it is comparatively simple to build a small converter which will make the total installation a superheterodyne regardless of whether the standard broadcast receiver is one.

The theory involved in the use of a converter in conjunction with a broadcast receiver may be stated simply that the converter, is a mixer stage in which the desired signal is made to mix with a locally generated oscillation. The frequency of the difference of these two frequencies is then caused to be received by the broadcast receiver, which is set at a fixed value and not touched again.

The tuning process of getting other stations is controllable solely by the converter's dials. Of course we have a wide choice in the matter of the intermediate frequency to which we tune our broadcast receiver and the point that is finally chosen will be determined by the point in the short wave spectrum that is desired in order to minimize possible interference.

For any purpose, three points on the broadcast receiver's dial will suffice and these have been chosen as 1,500, 1,000 and 550 kilocycles. A suggested circuit is shown in the sketch wherein by suitable plug-in or switch type coils any band of frequencies from 540 to 30,000 kc. may be chosen.

A tabulation of the coil sizes for the various bands is indicated below and it will be noted that there is shown one set of coils for the r-f stage while the choice of three sets of oscillator coil is available dependant upon the intermediate frequency chosen.

### TABULATED WINDING DATA

#### R-F COIL

| *Frequency band Kilocycles* | *Inductance Microhenries* | *1¼ in. form Number of turns* |
|---|---|---|
| 540— 1500 | 520 | 160 t. No. 32 en. |
| 1500— 4300 | 70 | 40 t. No. 32 en. |
| 4300—12000 | 8.5 | 14 t. No. 24 en. |
| 12000—35000 | 1.0 | 5 t. No. 14 en. |

#### OSC. COIL

| | | |
|---|---|---|
| **I.F. = 1500 kc** | | |
| 2040— 5800 | 37 | 35 t. No. 24 en. |
| 5800—13500 | 4.6 | 14 t. No. 14 en. |
| 13500—36500 | 0.85 | 4½ t. No. 14 en. |
| **I.F. = 1000 kc** | | |
| 1540— 5300 | 70 | 46 t. No. 28 en. |
| 5300—13000 | 5.6 | 15 t. No. 14 en. |
| 13000—36000 | 0.95 | 5 t. No. 14 en. |
| **I.F. = 550 kc** | | |
| 990— 2050 | 160 | 83 t. No. 28 en. |
| 2050— 4850 | 36 | 35 t. No. 24 en. |
| 4850—12550 | 6.5 | 17 t. No. 14 en. |
| 12550—35550 | 1.0 | 5 t. No. 14 en. |

# A Phonograph Oscillator

## It Permits Use of All of Set's Amplification

*By Leonard J. Wethers*

A GENERATION ago the phonograph was invented and the buying public flocked to obtain one of these devices that inhumanly spoke or sang back at them. The gradual technical perfection of this instrument into one of quality caused its worth to increase so that it entered the best homes and became a reliable source of entertainment whereby the world's greatest musical geniuses could be heard at will. For many years, it occupied an enviable position in the affairs of the home, and the industry prospered greatly. However, this was not to be the case forever, since the development of broadcasting caused the phonograph to become a backnumber.

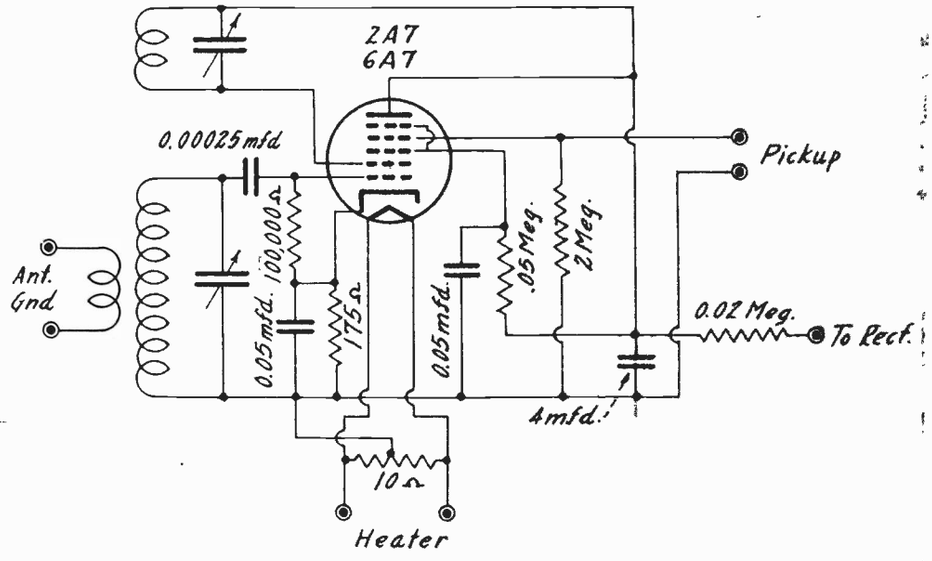
Thus, a very prosperous industry was reduced almost to ruin by the development of radio. However, the reverse of this ruin is now taking place. For, with the development of the electrical phonograph pick-up, greater quality in record reproduction has been obtainable and the industry has received a revival that is sure to be permanent, since radio can not take the place of recorded entertainment on certain occasions when there is a dearth of suitable radio programs. The need for recorded entertainment will accordingly always exist and the adaptation of the radio equipment to recording purposes is a step forward indeed at the same time that it rehabilitates a profitable industry. Anti-technocrats take notice!

### How Pickup Works

The old type of victrola was converted to the modern electric orthphonic phonograph by the introduction of the electric phonograph pick-up several years ago. Meanwhile electrical recording introduced great tonal improvements. The pick-up was a simple device, being essential one phone of a pair of headphones in which the diaphragm was replaced by an armature to which was attached a phonograph record needle. Thus, when the needle was placed in the groove of the record and the record was caused to rotate in orthodox fashion, the laterally oscillating cut in the phonograph record would cause the needle with its associated armature to vibration at frequencies the same as the original sound frequencies that were first recorded on the record.

This vibration of an iron armature in the axis of a pickup coil causes the inductance of this coil to vary in exact ratio with the variation in the grooves of the record. When this pickup is connected across the input to a sound amplifier, a voltage is set up across the coil which induces a varying current that is controlled by the varying impedance of the pick-up due to the changing inductance of the coil in it.

Thus, the lateral grooves in the phonograph record are instrumental in creating an alternating current of audio frequency by the pick-up's action. The effectiveness of this type of pick-up as contrasted with the old diaphragm type is vividly indicated by the fact that the diaphragm type of pickup is virtually given away in stores that still have them The electrical phonograph pick-up is decidedly far superior to the older type. especially when it comes to quality of reproduction. It is so good, that when a phonograph-radio combination is switched to the phonograph from the radio, the difference in tonal quality for most sets is appalling.




**Circuit for a phonograph oscillator, using a pentagrid converter tube, and taking the heater voltage from the set (any properly voltaged socket) and B voltage from either filament side of the set's rectifier.**

### The Old Way

In this arrangement of electrical pick-up and radio set, the pick-up is connected into the radio circuit at the detector stage so that the output of the pick-up does not pass through the radio-frequency or intermediate-frequency portions of the set. The process then is purely a matter of audio amplification to a point that is satisfactorily loud for anyone's purpose. It has been found that the ordinary circuit arrangement of detector and two stages of ordinary audio amplification serves sufficiently well to accomplish this purpose. However, to accomplish this end, means has to be provided for the plugging in of the pick-up was communicated into the detector stage of the radio receiver. Not all sets are thus equipped and in some it is well nigh impossible to thus get at the detector stage to accomplish a phonograph attachment, or even so, the amplification is not enough.

For those thus handicapped, we propose another scheme, whereby it is unnecessary to make any changes in the set's construction whatever. In addition, this scheme utilizes all the tubes of your receiver—not only the detector and audio frequency stages. Thus, maximum amplification is obtainable. Accordingly, the new method that we propose to outline has the advantages of affording greater amplification without the addition of any costly apparatus and at the same time obviates the necessity of altering the construction of your radio receiver.

### The New Way

It is proposed that we connect an electrical phonograph pick-up to a mixer arrangement, not unlike the mixer stage of a superheterodyne, so that we modulate a locally generated radio-frequency oscillation within the broadcast band with the audio-frequency variations of the phonograph record reproduced by the pick-up. This is accomplished by using the pentagrid converter type of tube which has been designed to perform simultaneously the functions of a first detector and an oscillator tube in superheterodyne circuits.

This tube (2A7 or 6A7) may be made to perform these functions by having the cathode, grid No. 1 and grid No. 2 act as the oscillator portion of the tube, while grids No. 3 and No. 4 and the plate perform the mixer functions.

We are thus feeding our broadcast receiver with a radio signal at any broadcast frequency generated by the p.o. that carries a reproduction of the phonograph record on the turntable at the time. Of course, it is desirable that the radio antenna and ground system be disconnected from the set so that no undue interference will result from broadcast stations leaking in. This may be accomplished by means of an appropriate switch which has a very small capacity.

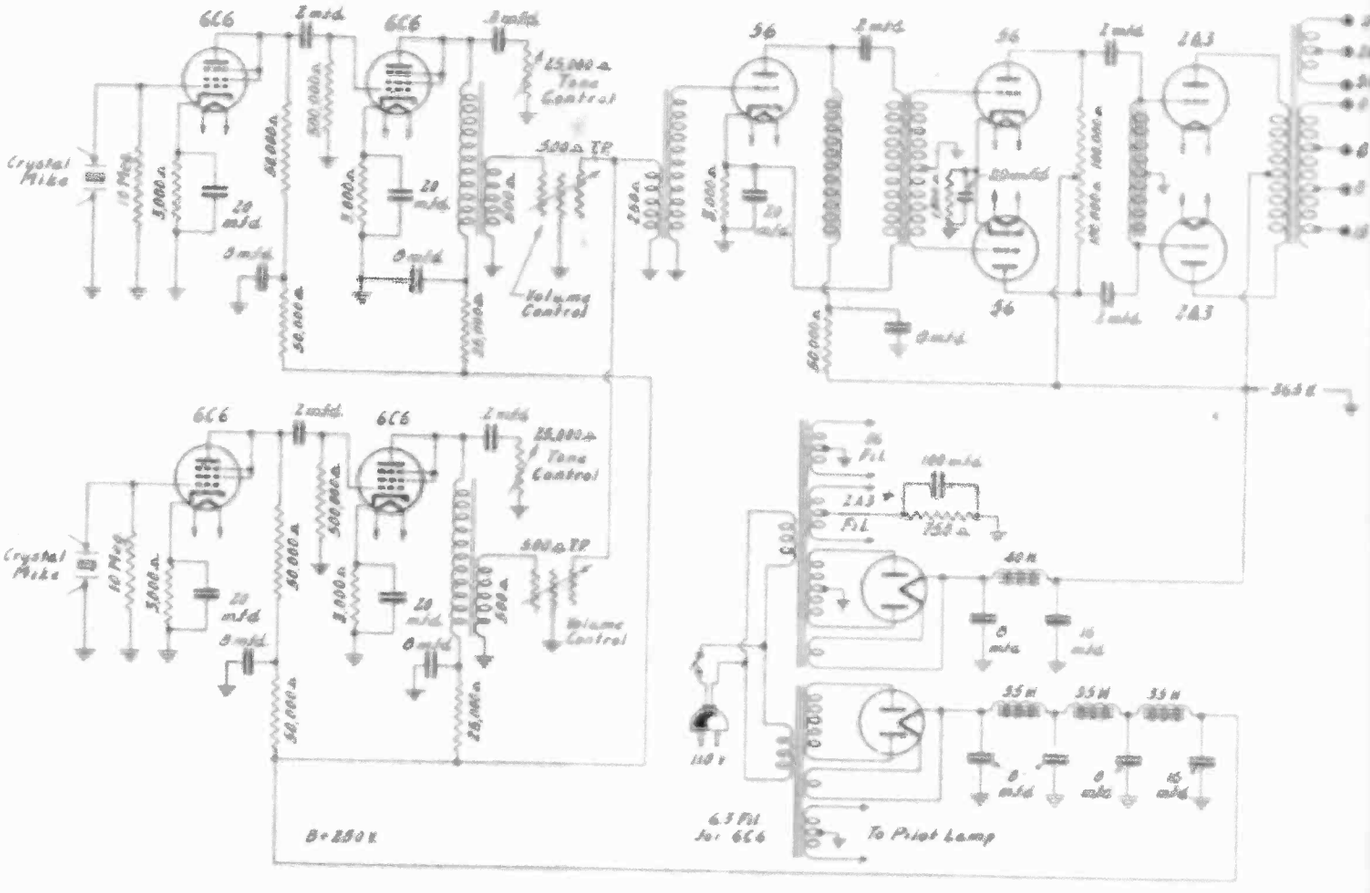
In operating this device, the phonograph pick-up is used in the ordinary manner by introducing its needle into the start of the groove of a rotating record. As indicated above, the output terminals of the phonograph adapter have been suitably connected to the antenna and ground posts of the receiver. The condenser of the oscillator circuit is then set at a point that produces the best results, the tuning system of the receiver resonating to this frequency. Since only frequency is necessary for the carrier, this device may be constructed so that it does not need any adjustment whatever, its carrier frequency being fixed by a fixed tank circuit. Thus, we have a very inexpensive device that should out-perform the ordinary radio-phonograph combinations, since greater amplification is available and greater ease of installation is involved in certain instances.

If a band-pass circuit of suitable width is used, as by tuning primary somewhat "off" from secondary, a fixed setting will enable choice of receiver frequency, say, from 1,350 to 1,500 kc, an unobstructed channel selected.

# A 15-WATT DE LUX

## Expert Reveals Technique

By Har
Harve




TOP-NOTCH power amplifiers have the distinction of winning the acclaim even of those who have to pay for them, not to mention the audience whose enjoyment of an occasion is enhanced by the needed extra sound level anywhere in a hall, auditorium, theatre or field. Instrumental musicians and singers appreciate the aid they get and credit redounds to them. It is a pleasurable experience all the way 'round.

Having spent years in power amplifier work, assisted by Louis G. Passavanti, and having gone to various parts of the country to make the installations, produced at a single base, it is my privilege to present some details of an excellent power amplifier that, in general, will be satisfactory for an audience of 5,000 persons. For smaller audiences the same outfit may be used, of course, with such attenuation as desired. If the acoustical conditions are bad, the 5,000 figure would have to be toned down. However, the amplifier upholds its own reputation, and has an output of 15 watts.

**Sampson's power amplifier, with microphone pre-amplifiers for crystal type input. Careful adherence to matching of impedances, to bypassing and filtration, plus use of transformers of extraordinary quality, make this an outstanding power amplifier. It is the result of two years developmental work and field experience.**

### Best Tone Quality

The quality of the reproduction must be of the best, and to make this possible the parts, particularly the audio transformers, must be exceptional, and this requirement puts them out of the low-price class entirely.

The first audio transformers observed in the diagram are the two related to the amplifiers following the microphones. For each microphone there is a separate amplifier, so in the diagram we account for two microphones, and these are of the crystal type. These the author uses extensively, but it is practical of course to use the condenser type microphone, without circuit changes, or a carbon microphone could be used with a microphone transformer at the input and the usual battery excitation.

It can be seen that the microphone amplifiers are identical and consist of a two-stage triode channel, the 6C6 tube having screen and suppressor tied to plate to constitute the triode, while the output of the pre-amplifier, becoming the input to the main amplifier, is coupled through a matching transformer, associated with which is a T pad. The secondary of the matching transformer has an impedance of 500 ohms, the T pad has a constant 500-ohm value, and since these two are in parallel, the feed is to a 250-ohm primary of the transformer coupling into the 56 driver of the main amplifier.

### Setting Microphone Levels

Associated with the plate circuit of the pre-amplifier is a tone control, while the T pad is the volume control, and of course each microphone amplifier output may be set to a pre-selected level. In fact, in this way one of the microphones may be eliminated from actual service, although the system is so constituted as to permit immediate entry of the silenced microphone into service, since the amplifier remains operative.

One B supply serves the microphone amplifiers, and since the B current drain

# POWER AMPLIFIER

## That Develops Finest Tone

*Sampson*
*dio Shop*

### LIST OF PARTS

#### Coils

Two audio transformers with 500-ohm impedance secondaries.
One single-sided input transformer with 250-ohm primary.
One audio B choke for plate circuit of 56.
One push-pull input transformer.
One center-tapped audio choke coil for grid circuits of output tubes.
One output transformer, impedance of primary for 2A3 push-pull self-bias operation; two secondaries, one tapped for 4, 8 and 15 ohms; other for 200 and 500 ohms.
Two power transformers; one for the pre-amplifier B supply; other for the main amplifier B supply.

#### Condensers

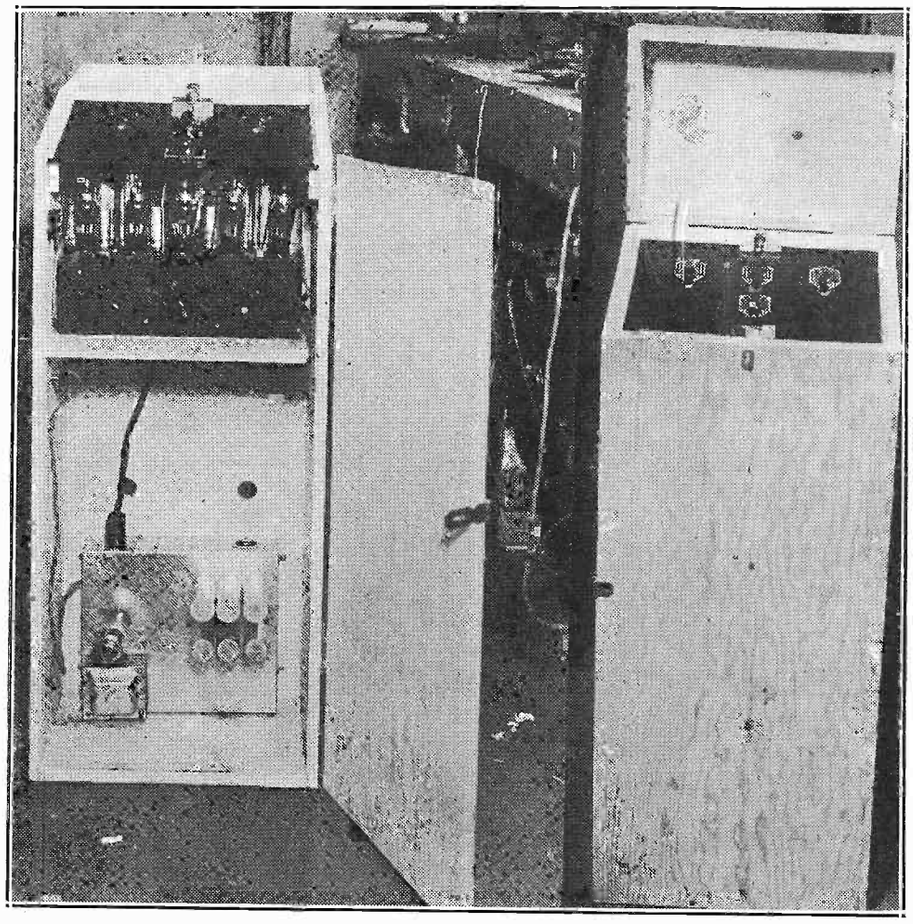
Six 20 mfd. electrolytic condensers, 20 volts rating.
Six 8 mfd. electrolytic condensers, 500 volts rating.
Two 8 mfd. paper condensers, 600 volts rating.
Two 16 mfd. electrolytic condensers, or four 8's, pairs in parallel.
One 100 mfd. electrolytic condenser, 100 volts rating.
Seven 0.2 mfd. paper condensers, 300 volts rating.

#### Resistors

One 750 ohm, 10 watt resistor.
Five 3,000 ohm resistors.
One 1,500 ohm resistor.
Two 25,000 ohm resistors.
Four 50,000 ohm resistors.
Two 100,000 ohm resistors.
Two 500,000 ohm resistors.
Two 10 meg. resistors.
Two 25,000 ohm rheostats, or potentiometers used as rheostats.
Two 500 ohm T pads.

#### Other Requirements

Eleven sockets: four four-hole; three five-hole; four six-hole.
Two crystal microphones.
Speakers.
Four grid clips.
One a-c cable and cord.
One a-c switch.
Eleven tubes: two 2A3, two 80, three 56, four 6C6.



**At left is a view of the wood cabinet housing the microphone amplifiers and their B supply, while at right the view is shown with the door closed and panel clearly revealed. This particular set-up was for three-microphone service.**

is moderate, of course more microphone amplifiers may be used with the same power supply. It so happens that the photographic illustrations deal with a three-microphone system. The choice of the number of microphones will depend on the extensiveness of the service to be rendered, but as a general rule two microphones will be found sufficient, especially as offering the opportunity of a singer being some distance from an orchestra, with each served by a microphone, and each microphone adjusted on the basis of careful and watchful monitoring.

It is not necessary that the microphones actually be close to their amplifiers, for by the use of low-impedance cable the distance between microphone and amplifier input may be considerable, and it simplifies some problems to maintain a respectable distance between the two, and between the main amplifier and the microphones.

### Avoidance of Reaction

The main amplifier consists of the 56 preliminary stage working into the push-pull driver stage that feeds the 2A3 output tubes. The grained wooden cabinet as shown in two photographs houses the microphone amplifiers (top) and their power supply (bottom). The most acceptable position for the B supply chassis is plainly evident, for by this angulation reaction between the two is avoided.

Also, the main amplifier has its own power supply, and this combination is housed in a rack and panel assembly, as shown in the third illustration. Microphones that need no pre-amplification may be connected to the main amplifier by transformer coupling, and excited independently by a small battery, and to illustrate the idea of this possibility a carbon microphone is shown next to the main amplifier cabinet.

The output of the main amplifier may be to one speaker or numerous speakers, as well as to a monitor consisting of simple earphone connection. The microphone levels may be set on the basis of listening at this point. Since the output transformer is built into the main amplifier, to be certain that only the best quality of transformer will be in service, the selection of taps from the secondaries depends on the voice coil impedance of the dynamic speaker or speakers used, or on the terminating impedance at the speaker

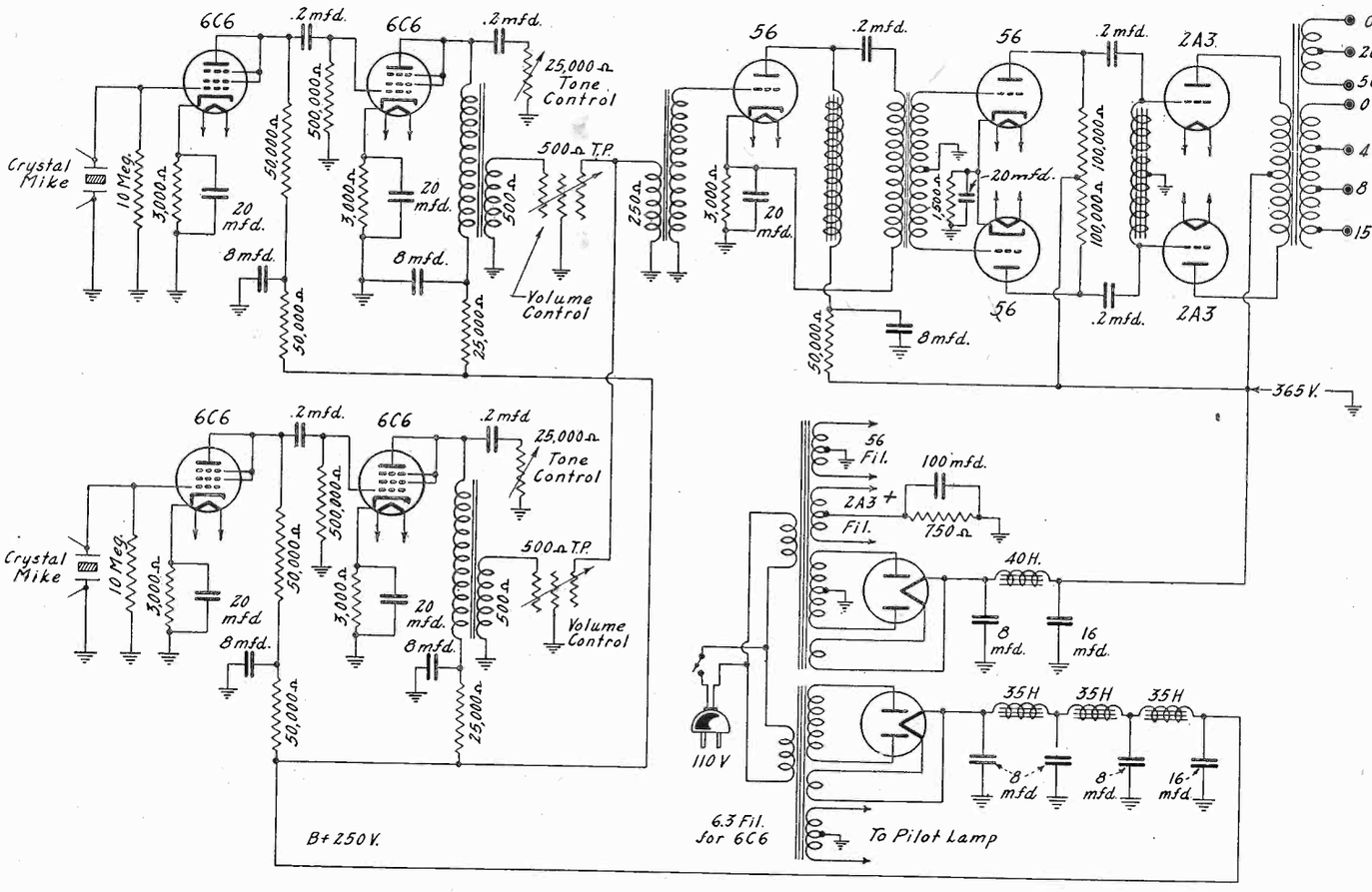
*(Continued on next page)*

# A 15-WATT DE LUX

## Expert Reveals Technique

*By Har*

*Harve*

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### Best Tone Quality

The quality of the reproduction must be of the best, and to make this possible

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# POWER AMPLIFIER

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One 750 ohm, 10 watt resistor.
Five 3,000 ohm resistors.
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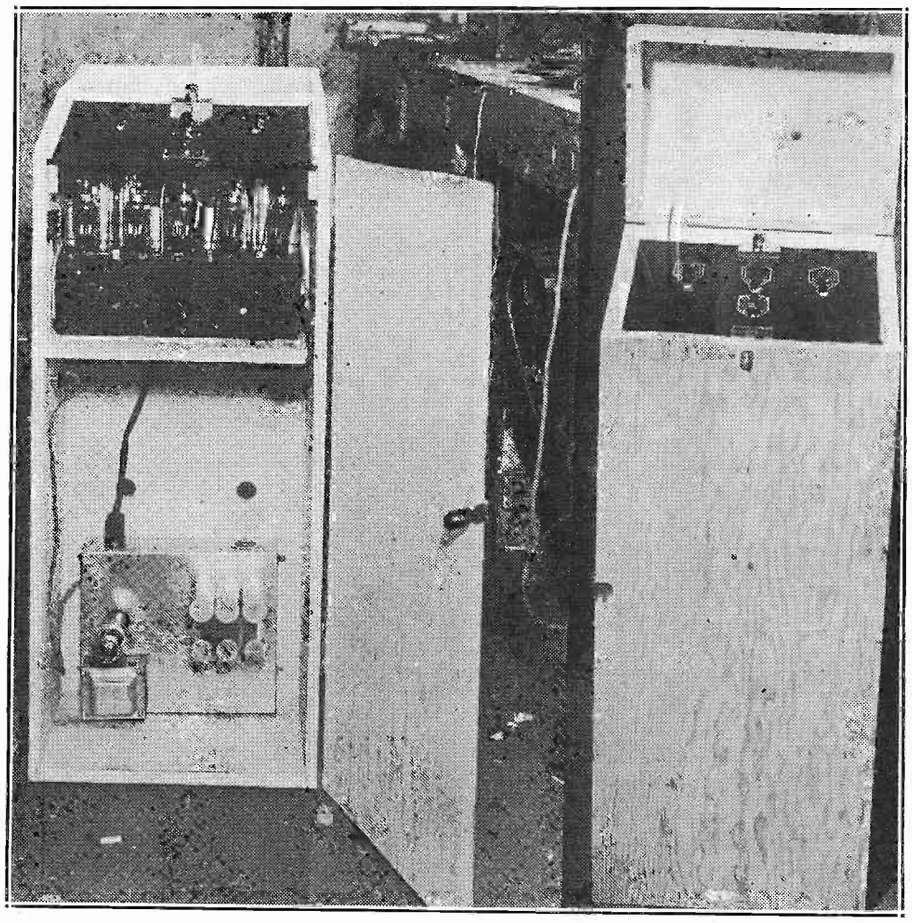

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# A 15-WATT DE LUX

## Expert Reveals Technique

*By Har*

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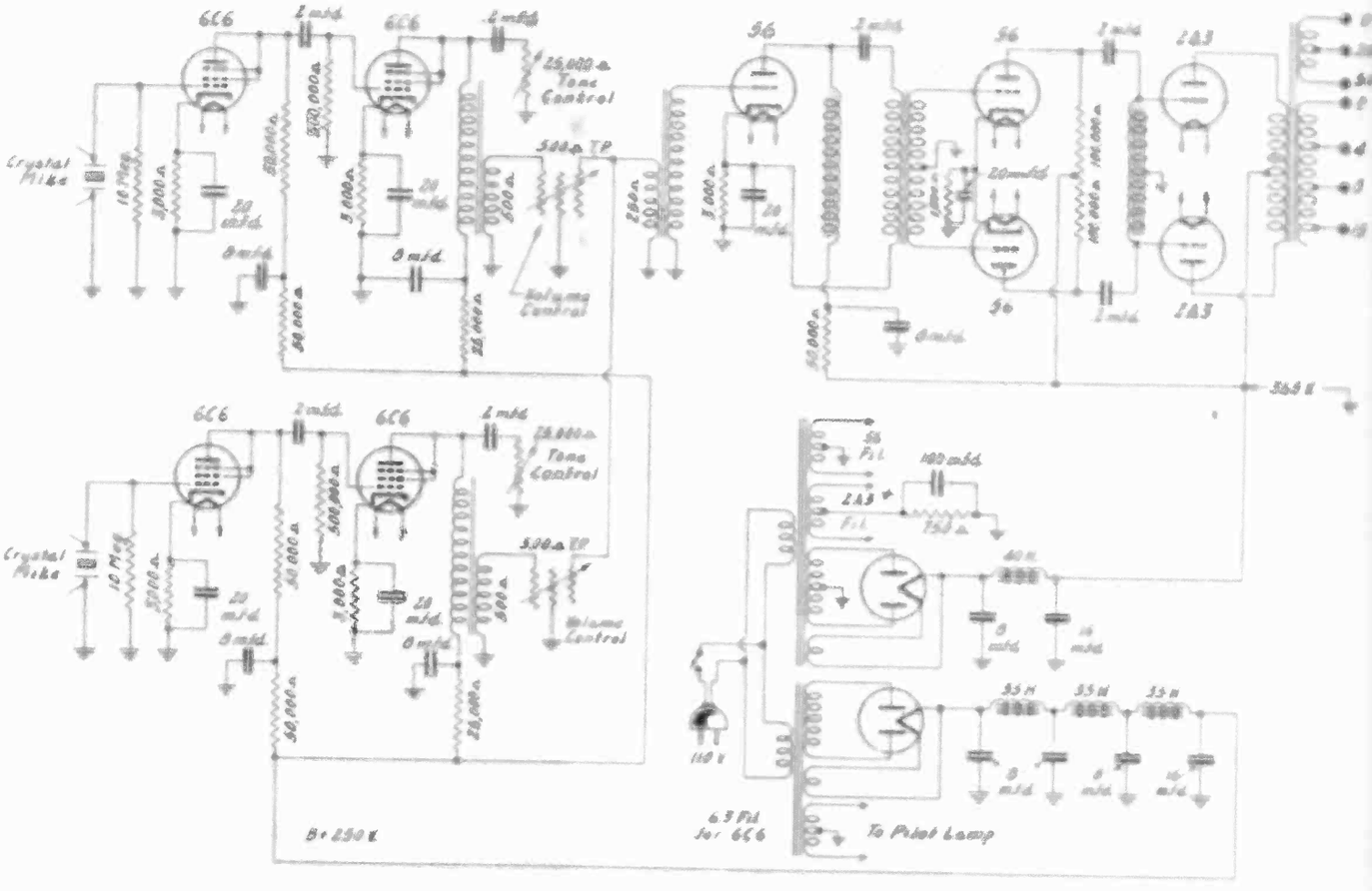


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## That Develops Finest Tone

*Sampson*
*dio Shop*

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#### Coils

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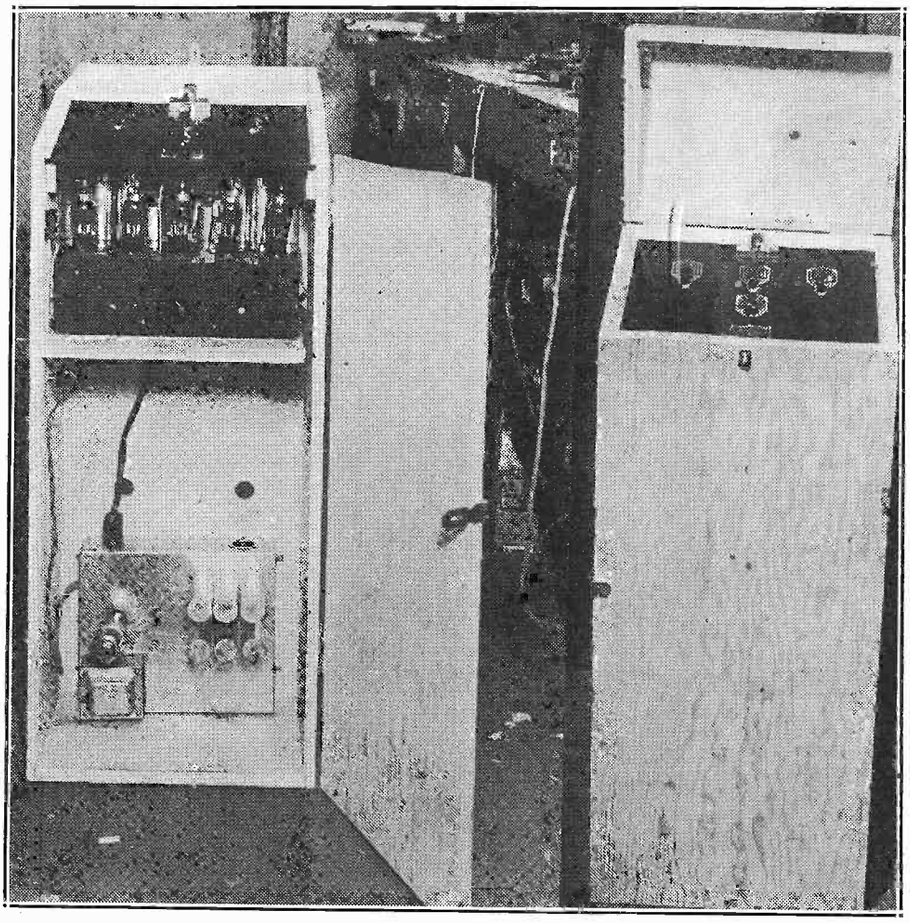

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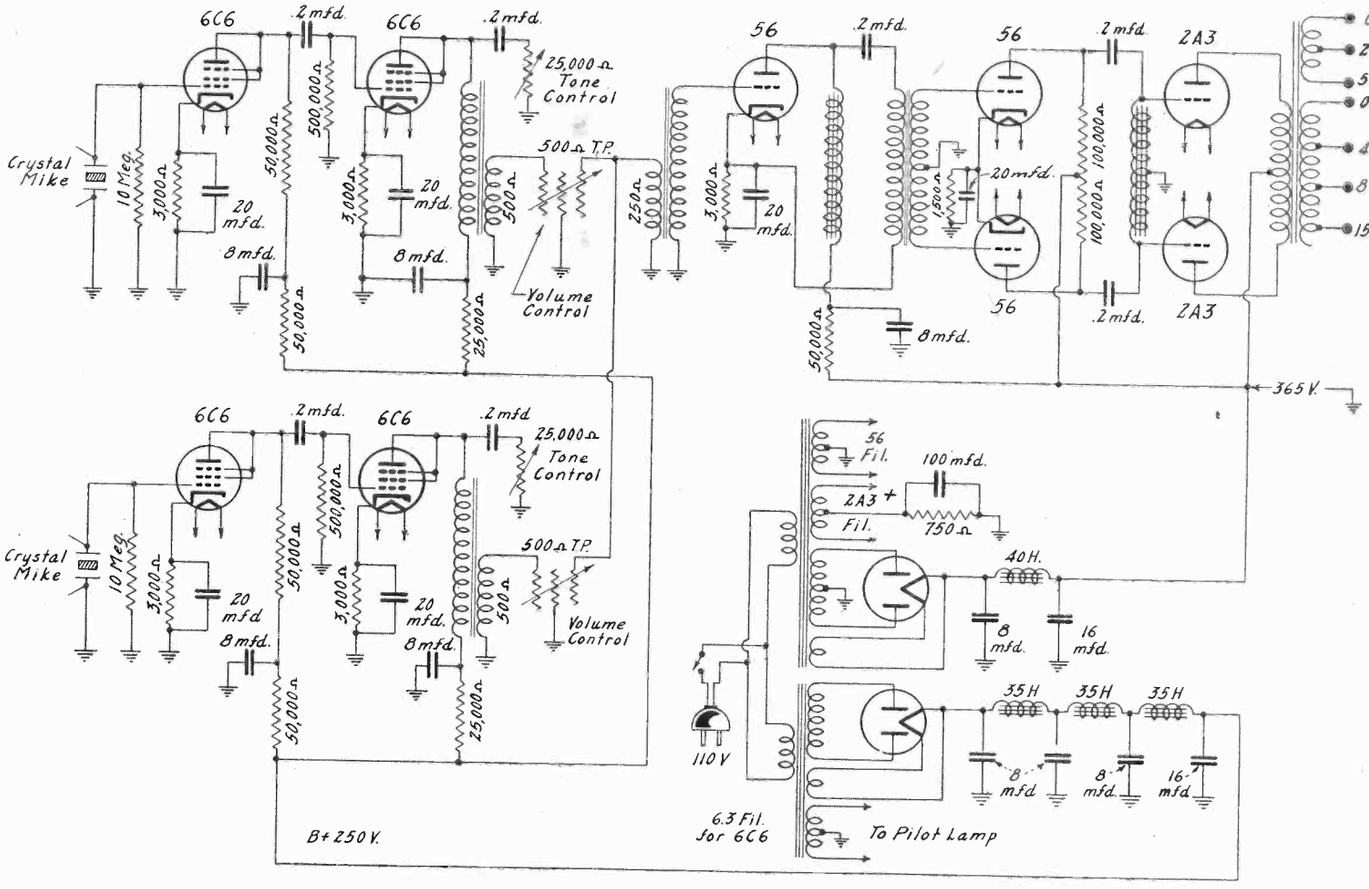
*Harve*




TOP-NOTCH power amplifiers have the distinction of winning the acclaim even of those who have to pay for them, not to mention the audience whose enjoyment of an occasion is enhanced by the needed extra sound level anywhere in a hall, auditorium, theatre or field. Instrumental musicians and singers appreciate the aid they get and credit redounds to them. It is a pleasurable experience all the way 'round.

Having spent years in power amplifier work, assisted by Louis G. Passavanti, and having gone to various parts of the country to make the installations, produced at a single base, it is my privilege to present some details of an excellent power amplifier that, in general, will be satisfactory for an audience of 5,000 persons. For smaller audiences the same outfit may be used, of course, with such attenuation as desired. If the acoustical conditions are bad, the 5,000 figure would have to be toned down. However, the amplifier upholds its own reputation, and has an output of 15 watts.

### Best Tone Quality

The quality of the reproduction must be of the best, and to make this possible

**Sampson's power amplifier, with microphone pre-amplifiers for crystal type input. Careful adherence to matching of impedances, to bypassing and filtration, plus use of transformers of extraordinary quality, make this an outstanding power amplifier. It is the result of two years developmental work and field experience.**

the parts, particularly the audio transformers, must be exceptional, and this requirement puts them out of the low-price class entirely.

The first audio transformers observed in the diagram are the two related to the amplifiers following the microphones. For each microphone there is a separate amplifier, so in the diagram we account for two microphones, and these are of the crystal type. These the author uses extensively, but it is practical of course to use the condenser type microphone, without circuit changes, or a carbon microphone could be used with a microphone transformer at the input and the usual battery excitation.

It can be seen that the microphone am plifiers are identical and consist of a two stage triode channel, the 6C6 tube havin screen and suppressor tied to plate t constitute the triode, while the output o the pre-amplifier, becoming the input t the main amplifier, is coupled through matching transformer, associated wit which is a T pad. The secondary of th matching transformer has an impedanc of 500 ohms, the T pad has a constan 500-ohm value, and since these two are i parallel, the feed is to a 250-ohm primar of the transformer coupling into the 5 driver of the main amplifier.

### Setting Microphone Levels

Associated with the plate circuit of th pre-amplifier is a tone control, while th T pad is the volume control, and of cours each microphone amplifier output may b set to a pre-selected level. In fact, i this way one of the microphones may b eliminated from actual service, althoug the system is so constituted as to permi immediate entry of the silenced micro phone into service, since the amplifier re mains operative.

One B supply serves the microphone amplifiers, and since the B current drain

# POWER AMPLIFIER

## That Develops Finest Tone

*Sampson*
*dio Shop*

### LIST OF PARTS

#### Coils

Two audio transformers with 500-ohm impedance secondaries.
One single-sided input transformer with 250-ohm primary.
One audio B choke for plate circuit of 56.
One push-pull input transformer.
One center-tapped audio choke coil for grid circuits of output tubes.
One output transformer, impedance of primary for 2A3 push-pull self-bias operation; two secondaries, one tapped for 4, 8 and 15 ohms; other for 200 and 500 ohms.
Two power transformers; one for the pre-amplifier B supply; other for the main amplifier B supply.

#### Condensers

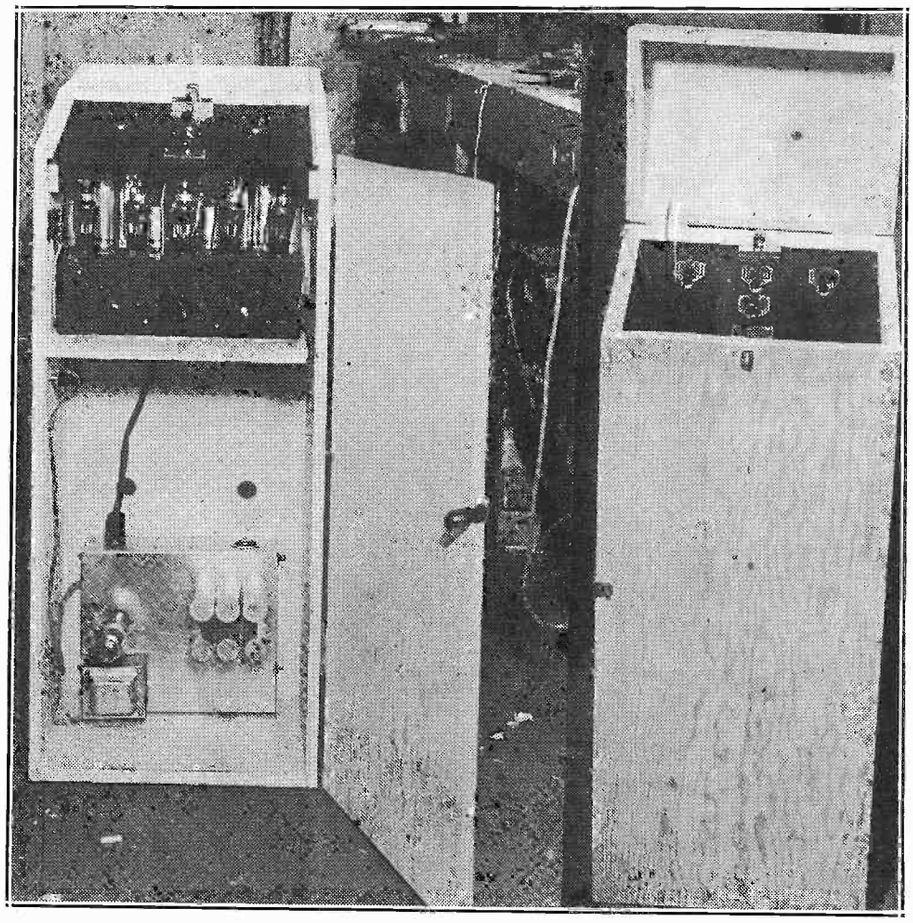
Six 20 mfd. electrolytic condensers, 20 volts rating.
Six 8 mfd. electrolytic condensers, 500 volts rating.
Two 8 mfd. paper condensers, 600 volts rating.
Two 16 mfd. electrolytic condensers, or four 8's, pairs in parallel.
One 100 mfd. electrolytic condenser, 100 volts rating.
Seven 0.2 mfd. paper condensers, 300 volts rating.

#### Resistors

One 750 ohm, 10 watt resistor.
Five 3,000 ohm resistors.
One 1,500 ohm resistor.
Two 25,000 ohm resistors.
Four 50,000 ohm resistors.
Two 100,000 ohm resistors.
Two 500,000 ohm resistors.
Two 10 meg. resistors.
Two 25,000 ohm rheostats, or potentiometers used as rheostats.
Two 500 ohm T pads.

#### Other Requirements

Eleven sockets: four four-hole; three five-hole; four six-hole.
Two crystal microphones.
Speakers.
Four grid clips.
One a-c cable and cord.
One a-c switch.
Eleven tubes: two 2A3, two 80, three 56, four 6C6.



**At left is a view of the wood cabinet housing the microphone amplifiers and their B supply, while at right the view is shown with the door closed and panel clearly revealed. This particular set-up was for three-microphone service.**

is moderate, of course more microphone amplifiers may be used with the same power supply. It so happens that the photographic illustrations deal with a three-microphone system. The choice of the number of microphones will depend on the extensiveness of the service to be rendered, but as a general rule two microphones will be found sufficient, especially as offering the opportunity of a singer being some distance from an orchestra, with each served by a microphone, and each microphone adjusted on the basis of careful and watchful monitoring.

It is not necessary that the microphones actually be close to their amplifiers, for by the use of low-impedance cable the distance between microphone and amplifier input may be considerable, and it simplifies some problems to maintain a respectable distance between the two, and between the main amplifier and the microphones.

### Avoidance of Reaction

The main amplifier consists of the 56 preliminary stage working into the push-pull driver stage that feeds the 2A3 output tubes. The grained wooden cabinet as shown in two photographs houses the microphone amplifiers (top) and their power supply (bottom). The most acceptable position for the B supply chassis is plainly evident, for by this angulation reaction between the two is avoided.

Also, the main amplifier has its own power supply, and this combination is housed in a rack and panel assembly, as shown in the third illustration. Microphones that need no pre-amplification may be connected to the main amplifier by transformer coupling, and excited independently by a small battery, and to illustrate the idea of this possibility a carbon microphone is shown next to the main amplifier cabinet.

The output of the main amplifier may be to one speaker or numerous speakers, as well as to a monitor consisting of simple earphone connection. The microphone levels may be set on the basis of listening at this point. Since the output transformer is built into the main amplifier, to be certain that only the best quality of transformer will be in service, the selection of taps from the secondaries depends on the voice coil impedance of the dynamic speaker or speakers used, or on the terminating impedance at the speaker

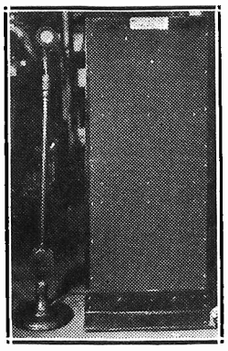
(*Continued on next page*)

(*Continued from preceding page*)
end when a transmission line is used. So, voice coil impedance of 4, 8 and 15 ohms are designated, and this range of selection takes care of the majority of speakers, and by selection of speakers will accommodate any that may be used. For transmission line impedances, two choices are offered, 200 and 500 ohms. These also will be satisfactory, particularly as 500-ohm lines are popular, and also because the terminating impedance at the speaker may be selected.

### Separately Cored Chokes

The importance of matching impedances is striking in audio practice, the object being of course to conduct the electrical vibrations from source to destination without loss. With matched impedances and proper cabling the loss is negligible. With mismatched impedances the loss is serious and the attrition of tone likewise.

In the interest of best tone and also sustenance of power output capabilities the B supplies for the main amplifier and pre-amplifier must be excellently filtered. The capacities next to the rectifiers, for both B supplies, are paper condensers for safety. The rest are electrolytics. Since both B supplies are shown in the diagram as being adjacent—although the physical separation will be realized to exist—it may be well to observe that there are three chokes in the microphone-amplifier B supply (lower right). These are on separate cores. Also there are four condensers, the reservoir condenser being 16 mfd. The reason for such extremely careful filtration is that whatever is put into the pre-amplifier is subject to intense amplification, and if some hum is included in the input, the hum is amplified practically as well as the program, since the overall amplifier has a characteristic practically flat from 60 cycles to 8,000 cycles.



**In this shield cabinet, of rack and panel interior construction, are housed the main amplifier and its separate B supply, also the exciter for the fields of whatever dynamic speakers would be used. Even clients who want as many as a dozen speakers could be accommodated, using this amplifier.**

A makeshift resort when trouble from hum arises is to use small capacity to bypass biasing resistors, because then for the low frequencies the negative feedback remains high enough practically to prevent gain at those frequencies, the hum period being among them. Here, however, we find large, indeed extremely large, bypass capacities, 20 mfd. generally, and in the example of the output stage, 100 mfd. Therefore any tone-quality amplifier such as this must have splendid filtration.

In the push-pull stages, of which there are two, there might be no absolute need of the bypassing, since if each such stage is truly push-pull it is symmetrical, and therefore the signal current in one direction through the biasing resistor is oppositely equal to the signal current in the other direction, due to the respective tubes of a stage operating oppositely. While the state of balance has been attained in the main amplifier where the push-pull circuits are found, the users of such devices as power amplifiers naturally depend on continuity of excellent performance. If the bypass condensers are included, as shown, should one of the push-pull tubes go dead, the other will function well, and though the power output will be less, the tone will be preserved, for a single-sided circuit requires the bypass condenser. Therefore the capacity is included as a precaution against discontinuity due to tube trouble, something over which the constructor or purchaser has no immediate control. And if the capacity is large the presence of the condenser is never a deterrent.

### Speakers

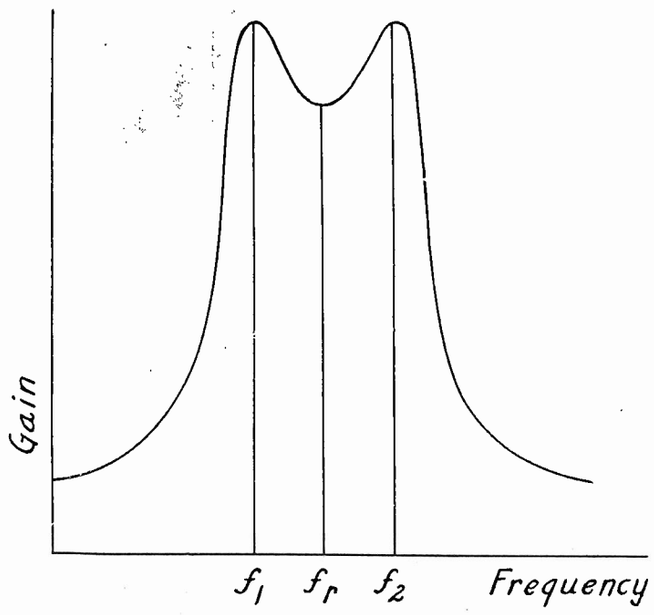
As for the speakers, since these will be dynamics it is well to have a separate exciter for their fields. This is practically necessary so that the regulation of the supply of the main amplifier or even pre-amplifier remain good. Besides, resort to extremely high voltages or currents is avoided. Another consideration is that the number of speakers may be different.

The main amplifier housing also contains the exciter for speakers, not diagramed because it is a conventional B supply. Speakers are connected with fields in series across 250 volts, so that the drop across each field is 125 volts, and where more than two speakers are to be used their quantity is four, six, eight etc., each two in series, each pair in parallel. The voice coils themselves are hooked up in series or in parallel to meet matching requirements, and connection made to the output transformer tap accordingly.

# Oscillograph Shows Gain and Selectivity

When two coils are coupled together inductively there will appear two resonance peaks at certain degrees of coupling which tend to become one peak if the coupling is loosened and which tend to cause the two peaks to separate a greater distance if the coupling is tightened. In this manner, the width of the selectivity curve of a coupled circuit may be readily controlled by means of variation in the degree of coupling. But it was the practice in the old days that if the resonance or selectivity curve was desired that it be obtained gradually by many readings which were then plotted upon a sheet of graph paper to result in the desired curve. If any changes were to be made in the coupling, this procedure would have to be repeated. Nowadays, the tedium of this process has been removed. By means of a cathode ray oscillograph, the curve would be represented on the fluorescent screen of the tube immediately that the appropriate voltages were set up across the circuit. Thus, the effect of changes in coupling could be rendered visible immediately that the change was effected, and also amplitude observed. Obviously, this is a valuable asset since one need no longer guess as to the effect of various changes. One could vary coupling to the point that he desired as indicated on the screen of the oscillograph.

**When suitably connected up, the oscillograph will show on its fluorescent screen a vivid picture similar to the sketch that will vary according to changes made in the hook-up immediately that they occur.**




## Hammarlund Issues New Catalogue, No. 35

Hammarlund Manufacturing Company has just issued its new catalog, number 35. Its usual line of condensers and coils is depicted in addition to several new items. Prominent among the new features are:

Type I BT trimming condenser using isolantite for insulation. The capacity ranges of this type of padder are 10-70 mmfd., 70-140 mmfd., 140-220 mmfd.

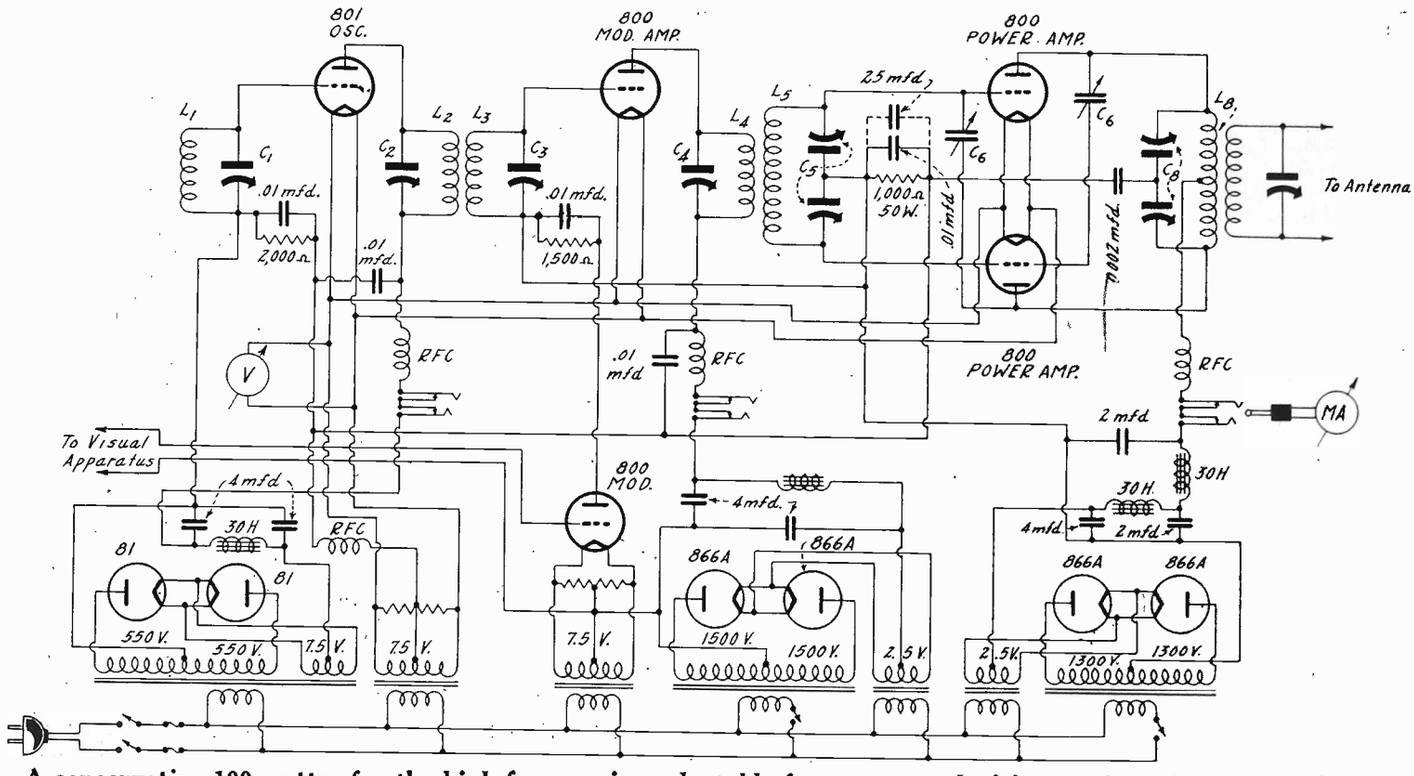
Type MEX midget equalizer using isolantite base and mica dielectric and phosphor bronze plates, a unique specialty. Type T and ST i-f transformers lattice wound with Litz wire for intermediate frequencies of 175 kc and 465 kc.

Type SWF plug-in coil forms of the new low-loss insulation XP-53.

# A Television Transmitter

## Suitable for 6-to-7 Meter Experimental Band, Also for Amateur Frequencies

*By Joseph M. Neusel*




**A conservative 100 watter for the high frequencies, adaptable for use at a television station. It may also be used for amateur purposes by having appropriate tank coils and condensers.**

TELEVISION has been noised about for a good many years and the patience of a good many persons has been tried. It was always said that "television is around the corner," but these seers failed to see that the depression also was an obstacle to vision. Thus have we awaited the debut of quality television without satisfaction. It is doubtless true that the depression served to retard television's introduction, but now that prosperity seems nearer television activities are once more coming into the open. And the discoveries of the dark days of 1930-1934 that have been made behind tightly-sealed doors show that we are really going to witness practical television some time not disappointingly remote.

Because we are soon to see such renewed activity in this field we have attempted a design for a television transmitter that is capable of operation on the high frequencies where such work will undoubtedly be carried on.

Among the frequencies that have been set aside for experimental television activities is the channel marked by 41,000 kc and it is proposed that this transmitter operate at this frequency. However, since this outfit could be made to operate on the amateur frequencies as well, the tank circuit constants are omitted so that they may be varied for the individual's particular purpose.

### Choice of Tubes

The high frequency of the carrier requires that tubes be used that are designed especially for this purpose with low input and output interelectrode capacitances. It is also a consideration that these frequencies exhibit the quasi-optical effect so that excess power becomes superfluous and wasteful. And so, in order that this transmitter be operative on these high frequencies with a power capability that is not wasteful yet is reliable, the 800 and 801 type of vacuum tubes have been chosen. It will be seen from the diagram that it is suggested that the 801 act as oscillator with an 800 in the modulated amplifier stage while two 800's in push-pull are the final power amplifier. It is interesting to note that the modulated amplifier stage makes use of the series modulation scheme, whereby two 800 tubes are connected in series across a common plate supply (modulator filament to negative high voltage, modulator plate tied to modulated amplifier filament, modulated amplifier plate to positive high voltage). In this way, any changes in the modulator grid circuit affect the plate current of the modulated amplifier directly.

### Visual System

In order that the various stages be independent of each other as far as power supply is concerned, it has been found advisable to use three separate high voltage sources. The separate supply for the oscillator tends to promote frequency stability and minimizes drift caused by variation in voltage. The supply for the modulator and modulated amplifier stages necessarily is separate in order to allow for the series connection. And, of course, the power amplifier also requires power so that a third power supply is necessitated. Though this seems an expensive arrangement as far as power is concerned, its adoption carries the reward of stability and good performance.

A discussion of the visual apparatus is purposely omitted at this time, since the many schemes that have been evolved are still in process of development and possibly the apparatus involves unhatched or individual ideas. Fundamentally, at present, there are the cathode ray and the Nipkow disc schemes, each of which has its individual advantages and each of which has its ardent proponents. In such a state it is not easy to recommend either video-frequency scheme until the full aspects of each are conclusive. At this early stage unknown advantages residing in either scheme require that we leave to the individual the exercise of his own choice of a vision system.

### What the Effect Is

In listening to the output of a radio receiver, especially since the advent of the wider use of the superheterodyne circuit, one hears many queer effects for which he did not bargain. He hears the disturbing spasms of natural static and its not unrelated brother, man-made disturbances. The maliciousness of fading and the interspersed cross-talk from the next channel have also served to prevent the perfect performance of a radio receiver. During the last half year or so, a new disturbance has been named; at least, it has always existed but it was considered as combined with other forms of interference. However this brand of ex-

(*Continued on next page*)

# Demonstration on 9 Centimeters

## Dr. Irving Wolff Thrills 1,800 with Micro-Wave "Tricks"

*By Herman Berman*

TRANSMISSION and reception on a 9 centimeter wave was demonstrated recently to 1,800 service men at a meeting in the main ballroom of the Hotel Pennsylvania, New York City, by Dr. Irving Wolff, research engineer of the RCA-Victor Company. Dr. Wolff set up a transmitter with parabolic reflector to beam the 3.6233-inch wave, and picked up the transmission on a receiver about 50 feet across the room. The receiving end consisted of another parabola for collection, the feed being to an iron-pyrites crystal, which delivered the rectified voltage to an audio amplifier that actuated a reproducer.

The modulation consisted of phonograph music. At first plate-circuit modulation was demonstrated. This worked fairly well, but, as Dr. Wolff had warned in a talk preceding the demonstration, there was frequency modulation as well as amplitude modulation. A 1-to-1 transformer was used to couple the pickup's output to the secondary in series with the plate, this changing the plate current and voltage at the music frequencies. Rotation of either the transmitting or receiving parabola outside the path of the beam stopped the reception, and it was noticed that with plate modulation partial stoppage was accompanied by choking.

### Better Modulation

Another form of modulation demonstrated was the illumination of a large gas-filled, corrugated glass tubing. The output from the transmitter struck the gas-tube that was in the wave path and the ionization was controlled by the modulation. The gas used was mercury type, although other gases had been tried, like neon helium and argon, in the RCA laboratories, with similar success. The ionization modulation was far superior, and the stoppage of reception when either parabola was moved outside the field, or the ignition of the gas-filled tube extinguished by removal of the separate excitation voltage, was clean and abrupt. There was no fringe choking, and also the quality of the reproduction was superior.

Besides the actual demonstration of the micro-wave generation and reception, reflections were successfully controlled. In one instance Dr. Wolff interrupted the beam with a conductive platter, carefully working his way to the critical point that resulted in cessation of reception. The reflection influences also showed up the more definitive results of ionization modulation. Then the demonstrator moved toward the back of the room, and the two parabolas were pointed in the general direction of his upraised platter. He found the focal point at which best reflection took place on this V-pattern of direction and won rounds of applause. Then he used the rear wall of the room alone as the reflecting service, with somewhat less convincing results, possibly because there was no continuous plane for reflection, curtains at the rear being variously drawn or wide open, as preparations were being made for demonstrations of other interesting radio and allied devices.

### Rider is Master of Ceremonies

The meeting was under the joint auspices of Wholesale Radio Service Company and RCA-Victor Company, in celebration of an exclusive mail-order jobbing franchise taken by Wholesale for RCA parts. John F. Rider, radio engineer whose manuals are the standby of service men, was master of ceremonies.

In opening his remarks Dr. Wolff said that the shortest wave propagated was 1 centimeter long (less than half an inch), achieved by Prof. Williams of the University of Michigan. The generation of this 30,000 mgc frequency was an experimental feat, said the speaker, remarking that the shortest wave to which any commercial use had been applied was 18 centimeters long, as exemplified in the two-way transmission across the English channel. The 9-centimeter experiment therefore falls short of present commercial use, but the region is being explored, he stated in answer to a question later, so that knowledge can be built up respecting all the frequencies on which radiation of radio waves is possible.

"Negative resistance is needed for oscillation purposes," said the speaker, and cited the example of the feedback circuit of familiar practice, where some of the plate-circuit voltage is fed back to the grid circuit to reinforce the grid circuit and thus create the negative resistance characteristic, whereby as the current decreases as the voltage increases. He remarked that a limitation existed in regard to ordinary radio tubes, in that it was found that use of the negative resistance characteristic was limited by frequency, and having attained a certain frequency representing the limit, it was impossible to create generation for higher frequencies without resort to other means. Then he cited the Barkhausen-Kurz oscillator, which uses an ordinary tube, usually of cylindrical elements, with a positive grid.

### Expediting Electrons

"While the negative resistance characteristic may be found to exist even beyond the limit of oscillation of ordinary tubes, using the feedback method," he said, "the electrons can not get across the grid to the plate fast enough, and so resort is had to the Barkhausen oscillator. When the acceleration is due to the positive potential on the grid we refer to the circuit as that of an electron oscillator. Approximately 40 centimeters is the limit of oscillation by this means, because as the potential is made more positive on the grid, the required power dissipation becomes greater than what the grid can stand and the heating becomes prohibitive."

He then described the next method for getting to higher frequencies, that is, the magnetron. This is a special tube in a magnetic field that bends the electrons. If this bending is so controlled that the electrons barely strike the plate, then the negative resistance characteristic is present, and oscillations become practical. The constants of inductance and capacity determine the frequency, rather than merely voltage as in the Barkhausen example.

The demonstration given later was of generation using the magnetron of the latest type, that is, with plates at the end, as it was found that the end-plate magnetron was more efficient. Also, the de-

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# *Odd Interference Noted by van der Pol*

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traneous noise has lately been segregated and given its own name of "Luxembourg effect."

The Luxembourg effect is not a result of lack of linearity or selectivity in a receiver. It has to do with the carrier of a signal that has been tuned in so that the wanted signal carries with it an unwanted signal. This effect is not recognizable at all locations nor at all times but when it does occur it has to be suffered, since it is a result of conditions that are not under human control. It has been theorized that this action between two waves is an occurrence that results from the non-linearity of the ionosphere.

A special study of this effect has been undertaken by B. van der Pol, Eindhoven, Holland. In this test, the transmitting station at Beromunster, Switzerland (100 kw, 556 kc) sent out its unmodulated carrier at specified intervals, while the trans- (150 kc, 230 kc), was sending out a modulated signal on its own carrier frequency of high percentage.

It will be noted from a map of this territory that these three points are located on an approximate straight line and that Eindhoven and Beromunster are at the ends, with Luxembourg in the center. If then the distant Beromunster transmitter on 556 kc is tuned in at Eindhoven, this unmodulated signal was found to have picked up the modulations of the Luxembourg transmitter (230 kc) so that the Luxembourg transmitter could be heard on a frequency that was 226 kc removed from it.

It was found that the quantitative aspects of this interference may be indicated as 8% modulation of the wanted carrier by the unwanted at an audio frequency of 100 cycles and a percentage of 1% at the audio frequency of 800 cycles. It has also been found that this effect was observable only at night and when the desired ground wave is too weak and the undesired station is not more than 100 miles away. The most recent tests have shown that the Luxembourg signal was observable on the carriers of the transmitting stations of Paris, Munich, Lyons, and Strasbourg. With the receiver in London, the effect was also noticeable on the carriers of Beromunster, Trieste, Breslan, etc. It seems that the effectiveness of this interference is greater, the longer the wavelength of the interfering stations.

vice of tilting the filament to an angle of five or six degrees, to enable larger output because of removal of interference with the desired stream, did not have to be used when the end-plate method was adopted and the magnetic field was of sufficient strength.

### 2.5 Watts Output

The output of the micro-wave generator that he demonstrated was 2.5 watts. A mitting station at Luxembourg, Germany questioner asked why the small power was used and Dr. Wolff answered that greater power would have been introduced if it were known how to accomplish this.

Even measurement of the power output was no easy matter, the speaker remarked, citing that three methods were utilized: (1) the decay of plate energy, since the direct current was less when the oscillation was present, and the effect could be compared by the cooling; (2) a pickup antenna 5 centimeters long, measurement being made of the amount of energy picked up as correlated to the energy of radiation; (3) using electric light bulbs, assuming that 1 watt would light a 1-watt bulb to normal brilliancy. Actually a 1-watt bulb was lit to more than normal brilliancy.

Parasitic oscillations proved present. For instance, a 9-centimeter transmission developed a parasitic wave of 50 centimeters. As the output of the oscillator tube (magnetron) was taken from a transmission line, also formed as a parabola, for proper beaming the plates were not directly tapped for takeoff, but a conductive strap was placed between the center of the parabola and the filament, which looked superifically like a short circuit, but the point represented a voltage node of the system, for 9 centimeters. For 50 centimeters the strap would have been a short circuit.

Reporting on the receiving system, he said that crystal detection proved superior. It was of course possible to use a tube for detection, since one was used for propagation, and although the sensitivity with the tube "was very much greater, the noise was very greatly much greater," said the speaker, laughingly, and the listeners laughed, too, because as service men, they have been hearing complaints about noisy reception, due to the ultra-sensitivity of some of the all-wave sets.

### Worked Up to 16 Miles

The 9-centimeter system has been tested up to a distance of 16 miles and found practical, using a beam. Reflections were noted 10 wavelengths across. The beam, therefore, is not strictly a beam, but the radiation is in the nature of cone-shaped, and this heightens the possibilities of interference, although the usual forms of interference are absent at these ultra frequencies, such as static. Line-of-sight transmission is used, hence visual obstructions result in absorptions. The energy dissipation in transmission was found, as expected, to vary inversely as the square of the distance, and the field strength to decline as the distance. When the field strength on occasion was found to drop seemingly less, the contradiction was ascribed to the zeal of the operators, who adjusted the crystal to maximum sensitivity, hence found a more sensitive point of contact and operation that gave an appearance of contradiction to the measurement, due to unequal conditions as bases of comparison.

C. A. Aiken, design engineer of RCA, told about apparatus that was exhibited on one side of the room, including a double doublet antenna, a beat frequency oscillator with amplifier flat from 30 cycles to 13,000 cycles; a cathode-ray oscillograph; a phonograph oscillator; an automatic graph recorder; a field intensity meter and a signal generator.

The beat oscillator enabled one to determine how good his ears were, how low in frequency and how high he could hear. The record-player, or phonograph oscillator, made a small power amplifier system out of a radio set, by enabling input from the external oscillator to the antenna post of the set, the oscillator modulated by the audio pulsations in the pickup field winding.

### Oscillograph Attractive

The cathode-ray oscillograph proved the most interesting of the side shows, since the alignment of a receiver could be made with it, one's voice "seen" on the fluorescent screen, besides measurement made of the harmonics of the voice; effects observed of change in magnetic coupling between primaries and secondaries, as well as by trimmer adjustment of such windings in intermediate transformers; and acoustic response of a radio set measured. Amateurs were interested also in the ability directly to measure percentage modulation.

Dr. Wolff, in his introdutctory remarks, said he would discuss the 9-centimeter experiment just as he would if addressing a gathering of radio engineers, remarking that service men are in general as familiar with radio parlance and practice, and know as much, if not more, than the engineers themselves. He must have been kidding his audience, as he stuck to irreducible simplicities, never once used the word "parameter," and used shorter words than in his address on the same topic to the Institute of Radio Engineers at its convention recently in Rochester, N. Y. However, E. M. Hartley, manager, RCA Parts Division, another speaker at the Hotel Pennsylvania gathering, bluntly told his listeners that the radio servicing business was up against the wall, estimated there were 100,000 persons trying to make a living out of servicing radio sets in this country, and stated there was room for only 50,000. As sets become more and more complicated, hence harder to service, the men who will be forced to drop out, he said, were those who were not best qualified to do the work, and one of the qualifications would be the possession of adequate equipment to make tests and measurements on the basis of which rapid and accurate repairs could be made.

### War On Racketeers

He read from a newspaper clipping headed, "San Antonio Traps Racketeers," and talked about Texas vigilantes who were determined to drive radio repair racketeers out of business, the type that charges inordinate amounts, particularly charging for material not supplied. He told of one trap laid for racketeers whereby a new set was carefully checked and tested by competent engineers and found to be in perfect condition. Then a plug was removed inside the receiver and the set was entrusted to a repair shop. The bill came in for "a tube, a condenser and a divider, and $1 for labor, total, $4.25."

The speaker emphasized the fact that a charge of $4.25 was reasonable and did not constitute racketeering, since the repair man had to call for the set and return it, requiring the use of a car; had to examine and test the set, and meet his usual obligations of rent, light, telephone, heat, insurance, payroll, tools, equipment, etc.

What constituted racketeering, said the speaker, was not the amount of the charge, but the itemization of the bill, whereby fictitious factors were introduced. If the charge had been $4.25 for labor and services, nothing for "new" parts, there could have been no just quarrel, he believed. Therefore he counseled service men to make a proper charge for the labor they performed.

He read one of the many letters that crossed his desk. This one came from a service man who reported his expenses and receipts, and found that he could repair properly about two sets a day, for 300 working days 600 sets a year, and that his expenses for, which were moderate, e.g., $20 a month for rent, $10 for telephone, $35 for salary drawn, totaled $2,800 a year. Had he to rely on this state of affairs alone for a living, the service man figured that at current rates he would lose $4 on each set he serviced, therefore recommended the flat-charge system, which in his case would be $4.66, plus whatever was deemed reasonable for profit, and thus "nobody would pay for more than he was getting and nobody would pay for less."

# Radio University

***ANSWERS to Questions of General Interest to Readers. Only Selected Questions Are Answered and Only by Publication in These Columns.***

### Fewer Parts, Better Results

IS IT POSSIBLE to achieve as good or better results with fewer parts than are customarily used in radio receivers? —V.C.S.

Yes, the new pentagrid converter tubes are a good example of this possibility. This tube combines the functions of first detector and oscillator that used to be performed by two tubes before its introduction. Thus, by the use of this type of tube to replace the two tubes formerly used, one tube and its associated equipment is not required which is a decided saving. Further, the use of this tube concentrates two circuits within one tube envelope which tends to minimize external fields so that interference is minimized from this cause and also simpler circuits are utilizable that are free from the effects of variation in oscillator voltage. Accordingly, we have achieved fewer parts, which paradoxically enough, give better results.

* * *

### Boosting the Lows

WILL YOU please state the technical details of method of loading the speaker for improved low-note response?—E. L.

It has been a long accepted principle of acoustics that the efficiency of the loudspeaker in a radio set in the low frequency region can be improved by using an acoustic filter to load the speaker at the low frequencies. Such an acoustic labyrinth has been recently introduced by the manufacturer of a high fidelity receiver and this principle is thus actually being applied for the first time in a production radio receiver. This particular set utilizes a high fidelity circuit with two loudspeakers of the dynamic type, one for the highs and the other for the lows. The sound energy is divided between these two speakers by means of a simple network of fixed condensers and air core coil that causes the limits of 60-2,500 cycles to be impressed on the low frequency speaker and the limits of 2,500-10,000 cycles per second to be impressed upon the high frequency speaker. As has been mentioned, the low frequency speaker's response is enhanced by the addition of an acoustic labyrinth which is built into the console of the receiver. The construction of this acoustic filter is such that its calculated length causes its fundamental resonance to occur in the frequency range where the efficiency of the cabinet as a baffle begins to fall off. Thus, the labyrinth serves to extend the low frequency limit below that made possible through the cabinet alone.

* * *

### The 801 Tube

WILL YOU PLEASE give some data on the 801 transmitter tube?—M.K.K.

This is a three-electrode transmitting tube that is well suited for the high radio frequencies. The internal structure of the tube together with its use of a ceramic base, allows its operation at full rating at frequencies as high as 60 megacycles. When used as an oscillator, its maximum power ratings are:

| | |
|---|---|
| D-C plate voltage | = 600 volts |
| D-C plate current | = 70 milliamperes |
| Plate dissipation | = 20 watts |
| Filament voltage | = 7.5 volts |
| Filament current | = 1.25 amperes |

### Readers, What Do You Want?

Are you a serviceman, amateur or commercial operator, home constructor, engineer, short-wave fan, radio dealer, educator, or what? Drop a line—even a postal card—to our Editorial Department, and tell us some particular topics you'd like to see printed in detail.

We are here to serve.

The Editor,
RADIO WORLD,
145 West 45th St., New York City.

This tube is indicated in a tuned-plate tuned-grid circuit which should be capable of sufficient stability if the ordinary precautions are taken. Should oscillation fail to occur, it may be started by parallelling the grid-plate terminals of the tube with a small capacity of a few micro-microfarads. Because of the high frequency upon which this circuit is intended to operate, a crystal is not incorporated in an oscillator circuit since the crystal would have to be very thin in order to oscillate at the required frequency. Some such tourmaline crystal exists but is not yet released to the public. It is therefore suggested that a piezo crystal be omitted from such a rig.

* * *

### Resistor Across Heater

WHAT IS THE purpose of the center-tapped resistor that is recommended in most circuits across the heater terminals of an a-c tube?—R.G.

The cathodes of heater type tubes, when operated from a-c, should be connected either to the mid-tap of the heater supply winding on the transformer used for that purpose or to the mid-tap of a 50 ohm resistor shunted across the winding. This practice results from the recommendation that no bias be applied between heater and cathode and that the potential difference between them be kept as low as possible to minimize hum in the circuit.

# *Dr. Goldsmith Probes the Radio Future*

Speaking through a tiny microphone no larger than a matchbox, fastened to his coat lapel, a device he described as "permitting one man to be heard above a multitude," Dr. Alfred N. Goldsmith, consulting engineer of the RCA Manufacturing Company, described and demonstrated some recent scientific developments to more than 400 guests of the Cleveland Chamber of Commerce, meeting in the Statler Hotel, Cleveland, Ohio.

The lapel microphone worn by Dr. Goldsmith utilizes the "velocity" principle of operation in which reproduction is obtained by the varying impact, or velocity of the human voice, on a sensitive metallic ribbon within the mechanism. With this device a public speaker can move about freely without impairing the quality of the sound.

### Touch, Taste, Smell, Maybe

Pointing out that we already hear and will eventually see by radio, Dr. Goldsmith suggested that in the remote future radio might appeal to man's other senses, such as touch, taste and smell. For example, he said, there was the possibility of transmitting three-dimensional replicas of objects in the studio through "teletactile broadcasting," so that a solid representation which "might even be touched as well as viewed could be sent into the home." "Telegustatory broadcasting," or the transmission of taste, might make it possible to "taste" a fine brand of coffee, for instance, by radio. The transmission of smells would perhaps be easier, he said, since the "telefactory" receiver need only spray into the air a duplicate of the odor transmitted. He emphasized, however, that these possibilities were now "only whimsical and remote imaginings."

To illustrate the remarkable progress which has been made in improving the quality of sound motion pictures, Dr. Goldsmith demonstrated for the first time in public a radically new system of high quality sound-on-film recording which according to the RCA Victor engineers who developed it will be the "motion picture sound of tomorrow," because it completely eliminates background hissing noises.

### His View of Television

Using a special film recording of a musical performance in the Radio City Music Hall in New York, Dr. Goldsmith called attention to the ability of the new system to reproduce the full definitions and shadings of all the instruments in the orchestra over the complete audible range of sound, as well as to the complete absence of hiss during the quieter portions of the music. With the new recording method, the sound waves are halved into two separate but symmetrical sound tracks, one negative and the other positive, automatically eliminating the unused portions of the sound track which is a necessary part of all existing sound-on-film systems.

Speaking of the development of facsimile picture transmission, or the transmission of "still" pictures by radio, Dr. Goldsmith said that ultimately facsimile transmission will become a public broadcasting service of great popularity. Any printed or pictorial material will, sooner or later, be capable of speedy transmission instantaneously into a multitude of homes provided with simple automatically functioning receiving equipment, he said.

While describing the steady and orderly development of television experimentally as amazing, Dr. Goldsmith felt it necessary to temper optimism with a note of restraint in discussing the future of television broadcasting. The problems of television extend beyond purely technical considerations of transmitter and receiver, he said. There is the tremendous economic problem of launching a nationwide television service, when the cost of connecting numerous broadcasting stations of only limited service range in a network is at present staggering.

Then there is the question of supplying almost overnight a demand for talent which will be pleasing to the eye as well as the ear in such quantities as would drain the available supply in Hollywood, for instance, in a very short time. Then there is the important question of who will pay for the high cost of putting this talent on the air, and whether commercial sponsors would be called upon to pay a substantial portion of the cost of a feature-film production for an hour's broadcasting. That these problems will be solved in time Dr. Goldsmith did not doubt, but it is evident, he said, that much must yet be accomplished in the interim.

# Station Sparks

**By Alice Remsen**

### IRENE RICH IN ANOTHER

IRENE RICH TOOK VERY KINDLY TO RADIO WORK. She likes it so much that now she has finished the series "Jewels of Enchantment," Miss Rich has inaugurated another series of original dramas, still under the sponsorship of Welch's Grape Juice. Each Friday at 8:00 p.m. over an NBC-WJZ network. . . . Josephine Gibson has returned to the air accompanied by Lois Miller and the Heinz organ in a new series of Hostess Counsel talks with musical backgrounds. Miss Gibson, who is also head of the home economics department of the H. J. Heinz Company, sponsor of the series, and Miss Miller, well-known organist, may be heard from the Heinz Kitchen in Pittsburgh, over an NBC-WJZ network, each Monday, Wednesday and Friday morning at ten o'clock. . . . An interesting program sponsored by the makers of Forhan's Toothpaste and Powder, is "Stories of the Black Chamber." It is a dramatic serial based on the experiences of Major Herbert O. Yardley, head of the American Cryptographic Bureau during the War. Jack Arthur, Paul Nugent, Walter Soderling and Helen Claire are featured in the series, which may be heard every Monday, Wednesday and Friday at 7:15 p.m. over an NBC-WEAF network. . . .

### RAY NOBLE QUALIFIES

Ray Noble, the English composer and conductor, who was not allowed to broadcast when he first came over, has joined the American Federation of Musicians, and will be heard some time in February on a new series of programs for the makers of Coty's perfumes. As a conductor and pianist, Ray Noble has directed orchestras in London, and enjoys an international reputation through the sale of his phonograph recordings. As a composer he has written both the words and music of such hits as "Goodnight, Sweetheart," "Love Is the Sweetest Thing," "The Very Thought of You" and dozens of others. In the United States for the past four months, he has spent most of his time since his arrival in this country in Hollywood writing songs for forthcoming pictures. He is the son of a distinguished English surgeon, a graduate of Cambridge University, and despite the fact that he has been prominent in musical circles for a number of years, still is only 28 years old. . . .

### MOTHER OF EIGHT CHILDREN HEADS NEW PROGRAM

Practical cookery and smart musical entertainment has been combined for the afternoon radio audience in Frances Lee Barton's new program over an NBC-WEAF coast-to-coast network on Fridays, at 2:30 p.m., E.S.T.

The Kitchen Party, as the new series is known, features the well-known cooking authority and a cast of popular musical entertainers, including Al and Lee Reiser, ace piano team; Jimmy Wilkinson, baritone; Warren Hull, musical comedy master of ceremonies, and others to be selected in weekly broadcasts from the NBC Radio City studios under the sponsorship of General Foods. . . .The mother of eight children, Frances Lee Barton has been broadcasting General Foods' Cooking School of the Air every Thursday morning for the past three years. Her long practical experience and her genuine interest in housewives' problems have made hundreds of thousands of radio friends for her, and have elicited countless letters which are largely responsible for her sponsor's decision to feature her on an augmented afternoon program over an enlarged network. . . .

### 3 OF A KIND—ALL GOOD

Henri Therien, one of the original members of Roxy's "Gang" has rejoined Roxy, and will once more be heard on the air over WABC, each Saturday at 8:00 p.m. . . . Also, Johnny Green is presenting a new singer with his dance band. Her name is Margery Logan, and she is a prominent society debutante. This is her first regular engagement on a network program, although she has done considerable night club work. . . . Jack Pearl, popular comedian of radio, stage and screen, will return to the air as the central figure of a new series of programs over the nationwide WABC-Columbia network sponsored by Frigidaire Corporation, refrigeration and air conditioning subsidiary of General Motors. The series, presenting the popular comic in an entirely new role, will be heard every Wednesday from 10:00 to 10:30 P.M., EST, beginning February 13. Pearl, who has long been identified as Baron Munchausen, will return to the microphone in the new character of Peter Pfeiffer. He will be assisted, as in the past, by Cliff Hall, familiarly known as "Sharlie." . . .

### TOURS AND BRADLEY, AMERICAN CITIZENS

Frank Tours, veteran theatrical musical director, is now the orchestral conductor of the "Gulf Headliners" programs over the WABC-Columbia network from 7:30 to 8:00 P.M., EST, each Sunday. Tours has replaced Oscar Bradley, who left for Hollywood to become musical director for Fox films, after winning renown for his musical support of Colonel Stoopnagle and Budd and of Will Rogers, who is currently featured on the "Headliners" broadcasts. This has been Bradley's first air series, having made his radio debut in October, when the programs came to the Columbia network. In addition to directing, Bradley was also heard in a speaking part with Stoopnagle and Budd, and his natural Oxford accent made him an excellent foil for the comedians. . . .

There is a remarkable parallel between the backgrounds of Frank Tours and his predecessor, Bradley. Both were born in England and studied at the Royal College of Music in London. Both came to America about 20 years ago, won fame as theatrical musical conductors, and are now American citizens. Tours came to America in 1912 and has conducted every Irving Berlin show on Broadway since "Watch Your Step" in 1914. He is currently conducting "The Great Waltz." As a composer he is best known for the long popular "Mother o' Mine." "Gulf Headliners" is his first major air series. He will be the third musical director for the series, and each of his predecessors, Al Goodman and Bradley, was taken from the theatrical pit and elevated to radio stardom. . . .

### PAGE BOY, COMIC GAME

To fill in those spare moments while not engaged in doing his regular job as page boy at the New York studios of WOR, Wilfred Lewis writes a weekly radio column for a Harlem publication which has a wide circulation in that area. . . . George Shackley, musical director of WOR, owns half the copyright and patent, together with William Glassmaker, on the new and hilariously funny book-game, "Fotofun." Shackley is a great practical joker and funster, and it is entirely in character that he should be one of the promoters of this game. It is a book of comic drawings of the gay nineties—all the characters without heads. The idea is for players to cut out heads from snapshots and paste them on the drawings. The results are amazing! . . .

### STUDIO NOTES

Sam Herman, NBC musician, is an artist with a paint brush as well as on the xylophone. He did the clever murals of radio stars in character that decorate the "play room" in the home of May Singhi Breen and Peter de Rose. . . . Jackie Heller was once a newsboy in Pittsburgh. . . . Ted di Corsia is looking for a publisher for his new novel. . . . Norman Cordon made his debut in opera, singing opposite Maria Jeritza in "La Tosca." . . . Louis Katzman was the first orchestra leader to make electrical transcriptions.

## Standard Committee Meets

For further discussion of tube standards, the RMA Tube Committee of the Engineering Division met at the Hotel New Yorker, Roger M. Wise, of Emporium, Pa., presiding.

Many radio and affiliated organizations have responded most favorably to the RMA invitations for the cooperative campaign to remove and reduce sources of radio interference. Dr. W. R. G. Baker, of Camden, N. J., chairman of the RMA Engineering Division, and Virgil M. Graham, of Rochester, N. Y., chairman of the Standards Section, with Dr. Alfred N. Goldsmith of New York, chairman of the organization committee on the interference project, are arranging detailed plans for consideration by the general industry committee on interference.

Proposed standards on radio power transformers are receiving the attention of RMA and NEMA standards committees. A draft of proposed transformer standards has been received from NEMA and submitted to the RMA for consideration.

## NOVEMBER 1934 EXPORTS

The November 1934 report of the Bureau of Foreign and Domestic Commerce of the U. S. Department of Commerce on radio exports records 77,844 receiving sets valued at $1,906,271; 602,928 tubes valued at $274,698; 18,235 speakers valued at $35,-171; receiving set components valued at $428,331; and other receiving set accessories valued at $49,647, together with transmitting sets, tubes and parts valued at $86,451.

## DR. ALEXANDERSON HONORED

Dr. Ernst F. W. Alexanderson, consulting engineer of the General Electric Company, noted for his contributions to radio, has been elected to membership in the Royal Academy of Science of Sweden. Among six other members of the society in the classification with Dr. Alexanderson, as foreign technical scientists, is Senatore Guglielmo Marconi.

## BRITISH PATENT DATA

Details of the British radio patent pool have been published by the Bureau of Foreign and Domestic Commerce of the U. S. Department of Commerce and will be supplied on written request to the Bureau. The British patent report details the various patents, the pool operation and the license plan directed by the Marconi Company.

# Acoustical Labyrinth Marks High-Fidelity Receiver

A new high-fidelity receiver, announced this year, boasts a development that cannot be found on other sets. That is an acoustical labyrinth. This high-sounding term means nothing more than a specially-designed tone chamber that eliminates cabinet cavity resonances, extends the bass frequency range, enables the bass speaker to reproduce large volume bass tones without distortion, and projects the sounds from the front of the cabinet only. In addition, there are included acoustic vanes that spread the sound uniformly for wide angle diffusion of sound.

This contrivance makes the speaker rather a bulky affair. When one listens to this latest product of faithful reproduction and contrasts it with the output of the pygmy, there can be no doubt in the mind of the listener as to which radio receiver is more desirable from all aspects.

This unit utilizes two speakers, one for the low frequencies and one for the high frequencies. The output of these two speakers is introduced into the labyrinth where it is combined in pleasing proportion in the cavity of the labyrinth that is constructed of sound insulating material. Thus, no reflections occur within the labyrinth and the tone therefrom is most effectively delivered to the auditor. The set is a Stromberg-Carlson.

(Continued from page 4)

cycles will be about 30 per cent., at 1000 cycles about 6.4 per cent., and so on as the frequency is increased.

Filters and special coupling transformers have been used which results in a comparatively flat response curve up to 5,000 cycles, but the power level is reduced approximately 35 decibels, which would necessitate additional amplification.

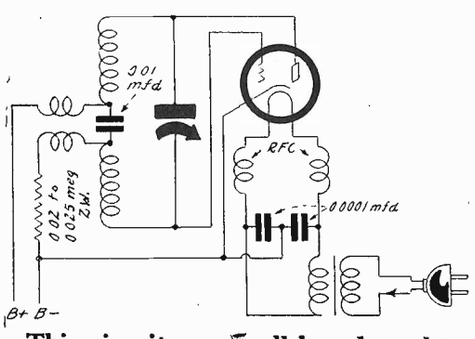
There are a great number of experiments and commercial uses where the cells are required to respond to light modulated at a constant frequency, say 60 cycles. Under such conditions, the cell will give an entirely satisfactory performance.

vanometers, or relays in connection with the Photronic cell the effect of the resistance of the meters must be considered. In most measurements it is desirable to have an approximately linear response, that is, when the current produced is directly proportional to the light intensity. To obtain this it is necessary to use an instrument of relatively low resistance, the value of which in turn depends upon the maximum intensity of illumination to be measured. For example, if the maximum illumination is, say, 250 foot-candles, a resistance of 200 ohms or less will be satisfactory. On the other hand if the maximum illumination is 5 foot-candles, then instrument resistances up to 1000 ohms or higher will give sufficiently linear response for practical purpose.

Relays usually require high torque to enable them to make reliable contact, and for this reason their resistances in general are considerably higher than in simple indicating instruments, and as a consequence, the action of a relay may depart considerably from a strictly linear relation, depending upon its resistance. This of course is not serious, but must be considered in the design of the equipment. In fact, in instruments having a definite full-scale range in light value, advantage is often taken of the non-linear characteristics of the cell with high external resistance, to increase the sensitivity for relatively low light values within the scale ranges. That is, the change in deflation per unit change in light value is greater in the lower part of the scale than in the upper part. When using high resistances however, consideration must be given to temperature errors which may occur as a result.

## A THOUGHT FOR THE WEEK

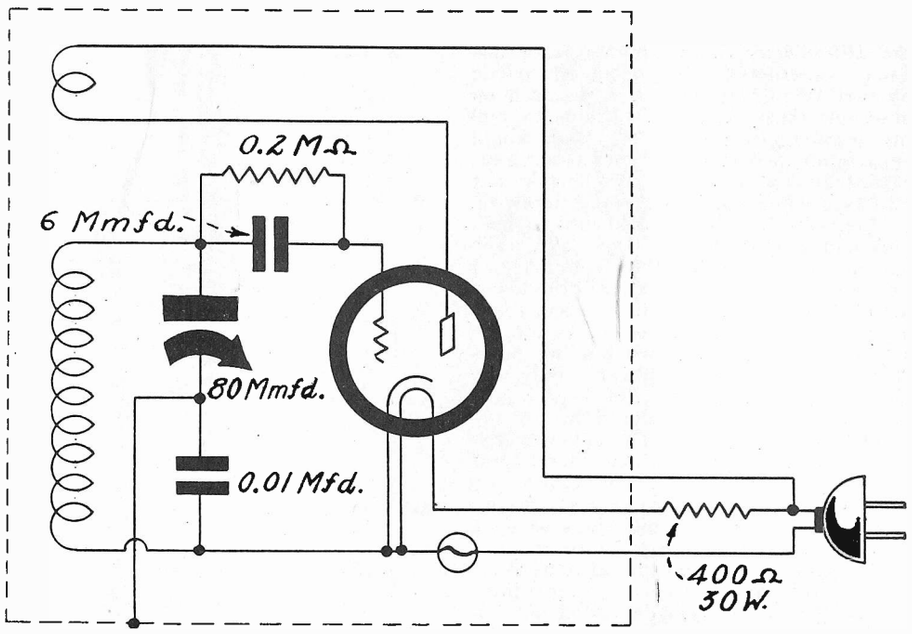
*"THE 'MARCH OF TIME" IS GOING RIGHT ON, for Remington Rand, Inc., has just signed a new contract for the continuation of this colorful series originally sponsored and produced by Time, the weekly news magazine. This will be good news for the listening public, for "The March of Time" has assuredly proved to be one of the real he-man air programs and unquestionably has set a new style in programs of this kind. Remington Rand, by the way, is said to have decided that while the program is an expensive one, it is worth more than its weight in typewriters.*




**This circuit may well be adapted to the purposes of ultra short wave transmission or reception.**

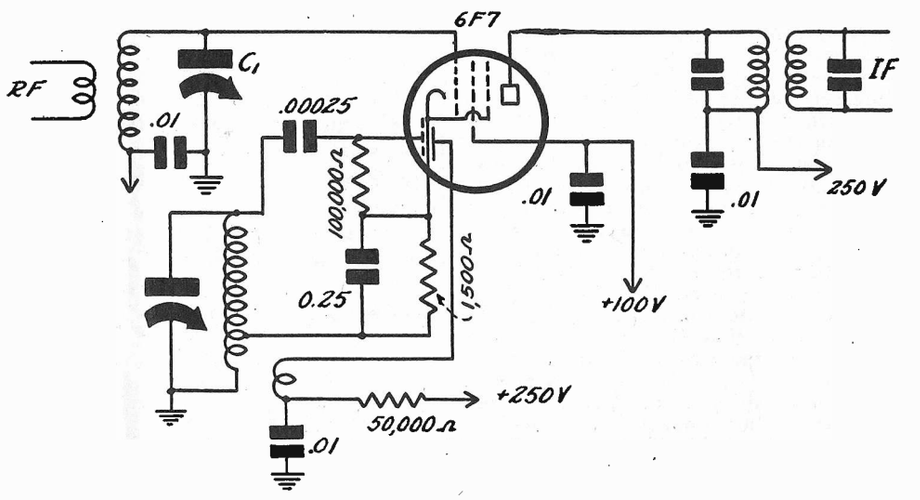
# Three Uses of Oscillators in Simple Circuits

## SIGNAL GENERATOR




**An oscillator that will generate radio-frequency oscillations that can be utilized for service work need not be a complicated affair, as the diagram shown above will prove. The use of a heater type 6.3-volt series tube is shown, 76 or 37.**

## DIODE-PENTODE IN MIXER




**The simplicity of the 6F7 in its connections is readily evident in this circuit diagram wherein a radio-frequency signal is mixed with the local oscillator signal to form the intermediate frequency signal.**

## FOR ULTRA FREQUENCIES

[See Circuit at Left]

# A Photo-Electric Relay

## Sensitive Device Needed for Control Switching

*By Nathan Perles*

AN ingeniously clever relay that is sensitive enough to operate on photo-electric currents and pluggable into the 110-volt a-c line for energizing has been constructed by our good friend Samuel Wein. His extended research on photo-electricity has caused him to feel the necessity of a good relay that would operate on such small currents as are generated by his cells and so a design that he has worked out is presented herewith.

This relay has been boxed into a small and handy case about 3" x 4" x 9". The outside appearance of the face panel of this device has been indicated in the lower sketch herewith. Here will be seen, reading from the top down, two jacks for the cell, the relay proper, two binding posts on the left for the a-c power supply, the potentiometer knob in the center and three binding posts on the right for the external control circuit. The upper sketch shows the manner in which these component parts are connected together.

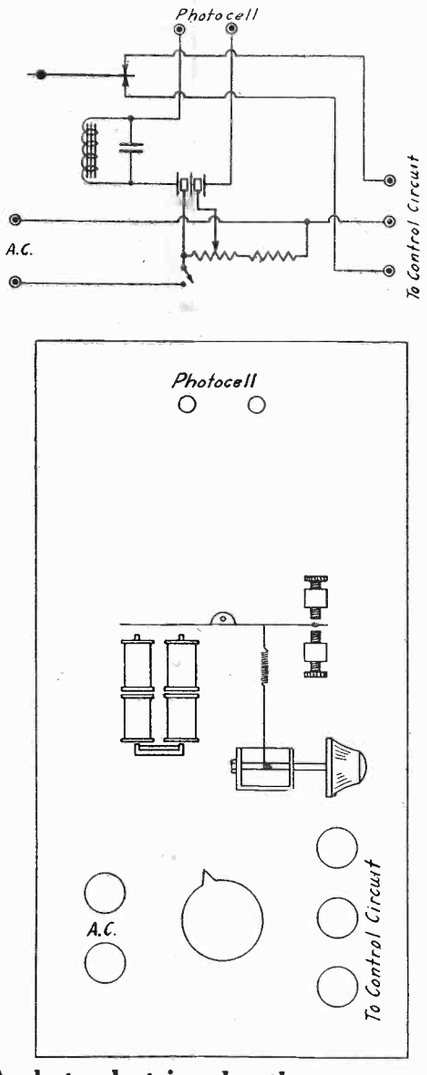
Designed as it was for very small currents on the order of a milliampere or so, it is important that the parts of this relay be made very light, especially the moving armature and the spring. Accordingly, the armature is made of sheet iron of about No. 26 gauge about ½" wide by 2½" long, pivoted at its center. The spring that holds it in normal, unenergized position is made of No. 30 phosphur bronze wire, the tension of which is controllable by means of the Bakelite knob shown in the sketch. By suitable adjustment of this knob, which controls the spring tension with wihch the armature is held in place, the minimum current necessary to operate this relay armature may be varied to suit the conditions of the particular operation to be performed.

### Polarity Important

The relay electromagnet is of more than passing interest since it is constructed of parts that are normally used for another very important purpose. That is for energizing headphones, for the coils of this electromagnet are really nothing more than the coils that one finds in the electromagnets of a pair of headphones or magnetic type of loudspeaker. Four of these coils are mounted upon a bar of soft iron of cross section comparable with the core section of these coils (about ⅛" x ¾") which is formed into a U shape. These coils are connected together in series, taking into consideration the fact that the connection should be reversed on one leg of the magnet from the connection on the other in order that the magnetism resulting from these coils be cumulative rather than negative, which would cause the absence rather than the presence of an electromagnetic field around this magnet

Of course, there are the usual tungsten or silver contacts mounted on the right-hand end of the armature wihch travels between two stationary contacts that lead to an external circuit to be controlled.

[Note: It is regretted that the circuit diagram contains an error that was noticed too late for correction in the drawing. This is that the armature should be connected to the wire that joins the upper binding post on the left side of the panel to the center binding of the three posts on the right side of the panel.]




**A photo electric relay that operates on alternating current in conjunction with the photoelectric relay. The top sketch shows the diagram of connections while the bottom shows a view of the panel of the box in which the apparatus is mounted. See note in text about correction of circuit diagram.**

The control knob that appears on the lower portion of the panel in the center represents the line voltage control that is fed to the electromagnetic coil circuit. It is a common type of volume control used in radio sets that is equipped with an on and off switch. In series with the volume control there is connected an additional fixed resistance for the purpose of limiting the current to a safe value for the minimum position of the volume control. By a variation of the volume control knob a suitable voltage can be impressed upon the cell circuit.

Since the cell and relay circuit must be furnished with a direct current, this device includes a neat little rectifier of the copper oxide type, specially constructed for this purpose by Mr. Wein. It is surprisingly small, as the plates measure 3/16ths of an inch square. This rectifier is, of course, connected in series with the relay coil and cell and across the potentiometer. Thus, a small d-c potential is introduced into the cell-relay circuit. Since there exists somewhat of a ripple in this rectified voltage, a condenser of about 0.5 mfd. is shunted across the relay coil to smooth out these pulsations.

To operate this device, the first step is to insert a selenium cell in the two upper jacks, then connect the two left hand terminals to a 110-volt a-c power line and the three right-hand terminals to the external circuit to be controlled. The potentiometer should be in such a position that there is zero voltage in the cell circuit or minimum resistance across the rectifier. The potentiometer control knob may then be varied until the relay armature moves for the conditions of light that the operator desires it to move. When the potentiometer adjustment has once been made, it is not necessary to reset it for the same operation.

The three terminals on the right hand side of the panel offer the operator a choice of two types of control of the external circuit, either that of opening or closing. If the external circuit is connected between the center terminal and the upper terminal, the external circuit would be closed when the electromagnet becomes energized as controlled by the amount of light that strikes the selenium cell. On the other hand, if the external circuit is connected between the center terminal and the lower terminal, the external circuit would be opened when the electromagnet becomes energized as controlled by the amount of light that strikes the selenium cell. Or, the operator may avail himself of the combination to result in the simultaneous opening and closing of two independent external circuits.

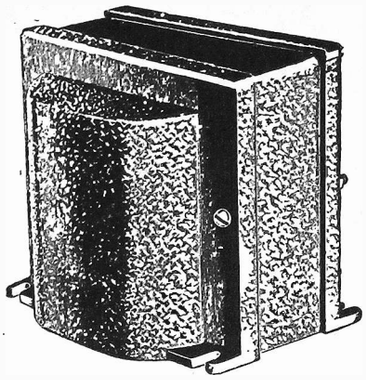
### Lighting Control

One of the most common applications of this device is for the automatic control of lighting. By its agency, it is possible to cause the lights in the home, office, store or factory to go on automatically as soon as the daylight reaches a predetermined minimum due to the setting of the sun or of the sudden appearance of a thunderstorm which materially obscures the sun, especially in midsummer.

Some persons will say that this is a lazy man's device that will make him lazier since it frees him from a daily task. On the contrary, we believe that this device is more for the man that is not lazy since he is always doing something that occupies his mind to the extent that he does not notice when the darkness incurred by twilight has set in and he works on, oblivious of the fact that he is harming his eyes. With this device, he need not maintain a mind that constantly should remember that the lights have to be put on The lazy man is hardly ever doing anything and so is readily conscious of the absence of light when the sun's rays disappear, and he needs this device less as a result. Of course, it cannot be denied that the lazy man also benefits from this contrivance. But, is this a disadvantage?

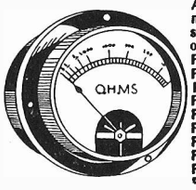
# GIFTS FOR YOU

## Heavy-Duty Power Transformer



WHY overwork a power transformer, run it hot, get poor results? Here is a power transformer that can be used for any set up to 18 tubes, and with good enough regulation even for Class B. It takes care of 2.5-volt tubes (up to fourteen of them), also one or two 2.5 volt output tubes, whether 2A5s, 47's, 2A3's, etc., and a 5-volt rectifier. Besides, it has a 25-volt winding at 0.6 ampere, so that if you want a second rectifier in a set you may introduce the a-c line voltage to a 25Z5 and take care of the heater from the 25-volt winding. Or, if you want to use four 6.3-volt tubes in series, from this 25-volt feed, you may do so, or even another four such tubes in series, connected in parallel with the other four. There is no other transformer on the market that affords this great versatility.
Primary = 115 volts, 60 cycles.
Secondary X = 14 amps at 2.5 volts, center-tapped.
Secondary Y = 6 amps at 2.5 volts, center-tapped.
Secondary HV = 200 ma at 400-0-400 v. a.c.
Lug terminals are at bottom. Connection code furnished with each transformer. Shipping weight 13 lbs. Sent express collect on receipt of $7.00 for 60 weeks subscription for RADIO WORLD (60 issues, one each week). Order P-1012. Remit with order and ask for NP-1012.

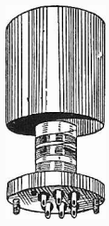
## Wide Range of Meters




Any one of these d-c meters free with a $1.50 subscription (13 issues, one each week).
P-1020—0-6 v.
P-1021—0-50 v.
P-1022—6 v. charge tester
P-1023—0-10 amp.
P-1024—0-25 ma
P-1025—0-50 ma
P-1026—0-100 ma
P-1027—0-300 ma
P-1028—0-400 ma
P-1029—0-3-0 v.

If there is any particular meter you desire, and it is not listed, write in for a subscription proposition. In fact, if there is anything in radio that you want as a premium, we will be glad to make you an offer. Write to Premium Editor, Radio World, 145 West 45th Street, New York, N. Y.

## Precision Tuning Coils



These coils may be used with condensers of from 0.00035 mfd. maximum to 0.0004 mfd. maximum. The inductances of coils are maintained equal by winding them to an identical axial length, spacing the end turns to accomplish this. The tuning is from 540 to 1,600 kc and from 1,620 to 4,800 kc. To utilize the police band, switching is necessary.
Three equal coils for t-r-f set (for use with three-gang condenser). Remit $2.00 for 16 weeks subscription (16 issues) and order P-1030 sent postpaid.
Four equal coils for t-r-f set (for use with four-gang condenser). Remit $2.50 for 20 weeks subscription and order P-1031 sent postpaid.
Two equal coils and one oscillator coil for superheterodyne at 175 kc i.f., (requires three-gang condenser). Remit $2.00 for 16 weeks subscription, order P-1032, and three coils will be sent postpaid.
Same as directly above, except for 465 kc i.f. Order P-1033.
Three equal coils and one oscillator coil for 465 kc. i.f. (for a four-gang condenser). Remit $2.50 for 20 weeks subscription and ask for P-1034. Four coils will be sent postpaid. For 175 kc order P-1034-175.
Three doubly-tuned i.f. coils, 465 kc, in aluminum shields. Remit $6.00 for one-year subscription (52 issues), and order P-1036 sent postpaid
Same as directly above, only for 175 kc. Ask for P-1035.

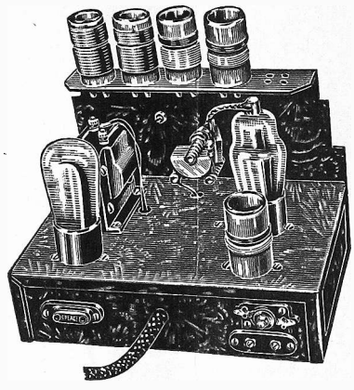
## Signal Generator Parts

Tuning condenser, two coils, two precision fixed condensers, frequency-calibrated disc dial, 3-pole -four throw switch, knob, two escutcheons, for 83-100 kc, 140-500 kc, 540-1,600 kc, 1,620-4,800 kc, all on fundamentals. Wavelength calibration also is in scale for the low frequency band. These parts comprise the foundation unit for the 333-A Signal Generator. Diagram included in offer. Remit $12 for two-year subscription (104 issues) and ask for P-1037 sent postpaid.

**RADIO WORLD**
145 West 45th Street, New York, N. Y.

# *World-Famous*
# SHORT-WAVE PRODUCTS

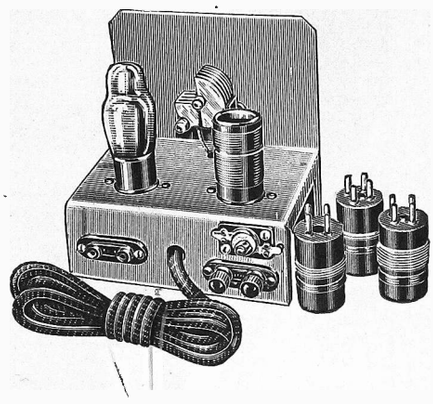
## "COSMAN TWO"



Battery operated S. W. receiver. Novel rack permits placing of five coils in proper band order—no groping for coils. Efficient design permits tuning from 15 to 200 meters. The regular broadcast band can be tuned with a broadcast coil (200 to 550 meters) at additional cost of 39c. Uses a 232 and 233 tube.

**Kit of parts.....$5.95**
**Wired and tested ..... 1.50 extra**
**Set of RCA licensed tubes..... 1.40**

## "DUO WONDER"



2-in-1 short wave receiver. Features the new type "19" tube. Supplied with coils to cover the entire wave band, without any gaps whatsoever, from 15 to 200 meters. A fifth coil, covering the broadcast band (200-550 meters) supplied for 39c additional.

**Kit of parts .....$4.95**
**Wired and tested..... 1.00 extra**
**RCA licensed '19 tube..... .60**

**RELIABLE RADIO CO., 145 W. 45th St., New York**

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Congress recently enacted a law making it compulsory for postmasters to charge publishers two cents for every change of address filed with the post office.
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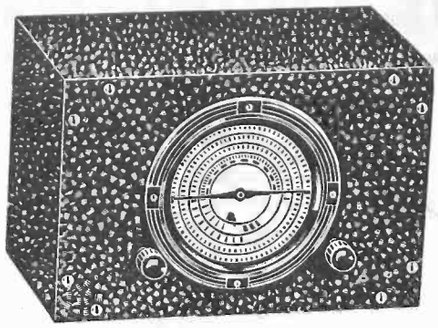
**RADIO WORLD. 145 West 45th Street, New York. (Just East of Broadway)**

# AN ALL-WAVE SIGNAL GENERATOR

## OF THREE TIMES USUAL ACCURACY, AT ONE-HALF THE PRICE!



## MODEL 339 ONLY $16.00

THE new 339 Signal Generator, designed by Herman Bernard, operates on fundamentals from 54 to 17,000 kc, 5500 to 18 meters, on a.c. or d.c., with modulation option in either use, and sells at approximately half the price of equivalent instruments. Bands are shifted by a front panel rotary switch.

One of the outstanding features of the 339 is the vernier airplane dial. This has direct-reading scale both in frequencies and wavelengths and is of the decimal-repeating type, a now invention of Mr. Bernard. Thus the top scale, in frequencies, is 54 to 170 kc. The lower scale in frequencies is 170 to 540 kc. The other bands are read as 10 or 100 times these frequencies.

### Answers in Wavelengths, Too

As wavelengths are calibrated on the dial, too, division by the same factors, applied to the wavelength scales that adjoin the frequency scales, gives the answer in wavelengths. Bernard signal generators are the only ones that yield determinations both in frequencies and wavelengths.

The dial is 3.5 inches in diameter and has a double pointer enabling close readings. The decimal repeating dial itself enables close readings because the circumference of scales is not diminished for succeeding bands. The 54 to 170 kc scale has gradations in spaces of only 1 kc. Thus for the broadcast band, 540 to 1700 kc, 10 kc separation prevails. The 170 to 540 kc scale has gradations in 1 kc from 170 to 200 kc, and bars separated by 5 kc for 200 to 540 kc.

Coincidence of generated frequency and scale reading is very close. Never is the accuracy less than 1 per cent., and for most settings there is no observable difference between the true frequency and the read frequency. This high order of accuracy obtains in no other instrument, selling at less than three times the cost of the 339.

### Why 339 is Best Choice

Many, no doubt, have been somewhat confused by the numerous types of signal generators, but will note that the best of them cover wide ranges on fundamentals, have an attenuator, and permit of presence or absence of modulation. Also they have a vernier dial and are direct-reading in frequencies, accurate to at least 3 per cent. The 339 has all these advantages, besides affording wavelength determinations as well, and operation on 90-125 volts a.c. (any commercial frequency) or d.c. And the accuracy is three times as great. Moreover, the 339 is well built, for lifetime use, and covers all waves fundamentally, besides permitting measurements of frequencies up to 100 mgc (down to 3 meters) by resort to a slight calculation method, applying a simplified harmonic system to the 5,400 to 17,000 kc fundamental band.

The 339 has a 37 rectifier tube, so that d.c. is used on the plate. Modulation is provided by a neon tube relaxation oscillator at a frequency of about 1,000 cycles. Limiting resistor for the tube heaters is built into the a-c cable assembly for maximum heat dissipation.

### Lowest Prices for Precision Products

By insulation of the oscillator and rectifier systems from the shield cabinet, danger of line shorting is removed and grounding the cabinet becomes practical. Output and ground posts are provided.

Model 339, wired, calibrated, adjusted, complete with three tubes, ready to operate; instructions (shipping weight, 5 lbs.) ..... **$16.00**

Model 339-K, complete kit, cabinet, instructions, everything except tubes (shipping weight, 5 lbs.) ... **12.50**

Model 339-FC, Founadtion Unit, consisting of dial, tuning condenser, five coils, instructions (shipping weight, 2 lbs.) ..... **5.45**

Model 339-LK, a-c line cord with limiting resistor built in (sent postpaid at this price in U. S., Canada, Mexico) ..... **.65**

### USES FOR THE 339

The primary purpose of the 339 is to enable lining up radio receivers at intermediate-frequency and station-carrier-frequency levels. The generator emits the desired radio frequency, accompanied or unaccompanied by a superimposed sound, as desired (switch controlled). The sound is generally useful when the indicator consists of speaker or earphones.

Also, the 339 serves as a frequency and wavelength meter for all stations, 54 kc to 17,000 kc, when the 339 is used in conjunction with a receiver. Not only is the 339 a station finder, but also a device for measuring the frequency and wavelength of the station. Hence listeners may use the 339 to advantage with their all-wave sets, without any molestation whatever of the receiver or its wiring.

The 339 has three knobs, instead of two shown.

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# FREE with a $1.00 8-weeks Subscription

### NEW STAR MIDGET CONDENSERS

Choice of 15 and 25 mmfd. maximum. Single hole panel mount.

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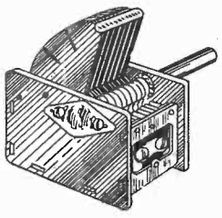
145 West 45th St., New York City

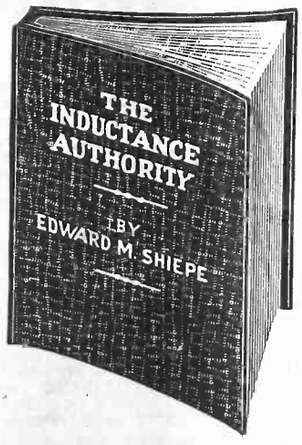
# TUNING UNIT FOR TEST OSCILLATOR





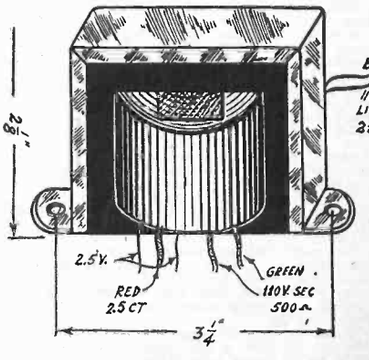
HERE is your very first opportunity to get the parts for constructing a universal, modulated test oscillator to cover fundamentals from 135 to 380 kc, and read higher intermediate frequencies and the entire broadcast band, by harmonics, all imprinted right on the dial. That is, the oscillator will be direct frequency-reading. The parts consist of one metal-etched scale, one metal escutheon, one 0.000406 tuning condenser with trimmer built in, one oscillation transformer (secondary inductance accurate to 0.1 per cent.), and one knob for condenser. Circuit diagram supplied for universal model modulated test oscillator (90-120 volts a.c., d.c. or batteries, same oscillator works on all three). Instruction sheet for lining up at broadcast and intermediate frequencies included. Line up the oscillator with one adjustment on broadcast band, beating with some station on 1,200 to 1,400 kc. Whole dial then will track. Order PRE-TUTO and send $6.00 for one-year subscription for (52 issues). Sent postage prepaid.

## VITAL BOOK




The biggest help any one can get who desires to wind radio-frequency coils for any frequency from just below the audio range to the fringe of ultra frequencies is to have a book that tells just what inductance is required for the condenser one possesses, and just how many turns of any kind of wire on any sensible diameter are needed to produce that inductance. "The Inductance Authority," by Edward M. Shiepe, gives you just that information, to an accuracy of 0.1 per cent. Send $4.00 for an eight-months subscription (39 issues) and order PRE-IA sent postpaid.

### Small Power Transformer




**POWER TRANSFORMER**

Primary—105-130 volts.
Secondary A-2.5 volts, center-tapped.
Secondary B-110 volts, no center tap.

Splendid for powering a-c test oscillator or any other rectifier for not more than three small tubes.

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